
CHAPTER 24: LT SWITCHGEAR

- 1.1. CONSTRUCTIONAL DETAILS OF SWITCHBOARDS AND DISTRIBUTION BOARDS**
- 1.1.1. All boards shall be of metal enclosed, indoor floor mounted, compartmentalised double front construction and freestanding type.
- 1.1.2. All board frames, shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Gland plate shall be cold rolled sheet steel having thickness not less than 3 mm in all cases. However, in case of termination of single core power cables, gland plate shall be of non-magnetic material of at least 4mm thickness.
- 1.1.3. All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.
- 1.1.4. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut-outs shall be true in shape and devoid of sharp edges.
- 1.1.5. All boards shall be of dust and vermin proof construction and shall be provided with a degree of protection of IP: 52, for category I enclosure as per IEC 60947 (Part-1). However, the busbar chambers having a degree of protection of IP: 42, in accordance with IEC 60947 (Part-1), are also acceptable where continuous busbar rating exceeds 1000 Amp. Provision shall be made in all draw out Air Circuit Breaker compartments for providing IP: 52 degree of protection, when Circuit breaker trolley, has been removed. Panels with lighting transformers shall have IP 31 degree of protection in accordance with IEC 60947 (Part-1). Door frame of panels, meters, relays, Breaker cut-outs shall be provided with neoprene rubber gaskets generally conforming to IEC/International Standards.
- 1.1.6. Provision of louvers on boards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating exceeds 1000 Amps. Panels with lighting transformers in lighting distribution boards shall have louvers.
- 1.1.7. All boards shall be of uniform height not exceeding 2450 mm.
- 1.1.8. Boards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers of bus bar chambers.
- 1.1.9. Boards shall be supplied with base frames made of structural steel sections, alongwith all necessary mounting hardware required for welding the base frames to the insert plates.
- 1.1.10. a) All boards shall be of double front construction and shall have:
- (i) A completely enclosed busbar compartment for running horizontal busbars and vertical busbars. Busbar chambers shall be completely enclosed with metallic portions. Bolted covers shall be provided for access to horizontal and Vertical busbars for repair and maintenance, which shall be feasible without disturbing feeder compartment. Vertical bus bar chambers shall be accessible from front as well as back side of the panel and shall be of at least 350 mm width. One set of vertical busbars shall be used in between two adjacent sections for switchgear connections. In case of ACB feeders, the panel shall have single front without any

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- vertical busbar chamber, however vertical busbars associated with ACBs shall be located in rear side and shall be additionally covered with metallic perforated/transparent acrylic or polyvinyl bolted sheets to avoid direct access after opening rear door of chamber.
- (ii) Completely enclosed switchgear compartment(s) one for each circuit for housing circuit breaker or MCCB or motor starter.
 - (iii) A distinct compartment or alley for power and control cables on each side of panel. Cable alley compartment shall have a through metallic partition for segregating cables on both sides. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts. Any live terminals shall be fully shrouded/insulated from safety aspects. However, it shall be of atleast 350mm width.
 - (iv) A compartment for relays and other control devices associated with a circuit breaker.
- b) Lighting transformers shall be supplied in separate and distinct panel completely assembled for incoming cable connection from bottom and outgoing connection through busbar with adjacent associated lighting distribution board. Lighting transformers shall have provision of base channel with rollers for taking in and out from the panel in case of maintenance after disconnecting incoming and outgoing connections. Provision of single-phase fans at least two (2) numbers of suitable ratings shall be made in the panel for ventilation. These fans shall run in sequential mode at suitable time interval to be controlled by thermostat and timer. The offered design of panel should be such that in no case, temperature rise of lighting transformers shall exceed the permissible limits for the class of insulation of lighting transformer.
- 1.1.11. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.
- 1.1.12. All equipments associated with a single circuit except MCB circuits shall be housed in a separate compartment of the vertical section. The Compartment shall be sheet steel enclosed on all sides with the withdrawal units in position or removed. The front of the compartment shall be provided with the hinged single leaf door, with locking facilities. In case of circuits controlled by MCBs, group of MCB feeders can be offered in common compartment. In such case number of MCB feeder to be used in a common compartment shall not exceed 4 (four) and front of MCB compartment, shall have a viewing port of toughen glass sheet for viewing and sheet steel door of module shall be lockable with star knob/panel key.
- 1.1.13. After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.
- 1.1.14. The minimum clearance in air between phases and between phase and earth for the entire run of horizontal and vertical busbars, shall be 25 mm. For all other components, the clearance between "two live parts", "A live part and an earthed part" and isolating distance shall be atleast ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal run of busbar minimum clearance of 25 mm should be maintained even if they are sleeved.

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- 1.1.15. The temperature rise of horizontal & vertical busbars when carrying rated current along its full run shall in no case exceed 55°C, with silver plated joints and 40°C with all other type of joints over an outside ambient temperature of 50°C.
- 1.1.16. All busbar chambers shall be provided with removable bolted covers. The covers shall be provided with danger labels.
- 1.1.17. All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carryout modifications.
- 1.1.18. All Circuit breaker boards shall be of Single Front type, with fully drawout circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between SERVICE, TEST and ISOLATED positions and for withdrawal from the Switchboard. Testing of the breaker shall be possible in the TEST position.
- 1.1.19. Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.
- 1.1.20. All disconnecting contacts for power circuits shall be of robust design and fully self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.
- 1.1.21. All AC & DC boards shall be of double Front type.
- 1.1.22. All module shall be fixed type except air circuit breaker module, which shall be drawout type.
- 1.1.23. The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.
- 1.1.24. All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to PURCHASER approval. Bidder shall submit dimensional drawings showing complete internal details of Busbars and module components, for each type and rating for approval.
- 1.1.25. The tentative power and control cable entries shall be from bottom. However, Purchaser reserves the right to alter the cable entries, if required, during detailed engineering, without any additional commercial implication.
- 1.1.26. Adopter panels and dummy panels required to meet the various busbar arrangements and layouts required shall be included in Bidder's scope of work.
- 1.2. DERATING OF EQUIPMENTS**
- 1.2.1. The current ratings of all equipments as specified in the Single Line Diagram for AC & DC System are the minimum standards current ratings at a reference ambient temperature as per relevant Indian Standards.
- 1.3. POWER BUS BARS AND INSULATORS**

