

**TENDER DOCUMENT**

**FOR**

**DEVELOPMENT OF SHIP DOCKING AND REPAIR**  
**INFRASTRUCTURE IN PATHFINDER CREEK**  
**AT VADINAR**

**VOL. II**

**SPECIFICATION FOR ELECTRICAL WORKS**



**DEENDAYAL PORT AUTHORITY**  
**ADMINISTRATIVE OFFICE BUILDING,**  
**POST BOX NO.50, GANDHIDHAM (KUTCH)**  
**GUJARAT – 370201.**



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## **1. INTRODUCTION**

### **1.1. Project Information**


Deendayal Port Authority (DPA) intends to develop a ship docking and repair infrastructure at Vadinar jointly with Cochin Shipyard Limited. The Ship Repair facility shall include two numbers of 300m length floating dry dock and one number of 150m length floating dry dock with necessary onshore facilities. The facilities shall include the following.

- Floating dry docks
  - 2 Nos of 300m x 55m x 15m x 12m
  - 1 No of 150m x 32m x 12m x 10m
- Floating dock berthing Jetties of
  - Outfitting jetty-1 (325m x 20m)
  - Outfitting jetty-2 (325m x 20m)
  - Outfitting jetty-3 (200m x 20m)
- Guide pin piles for Floating Dry Docks (6 x Nos)
- Berthing fenders and bollards for ships and crafts at Jetty
- Approach Trestle to land ~ 231.1m
- Crane rails for ELTT cranes and end stoppers.
- Electrical Power Supply including substation facilities.
- Cable trenches including cable reaving slots.
- Desalination plant and Potable Water supply facilities
- Firefighting water pump house and facilities
- Navigational Aids

As part of the project, the work also includes detailed engineering, design, procure, supply, installation, testing and commissioning power supply to the proposed facility including design, procure, supply, erection and commissioning of electrical system but not limited to the following.

- 1 No. of 11 kV Switchboard
- 2 Nos. of 11 kV/0.460 kV, 500 kVA Distribution Transformers
- 2 Nos. of 11 kV/0.433 kV, 500 kVA Distribution Transformers
- 2 Nos. of 11 kV/0.380 kV, 500 kVA Distribution Transformers
- 1 Nos. of 415 V PMCC
- Frequency convertor.
- 1 No. 110 V DC Supply System with Battery
- 1 No. Main Lighting DB
- Sub- Lighting DBs – as required.
- LED lamps with posts and fixtures as per specifications
- Power supply and distribution cables



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The Ship docking facility shall receive power supply from nearby substation of GUJARAT Urja Vikas Nigam Limited (GUVNL) via 11 kV Feeder. 11 kV Cables, 3C x 400 Sqmm, shall be laid from nearby GUVNL substation to proposed substation location through the DPA area and approach trestle.

## **1.2. Major Electrical Loads**

The major electrical loads include the following but not limited to the list as the list may not be exhaustive.

- (a) Shore power to the floating dry docks.
- (b) DTRO plant (1.2MLD) located within the pump house
- (c) Street lighting in the approach trestle
- (d) Street Lighting in the outfitting jetty
- (e) Internal illumination for substation and pumphouse
- (f) EOT Crane
- (g) Jockey pump (36 m<sup>3</sup>/hr)
- (h) Pump for DTRO plant (600m<sup>3</sup>/hr)
- (i) Convenience Sockets for small power

## **1.3. Scope of electrical works**

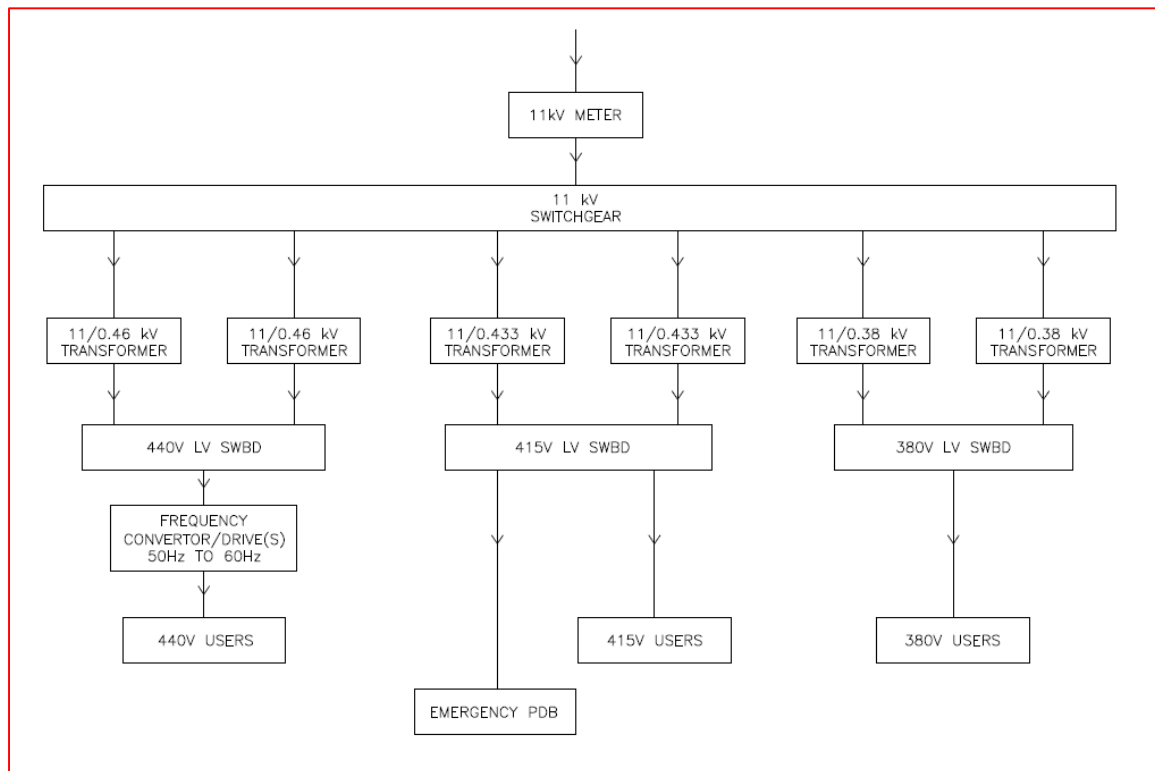
The Overall Scope of work can be divided into the following broad categories:

- a) Estimation of Electrical Load for the outfitting jetty and approach trestle: The preliminary load estimation for the proposed Jetty has been carried out and the same is shown in Appendix-E. Contractor's scope includes the verification of preliminary information provided in the tender and update the same during detail engineering,
- b) Pre- engineering site survey to the following areas:
  - Survey of the DPA area and approach trestle where the cable splicing is to be done.
  - Survey of the existing transformer to assess the feeders supplying the proposed Substation.
- c) Laying of 3C x 400 Sq.mm. 11kV HT cables from the existing transformer to the proposed substation.
- d) Setting up of the proposed Substation to cater to the needs of the various facilities listed in section 1.2 above.

## 2. DESCRIPTION OF ELECTRICAL WORKS

### 2.1. Power system schematic

The estimated power supply requirement of operation of the facility provided by CSL is 3000 kVA, hence the power is tapped from the substation (Paschim Gujarat Vij Company Limited (PGVCL)) located at the DPA premises on land. Power from the pump house cum substation (offshore) shall be routed through underground trench and through approach trestle. The block diagram for the entire offshore substation is shown in Figure 4.1.




**Figure 2.1 Power supply block diagram**

The power supply to various users within the floating dry dock and jetty are required at different voltage levels as required by CSL and the same are summarised in Table 2.1.

**Table 2.1 Power supply voltage level**

1	415V AC System	Voltage variation +10 to -15% Freq. Variation +3 to -3 %	Three Phase and neutral, 50 Hz, effectively earthed system
2	380V AC System	Voltage variation +10 to -15% Freq. Variation +3 to -3 %	Single phase and neutral, 50 Hz, effectively earthed system
3	440V AC System	Voltage variation +10 to -15% Freq. Variation +3 to -3 %	Single phase and neutral, 60 Hz, effectively earthed system

It has been assumed that rating for each for 415V, 380V and 440V voltage level as 1000 kVa and the same needs to be assessed during detailed engineering.

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*Note: It is assumed that the existing substation has sufficient capacity to feed the new substation planned for the proposed facility. This shall be verified during the pre-engineering survey by the contractor.*

## **2.2. Electrical Specifications**

The following sections detail out the technical specifications for the various equipment of the electrical services. The particulars of quality checks and standards that shall be adhered to during the manufacturing process have been detailed in these technical specifications. Topicalization of the equipment and suitability to marine environment shall be followed.

The technical specifications detail out the accessories and components that are required to make the specified equipment or system complete. The prices quoted by the bidders is deemed to include all these accessories and components even if they have not been explicitly listed out in the bill of quantities (unless these have been specifically mentioned to have been excluded and been included elsewhere separately).

## **2.3. Statutory Approvals:**

The installation shall be in accordance with the Indian Electricity Rules 1956 and Indian standards and all the Indian/ international standards for installation of electrical equipment. The contractor shall arrange to obtain all necessary approvals for the electrical installation as required by the prevalent laws of the state, necessary application forms as required to be filled up and submitted to the concerned authority shall be procured, filled and submitted for approval. Clearance from Central Electrical Authority for commissioning electrical system shall be obtained by the contractor. Necessary support for obtaining the same shall be provided by DPA. All expenses towards the overall approval of the installation including the statutory fees will be borne by the Contractor.

The Contractor shall provide the following along with the equipment:

- a) Internal wiring details with ferruling schemes and schematics to be hung as wall charts in the panel rooms for the operating and maintenance personnel.
- b) Onsite training for the customer's operating staff for the routine operation and maintenance procedures.
- c) All necessary signs required by the safety rules for the electrical equipment and substations.
- d) Maintenance and installation schedules of all the equipment.

Bidders shall explicitly list out all deviations from the technical specifications if any. These shall be consolidated and listed out separately and clearly in their bids failure to have done so will deem their bids to be as per the technical specifications specified herein. The bidder shall have valid electrical contractor license issued by PWD, Govt. of Gujarat.

## 2.4. Electrical Loads

The preliminary load estimate has been made and the power distribution planning was carried out during the tender stage. This is only for information purpose, and the Contractor shall develop a full load list in consultation with the Engineer's Representative to the satisfactory functioning of the electrical system for the whole facility.

## 2.5. Selection of Voltage Level

Following shall be the Voltage levels applicable for the project:

**Table 2.2. Voltage Level for the facilities**

Service	Voltage Level	Variation	Remarks
Incoming Power Supply	11 kV, 3 Ph 3 W, 50 Hz	To be verified by contractor	Note, the Contractor shall collect all data regarding existing system including fault level at the existing SWBD.
Motors,	415 V, 3 Ph, 3 W, 50 Hz	Voltage - $\pm 10\%$ Frequency $\pm 3\%$	
Packages etc	415 V, 3 Ph, 4 W, 50 Hz	Voltage - $\pm 10\%$ Frequency $\pm 3\%$	
Lighting and Convenience Socket outlets	240 V 1 Ph, 3 W, 50 Hz	Voltage - $\pm 10\%$ Frequency $\pm 3\%$	
Control Voltage to HV and LV Switchboards, Closing and opening of Breakers, metering and Protection relaying	110 V DC	Voltage $\pm 3\%$	Contractor shall install a suitably sized DC system consisting of Battery Chargers and Battery for 1 hour back-up
HV and LT Breakers Spring charging	240 V 1 Ph, 2 W, 50 Hz	Voltage - $\pm 10\%$ Frequency $\pm 3\%$	Power shall be through internal Control transformers from each bus section,

## 2.6. Voltage Drop Criteria

Following shall be the various voltage drops considered for the Project:

Service	Maximum Voltage Drop allowed
11 kV System from Existing Substation to New Jetty Substation Distribution Transformers	0.5 %
From 11 / 0.433 kV Transformer to 415 V PMCC	0.5 %
From 415 V PMCC to package Equipment	4.5 % See Note below:
From Lighting Transformer to MLDB	0.5%
Between MLDB & Sub-Lighting panels	2.5%
Between Sub- Lighting Panels to Lighting Points	2%
110 V DC for Breaker Control metering and Protection	3%


Note:

- i) It is presumed there are no MCCs within the Packages
- ii) The voltage drop at the PMCC bus shall not to exceed 10% of nominal voltage during start-up of the largest LV Motor when operating with base load.
- iii) The voltage available at the LV motor terminals during starting of the motor shall not fall below 80% of nominal voltage.

## 2.7. Electrical System

The 11 KV supply will be connected to 11 KV metering unit through 11 kV, XLPE armoured cable from onshore substation to the offshore substation. The electrical system for the jetty shall consist of the following.

- 11kV Switchboard
- 11kV / 0.380 kV, 11kV / 0.433 kV and 11kV / 0.440 kV Step down transformers
- 380V / 415V / 440V Switchgear
- Distribution system
- APFC
- Frequency convertor for 50 Hz to 60 Hz
- Lighting System
- 240V AC UPS system
- 110V DC system
- Emergency Power System (DG Set)
- Earthing System
- Lightning Protection system
- Cable and Trays

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## **2.8. Power system description**

### **2.8.1. Main Power supply**

Power for the proposed facility shall be taken from the existing 11 kV transformer at PGVCL Substation.

### **2.8.2. 11 kV HV Switchgear:**

The system fault levels considered at voltage levels is 11 kV at 35 kA for 1 Sec and exact fault level shall be decided / calculated during detailed engineering by the Contractor.

11 kV switchgear shall be 3 phase, 4-wire, solidly grounded system. Fault level on the 11 kV bus shall be 35 kA for 1 second. 11 kV switchgear shall be provided with three bus sections, three incomers and two bus coupler each rated for 100% of the loads connected to the switchgear. The continuous current rating of the bus bars, the incomers, bus couplers of the switchgear, which are fed by the transformers shall be rated at the HV side full load current of the corresponding transformers rating.

The substation shall be isolated from the fire water pump house by fire wall made of 345 mm brick wall or 230 mm thick RC wall. The transformers area and electrical room shall comply with the recommendations of IS-1646 and OISD-173, for Fire Safety of Buildings.

### **2.8.3. Stepdown Transformers:**

Compact Sub Station shall comprise of 11 KV, VCB, Dry type Transformers and LT outgoing feeder. This compact unit can be placed indoor. Rating of Transformers has been proposed considering the total load requirement. Voltage of step-down Transformers are proposed as follows.

- (a) Two (2) units of 11 KV VCB, 11 / 0.380 KV 500 kVA Dry Type Transformer and LT ACB.
- (b) Two (2) units of 11 KV VCB, 11 / 0.433 KV 500 kVA Dry Type Transformer and LT ACB.
- (c) Two (2) units of 11 KV VCB, 11 / 0.440 KV 500 kVA Dry Type Transformer and LT ACB.

Two (2) units for transformers are used in consideration of redundancy and maintenance aspects. Capacities of transformers are such that when one of transformers is under breakdown, the other transformer shall take the load of the full power requirement.

#### 2.8.4. LV System:

To cater to all the medium voltage (MV) loads, 2 Nos. each of 630 kVA, 11kV/0.340kV, 11kV/0.433kV and 11kV/0.440kV Dyn11, OCTC +/- 5% in steps of 2.5%, distribution transformers are envisaged. In normal condition both the transformers will feed power to PMCC, each with 50% loading. In case of failure of one transformer, another transformer will feed the entire load of PMCC. The 11 kV switchboard shall have vacuum circuit breakers in metal enclosed panels in draw out version with short circuit rating of 26.3 kA for 1 sec.

- (a) 380V/415V/440V PMCCs shall be single front, fixed type, metal enclosed (IP-52), indoor type extensible at both ends, with aluminium bus bars having 50 kA symmetrical breaking capacity and withstand time of 1 sec. along with necessary metering and protection. Air circuit breaker feeders shall be fully draw out type.
- (b) 415V Emergency PDB, 415V MOV PDB and other distribution boards shall be single front, fixed type, metal enclosed (IP-52), indoor type extensible at both ends, with aluminium bus bars, having 25 kA symmetrical breaking capacity and withstand time of 1 sec. along with necessary metering and protection.
- (c) For outgoing feeders, up to 630 Amps MCCB with microprocessor-based releases shall be provided. For 800 Amps & above rating feeders, ACB shall be provided.
- (d) All ACBs / MCCBs of PMCC/PDB shall be provided with microprocessor-based overload, short circuit and earth fault releases. The releases shall be current and time adjustable type with RS485 communication facility. Ratings shall be finalized during the detailed engineering.

#### 2.8.5. Lighting and Small Power Distribution:

2 Nos. of suitably sized 415 V / 240 V dry type lighting transformers shall be provided in the Jetty substation to cater to the 240 V 1 Ph lighting and small power loads in the Jetty. Each transformer shall feed the indoor and outdoor lighting and small power accordingly. The Main Lighting Distribution Boards (MLDB) shall be located inside the main substation. Sub distribution boards, as required, shall be located in the jetty and other areas.

#### 2.8.6. LED lights

The specifications for LED lights shall be as follows.

S. No	LED	Description
1	106W	Recess type square (600mmx600xx approx.) fixtures 106W with light source having high efficiency low glare optics with integrated independent driver box.
2	36W	Well glass/linear LED lighting fixtures Weatherproof (min-IP-

S. No	LED	Description
		65) with LED lamp, LED driver, reflectors, mounting hardware, clamps & brackets etc. (Light Output i.e. LUMENS equivalent to 125W HPMV lamp)
3	69W	Well glass/linear LED lighting fixtures Weatherproof (min-IP-65) with LED lamp, LED driver, reflectors, mounting hardware, clamps & brackets etc. (Light Output i.e. LUMENS equivalent to 125W HPMV lamp)
4	350W	Well glass/linear LED lighting fixtures Weatherproof (min-IP-65) with LED lamp, LED driver, reflectors, mounting hardware, clamps & brackets etc. (Light Output i.e. LUMENS of fixture 15000 to 16000 LM and min. 100LM/watt)

#### 2.8.7. Illumination system of building:

The internal illumination of pump house hall has been planned considering an average lux level of 180 lux at working plane of 750mm from finished floor level. The fixtures shall be installed such that necessary access for maintenance is provided.

The indoor lighting of substation facilities shall consist of suitable LED Lighting fixtures and accessories. The Lighting design shall meet relevant lighting lux level as per applicable Indian standards at a working plane of 750mm.

#### 2.8.8. External Illumination system:


The external illumination has been planned considering a lux level of 60 lux at working plane of 750mm above the road level or deck level. External illumination for approach trestle is installed at a height of 7.5m high octagonal GI pole. The external illumination for the pumphouse building shall be mounted on the building sides at suitable elevation on the wall and roof. The external lighting shall also consist of streetlights and pole mounted flood lights as necessary.

Rating of flood light fitting to be decided by the bidder during detailed engineering to ensure proper even lux distribution.

#### 2.8.9. Earthing protection:

For installations within the port on land, earthing would be conventional type i.e. earthing strips shall be terminated in the earth pits filled with mix of bentonite (clay) and soil. And for earthing of installations on approach trestle, unloading platform, control room and pump house etc. the earthing strips shall be terminated by clamping on to the piles below water level. For more effective earthing the earth strips shall be embedded in the foundation of piles.



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Earthing shall be designed as per guidelines of IS: 3043 latest edition - Code of Practice for Earthing and Central Electricity Authority (CEA) Regulation, 2010 (Measures related to safety and electric supply). Earthing system for proposed jetty plant shall be designed to obtain an overall earth resistance of 1 Ohm.

Electrical equipment like motors, HV & LV switchboards, transformers, DG set, neutrals of transformers & DG set, PMCC, PDBs, LDBs, control panels, etc. and non-current carrying equipment like tanks, cable trays, process equipment (if required), etc. shall be earthed in accordance with IS 3043.


#### 2.8.10. Lightning protection:

Lightning protection shall be designed and installed as per IS/IEC 62305 to protect the plant and buildings depending upon risk factor from direct and indirect lightning stroke.

#### 2.8.11. Engineering activities

The following engineering activities shall be included in scope as minimum but not limited to the list.

- i) Estimate and summarise the loads for the proposed facility for normal operation throughout the life including any peak load.
- ii) Prepare following documents and drawings.
  - Electrical Load List,
  - Key SLD
  - Panel SLDs and Schedules
  - Electrical Equipment Sizing calculations.
  - Electrical Equipment Layout
  - Lighting Cabling and Earthing sizing calculations.
  - System Short Circuit current shall be considered in sizing the cables.
  - Lighting Cabling and Earthing Layouts
  - Lightning Protection Calculation and Layout
  - Power and Control cable Schedule
  - MTO for all electrical equipment for the proposed facility
  - Equipment installation standard drawings
  - 110 V DC system sizing and Battery sizing calculation.
- iii) The power supply requirement for the effluent treatment and desalination plants will be confirmed during Detailed Engineering after obtaining the details from the other contractors and the same shall be incorporated in the design of electrical system. The loads provided as part of the tender is preliminary and is subject to change.
- iv) Design, Procure, supply and install complete electrical cables, fitting, accessories,

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lighting fixtures, poles, sockets, switchgear panels, Lighting and Small Boards, etc. for the complete functioning of proposed facilities and commission the system and handover to the authorities.

- v) Contractor shall obtain all necessary permits from Gujarat Electricity Board for statutory requirements related to the project prior to the installation.
- vi) Contractor shall comply with all necessary rules and regulations as stated in Gujarat Electricity Board guidelines and statutory requirements.

The list of equipment, lights and fixtures provide in the document and tender is only for guidance and the contractor shall carry out lighting and illumination lux level calculation and submit for approval of the Engineering / Engineer's Representative.

#### 2.8.12. Control Power Supply for Switchgears:

A 110 V DC System consisting of 2 x 100% Rectifiers / Battery Chargers and 1 x 100 % Lead Acid, SMF VRLA Battery shall be provided for control power supply for HT and LT switchboards. The Battery shall be sized for 1 hour back-up. The Contractor shall estimate the total load for the system and a DC system sizing calculation including Battery sizing calculation for review and approval by Owners Engineer.


### 2.9. Electrical Specifications

The following sections detail out the technical specifications for the various components of the electrical services. The particulars of quality checks and standards that shall be adhered to during the manufacturing process have been detailed in these technical specifications. Topicalization of the equipment and suitability to marine environment shall be followed.

The technical specifications detail out the accessories and components that are required to make the specified equipment or system complete. The prices quoted by the bidders is deemed to include all these accessories and components even if they have not been explicitly listed out in the bill of quantities (unless these have been specifically mentioned to have been excluded and been included elsewhere separately).

#### 2.10. Statutory Approvals

The installation shall be in accordance with the Indian Electricity Rules 1956 and Indian standards and all the Indian/ international standards for installation of electrical equipment. The contractor shall arrange to obtain all necessary approvals for the electrical installation as required by the prevalent laws of the state, necessary application forms as required to be filled up and submitted to the concerned authority shall be procured, filled and submitted for approval. Clearance from Central Electrical Authority for commissioning electrical system shall be obtained by the contractor. Necessary support for obtaining the

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same shall be provided by MBPA. All expenses towards the overall approval of the installation including the statutory fees will be borne by the Contractor.

