

## PANELBOARDS

### PART 1 – GENERAL

#### 1.1 WORK DESCRIPTION

- A. This specification covers the 'General Requirements' for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type low voltage switch boards up to 1000 V including necessary termination, cabling and bus work required for satisfactory operation .
- B. The Panel boards included, distribution boards and control panels shall be built in accordance with IEC 439 "Factory Built Assemblies for Low Voltage" or BS 5486 "Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000 AC and 1200V DC.
- C. All factory built assemblies subject to rain or wet conditions or located outside electrical switch room shall be weatherproof constructed to IP 65, able to withstand high impact strength of 60 KN/m<sup>2</sup> (min.), temperature resistant, flame retardant and corrosion resistant.
- D. Specific requirements shall be in accordance with single line diagram/specification & BOQ.
- E. The technical parameters of switchgear equipments, transformers etc. shall be referred.

#### 1.2 STANDARDS

- A. All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.
- B. The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.
- C. The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:
 

1.IS 13947	: A.C. Circuit Breakers
2.IS 3427	: Metal enclosed Switchgear & Control Gear
3.BS 162	: Safety Clearances
4.IS 2705	: Current Transformers
5.IS 3156	: Voltage Transformers
6.IS 3202	: Code of Practice for climate proofing of electrical equipment
7.IS 375	: Marking & Arrangement for Switchgear Bus Bars, main connections and auxiliary wiring.
8.ARE 722	: A.C. Electric Meters
9.IS 1248	: Direct acting Electrical Indicating Instruments
10.IS 3231	: Electrical Relays for Power System Protection
11.IS 2544	: Epoxy Cast Resin Insulators

12.IS 5082	: Electrolytic Copper/ Aluminium
13.IS 5792	: High Voltage HRC fuses
14.BS 88	: Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.
15.BS 89	: Direct acting electrical indicating analogue electrical measuring instruments and their accessories.
16.BS 142	: Electrical protective relays
17.BS 159	: Busbar and Busbar connection
18.BS 1433	: Copper for electrical purposes. Rods and bars.
19.BS EN 60898	: Circuit-breakers for over current protection for household and similar installations.
20.BS 3938	: Current transformers
21.BS EN 60947-2	: Low-voltage switchgear and control gear, Part 2 circuit-breakers.
22.BS 4794	: Control switches (switching devices, Part 1 including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC). General requirements.
23.BS 5419	: Air-break switches, air-break disconnectors, and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
24.BS 5420	: Degrees of protection of enclosures of switch Part I great Part I and control gear for voltages up to and including 1000V AC and 1200V DC.
25.BS 5424	: Control gear for voltages up to and including 1000V AC and 1200V DC – Part 1 Contactors.
26.BS 5486	: Low-voltage switchgear and control gear Part 1 assemblies. Part I: Requirement for type tested and partially type tested assemblies.
27.BS 5685	: Electricity meters – Part I: Class 0.5, 1 and 2 single phase and poly phase, single-rate and multi-rate watt-hour meters.
28.BS 5992	: Electrical relays
29.BS 6004	: PVC insulated cables, (non-armoured), for electric power and lighting.
30.BS 6231	: PVC insulated cables for switchgear and control gear wiring.
31.IS 3043/ BS7430	: Earthing

- D. BS/IEC or IS not mentioned above but are applicable to this installation shall also apply.

### 1.3 SUBMISSION

- A. Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout and earthing layouts, including equipment installation and cable termination details etc. prior to start of work.
- B. Such drawings shall show the proposed method of construction of the cubicles, method of supporting equipment and Busbar, full details of Busbar layout, method of support, electrical control wiring diagrams, equipment weight, colors, and surface treatment.
- C. The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for construction.
- D. Factory and site testing procedures and report formats shall also be included.
- E. Preparation of bill of materials for Different Items as mentioned in Schedule of Quantities.
- F. Lighting/power panel schedule.
- G. Interconnection drawing.
- H. Protection co-ordination drawings/tables for complete power system.
- I. Shop inspection and testing procedures.
- J. Field testing and commissioning procedures.
- K. Preparation of as built drawings for the services the contractor is rendering.

Any other work/activity which is not listed above; however is necessary for completeness of electrical system.