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- 1.3.1. All AC Distribution Boards shall be provided with three phase buses and a neutral bus bars and the DC Distribution Boards shall be provided with two busbars.
- 1.3.2. All busbars and jumper connections shall be of high conductivity aluminium/copper of adequate size.
- 1.3.3. The Cross-Section of the busbars shall be uniform through out the length of Switchgear and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents.
- 1.3.4. All busbars shall be adequately supported by adequate numbers of high strength type Polyester fibre glass Moulded Insulators to withstand short circuit withstand capability of panel. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided anti-tracking barriers shall be provided between the supports.
- 1.3.5. All busbars joints shall be provided with high tensile steel bolts. Belleville/spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated Busbars joints shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.
- 1.3.6. All busbars shall be colour coded as per IEC: 60446.
- 1.3.7. The Bidder shall furnish calculations, establishing the adequacy of busbar sizes for specified current ratings, On the basis of short circuit current and temperature rise consideration at specified ambient temp.
- 1.4. **EARTH BUS**
- 1.4.1. A galvanised steel earthing shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded/bolted to the frame work of each panel and breaker earthing contact bar vertical bus shall be provided in each vertical section which shall in turn be bolted/welded to main horizontal ground bus.
- 1.4.2. The earth bus shall have sufficient cross-section to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise.
- 1.4.3. Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Purchaser's earthing conductors. The horizontal earth bus shall project out the switchboard ends and shall have predrilled holes for this connection. A joint spaced and taps to earth bus shall be made through at least two bolts.
- 1.4.4. All non-current metal work of the Switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosures frame work and the truck shall be maintained even after painting.
- 1.4.5. The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions. SERVICES & ISOLATED, as well as through out the intermediate travel.
- 1.4.6. Air Circuit Breaker (ACB) module frame shall get engaged to the vertical earth bus, before the disconnecting contacts on these module are engaged to the vertical busbar.
- 1.4.7. All metallic cases of relays, instruments and other panel mounted equipments shall be connected to earth by independent stranded copper wires of size not less than 2.5 mm².

Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering is not acceptable. Looping of earth Connection which would result in loss of earth connection to the devices when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths or earth bus is acceptable.

- 1.4.8. VT and CT secondary neutral point earthing shall be at one place only, on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.
- 1.4.9. All hinged doors shall be earthed through flexible earthing braid.
- 1.4.10. Caution nameplate 'Caution-Live Terminals' shall be provided at all points where the terminals are like to remain live and isolation is possible only at remote end.
- 1.5. **AIR CIRCUIT BREAKERS**
- 1.5.1. Circuit breakers shall be three-pole air break horizontal drawout type and shall have inherent fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameter only after provision of releases or any other devices shall not be acceptable.
- 1.5.2. Circuit breakers shall be mounted along with its operating mechanism on a wheeled carriage. Suitable guides shall be provided to minimise misalignment of the breaker.
- 1.5.3. There shall be 'Service', 'Test' and 'Fully withdrawn' positions for the breakers. In 'Test' position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power Contacts shall be disconnected while the Control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the 'SERVICE', 'TEST' OR FULLY WITHDRAWN' position. It shall be possible to close the door in TEST position.
- 1.5.4. All circuit breakers shall be provided with 4 NO and 4 NC potentially free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker. Separate limit switches each having required number of contacts shall be provided in both 'SERVICE' & 'TEST' position of the breaker. All contacts shall be rated for making continuously carrying and breaking 10 Amps at 230V AC and 1 Amp (Inductive) at 220V DC.
- 1.5.5. Suitable mechanical indications shall be provided on all circuit breakers to show 'OPEN', 'CLOSE', 'SERVICE', 'TEST' and 'SPRING CHARGED' positions.
- 1.5.6. Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.
- 1.5.7. All circuit breakers shall be provided with the interlocks as explained in further clauses.
- 1.5.8. Movement of a circuit breaker between SERVICE AND TEST positions shall not be possible unless it is in OPEN position. Attempted withdrawal of a closed circuit breaker shall trip the circuit breaker.
- 1.5.9. Closing of a circuit breaker shall not be possible unless it is in SERVICE, TEST POSITION or in FULLY WITHDRAWN POSITION.