The Contractor shall provide the following along with the equipment:

- a) Internal wiring details with ferruling schemes and schematics to be hung as wall charts in the panel rooms for the operating and maintenance personnel.
- b) Onsite training for the customer's operating staff for the routine operation and maintenance procedures.
- c) All necessary signs required by the safety rules for the electrical equipment and substations.
- d) Maintenance and installation schedules of all the equipment.

Bidders shall explicitly list out all deviations from the technical specifications if any. These shall be consolidated and listed out separately and clearly in their bids failure to have done so will deem their bids to be as per the technical specifications specified herein. The bidder shall have valid electrical contractor license issued by PWD, Govt. of Gujarat.

### 3. SPECIFICATION - HT CABLES

Cable shall be capable of satisfactory performance when laid on trays, trenches, conduits, ducts and when directly buried in the ground.

Cables shall be capable of operating satisfactorily under a power supply system voltage variation of +10%, frequency variation +5%, and combined voltage and frequency variation of +10%.

#### 3.1. XLPE Construction

Voltage grade	: 11kV (E)
Conductor	: Well compacted Aluminium
Conductor screen	: This shall be extruded shield in the same operation as the insulation. The semiconductor polymer shall be cross linked.
Insulation	: Shall be cross-linked polyethylene.
Laying up	: The core shall be laid up with Polypropylene filling and tape.
Inner sheath	: Shall be extruded PVC
Aarmor	: Single galvanized steel strip armour
Outer sheath	: Shall be extruded ST-2 type PVC.
General	: The cable shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

#### 3.2. Conductors


The conductor consists of annealed copper wires compacted having a smooth circular shape as per IS: 8130-84.

#### 3.3. Conductor Screen

The conductor screen consists of a layer of smooth black extruded semi-conducting XLPE compound firmly bonded with the insulation. This eliminates electrical discharges at the interface between conductor and insulation.

#### 3.4. Insulation

The insulation consists of a super clean XLPE compound. The extrusion process is conducted in a clinically clean environment. The insulation thickness conforms to IS: 7098.

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### **3.5. Insulation Screen**

The screen consists of smooth black semi conducting XLPE compound firmly bonded with a smooth interface with the insulation. The conductor screen, insulation and insulation screen are extruded simultaneously in Dry cure process.

### **3.6. Moisture Barrier**

To make the cable longitudinally watertight a semi conducting tape is applied over the core to prevent water penetration in the cable. The tape is of non-woven material which has non-biodegradable characteristics.

### **3.7. Copper Wire Screen**

Copper wires are applied to carry the necessary earth fault current. A counter open helix copper tape is provided over the copper wires.

### **3.8. Poly-Aluminium Foil**

Aluminium foil coated with polyethylene used longitudinally as a moisture barrier is designed for making cable lighter in weight.

### **3.9. Jacketing**

The jacketing material consists of extruded black PVC or high-density polyethylene (HDPE).


### **3.10. Testing of Cables**

#### **3.10.1. Tests**

The cables shall be tested in accordance with the IS: 7098 – Part II. All the relevant tests shall be carried out at Manufacturer's premises.

All tests shall be carried out in accordance with relevant Indian Standard Code of Practice and Local Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Consultant / Employer.

The cables should be in standard drum length and straight joints should be avoided as far as possible. The rate of laying the cable shall be exclusive of cost of straight joints and jointing materials. The tenderer shall separately quote the cost of straight joints included in the BOQ attached to the tender document. The number of straight joints indicated in the Schedule of

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BOQ are based on the consideration that the cable shall be brought at site in standard drum lengths and not in shortcut lengths. In case the number of straight joints are in excess of those indicated in the Schedule of Quantities and Rates due to non- standard drum lengths, then the cost of such excess joints shall be borne by the contractor and shall not be paid for by the DPA.

For the cables supplied by the contractor to this Port Trust, the following shall be applicable.


- a) The rate for supplying the cable is called for on meters run basis in Schedule of Quantities and Rates and shall include handling charges to various points.
- b) The cost of excavation of cable trench, laying cable placing R.C.C. tiles for H.V. cables all along the cable and filling in the trenches to the ground level to the satisfaction of the engineer according to the individual items shall be quoted separately.
- c) The unit rate shall include the charges for certain trial pits at strategic points to ascertain the exact location of services of this Port Trust as well as Public Utility Bodies viz. Tata, BES, Telephone, MCGM, etc. The actual length of excavated cable trenches in which cables laid will be measured and paid for.

### **3.11. Cable Laying**

**These works shall generally conform to IS: 1255 of 1983 with up-to-date amendments- Code of practice for installation and Maintenance of Power Cables.**

#### **3.11.1. Cable storage, handling and laying:**

- i) All the drums should be stored on hard and well drained surface so that they may not sink. in no case drum should be stored on the flat surface i.e. with flange horizontal.
- ii) Rolling of drums should be avoided as far as practicable. For short distance the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled, in the same direction as it was rolled during taking up the cable.
- iii) For unreeling the cable, the drums should be mounted on jack or cable wheel. The spindle should be strong enough to carry the weight without bending.
- iv) The drum should be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.
- v) While laying cable, cable rollers should be used at an interval of 2 meters. The cable should be pushed over the roller by a gang of people positioned in between rollers.
- vi) Cable should not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable should not be less than that specified by

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the manufacturer.

- vii) All possible care should be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends.

Schedule of Quantities in BOQ are based on the consideration that the cable should be brought at site in one drum length and not in short cut lengths. The actual quantity will be measured and accordingly paid for.

3.11.2. The cable shall be laid as under:

- i) Depth of cable trench from the ground level should be 1200 mm (approx.) for H.V. cables unless specified otherwise. However, these depths can be varied up to + 300 mm depending upon the site condition and obstructions if any. This issue will be decided upon by the site engineers of DPA according to the requirements, conditions etc. as above.
- ii) The bottom of the trench should be properly levelled, and care shall be taken to remove all hard materials which may endanger the life of the cable. Before laying the cable, the trench should be covered by soft sieved an earth to a height of 100 mm and should be approved by the Chief Mechanical Engineer or his representative.
- iii) Cable should be laid in trenches in straight runs without any kinks and as far as possible without bends.
- iv) Cables should be clearly identified at joints and at every 100-meter interval by metal tags with engraved numbers.
- v) The cables thus laid should be covered with soft screened earth or sand to a height of 150 mm.
- vi) For HT Cable R.C.C. tiles bearing words "DPA 11 kV" cast on top. Only unbroken ones should be placed over sieved sand all along the length of the cable. The tiles should be so laid that the cable lies approximately below the centre of the tiles. The tiles should be laid along the run of the cable. The reinforcement of the tiles shall be by using 6 mm M.S. round bars 3 x 200 mm and 3 x 400 mm spaced 175 mm and 75 mm from centre.
- vii) If the new cables have to cross the existing cables, they should be laid under them at sufficient depth as required in Sub-clause (IX).
- viii) Where more than one cable is laid in the same trench, there shall be space of at least 200 mm between the two cables.
- ix) Where the cables are laid in the same trench, the heavier cables must be laid below the lighter ones normally at vertical spacing of not less than 200 mm, this space being filled and packed with soft sieved sand. The cables should be laid as directed.
- x) When two or more cables are laid together in the common trench, the joined are arranged to be staggered so as to reduce the excess width of trench and also to






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- isolate the joints from each other and reduce possibility of one joint failure affecting the other joints.
- xi) Wherever the cables cross a roadway or through culvert they shall be laid in R.C.C. pipe of approx. 150 mm. dia. and pipe ends shall be brick lined and plaster finished after the cables are passed through. G.I. Pipe should be used wherever R.C.C. pipe cannot be laid. The cable entry and exist in the G.I. pipe should be through bell mouth and padding prepared from lead sheath.
- xii) During the progress of any excavation work, the contractor/s should put up work display board at the sight of work at a suitable location easily from nearby road in accordance with the particulars given in this specification.
- xiii) The contractor/s shall make every effort to back fill the excavated portion within shortest possible period so that the disruption and inconvenience to the traffic is minimized. If the work of excavation, laying pipe ducts and refilling the trench, across the road remains incomplete during the day the portion of trench, across the road remains incomplete during the day the portion of trench affecting traffic movement shall be backfilled with sand bags and covered by suitable M.S. Plates to be provided by the contractor.
- xiv) The entire work of excavating trenches, laying RCC pipes, cables and refilling the trenches after the cables have been laid should be in accordance with and comply with modern practice of cable laying. All the materials viz. tiles, metal sand, cement etc. shall be supplied by the contractor. Surplus earth from cable trenches/ foundation pit shall be removed and dumped in BMC dumping ground at Deonar only. The surplus earth and debris removed from the site will be the property of contractors who should arrange to remove and transport them away from the Port Trust Estate. If any surplus excavated material, debris/ kutchra etc. is not cleared within a reasonable period and/or found dumped within DPA Estate, a fine of ₹50,000/-per lorry load shall be levied on the contractors. All the expenditure on this account is deemed to have been included in the respective item rates for transporting the surplus excavated material and no charges shall be paid extra in this regard.
- xv) In respect of the footpaths paved with slabs/set stones, the trenches shall be back filled and the slabs/set stones put back on the surface without jointing so as to be made usable by the public.
- In case of trenches with lengths exceeding 15 meter, portion of trench shall be back filled in short trenches as and when the work is completed during the progress of the work.
- During the progress of work of cable trenches, pole pits, feeder pillar foundations, etc., the contractors shall provide temporary barricades for the protection and convenience of the work and the public and provide necessary lights at night and keep sufficient watchman.
- During the progress of any excavation work, the contractor should put up a work display board at site of the works at a suitable location easily visible from nearby



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road, in accordance with the particulars given in the drawing No. SK 263/A.

### 3.11.3. Soiling and surfacing the ground:

The work of final soiling and surfacing the ground will be carried out by the contractor. Cable indicators of pre-cast concrete blocks with suitable inscription as to voltage etc., and bearing the words 'DPA' cast on top of the block, showing the run of the cables and position of bends, straight through joints, 'Tees, R.C.C. pipes, etc., shall be embedded in the final filling all along the route as shown on the drawing or as directed. Cable indicators should be provided at every 100 meters in the case of straight run of cables.

### 3.11.4. Cable Jointing and Termination

i) Crimping should be done only by using Hydraulic Crimping Tool. Crimping shall be all around the circumference of ferrules or line connectors and cable sockets should not be spot crimping.

ii) In the case of XLPE cable jointing / termination shall be done by heat shrink type kits as specified in the BOQ.

iii) The jointing kits shall provide effective and reliable stress control, superior surface protection, environmental sealing and increased dielectric strength.

iv) Tarpaulin tent should be provided where jointing works is being carried out in the open to prevent dust entering cable joint. The sides of the joints pit should be drape with suitable size tarpaulin sheets to prevent loose earth from the sides of the cable trenches falling on the joints during the course of making.


v) Identification tags made from aluminium sheet shall be attached to the end of cable by means of binding wire and tags) 136

vi) H. T. Cable jointing shall be done by using heat Shrinkable Jointing Kit

These shall be of Heat Shrinkable type jointing kit complete with all the cable jointing accessories of appropriate size suitable for all type of underground cables as specified in the BOQ. The joining kit should provide effective and reliable stress control, superior surface protection, and moisture-proof, environmental sealing and increased dielectric strength. The kit should meet I.E.C, IEEE – 404 VDE 0278 and other International Standard.

## 3.12. Testing and Commissioning of Cables

i) Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the megger for the cables from 6.6 KV to 11 KV grade shall be 5000 v.

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ii) H.V cables shall be tested for High Voltage Pressure test before commissioning as per the relevant standard. The DC test voltage applicable in India shall be as per table 6 in IS – 1255. The cable core must be discharged on completion of DC high voltage test and the cable shall be kept earthed until it is put into service.


iii) HV DC test voltage for new cable is 1.5 time rated voltage or as per IS specification. In each test the metallic sheath/screen/amour should be connected to earth. This Hi Pot should be carried out before and after jointing of the cable.

iv) Continuity of all the cores, correctness of all connections, correctness of polarity and phasing of power cables and proper earth connections of cable gland, cable boxes, amour and metallic sheath shall be checked.

v) Metallic sheath, screen and amour of all multicore cables shall be earthed at both equipment and switchgear end.

vi) Phase sequence testing of HT cable shall be carried out by the contractor after termination. Equipment's for testing the phase sequence shall be arranged by the contractor.

vii) Commissioning of Feeder and charge from one end.

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## **4. SPECIFICATION - LT CABLES**

### **4.1. General**

The LT power cables shall conform to IS-7098. The conductor shall be aluminium, multi-stranded, XLPE insulation PVC sheathed, steel armoured. The LT cables shall be suitable for grounded neutral system and shall be 1100 Volts grade.

### **4.2. Specification for the XLPE Insulated cables**

#### **4.2.1. Conductors**

The conductors shall be of electrical grade aluminium unless specified. The conductor shall be smooth, uniform in quality and free from scale, inequalities, splits and other defects. The stranded conductor shall be clean and reasonably uniform in size and shape and its conductors shall be either circular or sector shaped.


#### **4.2.2. Insulation**

The LT cables shall be insulated for 1.1 KV The insulation shall consist of high-quality cross-linked polyethylene, and it shall preferably be gas cured.

- Insulation shall be applied through extrusion process and chemically cross linked in continuous vulcanisation process to comply with the requirements of the relevant standards.
- Inner sheath. For all the cables having two or more cores, the individual cores shall be laid up and then be surrounded by common covering applied either by extrusion of wrapping or filling material containing a thermoplastic material. A proofed or plastic tape may be applied over the common covering employed. It must be ensured that the circularity of the cable is maintained. For LV cables, inner sheath shall be FRLS (Flame retardant low smoke).
- Armouring shall be arranged over the inner sheath. The Armour of the cable shall be galvanized round steel wires for multi core cables and aluminium rounds for single core cables.
- Outer sheath A tough outer sheathing of PVC insulating material in standard colours shall be provided over the armouring to offer a high degree of mechanical protection against abrasion. Outer sheath of LV cables should be FRLS (Flame retardant low smoke) type.

### **4.3. Manufacturer's identification:**

The manufacturer shall be identified throughout the length of the cable by manufacturer's name and trademark. Voltage grade and year of manufacturer of the cable indented, embossing should be done only on the outer sheath.

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#### **4.4. Packing and marking:**

The cable shall be wound on a drum of suitable size, packed and marked the marking done on the drum shall have the following information

- Trade name if any.
- Name of the manufacturer
- Number of cores and nominal area of the conductor.
- Type of the cable and voltage for which it is applicable.
- Length of the cable on the drum.
- Direction of rotation of drum.
- Drum number

The outer ends of the cables shall be sealed by means of non – hygroscopic sealing material.

#### **4.5. Cables Accessories**

- The cable glands shall be double compression type SS suitable for marine condition.
- Cable lugs shall be used for stranded conductors; cable lugs shall be fitted by crimping method only. The oxide inhibiting compound shall be used for removal of oxide film on conductor. Tinned copper lugs shall be used for cables up to 35sq.mm. and aluminium lugs shall be used for larger sizes.
- 25mm. X 3mm. G.I / aluminium strips, galvanized nuts, bolts and flat washers shall be used for cable clamping.
- Brass cable tag markers shall be used for identification of cables. The cable numbers shall be punched on the tag markers. 16 SWG G.I. Wires shall be used for fixing the cables tag markers. Cable markers shall be provided at a distance of 25 meters.
- All Cable Glands shall be of Double Compression Type.

#### **4.6. Cable Trays, conduits, Fittings & Accessories**

Cables shall be laid in Cable trays and conduits as per site conditions and per necessity. The Cable Trays, PVC cable conduits, necessary hardware, accessories, clamps and fittings etc. suitable for outdoor installation, required for cable laying. All the cable trays, conduits and their accessories shall be suitable for outdoor installation and shall be designed to operate under specified site conditions. If not specifically mentioned, a design ambient of 40°C and an altitude of 10 m above mean sea level shall be considered.

The contractor shall generate cable routing and cable tray and conduit arrangement drawings for review and approval from owner's engineer.

## 5. SPECIFICATION - 11 kV HT Switchgear

### 5.1. Applicable standards

The 11 HT Switchgear shall comply with the following Indian Standards.


IS-5	: Colours for ready mixed paints and enamels.
IS-694	: PVC-insulated cables for working voltages up to and including 1100 V
IS-1248	: Direct acting indicating analogue electrical measuring instruments and their accessories
IS-2071	: High Voltage Test Technique
IS-2544	: Porcelain post-insulators for systems with nominal voltage greater than 1000V
IS-2705	: Current transformers
IS-3156	: Voltage transformers
IS-3231	: Electrical relays for power system protection
IS-3427	: AC Metal enclosed switchgear and control gear for rated voltages above 1kV up to and including 52 kV
IS-3618	: Phosphate treatment of iron and steel for protection against corrosion
IS-5082	: Material data for aluminum bus bars
IS-5578	: Guide for marking of insulated conductors
IS 6005	: Code of practice of phosphating of iron and steel
IS 9920	: Switches and switch isolators for voltages above 1000 V
IS 9921	: AC disconnectors (isolators) and earthing switches for voltage above 1000V
IS 10601	: Dimensions of terminals of high voltage switchgear and control gear
IS 11353	: Guide for uniform system of marking and identification of conductors & apparatus terminals
IS 12729	: General requirements for switchgear and control gear for voltages exceeding 1000V

IS 13118	: General requirements for circuit breakers for voltages above 1000V
IS 13703	: Low voltage fuses for voltages not exceeding 1000V ac or 1500V dc.
IS / IEC 62271	: High Voltage Switchgear and Control gear
IEC 60479	: Effects of Current on Human Beings and Livestock
IEC 60376	: Specification and Acceptance of New Sulphur Hexafluoride
IEC 60480	: Guide to the checking of Sulphur Hexafluoride ( SF <sub>6</sub> ) taken from electrical equipment
IEC 60694	: Common specification for high voltage switchgear and control gear standards
IEC 61000-2-2	: Electromagnetic compatibility (EMC) – Part 2-2: Environment, Compatibility levels for low frequency conducted disturbances and signaling in public low-voltage power supply systems
IEC 61000-2-12	: Electromagnetic compatibility (EMC) – Part 2-12: Environment, Compatibility levels for low frequency conducted disturbances and signaling in public medium-voltage power supply systems
IEC 61869-2	: Instrument transformers – Part 2: Additional requirements for current transformers.
IEC 62271	: Guide for asymmetrical short-circuit breaking test duty
IS - 875	: Codes of practice for design loads (other than earthquake) for buildings and structures.
IS – 1893	: Criteria for earthquake resistance design of structures
IER	: Indian Electricity Rules
CPCB	: Central Pollution Control Board of India

## **5.2. Design & constructional requirements**

### **5.2.1. Ratings**

The switchgear / control gear rating shall be as noted on the data sheets and single-line diagrams and shall comply with IEC 62271. The switchgear / control gear shall be operated continuously at an ambient temperature as specified in Electrical Design Basis and more particularly on the datasheet, and shall not exceed the temperature rise limits listed in IS

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12729. Supplier shall submit the general arrangements drawing, single line diagram, bill of quantity, control scheme and QAP for the purchaser approved before starting the panel manufacturing.

#### 5.2.2. Description

The switchgear and control gear shall be loss of service continuity category LSC 2B, Partition class PM, metal enclosed, air insulated, dead front design, free standing, draw-out type, self-ventilating type, self-supporting, having a single bus bar system, and consists of a number of separate panels assembled into one or more sections prefabricated, cold rolled, sheet steel units of thickness not less than 2mm. Ratings are specified on the basis of the equipment / component being housed in the enclosures under natural ventilation.

#### 5.2.3. Interlocks

Interlocking systems shall be provided for all devices as noted on the single-line diagram(s) and protection, control and metering diagrams.

#### 5.2.4. Electrical Parameters


The equipment shall be capable of proper operation for voltage deviations of  $\pm 10\%$  and frequency deviations of  $\pm 2\%$ . In addition, contactors and relays shall be able to ride through voltage dips of 80% nominal, such as those experienced during motor starting. The switchgear shall be rated at the appropriate voltage, current and fault ratings shown on the data sheets, 50Hz, and the system will be 3 phase, 3 wire.

#### 5.2.5. Harmonic Immunity

The supplied equipment shall be immune from the harmonic currents and voltages on the electrical supply system that are at a level below the limits that are specified in IEC 61000-2-2, Table 1, for low-voltage systems and IEC 61000-2-12, Table 1, for medium-voltage systems. Immunity shall include the supplied equipment operating properly at the designed ratings.

#### 5.2.6. Electromagnetic Compatibility

All equipment shall comply with the requirements for Electromagnetic Compatibility (EMC) as defined in 5.18 of IEC 62271-1 and applicable sections of IEC 61000 in order to ensure that the conducted emissions in the equipment are controlled within acceptable limits. The electromagnetic disturbance generated by the switchgear and its individual components shall not exceed a level which would affect the correct operation of both radio and telecommunications equipment. The equipment shall have an adequate level of intrinsic

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immunity to external electromagnetic and conducted disturbance to enable it to operate as intended.

### **5.3. Enclosure**

#### **5.3.1. Structural Requirement**

Switchgear cubicles shall be metal enclosed, vermin proof, free standing, direct to floor mounting, flush fronted, single tier and arranged to form a single structure with a common bus bar assembly. They shall not exceed 2.5 m in height. All structure and metal parts shall be treated with anti-corrosion material before painting. Switchgear sections shall be arranged for lifting from the top with removable lifting brackets / Eyes. Switchgear shall be designed and constructed to facilitate inspection, cleaning, repair and maintenance and to ensure absolute safety during such work. It shall be possible to work safely within individual compartments whilst the remainder of the Switchgear is energized. All switchgear components requiring maintenance shall be easily accessible.

#### **5.3.2. Degree of Protection**

In case of indoor HV Switchboards, the degree of protection shall be minimum IP-42 for the external housing. Further, a minimum of IP-22 degree of protection shall be provided for accessible equipment within the enclosures.


#### **5.3.3. Shutters**

Partitions and shutters shall be Partition Class PM in accordance with IEC 62271-200. Automatic shutters shall be provided so that when a device is removed, disconnected, or placed in the “TEST” position, no live primary circuit elements will be exposed. Shutters shall be closed and opened automatically by the mechanical drive of the removable part when it is being racked out or racked into position. Each set of shutters, both for the bus bar and the cable side, shall be fitted with individual padlock facilities in its closed position. To facilitate testing, a manually operated device shall be installed to permit opening and closing in the test position, but not padlocking, of each set of shutters individually. The device shall be overridden by the moving part of the switching unit, restoring the automatic features of the shutters. Metallic parts shall be earthed.

#### **5.3.4. Dimensions**

The dimensions of the enclosure shall be of the supplier’s standard and subject to the Purchaser’s approval. In addition they should be approximate and shall be shown exactly on supplier’s drawings.



