

Chapter 12

TECHNICAL SPECIFICATION FOR ELECTRICAL LT, HT AND ALLIED WORKS

I. GENERAL

1.0 ELECTRICAL SYSTEM DETAILS

Incoming Voltage	-	11KV, 3Ph, 50Hz A.C Supply Earthed System
Operating Voltage for Power	-	433 V 3 Phases, 4 Wire
Operating Voltage for Lighting-		240V, 1 Phase, AC

2.0 SCOPE OF WORK

The scope of work covered by this Tender shall include Supply, Installation, Testing and Commissioning of the following:

The Scope of Work shall also include transportation of all material to site, unloading, safe keeping, storage and leading to site for installation.

It is the contractor's sole responsibilities to obtain all permits and statutory approvals from Governments.

3.0 BRIEF DESCRIPTION OF SCOPE OF WORK:

Design, Supply, Installation, Testing, Commissioning, Operation and Maintenance of the following:

1. 11KV XLPE HT Cable from Proposed TNEB RMG to Proposed Outdoor HT Single VCB Panel and 1 No. 400KVA, 33KV/415Oil type Transformers
2. Outdoor Single VCB Panel, installation of Transformers
3. Single Front, Draw out type, Cubicle, Floor mounting type and Single Busbar arrangement Main Power Control Centre with PLC controls at Sub-station Building and Various LT Panel Boards
4. LT – XLPE (FRLS) armoured cable and PVC armoured (FRLS) cable from MPCC to Various Panel boards, Fire Hydrants, AC Equipments, From Panel boards to Power and lighting Distribution Boards, Fire pumps & water pumps and Equipments etc.,
5. Cable trays of various sizes for cable laying suitably fixed to ceiling / wall inside the premises.
6. Supply and fixing of Light fittings with suitable fixing accessories as specified in BOQ.

7. Wiring in conduit for various light fittings / plug points etc as specified in BOQ.
8. Earthing of all the Substation equipments, MV panel, sub switch boards, distribution boards, control switches, busduct etc. and Separate Earthing System for UPS and connected works.
9. Wiring in conduit for various Power plug points etc., as specified in BOQ
10. External Lighting arrangements for Parking area, Roads, Focus lighting including cabling, lighting poles etc., as specified in BOQ.
11. Starters, Isolators and cabling works for AHUs, fresh air fans, Pantry exhaust, toilet exhaust and Lift shaft fresh air fans etc as specified in BOQ.
12. Ventilation arrangements for HT/LT panel room and Floor Electrical Rooms.
13. Power, Lighting & UPS Sub Panels and rising mains with adaptor boxes..
14. Preparation of drawings, submission to the Electrical Inspectorate Authorities of Government and obtaining approval, arranging inspection after completion of work and obtaining Safety Certificate etc., Necessary statutory fees will be paid by the contractor against Demand Notice and the amount will be reimburse by the client
15. Obtaining electrical load sanctions from State Electricity Board with necessary follow-up, obtaining service connection and energizes the entire installation.
16. The statutory fees payable to the Electrical Inspectorate Authorities / State Electricity Board will be paid by the contractor against Demand Notice and the amount will be reimburse by the client
17. The Client will render necessary assistance to the successful tenderers in the form of furnishing letter and documents for obtaining the above approval from statutory authorities. But the responsibility for obtaining the above approvals including arrangements for inspection etc. is with the tenderers. The necessary statutory fees will be paid by the contractor against Demand Notice and the amount will be reimburse by the client
18. Necessary minor civil works required for execution of works such as Installation of Transformer, HT panel boards, MPCC panel, Sub Panels, Wall mounting DBs, Cable trays etc. shall be included under the scope of electrical agency.
19. Chipping breaking grouting and making good of damaged civil works for cable trays, conduit pipes etc.

20. Construction of earth pits with heavy duty RCC slab/CI Cover for cover to suit heavy vehicle movements.
21. Automatic Power Factor Correction relay Capacitor Panels and Fixed capacitor panels with as given in the BOQ
22. DOL and Star-Delta Starters for Electrical equipments as specified in the BOQ
23. Push Button stations and Control cabling.
24. Termination of cables at equipment end for equipments supplied by others.
25. Providing UPS sockets and raw power sockets for work station, Meeting room etc
26. Providing UPS supply for computers, servers, Labs and emergency lighting.
27. Earth mat provision thro' antistatic flooring if required
28. Rubber mats to be provided in front of all electrical panels and backside of the panel if access is required.
29. SLD's of each panel and Main SLD's in HT Room & MV Panel Rooms to be displayed as required.
30. First aid boxes to be fixed and First aid charts in English, Hindi & Local Language to be displayed as required.
31. All the Displays shall be of laminated card boards suitable for wall mounted type.

4.0 SPECIFIC INCLUSIONS:

- Hot dipped GI Cable tray, bends, couplers, down rod supports, provision of Anchor fasteners, wherever required
- Epoxy painted steel angles and channel support for cable trays with proper earthing at equal intervals will be paid in separate line item.
- Steel support channels for panels / DBs.
- Excavation of pits for earth electrode, Construction of earth pits including masonry and covers as per IS 3043 standards
- Provision of pipe sleeves for cables and earth bus
- Chipping, Breaking and making good the damaged portion of civil works
- Calibration & Testing of all protective relays, meters & other measuring and Protective devices as specified in testing requirements

- Co-operation / Co-ordination for testing and commissioning with other suppliers
- Obtain drawing approval from necessary authorities, arrange inspection and obtain safety certificate for entire installation.
- Submission of 6 (six) copies of As Built Drawings, Documents and maintenance manuals
- Epoxy / Zinc rich painting, wherever required
- Preparation of working drawings, drawings for CEIG submission
- Power Supply during installation.
- Inspection charges for Transformer, HT panel and critical equipments

5.0 CHIEF ELECTRICAL INSPECTOR TO GOVT'S APPROVAL

The preliminary physical layout and schematic drawings and site plan will be furnished by the Architects.

It is the responsibility of the contractor to prepare all detailed working drawings required for erection and by Chief Electrical Inspector and obtain his approval. The contractor has to arrange for site inspection and get safety certificate to commission the installation for the entire scope of work carried out by him.

The inspection fee and drawing approval fee payable to the Electrical Inspector's office will be paid by the Contractor whose rates shall be inclusive of all such expenses.

6.0 ALTERATION OF WORK

If during inspection by Electrical Inspector, any defects are pointed out either on equipment supplied by the contractor or on the workmanship, the Contractor shall replace / repair the equipment and redo the work as per Electrical Inspector's requirements without any extra cost.

7.0 STATUTORY REGULATION

Contractor's License

The contractor shall hold valid contractor's license issued by competent authority of Government for carrying out the work covered in this tender.

Special condition to the contractors:**Shop Drawings / Co-ordination Drawings**

The Contractor shall arrange for detailed shop drawings / fabrication drawings and material specifications for specialized works including detailed design calculation and submit required copies each of the same for Client / Architect's prior approval. All shop drawings shall reflect the design intent as provided in the execution drawings and shall not be deviated without prior permission. The shop drawings shall be based on the actual site conditions and shall take into account all coordination as may be required in order to avoid any clash or interference with other service lines or any other building features. The shop drawings shall be fully supported by necessary design calculations wherever applicable or as directed by the Architect to the Contractors. Such design calculations shall be carried out by a competent agency and shall also comply with relevant Indian / International standards as applicable. Wherever so required, the Client reserves the right to demand a certificate as to the correctness of the design to be issued after verification by an independent proof checking agency that the Client may either approve or nominate.

All charges for preparing the shop drawings, coordination drawings, preparation of design, getting the same proof checked including carrying out any other modifications as necessary shall be fully covered in the quoted rates and no extra shall be payable for adherence of the above requirement.

As executed drawing shall be submitted within one month of completion of entire work. Copies of each of such built in drawings shall be submitted to the Client / Architects. The final version thereof submitted in hard copy format in triplicate as well as electronic format in AutoCAD latest Release as on date (not less than 2007)

II. GENERAL SPECIFICATION FOR RING MAIN SWITCHGEAR

11kV, 630A , 25 kA, Outdoor Ring Main Switchgear compressing 11kV, 630A, 25kA Vacuum Circuit Breaker

Construction Features:

Ring main switchgears shall be constructed of MS sheet steel not less than of 3mm for load bearing members and 2 mm for Non-load bearing members. The ring main switchgear shall be provided with a separate for main busbar, VCB / CT / PT / metering / relay chambers and cable termination. The ring main gear shall be of factory built assembly to high quality standard and shall comply with IS 3247. Panel shall be provided with pressure relief flap at top. Each panel shall have minimum 2 Nos. of lifting hooks at top for easy transportation. Panel shall be provided with 3mm aluminum gland plate at the rear with adequate clearance between the cable terminations. Each panel shall be fully segregated with a sheet steel and busbars through seal of bushing to avoid transfer of oxidation and carbonize during fire accident, if any. The Ring Main Switchgear shall be suitable for degree of protection for OUTDOOR. Ring Main Switchgear shall be finished with Light Grey to shade 631 of IS5, after undergoing a pre-treatment at 7-tank process.

Busbars:

Electrolytic Grade Copper Busbar shall be used as Main Busbar and interconnections. Busbar shall have uniform cross section throughout the Ring Main Switchgear. Busbar is provided with a heat shrinkable PVC sleeve. Color coding as per IS shall be made at regular intervals. The maximum current density of the busbars shall be 1.0A per Sq mm.

VACUUM CIRCUIT BREAKER:

Vacuum Circuit Breakers shall be robust and rigidly constructed, mounted on a wheel, with horizontal draw out and horizontal isolation mechanism. The mechanism shall be of spring charged stored energy type. The mechanism shall be simple, rigid and so constructed; it shall be suitable for both mechanical and electrical spring charging operations. The Vacuum Interrupters shall be of high quality standards. Vacuum Interrupters can withstand 100 operations under short circuit conditions. The

interrupters are mounted on epoxy housing to prevent the accidental damages. The spring charging motor shall be suitable for either 110/230V AC and closing & tripping coil shall be 110V DC. The power for closing, tripping & indicating circuits shall be derived from the potential transformer mounted on the RMG.

The VCB shall also have the following:

- 1) 4 NO+4NC auxiliary switch
- 2) Mechanical ON/OFF indication
- 3) Mechanical spring charge position indication
- 4) Mechanical operation counter
- 5) Pumping Anti feature
- 6) Manual / Motor operated spring charging mechanism
- 7) Mechanical ON/OFF Push Buttons
- 8) Automatic Safety shutters and push button
- 9) Self-Aligned plug in contacts:

The secondary contacts shall be self-aligned type, hence no need of manual plugging required during racking/withdrawal of VCBs. VCB can be operated manually through the push buttons both in test/service position without opening the front door. Safety shutters are designed in such a way avoid accidental touch during maintenance.

THE VCB TRUCKS SHALL HAVE THE FOLLOWING INTERLOCKS:

1. Front door cannot be opened, when the VCB is in Service position
2. VCB cannot be withdrawn from service position when it in “ON” condition.
3. VCB can be switched “ON”, only either in test or Service position
4. In Service Position, both Power and secondary contacts are engaged and in Test Position, Power Contacts are isolated and secondary contacts are engaged.

TECHNICAL SPECIFICATION FOR VCB:

Rated Voltage	: 11KV + 10%
Rated Current	: 630Amps
No. of Pole	: 3
Breaking capacity	: 25KA
Making capacity	: 65KA Peak
Short circuit withstanding capacity	: 25KA for 3 sec. A 12KV

Operating duty	: O-3MIN-CO-3Min-CO
Insulation level	
a) Power frequency	: 70KV rms for 1 Min.
b) Impulse	: 170KV Peak
Standards	: IS 13118/IEC56

CURRENT TRANSFORMERS:

Current Transformers are Epoxy Resin cast, dual core dual ratio type and shall comply as per IS 2705.

POTENTIAL TRANSFORMERS:

Potential Transformers are Epoxy Resin cast Draw-out type and shall comply as per IS 3516.

PROTECTION RELAYS:

Relays are of Flush Mounted Draw-out type pattern fully Comply as per IS 3231. All other Instruments/Switches and Wires & Cables shall comply with the latest IS.

BILL OF MATERIALS:

Outdoor floor mounting, free standing, dust & vermin proof Metal Clad type 11KV 630A, RING MAIN GEAR SHALL CONSIST OF:

INCOMER (2 SOURCES): 2NOS.

Each incoming panel of Vacuum circuit breaker comprising of:

- 11kV 630A, 350MVA, Air/Load break switch with Earth switch, with 2NO+2NC Aux. Contact, Spring charged mechanism Manually operated -1 set consists of:
- 1 No. Manual spring charging mechanism.
- 1 No. Mechanically interlocked earth switch.
- 3 Nos. 630A Vacuum Interrupters
- Manual / Electrically operated spring charging mechanism (Motor rated for 110/230V AC)
- Closing coil suitable for 110V DC.
- Tripping coil suitable for 110V DC.

- 2NO+2NC Auxiliary Switch
- Mechanical On/Off indication.
- Mechanical spring closing indication.
- Mechanical On/Off Push button
- Breaker Position indicator
- Mechanical operating counter.
- Automatic safety shutters.
- Secondary self-aligned plug in contacts.
- Anti-pumping feature.
- 1 No. TNC Switch
- 1 set. Tamper proof R/Y/B Phase indication lamps
- 1 set. On/Off/Trip indication lamps.
- 1 No. Trip circuit healthy indicating lamp with push button.
- 1 No. Motor spring charging mechanism indicating lamp.
- 1 No. Emergency off Push Button.
- 1 No. Power pack suitable for 110V DC with continuous and stored energy.
- 1 No. Test terminal block.
- 1 set. Power terminals suitable to receive XLPE cables without termination kit.
- Thermostat
- Space heater 230V/80W
- Compact fluorescent lamp
- Busbar phase to phase clearance not less than 356mm and phase to earth clearance not less than 320mm

OUTGOING: 1NO.

11 KV 630A, 25kA VCB Outgoing Panel Comprising of:

1No. 11KV, 630A, 25kA Horizontal draw out / Horizontal isolation Vacuum Circuit Breaker consists of:

- 3 Nos. 630A Vacuum Interrupters
- Manual / Electrically operated spring charging mechanism (Motor rated for 110/230V AC)
- Closing coil suitable for 110V DC.
- Tripping coil suitable for 110V DC.

- 4NO+4NC Auxiliary Switch
- Mechanical On/Off indication.
- Mechanical spring closing indication.
- Mechanical On/Off Push button
- Breaker Position indicator
- Mechanical operating counter.
- Automatic safety shutters.
- Secondary self-aligned plug in contacts.
- Anti-pumping feature.
- Three Phase, Resin Cast, Dry type, Draw out PT with HT/LT fuses of ratio (11kV/1.732)/(110V/1.732), Core 1:Cl. 0.2 30VA
- single phase, Resin Cast, Dry Type Current Transformer of suitable Ratio /5-5A, Core 1: Cl. 0.2s / 5VA for metering, Core 2: Cl. 5P20 / 5VA for protection
- Master Trip Relay.
- Electromechanical type Triple-pole Non-Directional, IDMT, 2O/C + 1E/F with Highset with 1.3 Sec, CDG 61
- Master trip Relay VAJH 13
- Analog Ammeter with 5 Position selector switch
- Analog Voltmeter with selector switch
- Cutout Provision for Digital Trivector Meter L & T (or) Secure Make
- Cutout Provision for Digital Trivector Meter L & T (or) Secure Make
- 1 set. Tamper proof R/Y/B Phase indication lamps
- 1 set. On/Off/Trip indication lamps.
- 1 No. Trip circuit healthy indicating lamp with push button.
- 1 No. Motor spring charging mechanism indicating lamp.
- 1 No. Emergency off Push Button.
- Trip circuit healthy indication lamp
- 1 No. Power pack suitable for 110V DC with continuous and stored energy.
- 1 No. Test terminal block.
- 1 set. Power terminals suitable to receive XLPE cables without termination kit.
- Thermostat
- Space heater 230V/80W

- Compact fluorescent lamp
- Main Bus: 630 Amps Copper Busbar with HT Sleeve insulation -1 set
- Control Wiring -1 set
- Heater ON/OFF switch with filament type 80W space heater and thermostat, Single phase switch with socket, Cubicle illumination lamp, Door limit switch, MCBs / Fuses for AC / DC Control - 1 set
- Auxiliary DC Power Source - 230V AC to 110V DC
- Enclosure
- MS Sheet steel suitable for Outdoor Installation Powder Coated with Siemens Grey Paint finish - 1 set
- Termination
- Incoming (Excluding cable termination kits, lugs and glands) Bus Bar Bottom entry
- Outgoing (Excluding cable termination kits, lugs and glands) Bottom entry

Note:

1. ***The panel shall be manufactured as required by the TNEB authorities and approval shall be obtained including commissioning.***
2. ***Any additional features required by the authorities shall be carried out at no extra cost.***

III. TECHNICAL SPECIFICATION FOR 11KV , 25KV 630A , OUTDOOR TYPE HT SINGLE VCB PANEL

1.0 Scope:

This specification covers the design, manufacture, testing, packing and supply of MV Outdoor Air Insulated draw-out type switchgear panels (Switchboards) upto 12 KV, incorporating Vacuum Circuit Breaker including extensible for future HT Panel complete with all accessories for efficient and trouble free operation. The switchboard shall be new which will be specifically manufactured against the enclosed detailed specification and the Single Line Diagram enclosed herewith.

The equipment offered under this specification shall be of proven design by way of commercial operation for 3 years.

TECHNICAL SPECIFICATION

Vacuum Circuit Breaker

11kV, 630A, 25KA Horizontal Draw out/isolation VCB fitted with Manual/Motor operated spring charging mechanism with 230V AC motor and motor control switch, shunt trip coil of 110V DC, closing coil of 110V DC, Auxiliary Contact 4NO+4NC, Mechanical ON/OFF indicator, mechanical operation counter, pumping Anti feature, Automatic safety shutters and Push button

Potential Transformer

Three Phase, Resin Cast, Dry type, Draw out PT with HT/LT fuses of ratio (11kV/1.732)/(110V/1.732), Core 1:Cl. 0.2 30VA

Current Transformer

single phase, Resin Cast, Dry Type Current Transformer of suitable Ratio /5-5A, Core 1: Cl. 0.2s / 5VA for metering, Core 2: Cl. 5P20 / 5VA for protection

Meters

Analog Ammeter with 5 Position selector switch

Analog Voltmeter with selector switch

Cutout Provision for Digital Trivector Meter L & T (or) Secure Make

Protection Relays

Electromechanical type Triple-pole Non-Directional, IDMT, 2O/C + 1E/F with Highset with 1.3 Sec, CDG 61

Auxiliary Relays

Master trip Relay VAJH 13

Indication Lamps

VCB On/OFF/Auto Trip/Spring Charge/Trip Circuit Healthy Indication Lamps LED Type

R,Y,B Phase Indication Lamps

Push Buttons

Trip Circuit Healthy Push Button

Control Switches

Breaker Control Switch (Close-Neutral-Trip)

Test Terminal Block

Bus Bars

Main Bus: 630 Amps Copper Busbar with HT Sleeve insulation -1 set

Control Wiring -1 set

Heater ON/OFF switch with filament type 80W space heater and thermostat, Single phase switch with socket, Cubicle illumination lamp, Door limit switch, MCBs / Fuses for AC / DC Control - 1 set

Auxiliary DC Power Source - 230V AC to 110V DC

Enclosure

MS Sheet steel suitable for Outdoor Installation Powder Coated with Siemens Grey Paint finish - 1 set

Termination

Incoming (Excluding cable termination kits, lugs and glands) Bus Bar Bottom entry

Outgoing (Excluding cable termination kits, lugs and glands) Bottom entry

11kV 630A, 350MVA, Air/Load break switch with Earth switch, with 2NO+2NC Aux. Contact ,Spring charged mechanism Manually operated -1 set

Bus Bars

Main Bus: 630 Amps Copper Busbar with HT Sleeve insulation -1 set

Control Wiring -1 set

Heater ON/OFF switch with filament type 80W space heater and thermostat, Single phase switch with socket, Cubicle illumination lamp, Door limit switch, MCBs / Fuses for AC / DC

Control - 1 set

Enclosure

MS Sheet steel suitable for Indoor Installation Powder Coated with Siemens Grey Paint finish - 1 set

Termination

Incoming (Excluding cable termination kits, lugs and glands) Bottom entry

Outgoing (Excluding cable termination kits, lugs and glands) Bus Bar

Note: Provision made for Main Busbar Extension to be given both end of the PANEL for future extension.

2.0 Codes and Standards:

The switchgear shall be manufactured and tested in line with the latest revisions of the following Indian as well as International Standards:

The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions Amendments of relevant Standards and conform to the following:

IEC56 : International Standard: - High voltage alternating current Circuit Breakers.

IEC298 : International Standard: - AC Metal enclosed Switchgear and Control gear for rated voltages above 11KV and upto & including 52KV.

IEC694 : International Standard:-Common specification for High Voltage Switchgear and Control gear standards.

IS2516 : International Standard:- Specification for Alternating Current Circuit Breakers. Voltages above 1000V up to and including 11000V.

IS12729 : General requirements for Switchgear and Control gear for voltages exceeding 1000V.

IS13118 : General requirements for Circuit Breakers for voltages above 1000V.

IS3427 : Metal enclosed Switchgear and Control gear for voltages above 1000V but not exceeding 11000V.

IS 5082 : Material for data for copper busbars.

IS 9920 : Switches and Switch Isolators for voltages above 1000V.

IS 2705 : Current Transformers.

IS 3156 : Voltage Transformers.

IS 1248 : Electrical indicating instruments.

IS 3231 : Electrical Relays for power system protection.

IS 6875 : Control switches and push buttons.

IS 694 :PVC insulated cables for working voltages upto and including 1100V.

IS 375 : Marking and arrangement for switchgear busbar main connections and auxiliary wiring.

IS 722 : AC Electricity Meters.

IEC 129 : AC Isolators &Earthing Switches

IEC 470 : HV AC Contactors

In case of conflict between the above standards and this specification, the requirements of this specification will prevail.

3.0 GENERAL REQUIREMENTS

The circuit breaker shall be vacuum.

Switchgear shall be Outdoor / Indoor, floor mounting, and metal clad drawout type, incorporating enclosures for the circuit breaker unit, bus bar chamber, current transformers, potential transformers, with necessary meters, relays switches and auxiliary wiring etc.

The Circuit Breaker shall be mounted on trolley, which shall be movable in all directions.

The Switchgear shall be of robust construction designed for maximum reliability of service in the tropical climate specified.

Each circuit breaker panel shall be extensible in both directions so that individual units may be joined together in any order to form a composite flush fronted switch board. For this purpose the busbar chamber shall have a removable cover.

Enclosures shall be manufactured from folded and welded cold rolled sheet steel of minimum 2.0 mm thick CRGO. Cable sealing boxes shall have a removable gland plate. They shall be amply sized for the cable and shall be positioned to give adequate ground clearance to facilitate cable termination.

All retaining catches, screws and bolts for doors and covers shall be Nickel plated. (Minimum 10 Microns average, 15 microns thick)The Brass Screws and bolts shall be Nickel plated for 15 Microns. They shall be corrosion proof for Ten years. Gasketting shall be done at suitable locations to achieve IP-54 degree of protection with .

Equipments to be mounted on the face of the cubicle shall be flush mounted.

Panel shall be fabricated in suitable transport sections.

All hardware for the complete equipment including foundation bolts, lifting lugs etc., shall be supplied along with the panel.

The switch gear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided.

Circuit breaker shall be provided with three distinct positions, namely, service, test and withdrawn. It should be possible to close fully the front access door with breaker in test position.

All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be located in a separate compartment on the front of the cubicle.

Bus bars shall be made of high strength, high conductivity aluminum with the current density of 0.8A/sq.mm. and maximum temperature rise limited to thermal limits of connected equipment, viz. cables, etc.

Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

Circuit breakers of identical rating shall be completely interchangeable.

Vacuum circuit breakers shall be provided with suitable surge protection devices to restrict rate of rise of restricting voltage.

Breakers shall be provided with motor wound spring charged trip free mechanism with anti-pumping feature and shunt trip. In addition facility for manual charging of spring shall also be available. One open - close - open operation of the breaker shall possible after loss of supply to the motor.

Each breaker shall be provided with a shrouded manual emergency trip push button, ON / OFF indication, operation counter and spring charged /discharged indicator.

The following minimum interlocks shall be provided for:

- i). breaker cannot be racked from one position to the other in closed position.
- ii). breaker cannot be operated in any intermediate position.
- iii). breaker cannot be opened or closed with compartment front door open.

- iv). with selector switch in “local” position breaker can only be operated in “test” position. For operation in “service” position, control must be from “remote”.

The following minimum indication lamps shall be provided for in the front of the cubicle.

- Breaker Open / Closed / Tripped, Vacuum pressure low, spring charged, trip circuit healthy and Control supply healthy.

- Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

After meeting all necessary control and indication requirements 2 nos. NO and 2 nos. NC auxiliary contacts of the breaker shall be made available for the purchaser, wired upto terminal block.

Meters and indicating instruments shall be of accuracy class and size specified where necessary motor ammeters shall have suppressed scale. Energy meters shall be provided with test terminal blocks.

All spare contacts of breaker, relays, switches etc shall be wired upto terminal blocks. Wiring shall be done with flexible, 1100 volts grade, PVC insulated FRLS cables, minimum size 1.5sq.mm for all circuits and 2.5mm² for CT circuits. Each wire shall be identified at both ends with permanently marked ferrules. All wire terminations shall be made with crimped connectors having insulating sleeves. Not more than 2 wires shall be connected to any terminal. Spare terminals equal to at least 20% of active terminals shall be provided in each terminal block. Terminals will also need to be segregated circuit wise and voltage wise.

Switch gear shall be suitable for cable entry from bottom as specified. Power and control cabling shall be completely segregated. Suitable space for termination / maintenance shall be provided in the cable compartment. Suitable working space between gland plate and power cable box shall be provided for and also for mounting core balance CTs if required. Gland plates shall be of 3mm thick aluminium plate for 3 core cables / nonmagnetic material for single core cables.

A ground bus rated for same short circuit level as the system shall be provided along the full length of the switch gear. Ground bus shall be of copper and bolted studs should be provided at each end of the switch gear to permit connection of flat / cable. All instrument transformer neutrals shall be connected to the ground bus through removable links. All removable / hinged doors and covers shall be grounded by flexible stranded connectors.