- 1.5.10. Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn. It shall however, be possible to open the shutters intentionally, against spring pressure for testing purpose.
- 1.5.11. A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.
- 1.5.12. Circuit breakers shall be provided with electrical anti-pumping and trip free feature, even if mechanical antipumping feature is provided.
- 1.5.13. Mechanical tripping shall be possible by means of front mounted RED 'Trip' push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.
- 1.5.14. Breaker controlled motors shall operate satisfactorily under the following conditions:
- (i) Direct on-line starting of Induction Motors rated 110 kW to 220 kW with a locked rotor current of seven times the rated current, and starting time of up to 30 seconds.
 - (ii) Breaking on-load, full load and locked rotor currents of Induction Motors for rated 100 kW to 220 kW.
- 1.5.15. Means shall be provided to slowly close the circuit breaker in withdrawn position. If required for inspection and setting of Contacts, in service position slow closing shall not be possible.
- 1.5.16. Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC Control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class 'E' or better.
- 1.5.17. The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.
- 1.5.18. Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.
- 1.5.19. The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.
- 1.5.20. Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
- 1.5.21. All circuit breakers shall be provided with closing and trip coils. The closing coils shall operate correctly at all values of Voltage between 85% to 110% at rated control voltage. The trip coil shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.
- 1.5.22. Provision for mechanical closing of the breaker only in 'TEST' and 'WITHDRAWN' positions shall be made.

1.5.23. PROTECTION CO-ORDINATION

- 1.5.23.1. It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and down stream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.

1.6. MOULDED CASE CIRCUIT BREAKER (MCCB) and MCB

- 1.6.1. MCCB shall in general conform to IEC: 60947 Part-2. All MCCB offered shall have $I_{cs} = 100\% I_{cu}$ rating.
- 1.6.2. MCCB shall be flush mounted on the AC/DC distribution boards and shall have extended handle.
- 1.6.3. MCCBs shall be provided with thermo-magnetic type release for over current and short circuit protection. The setting of the thermal release shall be adjustable between 80% to 100% of the rated current. The MCCB shall have breaking capacity not less than 20kA.
- 1.6.4. MCCBs used for ACDB incomers and Bus coupler shall be equipped with stored energy mechanism for electrical closing and tripping. All other MCCBs shall be manually operated. The operating handle should give a clear trip indication.
- 1.6.5. Miniature circuit breaker (MCB) shall conform to IEC: 60898.

1.7. RELAYS

- 1.7.1. All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-drawout cases.
- 1.7.2. All AC relays shall be suitable for operation, at 50 Hz with 110 volts VT secondary and 1 amp or 5 amp CT secondary.
- 1.7.3. All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.
- 1.7.4. All protective relays auxiliary relays and timers shall be provided with hand reset operation indicators (Flags) for analysing the cause of operation.
- 1.7.5. All relays shall withstand a test voltage of 2 KV (rms) for one minute.
- 1.7.6. Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

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- 1.7.7 All fuse-protected contactor-controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bimetallic strips), or as a separate device. The single phasing protection shall operate even with 80% of the set current flowing in two of the phases.

1.8 CONTACTORS

- 1.8.1 Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IEC: 60947 Part 4.
- 1.8.2 Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.
- 1.8.3 Direct on line starter contactors shall be of utilisation category AC2. These contactors shall be as per IEC:60947 Part 4.
- 1.8.4 Each contactor shall be provided with two (2) normally open (NO) and two (2) normally close (NC) auxiliary contacts.
- 1.8.5 Operating coils of contactors shall be of 230V AC Unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall drop out at 70% of the rated voltage.

1.9 INSTRUMENT TRANSFORMERS

- 1.9.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.
- 1.9.2 All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.
- 1.9.3 All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.
- 1.9.4 Current transformers may be multi or single core type. All voltage transformers shall be single phase type. The Bus VTs shall be housed in a separate compartment.
- 1.9.5 All VTs shall have readily accessible MCBs on both primary and secondary sides.

1.10 INDICATING INSTRUMENTS

- 1.10.1 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.
- 1.10.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

- 1.10.3 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.
- 1.10.4 Ammeters provided on Motor feeders shall have a compressed scale at the upper current region to cover the starting current.
- 1.10.5 Watt-hour meters shall be of 3 phase three element type, Maximum demand indicators need not be provided.
- 1.11 **CONTROL & SELECTOR SWITCHES**
- 1.11.1 Control & Selector switches shall be of rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.
- 1.11.2 Circuit breaker selector switches for breaker Controlled motor shall have three stay put positions marked 'Switchgear', 'Normal' and 'Trial' respectively. They shall have two contacts of each of the three positions and shall have black shade handles.
- 1.11.3 Ammeter and voltmeter selector switches shall have four stayput position with adequate number of contacts for three phase 4 wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries.
- 1.11.4 Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.
- 1.11.5 The contact ratings shall be at least the following :
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|-------|-----------------------------|---------------------------|
| (i) | Make and carry continuously | 10 Amp. |
| (ii) | Breaking current at 220V DC | 1 Amp (Inductive) |
| (iii) | Breaking current at 230V AC | 5 Amp (at 0.3 pf lagging) |
- 1.12 **AIR BREAK SWITCHES**
- 1.12.1 Air breaker switch shall be of the heavy duty, single throw group operated, load break, fault make type complying with IEC: 60947 Part-3.
- 1.12.2 The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.
- 1.12.3 Switch operating handles shall be provided with padlocking facilities to lock them in 'OFF' position.
- 1.12.4 Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in 'OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

1.12.5 Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

1.13 **PUSH BUTTONS**

1.13.1 Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 230V and 0.5A (inductive) at 220V DC.

1.13.2 All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

1.13.3 All push-buttons shall be provided with integral escutcheon plates marked with its function.

1.13.4 The colour of the button shall be as follows :

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|-------|-------|---|--------------------------------|
| (i) | GREEN | : | For motor START, Breaker CLOSE |
| (ii) | RED | : | For motor TRIP, Breaker OPEN |
| (iii) | BLACK | : | For overload reset. |

1.13.5 All push-buttons on panels shall be located in such a way that Red-push-buttons shall always be to the left of green push-buttons.