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## **5.4. Power Bus**

### **5.4.1. Power Bus/Material**

The entire length of the horizontal and vertical sections of the bus bar shall be insulated with a solid dielectric for the rated voltage. Material and instructions necessary for insulation of connections or terminations of the main power bus shall be supplied with the equipment. All primary and secondary bus elements and busses shall be made of high conductivity Copper.

### **5.4.2. Phase Indication**

The phase identification colour shall follow the Local standard practice or as per the IEC standard.

### **5.4.3. Joint Plating**

The joint plating shall be tin or silver.

## **5.5. Earthing**

### **5.5.1. Earthing Bus**

All cubicles shall be earthed to a common tin plated copper earthing bus of adequate cross sectional area running the full horizontal length of the assembly. Vertical sections with only one unit shall be equipped with an earth bus extending the full length of the cubicle for connecting the future unit. All internal earthing connections shall be made at the factory. Inside the compartments, adequate provisions shall be fitted for earthing the screen and/or armouring of each cable independently. Facility shall be provided for external earth connection using a minimum 70 sq.mm cable.


### **5.5.2. Main Bus bar Earthing**

The preferred method of earthing bus bars shall be by operation of the fully interlocked bus bar earth switch.

## **5.6. Earthing Devices**

### **5.6.1. Earthing Switch**

An integrally mounted two position, three phase earthing switch, capable of making and carrying the same prospective short circuit current as the circuit breaker / contactor and suitable for local, manual operation, shall be provided on the cable side of all circuit breakers / contactors / switching devices. The operation of the earthing switch shall be mechanically interlocked allowing closure of the earthing switch only when the breaker / contactor / switching device is not in closed position. Clear instructions, preferably pictorial, shall be installed showing the methods of switch operation.

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### 5.6.2. Effective Earthing and Padlocking

Fully draw-out parts shall be provided with padlocking facilities for locking the earthing switches in the open and closed positions.

### 5.6.3. Electromechanical Interlocking

All interlocks shall be provided as per Single Line diagram and data sheet. Interlocks shall be provided and arranged to ensure that it will not be possible to earth an incoming supply which has not been isolated and it will not be possible to switch on an incoming supply when the earth switch is still closed.

## 5.7. Cubicle Space Heaters

### 5.7.1. Requirements

Space heaters shall be provided to eliminate condensation within control junction enclosures and/or cable termination compartments. Space heaters shall be low surface temperature type and sized to maintain the interior of the enclosures 5°C above ambient temperature. A miniature circuit breaker shall be provided for overcurrent protection and means of disconnection.

### 5.7.2. Control

The space heaters shall be thermostatically controlled and shall operate at a voltage of 230VAC, 1 Phase, 50Hz. Thermostats for contactor control shall have a minimum rating of 5A at 0.35 inductive power factor at 230VAC. Power supply shall be internally derived.


### 5.7.3. Equipment Contact

The space heaters shall be adequately guarded to prevent personnel or equipment contact with the hot surfaces.

## 5.8. Incoming Line

### 5.8.1. Interconnections

The incoming line section shall contain main disconnecting means and shall include provisions for connecting the High-voltage or Medium-voltage switchgear to the incoming, three-phase, insulated bus bar or bus duct, incoming cables or cable bus as per the single line diagram. Bus and incoming line phase shall be identified on the Supplier drawings. Adequate space for terminations shall be provided and identified on the Supplier drawings.

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### 5.8.2. Metering

Each incoming line section shall contain switchboard metering, relaying, and / or instrument transformers as indicated on the datasheets.

### 5.8.3. Isolators

Isolators shall comply with IEC 62271-102. Isolators shall be rated for the full load rated current of the associated circuit breaker.

Switches with a load make/break capability shall comply with IS 9920.

Isolators and switches shall be capable of withstanding the short circuit current conditions specified in the data sheets. Test reports shall be provided.

Isolators operated live should be of the assisted type.

Disconnectors (isolators) shall be interlocked to prevent operation unless the circuit switching device is open.

Interconnection between the isolator mechanism and operating handle shall be robust and of high mechanical integrity.

## 5.9. Circuit Breaker

### 5.9.1. Circuit Breaker Type


HV switchgear shall be Vacuum-break air insulated, Class E2-M2 of the withdrawable type and shall consist of a service, test and fully withdrawn racking position.

All switchgear ratings shall comply with current carrying ampere ratings as shown on the single-line diagrams and datasheets.

Circuit-breakers shall be rated for the short circuit breaking current with percentage DC component specified on the Data Sheets. Circuit breakers shall be in accordance with IS 13118, electrically operated, stored energy type, trip free, with provision for manual operation in case of emergency or loss of control power source.

All circuit breakers shall be suitable for local operation only through control switches provided on the panel

The circuit breaker shall be suitable for carrying out the duty cycle of 0 – 3 min – CO – 3 min – CO.

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#### 5.9.2. Operating Counter

Anti-pumping devices (APD) shall be incorporated in the circuitry to prevent 'pumping actions' of closing mechanisms.

#### 5.9.3. Interchangeability

Breakers shall be interchangeable with others of the same voltage, current, and breaking ratings. It shall not be possible to interchange breakers of different ratings.

#### 5.9.4. Padlocks

Provisions shall be provided for locking the breaker in the "open" position. A padlocking provision shall also be provided to prevent unauthorized racking.

#### 5.9.5. Operating Delay

Delayed opening of circuit breakers in order to meet the specified short-circuit interrupting performance is not allowed.

#### 5.9.6. Auxiliary Contacts


Each breaker shall include two (2) Normally Open and two (2) Normally Closed unused auxiliary contacts pre-wired to a terminal block for Purchaser's use. Additional contacts shall be provided for controls and indications as required by the control schemes, single-line diagram(s), and datasheets. The contacts shall be wired to the terminal blocks in the control wiring compartment.

#### 5.9.7. Connections

Auxiliary and control connections of devices shall be made either with self-aligning plug and socket contacts or with a multi-conductor cable with plug and socket arrangement.

#### 5.9.8. Heater Contacts

Auxiliary switch contacts for motor space heater supplies shall be provided so that heaters are energized when the main circuit switch device is open or in the test position. When the switching device is closed, the space heater supply shall be isolated.

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## **5.10. Circuit Breaker Control**

### **5.10.1. Local and Remote Control**

The Breaker operation control shall be provided on the front facial of the panel. All switchgear positions shall provide a manual trip facility on the front of the panel, suitably protected to prevent inadvertent operation. A padlocking facility shall be provided to prevent unauthorized use of manual trip and close facilities. Circuit breakers and withdrawable type contactors shall be provided with a means of operational testing when in test or withdrawn isolated position.

The tripping and closing device local to panel shall be operable in the test position. All other automatic operations shall also be operable in this position to allow the complete testing and commissioning of equipment without the need for energizing power circuits. Individual control operations shall be selectable. It shall be possible to mechanically trip all circuit breakers at the Switchgear.

No remote operation of the breakers is envisaged.

## **5.11. Breaker Control Power**

### **5.11.1. General**

Control power for closing, tripping, and protection of circuit breakers, shall be through a 110 V DC system.

Refer to the bid single line diagram for protection and metering requirement. Each control bus used for breaker tripping power shall be provided with an under-voltage alarm relay, and a blue “Power Available” indicating light.

### **5.11.2. Protection For Trip Circuits**


Close and trip circuits for each switching device shall be separately protected. Both shall be switched off with the main switching device to completely de-energize the compartment.

### **5.11.3. Control Cabling**

This section is not applicable and deleted.

### **5.11.4. Trip Supply Alarm**

All circuit breaker trip coils and all lockout relay coils shall be supervised by normally energized “healthy trip” lights. In addition, any loss of trip supply shall operate an alarm relay with contacts wired up to terminals.

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#### 5.11.5. Indicating Lights

All indicating lights shall be multi-LED type, providing long life capacity, and shall be removable from the front panel.

The indicating lights for circuit breakers shall be:

- a) RED “ON” when breaker is closed
- b) GREEN “ON” when breaker is opened
- c) WHITE “ON” when indicating trip circuits / lockout relays are operational (healthy)
- d) AMBER “ON” when breaker tripped (indicates trip by device other than control switch)

### 5.12. Relays and Metering

#### 5.12.1. General

Protective relaying and metering shall be provided as specified on the datasheets and/or single line diagrams. In general, microprocessor-based, multifunction protective relaying and metering is preferred and shall be included in Supplier's base quotation. IEEE standard C37.2 device numbers shall be used in all documentation.

#### 5.12.2. Installation


Protective relays shall be flush or semi-flush mounted, and installed to facilitate ease of maintenance, inspection, flag reset and testing. Trip indicators on protective relays shall be clearly visible, indicating operation of the relay has occurred. The resetting of indicators shall be made from the front of the switchgear.

#### 5.12.3. Isolation

Instruments, meters, relays and other control devices and their associated wiring shall be isolated by earthed metal barriers from the primary-circuit elements. The only exception is the short lengths of wire from instruments, etc. to transformers and other related equipment.

#### 5.12.4. Door Mounting

Relays and instruments may be mounted on the door of the enclosure where the circuit-interrupting device is located, and access to the secondary or control compartment is allowed through this enclosure door.

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#### 5.12.5. Relay Contacts

Contact rating and performance shall be in accordance with IEC 60255. Protective relays shall derive their power supply from the switchgear DC control power bus.

#### 5.12.6. Auxiliary Relays

Any auxiliary relays required to multiply contacts or associated with protective relays may be located inside the units, except for lockout relays that shall be flush or semi-flush mounted. If several auxiliary switches and contacts are present on the same device, they shall be designated numerically 1, 2, 3, etc. On diagrams of all types, contacts and switches shall be shown in the de-energized or 'Off' position of the device.

### 5.13. Instruments Transformers

#### 5.13.1. Current Transformers

Current transformers shall be provided as per the single-line diagrams and/or data sheets and shall be in accordance with IS 2705 / IEC 61869. CT shall be epoxy cast resin type and be of the single phase type with separate core for metering and separate core for protection.

#### 5.13.2. Rated Output

The rated volt-ampere output shall match the requirements of the equipment connected. Current transformers for metering and protective relaying shall have current ratio and accuracy class as shown on datasheets or single line diagrams.

#### 5.13.3. Test Blocks


Secondary current injection capabilities shall be provided via test blocks located on the front of the cubicle door for current transformer circuit functional testing.

#### 5.13.4. CT Nameplates

Current transformer nameplates shall be mounted in a position so that they can easily be read when fitted in the cubicle.

#### 5.13.5. Voltage Transformer

Voltage transformers shall be in accordance with IS 3156 / IEC 61869. The rated output shall match the maximum load of the equipment connected and should be selected from the range of standard values. For secondary protection, industrial cartridge fuses shall be used in accordance with IS 12534 / IEC 60269. Alternatively, miniature circuit breakers may be used

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for this purpose provided the satisfactory protection and coordination will be obtained. VT shall be of synthetic resin insulation and be of the single phase draw out type.

#### 5.13.6. Metering and Protection

Voltage transformers for metering and protective devices shall have accuracy class and voltage ratio as stated on the data sheets.

#### 5.13.7. Earthing

One side of the low voltage winding of one-phase voltage transformers and the star point of the three phase's voltage transformers shall be earthed via an earthing link.

#### 5.13.8. Low Voltage Protection

Voltage transformers shall be protected at the HV side by High Rupturing Capacity (HRC), High Interrupting Capacity (HIC), short circuit current limiting fuses in accordance with IEC 60282, and at the LV side by industrial cartridge fuses or miniature circuit breakers located in the LV compartment. Fuses shall be readily accessible and suitably arranged for safe replacement while the bus bar remains live.

### 5.14. Switching and Indicating Lights

#### 5.14.1. Instrument Switches

Instrument switches shall be rotary-cam type with engraved dial plates. Switch escutcheon plates shall be clearly marked to show operating positions.


#### 5.14.2. Circuit Breaker Control Switches

A circuit breaker control switch and a set of contact position indicating lights shall be provided on the cell door of each electrically operated circuit breaker. The switch handle shall be located along the vertical center line of the cubicle and shall not be located adjacent to meter switches.

#### 5.14.3. Manual Operating Handles

When the switchgear is equipped with several operating controls requiring manual operating handles, these handles shall be of the supplier's standard, of different physical sizes and shapes to minimize the possibility of operating errors.



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## **5.15. Conductor Termination**

### **5.15.1. Incoming Line**

The incoming line section shall contain main disconnecting means and shall include provisions for connecting the High-voltage switchgear to the incoming, three-phase, insulated bus duct, cables, or cable bus as per the datasheets or single line diagram. Bus and incoming line phase shall be identified on the supplier drawings.

### **5.15.2. Outgoing Cables**

Number and size of the outgoing feeder cables shall be as specified on the single line diagrams or datasheets.

### **5.15.3. Surge Arrestors**

Station class surge arrestors in accordance with IEC 60099-4 shall be installed on incoming or outgoing line terminations if specified on the datasheets.

### **5.15.4. Cable Access**

Adequate access shall be provided for all cable terminating activities including single or multi-core cables, including stress relief terminations. Sufficient space shall be provided for the purchaser's termination of the power cables and shall be shown and dimensioned on the supplier's drawings.

### **5.15.5. Support**


Cable support shall be provided by the supplier to avoid induced strain on the cable termination.

### **5.15.6. Gland Plates**

3 mm thick of removable gland plates shall be provided for field installation of cables. Gland plates for single-core cables shall be made of a non-magnetic material. It shall be provided along with the neoprene gasket arrangements also.

### **5.15.7. Metering**

The requirements of metering will be specified on the datasheets. The meters will be flush or semi-flush switchboard type with 2% accuracy over the entire range. Analogue meters shall be 96sqmm minimum, 250° circular scale, white background with black graduation markings.

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## **5.16. Terminal Blocks**

### **5.16.1. General**

Terminal blocks shall be provided for connection of external wiring and shall be minimum IP20 rated, conveniently located, clearly numbered, and identified. All terminals shall incorporate a pressure plate such that screws or nuts do not bear directly on conductors. Terminals shall not have more than one conductor connected to each terminal side. Control wire terminal blocks shall accept a minimum of two 4 mm<sup>2</sup> wires.

### **5.16.2. Secondary Terminations and CT Terminal Blocks**

Terminal blocks shall be provided for all secondary wiring (such as metering, relaying and control) circuit connection points to facilitate troubleshooting and maintenance. The terminal blocks shall be mounted inside the switchgear and shall be accessible from the front of the switchgear without exposure to energized power voltage components. These terminals shall be barrier type with screw terminals for use with spade or ring type lugs as specified on the datasheet. Quick-disconnect type terminal blocks shall not be used. Shorting terminal blocks and ring type lugs shall be used for all CT circuits. All external connections for CT circuit terminals shall accept a minimum wire size of 6mm<sup>2</sup>.

### **5.16.3. Spare Terminals**

Supplier shall provide 20% spare capacity on each terminal block. Wiring and terminals shall be identified in accordance with the related wiring diagrams.

### **5.16.4. Field Wiring Terminals**

All functional units shall have the ability to be disconnected or completely removed without disconnecting the field wiring.


### **5.16.5. Terminal Markings and Warning Labels**

Terminal markings shall comply with IEC 60445. Terminals remaining live when a functional unit is isolated or removed shall be provided with a label stating, 'Danger XXX Volts Isolate Elsewhere', and shall be suitably shrouded.

## **5.17. Wiring**

### **5.17.1. General**

The secondary wiring shall be stranded, annealed copper conductor with flame retardant, 600/1000V insulation class and continuous from terminal to terminal with no splicing. Conductor ends shall be fitted with a crimped terminating device with an insulated shank. Wiring shall be neatly bundled and secured with wire ties.

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#### 5.17.2. Wire Markers

All wiring shall be marked on each end with permanently embossed wire markers of the heat shrinkable or slip on types. Wrap-around, adhesive, and rigid Snap-On markers are not acceptable. Wire numbers and terminals shall be identified in accordance with the related supplier wiring diagrams. Wire markers reflecting phase identification shall be provided at the ends of all phase conductors.

#### 5.17.3. Protection

Flexible cables shall be used for connections on door mounted equipment. Wiring shall be loomed, wrapped in flexible PVC conduit and be firmly clamped at both ends to prevent movement at terminations. Where wiring passes through a metal sheet or barrier, bushings, grommets, or other mechanical protection shall be provided.

#### 5.17.4. Minimum Conductor Size

The minimum conductor sized for power, control, signal cables, and CT leads shall be of the supplier's standard approved by the purchaser. In addition the wire markers should also be of the supplier's standard.

#### 5.17.5. Earthing Wire

All earth circuit wiring shall have green/yellow insulation.

#### 5.17.6. LSF Wiring and Ducts


All internal wiring shall be low smoke and fume (LSF) type wiring. Insulation shall be low smoke, zero halogen thermosetting insulation with an oxygen index of 30% minimum. All internal wiring ducts shall also be fabricated from LSF material.

#### 5.17.7. Power Supply Wiring

Wiring for circuits connected to bus-wired power supplies shall be protected by molded case circuit breakers or fuses for each switchgear unit.

#### 5.17.8. Unit Consistency

For functional units of a similar type, the schematic diagrams, wiring to outgoing terminals and components used shall be identical.

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## **5.18. Nameplates**

### **5.18.1. General**

Appropriate nameplates shall be supplied for operation and maintenance purposes. All components identified on the single line diagrams shall have a nameplate with the tag number and name of the component.

### **5.18.2. Components**

Nameplates shall identify each device on the local control panel and other devices such as instrument transformers, secondary fuses, inside the cubicle. Door-mounted components shall be identified on both the interior and exterior of the door. The nameplates shall not be obstructed when switchgear is fully assembled, and wiring is in place.

### **5.18.3. Material and Size**

All nameplates shall be an acrylic resin material and be machine-engraved, displaying black letters on a white background. Minimum letter height shall be as specified on the datasheet. However, the letter height for external component nameplates shall be as specified on the datasheet as well.

### **5.18.4. Language**

English language will be used on all nameplates. All symbols shall be in accordance with the latest IEC standards. Protective device numbering shall be per IEEE C37.2.

### **5.18.5. External Nameplates**


The nameplates shall not be obstructed when switchgear is fully assembled. Each nameplate shall be legible from the floor.

### **5.18.6. Fasteners**

Each nameplate shall be mounted with reusable and corrosion-resistant fasteners with the type to be of the supplier's standard if approved by the purchaser. The Supplier shall insulate the fastener or provide suitable protection against mechanical damage to the control wiring insulation when the fasteners penetrate into the cubicle. Mounting of the nameplates with adhesive is not acceptable.

### **5.18.7. Warning and Caution Nameplates**

In locations where dangerous situations may inadvertently be created, warning plates or caution notices shall be installed, identifying the danger points. This may be in a compartment or on the outside of an assembly. Warning plates or caution notices shall be

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engraved black lettering on yellow background. The warning plates shall be provided as follows:

- a) For incoming sources and outgoing feeder terminations with potential for feedback, warning plates shall be prominently mounted at each door. Warning plate shall read: DANGER HIGH VOLTAGE, ISOLATE AT THE SOURCE
- b) Termination points for all wiring brought to the switchgear from an external power source shall be identified. The warning plate shall read: CAUTION THIS UNIT CONTAINS EXTERNAL POWER SOURCE

#### 5.18.8. Danger Nameplates

Nameplate shall be engraved white letter on red background. The Nameplate shall comply with IS 2551.

#### 5.18.9. Instruction Plates

When the operation sequence of certain equipment in the assembly is not evident (for example: mechanical interlocking features), instruction plates, preferably pictorial, shall be engraved black on white background and provided near the point of operation.

#### 5.18.10. Mimic Diagram

Assemblies shall be provided with a durable single line mimic diagram, clearly indicating the specific function of the different compartments. The mimic diagram shall be of the supplier's standard if approved by the purchaser.

### 5.19. Inspection and testing


#### 5.19.1. General

All inspection and testing shall be carried out as per requirements of this specification, datasheet and applicable codes & standards.

VENDOR shall conform to the inspection and documentation/certification/approval requirements in his Quality Plan to be submitted for approval by the OWNER.

For each type and rating of switchgear offered, the Supplier shall provide certificates to prove that the design of switchgear has been successfully tested in accordance with applicable IS standards (IS 2071). Full type tests in accordance with type tested assembly (TTA) testing requirements are preferred. Switchgear tested in accordance with partially type tested assembly (PTTA) testing requirements may also be acceptable if fully supported by the following:

- a) Type test certificates for similar equipment

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- b) Details of changes between type test arrangement and that of equipment offered.
- c) Supporting documents
- d) All type tests shall have been undertaken by a recognized testing authority.

#### 5.19.2. Witness Testing and Notification

Tests shall be witnessed, unless waived, by the Purchaser, Purchaser's representative, or any third-party inspectors determined by the Purchaser. The Supplier shall notify the Purchaser not less than 10 working days before the equipment is ready for testing.

#### 5.19.3. Test Plan and Report

The Supplier shall verify by test that the operation of the assembled switchgear and control gear complies with the requirements specified in the purchase order documents and shall submit to the Purchaser a report incorporating measurements and results of all tests performed. Supplier shall include factory test procedures in accordance with the requirements of this article with their quotation.

#### 5.19.4. Mechanical Tests

\Mechanical tests shall be performed for each unit to verify satisfactory operation. These tests shall include checking withdrawable mechanisms, operating mechanisms, and interlock devices. The interchangeability of draw out units shall also be verified.

#### 5.19.5. Electrical Tests


Electrical operational tests shall be performed to verify circuit integrity and sequence of operation. These tests shall be accomplished by introducing operating and tripping currents and voltages to metering, control, and protective relays at the instrument or control transformers.

#### 5.19.6. Insulation Resistance Test

A short-time insulation resistance test (spot reading test) shall be performed to measure insulation resistance by using a test voltage of 1000 VDC (or higher) for one minute with a Megger instrument or a dielectric test set.

#### 5.19.7. Relay Settings

All relay settings (protection, configuration, and control) are to have been done before the FAT begins. Purchaser shall provide protection settings to Supplier prior to the FAT, for entry into the relays by Supplier. Supplier shall provide configuration, control, and transfer

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scheme programming for the relays, as required. During the FAT, the protection, control, and configuration settings are to be checked to confirm compliance with drawings and other documents. All settings are to be checked for all devices including the transfer schemes.

#### 5.19.8. Type Tests

Although Suppliers will be required to provide routine testing of their equipment, type test certificates issued by an independent third party proving that the equipment meets IEC standards will be made available at request any time to the Purchaser. Failure to be able to produce proper type test certificates when requested will result in rejection, replacement, or testing of the equipment at Supplier's expense.

#### 5.19.9. Factory Acceptance Tests (FAT)


Equipment shall be tested functionally in the complete assembled configuration at manufacture's shop before dispatch. OWNER or its designated representatives, or both, will be present at the factory and shall witness the test results and sign the test records to indicate approval. If the unit does not meet Purchase Order requirements, VENDOR and/or his sub-vendors shall correct the problems at no expense to OWNER. Records of the tests shall be maintained by the VENDOR and to be submitted to PURCHASER for review.