## PART 2 – PRODUCTS

### 2.1 PANEL BOARD

- A. The switch boards shall be cubicle type, suitable for indoor installation, floor mounting and free standing. The design shall be totally enclosed, dust - tight, damp-proof and vermin proof offering degree of protection not less than IP-42.
- B. Separate segregated compartments shall be provided for circuit breakers, bus bars, cable box, voltage transformers, wire ways, relays, and instrument and control devices. Switchgear cubicles/ modules shall be provided with hinged doors in front with facility for padlocking door handles.
- C. Vent openings shall be covered with grills so arranged that hot gases cannot be discharged through them in a manner that can injure the operating personnel. These vent openings shall be vermin proof.
- D. All panels shall be of same height, width and depth. Panels shall be bolted together to form a continuous flush front switch board, suitable for front of board operation.
- E. The switchgear cubicles shall be rigid and robust in design and construction, fabricated out of CRCA sheet steel. Cubicles shall be made from rigid welded structural frames made of structural steel sections or of pressed/formed sheet steel of not less than 3mm thickness. The frames shall be

enclosed by sheet steel of at least 2mm thickness, smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary.

- F. All doors, panels, removable covers shall be provided with non deteriorating (neoprene) gaskets all around the perimeter.
- G. All doors shall be removable and supported by concealed type hinges. The hinges shall be strong and braced to ensure freedom from sagging, bending and general distortion of panel or hinged part.
- H. Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm, keeping in view the operating height of top switch should not exceed 1750mm from FFL including base channel.

## 2.2 BUSBARS & BUSBAR CHAMBER

- A. Three phase bus bars shall be of high conductivity electrolytic Aluminium as stated in B.O.Q.
- B. The bus bars shall be air insulated and housed in a separate compartment, segregated from all other compartments.
- C. Bus bars & bus bar connections shall be of uniform cross section shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. The bus bars connections shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current specified. Normal operating temperature for bus bars shall be 85 Deg C. Short circuit rating of the bus bars shall be 20 to 50 KA for 1 sec as per BOQ.
- D. All bus bar joints and bus tap joints shall be silver or tin plated. Joints shall be bolted type and shall be insulated. Spring/Lock washers shall be provided to ensure good contact on the joints.
- E. Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental shorting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.
- F. All insulating materials used shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compounds to minimize accumulation of dust, condensation and tracking.
- G. All bus bars shall be color coded as per IS:375.

## 2.3 CURRENT TRANSFORMERS (CTs)

- A. Current transformers shall be of suitable ratio, burden & class/accuracy as specified in Single Line Diagram.
- B. Current transformers shall conform to latest edition to relevant standards. The Current transformers shall be epoxy resin cast with bar Primary or ring type.
- C. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.
- D. The current transformer shall preferably be capable of being left open circuited on the secondary side with primary carrying rated full load current, without overheating or damage. Short time current rating and rated withstand time shall be same as corresponding C.B.
- E. CT core laminations shall be of high grade silicon steel.

- F. Secondary terminals of CT shall be brought out to a terminal block which will be easily accessible for testing and external connections. Facility shall be provided for short circuiting and earthing of CT secondary leads through a removable and accessible link with provision for attaching test link.
- G. Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.
- H. Current transformers (core) shall be used for metering and protection.

## **2.4 POTENTIAL TRANSFORMERS (PTs)**

- A. Potential Transformers shall conform to latest edition of relevant standards.
- B. Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.
- C. The PTs shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PTs shall be suitable for continuous operation with a persistent phase to ground fault.
- D. Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg's above an ambient of 45 Deg's.
- E. HRC Fuses shall be provided secondary side. It shall be possible to replace PT fuses easily without having to de-energise the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.
- F. Voltage transformer ratio, output and class shall be as specified in the drawing & BOQ. Name plate as per relevant standards shall be provided on the PT.

## **2.5 PROTECTIVE RELAYS**

- A. Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings and B.O.Q.
- B. Relays shall be enclosed in rectangular shaped cases, suitable for flush mounting only, dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicalised.
- C. Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.
- D. Protective relays shall be draw out type. Where it is not possible to provide protective relays of the draw out pattern, fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.
- E. Relays shall be provided with positive action self reset type with indicator. The indicator/s shall be visible from the front.
- F. Relays conform to relevant standards in all respects.
- G. Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

## **2.6 SAFETY/ PROTECTION & INTERLOCKS/FEATURES**

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe, positive and full-proof.