1.14 **INDICATING LAMPS**

1.14.1 Indicating lamps shall be of the panel mounting cluster LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary.

1.14.2 Lamps shall have translucent lamp-covers of the following colours, as warranted by the application :

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| (i) | RED | : | For motor ON, Breaker CLOSED |
| (ii) | GREEN | : | For motor OFF, Breaker OPEN |
| (iii) | WHITE: | | For motor Auto-Trip |
| (iv) | BLUE | : | For all healthy conditions (e.g. control supply, and also for 'SPRING CHARGED') |
| (v) | AMBER | : | For all alarm conditions (e.g. overload) Also for 'SERVICE' and 'TEST' positions indicators. |

1.14.3 Lamps shall be easily replaceable from the front of the cubicle.

1.14.4 Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariable be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and Amber lamps should normally be located above the Red and Green lamps.

1.14.5 When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

1.15 **FUSES**

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- 1.15.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC Circuits shall be of class 2 type, 20 kA (RMS) breaking current at 400 AC, and for DC circuits Class 1 type 4 kA breaking current.
- 1.15.2 Fuses shall have visible operation indicators.
- 1.15.3 Fuses shall be mounted on fuses carriers, which are mounted on fuse bases, wherever it is not possible to mount fuses on carriers fuses shall be directly mounted on plug in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.
- 1.15.4 Fuse rating shall be chosen by the Bidder depending upon the circuit requirements and these shall be subject to approval of PURCHASER.
- 1.16 **TERMINAL BLOCKS**
- 1.16.1 Terminal blocks shall be of 750 volts grade and have continuous rating to carry the maximum expected current on the terminals. It shall be complete with insulating barriers, clip-on-type/stud type terminals for Control Cables and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring on diagrams. It shall be similar to 'ELEMEX' standard type terminals, cage clamp type of Phoenix or WAGO or equivalent
- 1.16.2 Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities. It shall be similar to 'Elem.' 'CATD' - Type.
- 1.16.3 In all circuit breaker panels at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.
- 1.16.4 All terminal blocks shall be suitable for terminating on each side, two (2) Nos. of 2.5 mm square size standard copper conductors.
- 1.16.5 All terminals shall be numbered for identification and grouped according to the function. Engraved white-on-black labels shall be provided on the terminal blocks.
- 1.16.6 Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.
- 1.16.7 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block. The minimum clearance between the first row of terminal block and the associated cable gland plate shall be 250 mm.
- 1.17 **NAME PLATES AND LABELS**
- 1.17.1 All switchgears, AC/DC distribution boards, shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.
- 1.17.2 All name plates shall be of non-rusting metal or 3-ply lamicaid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to PURCHASER approval.
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- 1.17.3 Suitable plastic sticker labels shall be provided for easy identification of all equipments, located inside the panel/module. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the module wiring drawings.
- 1.18 **SPACE HEATER**
- 1.18.1 Space heater shall be provided in all the boards for preventing harmful moisture condensation.
- 1.18.2 The space heaters shall be suitable for continuous operation on 230V AC, 50 Hz, single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.
- 1.19 **CONTROL AND SECONDARY WIRING**
- 1.19.1 All switchboards shall be supplied completely wired internally upto the terminal blocks ready to receive Purchaser's control cables.
- 1.19.2 All inter cubicle and inter panel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the bidder.
- 1.19.3 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour coded, PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires. Voltage grade and insulation shall be same as above.
- 1.19.4 Extra-flexible wires shall be used for wiring to device mounted on moving parts such as hinged doors.
- 1.19.5 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminals blocks.
- 1.20 **POWER CABLES TERMINATION**
- 1.20.1 Cable termination compartment and arrangement for power cables shall be suitable for stranded aluminium conductor, armoured XLPE/PVC insulated and sheathed, single core/three core, 1100 V grade cables.
- 1.20.2 All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. shall be provided by the successful bidder, to suit the final cable sizes which would be advised later.
- 1.20.3 The gland plate shall be of removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. For all single core cables, gland plates shall be of non-magnetic Material.
- 1.21 **TYPE TESTS**

1.21.1 Type tests reports on Panels (Switchgear and Control gear assemblies) as per IEC: 60439 Part-1 shall be submitted for the following tests in line with clause 9.0 of Chapter 2 GTR before the fabrication of switchgear is started:

- i) Verification of temperature rise limits
- ii) Verification of the dielectric properties
- iii) Verification of short circuit strength
- iv) Verification of the continuity of the protective circuit
- v) Verification of clearances and creepage distances
- vi) Verification of mechanical operation
- vii) Verification of degree of protection

1.21.2 Contractor shall submit type test reports for the following Switchgear and Control gears before the fabrication of switchgear is started:

1. Circuit breakers/MCCB as per IEC: 60947 Part 2.
2. Protective Relays as per IEC: 60255.
3. Lighting transformers as per IEC:60076

For above equipments, test conducted once are acceptable (i.e. The requirement of test conducted within last five years shall not be applicable)

1.22 **ERECTION, TESTING AND COMMISSIONING**

1.22.1 The Contractor shall unload, erect, install, test and put into commercial use all electrical equipment included in this specification.

1.22.2 Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in Contractor's drawings or as stipulated by purchaser. No equipment shall be permanently bolted down to foundations until the alignment has been checked and found acceptable by the purchaser.

1.22.3 Contractor shall furnish all supervision, labour tools equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time required to completely install, test and commission the equipment.

