

- f. Earth fault relays with adjustable settings and time delays fed from core balance CT shall be provided.
- g. Numerical / Digital Motor protection relay with short circuit, over load, earth fault, locked rotor and unbalance (NPS) load protection functions shall be provided for motor rated above 90 kW.

4.09.00 **Control Transformer**

4.09.01 LT Switchboard control supply

The Bidder shall provide one (1) no. adequately rated 415V/110V Control Transformer in each bus section with necessary taps and auto changeover facility for providing control power supply to various modules of the board, except motor feeders. Each motor feeder shall be provided with 415/110V control transformer of adequate capacity (min. 75VA) for control supply to such module. The sizing of control transformer shall be carried out by the Bidder considering the actual load of power contactors, auxiliary contactors, indicating lamps and other equipment in the module circuit. An additional load of 15watts shall be considered for each module for remote auxiliary relays and lamps to be connected in the control circuit of modules. Bidder shall also ensure that control transformer are adequately designed for meeting the momentary loading requirements and the voltage drop during this condition shall not be more than 5%. Each transformer shall be sized for catering to control supply of both bus sections.

4.09.02 LT Switchboard space heater supply

The Bidder shall provide one (1) no. adequately rated 415V/240V Control Transformer in each bus section with necessary taps and auto changeover facility for providing power supply to panel space heater, Motor space heater of motor rated 30 KW & above, Panel Illumination & Socket. The supply of these two (2) nos. control transformer are tapped from incoming supply of 415V PMCC/MCC before the incoming breaker. Incoming circuit to the space heater auxiliary bus shall be through isolating switch HRC fuse and neutral link of suitable rating. The supply of different modules shall be tapped individually from the auxiliary bus bars. Control supply healthy indication shall be provided. Each transformer shall be sized for catering to space heater supply of both bus sections.

4.10.00 **D.C. Starters**

4.10.01 D.C. Starter for emergency oil pump shall be fixed resistance type, designed to provide fast acceleration during starting.

4.10.02 DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push-buttons, lamps, etc.

4.10.03 Starters shall be furnished in totally enclosed floor-mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2mm.

4.10.04 The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54.

The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.

4.10.05 Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.

4.11.00 **Relays**

4.11.01 All incoming and bus-coupler circuits and circuit breaker operated outgoing feeders shall be provided with numerical relays. Breaker operated motor feeders shall be provided with numerical motor protection relay.

4.11.02 The numerical relays shall have provisions for interfacing with Plant DDCMIS / PLC.

4.11.03 Relays shall be of drawout design with built-in testing facilities. Small auxiliary relays may be in non-drawout execution.

4.11.04 All protective relays, auxiliary relays, and timers shall be provided with hand reset operation indicator (flag).

4.11.05 Relays shall be rated for operation on 110V secondary voltage and 5 A or 1 A. Number and rating of relay contacts shall suit the job requirements.

4.12.00 **Control and Indication**

4.12.01 Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following :

i) One (1) TEST-NORMAL-TRIAL selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism.

ii) On-Off control switches shall have three positions (T-N-C) and shall be spring return to 'Neutral' from close and trip positions. They shall have two contacts closing in close position and two contacts closing in trip positions, and shall have Pistol Grip handles. Lost motion feature shall be provided wherever required.

iii) Following indicating lamps on the front of the compartment:

Breaker open - GREEN

Breaker closed - RED

Breaker tripped - AMBER

Spring charged - WHITE

Trip Ckt. Healthy - BLUE

Motor Space heater 'ON' for motor circuit - YELLOW

- 4.12.02 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.
- 4.12.03 Each push button shall have minimum two (2) nos. normally open and two (2) nos. normally closed contacts rated 10 A at 240 V.
- 4.12.04 One (1) NORMAL-TRIAL selector switch shall be provided for all motor feeders.
- 4.12.05 Selectors switches shall be stay-put, rotary type with escutcheon plates marked to indicate the function and positions, and shall be lockable in each position. Selector switch contacts shall be rated for 10A at 240 V A.C.
- 4.12.06 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.
- The exact requirements of contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.
- 4.12.07 Lamps shall be clustered LED type with series resistor and coloured lens. Lens and lamps shall be replaceable from the front. Lamps shall be located just above the associated push button/control switch
- 4.12.08 The general scheme of connections for control, interlock and protection is shown in the enclosed drawings. Detailed requirements of individual circuits will be intimated later to the successful bidder, who shall develop and furnish the schemes accordingly.
- 4.13.00 **Meters**
- 4.13.01 All indicating instruments (96 x 96 mm) shall be switchboard type, with 250` scale, anti-glare glass and accuracy class of $\pm 2\%$ full scale. Each meter shall have zero adjuster on the front.
- 4.13.02 Motor ammeter shall be suitable to indicate starting current (6 to 8 times full load current) for DOL starting of motor.
- Motor ammeter shall be provided for motor rated 30 kW and above and for critical drives, to be finalized during detail engineering.
- 4.13.03 All incomers, tie feeders, circuit breaker operated motor feeders shall be provided with 3-phase multifunction meter with pulse output and communication port for interfacing with Plant DDCMIS / PLC.
- 4.13.04 Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.
- 4.14.00 **Current Transformer**
- 4.14.01 Current Transformer, shall be cast resin type rated 10 VA. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.

- 4.14.02 Accuracy class of the current transformers shall be:
- a) Class PS for REF
 - b) Class 5P20 for other relaying.
 - c) Class 1.0 ISF < 5 for metering.
 - d) Class 0.5 ISF < 5 for metering (Incomer & Bus coupler of PMCC)
- Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the bidder.
- 4.14.03 CT secondary shall be rated for 1A for metering & either 5A or 1A for protection.
- 4.15.00 **Voltage Transformer**
- 4.15.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For Incomer and bus coupler of PMCC accuracy class of voltage transformer shall be 0.5.
- 4.15.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.
- 4.15.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.
- 4.15.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.
- 4.16.00 **Transducers**
- 4.16.01 Transducer for conversion of AC electrical quantities such as voltage, current, KW etc. shall be supplied as required for remote connection to Plant DDCMIS / PLC. All transducers shall be dual output type.
- 4.16.02 The transducers for indicating type instruments shall be of very low burden type having 4-20 mA DC linear, galvanically isolated output, compatible with secondary instruments and Plant DDCMIS system.
- 4.17.00 **Secondary Wiring**
- 4.17.01 The PMCC/MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection and interlocking schemes.
- 4.17.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, push buttons and other devices shall be wired upto terminal blocks.

- 4.17.03 Wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated switchboard wires with stranded Copper conductors of 2.5 mm² for control & current circuits and 1.5 mm² for voltage circuits.
- 4.17.04 Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring diagrams.
- 4.17.05 Wire terminations shall be made with crimping type connector with insulating sleeves. Wires shall not be spliced between terminals. Separate colour code shall be used for AC & DC circuit wiring for easy identification.
- 4.18.00 **Terminal Blocks**
- 4.18.01 Terminal blocks shall be 1100V grade box-clamp type with marking strips similar to ELMEX 10 mm² or equal. Terminals for C.T. secondary leads shall have provision for shorting.
- 4.18.02 Terminal blocks used for interface with DDCMIS / PLC via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.
- 4.18.03 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
- 4.18.04 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- 4.19.00 **Cable Terminations**
- 4.19.01 PMCC shall be designed for cable entry from bottom. MCC/DB shall be designed for cable entry both from top and bottom. Actual configuration shall be intimated later sufficient space shall be provided for ease of termination and connection.
- 4.19.02 Power cables shall be 1100V, Copper/Aluminum conductor, XLPE insulated, armoured, FRLSH PVC overall sheathed.
- Control cables shall be 1100V, PVC insulated, armoured, PVC overall sheathed with 2.5 mm² stranded Copper conductor.
- 4.19.03 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned Copper/Aluminium lugs, brass compression glands with tapered washer (Power Cables only) and Terminal blocks.
- 4.19.04 Sufficient space shall be provided between the lower most power cable termination and gland plate for easy cable connection.
- 4.20.00 **Bus Duct Connection**
- 4.20.01 Bus duct connections shall be furnished along with transition panel, if required. Unless mentioned otherwise bus duct connections shall generally be from the top.

