
Electrical Works

Section I Specification and
List of Make

Section II Item Specification

Section I Specifications and List of Make

Section I: Electrical Works - Specifications, Testing and Make of Material

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Part A – Electrical Specification

E1. Internal Wiring

This section covers, definition of point wiring, system of wiring and supply, installation, connection, testing and commissioning of point wiring for light points, ceiling fan points, exhaust fan points, convenience socket outlet points, power socket outlet points etc. including fixing of light fixtures, ceiling fan, exhaust fan, wall fan etc.

1.1 Standards

The following standards and rules shall be applicable:

| Standard no. | Particular |
|--------------|--|
| IS : 732 | Code of practice for electrical wiring installation (System voltage not exceeding 650 V) |
| IS : 1646 | Code of practice for fire safety of buildings (General) Electrical installation. |
| IS : 2509 | Rigid non-metallic conduits for electrical wiring. |
| IS : 6946 | Flexible (Pliable) non-metallic conduits for electrical installation. |
| IS : 1293 | 3 pin plugs and sockets. |
| IS : 8130 | Specifications of conduits for electrical installation. |
| IS : 3854 | Switches for domestic purpose. |
| IS : 3415 | Fittings for rigid non-metallic conduits. |
| IS : 4648 | Guide for electrical layout in residential building Indian electricity act and rules. |

Regulations for the electrical equipment in buildings issued by the Bombay Regional Council of Insurance Association of India.

All standards and codes mean the latest.

1.2 Point Wiring

A point shall consist of the a switch as required, including the ceiling rose or pendant holder or swan holder, or ceiling fan box or socket or suitable termination. A point shall include, in addition, the earth continuity conductor / wire from the Switch Board to the earth pin / stud of the outlet / switch box and to the outlet points.

The point wiring shall be carried out in the under mentioned manner

- 1.2.1. Supply, installation, fixing of conduits with necessary accessories, junction / pull / inspection / switch boxes and outlet boxes. (Refer BOQ Item for Pipe Supply)

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- 1.2.2. Supplying and drawing of wires of required size including earth continuity wire.
- 1.2.3. Supply, installation and connection of flush type switches, sockets, cover plates, switch plates, etc.
- 1.2.4. The point shall be complete with the branch wiring from the Switch board to the outlet point, Pre laid conduit with accessories, junction, pull, inspection boxes, control switch, socket, outlet boxes, ceiling roses, button / swan holder, connector etc.

1.3 Point Rate

The rate per point shall include supply, installation, connection, testing and commissioning of point as described under “point wiring”. The measurements of the points will be enumerated. Rate for the point shall consist of wiring from the out let point to the switch board as required with a connector/ plate/ ceiling rose fan box with hook socket with switch. The point rate shall include phase and neutral wire a PVC insulated earth continuity wire from switch to outlet. The unit rate for the point shall consist of wiring from switchboard to outlet point through switch and/or socket, switch board as required and including the outlet points with connector, fan hook box or sockets etc...

1.4 System of Wiring

Unless otherwise mentioned on the drawings, the system of point wiring shall be as follows:

The system of wiring shall consist of single core, PVC insulated, 650/1100 volt grade, copper conductor FRLS wires laid through exposed (surface mounted) PVC conduits as directed.

1.5 General

The contractor shall submit for approval, the shop drawing of conduit layout indicating the route of the conduits, number and size of the conduits, location of junction / inspection / pull / outlet boxes, size and location of switch boxes, number and size of wires pulled through each conduit and all other necessary relevant details prior to laying of conduits. Only after the drawings are approved, the contractor shall proceed with the work of conduit laying.

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

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

1.6 Material

1.6.1 PVC Conduits

All non-metallic PVC conduits shall conform to IS: 9537. The conduit shall be plan and type as specified in IS: 9537 and shall be used with the corresponding accessories (Refer IS: 3419 specification for fittings for

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rigid non PVC metallic conduits). PVC conduits shall be rigid unplasticized, medium gauge having 1.6 – 1.8 mm. wall thickness up to 20 mm. diameter conduit and 1.8 - 2 mm. wall thickness for all sizes above 20 mm. diameter.