Each cubicle shall be provided with a space heater with thermostat control, one incandescent lamp with switch and 3 pin 5 amps plug socket.

The following power supplies shall be made available to each switch gear.

- a.) A.C Supply; Single feeder.
- b.) D.C Supply; Double feeder.

MCB shall be provided on incomer to each cubicle and D.C. supply shall have a selector switch (Source I & Source II). A.C load from control supply shall be so distributed so as to ensure proper balancing of three phase supply.

3.1 Labels

Labels shall be provided to describe the duty of or otherwise identify every instrument, or other item of equipment mounted internally and externally. Switch portions shall be fully identified, wording shall be clear, concise and unambiguous. Each label shall be permanently secured to the panel surface below the item to which it refers.

The labels shall be engraved / anodized aluminium with white letters on black background or non-removable stickers. The nameplates shall not be screwed on. In additions to component labels, each cubicle door shall bear a large identification label and the board shall include a large, prominent overall identification Label.

3.2 Painting

Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage or corrosion due to damp or humid conditions.

The Board shall be prepared, primed, filled and painted to the highest standards.

All items shall be cleaned and deburred, after fabrication and welding is completed. External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface, free from blemishes and imperfections. Paint shade shall be inside white. Outside color shall shade 631 as per IS: 5 for Outdoor type panel and shade RAL 7032 as per IS: 5 for Indoor type panel both inside and outside

The painting process shall be pre-approved by the Consultant / Owner.

4.0 CLEARANCE

Minimum insulator lengths and clearances in air shall be not less than those specified for class A switchgear in IS:3427.

5.0 TEMPERATURE RISE

The design ambient shall be 45 deg. C. The limits of temperature rise determined in accordance with the relevant standard, shall be reduced such that the final temperature obtained at site does not exceed the final temperature computed by the addition of the design ambient temperature to the permissible temperature rise of 40 deg. C.

The maximum busbar temperature rise shall not exceed 85 Degree C. All other electrical / insulated items shall have temperature rise as per the relevant Indian Standard.

Temperature rise & SC tests

The busbars shall be supported adequately on non-hygroscopic insulators. For indoor application epoxy insulators have been found adequate. Porcelain insulators are brittle and need careful handling and hence better avoided.

The temperature rise limit of the busbars shall be as per the limits of IEC-694 and with respect to ambient temperature as per IS 9676. To maintain the temperature within the limits particularly for higher currents, additional ventilation openings may be necessary. Manufacturers shall provide adequate ventilation arrangements.

The degree of protection of enclosure shall be coordinated in such cases. It is impracticable in certain cases to achieve required temperatures limits without ventilation fans

6.0 CURRENT RATINGS

Every current carrying part of the equipment, including circuit breakers, current transformers, isolating switches, busbars, connectors and joints shall be capable of carrying its rated current continuously and in no part shall the permissible temperature rise be exceeded.

In addition, all parts of the switchgear, including current transformers, shall be capable of withstanding, without thermal or mechanical damage, the instantaneous peak and the three second short time currents corresponding to the rated making and breaking capacity of the circuit breaker.

7.0 MAKING AND BREAKING CAPACITIES

Each circuit breaker shall be capable of making and breaking short circuit faults at 3 phase symmetrical fault and asymmetrical faults.

The supplier shall submit for approval certified test certificates of making and breaking tests carried out on similar equipment by approved independent testing authorities.

Opening time around 60ms, closing time around 80ms or faster.

8.0 CIRCUIT BREAKER TYPE

All circuit breakers shall be of same make and type and shall be interchangeable.

9.0 OPERATING MECHANISM

Spring charging motor shall be 110V Universal / DC motor.

Control supply of the entire HT Panels shall be 110V DC which has been feed from inbuilt power pack.

Tripping shall be effected by means of a D.C. shunt trip coil.

Each breaker shall be provided with a visual, mechanised, indicating device for 'Open' and 'Closed' position of the breaker. It shall be operative when the circuit breaker is in the 'Service', 'Test' and 'Isolated/Earthed' position. Operation counters shall be provided on each mechanism to count the number of trips and cannot be reset.

Means shall be provided for coupling the secondary, circuits on the fixed portion to those on the movable portion when the circuit breaker is in 'Test' position in order to permit closing, tripping and interlock circuits to be checked for operation test purposes.

It shall not be possible, without the use of tools, to gain access to the tripping toggle or any part of the mechanism which would permit defeat of the locking of the mechanical tripping feature or closing feature, casually or carelessly. The door shall not be openable unless the breaker is tripped.

Operating mechanism shall not hunt if a closing command and an opening command are simultaneously given. It shall first "Close" and then "Open" or first "Open" and then "Close".

It shall not be possible to render the electrical tripping feature in-operative by any mechanical locking device.

Adequate contacts shall be provided to open and close the breaker from remote.

Status of breakers, alarm and trip signals shall be available in the form of Potential free contacts for indicated in the Building Automation System.

9.0 CONTACTS

All contact parts shall be readily and quickly replaceable. Where contact parts are, by design, not intended to be dismantled the complete contact shall be easily replaceable with the minimum of special tools.

10.0 CIRCUIT BREAKER ISOLATING FEATURES

The circuit breaker shall have the positions, 'Service', 'Test' and 'isolated', with the cubicle door closed.

Each circuit breaker shall be connected to the busbars and feeder circuit through plug in type isolating devices.

Plug and socket arrangement shall be provided for connection of secondary circuit.

11.0 INTERLOCKS

All mechanical interlocks shall be of the preventive type and shall be arranged to prevent mal operation as close as possible to the point at which mechanical force is applied, in order to prevent defeat of the interlocks by distortion of linkages. Electrical interlocks shall also function so as to prevent the closing of the circuit breaker.

Undetectable mechanical interlocks shall be provided which are designed to prevent:

- a. A closed circuit breaker from withdrawn or inserted into the isolating contacts.
- b. Tripping by attempted isolation.
- c. The closing of a circuit breaker except when correctly located in service, and test position.
- d. A circuit breaker being closed in the service position when the secondary circuits between the fixed and moving portions are not completed.
- e. It shall not be possible to defeat the inter locks manually by the operating personnel.
- f. Withdraw of a closed Circuit Breaker from the 'Service' Position.

11.1 SPACE HEATER

A space heater of 230 Volts, AC supply has to be provided to prevent condensation during humid atmospheric condition.

12.0 SAFETY SHUTTER DEVICES

A set of metallic shutters shall be provided to cover stationery isolating contacts.

The shutters shall open automatically by a positive drive initiated by the movement of the circuit breaker. The closing operation shall also be automatic.

When padlocked/closed, the shutters shall completely shroud the stationary contacts, and it shall not be possible to force the shutters or part of the shutters, to gain access to the stationary contacts.

To facilitate testing, means other than locking shall be provided for securing the shutters in the open position. However, such means shall be automatically cancelled

and the automatic operation of the shutters restored upon reconnection of the circuit breaker to the fixed isolating contacts.

Busbar shutters shall be painted signal red, and shall be clearly and indelibly labeled 'BUSBARS' in large white letters. Circuit shutters shall be painted yellow, but shall not be lettered, except that on incoming feeders the circuit shutters shall be clearly and indelibly labeled 'DANGER LIVE CABLES' in large red letters.

Durable phase color identification shall be provided in a prominent position. Provision or access shall be made for lubricating the mechanical linkages.

All shutters shall be effectively earthed.

Shutters shall not operate towards the fixed isolating contacts.

Shutters shall not have less than 20 mm gap from the moving isolating contacts of the circuit breaker throughout the movement of the truck.

13.0 BUSBARS AND CONNECTIONS

Busbars and connections shall comply with applicable clauses of IS:1897.

The busbars and connections shall be made of high conductivity aluminium with current density of 0.7 Amps/ Sq.mm. The busbars shall be amply sized to carry the rated continuous current under the specified ambient temperature without exceeding the total temperature of 85 deg C.

The busbars and their connections shall be capable of withstanding, without damage, the thermal and mechanical effects of a through fault current equivalent to the short time rating of the switchgear.

Busbars shall be of uniform cross sectional area throughout their length with connections as short and straight as possible. The resistance of any length shall not be greater than an equal length of similar section conductor, without a joint.

Busbars shall be contained in a separate compartment within the general casing of the switchgear.

Access to busbars and the connections directly thereto shall be gained only by the removal of covers secured by bolts or screws.

Busbars shall be extensible at both ends, such extension shall entail the minimum possible disturbance to the busbar chambers. Compound filled busbar chambers are not acceptable.

Phase colours shall be red-yellow-blue and colour sleeves shall be provided at regular intervals.

All live parts should be shrouded by FRP transparent polycarbonate sheet of 2mm thick

All aluminium terminal busbar (where the incoming and outgoing cables will be terminated in the panel) should be tin coated over the entire length of terminal.

14.0 EARTHING

All metal parts, other than those forming part of an electrical circuit, shall be connected to a hard-drawn, high conductivity, 50x6 mm copper earth conductor on each unit.

Copper Earth bar should be run throughout the length of the switch gear. Should have short circuit with stand time same as phase bus bars.

It shall be bolted to the main frame and shall be located so as to provide convenient facilities for earthing cable sheaths and for use with earthing devices.

Earth bars of adjacent unit shall form a continuous earth bar.

Particular care should be taken to ensure the following:

The truck of draw-out circuit breakers shall be connected to the earth bar through a plug type contact and the plug shall be long enough to allow the busbar and feeder shutters to close before breaking contact.

Current transformer and voltage transformer secondary circuits shall be earthed at one point only.

Earthing facilities shall be provided in the incomer and outgoing circuit for discharging of busbar and power cable through earth trucks which has to be supplied along with this 5VCB panel.

The panel shall be provided with two earthing stud terminals with suitable nuts, washers etc., for connection to ground bus.

15.0 INSULATORS

Insulators of moulded or resin bonded material shall have a durable, non-hygroscopic surface finish having a high anti-tracking index.

Provisions shall be made to accommodate expansion and contraction of the connection, to take care the temperature rise likely to be attained during fault conditions.

16.0 CONTROL SWITCHES

Control switches shall be of 'spring return to neutral' type and selector switches shall be of stay put type. The contacts of all switches shall be shrouded to minimise ingress of dust and accidental contact.

17.0 AUXILIARY SWITCHES

Each circuit breaker shall be provided with auxiliary switches to interrupt the supply to the closing mechanism and to complete the trip circuit, when the circuit breaker is in the 'Closed' position, and to cover all the necessary indication, interlocking and control facilities.

All secondary connections between the fixed and moving portions of circuit breaker equipment shall be by means of plug and socket connections, arranged so as to eliminate, positively any false indication when the moving portion is racked into the service location.

Each circuit breaker shall be provided with 4 NO + 4 NC auxiliary contacts as spare in addition to the other functional requirements.

18.0 CURRENT TRANSFORMERS

The current transformers shall have synthetic resin insulation and be of the single-phase, wound primary type, with separate core for metering and separate core for protection.

The primary and secondary connections shall be clearly labelled.

The cores for measuring purposes shall be as per the drawing and specification.

All current transformers shall be dimensioned to carry continuously a current of 120% of the rated current. The rated secondary winding current shall be 1A.

19.0 VOLTAGE TRANSFORMERS

The voltage transformers shall be of synthetic resin insulation and be of the single phase, wound primary draw out type. Rated secondary voltage shall be $110 \text{ V} / \sqrt{3}$. Line VTs shall be mounted in Incomer Panel.

All primary and secondary connections shall be clearly marked.

The secondary windings shall have accuracy Class 1.0

The burden of all windings shall be as specified.

20.0 INSTRUMENTS, RELAYS AND INDICATION LAMPS

The instruments shall be 144mm square flush type with (at least) 90 deg. pointer deflection. The instrument shall be of Analog / Digital type. The relays shall be electro mechanical, draw out type.

Indicating lamps shall be of LED Cluster type. The lamp shall be adequately ventilated and arranged so that they can be changed from the front of the panel by manual means. All meters shall be provided as indicated in the drawing.

21.0 PANEL WIRING

The switchboard shall be completely factory wired and ready for external connections.

The wiring shall be carried out with flexible stranded 1.1 KV grade PVC insulated copper conductor cable of not less than 2.5 sq.mm. size for C.T / current carrying connections. For other control circuits 1.5 Sq. mm wires shall be used. Colour coding to be followed

All wiring shall be marked by numbered ferrules for easy identification.

The supplier shall provide single line diagram and control wiring diagrams for the switchboards inside the compartment/ panel.

22.0 TESTS

22.1 Factory Tests

Complete test shall be made at the manufacturer's works to determine the performance and operating characteristics of the assembled circuit breakers, and their respective accessories and to determine whether or not the guarantees have been met. The bidder shall give a complete description of the proposed test methods. All routine tests shall be witnessed by Client/Architect.

Unless otherwise specified, all tests shall be carried out in accordance with IS: 13118 and Panel to be type tested for following

21.0 TESTS:

The panel shall be completely assembled, wired, adjusted and tested for operation under simulated conditions to ensure accuracy of wiring, correctness of control scheme and proper functioning of all equipment.

21.1 Type Tests:

- Breaking and making capacity tests
- Short-time current tests
- Temperature rise tests
- Lightning impulse voltage test
- Mechanical operation test

The Bidder shall furnish the (2) sets of type test certificates for all the tests, conducted on similar panel.

21.2 Routine Tests (All Units):

- Mechanical operation tests
- Power frequency voltage test
- Tests on auxiliary & control circuits
- Measurement of IR of the main circuit

All routine tests shall be witnessed by the Purchaser / Consultant

23.0 DRAWINGS AND MANUALS

Following drawings and manuals shall be submitted in 4 sets, for approval.

General arrangement of circuit breaker showing.

Overall dimensions

Terminal location and dimensional data

Total weight

Operating mechanism

Bill of materials

Terminal pad details

Single line diagram for metering and protection.

Typical scheme drawing for each type of feeder.

Quality plan

Details of bushings and insulators including electrical and mechanical characteristics.

General arrangement of supporting structure

Schematic and wiring diagram for control

Manufacturing schedule and test schedule

Instruction manual of each equipment and all the components supplied

Calibration certificates of all the measuring equipment's

24.0 SPARES

24.1 Commissioning Spares

The quoted price shall be inclusive of all necessary Commissioning Tools & Spares.

- 24.2** List of recommended Essential spare for trouble free operation of 2 yrs shall be furnished with detailed list under the price quoted separately.

SPECIFICATION AND SCHEDULE OF OUTDOOR HT SINGLE VACUUM CIRCUIT BREAKER PANEL (OUTDOOR)

PANEL (Each)	INCOMING / OUTGOING
Quantity	1 No
Rating-KV	11KV
-KA	25KA
-AMPS	630A
Bus bars	Copper
Painting type	Powder coated with Siemens Gray Paint Finish
BREAKER	
Quantity	1 No
Type	Vacuum
Mechanism	Manually and Electrically
Motor voltage	230V / 110 V AC
Shunt Trip Coil	110V DC
Aux. Contacts	4 NO + 4 NC
Miniature circuit breakers	Suitable Nos Provide
Pressure switch	Provide
Anti-pumping Contactor	Provide
CURRENT TRANSFORMER	
Quantity	Single phase, Resin Cast, Dry Type
Ratio	Ratio /5-5A
Class	Core 1: Cl. 0.2s / 5VA for metering, Core 2: Cl. 5P20 / 5VA for protection
Burden	15 VA for higher as required
Short time rating	25 KA for 3 Sec.
POTENTIAL TRANSFORMER	
Quantity	3 Nos. x 1Ph.
Ratio	11KV / $\sqrt{3}$ / 110 V / $\sqrt{3}$
Class	Core 1: Cl. 0.2 30VA
Burden	200VA for higher as required
ACCESSORIES	
T-N-C Switch (Trip-Neutral-Close)	Provide
Local remote switch	Provide
Indication lamp	6 nos / breaker
Alarm Scheme	Hooter with 16W annunciator
Space heater with ON/OFF Switch	Provide
Power Pack	Provide

PANEL (Each)	INCOMING / OUTGOING
Load Manager / Multi function meter	Provide
Auxiliary Relay	
PROTECTION RELAYS	Electromechanical type Triple-pole Non-Directional, IDMT, 2O/C + 1E/F with Highset with 1.3 Sec, CDG 61 and Phase reverse relay (PRR)/Phase failure relay (PFR)

Meters:

The panel should have Maximum demand controller (which will trip the circuit breaker when it is reached the preset value) with RS 485 and digital type MULTI FUNCTION meter for measuring current, voltage, KVA, maximum demand indicator and as specified in the single line diagram. The surge protection device should be provided and the same should be connected to main earth grid directly.

Note:

- Panel shall be painted to shade RAL 7032 (Siemens Grey shade) both inside and outside for Indoor type
- Vacuum circuit breaker shall be horizontal draw out and shall be horizontal isolation type
- Phase to Phase clearance for panel shall be min. 356 mm.
- Phase to Earth clearance for panel shall be min. 320 mm.
- All routine tests shall be carried as per IS 13118.
- Shunt trip and closing coil shall be rated for 110 V DC.
- Breaker-operated auxiliary switch with 4 NO and 4 NC spare contacts shall be provided.

GUARANTEED TECHNICAL PARTICULARS FOR HT PANELS**(TO BE FILLED IN BY THE BIDDERS)**

1.0	Make	:
2.0	Service	:
3.0	Type	:
4.0	Nominal System voltage	:
5.0	Highest system voltage	:
6.0	Rated continuous current	:
7.0	No. of poles	:
8.0	Rated frequency	:

9.0	System earthing	:
10.0	Rated short circuit breaking	:
	current (3 phase)	
a.	Symmetrical breaking current	
11.0	Short time making current	:
12.0	Short time withstand current	
	for 3 seconds	:
13.0	Duty cycle	:
14.0	Insulation levels	
	a. Power frequency withstand Voltage – dry	:
	b. Lightning impulse withstand Voltage	:
15.0	Operating voltage	
	a. Trip coils	:
	b. Closing coils	:
	c. Spring charging motor	:
16.0	Number and type of spare	:
	aux. switches	
17.0	Busbars	
	a. Normal current rating	:
	b. Material and size	:
18.0	Reference standards	:
	Relays Meters & Accessories	:
19.0	IDMTL Relay for over current/ earth fault protection 50/51N	
	a. Type & make	:
	b. Rated current	:
	c. Characteristics	:
	d. Range	:
	e. Drawout / flush mounting	:
	f. Test Facility	:
	g. Reference standard	:

- 20.0 Auxiliary Relay
- a. Type & make :
 - b. Rated voltage :
 - c. Operating voltage range :
 - d. No. of contacts :
- 21.0 Control switches
- a. Type & make :
 - b. Type of handle :
 - c. Contact development :
- 22.0 Test terminal block
- a. Type & make :
 - b. System :
- 23.0 Wiring & Accessories
- a. Auxiliary wiring minimum cross section of wire for control circuits :
 - VT Circuits :

IV.SUPPLY, TESTING AND COMMISSIONING OF 11KV/433V 400KVA ONAN TYPE OUTDOOR TRANSFORMER WITH OLTC, RTCC PANEL + AVR

1.0 SCOPE

This specification covers the technical requirements of design, manufacture, testing at works, supply of Distribution transformer complete with all accessories for efficient and trouble-free operation.

2.0 STANDARDS

The equipment covered by this specification shall, unless otherwise stated, be designed, constructed and tested in accordance with latest revisions of relevant Indian Standards and shall conform to the Regulations of local Statutory Authorities.

- | | |
|------------|---|
| IS : 2026 | Power transformers |
| IS : 10028 | Code of practice for selection, installation and maintenance of transformers. |
| IS : 2099 | Bushing for alternating voltage above 1000V. |
| IS : 3637 | Gas operated relays. |
| IS : 4527 | Porcelain bushing for transformers. |

IS : 335	New insulating oils.
IS : 6600	Guide for loading of oil transformer.

3.0 GENERAL REQUIREMENTS

The distribution transformer shall be of core type, 3 winding (Primary-11KV and secondary- 433V) , 3 phase oil immersed having a rating by oil and natural air cooling and shall be suitable for OUT-DOOR installation.

3.1 Voltage and Frequency Variations:

Transformer shall operate without injurious heating on any Tap under the following conditions provided increase in voltage is not accompanied by reduction in frequency.

- i) At rated MVA at any voltage within $\pm 10\%$ of the rated voltage.
- ii) At rated current at a voltage equal to 105% of the rated voltage.
- iii) To deliver rated current under 10% continuous over fluxing.

3.2 Overloads

It shall be possible to operate the transformer satisfactorily upto overloads of 150% of the rated value in conformation with the loading guide specified in IS:6600. There shall be no limitation imposed by bushings, tap changers, auxiliary equipments to meet this requirement.

3.3 Rated Power and Temperature Rise

The transformer shall be capable of operating at rated power specified in the technical schedule on a continuous basis and with the cooling classification given at the most onerous simultaneous climatic conditions specified.

The temperature rise specified shall not be exceeded when the transformer is operated continuously at the rated power at the design ambient temperature of 50° C.

3.4 Rated Voltage and Tapping

The principal tapping rated voltage shall be as specified. The tapplings shall provide a variation in the transformation ratio without producing phase displacement. All tapplings shall be full power tapplings.

3.5 Impedance Voltage and Short Circuit Impedance

The impedance voltage at principal tapping shall be as specified.

3.6 Short Circuit Withstand Capability

The transformer shall be designed and constructed to withstand without damage to the thermal and dynamic effects of external short circuits between phases or between phase and ground.

3.7 Insulation Levels

The insulation shall withstand the rated lightning impulse voltage and power frequency withstands voltages as per IS

One Minute Power Frequency Withstand Voltage (KV) - 75KV

Impulse Withstand Voltage - 175KV Peak

3.8 Radio Interference

The transformer shall be designed and constructed so as not to cause any undesirable interference in radio or communication circuits.

4.0 CONSTRUCTIONAL FEATURES

4.1 General

Screws, studs, nuts and bolts shall be hot dip galvanised. Exposed parts shall be designed so that water cannot collect at any point.

Materials in contact with oil shall be such as, not to contribute to the formation of acid in oil.

All similar parts particularly the removable ones shall be interchangeable.

4.2 Core

The core shall be built up, interleaved with high grade, non-ageing, low loss, high permeability, cold rolled grain oriented, silicon steel laminations properly treated for core material.

The final core assembly shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibrations during operation.

The frame, clamps and core bolts shall be electrically insulated from the core. Such insulation shall be capable of withstanding maximum temperature existing in the core. Core clamps shall be electrically connected to the tank.

The core and windings shall be suitably braced to prevent displacement or distortion during transportation or abnormal electrical conditions in service.

The core shall be provided with lugs suitable for lifting the complete core and coil assembly.

All metal parts of the transformer core assembly except individual core laminations, core bolts and side-clamping plates shall be earthed. The magnetic circuit shall be

earthed to the clamping structure through one removable core insulation test link only, placed in an accessible position beneath an inspection opening provided in the main tank cover.

Following are the mandatory requirements:-

1. Transformer shall be of BOLTLESS core design.
2. Core should be procured from one of the following manufacturers
– Posco / Nippon/ Novex/ Ak Steels.
3. Mill's test certificates to be provided for the transformer core.
4. The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000V for one minute.

4.3 Windings

The coils shall be of high conductivity electrolytic copper conductor, properly insulated and stacked. Coil assembly shall be suitably supported between adjacent sections by insulating spacers and barriers, which shall be permanently secured in place.

Windings shall not contain sharp bends, which might damage the insulation or produce high dielectric stresses.

Coils shall be so insulated that the effects of impulse and power frequency voltage stresses are minimum.

The transformer winding shall be connected in group of vector symbols specified. All terminal and tapping markings shall be in accordance with IS:2026.

5.0 CONSTRUCTIONAL FEATURES

5.1 Tank

Tank shall be of all welded construction and fabricated from good commercial grade low carbon steel of adequate thickness. All seams shall be properly welded.

The tanks shall have sufficient strength to withstand the following without any deformation.

- i) The tank together with core and oil can be lifted and transported without damage or loss of oil tightness.
- ii) Mechanical shock during transportation. The tank cover shall be bolted onto the tank with weatherproof hot oil resistant, resilient gasket in between for complete oil tightness. Bushings, turrets, holes and other devices shall be designed to prevent any leakage of water into the tank or oil from the tank.

Tank cover shall not distort when lifted. Each tank shall be fitted with inspection covers of ample size to give any access to internal connections of the bushings, current transformers, winding connections and earth link for testing.

The design shall be such that the cover does not support the weight of the core and windings.

Tank cover shall be fitted with pockets for oil temperature indicator, which shall be located in the position of maximum oil temperature at maximum continuous rating.

The under-carriage of the transformer shall be provided with four flat cast iron rollers. The wheels shall be mounted on plain axle. Rollers shall be bi-directional.

Each tank shall be provided with following handling facilities capable of lifting and/or moving the transformer complete and filled with oil.

- i) Lifting lugs of adequate capacity shall be provided on tank to lift completely assembled transformer filled with oil.
- ii) Jacking pads in accessible position shall be provided to enable the transformer to be raised or lowered.
- iii) Suitable haulage holes shall be provided to tow the complete transformer.
- iv) Lifting handle shall be provided on the tank inspection covers.
- v) Rails for transformer movements.

Two numbers earthing terminals capable of carrying maximum system earth fault current for duration of at least equal to the period for which the main windings are designed shall be provided close to the base of the tank at diagonally opposite positions.

Tank, tank cover other associated components on the transformers shall have electrical continuity for earthing.

Tank with radiators, conservator etc shall withstand without any permanent distortion for the following conditions:

- a) Full vacuum of 760mm of HG.
- b) Internal gas pressure of 0.35 Kg/Sq.cm
- c) The material used for gaskets shall be cork neoprene or approved equivalent.

5.2 Explosion Vent

The explosion vent shall be of double diaphragm type. An explosion vent of sufficient size shall be mounted on the tank to protect the tank from damage and to control the explosion of oil during an internal fault. The explosion vent shall be mounted such that pressure relief is not invalidated by the operation of valves and it shall direct the oil downwards and away from tanks and bushings. It shall be capable

of maintaining the oil tightness of the equipment under all conditions of normal service.

5.3 Conservator Tank

A conservator tank shall be mounted on the top above the highest point of the oil circulating system of the transformer. It shall be of ample capacity to accommodate the expansion and contraction of oil in the whole system over the extreme possible temperature range.

Conservator tank shall be connected to the main tank by the pipe through Buchholz relay with stop valves at both ends. The connection shall be such that air or gas is not entrapped.