- 4.20.02 All connecting bus work shall have the same continuous current rating as associated PMCC bus and shall be fully braced for the LT system short circuit current.
- 4.20.03 All provisions such as matching flange and other accessories shall be furnished for connection to bus duct.
- 4.21.00 **Ground Bus**
- 4.21.01 A Cu / Al ground bus rated to carry the maximum fault current, shall extend full length of the MCC/DB.
- 4.21.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts & nuts at each end to receive 50 x 6 mm G.I. flats.
- 4.21.03 All stationary structures shall be directly connected to the ground bus for effective grounding.
- 4.21.04 The frame of draw out module shall be grounded at all times except when the power disconnects are separated by a safe distance.
- 4.21.05 All hinged doors shall be earthed through flexible copper braid wire.
- 4.22.00 **Nameplate**
- 4.22.01 Nameplate of approved design shall be provided for each control compartment and also at the top of each PMCC / MCC / DB.
- 4.22.02 The material of the name plate shall be anodized aluminium / lamicaid or approved equal, 3 mm thick, with white letter on black background. Name plates shall be minimum 20 x 75 mm for instrument / devices and 40 x 150 mm for panels.
- 4.22.03 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.
- 4.23.00 **Space Heater**
- 4.23.01 Panel and motor space heater shall be fed from separate AC auxiliary busbars running throughout the switchboard. The space heater bus shall be fed from control transformer described earlier. Suitable terminals shall also be provided to facilitate energisation of the control transformer from outside during long shutdown of the board.
- 4.23.02 Each vertical section of the PMCC / MCC / DB shall be furnished with thermostat controlled space heater and 5A, 5 pin plug socket.
- 4.23.03 In addition, motor feeders 30 KW and above shall be wired up for feeding motor space heater through starter auxiliary 'OFF' contacts.
- 4.23.04 Cubicle heater, Motor heater and plug socket circuit shall be provided with individual MCB/switch fuse units.

4.24.00 **A.C./D.C. Power Supplies**

4.24.01 Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C. supply and duplicate feeder shall be arranged for D.C. supply.

4.24.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C. Molded case circuit breaker (MCCB) shall also be accepted as an alternative.

4.24.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units / MCCB shall be provided at each cubicle for A.C/D.C. supplies.

4.24.04 A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.

4.25.00 **Tropical Protection**

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

4.26.00 **Painting**

4.26.01 All steel surfaces shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.

4.26.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.

4.26.03 For paint shade of finish coat, refer clause no.1.16.00 of Section E1, Volume V-A.

4.26.04 Sufficient quantity of touch-up paint shall be furnished for application at site.

4.26.05 Caution notice plate shall be affixed at the back of each vertical panel.

5.00.00 **TESTS**

5.01.00 All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

5.02.00 **Routine Test**

The tests shall include but not necessarily be limited to the following :-

- a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

- b. All wiring and current carrying part shall be given appropriate High Voltage Test.
- c. Primary current & voltages shall be applied to all instrument transformers.
- d. Routine test shall be carried out on all equipment such as circuit breakers, switch - fuse, contactors, relays, meters etc.

5.03.00 Type Tests

The type test certificates for the following tests carried out on an identical & similar type of switchgear shall be furnished. The date of tests shall be within the last five years.

- a. Temperature rise Test
- b. Short time current test on main circuit and earth circuit.
- c. Verification of making and breaking capacity.

Type test certificates of any equipment shall be furnished if so designed by the purchaser/ owner. Otherwise the equipment shall have to be type tested free of charge, to prove the design. Type test performed before five (5) years are not acceptable.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

6.02.00 To be submitted with the bid :-

- a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points etc.
- b. Typical foundation plan
- c. Typical control schematic
- d. Bill of materials
- e. Type test reports on circuit breaker
- f. Technical leaflets on :-
 - i) Circuit breaker
 - ii) Switch-fuse units
 - iii) Contactors
 - iv) Relays, meters, push buttons, selector switches etc.
 - v) Glands/terminals blocks

6.03.00 To be submitted for Owner / Purchaser's Approval and Distribution

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.