1.6.2 Boxes

All the boxes for switches, sockets and other receptacles, junction boxes, pull boxes and outlet boxes shall be fabricated from 2.0 mm. thick mild sheets painted with two coats of red-oxide and then two coats of enamel paints as called for. Colour of the paints shall be as approved by the client. The boxes shall have smooth external and internal finished surface. Boxes in contact with earth or exposed to the weather shall be of 2 mm. mild steel and hot dip galvanized after fabrication. Separate screwed earth terminal shall be provided in the box for earthing purpose. All boxes shall have adequate no. of knock out holes of required diameter for conduit entry. Switch boxes to receive switches, socket outlets, power outlets, telephone outlets, fan regulators, etc. shall be fabricated to the approved shape and size to accommodate all the devices without overcrowding. Outlet boxes to receive ceiling fan shall be fitted with adequately sized rod / hook to fix ceiling fan. The boxes shall be of minimum depth of 65 mm.

1.6.3 Cover Plate

The cover of the boxes to receive outlet points shall be of best anodized sheet cut to shape and size or plate of approved manufacturers of switches.

1.6.4 Cables

The cables shall conform to IS: 694. For all internal wiring FRLS wires of 650 / 1100 volts grade, single core shall be used.

The conductors shall be plain annealed copper conductors complying with IS: 1554.

The conductors shall be circular copper conductor.

The insulation shall be XLPE compound complying with the requirements of IS: 694. It shall be applied by an extrusion process and shall form a compact homogenous body.

The thickness of XLPE insulation shall be as set out in the relevant standards

The cores of all cables shall be identified by colours in accordance with the following sequence.

| | | |
|--------------|---|-----------------------|
| Single phase | - | Red |
| Three phase | - | Red, Yellow, Blue |
| Neutral | - | Black |
| Earth | - | Green or Green/Yellow |

Means of identifying the manufacturer shall be provided throughout the length of cable.

Unless otherwise specified in the drawings the size of the cables used for internal wiring shall be as follows:

In case of circuit wiring for lights, exhaust fans, convenience socket outlet points (P+N+E):

2 nos. of 2.5 mm² + 1 no. of 1.5 mm.² -From MCB at Panel/DB to switch boards.

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3 nos. of 1.5 mm.² -From switch boards to outlet points

2 nos. of 4.0 mm.² + 1 no. of 2.5 mm.² -From MCB at Panel/DB to 16/20 Amp socket.

1.6.5 Switches

Switches shall conform to IS: 3854, IS: 1293 and IS: 4615. The switches shall be single pole, single or two way and shown on the drawings or as specified. They shall be of moulded type rated for 250 volt, and of full 5 / 15 A capacity. They shall be provided with insulated dollies and covers.

The switches shall be rocker operated with a quite operating mechanism with bounce free snap action mechanism enclosed in an arc resistant chamber. The switches shall have pure silver and silver cadmium contacts. The switches shall be flush modular type the make of the switches shall be as indicated in the drawings or BOQ or make of material or as suggested and approved by the client. The switches installed in outdoor area shall be industrial, metal clad type, and shall be provided in weather proof enclosures, complete with weather proof gasketed covers.

1.6.6 Sockets

The sockets shall conform to IS: 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type, rated for 250 volts, and either of full 5 A or 15 A capacity, as mentioned on the drawings.

Sockets shall be of three pin type, the third in being connected to earth continuity conductor. The socket shall be flush modular type. The sockets installed in machine room, plant room or wet / damp area shall be metal clad weather proof type. The finishing and make of all the sockets shall be same as light switch. The socket shall have fully sprung contacts and solid brass shrouded terminals to ensure positive electrical connections.

The sockets shall be provided with automatic shutters, which open only when earth pit of the plug inserts in the socket.

The socket shall be provided with three pin plug top suitable to the socket and of the same make as socket.

1.6.7 Under Floor Raceways

The under floor duct for "in screed" system shall be "galvanized sheet" steel of 1.6mm thick with top and bottom plates are double folded and spot welded together to give required rigidity and to prevent the seepage of concrete and screed water. The duct must have two or three compartments to accommodate cables of different voltage ratings (Power , Data & Communication). The standard length of the duct shall be of 2.5 mtrs with a width of 100 / 200 /250 (or) 300 mm and with a height of 28 / 38 (or) 48mm.