The conservator oil outlet pipe shall be fixed above the base of the conservator to form a sump to trap condensation and sludge. One end of the conservator shall be fixed by bolts to enable the tank to be cleaned.

Each conservator shall be fitted with:

- i) At least one oil level indicator of direct reading prismatic glass type visible from ground level, provided with alarm contacts for minimum oil level.
- ii) Oil filling hole with cover.
- ii) The conservator tank shall be vented to atmosphere through a weather proof dehydrating breather with activated silica gel as dehydrating agent.

5.4 Cooling Units

The cooling unit shall consist of detachable type of radiators made of pressed sheet steel of thickness not less than 1.2mm. Radiators shall be designed so that all painted surfaces can be thoroughly cleaned by hand and subsequently painted inside by suitable brushes. They shall be also so designed to avoid pockets in which moisture, dust or sand may collect.

Radiators shall withstand the pressure tests appropriate to the main tank. They shall be also capable of withstanding without damage the full vacuum associated with oil treatment. The radiators shall be provided with the following accessories.

- i) Bolted gasketed flanges connection at each point of connection to the main tank.
- ii) Top and bottom shut off valves on each radiator.
- iii) Air release plug, on top.
- iv) Oil drain plug at bottom at convenient level.

- v) Lifting lugs.

5.5 Transformer Oil

Insulating oil shall be Non-PCB oil and conform to IS 335 and shall be suitable in all respects for operating the transformer at the ratings and under conditions laid down in the specification. **10 % extra oil in a non returnable drum to be supplied along with main equipment.**

5.6 Gas and Oil Actuated Relays

The Buchholz relay shall be as per the latest revision of IS 3637. The relay shall be fitted in the expansion pipe connecting the transformer tank to the conservator.

The pipe work shall be so arranged that all gas arising from the transformer shall pass into the relay. Sharp bends in the pipe work shall be avoided.

The design of the relay mounting arrangement and associated pipe work shall be such that the relay will not sustain damage during transport or service, or maloperate due to vibrations under service conditions.

The relay shall be provided with drain cock, air vent and facility for testing with air injection by hand pump. The device shall be provided with two independent floats and electrical contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure due to abnormal conditions. The relay shall be provided with a window through which a scale indication can be seen in order that the quantity of gas collected within the relay housing can be determined. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe. Two sets of electrical contacts (one for alarm and one for trip) shall be provided.

5.7 Winding Temperature Indicator

Winding temperature indicator shall be fitted locally in a weather proof box so as to be readable at a standing height from ground level. The device shall be provided with two sets of electrical contacts, one for alarm and one for trip.

5.8 Oil Temperature Indicator

Thermometer pocket and sensing element with dial type thermometer calibrated in degree Celsius, with a hand reset pointer to register the highest temperature attained, shall be provided for indicating temperature of the top layer oil in tank.

Two sets of electrical contacts, one for alarm and one for trip shall be provided. The cover of Marshalling Box shall be equipped with a viewing aperture of adequate size fitted with clear glass.

5.9 Breather

The conservator of the transformer shall be provided with a silica gel breather complete with oil seal and oil level indication window. Visual indication of the extent to which the silica gel has absorbed moisture shall be provided. The unit must allow simple cleaning and replacement of the desiccant and sealing oil without the use of tools, by using wing nuts or similar forms of corrosion resistant hand - tightening devices.

The breather shall be mounted at appropriate height from ground level and connecting pipe, fitted to the main tank by means of brackets. The breather should be placed at appropriate height of the supervisor at site.

5.10 Valves

The transformer shall be fitted with the following valves:

- i) One valve at the top and one valve at the bottom of the tank mounted diagonally opposite to each other, for connection to oil circulating and filtering equipments. The lower valve shall also function as drain valve. These valves shall be fitted with blank flanges.
- ii) Oil sampling valve at top and bottom of the tank.
- iii) Valves between radiator and tank.
- iv) 1 No. Air Release Plug.
- v) Shut off valves for Buchholz relay on both sides.

5.11 Cable Box and Disconnecting Chamber

- a. The cable box shall be of **outdoor type** sheet steel construction, self-supporting, with all standard facilities including the body earth terminal.
- b. Cable box shall be provided with undrilled gland plate.
- c. Adequate space shall be provided within the box so that the cable may be formed into the box without undue bending or stress on the lugs. Adequate electrical clearance shall be provided.
- d. The connections to the cable box from bushing of transformer shall be through the disconnecting chamber for isolating cables to facilitate movement of transformer without disturbing cable box and termination.

5.12 Termination

11KV terminals of the transformer shall be brought out through the side tank cover to terminate 11KV 3C 185sq mm (E) XLPE copper armored cables.

The neutral of the star-connected winding shall be brought out to a separate bushing terminal. The neutral bushing shall be provided on the tank side to facilitate lead of the earth conductor down to the ground level. One numbers of neutral CT should be provided (250A/5A 5P20 Class and 7.5VA burden) in this terminal within the terminal box.

Tank mounted pin type insulators shall be provided for supporting the neutral earthing bar of specified section, along its run from the neutral bushing to ground-level.

5.13 Earthing

The body of the transformer should be earthed by two separate and distinct earth connections connected to different earth pits. Control cabinet for the transformer and separately mounted radiator banks should be separately earthed. The transformer neutral for star connected windings should be earthed by two separate earthing leads, each one directly connected to an earth electrode put in a treated earth pit. The earth pits, in turn, should be connected to the station earth grid.

The following safety accessories to be provided:

1. Explosion's vent or pressure relief valve with alarm contact
2. Magnetic oil level gauge with low level alarm contact
3. Buchholz relay with alarm and trip contacts
4. Oil temperature indicator with high and too high alarm and trip contacts
5. Winding temp indicator with high and too high alarm and trip contacts
6. Oil surge relay with trip contacts
7. Emergency oil drainage valve and associated piping
8. Separate bushing to bring out neutral of star connected winding for earthing

6.0 MARSHALLING BOX

A marshalling box for outdoor use to transfer transformer control, alarm and annunciation terminals to control panel, shall be provided.

The box shall be mounted either on the transformer tank or on a separate mounting frame with brackets and shall conform to IP 55 degree of protection for the enclosure.

This box shall contain all auxiliary devices except those mounted on the transformer. The control terminals and connectors shall have suitable current carrying capacities.

A removable bottom gland plate shall be provided for cable entry. Cables between transformer and marshalling box shall also be provided.

7.0 TAP CHANGER

7.1 On Load Tap Changing Gear

The on-load tap changing gear shall comply with IS:8468. The tap changer shall be mounted in a separate tank or compartment in accessible position in/on the transformer tank. The operation of the transformer at any of the taps provided shall not produce phase displacement. All the tap changing switches shall be rated for full Uni-directional power flow.

Oil surge relay shall be fitted between the tap changer compartment and the conservator.

OLTC shall be provided with the following modes of operation.

Local : Manual Control and Electrically Operated

Remote: Manual Control and Electrically Operated with RTCC & AVR

Both local and remote operation shall be possible with RTCC Panel. OLTC should comply to the following:

- a) The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded i.e. 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.
- b) When a tap change has been initiated it should be completely independent of the operation of the control relays and switches. Necessary safeguard should be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.
- c) Oil in compartments which contain the making and breaking contacts of the OLTC shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. An Oil surge relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.
- d) Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valve pipe connections. Any gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.
- e) Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasket and bolted cover with lifting handles.
- f) OLTC driving mechanism and its associated control equipment (local) shall be mounted in an outdoor, weatherproof cabinet with IP 55 protection which shall include:-
 - Driving motor (433V, 3-phase, 50 Hz. AC squirrel cage).
 - Motor starting contactor with Motor Protection Circuit Breaker, isolating switch and MCBs.
 - Control switch: Raise/off/lower (spring return to normal type).

- Remote/local selector switch (maintained contact type).
- Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.
- Limit switches to prevent motor over-travel in either direction or final mechanical stops.
- Brake or clutch to permit only one tap change at a time on manual operation.
- Emergency manual operating device (hand crank or hand wheel).
- A five digit operation counter.
- Electrically interlocked reversing contactors (mechanical interlock preferred).
- 240V, 50 Hz. AC space heater with switch and MCBs.
- Interior lighting fixture with lamp door switch and MCBs.
- Gasketed and hinged door with locking arrangement.
- Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
- Necessary relays, contactors, current transformers etc.

g) Control requirements for OLTC: The following electrical control features shall be provided:

- Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
- Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.
- Cut-off of electrical control when manual control is resorted to. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
- Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

h) Automatic Control of OLTC: Automatic OLTC control shall include the following items:

- Voltage setting device.
- Voltage sensing and voltage regulating devices.
- Line drop compensator with adjustable R and X elements.
- Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation.
- Adjustable dead band for voltage variation.

7.2 Mechanical Control

The cranking device for operation of the OLTC gear shall be removable and located at a height not exceeding 1500 mm above ground level for easy

operation. The mechanism shall be complete with normal accessories including atleast the following.

- Tap position indicator.
- Mechanical operation counter
- Mechanical stops to prevent overcranking the mechanism beyond extreme tap positions.

7.3 Electrical Control

Control circuit shall incorporate the following.

- Local - electrical operation
- Device to ensure a positive and full completion of tap change once it is initiated even if the control supply fails.

7.4 Internal Earthing

The framework and clamping arrangement of core and coil shall be securely earthed inside the tank by copper strap connection to the tank.

8.0 NOISE AND VIBRATION

Care shall be taken to ensure in the design and manufacture so as to reduce noise and vibration to the level of that obtained in good modern practice. It should be in conformance to **NEMA Standards**

9.0 PAINTING

All accessories and transformer tank shall be sand blasted and grounded to produce a smooth, clean surface, free from scale, grease and rust.

After cleaning, the surfaces shall be given a phosphate coating followed by two coats of Epoxy primer.

The transformer shall be finished with two coats of Epoxy paint to shade 631 of IS 5.

10.0 PERFORMANCE GUARANTEE

The performance figures which will be indicated by the vendor shall be guaranteed subject to tolerances specified as per IS:2026.

Vendor shall also furnish guarantee for the design, manufacture, material, safe and trouble free operation of the equipment and its accessories for a period of twenty four (18) months from the date of commissioning or twelve (24) months from the date of supply which ever later.

11.0 TESTS

11.1 Factory Tests

Complete test shall be made at the manufacturer's plant to determine the performance and operating characteristics of the assembled transformer, and accessories to determine

whether or not the guarantees have been met. Unless otherwise specified, all tests shall be carried out in accordance with IS: 2026, and shall include the following. The temperature rise test shall be conducted on one transformer in the manufacturer's factory before despatch, which will be witnessed by Client/Architect

11.2 Routine Tests

- a. Resistance measurement of all windings on the rated voltage connection and on all taps.
- b. Ratio tests on the rated voltage connection and on all taps.
- c. Polarity and phase rotation tests.
- d. Impedance and load loss at rated current on the rated voltage connection and on all the taps.
- e. No-load loss and current at rated voltage on the rated voltage connection and at 95,110 and 115% of rated voltage.
- f. Power frequencies withstand test.
- g. Insulation resistance tests on winding, auxiliary devices core and tank.
- h. Mechanical operation test on Tap changer.
- i. Induced over voltage test
- j. Magnetic Balance test
- k. Magnetising Current Test
- l. Vector Group Check test
- m. Short circuit test
- n. 2KV With stand test for all wiring
- o. zero phase sequence impedance test
- p. Impulse test on any one phase of the HT winding of any one transformer

All routine tests shall be witnessed by the Purchaser's Engineer / Consultant.

12.0 DRAWINGS AND MANUAL

The following drawings and manual shall be submitted for the Engineer's approval:

- a. General arrangement and dimensional Drawing showing Constructional features and Disposition of various fittings and Accessories. (Drawings shall be to scale).
- b. General Arrangement Drawing of Marshalling Box.
- c. Wiring Diagram of Marshalling Box.
- d. Name plated drawing with Terminal Marking and connection Diagrams.
- e. Drawings of other major components.
- f. Technical Leaflets on All Components.
- g. Manufacturing Schedule in the form of Bar Chart/Net work.
- h. Manufacturing and supply record.
- i. Technical Particular Data-sheet duly completed and fill-in.
- j. Routine Test Certificates of transformer and OLTC
- k. Operation maintenance and instruction manuals for transformer and

- Certificates for associated fittings.
- m. Scheme / Wiring diagram for OLTC/RTCC Panel.
- n. Foundation drawing.
- o. Quality Plan

TECHNICAL SPECIFICATION FOR 400 KVA, 11 KV/433V OUTDOOR, ONAN TYPE DISTRIBUTION TRANSFORMER

Transformer Rating (continuous) KVA	400 KVA
Quantity	1 No.
Duty / Application	Continuous / Power Distribution
Service	Outdoor
Type of Winding / Core	Double Wound / Core Type
Winding type	Conventional Copper
Type of cooling	ONAN
No. of phases	Three
Supply frequency	50 Hz
Primary Winding (HV/incoming side)	Delta
Secondary Winding (LV/outgoing side)	Star with neutral
Vector Group Symbol as per IS 2026	Dyn 11
Ambient conditions (as per IS 2026):	
a) Max ambient air temperature	42 deg. Celsius
b) Design ambient temperature	50 deg. Celsius
c) Max daily average air temperature	40 deg. Celsius
d) Max yearly weighted average air temperature	32 deg. Celsius
e) Minimum ambient air temperature	-5 deg. Celsius
f) Minimum Altitude (above M.S.L.)	Not more than 1000 metres.
g) Impedance value	5% subject to IS tolerance
Guaranteed Temperature rise over above ambient conditions:	
a) By thermometer in top-oil	50 deg. Celsius
b) By winding resistance method:	55 deg. Celsius

Nominal Primary Voltage (No-Load) and at Principle tapping.	11,000 Volts
Nominal Secondary Voltage (No-Load)	433 Volts
Tapping in HV side	Provide for variation of incoming voltage
Type of tap-changing arrangement	ON load tap changer, with RTCC panel & AVR
No. of tap steps / positions	16 steps / 17 positions
Tapping range	+10% to – 10% in 2.5 % steps.
Incoming side voltage compensation range	35.97 KV to 28.05 KV
Total losses @ 50% loading	As per Latest IS 1180 Level-2
Total losses @ rated load	As per Latest IS 1180 Level-2
Space heater with temp control	LT and HT Termination area

The transformer(s) shall be supplied with first filling of mineral oil, as per IS 335 and with all standard accessories and fittings as per I.S 2026, as listed in below.

The transformer(s) shall conform to I.S 2026 (Parts – I-IV) and CBIP Manual on Power Transformers, and Standard manufacturing practice.

LIST OF FITTINGS AND ACCESSORIES BEING SUPPLIED ALONG WITH THE DISTRIBUTION TRANSFORMER.

The transformer(s) shall be equipped with the following standard fittings and accessories:

- 1 No. oil-conservator with oil filling hole and cap and drain plug.
- 1 No. prismatic plain oil level gauge mounted on conservator wall, with max./min level indication.
- 1 No. silica-gel dehydrating breather with oil-seal and with first fill of charge.
- 1 No. double-diaphragm type Explosion-vent for pressure relief purposes.
- Adequate Nos. of Thermometer pockets, including one no for accommodating bulb type thermometer.
- 1 No. top oil filter valve.
- 1 No. bottom oil filter cum drain valve.
- 1 Set of Rating, Diagram and Terminal Marketing plates.
- 2 Nos. earthing terminals, located on diagonally opposite sides of transformer tank-base .

1 Set of lifting lugs

1 Set of jacking pads

1 No. inspection cover on transformer-tank.

Under-carriage with 4 Nos. flat plain bi-directional rollers.

1 No. air release plug on main transformer tank.

Adequate Nos. of detachable type cooling radiators with top and bottom isolating valves.

The following additional fittings / accessories shall be provided for the transformer(s):

1. 1 No. double float Buchholz relay, with alarm and trip contacts, with two Nos. isolating valves on both sides.
2. Relays of transformer protection with alarm and trip contacts for Winding temperature, Oil temperature, Oil surge and Pressure release valve.
3. 1 No. 6 inch (150 mm) Dial type Oil Temperature Indicator (OTI), with MRP/RSD, with two pairs of alarm and top contacts.
4. 1 No. 6 inch (150 mm) Dial type Winding Temperature Indicator (WTI), CT-activated type, with MRP/RSD, with two pairs of alarm and trip contacts.
5. 1 No. outdoor, weatherproof type Marshalling box for housing the OTI and WTI.
6. 1 No magnetic oil-level gauge (MOG) mounted on conservator tank wall, for main-oil level indication, equipped with one pair of low Alarm contact.

Terminal Arrangements:

H.V Side (primary side)

Suitable gland cable box to be provided to terminate 11 KV, 1-3C x 185 Sqmm(E) 'XLPE' Aluminium armoured cable with oil filled (disconnecting chamber).

L.V. Side (Secondary side)

Suitable terminal box to be provided to terminate 3Nos of 300Sqmm XLPE Al Ar. Cable.

NOTE:

- a) The exterior surfaces of the transformer(s) shall be coated with two coats of Epoxy paint to Shade 631 (Light-Admiralty Grey as per **IS : 5.**)

SPECIFICATION FOR ON-LOAD TAP-CHANGING ARRANGEMENT (OLTC)

The transformer(s) shall be equipped with On Load Tap Changing equipment, comprising:

1. Transformer-tank mounted High-speed, Resistive type On Load Tap Changing Gear (OLTC) :

16-step / 17 position.

2. Separate Conservator and oil surge relay to be provided.

THE OLTC shall be supplied with the first fill of oil conforming to I.S:335

- a. High torque electric motor suitable for 433V, 3-Phase, 50Hz AC supply.
 - b. Motor drive and energy accumulator.
 - c. Overload protection.
 - d. Contactors for forward and reverse operation of motor.
 - e. 'Raise/Lower' control selector switch.
 - f. 'Local/Remote' control selector switch.
 - g. 'Raise/Lower' limit switches.
 - h. Retainer Push button.
 - i. Auxiliary transformer.
 - j. Anti-condensation heater with switch.
 - k. Interlock between manual and electrical operation.
 - l. Mains isolating switch/MCB.
 - m. A set of MCB.
 - n. Insulated terminal board (with connectors for transformer tap leads).
 - o. Mechanical (local) tap position indicator.
 - p. Handle for manual operation.
 - q. Tap changing operation counter.
 - r. Mechanical stops to prevent overcranking of the mechanism beyond extreme positions.
 - s. Rating plate.
 - t. Driving mechanism chamber locking arrangement.
 - u. Undrilled gland plate for Cable entry
 - v. Terminal strips
 - w. Lubrication chart
3. Indoor floor mounted type, Remote Tap Changing Control Cubicle (RTCC) panel, fitted with Automatic Voltage-regulating Relay (AVR).
 4. The paint shade of RTCC panel is RAL7032 – Siemens gray

An indoor floor mounted remote control cubicle (RTCC) with rear access door with wiring and with the following components:

- a. Remote tap position indicating digital meter

- b. Tap changer in progress signal lamp
- c. Raise/lower push buttons for remote operation
- d. Cubicle illuminating lamp with door switch with MCB control
- e. Terminal strips
- f. Supply ON signal lamp
- g. Undrilled gland plate (6mm thick) for HT cable entry

i) RTCC Panel:

The RTCC remote control equipment shall be suitable for 240V AC supply and shall be housed in an indoor sheet cubicle to be located in a remote control room. The OLTC control panel shall comprise of rigid welded structural frames made of structural steel section or of pressed and formed cold rolled steel and frame enclosures, doors and partitions shall be of cold rolled steel of thickness 2 mm. Stiffeners shall be provided wherever necessary. All doors, removable covers and plate shall be gasketed all around with neoprene gaskets. Panel shall be dust, weather and vermin proof providing degree of protection of **IP54**, colour of finish shade for interior and exterior shall be **Powder Coated RAL7032** respectively. Earthing bus shall be of 25 x 6 mm copper.

Control switch : Raise/Off/Lower

(spring return to normal type)

Auto/manual selector switch :

(Maintained contact type)

Tap position indicator :

1) Facia type alarm annunciator with “accept” and “lamp test” facilities. The following features should be included:

- a) A.C. supply failure
- b) Drive motor auto tripped
- c) Tap change delayed
- d) Selector switch auto/non-auto operation
- e) Voltage Transformer for RTCC

2) Necessary auxiliary relays

3) Lamp indications for:

- 1 Tap change in progress
- 2 Lower limit reached

3 Upper Limit reached

- 4) Cable glands for power and control cables
- 5) 240 V rated panel space heater with ON-OFF switch
- 6) Fluorescent type interior lighting fixture with lamp and door switch
- 7) MCBs
- 8) Terminal blocks
- 9) Internal wiring
- 10) Earthing terminal
- 11) Supply ON Indication Lamp.
- 12) Labels for Accessories.
- 13) Automatic Voltage Regulating Relay.
- 14) Heater Switch (Rotary Type)
- 15) Control Supply Switch (Rotary Type)
- 16) Hooter for Facia annunciator (230V AC)
- 17) Time Delay Relay for ‘Tap Change Delayed’ (110V AC)
- 18) H.V. Voltmeter (Digital Type)
- 19) H.V. Voltmeter Selector Switch (Rotary Type)
- 20) L.V. Voltmeter (Digital Type)
- 21) L.V. Voltmeter Selector Switch (Rotary Type)
- 22) PT for AVR.
- 23) **Tap changer Counter for registering No of times the Tap is changed for voltage correction**

The following indicating lamps to be provided in the RTCC Panel:

- a. Tap Changer – “Supply on”
- b. Tap Changer – “in progress”
- c. Upper limit reached
- d. Lower limit reached

The On Load Tap Changing equipment shall be suitable for the following tap-change operations:

- a) Local-manual tap change operation, with cranking handle.
- b) Local-electrical tap change operation, with Raise/Lower switches / push buttons on OLTC.
- c) Remote/electrical, independent tap change’ operation, with Raise / Lower switches / push buttons on RTCC panel.

d) Remote-electrical, automatic tap change operations through AVR

V. TECHNICAL SPECIFICATION FOR LT SWITCH BOARDS

1.0 SCOPE:

This specification covers the technical requirements of design, manufacture, test, supply of 415V L.T Switch Boards complete with all accessories for efficient and trouble free operation.

2.0 STANDARDS:

The equipment covered by this specification shall, unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory Authorities.

IS-722 A.C. electricity meters

IS -732 Code of practice for Electrical wiring installation.

IS -375 marking and arrangement for switchgear busbar main connections and auxiliary wiring.

IS -1248 Direct acting electrical indicating instruments.

IS -13947 LV Switchgear and Control Gear.

IS -2705 Current Transformers.

IS -3231 Electrical relays for power system protection.

IS -8623/13947 Specifications for factory Built assemblies for voltages upto 1000V A.C. and 1200V D.C.

IS 2147- 1962 Degrees of protection provided by enclosures for low voltage switchgear and control gear.

IS 5578- 1984 Guide for marking of insulated conductors.

IS 11353 - 1985 Guide for uniform system of marking and identification of conductors and apparatus terminals.

IS 8828 - 1996 Electrical accessories, Circuit breakers for over current protection for household and similar installations.

The panel supplied shall satisfy all the requirements of Local statutory authorities and modification if any required at site shall be carried out by the supplier at his own cost.

3.0 CONSTRUCTION:

The panel shall be metal-enclosed, free-standing compartmentalized, modular type form 4A suitable for indoor installation. The panel shall be dust and vermin proof and the enclosure shall provide a degree of protection of not less than IP-52. The panel shall be of uniform height not exceeding 2300 mm.

The board shall be fabricated out of adequate thickness mild steel structural sections. The frames shall be enclosed with steel of not less than 2.0 mm thickness

The panel shall be extensible on either side by the addition of a module. It shall be possible to extend the switch board irrespective of the type of end panel.

Each of the outgoing feeders in the switch board, terminal are brought out to the cable chamber to form convenient connection of the outgoing cables.

Incomers and outgoing feeders shall be provided with their own separate modules having separate doors, isolating switch of each units shall be mechanically interlocked with its respective doors.

Each cable chamber shall have cable entry from bottom / Top and suitable removable gland plates shall be provided for this purpose. The cable chamber shall be provided with suitable supporting arrangement between the gland plate and terminals, in the middle. The cable chamber shall have a minimum width of 300 mm depending upon the outgoing cables.

All retaining catches, screws and bolts for doors and covers shall be cadmium plated. Screws and bolts shall be captive. All covers, doors and joints shall be gasketed.

Equipment to be mounted outside cubicles shall be flush mounted on cubicle door. No externally mounted equipment shall be mounted above 1.8m or below 0.3m above floor level. The panel shall be fabricated in suitable transport sections and assembled on rolled steel channel box frame.

The switchboard shall be made from CRCA sheet steel 14/16 SWG thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pit wiped smooth with plumber metal. All panels and covers shall be properly fitted and square with the frames and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with shrunk nuts. Self-threading screws shall not be used in the construction of switchboards. The board shall be of totally enclosed design, completely dust tight and vermin proof. Gaskets between all adjacent and beneath all covers shall be used to render the joint effectively dust tight. Soft compressible gasket shall be used between all metal joints, doors and covers to prevent ingress of dust.

All similar materials and removable parts of the switchboard shall be interchangeable. The switchboards shall be filled with the same family of switches for various ratings with a view to ensure uniformity of design, maintenance and replacements. A horizontal wire way with screwed cover shall be provided at the top/bottom to take inter-connecting control wiring between different vertical sections. Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contractors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker busbar connections.

Switchgear type and construction data of switchgear

The indoor air insulated switchgear is basically a metal enclosed switchgear with an external metal enclosure intended to be earthed and complete except for external connections. The switchgear should be consists of 3 separate compartments. One each for the main switching devices and components connected one side of the main switching device, for ex. feeder circuit, and components connected to other side of the main switching device, for ex. Busbar. In addition, a separate compartment for low voltage

equipment also is provided depending upon the need. The enclosure is normally designed so that normal services, inspection, maintenance operations can be carried out safely.

The enclosure is designed to take care of the normal stress as well as the abnormal electromechanical stress due to short circuit conditions.

All the covers and doors provided shall offer adequate safety to the operating persons and the enclosures shall also offer the degree of protection as per IEC 298.

Ventilating opening and vent outlets shall be arranged such that the same degree of protection, as specified, for the enclosure is obtained and also opening and outlets shall be arranged in such a way that the gas of vapours escaping under pressure, does not endanger an operator.