1.22.4 Manufacturer's and purchaser's instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.

1.22.5 Contractor shall move all equipment into the respective room through the regular door or openings specifically provided for this purpose. No part of the structure shall be utilised to lift or erect any equipment without prior permission of Purchaser.

1.22.6 All boards shall be installed in accordance with relevant code of practices and at Purchaser's instructions. All boards shall be installed on finished surfaces, concrete or steel stills. Contractor shall be required to install and align any channel stills which form part of foundations. In joining shipping sections of switchboards together adjacent housing of panel sections or flanged throat sections shall be bolted together after alignment has been completed. Power bus, enclosures ground and control splices of conventional nature shall be cleaned and bolted together being drawn up with torque spanner of proper size or by other approved means.

1.22.7 All boards shall be made completely vermin proof.

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- 1.22.8 Contractor shall take utmost care in holding instruments, relaying and other delicate mechanism wherever the instruments and relays are supplied separately they shall be mentioned only after the associated panels have been erected and aligned. The packing materials employed for safe transit of instrument and relays shall be removed after ensuring that panel have been completely installed and to further movement of the same should be necessary. Any damage shall be immediately reported to Purchaser.
- 1.22.9 Equipment furnished with finished coats of paint shall be touched by up Contractor if their surface is specified or marred while handling.
- 1.22.10 After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards/panels and correctness of all equipment in each and every respect. The cable opening and cables entries for cables terminating to the panels shall be sealed with fire sealing materials.
- 1.23 **COMMISSIONING CHECK TESTS**
- The Contractor shall carry out the following commissioning checks, in addition to the other checks and tests recommended by the manufacturers.
- 1.23.1 **General**
- 1.23.1.1 Check name plate details according to the specification.
- 1.23.1.2 Check for physical damage.
- 1.23.1.3 Check tightness of all bolts, clamps, joints connecting terminals.
- 1.23.1.4 Check earth connection.
- 1.23.1.5 Check cleanliness of insulators and bushings.
- 1.23.1.6 Check all moving parts for proper lubrication.
- 1.23.1.7 Check settings of all the relays.
- 1.23.2 **Circuit Breakers**
- 1.23.2.1 Check alignment of breaker truck for free movement.
- 1.23.2.2 Check correct operation of shutters.
- 1.23.2.3 Check control wiring for correctness of connections, continuity and IR values.
- 1.23.2.4 Manual operation of breaker completely assembled.
- 1.23.2.5 Power closing/opening operation, manually and electrically.
- 1.23.2.6 Breaker closing and tripping time.
- 1.23.2.7 Trip free and anti-pumping operation.
- 1.23.2.8 IR values, minimum pick up voltage and resistance of coils.

- 1.23.2.9 Contact resistance
- 1.23.2.10 Simultaneous closing of all the three phases.
- 1.23.2.11 Check electrical & mechanical interlocks provided.
- 1.23.2.12 Check on spring charging motor, correct operation of limit switches, and time of charging.
- 1.23.2.13 All functional checks.
- 1.23.3 **Current Transformers**
- 1.23.3.1 Megger between winding and winding terminals to body.
- 1.23.3.2 Polarity test
- 1.23.3.3 Ratio identification checking of all ratios on all cores by primary injection of current.
- 1.23.3.4 Spare CT cores, if available, to be shorted and earthed.
- 1.23.4 **Voltage Transformer**
- 1.23.4.1 Insulation resistance test
- 1.23.4.2 Ratio test on all cores.
- 1.23.4.3 Polarity test.
- 1.23.4.4 Line connections as per connection diagram.
- 1.23.5 **Cubicle Wiring**
- 1.23.5.1 Check all switch developments.
- 1.23.5.2 Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawing. All interconnections between panels/equipment shall be similarly checked.
- 1.23.5.3 All the wires shall be meggered to earth.
- 1.23.5.4 Functional checking of all control circuit e.g. closing, tripping control, interlock, supervision and alarm circuit.
- 1.23.6 **Relays**
- 1.23.6.1 Check connections and wiring.
- 1.23.6.2 Megger all terminals to body.
- 1.23.6.3 Megger AC to DC terminals.
- 1.23.6.4 Check operating characteristics by secondary injection.

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- 1.23.6.5 Check minimum pick up voltage of DC coils.
- 1.23.6.6 Check operation of electrical/mechanical targets.
- 1.23.6.7 Relays settings.
- 1.23.6.8 Check CT and VT connections with particular reference to their polarities for directional relays, wherever required.
- 1.23.7 **Meters**
- 1.23.7.1 Check calibration by comparing it with a sub-standard.
- 1.23.7.2 Megger all insulated portions.
- 1.23.7.3 Check CT and VT connections with particular reference to their polarities for power type meters.
- 1.24 **SPECIAL TOOLS AND TACKLES**
- 1.24.1 The Bidder shall include in his proposal any special tools and tackles required for erection, testing commissioning and maintenance of the equipments offered.
- 1.24.2 The list of these special tools and tackles shall be given in the bid proposal sheets alongwith their respective prices.
- 1.24.3 The total price of the special tools and tackles shall be included in proposal sheets.
- 1.25 **EQUIPMENT TO BE FURNISHED**
- 1.25.1 The Bidder shall quote for various AC/DC distribution boards in accordance with this specification.
- 1.25.2 Standard scheme of interconnection of switchboards and distribution boards alongwith tentative feeder disposition for each board is indicated in Standard SLD of AC & DC system enclosed alongwith bid documents. The bidder shall quote board prices on the basis of standard SLD and their estimation of feeders for entire present and future bays requirement. Any other feeder required as per system requirement for efficient and reliable operation shall be deemed to be included in bidder's scope.
- 1.25.3 The Bill of Materials for each type of module shall be as under. These are minimum indicative requirement of the system. The necessary auxiliary relays, push buttons and indicating lamps shall be provided as per scheme requirement. Any other item/component required with in a module for efficient and reliable operation shall be deemed to be included in bidder's scope.
- 1.25.4 Module Type AE (Electrically controlled circuit breaker for incoming and Bus Coupler Circuit).
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|------|---------|--|
| (i) | One (1) | Triple pole air circuit breaker complete with all accessories and power operated mechanism as specified. |
| (ii) | Two (2) | Neutral link. |