Coupler have to be used to connect the standard sizes of the ducts in screed covered system. The end cap should lock in to the duct with out additional accessories to protect against dust or other foreign particles inside the duct. The riser bends should be easily mounted as well for quick entry of cables in the under floor system.

Under floor Junction & Service Outlet Access Boxes

The floor boxes must be of high quality material and should withstand heavy load and should have corrosion protection.

The Underfloor Junction and Service Outlet Boxes shall be robust in its construction with a base plate and side walls manufactured from minimum 1mm thick galvanized steel and main leveling frames from die-cast/extruded aluminium. Height of the Underfloor Service outlet and Junction Boxes shall be adjustable from 70 to 125mm inline with the height of the screed level for higher screed structures. The Junction and Service outlet boxes shall have suitable dimensions to eliminate congestion and to provide ample working space within the box. Junction Box shall be supplied with crossover bridges for segregation of power, voice and data cables. The sides of the Underfloor boxes shall be pre punched on all the sides for quick and easy installation of Underfloor Ducts at site.

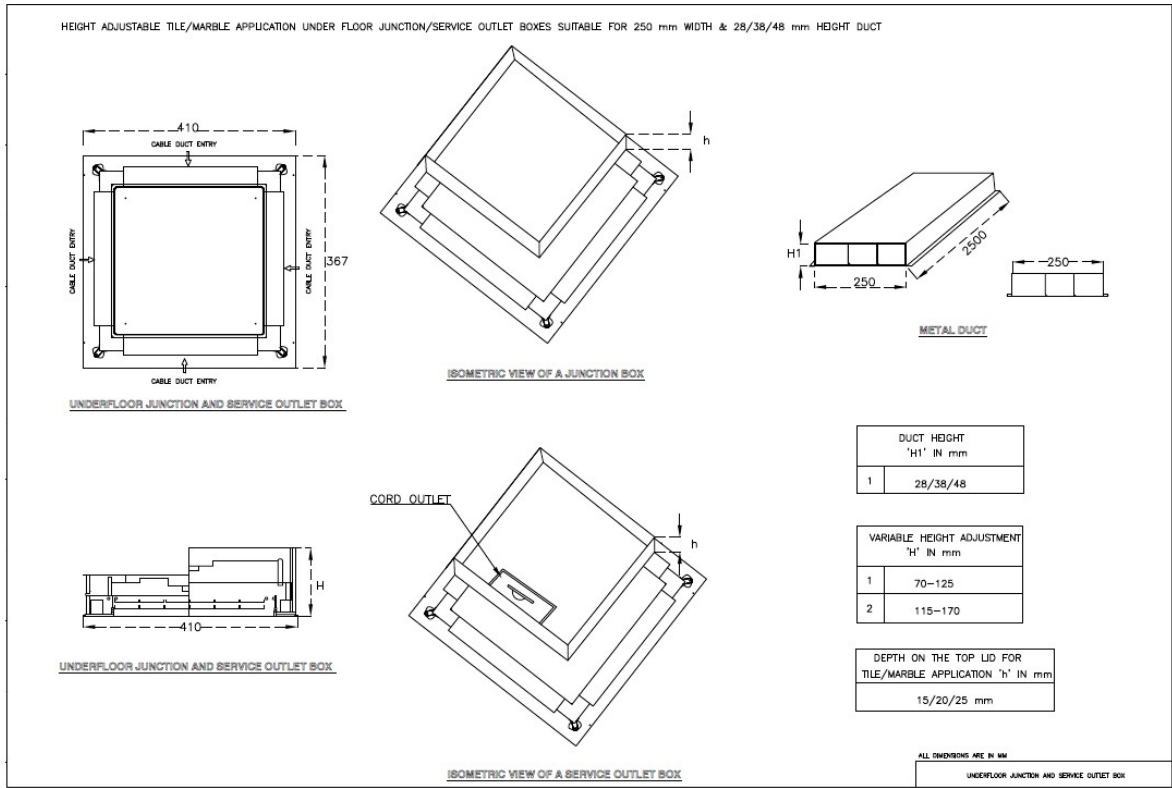
The Frame cassette for Stone finished application shall be manufactured from Stainless steel cassette with 10/15/20/25/30 & 40mm height options to support floor finishing stone of different heights. The cassettes shall also be fitted with a 4mm thick sheet steel plate for ensuring maximum rigidity and providing adequate load bearing capacity. The cassette shall be supported on the Underfloor boxes with the help of four part cassette frame screwed on the underfloor box firmly in place. The frame shall also house a square shaped gasket in single piece to prevent ingress of dirt and water through the gap between the cassette and frame.