#### 5.19.10. Site Acceptance Tests (SAT)

Site Acceptance Tests shall be carried out at site after installation of the equipment to demonstrate that the guaranteed performance of the equipment and its interface with other plant systems. VENDOR may be required to assist with the installation and commissioning of the equipment/ package as specified in the purchase order. VENDOR shall submit the Site Acceptance Test procedures for approval by OWNER. OWNER or its designated representatives, or both, will be present at the site and shall approve the test results and sign the test records to indicate approval. If the unit does not meet Purchase Order requirements, VENDOR and/or his sub-vendors shall correct the problems at no expense to PURCHASER. Records of the tests shall be maintained by the VENDOR and shall be submitted to OWNER for review. Final acceptance of the package shall be subject to the satisfactory performance functional and operational tests at site.

### 5.20. Quality assurance and quality control

VENDOR shall be fully responsible for their Quality Assurance and associated Quality Control process. Unless otherwise agreed by the PURCHASER, the VENDOR's Quality System shall meet the requirements of ISO 9001:2015 Quality System and shall be accredited by a recognized authority. VENDOR is required to establish an acceptable Quality Plan, inclusive of quality manual and procedures that cover all activities of the order, in order to comply with the Quality System requirements. VENDOR shall be responsible for

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arranging/liasing with the Third Party Inspection Agency and other agencies for design appraisal, inspection, survey and certification requirements as required by the specification/requisition. When required, waiver and acceptance of non-conformances shall be subjected to Third Party Inspection Agency approval before OWNER endorsement. These concession records shall be included in the Manufacturer's Final Documentation.

#### **5.21. Guarantees and warranties**

VENDOR shall guarantee the equipment and their selection, design, material, workmanship and the performance requirements as stated in this specification and/or equipment datasheet, to achieve continuously for all the conditions stated, for the period as specified in the Requisition / Purchase Order.

Unless otherwise agreed, all equipment shall be guaranteed as follows:

- a) All equipment shall perform satisfactorily under the specific operating conditions as detailed on the data sheet and shall be fit for the intended purpose; and
- b) Tests shall confirm the VENDOR's guaranteed performance.

VENDOR shall guarantee that all work will be performed in accordance with good and sound engineering and construction practices and within the requirements of this specification. The equipment, accessories and all materials supplied by the VENDOR shall be free from defects, shall be suitable for the use for which they are intended and shall perform in accordance with the requirements of this specification.

VENDOR shall agree to promptly correct, at his own cost at site, all the defects and mal performance of the equipment and/or the accessories supplied by VENDOR or failure by VENDOR to comply with the obligation expressed or implied under the Purchase Order and to extend the warranty period for the duration required to remedy such defects.


VENDOR shall assume full responsibility for the proprietary equipment and components supplied by him, and his sub-vendors, incorporated in the package are accordance with this specification.

#### **5.22. Spares and special tools**

VENDOR shall mandatorily include the spares required for the installation, pre-commissioning, commissioning and start-up along with the firm scope of supply.

VENDOR shall furnish a separate priced list for 2-years operating spares recommended for the package.



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VENDOR shall mandatorily include the special tools, if any, required for installation, commissioning, operation and maintenance along with the firm scope of supply.

### **5.23. Packing and shipment**

The equipment/package shall be prepared for shipment by VENDOR after all testing and inspections have been completed.

The equipment/package shall be prepared for the type of shipment specified, in the requisition.

Lifting points and the center of gravity shall be clearly identified on the equipment/packages. A recommended lifting arrangement shall be provided by the VENDOR.

The VENDOR shall be responsible for loading, anchoring and protecting the equipment during transportation. Care should be taken when loading and unloading to ensure that lifting hawsers, ropes, chains, etc. do not damage any finish coated surface.

VENDOR shall supply a delivery dossier to be sent along with the equipment on delivery. The dossier shall include, but not limiting to the following:

- (i) General Arrangement Drawing
- (ii) Weight Certificate
- (iii) Lifting Equipment Test Certificate
- (iv) Hazardous Substance Certificate/Data Sheet
- (v) A copy of any lifting and storage procedure
- (vi) A copy of any punch list and packing list


Materials shipped separately shall be identified by securely attached corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. Crated equipment shall be shipped with duplicate packing lists, one inside and one on the outside of the crate. The data to be recorded on each packing list shall contain following:

- (i) Name and address of VENDOR
- (ii) Purchase order number
- (iii) Case identification number
- (iv) Overall dimensions in meter
- (v) Gross weight of the case
- (vi) Item wise list of the contents

### **5.24. Vendor data requirement**

All documents and drawings shall be identified using a format acceptable to the OWNER.

All documents, drawings, certificate, manuals shall be submitted in English language.

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The units of measurement to be used on the project are generally to be in accordance with the International System of Units (SI). Where appropriate however, standard oilfield units will be used.


All documents shall be clearly identifiable on each page with project title and number, document number, revision number, equipment title and item number, as a minimum.

All drawings and documents prepared by VENDOR shall be checked and signed as such before submission. Failure to this may result in rejection by the OWNER / INSPECTOR without review.

Subsequent revisions to drawings should be cloud marked and revision marked in enclosed triangles. All revisions to documents and calculations shall be underlined / cloud marked and these revisions shall also be listed in front page of all documents. Failure to this may result in rejection by the OWNER / INSPECTOR without review.

Unless specifically excluded otherwise, VENDOR shall provide following documents Final Documents, as a minimum.

- (i) **Installations Manual** shall minimum include procedures and techniques for installation, alignment, testing after installation and subsequent removal, replacement, re-assembly and re-commissioning following major overhaul.
- (ii) **Commissioning Manual** shall minimum include pre-commissioning and commissioning checklist and step by step commissioning procedures, precautions etc.
- (iii) **Operating Manual** shall minimum include functional description of the equipment, start-up and shut-down procedures, operating, control and preservation procedures, fault finding and troubleshooting check list, operation limits and precautions etc.
- (iv) **Maintenance Manual** shall minimum include the maintenance instruction and program for preventive / routine maintenance and for curative / shut-down maintenance
- (v) **Manufacturer's Data Report (MDR)** shall include the following documents, as a minimum. All the documents attached with MDR should be duly reviewed / verified and certified / approved by VENDOR's QC and INSPECTOR.
  - a) Complete set of "AS-BUILT" drawings.
  - b) Design calculations.
  - c) Certificate of compliance of manufacturer and/or material manufacturer's mill certificates with supporting test reports for all materials.
  - d) Quality plan/ITP containing all inspection stages and test plan duly signed by VENDOR's QC and INSPECTOR in all stages.
  - e) Assembly and installation procedures and reports
  - f) Final dimensional check records
  - g) Final inspection certificate and release note from INSPECTOR.
  - h) Name plate rubbing or photograph duly witnessed by INSPECTOR

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- i) Packager's (VENDOR's) certificate of compliance and performance guarantee/warranty certificates

VENDOR shall prepare and submit the required number of Final Documentation / Completion Files as per Purchase Order.

## **6. SPECIFICATION - 11/ 0.460/0.433/0.380 kV Dry Type Transformer**

### **6.1. Applicable standards**

The Transformer shall comply with the following Indian standards:

IS: 5	: Colours for ready mixed paints and enamels
IS: 1271	: Thermal evaluation and classification of electrical insulation
IS: 2705	: Current transformers.
IS: 10028	: Installation & Maintenance of Transformers
IS: 11171	: Dry type Power transformer
IS/IEC 60529	: Degree of Protection provided by enclosures (IP Code)
IS: 875	: Codes of practice for design loads (other than earthquake) for buildings and structures.
IS: 1893	: Criteria for earthquake resistance design of structures

### **6.2. Design & constructional requirements**

#### **6.2.1. Electrical system**

Transformers shall be suitable for continuous operation at rated power at the above environment design criteria conditions with the following combined conditions of voltage and frequency without exceeding the over temperature limits.

Voltage	Frequency
+/- 10%	+/- 3%

Total harmonic distortion (THD) of the supply network voltage will not exceed 5%.

Current density for HV and LV winding of all transformer shall not exceed 2.8A /

Surge arrestor of appropriate voltage rating shall be provided.

Transformer core flux density shall not exceed 1.7 Wb / Sq.mm at any tap position with 10% Voltage variation.


Type of transformer shall be as specified in data sheet.

#### **6.2.2. Temperature-Rise**

The transformer shall conform to the requirements of temperature rise specified in IS-11171.

#### **6.2.3. Rated Power**

Transformers will not exceed the temperature rise limits during continuous running at the rated power with the tapping regulated on the minimum voltage value.

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#### 6.2.4. Voltage, Winding Connection and Vector Group

Rated voltages are those measured at no-load. Two windings transformers will have Delta-star winding connection with accessible neutral with vector group Dyn11 unless otherwise specified in the data sheet.

#### 6.2.5. Insulation

Insulating material for Transformer shall comply with Class 'H' for transformer rating more than 100 kVA and Class 'F' for ratings 100 kVA and below.

#### 6.2.6. Ability to withstand Short Circuit

Transformers shall be designed and manufactured to withstand the thermal and dynamic stresses caused by short circuit conditions.

#### 6.2.7. Losses

The losses under the full load condition, at the rated voltage and frequency shall be indicated by the vendor at 150 deg C. The values shall be guaranteed within the tolerable limits specified in IS: 11171 at principal tap position. The purchaser has the right to impose penalty charges or reject the transformer in case of any difference in the test and guaranteed values.

#### 6.2.8. Overloads

It shall be possible to overload the transformer satisfactorily in conformation with relevant IS.

#### 6.2.9. Impedance Voltage

The impedance voltage at principal tapping shall be as specified in data sheet.


#### 6.2.10. Radio Interference & Noise Level

The Transformer shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third & fifth so as to minimize interference with communication circuit.

The noise level of transformer when energized at normal voltage and frequency shall not exceed the value specified in IS when measured under standard conditions.

### 6.3. Earthing

Two earthing terminals shall be provided at the bottom on both sides.

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#### **6.4. Enclosure & Winding**

The transformer shall be dry type, AN cooled suitable for indoor installation.

Transformer shall be housed in free-standing enclosures of welded sheet steel frames with expanded metal screens of suitable size or louvers backed by wire-mesh. Transformer and the enclosure shall be suitably reinforced to prevent distortion during handling. Base channels shall be provided with bi-directional rollers skids and pulling eyes to facilitate handling. The Ingress protection shall be minimum IP33.

The transformer shall be double wound core type with cold rolled grain oriented (CRGO) silicon steel laminations perfectly insulated and clamped to minimize vibrations and noise. Core fastening bolts shall be insulated to reduce losses and to avoid hot spots. All parts of the magnetic circuit shall be effectively connected to earth system.

The winding shall be of copper and shall be designed for full load current and to withstand the thermal and electromagnetic stresses arising due to the through fault current. The current carrying winding joints shall be electrically brazed.

Vector group for distribution transformer shall be Dyn11, The windings shall be provided with Class 'F' insulation for lighting transformer up to 100 kVA and Class 'H' insulation for rating more than 100 kVA.

Different parts of transformers shall be connected by copper flexible for earth continuity purpose. All the fasteners and bolts shall be hot dip galvanized as per IS 802 or zinc passivated.

Lifting lugs & Jacking pads shall be provided.


#### **6.5. Off-circuit Tap Changer**

Unless otherwise specified in the data sheet, the primary (high voltage) winding shall always be equipped with voltage taps for a variation of no-load voltage as specified. Control shall be external and operable at no voltage.

Tap changer shall be complete with a position indicator and provided with a locking device in each tap position. The arrangement shall be such that padlock cannot be inserted unless contacts are correctly engaged.

#### **6.6. Terminals and Connecting Boxes**

All Bushing shall be made of enameled porcelain and shall confirm to the requirement of respective IS of latest revision. The current rating, impulse withstand levels and creepage

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distance of bushing shall be in accordance with data sheet. Bushing shall be suitable to withstand the stresses due to the short circuit and it shall be coordinated with the insulation class of the winding.

External connections to the transformer terminals may be carried out in one of the following methods:

- a) Bus duct
- b) Cable

Unless otherwise specified, the terminals (neutral included) of each winding shall always be housed within weather and dust-proof (IP55) air insulated cable boxes. The box shall always be sized in order to allow easy connection of cables and easy maintenance. The box shall be equipped with removable undrilled gland plate; gland plate shall be of nonmagnetic material in case of single core cables.

### **6.7. Rating plates**

Each transformer shall be provided with a rating plate of weather proof material, fitted in a visible position, Diagram and rating plate shall be provided indicating the details of transformer, connection diagram & vector group etc.

### **6.8. Terminal and Marshalling Box**

Marshalling box shall be weather-tight. All protective devices (Winding Temperature Indicator with Trip & Alarm facilities etc.) shall be wired up to marshalling box by means of PVC insulated armoured copper cables. Terminals shall be clamp type. Removable gland plate with double compression type cable glands shall be provided.


A separate external neutral bushing shall be provided in addition to Neutral Terminal in the cable box for neutral earthing of transformer. In such cases, suitable supporting arrangement shall be provided for mounting of neutral CT and for fixing of GI strip from neutral CT to earth. The external neutral bushing shall be provided with Terminal Connectors (Brass / Cast Aluminium) suitable for connecting 75x10 mm GI strip unless otherwise specified in the data sheet.

Wire termination shall be made with crimping type connectors with insulating sleeves, wire shall not be spliced between terminations.

The marshalling box shall be provided with inside lamp, door switch, space heater with thermostat and removable cable gland plate.

### **6.9. Accessories**

For transformers other than lighting transformer, following shall be provided.

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- i. Temperature sensing device in each limb.
- ii. Temperature sensing relay with one contact for alarm and one for trip.
- iii. Indicating Platinum resistance type thermometer with alarm and trip contacts.

## **6.10. Inspection and testing**

### **6.10.1. General**

All inspection and testing shall be carried out as per requirements of this specification, datasheet and applicable codes & standards.

VENDOR shall conform to the inspection and documentation/certification/approval requirements in his Quality Plan to be submitted for approval by the Owner.

- 1) The equipment shall be tested in accordance with the latest IS 2026 codes.
- 2) Each transformer shall receive all standard commercial tests in accordance with IS latest revision with test results available by serial number of the transformer.
- 3) Purchaser will have the option to witness all tests without causing any delays in factory schedules.
- 4) The Vendor will notify purchaser at least prior to commencing any of the tests.

### **6.10.2. Type (Design) Tests**

- i) Temperature-rise tests
- ii) Dielectric tests: Full-wave impulse-voltage withstand test


### **6.10.3. Routine Tests**

- i) Visual and Dimensional check
- ii) Bill of Material
- iii) Measurement of HV & LV winding resistance
- iv) Measurement of voltage ratio and check of voltage vector relationship
- v) Measurement of impedance voltage (principal tapping), short-circuit impedance and load loss
- vi) Measurement of no-load loss and current
- vii) Dielectric tests: Induced overvoltage withstand test and separate-source voltage withstand test.
- viii) Correctness of name plate

### **6.10.4. Special Tests**

- i) Dielectric tests: Impulse-voltage withstand tests including chopped waves
- ii) Measurement of zero-sequence impedance on three-phase transformers
- iii) Short-circuit test



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- iv) Measurement of acoustic sound level
- v) Measurement of the harmonics on the no-load current

If special tests other than those listed above are required, the test method shall be subject to agreement between the Manufacturer and the Purchaser.

A test report signed by a registered professional engineer shall be on file in the manufacturer's plant and available for examination.

Certified test reports shall be supplied upon request summarizing the results of all tests performed as specified on datasheet.

#### 6.10.5. Factory Acceptance Tests (FAT)

Equipment shall be tested functionally in the complete assembled configuration at manufacture's shop before dispatch.

Owner or its designated representatives, or both, will be present at the factory and shall witness the test results and sign the test records to indicate approval. If the unit does not meet Purchase Order requirements, VENDOR and/or his sub-vendors shall correct the problems at no expense to Owner.

Records of the tests shall be maintained by the VENDOR and to be submitted to PURCHASER for review.

#### 6.10.6. Site Acceptance Tests (SAT)


Site Acceptance Tests shall be carried out at site after installation of the equipment to demonstrate that the guaranteed performance of the equipment and its interface with other plant systems.

VENDOR may be required to assist with the installation and commissioning of the equipment/ package as specified in the purchase order.

VENDOR shall submit the Site Acceptance Test procedures for approval by OWNER.

OWNER or its designated representatives, or both, will be present at the site and shall approve the test results and sign the test records to indicate approval. If the unit does not meet Purchase Order requirements, VENDOR and/or his sub-vendors shall correct the problems at no expense to PURCHASER.

Records of the tests shall be maintained by the VENDOR and shall be submitted to OWNER for review.

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Final acceptance of the package shall be subject to the satisfactory performance functional and operational tests at site.

#### **6.11. Protective coating and painting**

- a) Transformer will be painted in accordance to manufacturer standard.
- b) However the painting must be suitable for the specified ambient conditions and in particular must be oil, grease, acid and salt corrosion resistant. Final paint shade shall be of 631 of IS-5 unless otherwise specified.

#### **6.12. Quality assurance and quality control**

VENDOR shall be fully responsible for their Quality Assurance and associated Quality Control process.

Unless otherwise agreed by the PURCHASER, the VENDOR's Quality System shall meet the requirements of ISO 9001:2015 Quality System and shall be accredited by a recognized authority.

VENDOR is required to establish an acceptable Quality Plan, inclusive of quality manual and procedures that cover all activities of the order, in order to comply with the Quality System requirements.

VENDOR shall be responsible for arranging/liasing with the Third Party Inspection Agency and other agencies for design appraisal, inspection, survey and certification requirements as required by the specification/requisition.


When required, waiver and acceptance of non-conformances shall be subjected to Third Party Inspection Agency approval before OWNER endorsement. These concession records shall be included in the Manufacturer's Final Documentation.

#### **6.13. Guarantees and warranties**

VENDOR shall guarantee the equipment and their selection, design, material, workmanship and the performance requirements as stated in this specification and/or equipment datasheet, to achieve continuously for all the conditions stated, for the period as specified in the Requisition / Purchase Order.

Unless otherwise agreed, all equipment shall be guaranteed as follows:

- (i) All equipment shall perform satisfactorily under the specific operating conditions as detailed on the data sheet and shall be fit for the intended purpose; and
- (ii) Tests shall confirm the VENDOR's guaranteed performance.

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VENDOR shall guarantee that all work will be performed in accordance with good and sound engineering and construction practices and within the requirements of this specification. The equipment, accessories and all materials supplied by the VENDOR shall be free from defects, shall be suitable for the use for which they are intended and shall perform in accordance with the requirements of this specification.

VENDOR shall agree to promptly correct, at his own cost at site, all the defects and mal-performance of the equipment and/or the accessories supplied by VENDOR or failure by VENDOR to comply with the obligation expressed or implied under the Purchase Order and to extend the warranty period for the duration required to remedy such defects.

VENDOR shall assume full responsibility for the proprietary equipment and components supplied by him, and his sub-vendors, incorporated in the package are accordance with this specification.

#### **6.14. Spares and special tools**

VENDOR shall mandatorily include the spares required for the installation, pre-commissioning, commissioning and start-up along with the firm scope of supply.

VENDOR shall furnish a separate priced list for 2-years operating spares recommended for the package.

VENDOR shall mandatorily include the special tools, if any, required for installation, commissioning, operation and maintenance along with the firm scope of supply

#### **6.15. Packing and shipment**


The equipment/package shall be prepared for shipment by VENDOR after all testing and inspections have been completed.

The equipment/package shall be prepared for the type of shipment specified, in the requisition.

Lifting points and the center of gravity shall be clearly identified on the equipment/packages. A recommended lifting arrangement shall be provided by the VENDOR.

The VENDOR shall be responsible for loading, anchoring and protecting the equipment during transportation. Care should be taken when loading and unloading to ensure that lifting hawsers, ropes, chains, etc. do not damage any finish coated surface.

VENDOR shall supply a delivery dossier to be sent along with the equipment on delivery. The dossier shall include, but not limiting to the following:

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- (i) General Arrangement Drawing
- (ii) Weight Certificate
- (iii) Lifting Equipment Test Certificate
- (iv) Hazardous Substance Certificate/Data Sheet
- (v) A copy of any lifting and storage procedure
- (vi) A copy of any punch list and packing list

Materials shipped separately shall be identified by securely attached corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. Crated equipment shall be shipped with duplicate packing lists, one inside and one on the outside of the crate. The data to be recorded on each packing list shall contain following:

- (i) Name and address of VENDOR
- (ii) Purchase order number
- (iii) Case identification number
- (iv) Overall dimensions in meter
- (v) Gross weight of the case
- (vi) Item wise list of the contents

#### **6.16. Vendor data requirement**

All documents and drawings shall be identified using a format acceptable to the OWNER.


All documents, drawings, certificate, manuals shall be submitted in English language. The units of measurement to be used on the project are generally to be in accordance with the International System of Units (SI). Where appropriate however, standard oilfield units will be used.

All documents shall be clearly identifiable on each page with project title and number, document number, revision number, equipment title and item number, as a minimum.

All drawings and documents prepared by VENDOR shall be checked and signed as such before submission. Failure to this may result in rejection by the OWNER / INSPECTOR without review.

Subsequent revisions to drawings should be cloud marked and revision marked in enclosed triangles. All revisions to documents and calculations shall be underlined / cloud marked and these revisions shall also be listed in front page of all documents. Failure to this may result in rejection by the OWNER / INSPECTOR without review.

Unless specifically excluded otherwise, VENDOR shall provide following documents Final Documents, as a minimum.

	<p style="text-align: center;"><b>DEVELOPMENT OF SHIP DOCKING AND REPAIR INFRASTRUCTURE IN PATHFINDER CREEK AT VADINAR</b></p> <p style="text-align: center;"><b>SPECIFICATION FOR ELECTRICAL WORKS</b></p>	<p style="text-align: right;"><b>Page: 69/ 131</b></p>
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- (i) **Installations Manual** shall minimum include procedures and techniques for installation, alignment, testing after installation and subsequent removal, replacement, re-assembly and re-commissioning following major overhaul.
- (ii) **Commissioning Manual** shall minimum include pre-commissioning and commissioning checklist and step by step commissioning procedures, precautions etc.
- (iii) **Operating Manual** shall minimum include functional description of the equipment, start-up and shut-down procedures, operating, control and preservation procedures, fault finding and troubleshooting check list, operation limits and precautions etc.
- (iv) **Maintenance Manual** shall minimum include the maintenance instruction and program for preventive / routine maintenance and for curative / shut-down maintenance
- (v) **Manufacturer's Data Report (MDR)** shall include the following documents, as a minimum. All the documents attached with MDR should be duly reviewed / verified and certified / approved by VENDOR's QC and INSPECTOR.
  - a) Complete set of "AS-BUILT" drawings.
  - b) Design calculations.
  - c) Certificate of compliance of manufacturer and/or material manufacturer's mill certificates with supporting test reports for all materials.
  - d) Quality plan/ITP containing all inspection stages and test plan duly signed by VENDOR's QC and INSPECTOR in all stages.
  - e) Assembly and installation procedures and reports
  - f) Final dimensional check records
  - g) Final inspection certificate and release note from INSPECTOR.
  - h) Name plate rubbing or photograph duly witnessed by INSPECTOR
  - i) Packager's (VENDOR's) certificate of compliance and performance guarantee/warranty certificates.