- A. It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.
- B. Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall be preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.
- C. Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.
- D. Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.
- E. 1 no. bus earthing truck shall be supplied with each panel to earth the out going cable of the VCB breaker.
- F. Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.
- G. Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.
- H. Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.
- I. Any other interlocks which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.
- J. All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.
- K. Components within cubicles shall be properly labeled to facilitate testing.

## 2.7 EARTHING

- A. The switch board shall be provided at the bottom throughout its entire length with an earth bus of copper of adequate size to carry the fault current for the duration same as short time rating of the circuit breaker. Earth bus shall have two earthing connection facility at its both ends of earthing conductor.
- B. All non-current carrying metal parts, frames and equipment mounted in the switch board shall be bonded to earth bus.
- C. Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.
- D. It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

- E. One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type/rating shall be provided.

## 2.8 INSTRUMENT & METERS

- A. Electrical indicating instruments shall be digital type with zero adjustment, probe from outside the cover.
- B. Multi function meter of CL 1.0 accuracy with RS 485 port shall be provided.
- C. Instruments/meters shall be suitable for flush mounting on the panel with flanges protecting outside the panel.
- D. All meters shall be industrial grade with accuracy of class 1.0 unless specifically indicated.

## 2.9 CONTROL WIRING

- A. All wiring for control, protection, alarm and indicating circuits on all equipment shall be carried out with at least 650V grade, PVC insulated, stranded, copper, 1.5 Sq.mm conductors.
- B. All wiring shall be run on the sides of the panels and shall be neatly bunched and cleared without affecting access to equipment mounted in the panel. Where wiring enters or passes through compartments containing HT apparatus then they shall be in earthed metallic conduits or ducts.
- C. All wiring shall be taken to terminal blocks without joints or tees in their run.
- D. All wiring shall be color coded as follows:
- Instrument Transformer AC circuit - Red, Yellow & Blue determined by the Phase with which the wire is associated.
  - AC Phase Wire - White
  - AC Neutral - Black
  - DC Circuits - Grey
  - Earth connections - Green
- E. Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted to each wire. Ferrules shall fit tightly on the wires, without falling off when wire is removed. Ferrules shall be of white color with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.
- F. All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.
- G. All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block.

## 2.10 FITTINGS AND ACCESSORIES

- A. Indicating Lamps
1. LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.
  2. Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp.
  3. Bulbs and lenses shall be interchangeable and replaceable from the front.

4. Following colors shall be used for the function indicated:

Red	-	Circuit Breaker 'ON'
Green	-	Circuit Breaker 'OFF'
White	-	Continuous trip supply supervision
Amber	-	Auto trip
Blue	-	Spring charged
R.Y.B	-	Potential indication

B. Push Buttons

1. All push buttons shall be push to actuate the contact type.
2. Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.
3. Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

C. Control & Selector Switches

1. Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.
2. All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.
3. Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in color. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.
4. Circuit breaker control switches shall normally have three position close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.
5. All other instruments and selector switches shall have stay put contacts.
6. Contacts of all control and selector switches shall be rated for 10 Amps at 240V AC or 20 Amps at 220V dc (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A A.C.

D. Control Terminal Blocks

1. Box - clamp type, 650V grade line up terminals of minimum 2.5 Sq.mm size shall be provided. Connection to terminals shall be from front.
2. Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.
3. Terminal blocks at different voltage shall be segregated into groups and distinctly labeled.



4. Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.
5. Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.
6. Separate terminal stems shall be provided for internal and external wiring.
7. Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plate shall be provided for the control cables at the bottom of each panel.
8. Minimum 10% of total number spare terminals shall be provided for future use.

### 2.11 NAME PLATES AND LABELS

- A. One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.
- B. Labels giving following details shall be affixed on each feeder panel:
  - i. Feeder No.
  - ii. Equipment reference no. & Description
  - iii. Rating (HP/KW/KVA/Amp.)
- C. All components whether mounted inside or on the door shall be permanently and clearly labeled with reference number/letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.
- D. All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.
- E. Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

### 2.12 SPACE HEATERS

- A. Adequately rated anti-condensation space heaters shall be provided in each cubicle.
- B. Space heater/s shall be trip type, rated with operation voltage of 240V, 50 Hz. AC supply.
- C. Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.
- D. The space heater shall be rated for maintaining the panel inside temperature 10 Deg.C above outside ambient temperature.