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|--------|------------|---|
| (iii) | Three (3) | Current Transformer for metering. |
| (iv) | One (1) | Ammeter with selector switch. |
| (v) | Three (3) | Current Transformer for relaying. |
| (vi) | One (1) | Triple pole instantaneous over-current relay having the setting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time. |
| (vii) | One (1) | Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20 - 80% of CT secondary current and adjustable definite minimum time. The earth fault relay shall be provided with a stabilising resistor. |
| (viii) | One(1) set | Current and Voltage transducers. |
| (ix) | One(1) set | High speed tripping relays. |

1.25.5

Module Type - M1 (Circuit Breaker Controlled Motor Feeder)

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|--------|-----------------|---|
| (i) | One (1) | Triple pole Air Circuit Breaker complete with accessories, and power operated mechanism as specified. |
| (ii) | One (1) | Three position 6 pole selector switch
'SWITCHGEAR/NORMAL /TRIAL'. |
| (iii) | Three (3) | Current Transformer for metering. |
| (iv) | One (1) | Ammeter with Ammeter Selector Switch |
| (v) | Three (3) | Current Transformer for relaying. |
| (vi) | One (1) | Triple pole instantaneous over-current relay for providing positive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as required. |
| (vii) | One (1) | Double pole inverse definite minimum time over current relays connected in R & B phases for over current protection of motor rated 110 kW - 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT Secondary current and time setting range of 0-30 Second. The relay shall be CDGM-22 of EE or equivalent. |
| (viii) | One (1)
have | Single pole adjustable definite time delay relay for motor overload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall continuously adjustable time delay range of 2.5 to 25 Sec. |
| (ix) | One (1) | Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor. |

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|--------|--|------------|---|
| | (x) | One(1) set | Current and Voltage transducers. |
| | (xi) | One(1) set | High speed tripping relay. |
| 1.25.6 | Module Type E | | |
| | (i) | One (1) | Four pole MCCB |
| 1.25.7 | Module G-1 (VT Module with under Voltage Relay) | | |
| | (i) | Three (3) | $\frac{400}{\sqrt{3}} / \frac{110}{\sqrt{3}}$ volts single phase voltage transformer star/star connect with star point solidly earthed mounted on common draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA Burden. |
| | (ii) | Six (6) | HRC Fuses mounted on the above chassis. |
| | (iii) | One (1) | Four position voltmeter selector switch. |
| | (iv) | One (1) | Voltmeter (0-500V) |
| | (v) | One (1) | Double pole instantaneous under voltage relays with continuous variable setting range of 40-80% of 110 Volts. |
| | (vi) | One (1) | Time delay pick up relay having a time setting range of 0.5 to 3 secs. with 3 'NO'. Self reset contacts, suitable for 220V DC. |
| | (vii) | One (1) | Auxiliary relay 220V DC with 2 NO. self reset contacts. |
| | (viii) | Three (3) | Indicating lamps with series resistor and colour lenses (Red, Blue & Yellow). |
| 1.25.8 | Module Type G-2 | | |
| | (i) | Three (3) | HRC Fuse |
| | (ii) | One (1) | Voltmeter (0-500V) |
| | (iii) | One (1) | Voltmeter selector switch four position (R-Y, Y-B, B-R OFF). |
| | (iv) | Three (3) | Indication lamps (Red, Blue & Yellow) |
| 1.25.9 | Module Type H & H (BC) (Isolating Switch Controlled Incoming Circuit) | | |
| | (i) | One (1) | Four pole MCCB |
| | (ii) | One (1) | Red Indicating lamp to indicate isolating switch closed position. |

- 1.25.10 **Module Type S : (DC Metering and Protection Module)**
- (i) One (1) Voltmeter 300-0-300V DC for 220V DC DB/Voltmeter 0-75V DC for 50V DCDB
 - (ii) One (1) Three (3) position voltmeter selector switch
 - (iii) One (1) Instantaneous under voltage relay with 95% of 220V DC. The resetting ratio of relay of relay should not be more than 1.25. The relay shall be provided with a series resistor and a push button across if for resetting (pick up) the relay at about 105% of the drop out voltage.
 - (iv) One (1) Instantaneous over voltage relay with setting range of 110% of 220V DC. The resetting ratio of relay should not be less than 0.8. The relay shall have a push button in series of resetting the relay at about 95% of the operating voltage.
 - (v) One (1) Earth leakage relay only for 220V DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220V DC/230V AC Auxiliary supply.
- 1.25.11 **Module Type X**
- One (1) Double pole 250 V MCB
- 1.25.12 **Module Type-DC (Incomer from Battery & Chargers)**
- (i) One (1) Double pole 250V DC MCCB for incomer from Battery.
 - (ii) One (1) DC ammeter with shunt and range of 90-0-400 Amps. For 220V DC DB and 90-0-200 Amp for 50V DC DB.
 - (iii) Two (2) Double pole 250V DC MCCB/MCB
 - (iv) One (1) Double pole single throw 250V DC air break switch connecting battery & charger sections to DC DB.
 - (v) **One(1) set Voltage and Current Transducers**
- 1.25.13 **Module Type DG-1 (Electrically Controlled Circuit Breaker for Incomer from DG Set)**
- a) One (1) Triple pole circuit breaker complete with all accessories and power operated mechanism as specified.
 - b) One (1) Frequency meter.
 - c) One (1) Voltmeter with selector switch.
 - d) One (1) Remote/Local Selector switch.
 - e) Three (3) Current transformer for metering.