Installation:

Underfloor trunking system shall be installed strictly as per manufacturer's instructions and to a level of workmanship to ensure that all the underfloor boxes are consistently in level with the screed level and any part of the boxes is not detected below and or above the floor slab. Failure to comply in this respect, the affected boxes shall be re-installed by the contractor, as required by the engineer.

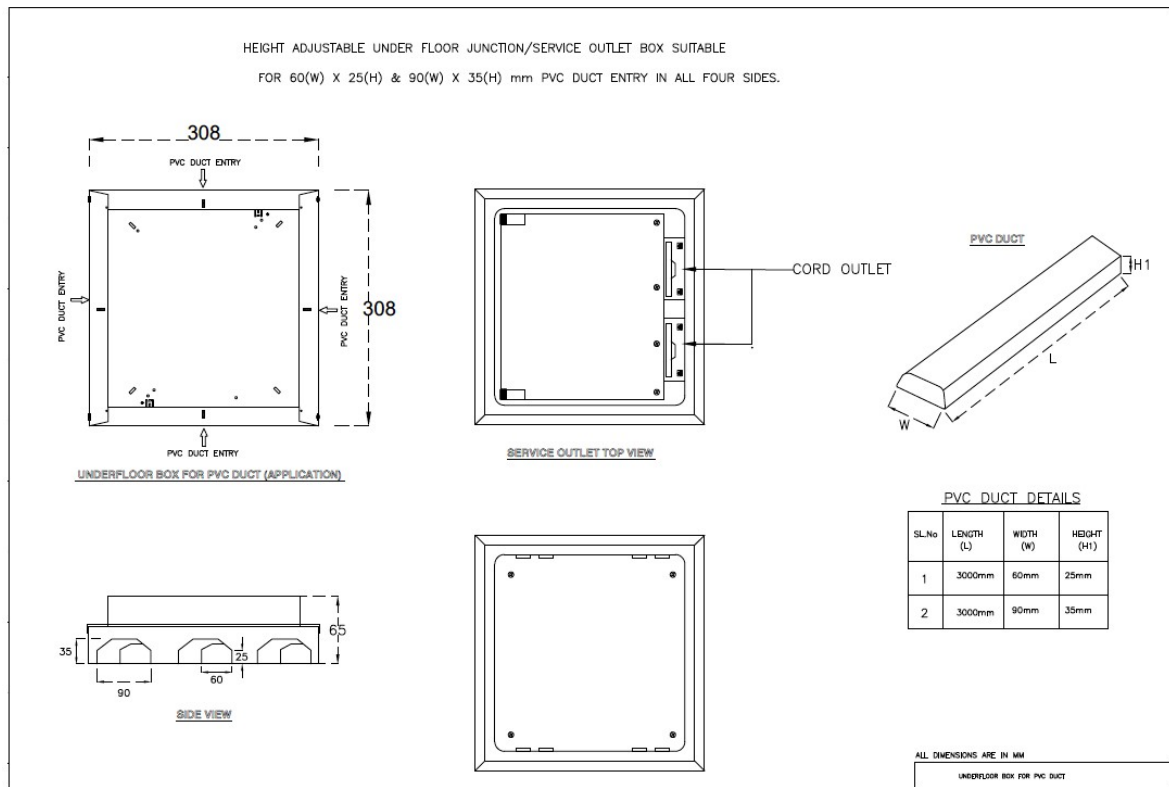
Cross-over bridges shall be installed at the junctions as required, to ensure that adequate segregation of power, voice and data service cables is maintained.

Service outlets shall be installed within floor boxes after installation is completed and wiring is carried out, on to cover plates which are provided with suitable blanks for installation of service outlets.