Suitable pressure relief devices are to be provided to minimise the danger to an operator during the internal fault conditions.

Details of main compartments

Switching device Compartment

The switching device compartment shall be designed to house the main switching device such as circuit breaker or contactor or load break switch.

The operating conditions of the switching device shall be clearly defined by the manufacturer and shall be mentioned in the operation and maintenance manual.

The interlocking shall be as per the logic conditions defined by IEC 298 or as specifically agreed between the manufacturer and buyer.

Busbar compartment

The busbar compartment shall house the main horizontal busbars to supply power to the entire switchboard. The busbars shall be supported adequately to withstand the electromechanical and thermal forces due to short circuit currents.

The busbar material shall be electrolytic copper or aluminium as per requirement. The cross section shall be uniform through the length of the switchboard and adequate to withstand and thermal and electromechanical forces.

The strength of busbars and busbar supports to withstand the thermal and electromechanical forces shall be proved by the manufacturer either by the calculations or by performing the recommended tests.

Cable compartment

The cable compartment shall be provided to terminate the user's cables. The size and type of cable shall be specified by the user at the time of enquiry. Manufacturer shall make suitable provision for the termination of these cables. If required, additional cable compartment may be used by the manufacturer to accommodate larger number of cables. However, such additional compartments shall satisfy all the requirements as those for the main structure. The instrument current transformers may also be housed in this compartment.

Low Voltage compartment

This separate compartment shall be provided to house all indicating and recording meters, protection relays, operating devices and the like.

GENERAL REQUIREMENTS FOR PANELS:

- The bus bars in all panels shall be electrolytic grade Aluminium, suitable for Short Circuit rating of as indicated in SLDs & shall confirm to IS 5082. Earth bus of the same rating shall be provided with facility to connect to purchaser's earthing conductor at both ends where ever indicated in SLDs enclosed with the specification. Calculations for bus bar sizing shall be furnished by vendor
- The main bus bars (horizontal) shall have uniform current ratings throughout their length.
- Bus bars shall be provided with color coded heat shrunk PVC sleeves.
- FRP shrouds shall be provided at joints and tap offs.
- The panel shall be suitable for Control supply of 230 AC.
- MV panel's incoming ACB shall be communicable type with inbuilt RS485.
- All ACB feeders shall be draw out type and MCCB feeders shall be fixed type.
- All Air Circuit Breakers will be considered with microprocessor based LSIG
- All incoming and outgoing breakers of MV panel should be provided with Microprocessor based LSIG except firefighting panel feeder which breaker should be suitable for motor application.
- All panels incoming breaker should have over current, Time adjustable short circuit and earth fault releases (LSIG).
- All sub panels (except MPCC panel) outgoing breaker should have over current and Time adjustable short circuit (LSI).
- Feeders rated above 630 Amps shall be with ACBs if not mentioned in SLD. All Incomer ACBs which is having electrical interlock arrangements shall be EDO type rest of all ACB shall be MDO type as mentioned in the SLD / BOQ.
- The breaker which is feeding the power to UPS should be thermal magnetic breaker in all ratings.
- All starter feeders and firefighting panel feeder should be provided with breaker which is suitable for motor application.
- All Panels incoming breaker should be provided with microprocessor based release.
- Except above three points, all breakers rated above 250Amps shall be microprocessor based release and 250Amps & below rated breaker shall be thermal magnetic released.
- For ACB's $I_{cu} = I_{cs} = I_{cw}$ shall be 100% and for MCCB's $I_{cu} = I_{cs}$.
- Watt-Loss of ACB/MCCBs to be provided to calculate total Power Loss occurring from each ACB/MCCBs.
- All multifunction meter should have RS485 port.

For ACB's The front panel of the circuit breaker truck shall have the following features:

1. Mechanical push buttons for breaker close/open.
2. Mechanical indications for spring charge/discharge.
3. Mechanical indications for breaker test/service position.
4. Mechanical indication for breaker ON/OFF.
5. Breaker Position indication

MCCB's shall be provided with Rotary type lockable handles with Lock out Tag out (LOTO) application.

MCCB feeders shall also be provided with door operating handle with pad lock arrangement & door interlock facility

Switchgear shall be provided with undrilled detachable 3mm thick gland plates of adequate sizes.

Switchgear shall be epoxy painted having color shade interior as glossy white and exterior Light Grey (Shade 631 of IS 5) / Siemens Grey (shade No. RAL.7032).

All the Panels shall be fuse less type.

All the Panels shall have thermal monitoring system.

The following equipment shall be providing for all the panels as required.

- LV compartment illumination lamp (Retrofit type LED)
- 16A, switch socket with MCB./RCCB (30mA sensitivity)
- Space heater with adjustable thermostat, MCB & interlocked with breaker.
- Terminal blocks suitable for given current rating.
- 20% spare terminals shall be provided in the terminal blocks.

Additional shrouding shall be provided with Polycarbonate/ acrylic sheet inside the panel wherever there are exposed live terminals, contacts, bus bars and at the rear / side of panel to be accessed during maintenance, such as to provide secondary barrier/protection.

All the unused auxiliary contacts of circuit breakers, protection, auxiliary, control relay etc. shall be wired up to the terminals.

Terminal blocks shall be located at suitable place for easy access. CT shorting, isolating terminals shall be provided for CT and isolating drop link type terminals shall be provided for PT connections.

In Cable chamber necessary supporting arrangements shall be provided for cable / cable termination.

The cable chamber shall be suitably sized for the required no. of cables.

The terminals for Copper, FRLS, and XLPE power cables shall be such that easy termination of cables shall be possible without overcrowding.

Control cables shall be 1100 V grade PVC insulated, extruded PVC inner sheathed, steel wire armored, extruded FRLS PVC outer sheathed, multi stranded copper conductor as per IS : 1554 (part 1) 1988. The control cable shall be of 1.5/2.5 sq. mm size.

All panels shall be provided with removable type lifting hooks. Lifting hooks shall be provided on blind holes (The removal of lifting hooks shall not result in opening in the equipment enclosure).

All panels shall have uniform height.

Operating height of all accessories shall be restricted between 300 mm to 1800mm from finished floor level.

All the panels shall be provided with top / bottom Cable entry as mentioned in the BOQ.

4.0 BUSBARS:

The busbars shall be air insulated and made up of high conductivity, Aluminium. It shall have a fault withstand capacity as mentioned in the BOQ & SLDs. All busbars shall be fully screened by means of PVC sleeves in their own compartment running throughout the length of the panel and also suitable allowance shall be made for bus expansion. Suitable segregation shall be provided in between busbar chamber and adjoining compartments.

The busbars shall be 4pole, the cross section of the neutral bus shall be 100% and 200% size of the phase busbar as referred / specified in the BOQ

The busbar shall be PVC sleeved with colour strips of red, yellow, blue and black and the same shall be arranged in accordance with IS-375.

All panel's bus bar should be capable of either withstanding continuous rated Amps rating or to withstand the fault current for 1 minute, whichever is higher.

All the earthing busbar in the panel should be provided with same capacity for entire length of panel and the same shall be capable of either withstanding the fault current for 1 minute or half the size of neutral busbar, whichever is higher.

The busbar should be provided either based on the temperature rise limit or the current density of 0.7A/sqmm and 1A/sqmm for aluminium and copper respectively. The copper purity test will conduct at site and if anything found impure, the same will be rejected directly.

The busbar shall be properly segregated, suitably braced with insulated supports (DMC/FRP/SMC) placed at appropriate intervals to withstand the electromagnetic stresses during short circuit. Minimum electrical clearances shall be maintained between phase, neutral and body as per standards.

Phase to Phase clearance	-	25mm
Phase to Neutral clearance	-	25mm
Phase to Earth clearance	-	25mm
Neutral to Earth clearance	-	20mm

5.0 INTERCONNECTION:

The interconnections of all the phases between the busbars and the incoming side of the switch control shall be inaccessible when the doors of the controls are opened for removal of fuses etc.

For each and every tapping from the busbars, separate connections shall be made. No direct tappings from the busbar shall be made for any feeder without control and protection. The incoming and outgoing cable shall be properly identified and also the circuit to which it is connected on each outlet.

6.0 AIR CIRCUIT BREAKERS:

6.1 General:

Air circuit breakers shall be of 4 poles / TPN as per BOQ and shall have over load, short Circuit and Earth Fault protections wherever specified. They shall be complete in all respects having the following minimum requirements.

- The Air Circuit Breakers shall be rated Service voltage of 690V AC and Insulation Voltage of 1000VAC. The Air circuit Breaker shall be 3/4 Pole Motorized/ manual Draw out type capable of handling rated current up to in ambient temperature of 45 deg Celsius. The vendor shall furnish derating chart in the submittals.
- The Air Circuit Breaker shall comply with latest international standards IEC60947-2.
- Should be suitable for Isolation as per standard.
- Shall have the Isolation between power circuit and Control circuit.
- Shall have Micro Processor trip-release with EMC compatibility.
- Facility to change setting in on condition.
- Breaker Capacity should be Ics value only.
- The breaker should be comply with $I_{cs}=I_{cu}=I_{cw}$
- All ACBs shall be with $I_{cu}=100\%I_{cs}=I_{cw}(1\text{Sec})$
- The ACB shall have front face with Insulation Class II ia for safety as per IEC 60947-2 allowing class II installations with breaker control from outside.
- Should have short time withstand capacity of 0.5, 1 & 3 Sec.
- Should have facility of local fault identification (O/C, SC, E/F) wherever E/F is specified in the BOQ
- The Breaking capacity shall be as indicated in the BOQ.
- The ACB shall have 100% neutral pole in case of 4 Pole breakers

Circuit breakers shall be provided with following accessories.

- Mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker.
- Mechanically operated, red 'trip' push button, shrouded to prevent accidental operation.
- Locking facilities in the 'Service', 'Test', and 'Isolated', positions.
- In test position the breaker will be tested without energizing the power circuits. The breaker shall remain fully housed inside the compartment in the test position.
- Minimum 6 NO and 6 NC potential free auxiliary contacts, rated 10 A at 240V A.C. and 1A (inductive breaking at 230 V AC.)
- 'Red', 'green' and 'amber' indicating lamps to show 'Closed' 'Open', and 'trip' status.
- 'Auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.
- Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation :
- Closing coils - 85% to 110% of rated voltage. Trip coils - 70% to 110% of rated voltage.
- When series trip circuit breakers are specified the following releases with adjustable settings shall be provided : (Oil dash-pot type release is not acceptable):
- Overload
- Short circuit
- Under voltage
- In addition to the adjustable current setting range specified in the Data, short circuit release shall be provided with atleast four adjustable time delay settings, If it is not possible to provide the specified adjustable current setting range for the short circuit releases, shunt trip circuit breakers together with necessary protective relays
- Facilities shall be provided for blocking the under-voltage release, if so required at Site.
- Each of the foregoing releases shall be provided with a single pole, double throw, and potential free alarm contact rated for 0.5A, 230V AC.

SPRING OPERATED MECHANISM

- The operating mechanism shall be manually operated spring charging stored energy type with motor, opening and closing springs, limit switches for automatic charging and all necessary accessories. Facility for manual charging of the closing spring shall be provided. The operating mechanism shall be trip- free and non-pumping electrically. An antidumping relay to achieve electrical anti-pumping feature even if the breaker has provision for anti-pumping by mechanical arrangement.
- Power operated mechanism shall be:
- Provided with facilities for remote panel closing and opening operations as per breaker module designation and respective enclosed control scheme drawing.

6.2 Construction:

- Shall have facility for rating interlocking.
- Motor wound spring closing mechanism wherever specified.
- Full draw-out type with indication for service, test and isolated positions.
- Trip free mechanism.
- Mechanical open, closed and spring charges indicator.
- Main contacts made up of copper.
- Magnetic blow out arc control device.
- Facilities for pad locking.
- Circuit breakers shall be sheet metal enclosed flush front, draw out type provided with trip free manual operating mechanisms with mechanical "ON"-"OFF" indicators. Shunt trips and closing coils suitable for 230 Volts AC/OR as per the specifications shall be provided. Circuit breakers shall be for continuous rating and suitable for specified fault levels at 415 volts or as specified in SLD

The circuit breaker shall be fully draw out type. Suitable guides shall be provided to facilitate easy withdrawal of the trolley. All identical feeder compartments shall be inter-changeable.

ACB shall have Safety Shutter as standard with provision for locking for safety.

ACB shall conform to stringent environmental directives i.e. ROHS & WEEE norms.

All current carrying contacts of the breaker shall be silver plated. Contacts subjected to arcing shall be tipped with suitable arc resisting material.

- Shall have facility of O/C Pre-Trip alarm at set current.

The contacts shall be self-aligning, plug-in type, designed to ensure adequate contact pressure on the main busbars and requiring minimum maintenance.

- ACB shall have Line and Load Reversibility.
- Should have the Anti-pumping feature.
- ACB shall have interchangeable Rating Plug facility

All accessories like Shunt trip/Under voltage/Closing Coils shall be common for all Breakers. Shunt trip shall be continuous rated coil.

ACB shall be provided with Arc Chute Cover and stainless steel filters to absorb all gases which are released in the event of Short circuit which ensures better safety

All ACBs shall be provided with Ready to Close Contacts as standard feature to check in the event of Closing under the following conditions:

- a. ACB is in OFF position
- b. Spring Mechanism is charged
- c. Opening order is not present
- d. device not completely racked in

6.3 Operating Mechanism:

The operating mechanism shall be trip-free. Failure of spring, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation. Closing of breakers shall be prevented unless the spring is fully charged.

6.4 Interlocks:

- Should be suitably of Isolation as per standard.
The breaker shall be provided with all necessary interlocks to prevent inadvertent operations and to ensure safety of operating personnel and also the equipment.

It shall not be possible to push in a drawn out breaker in closed condition or withdraw a breaker in closed condition. Compartment doors shall be interlocked against opening when breaker is in 'Closed' condition. It shall not be possible to operate the breaker in intermediate position while inserting or withdrawing a circuit breaker.

There shall be 3 distinct and separate positions of Test/Isolated/Service on circuit breakers on cradles which are self-lockable at each position:

6.5 Microprocessor Control Unit:

All ACBs shall have segregated LED fault indications and Mp fault indication.

- a. All ACBs shall be set for different protection settings using Rotary Dial potentiometer /DIP Switches and navigation keys.
- b. The Control unit shall be suitable to provide Overload, Short Circuit and Earth Fault protection The Control Unit shall not be a peak sensing device and shall measure the true RMS values to make the measurement free from the influence of harmonics. It shall have thermal memory.
- c. ACB shall be provided with Energy Release(whenever specified) and will measure the Following:
- d. Current –Phase and Neutral
- e. Voltage – Phase to Phase and Phase to Neutral
- f. Power- KW,KVAR,KVAH
- g. Energy- KWH
- h. Power Factor

The above parameters along with the status of breaker shall be displayed on front door of the panel. Also trip unit shall provide last 10 trip histories which include date and time stampings. It shall be possible to upgrade the breakers with Communication feature at Site.

With RS485 -2 way communication and further upgradable to Ethernet connectivity.

Total Discrimination study shall be provided in all LT panels for achieving total-discrimination (Based on kA) which reduces the thermal/electro dynamic stresses in the event of Short Circuit and earth fault and the same shall be submitted by the switchgear manufacturer.

ACB FEEDERS:

- Electrical draw out (EDO) / mechanical draw out (MDO), Air Circuit Breaker with microprocessor based IDMT over current, Time delay adjustable short circuit and earth fault releases and also complete anti pumping feature, closing coil, tripping coil, with manual spring charging facility, castle key and 6NO + 6NC (min.) auxiliary contacts and shall be communicable type on Ethernet protocol.
- Closing, tripping coils shall be suitable for 230V AC, spring charging motor, space heater supply and panel illumination lamp shall be suitable for 230V AC supply.
- The following equipment shall be mounted on panel door / inside LT compartment.
- Clustered LED indicating lamps for breaker ON, OFF, Trip, Breaker in service, test spring charged position & Trip circuit healthy suitable for 230V AC supply.
- Providing Relays, Meters with necessary CTs & control switches shall be as per BOQ / SLD and Multi function meter displaying all electrical parameters like current, voltage, frequency, kW, kWH, kVAR, PF etc. along with test terminal block. The meter should have RS 485 port.
- All ACB feeder should have one no. TRIP/NORMAL/CLOSE switch, One no. Emergency trip push button and trip circuit Healthy check push button with hinged acrylic covers.
- CT Requirements: 3 Nos. 1 phase, 1 core, Cl. 1.0, 15 VA cast resin CT's with ratio as indicated in single line diagram for metering.
- All MCCB feeders should have two nos potential free contactors to know the status from BMS.
- MPCC panel EB incomer should have Surge protection device with Class B / Type-I, 100kA for 3 phase, 4 wire system Power line protection for Handling Lightning surges of 10/350 μ s waveform.
- All ACB incoming feeders (other than MPCC) should have surge protection device with Class B+C / Type I + II, 40kA for 3 Phase 4 wire system power line protection for handling lightning and Switching surges of 10/350 μ s and 8/20 μ s waveform at the incomer of the all panels.
- Single family of ACB to be considered for all ACB Feeders
- All SPDs should be connected to main earth bus directly.

MCCB FEEDERS:

- All MCCB outgoings shall be 415V, --- A, 4P / TP with isolating neutral link, Fixed

type with 3NO+3NC auxiliary contacts.

- All the controls & indications for various feeders shall be as indicated in SLD.
- Providing Meters & necessary CTs & control switches shall be as per BOQ / SLD and Multi function meter displaying all electrical parameters like current, voltage, frequency, kW, kWh, kVAR, PF etc. along with test terminal block. The meter should have RS 485 port.
- MPCC panels outgoing MCCB feeder and all incoming MCCB feeders should have emergency trip lockable push button with reset facility.
- All MCCB incoming feeders should have surge protection device with Class B+C / Type I + II, 40kA for 3 Phase 4 wire system power line protection for handling lightning and Switching surges of 10/350 μ s and 8/20 μ s waveform at the incomer of the all panels and all SPDs should be connected to main earth bus directly.
- All UPS panel's (UPS O/G panel & floor wise UPS panel) incomer should have True RMS multi-function meter which has the facility to measure the value of current between neutral and earth with necessary CTs and required accessories.
- CT Requirements: 3 Nos. 1 phase, 1 core, Cl. 1.0, 15 VA cast resin CT's with ratio as indicated in single line diagram for metering.
- Single family of MCCB to be considered for all MCCB feeders.
- All MCCB feeders should have two nos potential free contactors to know the status from BMS.

Motor Starter Feeders

- All feeders with motor starter shall be Type-II coordinated as per IS 13947 with MCCB/MPCB + overload relay + contactor (AC3) rating as applicable for KW ratings as indicated in enclosed Single Line Diagram except for high inertia load like fans, blowers etc.
- Overload relay shall have adjustable tripping characteristics (i.e. class 10, 20 & 30).
- All Motors of rating <5 kW shall be provided with Direct-On-Line starter and wherever specified.
- All Motors of rating \geq 5 kW shall be provided with Star-delta starter.
- Sensitive Earth Fault Relay (with CBCT) shall be provided for motors 30kW & above & for critical motors as indicated in enclosed SLDs.
- All Motors of rating \leq 7.5 kW shall be provided with MPCB+ Contactor + over load relay.

- All Motors of rating >7.5 kW and ≤ 90 KW shall be provided with MCCB+ Contactor + Overload relay.
- All Motors of rating above 90 KW shall be provided with MCCB/ACB + Motor protection Relay.
- Red, Green and Amber clustered LED indicating lamps for breaker ON, OFF, Trip suitable for control supply of 230V AC shall be considered.
- 1no. Emergency trip push button with hinged acrylic covers and reset facility.
- Motor shall have Local/remote control facility where ever indicated in SLD / BOQ.
- In local mode -Local control station for all pump-motors located in field shall have START push button and mushroom head stop type STOP push button for start & stop operation of the motor. In remote mode – motor shall be controlled by IBMS
- In addition, loads indicated with "LOTO" shall be provided with local on load disconnector switch of the same rating as the up-stream MCCB with 2 NO + 2 NC. Contacts
- All Motors of rating 30 kW and above shall be provided with Space heater

7.0 MOULDED CASE CIRCUIT BREAKERS:

The MCCB upto 630A shall be current limiting category A and shall comply with the requirement of IEC 60947-2 / IS13947-2: test sequence I, II, III. MCCBs shall have Class II Front Facia (MCCBs shall have Double Insulation between Live Power Parts and the front parts of the apparatus). No live parts shall be accessible inside the frame where accessories are fitted in the breaker to ensure safety of the operators. Cross Bolt Termination facility shall be provided to avoid loose termination.

The breaker shall be Double Break type to reduce the let through energy in the event of short circuits. MCCBs shall be designed according to Eco-design complying with ISO 14062 Especially MCCB's materials shall be of halogen free type. They shall be supplied in recyclable packing complying with European Directives. The manufacturer shall implement nonpolluting production processes that do not make use of chlorofluorocarbons, chlorinated hydrocarbons, ink for cardboard markings, etc

- Should be suitable for isolation as per standard.
- Above 250A rated MCCBs should be provided with Microprocessor based release and 250A & below the rated MCCBs should be provided with thermal magnetic release.
- Microprocessor / electronic releases should be EMC compatibility, thermal memory and true rms sensing
- The breaking capacity shall be I_{cs} values as per the Schedule of Quantities.
- The breaker should be comply with $I_{cs}=100\% I_{cu}$
- Should have the facility to change the setting in on condition.
- Shall have the Isolation between power circuit and Control circuit.

- Shall have with front door handles
- MCCB shall have minimum 15000 cycles electrical life upto 160A

The MCCB shall comprise of switching mechanism, contact system, arc extinguishing device and the tripping unit all mounted inside a moulded case. The MCCB shall be provided with field settable over load protection and S/C protection.

MCCB shall employ quick make and quick break switching mechanism independent of the speed of operation of the operating handle. The operating mechanism also is trip free. The operating handle shall indicate the position of the MCCB in ON / OFF / TRIP. The operating handle shall have provision for padlocking. Door interlocking shall be provided in the drawing and specification.

MCCBs shall be rated as specified in the BOQ. All the MCCBs should be supplied with Front operating handle.

MCCBs should be electrically and mechanically interlocked wherever specified in the BOQ.

1. Electrical interlock should be done with timer and control contactor logic
2. Mechanical interlock should be done with MCCB has to be fitted in the mechanical frame with interlock lever.
3. Frame should be fitted in either direction (vertical or horizontal)

8.0 CONTACTORS:

Contactor shall be of electromagnetic type rated for uninterrupted duty as defined in IS-13947-4-1 unless otherwise specified and also suitable for capacitor duty. Operating voltage is 230V AC

The main contacts shall be of silver or silver alloy. The insulation class for the coil shall be class E or better.

Each contactor shall be provided with 2 N/O and N/C aux. contacts. Contactor coil rating shall be minimum pick up of 85% of rated voltage and minimum drop out of 75% rated voltage.

9.0 PUSH BUTTONS:

Push buttons shall be generally shrouded. Each push button shall be provided with 1 N/O and 1 N/C aux. contacts. "Stop" push button shall have, 'stay-put' feature. Colour code shall be as per IS-6875.

10.0 INDICATION LAMPS:

- 10.1 Indication lamps shall be provided in each feeder (all panels) with indicate ON, OFF & Trip.
- 10.2 Potential free contact shall be provided for monitory ON, OFF and Trip status in all feeders for automations and each cable shall be brought to panel for interfacing with IBMS.

- 10.3 Fire alarm trip contacts and lamp, hooter with test button circuit shall be provided in the incomers of main panel.

11.0 CONTROL TRANSFORMER:

Control transformer shall be double wound, dry type and Secondary output 110V AC (55V-0-55V) with centrally earthed transformer shall have good regulation (5% or less) to cope with inrush current of contactor coils with sufficient rating of ELCB with 30mA for primary and secondary.

Transformers for Control, Space Heating and Annunciator Supplies

Adequately rated single phase, two winding, dry type transformers shall be provided for providing supply to the switchgear control and alarm circuits, space heaters provided in plant equipment and space heaters in the switchgear and motor winding heating circuits.

As specified in the enclosed module control wiring drawing/bill of material either duplicate common transformer with one as stand by shall be provided in each switchgear or a separate control transformer shall be provided in each module to cater for that particular module. Common control transformer rating shall be adequate to cater for all the control equipment connected across it. For control transformers in each module, the minimum rating shall be as follows:-

All transformers of 500 VA and above shall be controlled by MCBs/switches on the primary and secondary side.

Common control transformer shall have MCB on all line leads of each winding and control transformer in individual module shall have fuse in the line lead of only secondary winding. The MCBs shall be of proper rating to protect the control transformers against over loads and short circuits. The neutral or the earth lead shall have earth link instead of MCBs.

12.0 SPACE HEATERS:

Anti condensation space heaters, with thermostat suitable for 230V, 1 Ph supply along with a control MCB shall be provided in each panel.

13.0 CONTROL SWITCHES:

A general purpose control switch shall be provided for selection of "Auto" & "Manual". The switch shall be provided with engraving plate in the front with "Auto", "Manual" & "Off" inscription. This switch shall be normally of the fixed-control bar type heavy duty unit.

14.0 MEASURING INSTRUMENTS:

Ammeters and Voltmeters shall be of digital type if not as analog type. They shall be industrial grade and shall have means of zero adjustment from the front without dismantling them. They shall be capable of carrying the normal full load current (via CTS) and shall not be damaged by effects of rated fault current. The instruments shall have an accuracy class of 1.0 as per IS - 1248.

15.0 CONTROL WIRING:

Panel shall be supplied with all internal wiring comprising of FRLS, PVC insulated 1.1 KV grade, multistrand flexible copper conductor of 2.5 Sq.mm cross section.

Wiring associated with a particular phase shall be the colour of that phase viz. Red / Yellow, or Blue, wiring associated with earthing shall be with green colour insulation and for neutral it shall be with black colour insulation.

Wiring shall be neatly laid and run on insulated cleats of limited compression type insulated straps.

All cables shall have crimped terminations and shall be identified by means of glossy plastic ferrules at both ends, showing the wire number as indicated in the schematic diagrams. The ferrules shall be indelibly marked.

Wiring to items mounted on hinged doors or wiring that is subject to movement, shall run in helical binding. The binding shall be securely anchored at both ends and sufficient slack provided to prevent any strain being imposed on wiring.