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|----|------------|---|
| f) | Six (6) | Current Transformers for differential protection (out of this 3 Nos. will be supplied loose for mounting in DG set panel). |
| g) | Three (3) | Current transformer for relaying. |
| h) | One (1) | Ammeter Selector Switch. |
| i) | One (1) | Ammeter |
| j) | One (1) | Wattmeter of range 0-300 KW. |
| k) | One (1) | Three pole voltage controlled definite time delay relay having current setting range of 50-200% of CT secondary current and adjustable time delay 0.3 to 3 secs. |
| l) | One (1) | Watt hour meter with six (6) digits and minimum count of one (1) kwh. |
| m) | One (1) | Single pole definite time over current relay having a continuous setting range of 50-200% of CT secondary current and a time delay of 2.5-25 secs connected in CT of Y phase for overload alarm. The relay shall have a setting ratio of not less than 90%. |
| n) | One (1) | Three pole differential protection relay having an operating current setting range of 10-40% of generator full load current. The relay shall be of high impedance type, with necessary stabilizing resistors. |
| o) | Two (2) | Push buttons for Remote starting & stopping of DG Set (Red, Green). |
| p) | One(1) set | Current and Voltage transducers. |
| q) | One(1) set | High speed tripping relays. |

1.25.14 **Module Type H1**

- One (1) Double pole DC Switch with pad locking facility in off position.

1.25.15 **Module Type EL**

- | | | |
|-------|--|----------------|
| (i) | One (1) | Four pole MCCB |
| (ii) | One (1) | Contactor |
| (iii) | Electronic Timer suitable for continuous operation, push button and selector switch be as per scheme requirement | |

1.26 **PARAMETERS**

1.26.1 **Power Supply**

1.26.1.1	AC System	3 phase, 4 wire, solidly earthed
	a) Voltage	400 Volts, $\pm 10\%$
	b) Frequency	50 Hz $\pm 2.5\%$
	c) Combined variation	$\pm 105\%$ Absolute Sum in Voltage & frequency
	d) Fault Level	20 kA (rms)
1.26.1.2	DC System	2 Wire, unearthed
	a) System voltage	220V $\pm 10\%$
	b) Fault Level	4 kA
	c) System Voltage	48 V $\pm 10\%$
	d) Fault Level	--
1.26.2	Control Supply Voltage	
	a) Trip and closing coils	220V DC Unearthed
	b) Spring charging	220V DC Unearthed
1.26.3	Cubicle Data	
1.26.3.1	Busbar Rating	
	a) Continuous for Vertical panels.	As specified in Standard SLD For AC & DC system.
	b) Short time (1 sec. kA (rms)	20 kA
	c) Momentary (kA) PEAK	45 kA
	d) Ambient Temperature	50°C
	e) One Minute Power Frequency Withstand	
	I. Power Circuit	2500 Volts (rms)
	II. Control Circuit	2500 Volts (rms)
1.26.3.2	Cubicle Colour Finish	

- | | |
|-------------|-------------------------|
| a) Interior | Smoke Grey shade No.692 |
| b) Exterior | Smoke Grey shade No.692 |

1.26.4 **Circuit Breaker**

- | | |
|--|--|
| a) Type | Air Break |
| b) No. of poles | 3 |
| c) Voltage & Frequency | 400 Volts, $\pm 10\%$, 50 HZ $+ 2.5\%$ |
| d) Rated Operating Duty | As per IEC |
| e) Rated service short-circuit Breaking capacity (Ics) | 20 kA (RMS) |
| f) Short Circuit making current | 45 kA (Peak) |
| g) Short time withstand current for 1 sec. duration. | 20 kA (RMS) for 1 sec. |
| h) Operating Mechanism current for 1 sec. duration. | 20 kA (RMS) for 1 sec. |
| i) No. of auxiliary contacts | 4 NO & 4 NC contacts for Purchaser's use on fixed portion of the cubicle |
| j) Short Circuit breaking current | |
| I. AC Component | 20 kA (RMS) |
| II. DC Component | As per IEC: 60947 (Part 2) |

1.26.5 **MOULDED CASE CIRCUIT BREAKER**

- | | AC System | DC System |
|--|--|-------------|
| a) No. of poles | 4 | 2 |
| b) Voltage & Frequency | 400 Volts, $\pm 10\%$
50 HZ $\pm 2.5\%$ | 250V |
| c) Rated Operating Duty | As per IEC | |
| d) Rated service short-circuit Breaking capacity (Ics) | 20 kA (RMS) | 4 kA |
| e) Short Circuit making current | 45 kA (Peak) | - |
| f) No. of auxiliary | 1 NO & 1 NC | 1 NO & 1 NC |