VENDOR shall prepare and submit the required number of Final Documentation / Completion Files as per Purchase Order.

## 7. SPECIFICATION - LT SWITCH BOARD

### 7.1. Applicable Standards

The LV SWBD shall comply with the following Indian Standards:

IS-5	: Colours for ready mixed paints and enamels.
IS 1248	: Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories
IS 2705	: Current Transformers
IS 2824	: Method for determining the proof and the comparative tracking indices of solid insulating materials.
IS 3043	: Code of practice for earthing
IS 3156	: Voltage Transformers
IS 3231	: Electrical relays for power systems protection
IS 3618	: Phosphate treatment of iron and steel for protection against corrosion
IS 3716	: Application guide for Insulation Coordination
IS 4146	: Application guide for CT / VT
IS 5082	: Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes
IS 5578	: Guide for marking of insulated conductors
IS 6005	: Code of practice for Phosphating of iron and steel
IS 8623	: Specification for low voltage switchgear and control gear assemblies
IS 9676	: Reference ambient temperature for electrical equipment
IS10118	: Code of practice for selection, installation and maintenance for switchgear and control gear
IS 11353	: Guide for uniform system marking and identification of conductors and apparatus terminals
IS 13234	: Guide for short circuit calculations in three phase AC systems
IS 13703	: Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC
IS 13947	: Specification for low voltage switchgear and control gear
IEC 60050-441	: International Electro technical Vocabulary Chapter 441: Switchgear, Control gear and Fuses
IEC 60073	: Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Coding Principles for Indicators and Actuators
IEC 60255	: Measuring relays and Protection Equipment
IEC 60269	: Low Voltage Fuses
IEC 60309	: Plugs, socket-outlets and couplers for industrial purposes
IEC 60364	: Low-voltage electrical installations
IEC 60445	: Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors
IEC 60529	: Degrees of protection provided by enclosures (IP Code)
IEC 60947	: Low-voltage switchgear and control gear

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IEC 61000-2-2	: Electromagnetic compatibility (EMC) – Part 2-2: Environment, Compatibility levels for low frequency conducted disturbances and signaling in public low-voltage power supply systems
IEC 61000-2-12	: Electromagnetic compatibility (EMC) – Part 2-12: Environment, Compatibility levels for low frequency conducted disturbances and signaling in public medium-voltage power supply systems
IEC 61000-3	: Electromagnetic compatibility (EMC) Part 3, Limits
IEC 61000-4	: Electromagnetic compatibility (EMC) Part 4, Testing and measurement techniques
IEC 61000-6-2	: Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments
IEC 61000-6-4	: Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
IEC 61180	: High-voltage test techniques for low-voltage equipment
IEC 61439-1	: Low-voltage switchgear and control gear assemblies – Part 1: General rules
IEC 61439-2	: Low-voltage switchgear and control gear assemblies – Part 2: Power switchgear and control gear assemblies
IEC 61439-6	: Low-voltage switchgear and control gear assemblies - Part 6: Bus bar trunking systems (bus ways)
IEC 61558	: Safety of power transformers, power supplies, reactors and similar products
IEC 61641	: Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault
IEC 61915-1	: Low-voltage switchgear and control gear – Device profiles for networked industrial devices – Part 1: General rules for the development of device profiles
IEC 62026	: Low-voltage switchgear and control gear–Controller-device interfaces (CDIs)
IEC 62208	: Empty enclosures for low-voltage switchgear and control gear assemblies - General requirements and control gear assemblies - General requirements
IEC 62314	: Solid-state relays
IS - 875	: Codes of practice for design loads (other than earthquake) for buildings and structures.

## **7.2. Design & constructional requirements**

### **7.2.1. General**

Unless otherwise stated in data sheet, the switchgear and control gear shall be fully withdrawable construction and shall be a type-tested assembly (TTA). The equipment shall include all protective relaying, buses, and accessories arranged in cubicle-type, freestanding, dead-front assemblies of metal-enclosed design. The ratings shall be as noted in this specification, datasheets, single-line diagrams and Purchaser requisition documents. The equipment shall be operated continuously at the ambient conditions as specified in Electrical Design Basis.



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Supplier shall submit the GA, single line diagram, Bill of Quantity, Control scheme and Quality assurance Plan for the purchaser approval before starting the panel manufacturing.

#### 7.2.2. Description

Switchgear and control gear assemblies shall be multi-cubicle type in accordance with IS 8623 with components based on IS 13947.

#### 7.2.3. Layout

When specified in data sheet, the assembly shall form an integral line-up with its incoming supply transformer, close coupled to one end of the assembly, with the other end suitable for future extension without cutting or drilling any part of the enclosure. The switchgear supplier shall be responsible for coordinating the interface with the transformer and shall provide the LV bus bar connections between the switchgear and the transformer, which shall be a certified design for the rated short circuit currents. Supplier shall state the short circuit rating by a certifying authority for the complete package.

#### 7.2.4. Installed Spares


Installed spares shall be provided for each type/rating of unit. The number of installed spares shall be 10% of the number of units indicated on the datasheets/purchase documents at time of quotation. When there are few units of a particular type, at least one equipped spare shall be provided.

#### 7.2.5. Interlocks

Interlocking systems shall be provided for all devices as noted on the single-line diagrams or protection, control and metering diagrams. Mechanical interlocks shall be of the preventive type and shall be arranged to prevent mis-operation of the equipment. As a minimum, the following mechanical interlocks shall be provided:

- a) Access to interior of functional units shall be prevented while in the connected position.
- b) Prevent a withdrawable unit from being withdrawn or inserted unless the unit is isolated. Defeating mechanisms to override this function shall NOT be permitted.
- c) It shall not be possible to close the isolating device unless the unit is in either a connected or test position.
- d) Prevent the insertion of a withdrawable unit into a compartment of higher rating.



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#### 7.2.6. Harmonic Immunity

The supplied equipment shall be immune from the harmonic currents and voltages on the electrical supply system that are at a level below the limits that are specified in IEC 61000-2-2, Table 1. Immunity shall include the supplied equipment operating properly at the designed ratings.

#### 7.2.7. Electromagnetic Compatibility

All switchgear and control gear shall comply with the requirements for Electromagnetic Compatibility (EMC), as defined in IEC 60947, IEC 62026, IEC 61439-1, IEC 61000-6-2, and IEC 61000-6-4 to ensure that the conducted emissions in both the power supply input and output of the units are controlled within acceptable limits. The electromagnetic disturbance generated by the switchgear and control gear and the individual components shall not exceed a level which would affect the correct operation of both radio and telecommunications equipment. The equipment shall have an adequate level of intrinsic immunity to external electromagnetic and conducted disturbance to enable it to operate as intended.

### 7.3. Equipment Ratings

#### 7.3.1. Voltage and Frequency


The low voltage switchgear and control gear ratings are defined on the individual data sheets. The equipment shall be capable of proper operation for voltage deviations of  $\pm 10\%$  and frequency deviations of  $\pm 2\%$ . In addition, contactors and relays shall be able to ride through voltage dips to 80% nominal, such as those experienced during motor starting. This system will be a 3 phase, 4 wire. The switchgear shall be rated at 415V AC, 50Hz.

#### 7.3.2. Component Ratings

The type of components, number of poles/wires, voltage, frequency, trip or current ratings, and interruption capacity of the equipment shall be as specified in this document, on the datasheets or single line diagrams. The rating of each component shall be based on its installation in the switchgear or control gear assembly. Supplier shall provide de-rating information for all circuit breakers, starters, combination contactors, fused switches, and other components. Equipment of the same type, current rating, and circuit duty shall be interchangeable.

#### 7.3.3. Short Circuit Breaking Capacity

The minimum short-circuit breaking rating of all low-voltage circuit breakers shall be such that the short circuit service breaking capacity must be equal to the percentage of the ultimate short circuit breaking capacity as specified on the datasheet.

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#### 7.3.4. Rated Short-Circuit Withstand Current

The rated short-circuit withstand current ( $I_{cw}$ ) for all applicable components shall be equal to the short-circuit service breaking current with a time duration as specified on the data sheet.

#### 7.3.5. Short Circuit Making Capacity and Power Factor

The rated short-circuit peak making capacity of a circuit-breaker shall not be less than its rated ultimate short-circuit breaking capacity, multiplied by the factor  $n$  based on IS 13947.

#### 7.3.6. Bus Short Circuit Ratings

The bus bracing shall be capable of withstanding the mechanical and thermal effects of the maximum short-circuit withstand current and time, as specified on the data sheets, without damage or deformation, applied when the bus bars have reached thermal equilibrium with rated continuous current, at maximum ambient temperature.

#### 7.3.7. Power Bus Current Ratings

Power bus bars shall be rated for the continuous current carrying capacity specified on the data sheets and single line diagrams. Unless otherwise noted, horizontal bus bars shall be of the same current rating throughout their length. All vertical bus bars shall have the same current rating throughout the switchboard.

#### 7.3.8. Short Circuit Protective Device Ratings

Short-circuit protective devices shall be rated for the continuous current carrying capacity specified on the data sheets.


### 7.4. Enclosures

#### 7.4.1. Construction

The switchgear shall contain a number of enclosures erected vertically to form a complete assembly with provisions for future extensions. Front and rear access shall be hinged doors.

The switchboard shall comprise of standard prefabricated, cold rolled, sheet steel units of thickness not less than 2 mm (14 SWG)

The height of the switchboard shall be uniform throughout the length of the panel and shall not exceed 2400 mm. However height of the switchgear handle should be above 300 mm but below 1800 mm to facilitate easy operation without the aid of stool. Depth of the panel shall be adequate to gland all the incoming and outgoing cables.

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The switchgear shall be provided with bottom cable entry facility with a 3mm thick removable gland plate with gasket.

#### 7.4.2. Component Access

All components shall be easily accessible for maintenance. Front access only gear shall have all components and cable connections easily accessible from the front.

#### 7.4.3. Number of Units per vertical section

The number of circuit breakers or motor controllers in a vertical tier shall be as per the supplier's standard design, unless specified otherwise.

#### 7.4.4. Form of Separation

Switchgear and control gear shall have a form of internal separation as specified on the data sheet, based on IS 8623-1. Sheet-steel barriers shall be provided between the vertical sections and between the control compartments and the power compartments. Horizontal and vertical buses shall be isolated such that when the rear panel of a vertical section is open, the only exposed "live" bare parts will be the load terminals of feeder breakers.

#### 7.4.5. Testing for Arc Due to Internal Fault


The equipment shall be designed and tested to meet the requirements of IS 8623 for arcing due to an internal fault such that the arc is confined in the section where it occurs and adjacent sections are not affected.

#### 7.4.6. Ventilation

The enclosure shall be naturally ventilated. Non-ventilated or forced air cooling shall not be permitted unless approved by the Purchaser. When a transformer, variable speed drives (VSDs), or other heat producing equipment will be installed within the gear, Supplier shall provide internal heating calculations. Internal heat dissipation data shall be provided by the Supplier in any case.

#### 7.4.7. Painting

All interior and exterior surfaces of the switchgear and control gear enclosures shall be painted. The interior and exterior colour finish and the painting process shall be the supplier's standard unless specified otherwise. Bidders shall provide details of metal fabrication and painting.

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#### 7.4.8. Unoccupied Compartments

Spare and empty switchgear compartments shall provide for future installations of breakers without requiring a shutdown of the switchgear line-up as stated in data sheet or Single Line Diagrams. Cables and stabs shall be adequate for the largest breaker that could be installed in the available space.

#### 7.4.9. Assembly Degree of Protection

The degree of protection shall be IP41 for the external housing and the internal separation of assemblies shall be IP20. Assemblies with withdrawable units shall be designed so that the specified degree of protection applies to all positions and during transfer from one position to another. With doors open, live terminals of all door- mounted, internal components and bus contact openings shall be shrouded or otherwise protected by barriers to a minimum degree of protection as specified.

### 7.5. Power Bus

#### 7.5.1. Power Bus Bars


Power bus bars shall run the entire length of the equipment except where it is necessary to cut and provide splice plates for shipping sections. All primary and secondary bus elements and all horizontal and vertical buses shall be of copper material. Bus bars shall be single bus configuration designed and manufactured in accordance with IS 8623. All bus bar ends shall be drilled and supported to enable extension without modifications to the existing bars.

#### 7.5.2. Neutral Bus Bar

The neutral bus bar shall run parallel with the power bus bars, run the length of the equipment, and shall be fabricated and plated with the same material as specified for the power bus. Neutral bus bar current ratings shall be equal to the phase bus bar current rating in vertical and horizontal bus bar system. The neutral conductor shall be marked 'N' and coloured black and the earth conductor marked 'E' and twin coloured, green/yellow. The terminals for external earth conductors shall be marked with the standard earthing symbol.

#### 7.5.3. Joint and Bus Plating

All joints between vertical and horizontal power buses, multiple horizontal buses, and incoming connections shall be plated with tin or silver. All un-insulated bus shall also be plated with the specified material. Bus bar joints shall be made using high-tensile steel bolts (hydrogen relieved), nuts and washers. Provision shall be made in the bus bar compartment to allow access for inspection and maintenance of connections.

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#### 7.5.4. Bus Insulation

Unless specified as none (i.e. air insulated), power bus bar and neutral bus bar insulation shall consist of physical barriers between phases (isolated) or complete encapsulation with suitable dielectric material (fully insulated). For full insulation, the entire length of the power bus (i.e. horizontal and vertical sections including the neutral) shall be insulated for the rated voltage. Material and instructions necessary for insulation of all bus splices, connections, and terminations shall be supplied with the equipment. The bus bar insulation shall be continued into the main switching device compartment as far as practicable whereas the main and dropper bus bar insulation system shall use flame retardant, non-hygroscopic and non-tracking material.

#### 7.5.5. Bus Bar Connections

Bus connections to and from circuit breaker units, fused units, or motor starters shall be insulated, as specified on the data sheets, and shall have a short circuit rating at least equal to the maximum specified short circuit current. The bus connections to the circuit breaker and fused units shall have a continuous current rating at least equal to the largest breaker or fuse which may fit into that particular section. The continuous current rating of the motor starter bus connections shall be equal to the maximum current drawn by the largest starter of the size that may fit into that particular section.


Minimum Clearance between Phase to phase shall be 25 mm, Phase to Earth & Phase to Neutral shall be 19 mm

#### 7.5.6. Shutters for Bus Contact Openings

Automatic shutters shall be provided for functional units, so that when a unit is removed, disconnected, or placed in the 'TEST' position, no live primary-circuit elements will be exposed. Each set of shutters shall be individually operated and activated by the movement of the withdrawable unit and shall not depend on gravity for operation. All shutters shall be pad lockable in the closed position. The bus contact openings for all withdrawable units shall automatically have an internal degree of protection; the type of protection shall be per supplier standard. Metallic parts shall be earthed.

#### 7.5.7. Warning Labels

All covers providing access to bus bars shall carry a 'Caution – Risk of Electric Shock' warning label.

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#### 7.5.8. Phase Identification

Bus bar phase identification shall be R, Y, B, and N. Phase arrangement and primary circuit connections shall be clearly shown on Supplier's drawings.

#### 7.5.9. Wiring

No wiring shall be contained within bus bar compartments, other than the phase connections to incoming and outgoing main circuits.

### 7.6. Earthing Bus Bar

#### 7.6.1. Description

All switchgear and control gear compartments shall be earthed to a common earthing bus bar running the full horizontal length of the assembly fabricated from the material and sized as specified. Vertical earth bars shall be provided. The minimum area of the earthing bus bar shall be as specified on the datasheet. The earth bus bar material shall be tin plated copper.

#### 7.6.2. Connections

The earth bus in each vertical section shall have at least six pre-drilled holes for terminating earthing conductors. All internal earthing connections shall be made at the factory.

#### 7.6.3. External Cable

Each gland plate shall be bonded to the earth bus by connection complying with IEC 61439. Provision shall be made within each cable box for connection of all external cable earth cores.

#### 7.6.4. Earth Bus and Neutral Bus Bonding


This clause is not applicable and is deleted.

#### 7.6.5. Panel Earthing

Each end of the panel shall be earthed to the main earth grid. Supplier shall extend the earth bus outside of the panel for purchaser connect to the main earth.

#### 7.6.6. Door Earthing

Each compartment door shall be earthed separately.

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## **7.7. Section Space Heaters**

### **7.7.1. Space Heaters**

Space heaters shall be provided to eliminate condensation within control junction enclosures and/or cable termination compartments. Space heaters shall be sized to maintain the interior of the enclosures 5°C above ambient temperature. A miniature circuit breaker shall be provided for overcurrent protection and means of disconnection.

### **7.7.2. Space Heater Control**

The space heaters shall be thermostatically controlled and shall operate at a voltage supply of 230VAC, 1 Phase, 50Hz. Thermostats for contactor control shall have a minimum rating of 5A at 0.35 inductive power factor at 230VAC.

### **7.7.3. Equipment Contact**

The space heaters shall be adequately guarded to prevent personnel or equipment contact with the hot surfaces.

## **7.8. Control Power**

### **7.8.1. Electrically operated Circuit Breaker Control Power Sources**


Control power for closing, tripping, and protection of Electrically Operated Circuit Breaker, shall be as per data sheet from a 110V DC system. The common control supplies for tripping, closing, indication and protection relay auxiliary supplies provided for each bus shall be equipped with a make before break change over switch to permit either bus to be fed from either supply source or individually. Automatic changeover facility shall be provided in case of failure of supply to one bus. Redundant control power supply shall be provided for all switchgears.

Refer to protection & metering Single Line Diagrams. Each control bus used for breaker tripping power shall be provided with an under voltage alarm relay, and a blue “Power Available” indicating light.

### **7.8.2. Motor Starter/ Contactor Control Power**

Control power for motor starters, contactors, motor relays, motor IEDs, and other solid state/electronic devices in the control gear shall be 230VAC, via internal Control Power Transformers. The Control power transformer shall be provided per bus bar section for all motor starters and feeder contactors fed from that section.

The auxiliary supplies provided for each bus shall be equipped with a make before break change over switch to permit either bus to be fed from either supply source or individually.

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Automatic changeover facility shall be provided in case of failure of supply to one bus. Redundant control power supply shall be provided for all switchgears.

#### 7.8.3. Control Power Transformer Protection

The primary windings of all control power transformers shall be connected via current limiting fuses for the phase connections and a link for the neutral connections. One pole of the secondary winding shall be earthed and the other pole shall be protected by a suitably rated fuse.

#### 7.8.4. Switchgear and Control gear Load Profiles

Supplier shall provide detailed switchgear and control gear load profiles for sizing the external AC or DC power supplies. Supplier shall provide power and current ratings (at the specified control voltage) for trip, close, and lockout relay coils, charging motors, remote racking motors, solid-state and microprocessor relays, meters, and IEDs, indicating lights, and all other devices that will require external control power.

### 7.9. Earth Fault Protection

#### 7.9.1. Electrically Operated Circuit Breakers

Electrically operated Circuit breakers shall have earth fault protection with adjustable pickup and time delay characteristics available for proper coordination with downstream breakers and starters.

### 7.10. Terminal Blocks


#### 7.10.1. General

Terminal blocks shall be provided for connection of external wiring and shall minimum IP20 rated, conveniently located, clearly numbered, and identified. All terminals shall incorporate a pressure plate such that screws or nuts do not bear directly on conductors. Terminals shall not have more than one conductor connected to each terminal side.

#### 7.10.2. Power Cables

All line-ups shall be designed to accommodate cable entry from bottom as specified on the data sheets. Compression-type lugs and required support shall be provided within the equipment for the termination of all power wiring. Sufficient space shall be provided for the termination of power cables and shall be shown and dimensioned on the Supplier's drawings. All line-ups shall be equipped with gland plates. For single core cables, gland plates shall be of a non-ferrous material. The details of cable sizes and type will be provided on the data sheets or single line diagram.



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### 7.10.3. Control Wires

All control wire terminal blocks shall be screw type with a spare capacity of 10%, designed to accommodate pre-insulated, bootlace-type ferrules, and shall accept a minimum of two 4 mm<sup>2</sup> wires. A separate control terminal block shall be provided for each functional unit.

### 7.10.4. CT Terminal Blocks

All CT terminal blocks shall be of the shorting-terminal type. All external connections for CT circuit terminals shall accept a minimum wire size of 4 mm<sup>2</sup>.

### 7.10.5. External Cable Connections

Terminals shall be provided for all external connections and shall be located within the cable box allowing easy access for terminating, testing, and maintenance. External connections shall not be made directly to terminals forming an integral part of components. In addition, the power cable and control cable entries shall be bottom entries.

### 7.10.6. Field Wiring Terminals

All functional units shall have the ability to be disconnected or completely removed without disconnecting the field wiring.


### 7.10.7. Terminal Markings and Warning Labels

Terminal markings shall comply with IEC 60445. Terminals remaining live when a functional unit is isolated or removed shall be provided with a label stating, 'Danger XXX Volts Isolate Elsewhere', and shall be suitably shrouded; where 'XXX' is the maximum voltage normally present at the live terminal.

## 7.11. Wiring

### 7.11.1. General

All conductors shall be stranded copper with flame retardant, 600/1000 V insulation and continuous from terminal to terminal with no splicing. Conductor ends shall be fitted with a crimped terminating device with an insulated shank. Wiring shall be neatly bundled and secured with wire ties. Minimum conductor sizes for current transformer, for power circuits, for control circuits and for signal wiring to electronic instruments, shall be as per the data sheets.

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#### 7.11.2. Wire Markers

Wire markers shall be provided on both ends of all conductors, shall match the supplier's drawings, and shall be of the type specified in the purchaser requisition documents. Wrap-around, adhesive, and snap-on markers are not acceptable. All wiring shall be marked on each end of the conductors with permanently-embossed wire markers of the heat shrinkable or slip on types.

#### 7.11.3. CT Wiring and Protection

All CT circuit wiring shall be provided with a screw-type terminal and ring lugs. Where wiring passes through a metal sheet or barrier, bushings, grommets, or other mechanical protection shall be provided. Wiring across door hinges shall be protected from mechanical damage, preferably by the use of flexible conduit.

CT mounted on the buses shall be supported and clamped adequately. CT shall be Cast resin type.

#### 7.11.4. Earthing Wire

All earth circuit wiring shall have green/yellow insulation.

The instrument compartment door should be earthed with flexible braided copper wire.

#### 7.11.5. Power Supply Wiring


Wiring for circuits connected to bus-wired power supplies shall be protected by moulded case circuit breakers or fuses for each switchgear unit.