16.0 EARTHING:

All the metal parts of all equipment supplied within the panel (including doors and gland plates) other than those forming part of all electric circuit, shall be connected by means of two independent earth conductors to continuous aluminium earth bar running along the full length of the panel.

The panel shall be provided with two brass earthing stud terminals, with suitable nuts, washers etc. for connection to ground bus.

17.0 TERMINAL BLOCK:

Terminal blocks shall preferably be grouped according to circuit functions and each terminal block group shall have at least 20% spare terminals. Terminal blocks for control circuit shall be of 1100V grade with contact ratings not less than 10A and stud/clamp type. Not more than two wires shall be connected to any terminal block.

Terminal blocks for CTs and VTs shall be provided with test links and isolating facilities and CT terminals shall have short circuiting and earthing facility. All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.

18.0 LABELS:

Labels shall be provided to describe the duty of or otherwise identify every Instrument, or other item of equipment mounted internally and externally. Switch positions shall be fully identified. Wording shall be clear, concise and unambiguous.

Each label shall be permanently secured to the panel surface below the item to which it refers.

The labels shall be engraved plastic (4 mm THICK) with white letters in black background.

In addition to component labels, each cubicle door shall bear a large identification labels and the panel shall include large, prominent overall identification label.

19.0 PAINTING:

Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage or corrosion due to damp or highly humidity conditions.

The panel shall be prepared, primed, filled and painted to the highest standards.

All items shall be cleaned and deburred after fabrication and welding is complete. External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface free from blemishes and imperfections and the whole shall be Powder Coated with Epoxy paint and the shade shall be indicated later.

The panels shall be fabricated at such work shops where the following facilities are available.

- a) Sand blasting
- b) Pre-treatment (Seven tank process)
- c) Spray booth
- d) Heating oven for all sizes of panels.
- e) Heat shrinking of PVC sleeves.

20.0 SPECIAL REQUIREMENTS FOR AUTO/MANUAL SYNCRONISING PANEL

OBJECTIVE:

The system will normally operate from the local EB power supply. Once the EB supply fails, the system has to be run from the DG sets as follows.

- a) The change over from EB power to DG power and DG power to EB power should be totally automatic without any manual intervention.
- b) When the System is on DG, the load of the system should be equally distributed on all DGs to ensure proper hunt free operation of DGs to avoid System black out.

SCOPE OF WORK ENVISAGED IN THE SCHEME ARE:

- EB supply failure detection
- Sequential starting of all DGs after EB supply failure.
- Auto synchronization of generators to the bus. (Auto/Manual)
- Auto Load sharing of generators after synchronization of DGs.
- Maintaining the operation of required DGs for the system load.

- Interlocks required for safe operation of the system.
- Protection of generators.

EB supply failure detection:

This is done by the under voltage element of the relay. When the EB goes off, the relay picks up and gives a trigger for DG starting.

Sequential starting of Diesel engines after EB supply failure:

- When the EB supply fails, the required numbers of DGs are started and will get synchronized and feed the system loads.
- The neutral contactors of the master DG will be connected in the system and slave DGs neutral contactors are isolated.
- During starting, if the master engine does not start after EB supply failure, the next engine in line will start after the engine fail alarm.

Auto synchronization of generators to the bus: (future)

- DGs are auto synchronized to the bus by auto synchronizing relay. It controls the governor and exciter of DG and gives a breaker closing command in synchronizing condition. If individual controllers are used as per the design of the manufacturers, the same is acceptable and required operational requirements shall be met.
- Only one auto synchronizing relay is used to synchronize all DGs one after the other by a PT selection.
- As soon as the EB power supply fails, the auto synchronizing relay will act in AMF logic and the first DG will get connected to the dead bus only after its voltage and frequency are of nominal values.
- After the first DG is connected to the bus, auto synchronizing relay is automatically connected to the second DG's PT. The relay will again start controlling the governor and exciter of next DG controls for synchronizing. After matching the DG voltage, frequency and phase angle to the bus, the relay gives the breaker close command to close the second DG.
- Similarly remaining DGs will be synchronized with the bus.
- When DGs are in operation, logics required for PT switching of DGs for auto synchronization and running the desired DGs according to the system load is performed by PLC.

Auto Load sharing of generators after synchronization: (future)

- After the DGs are connected to the bus, the auto load sharing scheme is enabled.
- The set of load sharing relays monitor the total load on the bus and accordingly adjust the voltage and frequency levels of the DGs by increase and decrease of pulses to ensure that the load is equally shared by each of the DGs.

- The Load sharing system will ensure that the power delivered by each DG is restricted to the same percentage level of its rated capacity.
- This process is online and continuous without any manual intervention.

Interlocks required for safe operation of the system has following interlocks built in

- The DGs are started only when EB power supply has failed and the incomer is open.
- If the engine has not started in three attempts, further start impulses are locked out and the next engine is started.
- Auto synchronizing relay is enabled for synchronizing only after receiving the start ok signal from the engine.
- At any time only one operation will be on - either synchronization or load sharing operation. Both will never be on simultaneous.
- Provision is made for operating all the DGs individually when both the bus couplers are open.

The panel shall consist of the following:

- 1 No integrated microprocessor based Auto Synchroniser with outputs for voltage increase/decrease, Frequency increase/decrease, and programmable breaker closing time.
- 3 Nos. Integrated Active/Reactive load balancing relay set.
- 1 No. Check synchronizing relay for manual synchronizing.
- 1 No Master/Slave selector switch.
- 1 No single/ parallel selector switch.
- 1 No Auto/manual selector switch.
- 4 Nos Lockable spring return type switches/Push buttons for Voltage/ frequency rise, low in manual synchronizing mode.
- Motorised potentiometer for adjustment of voltage of the DG sets.
- 1 set of Dual type voltmeter, frequency meter, Synchroscope and set of lamp for back-up manual synchronising.
- 128 digital configurable I/O PLC with HMI with redundant power supply and sufficient memory, for Synchronizing logic development as well for monitoring the status of the DG and the associated equipments.

Following functions shall be achieved through PLC.

- DG set priority selection such as Master slave No of DG etc
- Auto, Manual, Single / parallel selection.
- Bus coupler closing logic.
- Neutral contactor closing and conditions monitoring with the breaker interlocking logic

- Monitoring and collection of details of all equipments such as DG, ACB, MCCB, Fuel systems, Faults, Events with RTC, and status displayed visually through HMI and also for transfer of information to IBMS.
- All commands from PLC should have a check back confirmation loop and Error reports to be generated and displayed in clear text in the HMI and report files created for transmission to BAS/IBMS.
- The PLC shall have multiple ports for configuring, connecting a PC at the DG room and also a remote port with integrated modem for transferring information to the upper level such as BAS/IBMS
- The responsibility includes the Protocol emulations and data harmonizing of the various equipments at the DG room and also the schemes and visualizations at the local level.
- The contractor shall submit the complete as built drawings and implemented programme and logic diagram and configuration tool along with the supply.

21.0 TESTS:

The panel shall be completely assembled, wired, adjusted and tested for operation under simulated conditions to ensure accuracy of wiring, correctness of control scheme and proper functioning of all equipment.

21.1 Type Tests:

The Bidder shall furnish the (2) sets of type test certificates for all the tests, conducted on similar panel.

1. Strength of materials and parts of the assembly.
2. Degrees of protection provided enclosures
3. Clearance
4. Creepage distances
5. Short circuit with stand strength.
6. Protection against electric shock and continuity of PE circuits
7. Internal electric circuits and terminals
8. Terminal connections for external conductors
9. Dielectric properties
10. Temperature rise limit test
11. Short-circuit resistance
12. Electromagnetic compatibility (EMC)
13. Mechanical function
14. One minute power frequency voltage withstand test.
15. Corrosion, insulating material, lifting.

21.2 Routine Tests: (To be witnessed by Client / Consultant)

- A) Verification of Construction:-
- i. degree of protection of enclosures
 - ii. Clearances and creepage distances

- iii. Protection against electric shock and integrity of protective circuits
- iv. Incorporation of switching devices and of components
- v. Internal electrical circuits and connections
- vi. Terminals for external conductors
- vii. Mechanical operation

B) Verification of Performance:

- i. Dielectric properties (power-frequency withstand voltage at 50 Hz and impulse withstand voltage)
- ii. Wiring, operational performance and function.

Temperature rise & SC tests

The busbars shall be supported adequately on non-hygroscopic insulators. For indoor application epoxy insulators have been found adequate. Porcelain insulators are brittle and need careful handling and hence better avoided.

The temperature rise limit of the busbars shall be as per the limits of IEC-694 and with respect to ambient temperature as per IS 9676. To maintain the temperature within the limits particularly for higher currents, additional ventilation openings may be necessary. Manufacturers shall provide adequate ventilation arrangements.

The degree of protection of enclosure shall be coordinated in such cases. It is impracticable in certain cases to achieve required temperatures limits without ventilation fans

22.0 DRAWINGS AND DOCUMENTS:

The following drawings and documents shall be furnished.

- a. General Arrangement drawing of the panel showing.
 - i. Overall Dimensions
 - ii. Terminal locations
 - iii. Total weight
 - iv. Foundation details
 - v. Sectional view
 - vi. Bill of materials
- b. Single line diagram and wiring diagram.
- c. Technical details for ACBs, Switchgear, lamps, meters etc.
- d. Manufacturing schedule and test schedule.
- e. Calculation for sizing of busbars.
- f. Quality Plan
- g. O & M manual

The bidder shall furnish a tentative drawing showing the overall dimensions of the panel, along with the bid.

23.0 TOOLS AND TACKLES:

All tools, normal as well as special tools if any, required for the repairs or maintenance of panel shall be recommended and supplied along with the panel without extra cost.

VI. TECHNICAL SPECIFICATION FOR AUTOMATIC POWER FACTOR CORRECTION PANEL (APFCR) & FIXED CAPACITOR PANEL

1.0 SCOPE:

The scope of work under this section includes design, manufacture, assembly, testing at manufacturer's works, inspection, packing for transportation, delivery at site, installation, connection, testing and commissioning of Automatic Power Factor Correction Panel & Fixed capacitor panel. Panel shall include all the specified Capacitor banks, Switchgears, Control Gears, Bus bars, meters, earthing, interconnections etc as specified in the data sheets / BOQ / Schematics.

2.0 STANDARDS:

All equipment, material and components shall comply with the requirements of the latest edition of Indian Standards and Electricity Rules with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed. The equipment offered complying with other standards; shall be equal to or superior to those specified below:

IS 13340 -1993 & 13341-1992 Capacitors for power system
 IEC 60831-1+2 Capacitors for power system
 IS 13947 Low Voltage Switchgear and Control Gears Specifications
 IS 8623 Low Voltage Switchgear and Control gear assemblies
 IS 4237 General requirements for switchgear & control gear for voltage not exceeding 1000V.
 IS 2147 Degree of protection for enclosures for low voltage switchgear and control gear.
 IS 5082 Electrolytic Copper / Aluminum
 IS 2705 Current Transformers
 IS 3156 Voltage Transformers
 IS 14697 AC Electric Meters
 IS 3231 Electrical Relays for Power System Protection
 IS 3043 Earthing
 IS 2551 Danger Notice Plates
 IS 2516 Circuit Breakers, voltages up to 1000 Volts
 IS 4064 Air Break Switches, Air Break Disconnectors, for voltages not exceeding 1000V AC or 1200V DC.
 IS 8828 Miniature Circuit Breakers for voltages not exceeding 1000V AC
 IS 2959 Contactors for voltages not exceeding 1000 Volt A.C or 1200 Volts D.C
 IS 12640 Residual Current operated Circuit Breakers
 IS 375 Marking & Arrangement for Switchgear, Bus Bars, main connections and auxiliary wiring

3.0 CONSTRUCTION:

The panels shall be floor mounting, fixed type, single front, self-standing, totally enclosed to make it dust and vermin proof.

The Panels shall be fabricated with 14/16 SWG cold rolled sheet metal.

The Panels shall be fully compartmentalized with all doors in front only.

The number of steps and the KVAR rating of the Panels shall be as per the BOQ

Adequate lifting facilities shall be provided and the lifting eye bolts are removable.

The panel consists of 3 nos. of bus-bars for Phases and 1 no. for neutral. The bus-bars are of high conductivity aluminium with current density of 0.7A/Sqmm and are of sufficient cross section to carry fault current without any damage. The bus-bars shall be supported on epoxy resin impregnated insulators and covered by heat shrinkable PVC tapes. The main bus bars shall be adequately supported to withstand stresses developed due to short circuit current. Tapping points shall be treated against oxidation. Appropriate identification markings/labels shall be provided on the bus-bars and trappings for distinguishing the various phase and neutral.

The cable alleys shall be provided with hinged doors for easy access to cables inside. The cable alley door shall be provided with bolts, which can be opened with special keys by authorized persons.

The compartment doors shall open away from the cable alley and shall be provided with special locks, which will ensure tight closing of doors making the compartment effectively dust proof.

The fabricated panel shall undergo a treatment of degreasing, picking and 2 coats of primer, before inside and outside powder coating.

The equipment inside the compartment shall be arranged in a logical manner for ease of reference at site.

Undrilled gland plates shall be provided at top and bottom of the panel and shall be removable type with nuts and bolts for proper fixing.

The control supply shall be tapped after the mains incomer ACB/MCCB. Control circuit shall have protection MCBs.

Indicating lamps shall be provided on each rack. Capacitors “ON” & “OFF” indications shall be provided on APFC relay.

Panels shall be provided with sufficient cooling through cooling fans for containing the excessive temperature with suitable mesh doors for natural ventilation as required by the Local Electrical Inspectorate.

4.0 INCOMING FEEDER

MCCB incoming feeder shall be same as cause above specified for MCCB feeder except the following requirements:

Timer for manual operation shall be mounted on panel door / inside LT compartment

In APFC panel, 1 No. Automatic power factor correction relay shall be suitable for the stages of the outgoing feeders. It shall be duly connected to upstream PCC Panel.

Separate Auxiliary contactor shall be provided for closing the main contactor through APFC relay in Auto mode. The contactors shall be interlocked such that the opened capacitor feeder cannot be closed for minimum 2 minutes.

Provision of interlock with Grid Incomer of the upstream PCC shall be provided such that when grid power is not available, it shall not be possible to close the Incomer of APFC Panel and vice versa.

5.0 Outgoing Feeder

Clustered LED indicating lamps for breaker ON, OFF & Trip shall be considered.

Recessed type Start and stay put type Stop push button.

In each capacitor feeder a coil of PVC wire of necessary turns shall be inserted to reduce the inrush.

All the capacitors shall be of Metal Poly Propylene type, with insulation designed to withstand for 480V, with kVAR each as indicated in enclosed SLD.

The capacitor unit shall follow three phase Delta connection.

3 Nos. 1 phase, 1 core, 15VA cast resin CTs with ratio as indicated in SLD, Cl. 1.0 for metering for each feeder. The feeders & components shall be suitable for the required capacitive duty.

6.0 PUSH BUTTONS:

Push buttons shall be generally shrouded. Each push button shall be provided with 1 N/O and 1 N/C auxiliary contacts. “Stop” push button shall have, ‘stay-put’ feature. Colour code shall be as per IS-6875.

7.0 INDICATING LAMPS:

2 Nos. indicating lamps (LED Type) shall be provided in each capacitor feeder with red and green colour to indicate ‘ON’ or ‘OFF’

8.0 CURRENT TRANSFORMERS:

Current transformer shall be double wound, dry type and shall have good regulation (5% or less) to cope with inrush current of contactor coils with sufficient rating of HRC fuses for primary and secondary.

9.0 SPACE HEATERS:

Anti-condensation space heaters, with thermostat suitable for 230 V, 1 Ph supply along with a switch fuse/MCB shall be provided in each panel.

10.0 CONTROL SWITCHES:

A general purpose control switch shall be provided for selection of “Auto” & “Manual”. The switch shall be provided with engraving plate in the front with “Auto”,

“Manual” & “Off” inscription. This switch shall be normally of the fixed control bar type heavy duty unit.

11.0 APFC RELAY:

The APFC Panels shall be provided with APFC relay having 8/10/12/14 steps with facility for setting target P.F. range in the form of high and low, step indication, low current indication, and auto manual selection. A 7 segment LED display is provided to indicate existing power factor. The relay also provides over voltage protection upto 10% of rated voltage. Lead power factors are completely eliminated and the switching takes place on FIFO arrangement.

13.0 INCOMER CIRCUIT BREAKERS:

ACB/MCCB as specified in the Schedule of quantities.

14.0 EARTHING:

The Panels shall be provided with 2 earthing terminals of minimum M8 size on both sides of the Panel.

15.0 TESTS AND INSPECTION:

The panel shall be completely assembled, wired and tested as per IS-8623 at the factory in the presence of the Consultant/Purchaser's Engineer at no extra cost.

The test shall include wiring continuity tests, insulation resistance tests, high voltage tests (2.5 KV AC for 1 min) and functional tests to ensure operation of control scheme and individual equipment.

Manufacturer's Test Certificates in respect of all meters, contactors, switch fuse, capacitors, ACB etc shall be forwarded to Owner prior to inspection, by Bidder.

Panels to be type tested as per IEC 61439 as explained above in LT Panels requirement

All the Panels type tests to be witnessed in Factory before dispatch

16.0 DRAWING AND INSTRUCTION MANUAL:

Along with the offer, the Bidder shall submit the following documents:

- a. General arrangement drawings of the Automatic Power Factor Capacitor Panel.
- b. Single line diagram.
- c. Technical leaflets on meters fuse switches, switches, contactors, lamps, capacitors, power factor controller and its technical review etc.
- d. Type test reports conducted on similar equipment.

After award of the order, the manufacturer shall submit the following documents for approval.

- e. Arrangement of compartments, capacitor tray etc.
- f. Single line diagram.
- g. Control schematic diagram & power wiring.
- h. Complete technical particulars of all the equipment, meter etc.
- i. Commissioning & maintenance instructions for all equipments supplied.
- j. Set of reproducible for all the above drawings.
- k. 3 sets of “AS-BUILT” drawings along with tracings should be handed over to the Owner after commissioning.

VI SPECIFICATION FOR LOW VOLTAGE CAPACITORS

1.0 STANDARDS:

The capacitors shall conform to IS: IS 13340-1993, IS 13341-1992, IEC 60831-1+2 MPP capacitors for power system.

2.0 CONSTRUCTION:

The MPP type capacitors shall be suitable for operation on 440V, 3 Phase, 3 wire, 50 Hz solidly earthed AC supply system.

The capacitor element shall comprise of aluminium foils as conducting layers (electrodes) separated by 2 layers of electrical grade haze dielectric polypropylene film with both side roughness for better impregnation. The unit should be impregnated in the vacuum environment with Non-PCB Oil as the impregnate.

Several such elements shall be assembled into packs, connected to the terminals and enclosed in a metallic container. Each element shall be protected by fuse/PSD (Pressure Sensitive Disconnector). In the event of a localised fault, only the faulty element shall be isolated by its fuse from the rest of the elements without any appreciable change in the performance or output of the capacitor.

The capacitor unit rating shall be of 25KVAR, 440volt, 3 phases. The air in the container and the moisture absorbed by the PP shall be removed under high vacuum, at an elevated temperature and filled by high permeability, high dielectric strength and flame resistant oil.

After evacuation and impregnation, all voids shall be completely filled with the impregnate and the container shall be hermetically sealed to prevent ingress of air, dust and moisture.

The capacitor shall be suitable for a rated voltage of 440 volts and shall be of continuously operating at a maximum over-voltage of 10% above the rated voltage.

The Dielectric loss (operating loss) of the material should be restricted to ≤ 0.2 watts/kvar. Total losses of the capacitor unit (including discharge resistor) should be restricted to ≤ 0.45 watts/kvar.

The rated frequency is, 50 Hz. The capacitor shall however, be suitable for continuous operation with a frequency variation of + 5% from the rated frequency.

The capacitor shall be suitable for operation in temperature category 50 Deg.C. As per table 1 of IS: 13585-1994.

The capacitor shall also be capable of carrying without injury an increase in current loading upto 70% of the rated current which may arise due to increase in voltage, increase in frequency, presence of non-sinusoidal voltage supply or other causes. The maximum continuous reactive output of the capacitor shall not exceed 70% over the rated reactive output.

All capacitors shall be suitably tropicalized and rated for the service conditions on site. The capacitors shall be liberally designed and manufactured from best materials for satisfactory operation under onerous service conditions without causing any permanent injury or shortening of the life.

The capacitors shall be suitable for mounting in the rack modules of panels. Due to pressure of non-sinusoidal wave capacitor should be supplied with 7% detuned reactor.

3.0 DISCHARGE DEVICES:

Each capacitor bank shall be internally fitted with a low loss continuously rated effective discharge device. It shall be designed to discharge the entire capacitor from the peak A.C voltage to a voltage not exceeding 50 volts measured at the terminals of the capacitor within a maximum period of 1 minute of disconnection from supply.

VII. TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARDS

1.0 SCOPE:

This specification covers the design, manufacture, assembly, testing at works and supply of Distribution Boards. Complete with all accessories for efficient and trouble free operation.

2.0 CONSTRUCTION:

The distribution boards shall be fabricated out of 1.6mm thick sheet steel and shall be totally enclosed, dust and vermin proof, dead front, with hinged door type of bolted / welded construction suitable for wall mounting.

Each DB shall have individual hinged/bolted gasketed doors with can lock. Removable conduit entry plates shall be provided at top and bottom of the DB to facilitate drilling the conduit holes at site to suit individual requirements or knockout shall be provided.

Protective insulated cover plate shall be provided inside the panel to shroud all the live parts. Only the operating handle of the switch and the operating knobs of the miniature circuit breakers shall be projecting outside the cover plate. The unused outgoing gap of DB shall be suitably blanked with PVC plate at no extra cost. The incoming switch terminals should be suitably shrouded to avoid accidental contact. Each phase or way shall also be suitably shrouded with DMC/SMC/FRP. The boards shall be factory wired and assembled. Circuit identification cables shall be provided on the cover.

All Lighting/Power/UPS Distribution Boards shall be provided with Double Door arrangements with Phase segregation Type.

All components in the Distribution boards shall be same make.

3.0 BUSBARS:

The busbars shall be air insulated and made of high conductivity high strength Electrolytic copper busbars liberally sized with high safety factor for the required rating (both short circuit and continuous currents). The neutral busbar shall have adequate number of terminals for all outgoing single phase circuits. A copper earth bus of suitable size shall be provided in each DB for earthing of the power, lighting circuits and earthing of DB.

4.0 MINIATURE CIRCUIT BREAKERS:

The Miniature Circuit Breakers (MCBs) shall be heat resistant, moulded type, designed, manufactured and tested as per IS 8828. The MCBs shall have inverse-time tripping characteristic against over loads and instantaneous trip against short circuits. The MCBs shall be of fault current limiting type also. The MCBs shall be slip on type to the busbar. The ON and OFF machines of the switch handle shall be clearly marked. The MCBs shall be suitable for operating in ambient of 45deg.C without derating. The incoming and outgoing of the MCBs shall be accessible only after opening the front door of the DB. The MCBs shall be suitable for 415V, 3 phases, 4 wires, 50 Hz system with the fault level of 10 KA RMS symmetrical. The terminals of MCBs shall be suitable for use with eye lugs. The 4 pole, 3 pole and 2 pole MCB knobs shall be trunked with adequate strength tandem pin.

The MCB value of the instantaneous tripping current, they are categorized into 3 types, namely, B,C and D. Type B is for resistive or slightly inductive loads such as heating and lighting, Type C for Inductive loads such as motors or transformers and Type D for loads such as UPS,VFDs and high discharge illumination.

5.0 EARTH LEAKAGE CIRCUIT BREAKERS:

Incomer of the DB shall be provided with current operated Earth leakage circuit breakers with a sensitivity of 30mA/100mA/300mA as specified in the BOQ. The ELCB shall have Trip free mechanism and shall operate even on neutral failure.

The ELCB shall be provided with a Test Push Button to stimulate leakage and test the ELCB. The ELCB shall operate and switch off the circuit within milliseconds in case of a fault.

The enclosures of the ELCB shall be moulded from High quality insulating materials, which shall be fire retardant, anti-tracking, non-hygroscopic, and impact resistant and shall withstand high temperatures.

ELCB (HI/SI/Hpi Version) used for UPS application shall have enhanced high immunity against transient current and voltage and hence reduce unwanted tripping of the circuit in environments with disturbances and defects faults with DC components

6.0 GROUNDING:

The DBs shall be provided with two Nos brass earthing stud terminals with suitable nuts, washers etc for connection to earth bus outside the DB.

7.0 PAINTING:

Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage or corrosion due to damp or highly humid conditions.

The DB shall be prepared, primed, filled and painted to the highest standards.

All items shall be cleaned and deburred after fabrication and welding is complete.

External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface free from blemishes and imperfections and the whole shall be powder coated with epoxy paint and the shade shall be indicated later.

8.0 TEST:

All necessary routine tests shall be performed on the equipment to demonstrate satisfactory performance to owner / consultant at works without any extra cost. Equipment shall not be despatched without obtaining approval of test certificates for type, routine and acceptance tests.

9.0 DRAWINGS AND INSTRUCTION MANUALS:

Along with the offer, the bidder shall submit the following documents, in Triplicate.

- a. General arrangement of DB
- b. Technical leaflets on DB, MCB, isolator etc.
- c. Type test reports as per IS 8828
- d. Tripping characteristic curves for MCB.

After award of the order, the contractor shall submit the following documents for approval, in six copies.

- a. General arrangement drawing showing the constructional features, dimensions, installation details etc.
- b. Complete technical particulars of Distribution boards, miniature circuit breakers, isolators etc.
- c. Tripping characteristic curves for MCB.

Before taking up manufacturing of the equipment the Bidder shall have to take the approval of for design and drawing. Any manufacturing done prior to approval shall be rectified by the bidder at his own cost and the equipment shall also be supplied within the stipulated period.