	Contacts (only for incomer And bus-coupler MCCBs)		
	g)	Rated Ultimate Short Circuit breaking capacity	
		I. AC Component	20 kA (RMS) As per IEC
		II. DC Component	As per IEC 60947 As per IEC 60947
1.26.6	Meters		
	a)	Accuracy class	2.5
	b)	One minute power frequency withstand test voltage in KV	2.0
1.26.7	Current Transformers		
	a)	Type	Cast resin, Bar primary
	b)	Voltage class and frequency	650V, 50 Hz
	c)	Class of Insulation	E or better
	d)	Accuracy class metering CT	Class 1, VA adequate for application but not less than 7.5 VA.
	e)	Accuracy class protection CT	5 P 15, VA adequate for application, but not less than 7.5 VA.
	f)	Accuracy class differential protection	PS, KPV = 300V
	g)	Short Time Current Rating (for CTs Associated with circuit breakers)	
		I. Current	20 kA (RMS)
		II. Duration	One Second
		III. Dynamic Rating	45 kA (Peak)
		IV. One minute power frequency withstand test voltage.	2.5 kV (rms)
1.26.8	Voltage Transformer		
	a)	Type	Cast Resin

b)	Rated Voltage	
	Primary	400/ $\sqrt{3}$ V
	Secondary	110/ $\sqrt{3}$ V
c)	Method of connection	
	Primary	Star
	Secondary	Star
d)	Rated voltage factor	1.1 continuous, 1.5 for 3 seconds
e)	Class of insulation	E or better
f)	One minute power frequency withstand voltage	2.5 KV (RMS)
g)	Accuracy class	0.5, not less than 20VA

1.26.9 Relay

a)	One minute power Frequency withstand test	2 kV (rms)
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1.26.10 Transducers (1 phase)

	Current	Voltage
a) Operating Voltage	220 V DC	220V DC
b) I/P	1A.	110V AC
c) O/P	4-20 mA	4-20 mA
d) Type	Analogue	Analogue

1.26.11 Lighting Transformers

Lighting transformers shall have capacity of minimum 100 KVA or as per actual requirement whichever is higher, 400/4400 V, 3 phase, 50 Hz Dry type natural air cooled type. The technical parameters of these lighting transformers are as follows:

Technical Parameters of Lighting Transformer

Type of transformer	:	Dry type natural air cooled
Rating	:	min. 100 KVA or as per actual requirement
Voltage ratio	:	400/400 volts
No. of phases	:	Three
Frequency	:	50 Hz
Winding connection	:	Dyn-1

Class of insulation	:	'B' class
Impedance	:	4% \pm 10%
No. of taps & steps	:	5, \pm 5% in steps of 2.5%
Ref. standard	:	IEC: 60076

1.27 AUTOMATIC CONTROL OF OUTDOOR LIGHTING

- 1.27.1 EL-type module of 400V Main lighting distribution board and Emergency lighting distribution board and shall be controlled by timer and contactor module to facilitate its operation automatically.

1.28 AUTOMATIC SUPPLY CHANGEOVER

Automatic changeover between Incomer I, Incomer II, and DG set is to be carried out during the failure of supply in one/or both the incomers. After the restoration of the supply, system shall be restored to normal condition automatically. The requirement of changeover under various conditions are as below:

- (i) Under normal conditions i.e. when supply is available in both the incomers, incomers I&II of 400 V Main switchboard, ACDB shall be in closed condition and Bus couplers and DG set breaker shall be in open condition.
- (ii) In case of failure of either of the sources, the incomer of that source shall trip and Bus coupler shall get closed. On restoration of supply, normal conditions described above are to be established automatically.
- (iii) In case of failure of supply in both the sources, both incomers, incomers of ACDBs and ACDB Bus coupler shall trip and DG set breaker switched on. On restoration of one or both sources, DG set breaker shall trip, DG set stopped and conditions described in paragraph (i) /(ii) shall be restored.

To avoid unnecessary operation of switchgear for momentary disturbances all changeovers from one state to another shall be initiated after a time delay, after the conditions warranting such change has been detected.

1.29 ANALOGUE INPUTS

LT System shall have provision of following analogue inputs for owner's substation automation purpose. These analogue inputs shall be generated by distinct transducers to be provided in respective modules. These inputs shall be wired up to respective terminal blocks.

ANALOGUE INPUTS:

- i) Voltage R-Y, Y-B, B-R of Main Switch Board section-I
- ii) Voltage R-Y, Y-B, B-R of Main Switch Board section-II
- iii) Current from LT transformer-I
- iv) Current from LT transformer-II
- v) Voltage of 220V DCDB-I
- vi) Voltage of 220V DCDB-II
- vii) Current from 220V Battery set-I
- viii) Current from 220V Battery set-II

- ix) Voltage of 48V DCDB-I
- x) Voltage of 48V DCDB-II
- xi) Current from 48V Battery set-I
- xii) Current from 48V Battery set-II

1.30 DIGITAL (Potential Free) INPUTS:

LT System shall have provision of following digital inputs for owner's substation automation purpose. These digital inputs shall be made available in the form of potential free contacts to be provided in respective modules. These potential free contacts shall be wired up to respective terminal blocks.

- i) Main (MSB) Incomer-I breaker On/Off
- ii) Main (MSB) Incomer-II breaker On/Off
- iii) Main (MSB) 400V Bus-I/II U/V
- iv) Main (MSB) bus coupler breaker on/off
- v) DG set breaker on/off
- vi) LT transformer-I Bunchholz Alarm & trip
- vii) LT transformer-II Buchloz Alarm & trip
- viii) LT transformer-I WTI Alarm & trip
- ix) LT transformer-II WTI Alarm & trip
- x) LT transformer-I OTI Alarm & trip
- xi) LT transformer-II OTI Alarm & trip
- xii) 220 V DC-I earth fault
- xiii) 220V DC-II earth fault