#### 7.11.6. Inter-Wiring Ducts

All switchgear inter-wiring for interlocking, alarms, etc., shall be routed between compartments by means of a duct. Wiring ducts shall be accessible without the need to de-energize any circuits.

#### 7.11.7. LSF Wiring and Ducts

All internal wiring shall be low smoke and fume (LSF) type wiring. Insulation shall be low smoke, zero halogen thermosetting insulation with an oxygen index of 30% minimum. All internal wiring ducts shall also be fabricated from LSF material.

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#### 7.11.8. Auxiliary Circuits of Draw out Units

The connections of the auxiliary circuits of draw-out units shall be of the plug-and- socket type, automatically operated by the unit.

#### 7.11.9. Cable Screening and Segregations

The following cable segregation requirements shall be observed during construction of the switchboard:

- a) Low voltage, digital and analogue I/O cables shall be loomed separately from, and have maximum separation to main voltage cables.
- b) Unless approved by the Purchaser, all communications shall be run using screened twisted pair or fiber-optic cabling.
- c) Analogue signals not transmitted over the communications network shall be run via screened twisted pairs. Single wiring within equipment shall be manually twisted in pairs, with due care taken to minimize the length of any untwisted wiring.
- d) Incoming digital I/O (Input/Output) cables to the Intelligent Motor Controller (IMCS) shall be screened.
- e) Signal Cable screens shall only be single point earthed at the switchboard end. The screen to instrument earth bar connections shall be as short as practical. Screens on different analogue signal pairs shall be kept isolated except at earthing points.

### 7.12. Name Plates

#### 7.12.1. General


Nameplates shall be placed on the outside of each cubicle door identifying the service by name and equipment number in accordance with the datasheets. All external nameplates shall be of an acrylic resin material. The language used shall be English and the background of the nameplate should be white with black letters to be used. The nameplate size and letters' height should be of the supplier's standard.

#### 7.12.2. Fastening

Nameplates shall be attached to the enclosure by two stainless steel screws. Adhesive backing shall NOT be permitted unless approved by the Purchaser.

#### 7.12.3. Component Nameplates

Nameplates shall identify each device on the instrument panel and other devices such as instrument transformers, secondary fuses, etc. inside the cubicle. Door- mounted components shall be identified both on the exterior panel door and internally. The positions of control and selector switches shall also be labelled. Nameplates shall remain in place when the component has been removed.

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#### 7.12.4. Warning and Caution Nameplates

In locations where dangerous situations may inadvertently be created, warning plates or caution notices shall be installed, identifying the danger points. This may be in a compartment or on the outside of an assembly. Warning plates or caution notices shall be engraved black lettering on yellow background. Applications include, but are not limited to the following:

- a) Incoming sources with potential for feedback from an alternate source.
- b) Termination points for all wiring brought to the switchgear from an external power source.

#### 7.12.5. Danger Nameplate

Nameplate shall be engraved white latter on red background. The Nameplate shall comply with IS 2551.

### 7.13. Incoming Line Sections

#### 7.13.1. General

The incoming line section shall contain main disconnecting means and shall include provisions for connecting the low-voltage switchgear to the incoming, three-phase, insulated bus duct, incoming cables, or cable bus as per the data sheets and the single line diagram. Bus and incoming line phase shall be identified on the supplier drawings. Adequate space for terminations shall be provided and identified on the supplier drawings.


#### 7.13.2. Switchboard Components

Each incoming line section shall contain switchboard and/or multifunction microprocessor metering (MFM), relaying, and/or instrument transformers as specified on the single line diagrams or protection, control and metering diagrams. Each analogue switchboard type meter shall be 90 mm minimum, 250° circular scale, white background with black graduation markings with a four-position selector switch.

### 7.14. Electrically Operated Circuit Breakers

#### 7.14.1. General

The switchgear circuit interrupting device shall be of the draw out, air break, electrical type, with five-cycle closing and interrupting duty, and solid-state trip unit with long-time, short-time and/or instantaneous, and earth fault protection as specified in this document, the datasheets, or single line diagrams. The utilization category for circuit breakers as per IS 13947 shall be Category B, suitable for continuous duty.

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#### 7.14.2. Electrically Operated Breakers

Switchgear main and tie circuit breakers shall be electrically operated. Electrically operated feeder circuit breaker shall be provided only when indicated in data sheet or Single Line Diagrams. Electrically operated circuit breakers shall have means of tripping when control power is not available. On electrically-operated circuit breakers, secondary disconnecting devices shall be provided for auxiliary functions and control circuits.

#### 7.14.3. Circuit Breaker Positions

Circuit breakers shall be withdrawable to an isolated test position or disconnected position or completely withdrawn from the breaker cubicle. In the test position, the breaker shall be operable (with auxiliary circuits energized) but shall not energize the power circuit.

#### 7.14.4. Interchangeability

Breakers shall be interchangeable with others of the same voltage, current, and breaking ratings. It shall not be possible to interchange breakers of different ratings.

#### 7.14.5. Breaker Spring Charging

In addition to electrical spring charging using a motor, on the breaker control panel (face of the breaker), a handle for manually charging springs, a contact-position indicator, a charging mechanism position indicator, and pushbuttons for closing and tripping shall be provided.

Spring mechanisms shall be arranged such that a closing operation cannot occur until the spring is fully charged


#### 7.14.6. Breaker Mechanism

Operating mechanisms shall be electrically and mechanically trip free, include an anti-pumping device, incorporate a local manual trip facility, and give positive indication of breaker position. Tripping mechanisms shall be provided with a mechanical tripping device. Operating mechanisms equipped for electrical closing shall include an interlock arranged such that closing cannot be initiated when a trip condition exists.

### **7.15. Electrically Operated Circuit Breaker Control**

#### 7.15.1. Local and Remote Control

Local closure control of switchgear shall be limited to operation for maintenance and test purposes. The closing of breakers from the front of switchgear panels under service position shall be prohibited. Additional control functionality shall be as defined in the data sheets and Single Line Diagrams.

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All switchgear positions shall provide a manual trip facility on the front of the panel, suitably protected to prevent inadvertent operation. A padlocking facility shall be provided to prevent unauthorized use of manual trip and close facilities.

Circuit breakers shall be provided with a means of operational testing when in test, or withdrawn isolated position. The tripping and closing device local to panel shall be operable in the test position. All other automatic operations shall also be operable in this position to allow the complete testing and commissioning of equipment without the need for energizing power circuits. Individual control operations shall be selectable.

It shall be possible to mechanically trip all circuit breakers at the Switchgear.  
No remote operation of the breakers are envisaged.

#### 7.15.2. Auxiliary Contacts

Each breaker shall include two (2) Normally Open and two (2) Normally Closed unused auxiliary contacts pre-wired to a terminal block for Purchaser's use.

### 7.16. Controllers and Feeders

#### 7.16.1. Motor Starters


Starters shall be of the direct on-line, non-reversing, combination type for use with squirrel-cage induction motors, unless specified otherwise on the datasheets. Contactors shall comply with IS 10118-1 and shall be air-break, electromagnetically operated, and electrically held. Contactors shall have an AC-3 utilization category to IEC 60947-4-1 at the max load current of the outgoing unit. Irrespective of the size of motor, the minimum starter size shall be 5.5 kW controlled by an intelligent motor controller (IMC).

#### 7.16.2. Protection & Isolation

Unless otherwise stated in the data sheet, motor starters shall include a fused switch for short-circuit protection and means of disconnection. Overload and other motor protection functions shall be provided by the microprocessor based protection relay provided as a part of the intelligent motor controller. Supplier shall confirm that the overcurrent device will coordinate with the inrush current of motors.

#### 7.16.3. Coordination Type

The coordination between starters or contactor feeders and associated short circuit protective devices shall be in accordance with IS 10118-1, Type 2 coordination based on the specified short-circuit current. The Supplier shall provide test evidence to verify that the specified coordination has been achieved.

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#### 7.16.4. Overload Relays

Only when explicitly indicated in the data sheet or single line diagrams, starters shall include a three-phase overload (OL) relay, type as indicated on the datasheet, with a thermal sensing element in each phase. The overload relays will be of the manual/auto reset type. The manually resettable relays shall be reset by using an externally operable button as indicated on the datasheet.

#### Protection Functions for Multifunction Relays or Intelligent Motor Controllers

Motor overload and other protection/functions shall be incorporated within a multifunction protection relay or intelligent motor controller with the following minimum features:

- Thermal overload with temperature compensation
- Multiple start protection
- Stall and start time protection
- Undercurrent protection
- Under voltage and voltage unbalance protection
- Single phasing protection
- RTD/ Thermistor monitoring

#### 7.16.5. Padlocking

Padlocking provisions for the off position with the drawer in or out shall be included.

#### 7.16.6. Motor Space Heater Contacts

This clause is not applicable and is deleted.


#### 7.16.7. Feeder Breakers

All MCCB shall be provided with 2NO + 2NC auxiliary contacts

Feeders for general circuits (e.g. welding outlets, lighting and small power, heaters, etc.) shall consist of MCCB as specified on the data sheets, for inverse-time overcurrent protection, instantaneous short-circuit protection, earth fault protection and means of disconnection.

MCCB shall be provided for large heaters supplied with a separate heater control panel.

MCCB protected circuits shall comply with utilization category B.

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## **7.17. Relay, Metering and Control**

### **7.17.1. General**

Protective relaying and metering shall be provided as specified on the datasheets and/or single line diagrams. In general, microprocessor-based, multifunction protective relaying and metering is preferred and shall be included in supplier's base quotation.

### **7.17.2. Isolation**

Instruments, meters, relays, and other control devices and their associated wiring shall be isolated by earthed metal barriers from the primary-circuit elements. The only exception is the short lengths of wire from instruments, etc. to transformers and other related equipment.

### **7.17.3. Mounting**

Relays and instruments may be mounted on the door of the enclosure where the circuit-interrupting device is located, and access to the secondary or control compartment is allowed through this enclosure door.

## **7.18. Protective Relays and auxiliaries**

### **7.18.1. General**

Protective relays shall be flush or semi-flush mounted, and installed to facilitate ease of maintenance, inspection, flag reset, and testing. Trip indicators on protective relays shall be clearly visible, indicating operation of the relay has occurred. The resetting of indicators shall be made from the front of the switchgear. The minimum output contact rating shall be as specified in the datasheet.

In general, microprocessor-based, multifunction protective relaying and metering is preferred and shall be included in Supplier's base quotation. IEEE standard C37.2 device numbers shall be used in all documentation.


### **7.18.2. Relay Power**

Contact rating and performance shall be in accordance with IEC 60255. Protective relays shall derive their power supply from the switchgear control power bus.

### **7.18.3. Protective Relay Testing and Calibrating**

Each protective relay shall have the provision for testing and calibrating the relay using an external power source, without the need to disconnect the permanent wiring. Test plugs for secondary injection shall be provided for all separately mounted instrument transformers. Any additional components such as test blocks necessary to achieve this shall be provided by the Supplier.



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#### 7.18.4. Protective Relay Factory Testing

All protection relays shall have been fully configured and tested by the supplier prior to installation in the switchboard. The scope of relay testing shall be proposed by the supplier as part of his inspection and test procedure for purchaser's approval.

#### 7.18.5. Auxiliary Relays

Any auxiliary relays required to multiply contacts or associated with protective relays may be located inside the units, except for lockout relays that shall be flush or semi- flush mounted. If several auxiliary switches and contacts are present on the same device, they shall be designated numerically 1, 2, 3. On diagrams of all types, contacts and switches shall be shown in the de-energized or 'Off' position.

#### 7.18.6. Voltage Transformer

Voltage transformers (VTs) provided per the single line diagrams and/or datasheets shall be in accordance with IS 3156. The standard rated secondary voltages shall be those given in IS 3156 or as shown in protection, control and metering diagrams/data sheets. The measuring VT minimum accuracy class is as specified in the datasheet. VT's shall be selected according to the recommendation of protection relay Supplier. VT shall have cast resin type insulation

#### 7.18.7. Primary Circuits

The primary circuits of all VTs shall include current-limiting fuses. One leg of the secondary circuits shall be fused and the other leg earthed.

### 7.19. Current Transformer


#### 7.19.1. General

Current transformers provided per the single line diagrams and/or datasheets shall be in accordance with IS 2705. The rated primary currents shall be those given in IS 2705 or as shown in protection, control and metering diagrams/data sheets, and the preferential values shall be used. Integrally mounted CTs shall have a rated secondary current as per supplier's standard.

CT shall have cast resin type insulation

#### 7.19.2. Accuracy

Current transformers shall have a relaying and metering accuracy class to provide satisfactory performance for the burden to be applied. CTs shall be of the required insulation class and shall be designed to mechanically and thermally withstand the maximum let-through current

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of the associated protection equipment. Current transformers for metering shall have saturation characteristics such that meters and instruments are not damaged during main circuit fault conditions. CT's shall be selected according to the recommendation of protection relay supplier.

#### 7.19.3. Accuracy Calculation

Supplier shall provide CT burden calculations for purchaser's review to confirm correct CT application.

#### 7.19.4. Connections

Secondary terminals of current transformers shall be wired up to a terminal block with short-circuiting links, in an accessible location. All secondary windings shall be earthed at one point only by means of a removable link.

### **7.20. Control Switches, Push buttons and Indicating Lights**

#### 7.20.1. Instrument Switches

Pushbuttons and related control switches shall comply with IS 13947. All pushbutton switches, except stop switches shall have a full shroud to prevent inadvertent operation. Instrument switches shall be rotary-cam type with engraved dial plates. Switch escutcheon plates shall be clearly marked to show operating positions.

#### 7.20.2. Circuit Breaker Controls

A circuit breaker control switch and a set of contact position indicating lights shall be provided on the cell door of each electrically operated circuit breaker. The switch handle shall be located along the vertical center line of the cubicle and shall not be located adjacent to meter switches.


#### 7.20.3. Operating Handles

When the switchgear is equipped with several operating controls requiring manual operating handles, these handles shall be of different physical size and shape to minimize the possibility of operating errors, as specified.

#### 7.20.4. Indicating Lights

All indicating lights shall be multi-LED type, providing long life capacity, and shall be removable from the front panel.

The indicating lights for circuit breakers shall be:

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- a) RED “ON” when breaker is closed
- b) GREEN “ON” when breaker is opened
- c) WHITE “ON” when indicating trip circuits/lockout relays are operational (healthy)
- d) AMBER “ON” when breaker tripped (indicates trip by device other than control switch)

**The indicating lights for motor feeders & contactors shall be:**

- a) RED “ON” when contactor is closed (motor running or Feeder ON)
- b) GREEN “ON” when contactor is opened (motor stopped or Feeder OFF)
- c) AMBER “ON” when contactor tripped (indicates trip by device other than control switch)

## **7.21. Control Relays**

### **7.21.1. General**

Control relays shall comply with IS 3231 and shall not be of the plug-in type, unless approved by Purchaser.

### **7.21.2. Operational Requirements**

Control relays shall operate correctly between 80% and 110% supply voltage, measured at the bus bars. Control relays shall remain energized without chatter at 75% supply voltage, measured at the bus bars.

## **7.22. Isolating Devices**

### **7.22.1. General**


Isolating devices shall consist of a moulded case circuit breaker (MCCB), disconnecter-fuse, or a fuse-disconnect. Switches associated with fuses shall be load-break switches.

### **7.22.2. Disconnector Utilization Category**

Disconnector-fuses and fuse disconnectors shall be to IS 13947 for uninterrupted duty, AC-23B utilization category.

### **7.22.3. Mechanism**

The mechanism shall be of the independent manual type.

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## **7.23. Metering**

### **7.23.1. General**

Metering requirements are specified on the datasheets and/or single-line diagrams. Analog meters, when specified, shall be 90 mm minimum, 250° circular scale, white background with black graduation markings.

### **7.23.2. Class Index**

Analog meters shall be flush or semi-flush mounted complying with IS 1248. All meters shall have a class index of 1.5, except meters for individual motor starters, which shall have a class index of 2.5. External zero adjustment shall be provided.

### **7.23.3. Ammeter Scales**

Ammeter scales shall be selected so that full load current appears between 50% and 80% of the normal scale angular deflection. Analog ammeters connected in motor starter main circuits shall have suppressed upper scale readings to match the motor starting currents. If no other information is available then a suppressed scale to at least 6 times the range of the ammeter shall be selected.

## **7.24. Inspection and testing**

### **7.24.1. General**

All inspection and testing shall be carried out as per requirements of this specification, datasheet and applicable codes & standards.


VENDOR shall conform to the inspection and documentation/certification/approval requirements in his Quality Plan to be submitted for approval by the OWNER.

### **7.24.2. Witness Testing and Notification**

Tests shall be witnessed, unless waived, by the Purchaser, Purchaser's representative, or any third-party inspectors determined by the Purchaser. The Supplier shall notify the Purchaser not less than 10 working days before the equipment is ready for testing.

### **7.24.3. Test Plan and Report**

The Supplier shall verify by test that the operation of the assembled switchgear and control gear complies with the requirements specified in the purchase order documents and shall submit to the Purchaser a report incorporating measurements and results of all tests performed. Supplier shall include factory test procedures in accordance with the requirements of this article with their quotation.

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#### 7.24.4. Mechanical Tests

Mechanical tests shall be performed for each unit to verify satisfactory operation. These tests shall include checking withdrawable mechanisms, operating mechanisms, and interlock devices. The interchangeability of draw out units shall also be verified.

#### 7.24.5. Electrical Tests

Electrical operational tests shall be performed to verify circuit integrity and sequence of operation. These tests shall be accomplished by introducing operating and tripping currents and voltages to metering, control, and protective relays at the instrument or control transformers.

#### 7.24.6. Insulation Resistance Test

A short-time insulation resistance test (spot reading test) shall be performed to measure insulation resistance by using a test voltage of 1000 VDC (or higher) for one minute with a Megger instrument or a dielectric test set.

#### 7.24.7. Relay Settings


All relay settings (protection, configuration, and control) are to have been done before the FAT begins. Purchaser shall provide protection settings to Supplier prior to the FAT, for entry into the relays by Supplier. Supplier shall provide configuration, control, and transfer scheme programming for the relays, as required. During the FAT, the protection, control, and configuration settings are to be checked to confirm compliance with drawings and other documents. All settings are to be checked for all devices including the transfer schemes.

#### 7.24.8. Type Tests

Although Suppliers will be required to provide routine testing of their equipment, type test certificates issued by an independent third party proving that the equipment meets IEC standards will be made available at request any time to the Purchaser. Failure to be able to produce proper type test certificates when requested will result in rejection, replacement, or testing of the equipment at Supplier's expense.

#### 7.24.9. Factory Acceptance Tests (FAT)

Equipment shall be tested functionally in the complete assembled configuration at manufacture's shop before dispatch.

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OWNER or its designated representatives, or both, will be present at the factory and shall witness the test results and sign the test records to indicate approval. If the unit does not meet Purchase Order requirements, VENDOR and/or his sub-vendors shall correct the problems at no expense to OWNER.

Records of the tests shall be maintained by the VENDOR and to be submitted to PURCHASER for review.

#### 7.24.10. Site Acceptance Tests (SAT)

Site Acceptance Tests shall be carried out at site after installation of the equipment to demonstrate that the guaranteed performance of the equipment and its interface with other plant systems.

VENDOR may be required to assist with the installation and commissioning of the equipment/ package as specified in the purchase order.

VENDOR shall submit the Site Acceptance Test procedures for approval by OWNER.

OWNER or its designated representatives, or both, will be present at the site and shall approve the test results and sign the test records to indicate approval. If the unit does not meet Purchase Order requirements, VENDOR and/or his sub-vendors shall correct the problems at no expense to PURCHASER.

Records of the tests shall be maintained by the VENDOR and shall be submitted to OWNER for review.


Final acceptance of the package shall be subject to the satisfactory performance functional and operational tests at site.

#### 7.25. Quality assurance and quality control

VENDOR shall be fully responsible for their Quality Assurance and associated Quality Control process.

Unless otherwise agreed by the PURCHASER, the VENDOR's Quality System shall meet the requirements of ISO 9001:2015 Quality System and shall be accredited by a recognized authority.

VENDOR is required to establish an acceptable Quality Plan, inclusive of quality manual and procedures that cover all activities of the order, in order to comply with the Quality System requirements.

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VENDOR shall be responsible for arranging/liasing with the Third Party Inspection Agency and other agencies for design appraisal, inspection, survey and certification requirements as required by the specification/requisition.

When required, waiver and acceptance of non-conformances shall be subjected to Third Party Inspection Agency approval before OWNER endorsement. These concession records shall be included in the Manufacturer's Final Documentation.

#### **7.26. Guarantees and warranties**

VENDOR shall guarantee the equipment and their selection, design, material, workmanship and the performance requirements as stated in this specification and/or equipment datasheet, to achieve continuously for all the conditions stated, for the period as specified in the Requisition / Purchase Order.

Unless otherwise agreed, all equipment shall be guaranteed as follows:

- a) All equipment shall perform satisfactorily under the specific operating conditions as detailed on the data sheet and shall be fit for the intended purpose; and
- b) Tests shall confirm the VENDOR's guaranteed performance.

VENDOR shall guarantee that all work will be performed in accordance with good and sound engineering and construction practices and within the requirements of this specification. The equipment, accessories and all materials supplied by the VENDOR shall be free from defects, shall be suitable for the use for which they are intended and shall perform in accordance with the requirements of this specification.


VENDOR shall agree to promptly correct, at his own cost at site, all the defects and mal-performance of the equipment and/or the accessories supplied by VENDOR or failure by VENDOR to comply with the obligation expressed or implied under the Purchase Order and to extend the warranty period for the duration required to remedy such defects.

VENDOR shall assume full responsibility for the proprietary equipment and components supplied by him, and his sub-vendors, incorporated in the package are accordance with this specification.

#### **7.27. Spares and special tools**

VENDOR shall mandatorily include the spares required for the installation, pre-commissioning, commissioning and start-up along with the firm scope of supply.

VENDOR shall furnish a separate priced list for 2-years operating spares recommended for the package.

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VENDOR shall mandatorily include the special tools, if any, required for installation, commissioning, operation and maintenance along with the firm scope of supply

## **7.28. Packing and shipment**

The equipment/package shall be prepared for shipment by VENDOR after all testing and inspections have been completed.

The equipment/package shall be prepared for the type of shipment specified, in the requisition.

Lifting points and the center of gravity shall be clearly identified on the equipment/packages. A recommended lifting arrangement shall be provided by the VENDOR.

The VENDOR shall be responsible for loading, anchoring and protecting the equipment during transportation. Care should be taken when loading and unloading to ensure that lifting hawsers, ropes, chains, etc do not damage any finish coated surface.