VIII. TECHNICAL SPECIFICATIONS FOR 11KV HT CABLE

Sl.	Description	Application
1.	Type	: 11KV (E) , 3C XLPE compacted circular shaped cables consisting of H2/H4 grade stranded aluminium conductors, screened with extruded semi-conducting compound XLPE insulated, insulation screened with extruded semi-conducting compound in combination with a layer of non-magnetic copper tape. The inner sheath in between metallic screening and armouring and the outer sheath over armour shall be of extruded PVC compound. Armouring shall be of non-magnetic material. The cables shall conform to IS 7098/Part –2/1985 with amendments upto date and with ISI marking.
2.0	Voltage	: 11KV(E)
2.1	Purpose	: For use in H.T network (earthed system).Cables to be laid in ground.
2.2	Conductor Size & Material	: Size shall be as per BOQ & H2/H4 Grade Aluminium conductor.
2.3	Formation of Conductor	: Compacted circular
2.4	Number of Strands per core	: Shall comply with class 2 of IS:8130-1984
3.0	Cable lengths	: Cable shall be supplied in continuous drum length of 500 metres with a tolerance of plus or minus 3%.
3.1		A quantity of cable not exceeding 5% of the ordered quantity will be allowed to be supplied in non-stranded length, but none of which shall be less than 50% of the standard length mentioned.
4.	The following details / words may be indented, printed or embossed on the outer sheath of the cable at intervals of two metres approximately.	i. Trade mark ii. Manufacturers identification.
5.	Packing	: The cables should be securely packed in non-returnable wooden drums so as to withstand rough handling during transport by Rail, Road etc. and subsequent storage. The diameter of the

Sl.	Description		Application
			barrel of the drums should not be less than 20 times of overall diameter of the cable.
6.	The following information shall be stenciled on drums in bold letters :	:	<ul style="list-style-type: none"> a. Reference to the Indian standard specification. b. Manufacturer's name, brand name or trade mark. c. Type of cable and voltage grade. d. Number of cores. e. Nominal Cross sectional area of the conductor. f. Cable code. g. Length of the cable in metres. h. Number of the lengths in the drum. i. Direction of rotation of the drum. j. Approximate gross weight. k. Year of manufacture. l. The drum may also be marked with ISI certification mark.
6.1			The location of the outer end of the cable shall be indicated by an arrow mark in the drum.
7.0	Cable end Sealing	:	The ends of the cables shall be capped and sealed at both ends with end caps suitably to avoid entry of moisture.
8.0	Conductor Screening	:	Conductor screening over the conductor shall be provided by applying non-metallic extruded semi-conducting compound as per Clause – 10 of IS 7098/Part – 2/1985.
9.0	Insulation	:	The conductor shall be provided with cross linked polyethylene insulation as per Clause – 11 of IS 7098/Part – 2/1985 with its amendments upto date.
10.0	Insulation Screening	:	Cables shall be provided with insulation screening as per Clause – 12 of IS 7098/Part-2/1985 with its amendments upto date. Non-metallic part by extruded semi-conducting compound. Metallic part shall consist of non-magnetic copper tape.
11.0	Outer Sheath	:	The outer sheath shall be applied by extrusion as per Clause-17 of IS 7098/Part-2/1985 with its amendments upto date. The colour of the outer sheath shall be black.
12.0	Armouring	:	Armouring applied over the non-metallic part of insulation screening shall be of non-magnetic material only, and as per Clause –16 of IS 7098/Part-2/1985 with its amendments upto date. The armour wires/strips shall be applied as closely as practicable
13.0	Test Certificates	:	Type, routine and acceptance test and other special tests as per IS 7098 / Part – 2 / 1985 with its amendments upto date shall be conducted and test results shall be furnished.

IX. TECHNICAL SPECIFICATION FOR CROSS LINKED POLYETHYLENE [XLPE] PVC POWER AND CONTROL CABLES

1.0 SCOPE:

This specification covers the design, manufacture, testing at works, inspection and delivery at site of XLPE insulated and PVC power and Control cables.

2.0 STANDARDS:

The cables covered by this specification shall, unless otherwise stated, be designed manufactured and tested in accordance with the latest revisions of relevant Indian standards.

IS-694	:	PVC insulated cables for working voltages upto and including 1100 volts.
IS-1554	:	PVC insulated heavy duty cables for working voltages upto and including 1100 volts.
IS-3961	:	Recommended current ratings for PVC insulating and PVC sheathed heavy-duty cables.
IS-8130	:	Conductors for insulated electric cables and flexible cords.
IS-5831	:	PVC insulation and sheath of Electric cables.
IS-3975	:	Mild steel wires, strips and tapes for armouring of cables.
IS-7098	:	Cross linked polyethylene insulated PVC sheathed cables.
IS-6130	:	Conductors for insulated electric cables and flexible cords

3.0 CONDUCTOR:

The conductor shall be Copper as specified in the Schedule of Quantities. It shall be smooth, uniform in quality and free from scale and other defects. The stranded conductor shall be clean and reasonably uniform in size and shape. The conductor shall be either circular or shaped.

4.0 CONDUCTOR SHIELD:

Conductor shield shall be extruded in the same operation as the insulation. The semi-conductor polymer shall be cross linked.

5.0 INSULATION:

- a) Insulation shall be cross linked polyethylene and it shall preferably be gas-cured for XLPE cable
- b) Insulation shall be PVC for PVC cable as specified in the Schedule of quantities.

5.1 OUTER SHEATH:

All cables specified in the Schedule of Quantities shall have Outer sheath with XLPE / PVC, Fire retardant low smoke (FRLS) to reduce the Fire hazard.

- a. Oxygen Index - 29 when tested at $27 \pm 2^\circ\text{C}$.
- b. Temperature Index - Minimum 250°C at Oxygen Index 21.
- c. Flammability - As per IS 10810 Part 53 – 61 & 62.
- d. Smoke Generator - Smoke density rating shall not be More than 60%.
- e. Acid gas generation - Less than 20% by weight.

6.0 INSULATION SHIELD:

This shall preferably be of the strippable, triple-extruded thermoset type.

7.0 ARMOUR:

The armour may be of galvanised steel wires or galvanised steel strips

8.0 SERVING:

The cable serving shall protect the cable sheath and armour from electrolysis caused by stray currents, and from galvanic action. It shall also protect the cable from mechanical damage and corrosion.

9.0 GENERAL:

The cable shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

10.0 TEMPERATURE RISE:

The maximum conductor temperature shall not exceed 90°C during continuous operation at full rated current. The temperature after short circuit for 1.0 second shall not exceed 250°C with initial conductor temperature of 90°C .

Bidder shall give the following information in the Bid for each conductor cross section specified.

- a. Rated continuous current
- b. Rated 1.0 second short circuit / short time current

Rating factor shall be given by the Bidder for the following:

- a. Variation in ground temperature
- b. Variation in soil thermal resistivity
- c. Variation of Ambient Temperature
- d. For the cables laid side by side, at ID spacing and in Tier formation.

The Bidder shall also indicate the percentage overload that the cable can carry and its duration, when operating initially at a conductor temperature of 90 degree C, with peak conductor temperature of 130 degree C.

11.0 CABLE DRUMS:

Cables shall be supplied in non-returnable drums of sturdy construction. All ferrous and other metal parts of drum shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage. Type of dust preventive finish and coating adopted may be mentioned.

The length of cable on each drum shall be determined by manufacturer considering the transport limitations from manufacturer's works to the site.

12.0 TESTS:

12.1 Routine Tests: (To be performed on each drum length)

All tests as per relevant IS shall be conducted and shall be witnessed by the Client.

12.2 Type Tests:

The Bidder shall furnish two (2) copies of type test certificates conducted on similar cables along with the Bid.

- a. Partial discharge test
- b. Bending test followed by partial discharge test
- c. Dielectric power factor as function of voltage
- d. Dielectric power factor as function of temperature
- e. Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests.
- f. Impulse withstand test
- g. High voltage test.

13.0 SPECIFICATION FOR PVC ARMoured CABLE:

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard codes of practice or the British Standard Codes of practice where Indian standards are not available.

13.1 Cables:

All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. Cables shall have high conductivity stranded copper conductors and cores shall be colour coded to the Indian Standards.

All cables shall be new without any kinds or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600 mm centres.

14.0 INSTALLATION:

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain

the approval of the Architect / Client before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown on the schedule of work shall be regarded as a guide.

Cables rising indoors shall be laid on walls, ceiling, inside shafts, or trenches. Single cables laid shall be fixed directly to walls or ceiling. All supports shall be at not more than 500 mm. Where numbers of cables are run, necessary cable trays shall be provided wherever shown. Cables laid in built-up trenches shall be on steel supports. Aluminium identification tags shall be provided at every 20 m.

Cables shall be bent to a radius not less than 12 times the overall diameter of the cable, or in accordance with the manufacturer's recommendations whichever is higher.

In case of direct buried cables, the cable route shall be parallel or perpendicular to roadways, walls, etc., Cables shall be laid in an excavated, graded trench, over a sand cushion to provide protection against abrasion. Width of excavated trenches shall be as per drawings. Backfill over the cables shall be sifted earth 90% compacted cables shall be buried with a minimum earth cover of 600 mm. The cables shall be provided with cable markers at every 20 metres.

The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel / Distribution Board from where it is being laid. All cable terminations for conductors' upto 4sq.mm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cables terminations shall have necessary brass glands. The end- terminations shall be insulated with a minimum of six- half- lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

15.0 TESTING:

MV cables shall be tested upon installation with a 500 V Megger and the following readings established.

- 1) Continuity on all phases
- 2) Insulation Resistance(a) between conductors; (b) All conductors and ground

All test readings shall be recorded in the separate book and the same to be handed over to the Client/Architects.

SPECIFICATION FOR CABLE LAYING:**1. GENERAL:**

All cables shall be laid in ground, trenches & or on walls, trays as may be specified and as per schematic diagram.

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Engineer-in-charge before laying the cable.

All cables shall be clamped properly when laid along the wall /ceiling /cable tray. Cables laid in built-up trenches shall be on steel supports. Aluminium identification tags shall be provided at every 20 m.

Cables shall be bent to a radius not less than 12 times the overall diameter of the cable, or in accordance with the manufacturer's recommendations whichever is higher.

Cables shall be identified at end terminations indicating the feeder number and size and no. of runs and the Panel / Distribution Board from where it is being laid.

For Cables laid in soil, the cable route shall be parallel or perpendicular to roadways, walls, etc,

Cables shall be laid in an excavated, graded trench, over sand cushion to provide protection against abrasion.

Width of excavated trenches shall be as per drawings/ department specifications.

<u>Width of trench</u>	<u>Height of trench</u>	<u>sand cushioning</u>
i. For MV cable 250mm	600mm	750mm
ii. For HT cable	600mm	1200mm
		250mm

The cables laid in the excavated trenches shall be protected with bricks over the cable. The bricks should be laid laterally to the trench.

The cables laid in buried underground trench shall be provided with cable markers at every 10 metres.

All cable terminations for conductors' upto 4 sq.mm may be insertion type and all higher sizes shall have compression lugs.

Cable terminations shall have necessary brass glands.

Wherever cables pass through floor or through wall openings, it shall be taken through HDPE PVC/GI sleeves. The open ends of the sleeves shall be sealed by cold setting compound after cables are pulled through them to prevent entry of vermin and ingress of water.

In making connection on switches and other terminals no strand of conductor shall be cut to facilitate termination.

Cable armouring shall be earthed at both ends

The cable shall be as per the relevant IS amended from time to time, Test certificate should be submitted by the contractor for the cables supplied by him.

The contractor at his own cost and risk shall arrange all necessary tools & plants. The contractor will be held responsible for any damage to the building or equipment at the time execution of work.

2. TESTING:

Testing of complete cable installation shall be done as provided in general Specification for electrical works (Part 2 External) 1994/1995 amended upto date.

MV cables shall be tested after installation with a 500 V Megger and the following readings established.

- 1) Continuity on all phases
- 2) Insulation Resistance(a) between conductors; (b) All conductors and ground

All test readings shall be recorded in the separate book and the same to be handed over to the Engineer-in-charge.

X. TECHNICAL SPECIFICATION FOR CABLE TRAY

General Requirement:-

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in Electrical/ Instrumentation/ Communication systems.

Design and Fabrication of Cable Trays / Ladders:-

The cable trays / ladders shall be fabricated according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 3 meters						
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)			
			1.5m	2m	2.5m	3m
			Permitted Load (in kg/meter)			

Perforated Cable Tray	35	50 - 300	125	90	50	-			
	60	50 - 600	150	100	50	-			
	85	100 - 600	175	110	50	-			
	110	100 - 550	185	130	75	60			
Cable Ladder	45	200 - 600	180	140	100	55			
	60	200 - 600	-	225	150	100			
	110	200 - 600	-	310	200	140			
Safe Working Load (SWL) with a span length up to 10 meters									
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)						
			4m	5m	6m	7m	8m	9m	10m
			Permitted Load (in kg/meter)						
Perforated Cable Tray for long span distance	110	200 - 300	160	110	75	-	20	-	-
		400 - 600	200	150	100	-	40	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
Cable Ladder for long span distance	110	200 - 300	160	110	80	40	-	-	-
		400 - 600	210	150	100	70	-	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
	200	200 - 600	-	-	300	250	200	140	100

Fabrication of Tray / Ladder and accessories at site and welding is not permitted. In unavoidable circumstances, If any cut or holes are made in the trays/Ladder/accessories, zinc spray need to be applied over the surface. The metal edge has to be protected by edge protection sleeves to avoid cable damage. Edge of the supports has to be protected with plastic END caps. Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.

Cables shall run in cable tray / ladder mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures using mounting accessories

Cable Tray:-

The cable tray and all accessories shall be fabricated from sheet steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications & should have a Base Perforation Class B according to IEC 61537. The cable trays shall be supplied in standard lengths of 3000mm and the width of the tray shall be as follows.

Width: 50, 100, 150, 200, 300, 400, 500, 600 & 750 mm.

All the cable tray accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be from the same material as of the tray and modular type, it should be connected with the trays by using fasteners. Typical details of trays, fittings and accessories; etc are shown in the enclosed drawings.

For Cable trays designed, tested and confirming to IEC 61537, thickness of cable tray should be according to the manufacturer's catalogue. For locally fabricated and non-tested tray, thickness should be 2 mm up to span length of 1.5 meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meter

Cable ladder:-

The cable Ladder and all accessories shall be fabricated from sheet steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications & should have a Free Base Area classification Y according to IEC61537. The cable ladders shall be supplied in standard lengths of 3000/6000 mm and the width of the tray shall be as follows.

Width: 200 to 1200 mm in multiples of 100 mm

Maximum rung spacing in the ladder shall be 300mm. The rungs should be made of C profiles suitable to fix cables by special metal clamps according to the drawing. The ladder shall be of riveted and foldable type for easy transportation and to avoid damage during transportation and storage. All the ladder accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be made from the same material as of the ladder and modular type, it should be connected with the ladder by using fasteners. The details of ladders, fittings and accessories .etc are shown in the enclosed drawing.

For Cable Ladders designed, tested and confirming to IEC 61537, thickness of cable Ladder should be according to the manufacturer's catalogue. For locally fabricated and non-tested Ladder, thickness should be 2.5 mm up to span length of 1.5 to 2 meter, 3 mm for span length between 2.5 to 4 meter and 3 to 4 mm for span length between 5 and 10 meter

Cover for Cable Trays / Ladders:-

Cover for trays/ladders to protect the cable insulation from falling objects, water droplets, harmful effects of ultraviolet rays and accumulation of dust. The cover shall be made either from Hot Dip Galvanized sheet steel or superior quality Double Dip Galvanized Sheets. For Outdoor application, Double dip Galvanized material shall be used. The covers should be fitted properly to the Ladder / Tray by using pre fixed and tested locks which ensure that covers are fitted rigidly to Tray / Ladder. For outdoor application in high wind areas, additional cross over beadings to be used for fixing the cover on tray / ladder of width more than 500 mm.

Mounting Accessories (supports and Brackets):-

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hard ware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

Corrosion Protection:-

The cable tray / ladder/accessories shall be of HOT DIP Galvanized (ISO 1461-1999) for installations in corrosive atmospheres both indoor and outdoor application. Sample tray / ladder / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 for > 500 hours. (*550 hours according to class 6 for Hot dip Galvanized surface as per ISO)

Testing and Certification:-

Cable tray / Ladder, bend, T Bend, cross, and all supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray/ladder should not deflect more than $1/100^{\text{th}}$ of the span length at SWL in Mid span and the transverse deflection of all mounting accessories at SWL shall not exceed $1/20^{\text{th}}$ of the length. The cable tray / cable ladder should be tested up to 1.7 times SWL at minimum and maximum room temperature. The temperature classification of cable tray system should be - 5 to + 150°C.

Marking, Documentation, Compliance and Inspection:-

Each system component shall be durably and legibly marked with:

- the manufacturer's or responsible vendor's name or trade mark or identification mark;
- a product identification mark which may be, for example, a catalogue number, a symbol, or the like.

When system components other than cable tray lengths and cable ladder lengths are supplied in a package, the product identification mark may be, as an alternative, marked on the smallest package unit.

Marking shall be applied, by moulding, pressing, engraving, printing, adhesive labels, or water slide transfers. Compliance is checked by inspection and, for marking on the product, by rubbing by hand for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with petroleum spirit. Marking made by moulding, pressing, or engraving is not subjected to the rubbing test. After the test, the marking shall be legible.

If a system component is stored and transported at a temperature outside the declared minimum and maximum temperatures, the manufacturer or responsible vendor shall declare the precautions and the alternative temperature limits. Compliance is checked by inspection.

The manufacturer or responsible vendor shall provide in his literature all information necessary for the proper and safe installation and use of the cable tray system and cable ladder system. The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include;

- a. Instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables.
- b. Thermal Expansion properties and precautions to be taken, if necessary,
- c. Material, Surface Treatment and Salt Spray Test certificate
- d. Relative humidity if it affects the material and Surface Treatment
- e. Information on holes or devices provided for equipotential bonding or to run Earth Bonding Bar
- f. Precautions for transport and storage outside the declared temperature classification, where applicable
- g. Product dimensions
- h. Torque setting in Nm for screwed connections and internal fixing Devices. These devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections. To test the screwed connections, it shall be tightened and removed.
- i. End Span Distance
- j. Position and type of coupling along the span
- k. SWL in kg/m for the fittings when not directly supported
- l. Fixing method for installing cable tray or cable ladder to the supports
- m. SWL in kg/m for the cable tray lengths or the cable ladder lengths including joints for various Span Distances. SWL information can be given in the form of a diagram, table or similar. Compliance is checked by inspection
- n. SWL in kg for cantilever brackets
- o. SWL for pendants as a bending moment in kg and /or as a force in N
- p. The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable

XI. TECHNICAL SPECIFICATION FOR WIRING

1.0 SCOPE

This specification covers the standards of internal wiring.

2.0 INTERNAL WIRING

System of Wiring

The system of wiring shall consist of FRLS PVC insulated copper conductor wires in MS / PVC conduits and shall be concealed or surface mounted as called for.

3.0 GENERAL

Prior to laying and fixing of conduits, the Contractor shall carefully examine the working drawings prepared by him and approved by the Consultant, indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switchboxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor shall be got approved before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit and as far as possible, No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

4.0 CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. Joints between conduits and accessories shall be securely made.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 1100 volt grade FRLS PVC insulated wires that may be drawn into rigid non metallic or MS / GI Conduits are given below :

Size of wires Nominal cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

5.0 BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and / or circular inspection boxes with adequate and suitable inlet and outlet joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 4.5 cms or three times the outside diameter of the conduits.

6.0 FIXING OF CONDUITS

All conduits shall be installed so as to avoid steam and hot water pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, insects or another foreign matter does not enter into the conduit system.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface.

7.0 SWITCH OUTLETS AND JUNCTION BOXES

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 2 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in BOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall be of a minimum depth of 65 mm.

8.0 INSPECTION BOXES

50 mm dia inspection boxes of cast iron shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

9.0 CONDUCTORS

All FRLS PVC insulated copper conductor wires shall conform in all respects to Indian Standards.

10.0 BUNCHING OF WIRES

Wires carrying current shall be so bunched that the outgoing and return wires are drawn in to the same conduit. For lighting wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate.

11.0 DRAWING CONDUCTORS

The drawing and jointing of FRLS PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks.

Insulation shall be removed by insulation stripper only. Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal

screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

All light points will terminated through a connector. Conductors having nominal cross sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring license to Client) and cable jointers shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing. For all internal wiring FRLS PVC insulated wires of 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all work of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of FRLS PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 1.5 sq.mm copper Separate neutral to be pulled for each circuit.

12.0 JOINTS

All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

13.0 COLOUR CODE OF CONDUCTORS

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

XII. TECHNICAL SPECIFICATION FOR THE LIGHTING LUMINARIES

1.0 SCOPE

This specification covers the design, material specification, manufacture, testing at works, inspection and delivery at site of light fittings and their associated accessories.

2.0 STANDARDS

The light fittings and their associated accessories such as lamps / tubes, reflector, housings, ballasts etc. shall comply with the latest applicable standards. All luminaries, lamps and accessories shall be of same make.

3.0 GENERAL REQUIREMENTS

Fittings shall be designed for continuous trouble-free operation under hot humid atmospheric conditions, at the specified ambient temperature, without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather proof and rain proof type.

The fittings shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps / starters etc.

Connections between different components shall be made in such a way that they will not work loose by small vibration.

For each type of light fitting the Contractor shall supply the utilisation factor to indicate the proportion of the light emitted by the bare lamp which falls on the working plane.

The fittings shall be supplied complete with lamps.

The fittings and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant standards.

All Discharge Lamp fittings shall be complete with accessories like lamps, ballasts, power factor improvement capacitors, starters / igniters wherever applicable, etc. These shall be mounted as far as possible in the fitting assembly only.

Outdoor type fittings shall be provided with Weather Proof control gear box. The fittings shall be power factor corrected to 0.99 lagging (Maximum).

Each fitting shall have a terminal block suitable for loop-in, loop-out and T-Off connection. The internal wiring shall be completed by the Manufacturer by means of stranded copper wire and terminated on the terminal block.

All hardware used in the luminaries shall be cadmium plated / zinc passivated.

4.0 EARTHING

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

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

5.0 PAINTING / FINISH

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

The housing shall be stove- enamelled / epoxy stove- enamelled / vitreous enamelled or anodised as indicated under various types of fitting. The finish of the fitting shall be such that no bright spots are produced either by direct light source or by reflection.

TECHNICAL SPECIFICATIONS FOR EXIT LIGHT SPECIFICATION

INPUT: 230V AC

LAMP: LED

BATTERY: 6 VOLT 4.2 AH MAINTENANCE FREE BATTERY

CHARGING TIME 16 HRS

SIGN LIGHTING:

INPUT: 230V AC

LAMP: LED

BATTERY: 6 VOLT 4.2 AH MAINTENANCE FREE BATTERY

CHARGING TIME 16 HRS

6.0 LED FITTING

For LED light fittings, the complete luminaire should have a warranty for 5 years which includes the housing + LED + Driver

During the procurement of LED lighting, the following specification should be followed:-

1. Technical requirements for LED:

- a. LED efficacy shall be greater than 100 Lumens/Watt (for luminaire system wattage upto 45W)/120 Lumens/Watt (for luminaire system wattage above 45W) @ 350mA drive current. In respect of LEDs of higher power ratings, drive current greater than 350mA can be accepted if the LED's LM 80 / IS: 16105 test reports support the same.
- b. LED used should be of SMD type only.
- c. LM – 80 / IS : 16105 Test Reports of specific LED at the soldering point temperature of 85°C for the driving current at which the LEDs shall be driven, shall be obtained during procurement.
- d. Reported life Span of LEDs used in the Luminaire shall be greater than 50,000 Hrs at the soldering point temperature of 85°C and at the luminaire driving current.

- e. The LEDs shall comply to Photo biological Safety norms as per IEC 62471 / EN 64271 / IS: 16108
- f. View angle: Typical 120°
- g. Colour temperature of the proposed white colour LED shall be 5700K (i.e. 5665K±355K, as per ANSI standard C78.377A). Colour point should fall within the 7Step McAdam as per ANSi standard C78.377A.
- h. Colour Rendering Index (CRI); Greater than or equal to 65

2. Technical requirements for LED driver:

- I. Min. efficiency of driver: 85% (for driver power output rating \leq 100W); 90% (for driver power output rating $>$ 100W).
- II. Power factor of complete fitting : Greater than 0.90
- III. Input Operating Voltage: 140 V to 277V AC.
- IV. In – build high and low voltage cut – offs : 140V (Low) and 277V (High)
- V. Short circuit protection / Open load protection
- VI. Driver Surge Protection standard: Min 3kV. If a site / location is prone to lightning and surges, 10 k V surge protection (external to the driver circuit) to be provided with the luminaire. The Surge Protection Device (SPD) should fail safe (i.e. without leading to fire hazard) and its failed status should be clearly visible through a flag/indication.
- VII. Total Harmonic Distortion (THD) : Less than 20% at full load
- VIII. Tc (Maximum Driver case temperature) must be declared for the luminaire.
 - i. Isolated driver should be used.
 - j. Potting of LED Driver: For driver power output rating \leq 50W, potted driver shall be preferable (but not mandatory). But for driver power output rating $>$ 50W, potted driver shall be a mandatory requirement.
 - k. The power supply shall be connected to be LED PCBs through proper connectors.
 - l. CMI/EMC compliance: Compliance to the following EMI/EMC standards:
 CISPR 15/IS:6573
 IEC: 61547 (reference standards are listed as follows)
 - IEC 61000 – 4 – 2 / IS:14700 P art 3: Sec 2
 - IEC 61000 – 4 – 3
 - IEC 61000 – 4 – 4 / IS: 14700 Part 3L Sec 4
 - IEC 61000 – 4 – 6
 - IEC 61000 – 4 – 11 / IS: 14700 Part 3: Sec 11

IEC: 61000 – 3 – 2 (Class C) / IS:1534 Part 1 (d) IEC: 61 000 – 3 – 3 / IS 14700: part 3: Sec 2

- m. Driver shall comply with the safety requirements laid down in IEC: 61347 – 2 – 13 / EN: 61347 – 2 – 13 / IS: 15885 – 2 – 13.
- n. Driver shall also comply with the performance requirements as per IEC: 62384 / IS: 16104.

3. Technical requirements of electronic components used:

The circuit boards and electronic components to be used in the luminaire should be of rating / type so as to provide reliable functioning. Following shall be the requirements during procurement;

- a. Junction temperature rating of I.C. shall be obtained for the luminaire.
- b. Capacitor type and temperature rating shall be obtained for the luminaire.
- c. Material of resister shall be furnished
- d. Junction / channel temperature rating of switching device s like MOSFET and transistor shall be obtained.
- e. MCPCB is to be used for mounting of LEDs
- f. FR4 grade PCBs of min. thickness of 1.6 mm shall be used in driver circuits.