### 2.13 CUBICLE LIGHTING

- A. Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from a 240V single phase, 50 Hz. A.C. supplies.

**2.14 AUXILIARY SUPPLY**

- A. Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

**2.15 FUSES**

- A. Fuses shall be HRC cartridge link type (Diazed Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.
- B. Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.
- C. It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provide. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.
- D. Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

**2.16 CONTACTORS**

- A. The contactors shall be air break type, equipped with three main contacts and minimum 2 NO + 2 NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.
- B. The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).
- C. Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, + 10% and – 15% 1 PH, AC supply. The contactor drop off voltage shall be between 15% to 65% of the rated coil voltage.

**2.17 SINGLE PHASING PREVENTOR (SPP)**

- A. Unless specified otherwise SPPs shall be provided in all motor starter modules with contactor rating of 200 Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.
- B. In case of single phasing, the SPP shall operate after a time delay of 2 to 3 secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.
- C. The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

**2.18 CABLE TERMINATION**

- A. The switch board panel shall be complete with suitable cable end termination for XLPE insulated cables. Cable and sealing box shall preferably be mounted inside the panel. For XLPE cables adequate space and clearances shall be made for heat shrinkable termination e.g. Raychem or cold flowing stress grading joints.
- B. Two earthing terminals shall be provided in each panel in cable box/cabling chamber for earthing armour/screen.

- C. Where more than one core is terminated on each phase, links suitably designed and properly supported shall be provided to avoid unnecessary bending of cable cores without decreasing the length of insulated cable tail. Electrical clearances which would normally be required when using one core per phase shall be maintained.
- D. Where core balance type current transformers are provided on switchgear feeder circuit cable/s for earth fault protection sufficient space, clearance and support, mounting arrangement shall be provided for the CT.

## **PART 3 – EXECUTION**

### **3.1 TESTING AND COMMISSIONING**

- A. All panel boards shall be inspected & tested in the presence of Owner/ Consultant's representative and certified by the installation Engineer that it is safe before supply is energized, and that all the equipment comply with the requirements of the Specification.
- B. Generally such tests in the factory and repeated at site are as follows:
1. All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
  2. Test for protective relay operation by secondary injection method.
  3. Operation of all meters.
  4. Secondary wiring continuity test
  5. Insulation test with 1000 Volts mugger, before and after voltage test.
  6. HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
  7. Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
  8. Measurement of power required for closing/trip coil of the breaker.
  9. Pick up and drop out voltages for shunt trip and closing coils.
  10. CT Polarity test.
  11. Power frequency voltage withstand test.
  12. Earth continuity tests;
  13. Check of clearance and creep age distances;
  14. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
  15. Interfacing test with BMS control function
  16. All other tests required by the Engineer to verify compliance with the Specification.
- C. Triplicate sets of all principal test records and test certificates are to be supplied for all the tests carried out in accordance with the Specification to the Engineer for approval before dispatch from the factory.
- D. All costs, materials, equipment, labour, etc. necessary for the execution of the testing shall be included in this portion of work.

### **3.2 DRAWINGS AND INFORMATION**

- A. The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:
1. General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.

2. Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
  3. Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
  4. Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
  5. Relay wiring diagrams.
  6. Equipment List.
- B. Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.
- C. The information furnished shall include the following:
1. Technical literature giving complete information of the equipment.
  2. Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
  3. A comprehensive spare parts catalogue.

### **3.3 TOOLS**

- A. One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

### **3.4 SPARES**

- A. The manufacturer/tendered shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

### **3.5 TRANSPORTATION**

- A. Panel boards are not allowed to be delivered to site until the electrical room or switch room is in a clean and acceptable condition with lockable doors.
- B. Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.
- C. Panel boards, which are poorly packed and result in signs of corrosion, will be rejected.
- D. All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

### **3.6 REJECTION OF PANELBOARDS**

- A. Deviation from specification must be stated in writing at the quotation stage.
- B. In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.

- C. If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

**END OF SECTION**