VENDOR shall supply a delivery dossier to be sent along with the equipment on delivery. The dossier shall include, but not limiting to the following:


- a) General Arrangement Drawing
- b) Weight Certificate
- c) Lifting Equipment Test Certificate
- d) Hazardous Substance Certificate/Data Sheet
- e) A copy of any lifting and storage procedure
- f) A copy of any punch list and packing list
- g) Materials shipped separately shall be identified by securely attached corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. Crated equipment shall be shipped with duplicate packing lists, one inside and one on the outside of the crate. The data to be recorded on each packing list shall contain following:
  - h) Name and address of VENDOR
  - i) Purchase order number
  - j) Case identification number
  - k) Overall dimensions in meter
  - l) Gross weight of the case
  - m) Item wise list of the contents

## **7.29. Vendor data requirements**

All documents and drawings shall be identified using a format acceptable to the OWNER.

All documents, drawings, certificate, manuals shall be submitted in English language.



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The units of measurement to be used on the project are generally to be in accordance with the International System of Units (SI). Where appropriate however, standard oilfield units will be used.

All documents shall be clearly identifiable on each page with project title and number, document number, revision number, equipment title and item number, as a minimum.

All drawings and documents prepared by VENDOR shall be checked and signed as such before submission. Failure to this may result in rejection by the OWNER / INSPECTOR without review.

Subsequent revisions to drawings should be cloud marked and revision marked in enclosed triangles. All revisions to documents and calculations shall be underlined / cloud marked and these revisions shall also be listed in front page of all documents. Failure to this may result in rejection by the OWNER / INSPECTOR without review.

Unless specifically excluded otherwise, VENDOR shall provide following documents Final Documents, as a minimum.

Installations Manual shall minimum include procedures and techniques for installation, alignment, testing after installation and subsequent removal, replacement, re-assembly and re-commissioning following major overhaul.


Commissioning Manual shall minimum include pre-commissioning and commissioning checklist and step by step commissioning procedures, precautions etc.

Operating Manual shall minimum include functional description of the equipment, start-up and shut-down procedures, operating, control and preservation procedures, fault finding and troubleshooting check list, operation limits and precautions etc.

Maintenance Manual shall minimum include the maintenance instruction and program for preventive / routine maintenance and for curative / shut-down maintenance


Manufacturer's Data Report (MDR) shall include the following documents, as a minimum. All the documents attached with MDR should be duly reviewed / verified and certified / approved by VENDOR's QC and INSPECTOR.

- a) Complete set of "AS-BUILT" drawings.
- b) Design calculations.
- c) Certificate of compliance of manufacturer and/or material manufacturer's mill certificates with supporting test reports for all materials.
- d) Quality plan/ITP containing all inspection stages and test plan duly signed by VENDOR's QC and INSPECTOR in all stages.
- e) Assembly and installation procedures and reports
- f) Final dimensional check records

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- g) Final inspection certificate and release note from INSPECTOR.
- h) Name plate rubbing or photograph duly witnessed by INSPECTOR
- i) Packager's (VENDOR's) certificate of compliance and performance guarantee/warranty certificates

VENDOR shall prepare and submit the required number of Final Documentation / Completion Files as per Purchase Order.

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## **8. ILLUMINATION SYSTEM**

### **8.1. General Requirements**

For design requirements of lighting for the Jetty area refer section 3.16 – Design Basis.

### **8.2. Power Supply**

Unless otherwise specified, all AC lighting fixtures/control gear boxes/junction boxes shall be suitable for 220 - 250 volts, SPN, 50Hz.  $\pm 3\%$  power supply.


### **8.3. Certification**

The equipment shall have test certificates issued by recognized independent test house based in India. All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous equipment shall have valid BIS license and marking as required by statutory authorities,

### **8.4. Technical Requirements**

#### **8.4.1. Construction**

- All lighting fixtures shall be suitable for outdoor, Marine, Tropical climate, highly humid location. All equipment shall be suitable for use in outdoor open locations and shall have
- IP-65 degree of protection.
- The equipment shall be provided with gaskets made of non-inflammable and self-extinguishing plastic material.
- The enclosures shall be treated and prepared for painting with two coats of epoxy paint with final colour shade (Both internal and external) as per Indian standards.
- A warning inscription "Isolate power supply elsewhere before opening" shall be provided on each enclosure". The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning plate shall be of stainless steel.
- All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304, whereas the clamps and supporting brackets shall be hot dip galvanized steel. The thickness of galvanising shall be 610gms/m<sup>2</sup>.
- All equipment shall be provided with an independent earth terminal with lug inside the enclosure for terminating the third (earth) core of the cable and shall have facility for looping.
- A nameplate shall be provided to indicate the details of testing agency, test certificate no. with date, statutory approval no. with date and agency BIS license number and date, applicable gas group etc. The nameplates shall be engraved on 3 ply black white black lami cold sheets using square cutters. Black engraved perspex sheet nameplate shall also

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be acceptable. Nameplates shall be fixed by screws and shall not be pasted. In case the details given above are embossed on the enclosures, the same need not be repeated on the name plate.

#### 8.4.2. Lighting Fixtures

- All Lighting fixtures shall be LED type.
- Glass used for lighting fixture shall be clear suitable for use under conditions involving exceptional risk of mechanical damage.
- The lighting fixtures shall cable entries suitable for be provided with 2 nos. threaded entries and 2 nos double compression nickel plated brass cable glands. The glands shall be suitable for the specified cable size. 20 % of the fixtures having double cable entry shall be supplied with 1 no. nickel plated brass plug for sealing unused entry. The plugs shall be supplied loose.
- The flood lighting fixtures shall be supplied with adjustable mounting arrangement both in horizontal and vertical plane.
- All lighting fixtures shall be provided with suitable vitreous enamelled or anodised aluminium internal reflector. Additionally all well glass fixtures shall be provided with an epoxy painted external reflector.

#### 8.4.3. Control Gear Box


This clause is not applicable and is deleted.

#### 8.4.4. Junction Boxes

Unless otherwise specified the junction boxes shall be of sheet steel construction. All junction boxes for looping of single-phase lighting circuits using cables up to 4mm<sup>2</sup> shall be minimum 80 mm diameter in size. Each junction box shall be complete with requisite number of cable entries and double compression nickel plated brass cable gland to suit specified cable size.

#### 8.4.5. Terminals & Wiring

- The fixtures and junction boxes shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Unless otherwise specified the terminals for external cable termination shall be suitable for 2.5 mm<sup>2</sup> solid copper conductor. In case lugs are required for cable termination, tinned copper type lugs shall be provided.
- All internal wiring shall employ 2.5 mm<sup>2</sup> 660V grade, FRLS PVC insulated copper conductor wires, colour coded for phase, neutral and earth.
- All terminals in equipment shall be of non-sparking and anti-loosening design such that they do not produce any arc or spark during normal operation.

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## **8.5. Specifications for lighting poles**

### **8.5.1. 12.0 m high octagonal peripheral boat parking lighting pole**

Supply, delivery, installation, testing and commissioning of 12.0 meters high hot dip galvanized octagonal peripheral boat parking lighting poles with top shall be 90mm, bottom 210 mm made up of 3 mm thickness H.T. steel plates having a base plate of size 300x300x16 mm thick with 1000 mm long arm bracket made up of 48.3x3.25 mm thick pipe including EN8 grade foundation bolt with required template.

### **8.5.2. 7.5m high octagonal street lighting pole**

Supply, delivery, installation, testing and commissioning of 7.5 meters high hot dip galvanized octagonal street lighting poles with top shall be 90mm, bottom 210 mm made up of 3 mm top/4mm bottom/5 mm counter weight thickness of H.T. steel plates having a base plate of size 300x300x16 mm thick with 1000 mm long bracket made up of 48.3x3.25 mm thick pipe having 90° angle including EN8 grade foundation bolt with required template.

## **9. INTERNAL ELECTRICAL INSTALLATION WIRING**

### **9.1. General**

This specification covers supply, erection, testing and commissioning of all internal electrification items like conduits, wiring, switches, plug points, power points, A/C sockets etc. The electrification work covered under this section covers the following works:

- Electrical installation work like points for lights, fans, computers, exhaust fans, air conditioners, spare power points, MCBs with their DBs etc
- Electrical installation work for all internal illumination like wiring in conduits or surface, MCBs with their DBs, switches etc

### **9.2. Design**

After the award of work, contractor shall survey the site, prepare the scheme for the internal electrification and get it approved by consultant/ client.

### **9.3. Conduit wiring**

#### **9.3.1. PVC Conduits and accessories**


Conduits shall be IS embossed along the length as stipulated in the IS. Standard conduit accessories like bends, tees, junction boxes, pull boxes etc shall be suitable for site conditions. At the termination point Sealing Conduit shall be used along with union suitable for site conditions.

### **9.4. Laying of Conduits**

#### **9.4.1. Cross section**

The conduits shall be of ample sectional area to facilitate simultaneous drawing of wires and permit future provision also. Total cross section of wires measured overall shall not normally be more than half the area of the conduit. Maximum number of PVC insulated 1100 Volt grade copper conductor wires conforming to IS: 694 -1990 shall be as per table given herein after. Table for maximum permissible number of 1100 V grade single core cables that can be drawn into rigid steel conduits

Nominal Cross-Sectional Area of single core Conductor in sq. mm	Size of conduit					
	20 mm		25 mm		32 mm	
	S	B	S	B	S	B
1.5	7	5	12	10	20	14
2.5	6	5	10	8	18	12
4	4	3	7	8	12	10
6	3	2	6	5	10	8

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- The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
- The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- Conduits sizes are the nominal external diameters.


#### 9.4.2. Concealed Conducting

Concealed conduits in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embed the entire run of conduits and ceiling outlet boxes with a cover of minimum 12mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 meter. No reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building. Spare conduits shall be laid, to be used in future.

Concealed conduits in brickwork shall be laid in chases to be cut by electrical Contractor in brickwork before plastering. A chase cutting electric machine shall cut the chases. The chases shall be of sufficient width to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster over conduits. The conduits shall be secured in the chase by means of suitable clamps at intervals of maximum 1 meter. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering.

Entire concealed conduit work in concrete members and in brickwork shall be carried out in close coordination with progress of civil works. Conduits in concrete members shall be laid before casting and conduits in brickwork shall be laid before plastering. Should it become necessary to embed conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimizing this cutting, conduits of lesser diameter than 25 mm and outlet boxes of lesser depth than 50 mm could be used by the Contractor for such extensions only after obtaining specific approval from consultant/client. For embedding conduits in finished and plastered brickwork, the chase would have to be made in the finished brickwork. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish without any extra cost. Contractor shall carry such extensions only after obtaining specific approval from consultant/client

Cutting chases in finished concrete or finished plastered brickwork for embedding conduits and the Contractors without any extra cost shall do that.

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#### 9.4.3. Protection of Conduits

To safeguard against filling up with mortar/plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs, which shall be replaced by sheet/plate covers as required. All screwed and socketed joints shall be made fully water tight with white lead paste.

#### 9.4.4. Cleaning Of Conduit Runs

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables. The cleaning shall be done through a blower to clear the dust.

#### 9.4.5. Earthing

Continuous earth wire shall be provided for all points outlets and sub-mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc. Earthing of metallic cable conduits to be done at regular intervals as appropriate

### 9.5. Wiring

#### 9.5.1. Light points


Point wiring for light points shall commence at the distribution board terminals and shall terminate at the connector in ceiling box/fixture terminal via the control switch. Rates quoted shall be deemed to be inclusive of the cost of entire, materials and labour required for completion of point wiring thus defined including:

- Conducting system complete with all accessories, junction/ draw/inspection boxes, bushes, check nuts etc. Complete as required.
- Wiring with stranded copper FRLS, insulated 1100 volt grade wires for point wiring including circuit wiring (wiring from distribution board terminals to the first switch in the sub-circuit) and terminations etc. Complete as required.
- Control switch with switch box and cover plate of specified type including fixing screws, earth terminal etc comp etc as required
- Loop earthing with insulated stranded copper wires of 1.5 sq.mm complete as specified.

#### 9.5.2. Circuit Wiring

Minimum size of PVC insulated copper conductor wires for lighting circuits shall be 1.5 sq.mm FRLS copper conductor, and that for 16A sockets 2.5 sq.mm FRLS copper conductor unless otherwise specified. Circuit wiring for 40A sockets used for AC shall be 4.0 sq.mm.



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Light points, fan points and 6 amp socket outlet points may be wired on a common circuit. Such circuit shall not normally have not more than a total of 10 light, fan or socket outlets or a load of 800 watts unless otherwise is stipulated.

Power circuits shall normally have maximum one 40 amps socket outlet unless otherwise stated.

Point wiring rates shall include painting of conduits and other accessories as required, Point wiring rates shall include cleaning of dust, splashes of colour wash or paint from all fixtures, fans, fittings etc. at the time of taking over of the installation.

All circuits, light points, fan points, sockets, mains and sub mains shall be provided with numbering ferrules at both ends of the wires.

## **9.6. Plug & Sockets**

### **9.6.1. General Requirements**

The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

### **9.6.2. Power Supply**


Unless otherwise specified, all AC lighting fixtures/control gear boxes/junction boxes shall be suitable for 220 - 250 volts, SPN, 50Hz.  $\pm 3\%$  power supply.

### **9.6.3. Certification**

The equipment shall have test certificates issued by recognized independent test house. All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous equipment shall have valid BIS license and marking as required by statutory authorities.

### **9.6.4. Construction**

- The enclosures shall be sized to facilitate easy maintenance and heat dissipation.
- The enclosures shall be provided with gaskets made of non-inflammable and self-extinguishing material.
- The enclosures shall be treated and prepared for painting with two coats of epoxy paint with final colour shade (both internal and external) as below:
- All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.
- Internal earth terminals shall be provided in each enclosure for all single phase plugs and sockets for connecting the earth core of the cables.
- The sockets shall be provided with 2 nos. suitably sized cable entries at the bottom

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for specified cable sizes and complete with 2 ns. Double compression type SS cable glands. Each socket shall be supplied with 1 no nickel plated brass sealing plug, for plugging the unused cable entry.

- The plugs shall be supplied with 1 no. Suitably sized cable entry for specified cable size and complete with 1 no. Double compression type SS cable gland.

The sockets shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type. A nameplate indicating TAG NO. Shall be provided on each socket. Separate nameplate shall also be provided to indicate the details of testing agency, test certificate no. with date, statutory approval no. With date and agency, BIS license number and date, applicable gas group etc. The nameplates shall be engraved on 3 ply black white black limacoid sheets using square cutters. Black engraved Perspex sheet nameplate shall also be acceptable. Nameplates shall be fixed by screws and shall not be pasted. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the nameplate.

#### 9.6.5. Other requirements

- The sockets shall be provided with a switch and a mechanical interlock so as to break the electrical circuit before the plug is completely withdrawn and make the circuit after the plug is fully inserted.
- In order to prevent accidental removal of plug from socket, the engagement and disengagement shall be by two separate and distinct movement and positions.
- Unless otherwise specified, 415 V, 63 A three phase plug and socket meant for welding receptacle/ any other three phase auxiliary load, shall be provided with 4 pins (3P+E).
- 4 pin sockets shall be provided with 63 A, three pole heavy duty switch: whereas,
- 5 pin sockets shall be provided with four pole (TPN) heavy duty switch.
- 240 V, 15 A and 240V, 40A single phase plug and socket shall be provided with 3 pins (2P+E).
- The sockets shall be provided with either a spring-loaded hinged cover, or with a cap connected through metallic chain, to close the same when not in service.
- Scraping earth connection shall be provided between the plug and socket. Earth pin of plug shall first engage with earth pin of switch socket.
- The plug assembly shall be mechanically rugged, light and shall not unduly stress the socket or its own pins when fitted on to the socket. The diameter of the earth pin of the plug and socket shall be at least 1.1 times the diameter of the phase pins.

#### 9.7. Schedule of wiring

The wiring schedule for various type of wiring shall be as under:

WIRING SCHEDULE		
DESCRIPTION	PHASE & NEUTRAL WIRE	EARTH WIRE
Point Wiring	1.5 Sq. Mm Flexible Cu Wires	1.5sq. Mm Insulated Cu Wire
Light Circuit	1.5 Sq. Mm Flexible Cu Wires	1.5sq. Mm Insulated Cu Wire
16A sockets	2.5 Sq. Mm Flexible Cu Wires	2.5sq. Mm Insulated Cu Wire
AC	4.0 Sq. Mm Flexible Cu Wires	2.5sq. Mm Insulated Cu Wire
Note: All Wires Shall Be FRLS Insulated Flexible Copper as Per Is: 694		

### 9.8. Light control switch

Light control switches shall be suitable for installation marine condition open to weather such as wind and dampness and shall have features for weather proof.


### 9.9. Plugs and Sockets 25 A for Air conditioner

Industrial plugs and sockets for air conditioner shall have the technical parameters, construction as detailed here under.

Current Rating	Type	No. of Pole	Rated Voltage	MCB protection
25 A	Plug	2 + E	240 V	25 A
25 A	Socket	2 + E	240 V	25 A

#### 9.9.1. Construction

The outer casting shall be made of non-corroding die cast aluminium alloy. The interiors shall be moulded out of superior grade phenolic/polyester compound. Protective cap/cover shall be provided for socket to ensure safety when socket not in use. Contact tubes of socket shall be deeply recessed to prevent finger contact. An overhang around the pins of the plug shall be provided for finger protection from accidental contact. The earth connection shall make first and breaks last. Rubber cable guard in the plug shall be provided for giving protection to incoming flexible cable. MCB of the rating as mentioned in the table shall be provided. Plug, socket, MCB shall be housed in a sheet steel enclosure which shall be chemically phosphate and powder painted.

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## **10. LIGHTNING PROTECTION**

### **10.1. General**

A Lightning risk assessment survey shall be carried out in accordance with applicable standards.

Lightning protection shall be provided following rolling sphere method as per IS/IEC – 62305.

All air terminals shall be earthed directly to a grid using GI flats. The grid/ down conductors shall be connected to a separate lightning earth network which shall be in-turn connected to the pile earthing grid. Number of down conductors from buildings shall be as per calculation.

Earthing conductor material shall be GI, size shall be per calculation, but minimum size shall not be less than 30 x 6.


### **10.2. Principal Components**

The principal components of the lightning protective system shall be as under: -

- Air terminations,
- Down conductors,
- Joint and bonds,
- Testing joints,
- Earth terminations, and

Separate lightning Earth network and pile earths

- Materials
  
- The materials of air terminations, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion or be adequately protected against corrosion i.e. G.I.

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## **11. EARTHING SYSTEM**

### **11.1. General**

This section covers the earthing requirements for the equipment, L.T. panels etc.

This part covers the technical requirements of design supply, installation and testing of earthing system complete in all respect. Earthing protection as specified shall be carried out as per best engineering practices. Main earthing shall be through pile earthing.

### **11.2. General requirements**

Earthing system shall be for safe limits of step and touch potentials along with earth electrodes.

An indicative earthing quantity have been furnished with the tender document however after the award of contract, the contractor shall design the earthing system and submit the same for the approval of the consultant After that he will re-confirm the design of the earthing system and will get it approved by client/ consultant, this also includes drawing/s of earthing system.

### **11.3. Pile Earthing-**


The pile reinforcement cage shall be connected through a pile reinforcement ring, suitably exothermally welded. This cage shall be exothermally welded to the copper earthing strip of 50x6 mm. This strip shall then be connected in a form of ring and risers from the ring shall be connected to the equipment like transformer, breaker, L.T. panel etc. All of such earthing shall be interconnected by a copper strip of 50x6 mm size. Total minimum number of pile earthing shall be 8 Nos spread throughout the proposed facility. Contractor shall check the requirements add additional pile earthing as per the actual if the above numbers found to be inadequate at no extra cost.

### **11.4. L.T. panels**

Every L.T. electrical panel shall have two separate earth connections. The pile earthing shall be connected to the body of L.T. panels with 32X6 mm copper strip.

### **11.5. Equipment Earthing**

- Three phase motors and other three phase apparatus shall have two distinct earth connection of size equal to 50% of the connecting cables.
- For all light fittings and fans one core of the supply cable shall be used as an earthing conductor not less than the size of the phase conductor.
- Cable tray earthing shall be through GI flats.

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## **11.6. Earth Continuity Conductor**

- Metallic conduit shall not be accepted as an earth continuity conductor.
- For the cable tray carrying the LT cables, two earthing strips of 20x6 mm GI flat shall be running all along the cable tray and shall be connected to the cable trays at regular intervals of not more than 30 meters.
- For other equipment, copper wire of size 6 SWG shall be provided.


## **11.7. Erection**

- Joints

The joint of earthing conductor shall be brazed or welded. Welded surfaces shall be painted with red oxide and then aluminium painted.

- Termination

Where the diameter of the bolt at the joints exceeds one quarter of the width of the earth continuity conductor, the connection shall be made with a wider piece sandwiched between two conductors.

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## **12. DC SYSTEM**

### **12.1. UPS Configuration and Operational Requirements**

The DC UPS system shall include:

- 2 x 100 % float-cum-boost chargers
- 1 x 100 % battery bank

The nominal DC output voltage shall be 24 VDC, 110 VDC or as indicated on the data sheet / project drawings.

Normally both the chargers shall supply the DC load and also keep the battery under float charge. On failure of supply from one charger, the other charger shall take the complete load. During of failure of incoming AC power supply or in case of failure of both the chargers, the battery shall take over without any interruption.

When the battery requires boost charging, one charger will operate on boost charge mode, while the second charger will supply the DC load on float mode. In the event of failure of charger feeding the load and when battery is boost charged by other charger, continuity in DC supply shall be maintained from the battery through 80% tap of the battery bank.

In case of power supply failure when one of the chargers is feeding the load and battery is boost charged by other charger, continuity in DC supply shall be maintained from battery to load through 80% tap of the battery bank followed by full battery supplying the load.

The charger rating selected shall be at least 25% higher than DC load requirement together with charging the batteries from 1.85 volts per cell to fully charged condition in 8 hours.

Battery shall be SMF - VRLA type unless stated otherwise elsewhere.


The DC distribution board shall feed the power from the charger / battery to various facilities as required.

### **12.2. Rectifiers / Chargers**

Incoming AC supply shall be converted to DC through three phase full wave-controlled rectifiers.

Rectifiers shall operate according to the constant voltage current limiting principle and shall incorporate a "Soft Start" feature to gradually accept load on initial energizing.

Rectifier section of the DC UPS system shall be capable of precise regulation to prevent damage to the battery.

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DC UPS system shall be galvanically isolated from input power supply system by providing double wound transformers that are natural air cooled, dry type suitable for location inside the panel.

Performance of DC UPS system shall not get affected or in any way be degraded by the use of portable radio transmitter receiver in the UPS room.

Transient/surge protection circuit shall be provided in the input circuit to rectifiers to protect the DC UPS from surges & voltage spikes.

Rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current.

Rectifiers shall be protected against reverse battery connection at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the battery current.

Battery may be taken out of service for maintenance, during that period it shall be possible for the rectifier to continue operation by drawing power from the external source. Ripple content at the DC link shall not exceed 2% even with battery disconnected.

Transient mains supply voltage depressions of not more than 20 %, which may be the result of motor starting activities, shall not result in a trip of the rectifier or the initiation of battery discharge.