4. Technical requirements of luminaire

- a. The luminaire shall have LM – 78 / IS: 16106 test report from a NABL accredited laboratory.
- I. The min. system lumen efficacy of the luminaire shall be as follows:
- II. 80 lm / W (luminaire system wattage \leq 45)
- III. 90 lm / W (luminaire system wattage \geq 45)

The luminaire must have secondary lens/optics. Though the secondary lens/optics does result in minor loss of lumens, it is nevertheless a must to distribute the light output of the LED s so as to achieve the desired polar curve characteristics for the luminaire – no exemption shall be permitted on this account. The material of lens should preferably be PMMA.

Color temperature: 5700K (5665 \pm 355K, as per ANSI standard C78.377A)

CRI: Greater than or equal to 65

Housing of luminaire: Pressure die – cast LM6/ADC12/LM24 housing

Cover type: Toughened glass or UV stabilized polycarbonate cover

Housing protection: IP – 65. If the LEDs and LED Driver are in different compartments, then the two compartments must be individually IP – 65. For achieving IP – 65, proper gaskets should be provided.

Impact Resistance: IK – 05

Temperature rise test: When the luminaire has stabilized thermally, soldering point temperature of the LEDs must be equal to or less than 85°C. Temperature rise (above ambient) of heat sink should generally remain within 20°C – relaxation on this account can be granted as long as the soldering point temperature limit of 85°C is not violated and there is no unacceptable outcome.

- IV. During procurement, the photometric data report in respect of the luminaire offered (through DIALux, CALCULUX or other simulation software) should be obtained. IES Photometric File is also to be supplied and firms to be warned of serious consequences against submission of a tempered/doctored report.

Conformance Standards for LED lamps:

1. LM80 compliance certificate to be adhered by the LED manufacturer. LED data sheet should comprise of lumen output, junction temperature, pad temperature, thermal resistance, and LED drive current.
2. The luminaire shall conform to IEC 60598 or equivalent standard and the driver should comply with IEC 61347-2-13, IEC 61547, CISPR-15, IEC 62124 and IEC 62384.
3. Luminaire should be tested as per BIS 10322 standards and following Test Reports should be submitted: Heat Resistance Test, Thermal Test, Ingress Protection Test, Drop Test, Vibration Test, Electrical / Insulation Resistance Test, Endurance Test, Humidity Test, Photometry Test (LM 79 Report), Electronics Test.

Technical Specifications of Galvanised Octagonal Poles (Street light)

Design:

The poles shall be designed to withstand the maximum wind speed of 180 km / hr. The top loading i.e. the weight and the area of top luminaires are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982. For the Design of Octagonal Poles, the Structural Calculation Details, confirming the suitability as per standards, shall be produced by the Supplier.

Pole Shaft:

The pole shaft shall have **Octagonal** cross section and shall be continuously tapered with **single longitudinal welding**. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process.

The **Octagonal** pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection Agency.

Door opening:

The pole shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Material - Octagonal Poles Conforming to Gr. S355JO as per BSEN 10025 With

Yield Strength - 355 N/ Sq.mm

Tensile Strength- 490 – 630 N/ Sq.mm

Base Plate - Fe 410 conforming to IS 226/ IS 2062

Foundation Bolts - 6.8 Gr. As per IS 1367

Test Certificates from the Steel Manufacturer for the above to be produced by the supplier.

Welding

The welding shall be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal pole shafts.

Pole sections The Octagonal Poles up to the length of 8 meters shall be in single piece with single longitudinal welding joint. There shall not be any circumferential weld joint.

Galvanization The poles shall be hot dip galvanised as per IS 2629/ IS 2633/ IS 4759 standards with average coating thickness of 65 micron. The galvanizing shall be done in single dipping. Galvanising Test Reports as per standards shall be produced by the manufacturer of Poles. The supplier should show the average galvanizing coating thickness of 65 microns on the poles during supply before the erection.

Fixing Type: The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity. The Test Certificate for Foundation Bolts shall be produced by the supplier.

Top Mountings Galvanized fixture mounting bracket shall be supplied along with the poles for installation of 1 No.(for Single Sided Arrangement) or 2 nos.(for Centre verge Arrangement) 45W LED Street Light Fittings.

XIII. TECHNICAL SPECIFICATION FOR CEILING FANS AND EXHAUST FANS

1. HEAVY DUTY EXHAUST FANS:

- The exhaust fan shall be capacitor start and run type, continuously rated motor.
- Double ball bearing with Class A and E insulation.
- Dynamically balanced propeller type impeller.
- Silence motor that lasts longer and delivers the maximum output at lower operating cost.
- Low sound level.

2. CEILING FANS

Ceiling fans shall be complete with fan suspension – stem canopies and regulators (Electronic type). Required length of suspension –stem shall be provided at site. The stem shall be heavy duty galvanised steel tubes to I.S 1239 – 1958.

Fans shall be mounted on a pre-embedded hook with hard rubber isolator. Regulators shall be non-stop type mounted in the switch box.

The fan shall be made out of following accessories.

- Double ball bearing.
- Blades are aerodynamically designed and made of heavy gauge aluminium sheets.
- Motor is made of superior grade copper wire and low-loss silicon steel stampings.
- Coated with special anticorrosive enamel paint in Brown or White colour.
- Fans shall be confirming to ISI specification.
- Suitable rating of capacitor.

XIV. TECHNICAL SPECIFICATION FOR EARTHING SYSTEM

1.0 EARTHING:

1.1 Scope:

This specification covers the supply, installation testing and commissioning of earthing system.

1.2 Standards:

IS 3043	:	Code of Practice for earthing
Indian Electricity Rules	:	1956
Indian Electricity Act	:	1910
And Local Electrical Inspectorate Regulations.		

1.3 General Requirements:

The plant shall be provided with complete earthing system comprising earth electrodes in conjunction with earth grid.

Design criterion:

Earthing system should be TNS. The system to be as per IS 3043

Earth Grid:

A composite earthing grid to cover all plant area, indoor switchgear and transformer rooms, outdoor switchyard and transformer yard should be provided.

The outdoor earthing grid should comprise earthing strips, earth electrodes driven into ground and earth pits where earth electrodes are put in to treated pits

The buried earthing strips should be put around the perimeter of the plant buildings as per earthing drawings

The indoor and outdoor earthing strips and all earthing electrodes should be interconnected to form a composite earth grid

The resistance of the earth grid to earth should be less than 1 ohm, to achieve this additional external buried earthed conductors and earth electrodes should be provide as per earthing drawing

Main Earth grid conductor:

Galvanized steel flats which should be able to carry the system earth faults current for 1sec wherever the earthing conductor crosses or runs at less than 300mm distance along metallic structures such as gas, water and steam, conduits, pipes etc., and steel reinforcements in concretes , it should be bonded to the same.

All panels, DBs, Junction boxes, field switches, cable end boxes, glands, fittings and fixtures should be double earthed

Flexible earthing connectors should be provided where flexible conduits are connected to rigid conduits to ensure continuity.

Jointing:

Earthing connections to equipment earthing terminals should be of the bolted type with GI bolts and nuts, two bolts should be provide for making each connection. Equipment bolted connections should be painted with an anti-corrosive paint/compound.

Connection between equipment earthing lead and main earthing conductors and between main earthing conductors should be of the welded type

Steel to copper connection should be of the brazed type.

Bonding and Earthing for static electricity:

All electrical equipment, structure, plants, metallic bodies as well as all joins in pipe lines, valves, storage tanks etc. should be made electrically continuous by bonding and earthing

Some of the statutory provisions for earthing are as follows.

1. All medium voltage (i.e. which does not exceed 650V under normal conditions of supply) equipment shall be earthed by means of two separate and distinct connections with earth.
2. As far as possible all earth connections will be visible for inspection.
3. No cut out, link or switch other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and live conductors shall be inserted on any supply system.

The basic system of earthing shall be TNS wherein separate neutral and protective conductors are provided throughout the system. This ensures that a metallic path is available for earth fault currents to flow from the installation to the earthed points of the source.

A bi-colour combination using green and yellow shall be used for identifying the protective conductor and no other purpose. This is the only colour permissible as per IS 3043.

1.4 Details of Earthing System:

Unless otherwise specified main earthing shall not be less than 65x10mm GI flat.

The minimum size of earthing conductor of various equipment shall be as follows:

- | | | | |
|----|--|---|------------------------|
| a. | 400KVA Transformer & 380KVA DG Neutral | - | 26 x 06 mm copper flat |
| b. | Transformer, DG& HT Panel body | - | 50 x 06 mm GI flat |
| c. | MPCC Panel body | - | 50 x 10 mm GI flat |
| d. | LT Switch boards body | - | 25 x 06 mm GI flat |
| e. | Distribution Panels | - | 25 x 03 mm GI flat |

1.5 Earth Electrode:

Earth electrodes shall be erected 1.5 Mtrs away from the building edge and minimum spacing between the electrodes 3 Mtrs shall be maintained as per IS: 3043

1.6 Earthing Layout:

Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise.

Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, etc. it shall be laid minimum 300 mm below and shall be re-routed in case it fouls with equipment structure foundations.

Tap-connections from the earthing grid to the equipment/structure to be earthed shall be terminated on earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid, otherwise, "earth riser" shall be provided near the equipment foundation/ pedestal for future connections to the equipment earthing terminals.

Earthing conductors along their run on cable trench ladder columns, beams, walls, etc shall be supported by suitable cleating at intervals of 750 mm. Earthing conductors along cable trenches shall be cleated to the wall nearer to the equipment. Cable trays and supports shall be connected to the earth mat at every 10 meters interval. Wherever it passes through walls, floors, etc GI sleeves shall be provided for the passage of the conductor.

Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.

1.7 Equipment Earthing:

All electrical power items shall be earthed by two separate and distinct earth connections from main earth bus.

Earthing pads shall be provided by the supplier of the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by short and direct earthing lead free from links and splices.

Electrical continuity shall be ensured by bonding the different sections of hand-rails and metallic stairs.

Metallic pipes, and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

Metallic conduits shall not be used as earth continuity conductor.

Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, pipes etc. and steel reinforcement in concrete, it shall be bonded to the same.

Cable endboxes, glands, etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points.

The metallic screens of the single core cable shall be connected to earth at one end only.

1.8 Jointing:

Earthing connections with equipment earthing pads shall be bolted type. Contact surface shall be free from scale, paint enamel, grease, rust or dirt. Two bolts shall be provided for making each connections. Bolted connections, after being checked and tested shall be taped with PVC tape.

Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

The jointing between copper and GI or copper and Aluminium or GI and aluminium should be done by using suitable bimetallic strip for entire area of jointing.

1.9 General:

Excavation and refilling of earth necessary for laying of underground earth bus and earth pipes shall be the responsibility of the Contractor.

All earth electrodes shall be tested for earth resistance by means of standard earth resistance tester.

Earthing resistance of the main bus shall be measured after connecting all the electrodes to the bus and the resistance shall not exceed one (1) ohm.

The exact location of Earth Bus/conductor, earth electrodes and earthing points on the equipment shall be determined at site in consultation with owner. Any change of methods, routing, and size of conductor shall be subject to approval by Owner.

XV. TECHNICAL SPECIFICATION FOR INSTALLATION

1.0 GENERAL:

The electrical installation shall be complete in all respects and any item not included in the specification but essential for proper installation and functioning of the electrical system shall be deemed to be included in the scope of the specification whether specifically mentioned or not.

All equipment shall be shifted from the place of storage to erection site by the Contractor and shall be thoroughly cleaned of packing materials, scales, rust, oil, grease etc prior to commencement of the installation work. All equipments shall be checked physically for the completeness of all devices before taking up installation.

After installation all unused cable/conduit entries shall be efficiently sealed.

All equipments and accessories shall be installed strictly in accordance with the manufacturer's instructions/ drawings. Equipments supplied in sections or dismantled

condition shall be reassembled at site with all associated accessories as per the manufacturer's instructions. All accessories required like hardware, junction box glands, transparent polycarbonate sheets etc. shall be supplied by Contractor.

A Model installation shall be made for approval by the Client, before proceeding with the final installation.

The system under the scope of work shall conform to the latest codes and standards as amended in the respective technical specification and schedule of works. Nothing in the specification shall be construed to relieve the successful tenderer's from the responsibilities where specifically mentioned in the tender or not.

The following standards as amended shall also be covered.

Installation:

All electrical works shall comply with following standards:

Indian Electricity Rules – 1956.

Gujarat State Code of Practice for Installation.

- a. Contractor shall follow all the rules & regulations prescribed in Roads & Buildings department electrical Schedule of rates (SOR)

Local Electrical Inspectorate Guidelines on electrical installation.

IS10028 : Code of Practice for installation of transformers

IS732 : Code of Practice for electrical wiring installation.

IS5216 : Guide for safety procedures & practices in electrical work.

IS10118 : Code of practice for section, installation and maintenance of LT Switch, switch gears & control gears.

IS:12063 : Degree of Protection provided by enclosures

IS:8623 : Specification for Factory Built Assemblies for Voltages upto 1000V AC & 1200V DC

IS:1646 : Code of Practice for Fire Safety of Buildings (General) Electrical Installation

IS:3043 : Code of Practice for Earthing

Workmanship shall be highest standard and /quality.

EQUIPMENT AND MATERIALS

All equipment and materials supplied by the Contractor shall be suitable in all respects, for the type of environment specified.

All equipment and materials supplied shall be to the approval of the Contractor regarding Quality, Conformity to the specification and standards and suitability for the specified site conditions.

STORAGE AND CARE PRIOR TO ERECTION

The Contractor shall be fully responsible for the safe storage and care of equipment and materials. The Contractor shall be responsible for care and maintenance of all the Electrical equipments, whether supplied /erected by him, after the installation is completed and until the final certificate of acceptance of Electrical Installation is signed.

Equipments:

All equipments shall be installed strictly in accordance with manufacturer's instructions / drawings.

All HT and LT panels shall be erected on suitable base frame.

Distribution boards shall be erected on wall such that height of top of board will be at 1800 mm.

Switch boards / MCCs shall be erected with a front clearance of not less than 1000 mm and a clearance of not less than 750 mm at the rear clearance of there are cable entries or with a rear clearance of less than 200 mm in case there are no cable entries or attachments at the rear.

TRANSFORMER

Transformer shall be handled and erected as per relevant code of practice and as per manufacturer's drawings and instructions.

After erection of the transformer on the plinth, suitable wheel stopper shall be fixed.

MPCC PANEL

MPPC Panels shall be erected as per relevant code of practice for Installation.

After erection of all the panels, necessary inter panel wiring shall be done.

All panel fixing bolts and busbar bolts shall be tightened using torque wrench.

Necessary front / rear / side clearance shall be maintained as per statutory regulations.
All unused holes shall be blocked.

LV PANELS

All busbar joints shall be tightened using torque wrench and all shipping sections shall be properly bolted together.

After completion of cable terminations, all unused cable entry holes are to be covered to make the panel vermin proof.

CABLES:

Cable shall be taken on trays fixed on ceiling / wall.

Cable tray shall be of Galvanised iron with welded runs.

All cable shall be provided with punched aluminium identification tags at every 100 m interval at both ends.

EARTHING:

Earthing shall be as per IS 3043.

All electrical power items shall be earthed by two separate and distinct earth connections from main earth bus.

General grounding shall be done to achieve earth resistance of less than 1 Ohms.

Special grounding shall be done to achieve earth resistance of less than 0.5 Ohms.

Earth electrodes shall be erected 1500 mm away from the building edge and minimum spacing between the electrodes shall be 3000 mm.

Earth electrodes – 40 mm Dia GI pipe 3 m long with 600 x 600 x 3mm Copper (or) 600 x 600 x 6mm GI plate earthing.

TYPE OF WIRING:

Substation building, electrical rooms :Open wiring using M.S conduit

General office & Toilet areas :Open conduit wiring Using MS conduit above false Ceiling & concealed wiring below false ceiling

LIGHTNING PROTECTION:

Lightning protection shall be as per IS 2309 / IEC 62305

Size of lightning shall be as per IS 2309 / IEC 62305

MCB DISTRIBUTION BOARDS:

All DBs shall be phase segregated type as required by the Electrical Inspectorate.

All DBs shall be powder coated, double door type.

All MCB breaking capacity shall be 10 KA.

DISTRIBUTION BOARDS:

Distribution boards shall be erected on wall with concealed system inside the premises areas and open system in all electrical rooms. Erection cost shall be inclusive of all fixing brackets, hardware etc.

Necessary clearance shall be maintained in front of the Distribution Boards for operation and maintenance

LIGHT FITTINGS:

All equipment shall be thoroughly cleaned of packing materials, scales, rust, oil, grease etc prior to commencement of the installation work.

All equipments shall be checked physically for the completeness of all devices before taking up installation.

All equipments and accessories shall be installed strictly in accordance with the manufacturer's instructions/ drawings. Equipments supplied in sections or dismantled condition shall be reassembled at site with all associated accessories as per the manufacturer's instructions. All accessories required like hardware, junction box glands, hylum sheets etc to be supplied by contractor.

3.0 LIGHTING:

The Installation charges shall include all fixing accessories like screws, anchor fasteners, clamps, cleats, down rods, ball socket, earthing, cabling and wiring works etc. The AC lighting shall operate at 230V, 1 Phase, the supply being taken from the lighting DB.

3.1 Indoor Lighting:

Open conduit system using MS conduits above false ceiling and concealed conduit system below false ceiling, shall be adopted, as required.

In all Service building, Electrical room, AHU room, open conduit wiring using MS conduit shall be adopted and in all Staircase area concealed conduit wiring using PVC conduit shall be adopted and general office area & Toilet area open conduit wiring using MS conduit shall be adopted above the false ceiling area & concealed conduit wiring using PVC conduit shall be adopted below the false ceiling.

Conduit pipes, whenever necessary, shall be fixed by 16 SWG saddles with spacers, in an approved manner at intervals of every 300mm.

Saddles shall be fixed on either side of couplers, bends or similar fittings at a distance of 300mm from the centre of such fittings.

The cost of saddles, clamp etc., shall be deemed to have been included in the installation charges.

Switches of lighting circuits shall be mounted at 1300mm above finished floor level.

Where fittings are suspended, ball and socket type suspension units shall be used.

Earth continuity shall be maintained throughout the entire installation.

4.0 CABLING:

No cable shall be laid alongside a water main. Spacing equal to the diameter of the cable shall be maintained between adjacent power cables.

Selection of cable drums for each run shall be so planned as to minimise straight through joints. In each cable run, extra length shall be kept at a suitable point to enable one straight through joint to be made, should the cable develop a fault at a later date.

All due care shall be taken during unreeling, laying and termination of cable, to avoid damage due to twist, kink and sharp bends, etc. Wherever cables pass through floor or through wall openings, it shall be taken through Al. pipe sleeves. The open ends of the sleeves shall be sealed by cold setting compound after cables are pulled through them to prevent entry of vermin and ingress of water.

While laying cable, cable rollers shall be used at an interval of 2.0 Mts. The cables shall be pushed over the rollers by a gang of people positioned between rollers. The cable shall not be pulled from the end without intermediate pushing arrangement. The bending radius shall not be less than that specified by the manufacturer.

Each cable shall be provided with an identification tags at entrance and exit from any equipment. The tag shall be of aluminium, with the number punched on it and securely attached to the cable by not less than two turns of GI wire.

Single core cables shall be laid in trefoil formation and clamped with trefoil clamps at every 600mm intervals.

All multi core cables shall be secured to the cable tray by clamps at every 600mm intervals.

Cables from overhead cable trays to the equipment shall be taken in prefabricated cable tray with cover/GI Pipe sleeves.

4.1 Direct In Ground:

Power and control cables laid directly in ground shall be laid generally conforming to the requirements of code of practice IS: 1255. Generally cables shall be taken at a depth of 750mm from finished ground level and shall be provided at least 150mm sand cushioning both at top and bottom and brick protection.

Control cables shall be laid touching each other without any horizontal spacing. However the distance of the control cable from the nearest power cables shall be 150mm. Power and control cables shall be laid separately in groups.

Wherever power or control cables crosses fire hydrant or any other pipelines of earth flat the cable shall be taken 300mm below the pipeline.

After laying of cables, the trench shall be back filled with good excavated soil and well rammed in successive layer not less than 300 mm depth. The width of the trench shall be in accordance with the number of cables to be laid and in no case shall be less than 300 mm.

Cast Iron cable route markers (Cast Iron) shall be provided at every 100M intervals and at bends.

4.2 Laid On Cable Tray:

The cables inside the plant buildings shall be taken on trays fixed on the ceiling.

Cable trays shall be of prefabricated GI with necessary accessories like Tees/Bends etc. and shall be supplied along with fasteners.

Cable trays shall be hot dip galvanised as per IS: 2629.

The top tray shall be provided with cover if required.

Galvanised angle supports for trays shall be welded to insert plates. The support shall be spaced at 1500 mm centres.

Cables inside the premises shall be taken on cable trays running on ceiling.

Vertical spacing between cable racks/trays shall be minimum 300 mm. Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers.

Contractor shall include in their scope of supply all Insert plates, Anchor fasteners, etc. required for the laying of cable trays. Fastening on walls/RCC columns shall be by Anchor Fasteners only.

4.3 Cable Termination:

Termination and jointing of LT XLPE /PVC armoured cables shall be by means of compression method using double compression type glands and compression type lugs. Control cables are to be terminated by means of terminal lugs; the same shall be of tinned copper compression type.

Whenever copper cables are to be terminated on copper busbar or vice versa, necessary bimetallic washers shall be provided. All control cables shall be terminated using pin type lugs.

Cable tails shall be sufficiently long to run all cores to the farther most terminal and then back to the appropriate point of connection.

All cable glands shall be properly earthed using suitable earthing clips and connected to main earth bus. Wherever required, extension boxes shall be provided.

Cable tails shall be sufficiently long to run all cores to the farther most terminal and then back to the appropriate point of connection.

HT cables shall be terminated / jointed by means of cold setting epoxy based cast resin jointing kits as heat shrinkable type or cold setting kit.

5.0 EQUIPMENT ERECTION:

Circuit breakers, power transformers, and switch boards shall be handled and erected as per the relevant codes of practice and manufacturer's drawings and instruction manuals.

HT & LT Panels shall be erected on suitable base frame.

The details of foundation pockets required for grouting the frame shall be furnished by the Electrical Contractor.

For power transformer drying out and oil filling as required, after checking and testing the dielectric strength shall be carried out by the contractor. Oil filtration shall be carried out by the contractor.

6.0 EARTHING:

The overall earth resistance of the system shall not be greater than one (1) ohm.

All panels, Distribution boards shall be provided with two (2) independent earth connections of adequate capacity to discharge the max. Earth fault current.

The size of Earth bus and earth electrode shall be as per specification and as per schedule.

Minimum spacing between earth electrodes shall be provided as per IS: 3043.

Water stops shall be provided wherever earthing conductor enters the building from outside, below grade level.

7.0 INSPECTION:

After completion of erection/installation, each piece of equipment shall be thoroughly inspected in the presence of Contractor for correctness and completion of erection and operation.

8.0 MISCELLANEOUS ITEMS:

The contractor shall supply and install the safety devices as required by the statutory authorities but not limited to the following, for each Substations

- a) Danger boards for HT and LT Panels & Transformers
- b) Rubber mats for switchgear panels, power distribution boards etc.
- c) Rubber gloves, first aid charts, first aid box etc.
- d) Fire extinguishers and Fire Buckets
- e) Discharge rods.

XVI. TECHNICAL SPECIFICATION FOR TESTING AND COMMISSIONING

1.0 GENERAL:

The testing and commissioning for all electrical equipment at site shall be according to the procedures laid down below:

All electrical equipment shall be installed, tested and commissioned in accordance with the latest relevant Standards and Codes of Practices published by Indian Standards Institution wherever applicable and stipulations made in relevant general specifications.

The testing of all electrical equipment as well as the system as a whole shall be carried out to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards, as well as accepted codes of practice and stipulations made in the relevant general specifications.

All tests shall be carried out by the Contractor using his own instruments, testing equipment as well as qualified testing personnel.

The results of all tests shall be conforming to the specification requirements as well as any specific performance data guaranteed during finalization of the contract.

2.0 PREPARATION OF THE ELECTRICAL SYSTEM FOR COMMISSIONING:

After completion of the installation at site and for the preparation of Electrical system commissioning, the contractor shall carry out check and testing of all equipment and installation in accordance with the agreed standards, codes of Practice of Indian Standards Institution and specific instruction furnished by the particular equipment suppliers.

Checking required to be made on all equipment and installations at site shall comprise, but not be limited, to the following:

The following checks shall be made on all equipment and installations at site:

- I. Physical inspection for removal of any foreign bodies, external defects, such as damaged insulators, loose connecting bolts, loose foundation bolts etc.
- ii. Check for grease, insulating/lubricating oil leakage and its proper quantity.
- iii. Check for the free movement of mechanism for the circuit breakers, rotating part of the rotating machines and devices.
- iv. Check for tightness of all-cable, busbars at termination/ joints ends as well as earth connections in the main earthing network.
- v. Check for clearance of live busbars and connectors from the metal enclosure.
- vi. Check for proper alignment of all draw out device like draw out type circuit-breakers.
- vii. Continuity check in case of power cables.
- viii. Checking of all mechanical and electrical interlocks including tripping of breakers using manual operation of relay.
- ix. Checking of alarm and annunciation circuits by manual actuation of relevant relays.
- x. Check and calibrate devices requiring field adjustment/ calibration like adjustment of relay settings etc.
- xi. Check proper connection to earth network of all noncurrent carrying parts of the equipment and installation.
- xii. Test reports for all meters are to be furnished.

The tests that shall be carried out on the equipment shall include but not be limited to the above.

2.1 HT Breaker:

The following tests shall be carried out in accordance with IS: 13118.

- I. Mechanical operation tests.
- ii. Power frequency HV test.
- iii. Insulation resistance test.
- iv. Functional tests on control circuits.
- v. Relay operation tests by primary, secondary injection method.
- vi. Checking of settings of all relays/releases as per single linediagram/specification.

2.2 PowerTransformers:

The following tests shall be carried out in accordance with IS: 2026.

- I. Measurement of winding resistance at all taps.
- ii. Measurement of voltage ratio on all taps.
- iii. Vector group check.
- iv. Measurement of impedance voltage / Short Circuit impedance (At principal tapping and load loss).
- v. Measurement of no load loss and current.
- vi. Measurement of insulation resistance.
- vii. Power frequency withstand test.
- viii. Operational tests to know the correct functioning of all devices associated with the transformer.

2.3 Low Voltage Switchgear (upto 1000V AC or 1200V DC):

- I. Insulation resistance test with 1000V megger for main circuits. The minimum value of insulation resistance shall be 1 Meg ohm.
- ii. Insulation resistance test with 500V megger for control, metering and relaying circuits. The minimum value of insulation resistance shall be one Meg ohm.
- iii. Relay operation test by primary & secondary injection method.
- iv. Functional tests of control circuit.
- v. Checking of settings of all relay/releases as per single line diagram/specification.
- vi. ON/OFF operation of breakers both manually and electrically in "Test" as well as "Service" positions.

2.4 Cables:

- I. Insulation resistance test with 2,500 V megger for high voltage power cables rated above 1.1 KV grade and 1,000 V megger for cables rated up to 1.1 KV grade.
- ii. All cables of 1.1 KV and all H.V. cables shall be subjected to high voltage test after joining and terminating but before commissioning as per relevant standards.
- iii. In each test, the metallic sheath/screen/armour should be connected to earth.
- iv. Continuity of all the cores, correctness of all connections as per wiring diagram, correctness of polarity and phasing of power cables and proper earth connection of cable glands, cable boxes, armour and metallic sheath, shall be checked.

2.5 Earthing System:

- I. Tests to ensure continuity of all earth connections.
- ii. Tests to obtain earth resistance of the complete network by using earth tester. The test values obtained shall be within the limits.

All documents / records regarding test data, oscillographs and other measured values of important parameters finalised after site adjustment shall be handed over to the Owner in the form of test

XVII. TECHNICAL SPECIFICATIONS FOR DIESEL GENERATOR SETS

.1.0 Scope of Work:

- 1.1.1 The Engine alternator shall be suitable to generate 380KVA at the site conditions.
- 1.1.2 The Engine and the alternator shall be mounted on a common base frame through a suitable direct flexible coupling.

1.1.3 Site conditions:

Generating sets to be installed will be required to operate under the following climatic conditions:

- a. Altitude – Less than 100 mtrs. From MSL
- b. Max. temp. – 45deg C
- c. Max RH - 95 %

1.1.4 Scope of Work and Exclusions :

The scope of the work shall include but not be limited to the supply, installation, testing and commissioning the following items.

- 1.1.5 The supplier shall study the requirements stipulated in the specifications and also to suit the site conditions and offer a complete system with guaranteed performance under the severest operating conditions specified.

1.1.6 1Nos. Diesel Generator sets of 380KVA capacity of continuous rating at 0.8 PF lag at site conditions developing 415V, 50 Hz, three phase and 4 wire AC supply, along with AMF control, panel, Fault monitoring devices, heavy duty batteries including cabling along with all accessories and components.

- 1.1.7 Exhaust pipes and Silencers with thermal insulation, chimneys as required.
- 1.1.8 Exhaust Chimney shall conform to the statutory regulations by Environment Authorities.
- 1.1.9 The height of the Chimney shall be 30 Mtrs. The Chimney shall be self supporting type and shall include necessary holding down bolt arrangements.
- 1.1.10 Heavy duty anti-vibration spring type mounts (AVM) suitable for the DG sets as per manufacturers' recommendations.

- 1.1.11 Acoustic enclosure:
- 1.1.12 Minor building work including cutting and making good, including clamps, supports, grouting etc.
- 1.1.13 The installation shall conform to norms of CPCB and other statutory bodies.
- 1.1.14 Design and Preparation of related schematic and GA drawings for DG installation, Exhaust piping & Chimney, Fuel piping, acoustic enclosure/scrubber etc. obtaining approval, from Engineer- in Charge.
- 1.1.15 Testing and commissioning of the installation are including arranging for Inspection and obtaining clearance from Acceptance testing authorities of Engineer- in Charge. Consumables and artificial load for testing shall be in the scope of the Contractor.
- 1.1.16 Water line with necessary coupling valves, taps etc. for radiator cooling. Coolant in hit or shall be provided to prevent corrosion of radiator tubes.
- 1.1.17 The foundations for chimney, fuel transfer pump, day and reserve tanks and DG sets with acoustic enclosure shall be carried out by the Principal civil contractor. However, detailed design drawings shall be prepared and submitted by the DG contractor based on which the foundations will be constructed by the civil contractor after approval by Electrical & Civil Engineer- In Charge.
- 1.1.18 The DG contractor shall however supply necessary bolts, insert plates, connectors etc., as may be required in-time and co-ordinate with the civil contractor during construction.
- 1.1.19 In the attached site plan and building drawings, space allocation has been shown for the D.G sets as well as all accessories. The contractor shall ensure that all equipments are accommodated within the space earmarked.
- 1.1.20 The installation shall conform to emission limits and noise limits as laid down in the environment (protection) Rules 1986 amended up to date.
- 1.1.21 The type approval and certificate of conformity of production for the DG set model with enclosure which will be supplied shall be obtained in the current year from authorised agencies for certification as per Environment (protection) rules 1986 amended upto date.
- 1.1.22 The supplier of the DG set shall affix a conformance label on the DG set with the following information .The label shall be durable and legible and shall be affixed on a part necessary for normal operation and not requiring replacement during DG sets life.
 - a. Name & address of the supplier.
 - b. Statement “ this product conforms to Environment (protection) rules 1986 “

- c. Noise limit viz 75dB (A) at 1m.
- d. Type approval certificate number (both emission and noise)
- e. Date of manufacture of DG set.

1.2.0 Diesel Engine

1.2.1 Codes and Standards for Diesel Engine

The Diesel Generator Set with all its components shall comply with BS:5514 or ISO 3046 standard

- 1.2.2 The diesel engine shall be VEE type single acting direct injection type with turbo charged and after cooled.
- 1.2.3 The speed of the diesel engine shall not exceed 1500 RPM.
- 1.2.4 The engine offered shall be a four (4) stroke engine designed for operating on high sulphur diesel (HSD).
- 1.2.5 The engine shall be capable of withstanding without any damage, a 10% over load for a period of one hour in every twelve hours of operation.
- 1.2.6 The diesel engine shall consist of the following:

a. Air Inlet System

- i. Air intake filters (dry type) with service indicators.
- ii. Turbo charger
- iii. After cooler

b. Exhaust System

- i. Exhaust elbow dry
- ii. Exhaust manifold dry
- iii. Stainless steel Exhaust flexible fittings
- iv. Silencers – Residential

c. Flywheel Housing

- i. Flywheel
- ii. Flexible coupling/Flex plate
- iii. Coupling guard
- iv. Flywheel housing

d. Cooling System

- i. Engine driven water pump of centrifugal type
- ii. Radiator complete with hoses, fan, fan drive and fan guard

- iii. Engine Thermostats
- iv. Coolant inhibitor

e. Fuel System

- i. Injectors
- ii. Fuel lines
- iii. Fuel filter
- iv. Fuel oil pump (engine driven)
- v. Reserve shall be made of 3mm thick M.S Sheet enclosure with necessary painting etc., with Outdoor weather proof arrangement for day/reserve tank and necessary fixing arrangements with Fuel pipe lines from day/reserve tank.
- vi. Reserve fuel tank shall be installed on a suitable raised pedestal.

f. Lube oil System

Lube oil cooler
Oil filling point with dipstick
Oil pump gear type
Oil pan
Crankcase breather
Lube oil filters
Lube oil priming pump

g. Electrical starting and charging system

Heavy duty batteries (4Nos,12V, DC with minimum capacity of 200AH with 27 plate and leads and terminals)
Starting motor
Charging alternator
Electronic Engine control panel

h. Engine control panel

Start and stop switch
Emergency stop
Oil pressure indication
Water temperature indication
Battery voltage indication
Hour meter
RPM indicator

i. Governing System

Electronic governing - Class A-I

j. Safety system

Safety control against

- a) low lube oil pressure
- b) High water temperature
- c) Over speed

k. Others

Anti vibration mounting as per manufacturer's recommendation for the DG set

l. General

The engine control panel should give indication for faults related to engine.

m. Type tests and routine tests:

The Contractor shall submit certificates of Type tests conducted on ENGINE of same capacity.

1.3.0 A.C. Generator

1.3.1 The equipment offered shall conform to the relevant codes/standards as amended upto date and relevant local bye-laws.

1.3.2 The generator shall be of Brushless type rated for a continuous output of 380KVA at 0.8 PF (lag) at site conditions at 415 volts, 3 phase, 50 Hz suitable for 4 wire system exclusive of power requirement of auxiliaries.

1.3.3 The Generator shall be of Double bearing type. The degree of protection shall be IP-23.

1.3.4 The alternator stator windings shall be of class 'F' insulation. The windings and overhangs shall be braced to withstand the temperature and short-circuit forces.

1.3.5 The field windings shall have Class 'F' insulation.

1.3.6 The alternator shall be provided with necessary lifting hooks.

1.3.7 Overload

The alternator shall also be capable of withstanding without any damage a 10% overload for a period of one hour after six hours of operation.

1.3.8 Space Heaters

Suitably rated anti-condensation space heaters shall be installed within the generator. Location and maximum surface temperature of the heaters shall be such that no damage is caused to the insulation.

1.3.9 The leads of the space heater should be brought to a separate terminal box. Heaters shall be suitable for single phase 240 V AC. 50 Hz with thermostat and Auto Cut off feature.

1.3.10 The heaters shall be ON only when the set is OFF.

1.3.11 Winding temperature sensors :

Suitable No. of RTD shall be provided in each phase for temperature monitoring.

1.3.12 Bearing temperature sensors:

BTD (Bearing Temperature Detector) shall be provided for each bearing for monitoring the temperature (1 no. BTD per bearing).

1.3.13 Excitation System

The generator shall be provided with a PMG excitation system capable of supplying the excitation current of the generator for any change in output between no load and full load at any power factor between 0.5 and unity, lead and lag for an engine speed variation of 4%.

1.3.14 Automatic Voltage Regulator (AVR)

The automatic solid state voltage regulator shall be provided with the following features as minimum

- a. -Under frequency protection
- b. -Short-circuit protection
- c. -Over voltage protection
- d. -Over excitation protection

1.3.15 Terminal Box:

Terminal box shall be fabricated of cold rolled sheet steel and shall be complete with accessible cover.

1.3.16 The bus bar material used in the terminal shall be electrolytic aluminium sleeved with flame- retardant insulating material.

1.3.17 Terminal bus bars shall be supported on fibreglass insulators at regular intervals to withstand short-circuit forces arising out of specified fault level.

1.3.18 Rating Plate

A rating plate shall be fixed on the generator frame and shall give the following information:

- a. Manufacturer's Name
- b. Serial Number, Type and frame reference.
- c. Rated output in KVA/MVA and KW/MW.
- d. Rated power factor
- e. Rated frequency

- f. Rated voltage
- g. Current in amperes at rated output
- h. Rated speed in Rev/Min
- i. Class of insulation

1.3.19 TESTS on Alternator and assembled DG Set

The Contractor shall submit certificates of Type tests conducted on generator of same capacity

1.3.20 The following routine tests shall be carried out on one of the assembled DG sets at the manufacturers' works as per relevant IS (amended upto date) in the presence of Engineer- In Charge.

1.3.21

- a. Measurement of resistance.
- b. Insulation resistance test.
- c. Phase sequence test.
- d. Regulation test.
- e. Measurement of open-circuit characteristic
- f. Measurement of short-circuit characteristic
- g. High voltage test

- h. 50% load test for 30 minutes.
- i. 75% load test for 30 minutes.
- j. 100% load test for 30 minutes.
- k. 110% load test for 30 minutes.

1.3.22 Tools

Standard tools shall be supplied for field inspection and maintenance of the generator.

1.4.0 AMF CONTROL PANELS

1.4.1 GENERAL

Free standing floor mounting indoor type cubicle D.G. control panel, fabricated out of steel sheet with hinged doors in the front and bolted type doors on the rear side, dust and vermin proof totally enclosed.

1.4.2 STANDARDS

The equipment covered by this specification shall, unless otherwise stated, be designed, constructed and tested in accordance with the requirements of the latest revision of Indian standards.

1.4.3 CONSTRUCTION

- The control Panel shall be fabricated out of sheet steel and shall be compartmentalized, modular type, and suitable for Indoor installation.
- 1.4.4** The control Panel shall be dust and vermin proof and the enclosure shall provide a degree of protection of not less than IP45.
- 1.4.5** Control Panel shall be fabricated out of structural sections.
- 1.4.6** The frames shall be enclosed with steel sheet of not less than 2.0 mm thickness with rubber gaskets at all joints.
- 1.4.7** All bolts, nuts and other fasteners shall be cadmium plated only.
- 1.4.8** The ACB control Panel shall be fully draw out type.
- 1.4.9** The draw out module shall consist of 'plug in' contacts for power connection and sliding contacts for secondary control connection. The power contact shall be spring loaded silver-plated electrolytic copper.
- 1.4.10** Each draw out module shall have three positions viz. service, test and isolated position with necessary position interlocks.
- 1.4.11** All bolted joints shall be provided with toothed/spring washers to ensure good continuity.
- 1.4.12** The maximum operating height of the devices on the panel shall not exceed 1800 mm and minimum-operating height shall not be less than 300 mm.
- 1.4.13** Control Panel shall be supplied along with base channel fabricated out of 3.25 mm thick steel sheet, painted black.
- 1.4.14** Space heaters, with thermostat suitable for 230 V, 1 Ph supply along with a switch / fuse shall be provided in each panel.
- 1.4.15** A general purpose control switch shall be provided for selection of "Auto" & "Manual". The switch shall be provided with engraving plate in the front with "Auto", Manual" & "Off" inscription.
- 1.4.16** Digital type meter shall be provided for measuring the parameters like current, voltage, kilowatts, KVA, KWH,PF, frequency etc.
- 1.4.17** The instruments shall have an accuracy class of 1.0.
- 1.4.18** Panel shall be supplied with all internal wiring comprising of PVC insulated 1.1 KV grade, multi-stranded flexible copper conductor of 1.5 Sq.mm cross section.
- 1.4.19** Wiring associated with a particular phase shall be the colour of that phase viz. Red, Yellow or Blue. Wiring associated with earthing shall be with green colour insulation and for neutral with black colour insulation.

-
- 1.4.20** Wiring shall be neatly laid and run on insulated cleats of limited compression type insulated straps.
- 1.4.21** All cables shall have crimped terminations and shall be identified by means of glossy plastic ferrules at both ends, showing the wire number as indicated in the schematic diagrams. The ferrules shall be indelibly marked.
- 1.4.22** Wiring to items mounted on hinged doors or wiring that is subject to movement, shall run in helical binding. The binding shall be securely anchored at both ends and sufficient slack provided to prevent any strain being imposed on wiring.
- 1.4.23** All the metal parts of all equipment supplied with in the panel (including doors and gland plates) other than those forming part of all electric circuit, shall be connected by means of two independent earth conductors to continuous copper earth bar of size 50 x 6 mm running along the full length of the panel.
- 1.4.24** The panel shall be provided with two brass earthing stud terminals, with suitable nuts, washers etc. for connection to ground bus.
- 1.4.25** Terminal blocks shall preferably be grouped according to circuit functions and each terminal block group shall have atleast 10% spare terminals. Terminal blocks for control circuit shall be of 650V grade with contact ratings not less than 10A and stud/clamp type.
- 1.4.26** Not more than two wires shall be connected to any terminal.
- 1.4.27** Labels shall be provided to describe the duty of or otherwise.
- 1.4.28** Identify every Instrument, or other item of equipment mounted internally and externally. Switch positions shall be fully identified. Wording shall be clear, concise and unambiguous.
- 1.4.29** Each label shall be permanently secured to the panel surface below the item to which it refers.
- 1.4.30** In addition to component labels, each cubicle door shall bear a large identification labels and the panel shall include large, prominent overall identification label.
- 1.4.31** Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage or corrosion due to damp or highly humid conditions.
- 1.4.32** The panel shall be prepared, primed, filled and painted to the highest standards.
- a. All items shall be cleaned and deburred after fabrication and welding.
 - b. External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface, free from blemishes and imperfections and the whole shall be Powder Coated with Epoxy paint and the shade shall be approved by Engineer-in-charge.

1.4.33 The panel shall be completely assembled, wired, adjusted and tested for operation under simulated conditions to ensure accuracy of wiring, correctness of control scheme and proper functioning of all equipment and internal routine test certificate shall be furnished to Engineer- In Charge.

1.4.34 PARTICULAR REQUIREMENTS

- | | | | |
|----|--|---|--|
| a. | Service | - | Indoor |
| b. | Type | - | Cubicle, Metal enclosed, free standing |
| c. | Degree of Protection | - | IP 45 |
| d. | Bus bars | | |
| | i. Number phase/wires | - | 3 Ph, 4 wire |
| | ii. Continuous current | - | As per particular requirement |
| | iii. Frequency | - | 50 HZ |
| | iv. Fault level | - | 55KA |
| | v. Material | - | Aluminium |
| e. | Insulation level | | |
| | i. Power frequency with stand voltage dry- | | 2.5 KV RMS |
| g. | Bus bar support insulator Material | - | FRP / DMC / SMC |
| h. | Design Ambient Temperature | - | 40 Deg.C |
| i. | Painting | - | Powder coating |
| j. | Earthing | | |
| | i. Material | - | Copper |
| | ii. Size | - | 50 x 6 mm (minimum) |

TECHNICAL SPECIFICATION FOR BATTERY CHARGER

2.1.0 GENERAL

- 2.1.1 This specification covers the design, manufacture, Supply, installation, Testing and commissioning of Battery Charger & Batteries, and DC Distribution Board, with all accessories for efficient & trouble free operation.
- 2.1.2 Battery charger shall be housed in a metallic enclosed, free standing compartmentalised, sheet steel Panel.
- 2.1.3 The Batteries shall be housed over the insulating pad.
- 2.1.4 The Panel shall be fabricated out of adequate thickness mild steel of not less than 1.6 mm thickness. All retaining catches, screws and bolts shall be cadmium plated.
- 2.1.5 A base channel of 75mm x 40 mm fabricated out of 3.25 mm thick hot rolled sheet steel painted black shall be provided to prevent corrosion of the sheet steel cubicles and facilitate cleaning of floors

2.2.0 STANDARDS

The equipment covered by this specification shall unless, otherwise stated, be designed, constructed and tested in accordance with the latest revisions of relevant Indian standards and shall conform to the regulations of Local Statutory authorities.

2.3.0 CONNECTION

- 2.3.1 All inter-cell connections shall be made with copper rod supported on suitable insulators. The copper rod, as well as the cable connections, shall be protected from corrosion by painting with two coats of anti-sulphuric enamel or other approved means.
- 2.3.2 Intercell connections shall be of low resistance and shall be in a clean condition when bolted and shall be protected by petroleum jelly. Alternatively, intercell connections may be soldered.

2.4.0 BATTERY CHARGER

- 2.4.1 The charger shall be SMPS type suitable for 48V (dc), 200AH battery with provision for float charge and Boost charge.
The charger shall be provided with input/output HRC fuses/MCBs.
- 2.4.2 The following meters shall be provided.
- Input AC Voltmeter iron type
 - Output DC Voltmeter / Ammeter
 - DC Ammeter (Charging) with fuse
- 2.4.3 Indication lamps for Power 'ON', Float / Boost charging shall be provided with accept / reset / Lamp Test Push Buttons, Alarm Annunciation shall be provided for the following.
- Rectifier Failure
 - Mains failure
 - AC Input fuse fail
 - DC Output fuse fail
 - AC under voltage
 - Battery MCB trip
 - Load on Battery
 - Reverse polarity

2.5.0 EARTHING

- 2.5.1 Battery charger body shall be suitably earthed.

2.6.0 Battery Charger

- Rated input voltage (a.c.) : 240 V Single Phase
- Rated frequency : 50 HZ
 - Setting range of input voltage $\pm 10\%$

The output voltage regulation of the Battery Charger shall be limited to + 1% for 100% Output current variation and +10% or -10% input voltage variation.

ACOUSTIC ENCLOSURE

5.1.0 SCOPE OF SUPPLY:

- 5.1.1 Supply of containerised type ACOUSTIC ENCLOSURE suitable for 380KVA DG set driven by radiator cooled diesel engine including Design and Preparation of the drawings, submission and obtaining approval.
- 5.1.2 As per Environment (protection) rules 1986 amended up to date, the DG set shall be supplied with acoustic enclosure.
- 5.1.3 The maximum permissible sound pressure level shall be 75dB (A) at 1 metre from the enclosure surface.
- 5.1.4 The manufacturer of DG set shall obtain valid certificates of Type approval and also valid certificates of conformity of production from the authorised agencies for certification in the current year for the DG model which will be supplied to Engineer- In Charge.
- 5.1.5 The supplier shall also affix a conformance label as detailed in Clause 2.14 of this specification.
- 5.1.6 The DG Agency shall comply the pollution control board norms and any deviation, shortfall in the parameters notified by the CPCB shall be carried out at no extra cost.

5.2.0 CONSTRUCTIONAL FEATURES :

- 5.2.1 The acoustic enclosure shall be of free standing, floor mounting type integral with the DG set.
- 5.2.2 The construction and design of the Acoustic enclosure shall be very rugged, durable and shall be virtually maintenance free.
- 5.2.3 The enclosure shall be provided with rugged heavy-duty structural steel base frame.
- 5.2.4 The enclosure shall be prefabricated factory-built and modular in construction, so that it can be easily assembled at site around the DG set.
- 5.2.5 The enclosure shall consist of acoustically treated panels housed in rugged steel frames, which shall be bolted together to form the body of the enclosure.
- 5.2.6 The acoustic panels shall be filled with a special grade high-density mineral wool retained on the inside by perforated GI sheets specially designed for optimum sound attenuation.
- 5.2.7 The outer surface of the Acoustic Panels shall be fabricated of performed 1.6mm corrugated CRCA sheet steel. All sheet steel frames shall be of 1.6mm CRCA sheets.
- 5.2.8 All structural members such as angles / channels used in the construction of the enclosure frame shall be of TISCO / SAIL make only.
- 5.2.9 The sheet steel treatment shall consist of degreasing, de-rusting and phosphating followed by powder coating

- 5.2.10 Hinged doors shall be provided, on either side, which shall also be acoustically treated, thereby providing easy access to the DG set while minimizing the operating space requirements.
- 5.2.11 The construction of the acoustic enclosure shall be such that with both the acoustic doors open on the either side, full access is available to the engine and alternator.
- 5.2.12 For fresh air inlet into the system a parallel baffle air inlet silencer shall be provided.
- 5.2.13 For hot air discharge, an acoustic discharge plenum shall be provided in front of the engine radiator, for discharge of hot air into the surroundings through a parallel baffle air outlet silencer.
- 5.2.14 It shall be ensured that at least 800mm (min.) clear space is available all around the Acoustic Enclosure to ensure free air flow for the Genset as required and to facilitate accessibility for generator operation and routine maintenance.
- 5.2.15 The enclosure shall be provided with suction fans to ensure that the adequate cooling and combustion air is made available to the engine and the temperature within the enclosure is limited to 5 deg. C above ambient.
- 5.2.16 The fan shall be designed with sufficient static to draw the requisite quantity of air from the duct provided for this purpose. Calculations shall be furnished to prove the adequacy of the ventilation system offered.
- 5.2.17 The suction fan shall be of the axial flow type designed to handle the static pressure estimated based on the inlet air duct size and length.
- 5.2.18 Two light points controlled by a switch complete with 28W, T-5 fluorescent Luminaire and lamps shall be provided. Provision shall also be made for fixing a heat detector inside the acoustic enclosure which will be connected to the central fire alarm panel.
- 5.2.19 Necessary openings shall be made for the entry of power cable and control cables, fuel piping, exhaust piping, air inlet pipe etc.

5.3.0 PERFORMANCE:

- 5.3.1 With the above Enclosure, the sound pressure levels when measured at a distance of 1 meter outside the Acoustic Enclosure shall be around 75 dB (A) under free field conditions average taken at 8 points.
- 5.3.2 With the installation of the acoustic enclosure, there shall not be any de-rating of the DG set. The DG set shall give rated output continuously.
- 5.3.3 The maximum temperature of oil and water shall not exceed the limits prescribed by the manufacturer of the engine.
- 5.3.4 The ventilation system shall be designed to provide an air volume of not less than 80,000CFM whenever the DG set is in operation.

Automatic Mains Failure Control Panel

7.1.0 Air Circuit Breakers for AMF control panel

7.1.1 General

- a. Air circuit breakers shall be 4 pole and shall have Over load, short Circuit and Earth Fault protections wherever specified and shall be complete in all respects.
- b. Shall be suitable for Isolation as per standard.
- c. Shall have the Isolation between power circuit and Control circuit.
- d. Facility to change setting in “ON” condition.
- e. The Breaking capacity shall be as indicated in the Schedule of Quantities.
- f. Communication RS485 Port wherever specified in schedule.

7.1.2 Construction

- a) Shall have facility for raking interlocking.
- b) Motor wound spring closing mechanism wherever specified.
- c) Full draw-out type with indication for service, test and isolated positions.
- d) Trip free mechanism.
- e) Mechanical open, closed and spring charge indicator.
- f) Main contacts made up of copper.
- g) Magnetic blow out arc control device.
- h) Facilities for pad locking.
- i) Contact corrosion prevention.
- j) Suitable guides shall be provided to facilitate easy withdrawal of the circuit breaker trolley.
- k) All identical feeder compartments shall be inter-changeable.
- l) All current carrying contacts of the breaker shall be silver-plated.
- m) Contacts subjected to arcing shall be tipped with suitable arc resisting material.
- n) The contacts shall be self-aligning, plug-in type, designed to ensure adequate contact pressure on the main busbars and requiring minimum maintenance.
- o) ACB shall have Line and Load Reversibility.

7.1.3 Operating Mechanism

- a. The operating mechanism shall be trip-free.
- b. Failure of spring, vibrations or shocks shall not cause un-intended operation of breaker or prevent intended tripping operation.
- c. Closing of breakers shall be prevented unless the spring is fully charged.

7.1.4 Interlocks

- a. Should be suitable for Isolation as per standard.
- b. The breaker shall be provided with all necessary interlocks to prevent inadvertent operations and to ensure safety of operating personnel and equipment.
- c. It shall not be possible to push in a drawn out breaker in closed condition or withdraw a breaker in closed condition.

- d. Compartment doors shall be interlocked against opening when breaker is in ‘Closed’ condition.
- e. It shall not be possible to operate the breaker in intermediate position while inserting or withdrawing a circuit breaker.