The set value of float-charge voltage shall be adjustable on-line by means of either a potentiometer on the relevant control circuit card or, where applicable, by an appropriate menu-driven software change.

The DC output current of the rectifier, when operating under current-limiting conditions, shall be controlled within  $\pm 2$  % of the set value.


The DC system shall be equipped with reverse current diode protection. DC earth fault relay for earth leakage detection shall be provided.

### **12.3. Batteries and Rack**

Batteries shall be of heavy-duty, industrial sealed lead acid, valve regulated recombination type.

Batteries shall be designed for service under the loading and environmental conditions specified in the data sheet.



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Battery banks shall have capacity to supply the full rated inverter load as per the load profile provided in the material requisition or data sheet without discharging the batteries below their minimum charge voltage / cell.

Insulated covers for terminals and connectors shall be provided for personnel protection. Battery sizing calculations as per IEEE 1115 shall be submitted for approval before engineering/fabrication.

Calculations shall take into account battery aging factors and the rated battery life and shall include temperature correction factors based on the battery ambient temperature as specified in the data sheet. Supplier shall be completely responsible for calculating the required ampere-hour rating based on their supplied equipment.

Polarity of each cell terminal shall be plainly and durably identified as positive or negative.

Each cell shall identify the manufacturer, the type, ampere-hour capacity, the number of hours on which the rating is based and the date of manufacture.

Online battery circuit monitoring facilities shall be provided which maintain a continuous assessment of the overall condition of the battery string under normal operating conditions and provide an alarm when this falls outside prescribed limits.


DC UPS shall also provide for on-line battery testing by means of a short-duration battery discharge into the load, either manually or automatically.

Monitoring system shall compare the discharge values with the actual pre- programmed battery discharge characteristics and shall be capable of providing a detailed analysis of the battery condition. Additionally, provisions shall be included to manually select a full battery discharge test by manually disabling the rectifier output.

Battery connection to the DC UPS shall be through a two-pole overcurrent protective circuit breaker for battery maintenance disconnect and fault protection.

Cell containers shall be made of heat and impact-resistant plastic material. Each cell cover shall have sufficient strength to prevent cracking or warping during the life of the cell. The plastic containers shall permit the electrolyte level to be viewed through the container material.

Batteries shall be supplied either rack mounted, or enclosure mounted as stated in the Purchaser requisition document. In either case, the mounting arrangement shall allow easy and unrestricted access for routine maintenance and battery removal.

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## **12.4. Controls, Monitoring, and Communication**

DC UPS shall have a control and monitoring panel that provides system controls, system status, diagnostic, metering, alarm indications and event logging.

Battery Monitoring system (BMS) shall be provided with every UPS to monitor the charging / discharging current of the battery bank, status of battery bank, life of battery in cycles and months, backup time left to discharge completely in minutes, battery AH capacity.

As a minimum the following indications or status messages shall be displayed:

- Primary power source available / not available
- Inverter output out of tolerance
- Load on inverter / Load on bypass
- Status of input, battery and output circuit breakers or switches
- Float / equalize
- Low DC bus voltage
- DC UPS on battery
- System shutdown
- Fan failure (where applicable)
- Over-temperature
- Rectifier on

Meters may be analogue or digital. As a minimum, the following measurements shall be displayed:

- DC UPS input / output voltage
- DC UPS input / output current
- Input frequency
- Battery voltage / DC circuit voltage
- Battery charge / discharge current
- Autonomy time of the UPS remaining (in % and in minutes)

Where an LCD or digital display is provided, the following additional measurements shall be provided:

- Output kW
- Percent of rated load being supplied by the DC UPS
- Battery time remaining during battery operation

As a minimum, the following alarms shall be displayed:

- Fan failure (where applicable)
- Battery supplying load
- DC bus overvoltage
- Battery disconnected

Where an LCD or digital display is provided, the following additional alarms shall be displayed:

- Loss of input power
- Input voltage out of tolerance
- Input /output frequency out of tolerance
- Low battery warning
- Low battery shutdown
- Charger / Rectifier failure
- Charger / Rectifier in current limit
- Output under voltage / overvoltage
- Control power supply failure
- Over temperature shutdown
- Charge failure / battery discharging
- Cubicle over temperature

The following trip functions with hand reset associated with alarm shall be provided as minimum

- |                                 |   |                |
|---------------------------------|---|----------------|
| • A.C input phase under voltage | - | Trip rectifier |
| • Rectifier failure             | - | Trip rectifier |
| • D.C over voltage              | - | Trip inverter  |
| • D.C under voltage             | - | Trip inverter  |
| • Cubicle over temperature      | - | Trip inverter  |

## 12.5. Construction

DC UPS shall be suitably housed in sheet steel panels complete with all interconnections. Panels shall be free standing, fitted with suitable covers for ventilation and cooling fans as required.


Hinged doors shall be provided at the front and back with dust tight gaskets.

Maximum and minimum operating height of the switches shall be 1800 mm and 300 mm respectively

Power and control cables shall be with copper conductors, all the cable connections shall be from bottom and front of the panel, if not specified otherwise in the data sheet.

A removable bolted gland plate shall be provided for external cable connections.

## 12.6. Name Plate

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The equipment shall be provided with a stainless-steel nameplate. Nameplate, as a minimum, shall have the following details:

- i. Project name
- ii. Client's name
- iii. Manufacturer's name, serial no. and year of built
- iv. Item no.
- v. Design and construction code
- vi. Equipment rating
- vii. Ingress protection
- viii. Date of last test
- ix. Inspection by & Inspection agency stamping.

## **12.7. Painting**

Painting shall be done with corrosion proof paints as per shade 631 of IS-5

### 13. LIST OF RELEVANT STANDARDS

#### 13.1. General

The following standards are to be followed for various works as mentioned earlier. If for certain components, Indian Standards are not available, the relevant IEC/BS code shall be followed. It is also to be noted that updated and current standards shall be applicable irrespective of the dates mentioned along with the IS standards in the tender.


#### 13.2. L.T. Cables

- IS-3975 Mild steel wires, formed wires, and tapes for armouring of cables
- IS-7098 Cross linked polyethylene insulated PVC sheathed cable.
- IS-1255 Code of practice for insulation and maintenance of power cables up to and including 33 KV.
- IS 694 PVC insulated cables for working voltages up to and including 1100 V.
- IS 1554 PVC insulated heavy duty electrical cables for working voltage (Part-1) up to and including 1100 V.
- IS 3961 Recommended current ratings for PVC insulated and PVC (Part II) sheathed heavy duty cables.
- IS 8130 Conductors for insulated electric cables and flexible cores.
- IS 5831 PVC insulation and sheath of electric cables

#### 13.3. LT Switch boards

The design, manufacture and testing of LT Switchboard shall comply with the latest issue of the following standards: -

IS- 2516 (Part-I, Sec. I)	A.C. Circuit breaker requirement, voltages not exceeding 1000 Volts.
IS- 2516 (Part- II, Sec. II)	A.C. circuit breaker, tests, voltages not exceeding 1000 Volts.
IS – 4237	General requirement for switchgear and control gear for voltages not exceeding 1000 Volts.
IS- 4047	Specification for heavy duty air break switch.
IS- 2208	Specification for H.R.C. cartridge fuse links up to 650 Volts.
IS- 2705	Specification for current transformers.
IS- 2067	Specification for aluminium bus bars.
IS- 1336	Recommendation for colour of push buttons.
IS- 1248	Specification for direct acting electrical instruments.
IS – 2147	Degree of protection provided by enclosure for low voltage switchgear.
IS- 375	Specification for marking & general arrangement for switchgears, bus bars, main connection and auxiliary wiring.

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IS- 722	Specification for A.C. Electricity meters.
IS-732	Code of practice for electrical wire installation
IS-3231	Electrical relays for power system protection
IS-5082	Wrought aluminium and aluminium alloy bars, rods, tubes, and sections for electrical purposes
IS- 2675	Specification for enclosed distribution fuse board and cut-outs for voltages not exceeding 1000Volts.
BS - 3871 (Part- I)	Specification for miniature circuit breakers
IEC 309-1	Plug and socket

### 13.4. Illumination


The design, manufacture, erection, testing and commissioning shall comply with, but not limited the latest issue of the following standards and rules: -

IS 9537 (Part III)	Specifications for rigid PVC conduit for electrical wiring
IS 694 (Part I)	PVC insulated cables with copper conductors for voltages up to and including 1100 V.
IS 732	Code of practice for electrical wiring installation
IS 1646	General code of practice for fire safety of buildings electrical installation
IS 3043	Code of practice for earthing
IS 3646	Code of practice for internal illumination
IS 4615	Switch socket outlets
IS 3854	Switches for domestic and similar purposes
IS 5133	Boxes for enclosures of electrical accessories
IS 1644	Code of practice for personal hazard for safety of buildings

- Indian electricity act 1910 as amended up to date and rules issued there under (Indian electricity rules 1956) and local supply authorities' rules and regulations.

### 13.5. Internal wiring

650/1100 V grade PVC insulated wires.	IS 694: 1977
Rigid steel conduits for electrical wiring.	IS 9537: 1981
PVC conduits for electrical wiring.	IS 9537: 1981
Accessories for rigid steel conduits	IS 3837: 1976
Flexible steel conduits for electrical wiring	IS 3480: 1966
Switch socket outlets	IS 4615: 1968
Switches for domestic and similar purposes	IS 3854: 1966
Boxes for the enclosure of electrical accessories	IS 5133 : 1969
Code of practice for personal hazard fire safety of buildings	IS 1644: 1960
Code of practice for electrical installation fire safety of buildings	IS 1646 : 1982
Code of practice for electrical wiring installations	IS 732 : 1989

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### **13.6. Earthing**

The following standards and rules shall be applicable: -

- IS - 3043(latest) Codes of practice for earthing.
- Indian Electricity Act' 1910 and rules issued there under.

### **13.7. Lightning protection system-**

The design, installation, testing and commissioning of lightening protection system shall comply with the latest issue of the following standard:-

- IS – 2309 Code of practice for protection of buildings and (1969) allied structures against lightening.



## **14. INSPECTION AND TESTING**

This section covers the inspection and tests to be done on various equipment. The inspection and test results shall be submitted in quadruplicate for consultant's approval. If the result of inspection and tests are not satisfactory, the defects shall be rectified, and tests shall be repeated to entire satisfaction of engineer/consultant without any extra charge to employer the inspection and tests result shall be submitted in quadruplicate for engineer/consultant's approval.

### **14.1. Inspection at manufacturer's place**

Following equipment are required to be inspected during their manufacturing at manufacturer's place-

- LV Panels

A suitable detailed Method Statement, clearly defining the sequence, methodology and resources to be used in the inspection shall be submitted to the Engineer for approval a minimum of 28 days prior to the planned start of any testing. Owner/Engineer shall witness tests on all the major equipment, cost of which shall be borne by the contractor.

### **Further Tests**

MBPA reserves the right of having other reasonable tests carried out at his own expense either before shipment, or at site to ensure that the transformer complies with the requirements of this specification. Vendor can submit their charges for the following additional type/special tests along with the quotation.

### **Type Tests/Special Tests**

The type test certificates to be submitted by the Vendor shall include but not be limited to the following:

#### **Impulse test:**

- a) Short circuit withstand test.

All auxiliary equipment shall be tested as per the relevant standard. Test certificates shall be submitted for bought out items. High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

### **Test Reports**

After all tests have been completed seven certified copies of each test report shall be





furnished. Each report shall supply the following information:

- a) Complete identification data including serial number of the equipment
- b) Method of application, where applied, duration, and interpretation of results for each test.
- c) Temperature data corrected to 75 °C including ambient temperature.

## **14.2. LT CABLING**

Complete test shall be made at the manufacturer's works to determine the performance and operating characteristics of the cable to determine whether the guarantees have been met or not. The successful bidder shall give a complete description of the proposed test method.

### **Type tests**

The successful bidder shall submit the following type test reports conducted on similar equipment for the approval of the consultant.

- Annealing test (for copper)
- Tensile test (For aluminium)
- Conductor resistance test
- Test for Armour wires
- Test for thickness of insulation and sheath
- Physical test for insulation
- Physical test for PVC sheath
  - fire resistance
  - Cold –Impact
  - Bleeding and blooming
- Partial discharge test.
- Bending test
- Dielectric power factor loss
- Heating cycle test
- Impulse with stand test
- High voltage test (Water immersion test)

### **Routine tests**

- Conductor resistance test
- Partial discharge test (For screened cables only)
- High voltage test

### **Acceptance test**

- Conductor resistance test
- Test for thickness of insulation and sheath
- Partial discharge test (for screened cables only)



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- High voltage test (Water immersion test)
- Annealing test (For copper)
- Tensile test (For aluminium)
- Wrapping test (For aluminium)

#### **Site Tests**

- Insulation resistance test

The following tests shall be carried out –

#### **Continuity Test:**

The continuity test shall be established with multi-meter

#### **Insulation Resistance Test:**

The insulation resistance shall be measured between phase and phase and phase to earth before and after the high voltage power frequency with 5000 V meagre.

#### **High Voltage Power Frequency Test:**

This test shall be carried out for providing phase to phase insulation and phase to earth insulation. The cables should withstand the appropriate voltage for one minute.

### **14.3. L.T. SWITCH BOARD**

#### **Inspection test**

The inspection shall consist of following but shall not limit to the same-

- a) Appearance and construction
- b) Dimensions and mounting details
- c) Feeder arrangement and feeder details
- d) Door alignment and gaskets etc.
- e) Alignment of switch drives and handle.

#### **Insulation Resistance**

The insulation resistance shall be measured between phases and from phases to earth. The insulation resistance shall be measured with 1000 Volts Megger test kit. The insulation resistance shall not be less than fifty mega ohms in any case.

#### **High Voltage Test**

This test shall be carried out by applying a voltage of 2.5 KV for one minute: -



- a. between all the three phases and earth
- b. between the phases

### **Operation Test**

- a) ON-OFF operation of switches, contactors, indicating lamps, tripping of contactors etc. Shall be checked.
- b) Breaker testing and breaker details: - Breaker operation shall consist of, but not limited to: Site Test
  - Manual closing and tripping
  - Electrical closing and tripping
  - Breaker tripping through releases

The breaker operation shall be checked in test position as follows: -

- Manual closing and tripping,
- Breaker tripping through releases/relays,
- Inter locks - Protective releases/relays and the breaker tripping time shall be set as specified.
- Emergency trip
- ON-OFF indication
- Breaker annunciation and indication.

### **Type test**

Bidder shall furnish copies of type test certificates for all the tests indicated below along with bid conducted on switch boards-

- Short time current test
- Temperature rise test
- One minute power frequency voltage with stand test.

## **14.4. Lighting Power and distribution board**

### **Inspection**

The inspection shall consist of following, but shall not be limited to the same: -

- Appearance and construction
- Dimensions, mounting details etc.
- Feeder arrangement and feeder details
- Door alignment, gaskets etc.

### **Routine Tests**

The following tests shall be carried out: -

### **Insulation Resistance**



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The insulation resistance shall be measured between phases, between phase and neutral and between phase and earth. The insulation resistance shall be measured with 1000Volts meagre, both before and after high voltage power frequency test. The insulation resistance shall not be less than five mega ohm in any case.

#### High Voltage Power Frequency Test

This test shall be carried out by applying a voltage of 2.5KV for a minute.

- Between all three phases and earth
- Between the phases
- Between phases and neutral
- Routine test as per IS and heat run test (type test) shall be carried out on the panel.

### 14.5. Lighting installation-

#### Testing of Installation

Before the installation is put into service, the following tests shall be completed with: -

#### Insulation Resistance

The insulation resistance shall be measured by applying between earth and whole system of conductors or any section thereof. 500Volts D.C. for single phase system shall be means of a Megger. The insulation resistance shall not be less than five mega ohms.

#### Testing Earth Continuity Path

The earthing conductors shall be tested for electrical continuity. The electrical resistance of the same along with earthing lead from connection with earth electrode to any point, in earth continuity conductor in the complete installation shall be less than one ohm.

#### Testing of Polarity of Single Pole Switch

The test shall be made to verify that all single pole switches have been fitted between the phase conductors and light/fan/socket outlet.

### 14.6. Earthing

#### Site Test

The following earth resistance values shall be measured with an approved earth meagre and recorded.



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- Each earthing station
- Earthing system as a whole
- Earth continuity conductors



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## 15. L.T. SWITCHGEAR PANEL

Contractor to complete the following Performa in their tender submission for each of the L T Switchgear panel.

S. No.	Description		Specified	Vendor Data
1.	Switchgear designation	:	LT Switch Board	
2.	Rated Voltage	:	415V,3Ph,4Wore, 50Hz	
3.	Rated frequency withstand voltage for	:		
	a) Power circuits	:	2.5 KV for one minute	
	b) Control circuits	:	2.5 KV for one minute	
4.	Reference ambient temperature 'C	:	40 degree C Max.	
5.	Main bus bar material	:	Copper (Electrolytic)	
6.	Earth bus bar material	:	Copper (Electrolytic)	
7.	Bus bar rating short time	:	50 KA for one second	
8.	Single front/double front	:	Single front	
9.	Fully draw out/semi draw out/fixed type	:	Fixed type (ACB Draw out)	
10.	Cable entry Power Cable	:	Bottom	
11.	Control Cable	:	Bottom	
12.	Painting Shade - Exterior	:	Shade No. 631(Light Grey)	
13.	Interior	:	Shade No. 631 (Light Grey)	
<b>CIRCUIT BREAKER (ACB)</b>				
14.	Rated voltage frequency & type	:	415V,50Hz, Draw out type	
15.	Normal current under site conditions	:	AS indicated in Dwg.	
16.	Symmetrical interrupting current	:	50 KA	
17.	Short circuit making current	:	140 KA	
18.	Short time current and duration	:	50 KA for one second	
19.	Operating mechanism	:	Motor Operated	
20.	Shunt trip	:	Yes, on ACB	
21.	Relays	:	As per Dwg.	
22.	Releases	:	O/C, S/C, E/F	
<b>GENERAL</b>				



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S. No.	Description		Specified	Vendor Data
23.	Rated voltage	:		
24.	Short circuit withstand at rated voltage	:	50kA	
25.	Thickness of sheet steel	:		
26.	Base frame channels with bolts	:		
27.	Overall dimensions of each switchgear	:		
28.	Single front/double front	:		
29.	Fully draw out/semi draw out/fixed type	:		
30.	Switchgear weights	:		
31.	Material and size of earth bus bar	:		
<b>BUS BARS</b>				
32.	Material and size	:		
33.	TP / TP & N	:		
34.	Bore/Pointed/toped/insulating sieve	:		
35.	Minimum clearance in air	:		
36.	Continuous current rating at site conditions	:		
37.	Temperature rise over design ambient temperature	:		
38.	Bus bar support - Material	:		
39.	Bus bar support - common or individual support	:		
40.	Bus bar support – Anti tracking barrier provided	:		
<b>CIRCUIT BREAKERS</b>				
41.	Manufacturer's name	:		
42.	Type	:		
43.	Rated voltage and frequency	:		
44.	Continuous current under site conditions	:		
45.	Rated symmetrical interrupting current	:		
46.	Making current capacity	:		
47.	Short time current (1 sec)	:		
48.	Power frequency withstand voltage	:		
49.	Duty cycle for breaking capacity	:		
50.	No. of breaks per phase	:		
51.	Minimum clearance - between poles	:		
52.	Minimum clearance - in air, between live parts and earth	:		
53.	Fixed trip/trip free	:		
54.	Electrical and mechanical anti pumping feature provided	:		
55.	Type of operating mechanism	:		
56.	Overload release setting range	:		



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S. No.	Description		Specified	Vendor Data
57.	Short circuit release setting range and time relay feature provided	:		
58.	Under voltage release setting range	:		
59.	Make type and brief particulars of	:		
60.	Switch	:		
61.	Fuse	:		
62.	Contactor (Neutral)	:		
63.	Thermal overload relay	:		
64.	Single phasing preventers	:		
65.	CT	:		
66.	Indicating lamps/push buttons	:		
67.	Relays	:		
68.	Selector switches	:		
69.	Indicating instruments/meters: KWH	:		
70.	Terminal blocks	:		





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**16. MCCB**

S. No.	Title	To be filled in by tenderer
1.	Type/Model	
2.	Reference Standards	
3.	Current Range (A)	
4.	No. of Poles	
5.	Rated Operational Voltage (Ui)	
6.	Rated Insulation Voltage (V)	
7.	Rated Impulse Voltage (Kv)	
8.	Rated Ultimate Short Circuit Breaking Capacity (Icu) at 415V	
9.	Rated Ultimate Short Circuit Breaking Capacity (Ics) at 415V	
	<b>Type of Release</b>	
A)	Thermal Magnetic with following protections	
i)	Over Load setting	
ii)	Short Circuit setting	
B)	Microprocessor based with following inbuilt protections	
i)	Over Load setting (L)	
ii)	Short Circuit setting(S)	
	Time delay on SC (msec)	
iii)	Instantaneous Protection (I)	
iv)	Earth Fault (G)	
10.	Time delay on Earth Fault (m sec)	
11.	Mechanical Ante reclosing	
12.	Engg. Plastic used conforms to Glow wire test	
13.	Spreader Links phase barriers	



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## 17. CABLING

Following details to be given by Tenderer for every size of the cable.

<b>L. V. CABLE</b>				
<b>DATA SHEET</b>				
<b>S. No.</b>	<b>Description</b>		<b>Specified</b>	<b>Vendor Data</b>
<b>CLIMATIC CONDITIONS</b>				
1.	Maximum ambient temperature	:	40 degree C	
2.	Relative humidity	:	100%	
3.	Altitude	:	around 10 metre	
<b>RATINGS</b>				
4.	Voltage grade	:	1.1KV (E)	
5.	No. of cores & size	:		
6.	Cable types XLPE/Paper/PVC	:	XLPE	
7.	Quantity	:	As required	
<b>CONSTRUCTIONAL</b>				
8.	Material of conductor Aluminium/Copper	:	Aluminium	
9.	XLPE Cable - Insulation	:	XLPE	
10.	XLPE Cable - Overall Sheath	:	Heat Resistant PVC	
11.	Earthed/unearthed	:	Earthed	
12.	Screened/unscreened	:	Screened	
13.	Armoured/unarmoured	:	Armoured	
<b>GENERAL</b>				
14.	Manufacturer's type designation	:		
15.	Voltage grade	:		
16.	Max conductor temp. for	:		
17.	Continuous Temp. for continuous running	:		
18.	Temperature of conductor after short circuit	:		
19.	Type of conductor - circular/shaped	:		
20.	Armouring - Round wire/flat type	:		
21.	Normal delivery length of cable	:		
22.	Nominal sectional area of the conductor of the cable	:		
23.	Approximate gross weight of delivery length incl. drum	:		
24.	drum dimensions	:		



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1	Schedule of LT Panels and MDBs	Appendix A
2	Schedule of Luminaires	Appendix B
3	Schedule of earthing	Appendix C
4	Schedule of lightning protection	Appendix D
5	Load schedule	Appendix E

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