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1.6.8 Under Floor PVC Raceways



1.7 Drawing Of Conductors

The drawing and joining of copper conductor or wires shall be executed with due regard to the following precautions, while drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends.

Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or ringing.

PVC insulated copper conductor wire ends before connection shall be properly soldered (at least 15 mm length) with soldering flux / copper solder, for copper conductor. Strands of wires shall not be cut for connecting to the terminals. The connecting brass-screws shall have flat ends. All looped joints shall be soldered and connected through terminals block / connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. Conductors having nominal cross section are exceeding 4 sq. mm shall always be provided with crimping type cable sockets. At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used. Brass nuts and bolts shall be used for all connections.

Only certified wire man and cable jointers shall be employed to do joining work.

For all internal wiring PVC insulated wires of 650 / 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in looping system and no joint shall be allowed in the length of the conductors. No wire shall be drawn in to any conduit, until all work of any nature that may cause injury to wire is

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completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Before the wires are drawn into the conduits the conduits shall be thoroughly cleaned of moisture, dust, and dirt or any other obstruction by forcing compressed air through the conduits.

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

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

1.8 Joints

The wiring shall be by looping back system, and hence all joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switch boxes only. **No joints shall be made inside conduits and junction boxes.** Joints where unavoidable, due to any specified reasons, prior permission in writing shall be obtained from the client before making such connections. Joints by twisting conductors are prohibited.

1.9 Load Balancing

Balancing of circuit in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

1.10 Earthing

All earthing systems shall be in accordance with IS: 3043 - 1985 code of practice for earthing.

1.11 Testing Of Installation

Before a completed installation is put into service, the following tests shall be complied with

1.11.1 Insulation Resistance

The insulation resistance shall be measured by applying 500 volt megger with all fuses in places, circuit breaker and all switches closed.

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The insulation resistance in mega ohms of an installation, measured shall not be less than 50 mega ohms divided by the number of points on the circuit.

The insulation resistance shall be measured between

EARTH TO PHASE

EARTH TO NEUTRAL

PHASE TO NEUTRAL

PHASE TO PHASE

1.11.2 Earth Continuity Path

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

1.11.3 Polarity Of Single Pole Switches

A test shall be made to verify that every no-linked, single pole switch is connected to one of the phase of the supply system.

1.11.4 Completion Certificates

All the above tests shall be carried out in presence of client and the results shall be recorded in prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be re tested. The completed test result form shall be submitted to the client for approval.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

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E2. Distribution Boards

Distribution Boards (DB's) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum dielectric strength of 2.5 KV / Sec. All Distribution Boards shall be manufactured by a manufacturer listed in Appendix-I.

DB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

1.1 Construction Features

DB's shall be **IP 43** & made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of DB shall be folded and braced as necessary to provide a rigid support for all component. DB shall be suitable for indoor / outdoor installation, wall mounting free standing type, in double door construction. The Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sq mm tinned stranded copper connectors. Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of DBs.

Three phase boards shall have phase barriers and a wire channel on three sides. Neutral bars shall be solid tinned copper insulated bars with tapped holes and chase headed screws. For 3 phase DB's, 3. Independent neutral insulated bars shall be provided. All DB's shall be internally pre-wired using copper insulated PVC wires brought to a terminal strip of appropriate rating for outgoing feeders.

Knockout holes of appropriate size and number shall be provided in the DB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

Distribution Boards shall comprise of the following:

- 1.1.1. A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.
- 1.1.2. Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc... Neutral bus bars & earthing bus bars required in the circuit. All bus bars in the FDB shall be insulated type.
- 1.1.3. Service cable /interconnection shall be part of the Distribution Boards.
- 1.1.4. The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.
- 1.1.5. Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen & laundry and IP-55 for outdoor application.

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1.1.6. All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.

1.1.7. Phase segregation to be maintained in all three phase distribution boards.

1.1.8. Earthing shall be provided in each FDB's.

1.2 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCB's shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

MCB should be having an integrated label holder with dual side din rail locking facility. Incoming & Outgoing should have facility for termination of Busbar & Cable separately.

Cable termination facility should be up to 35 sq. mm.

1.3 Residual Current Circuit Breaker Current Operated Type (RCCB)

i. System Of Operation

Residual Current Circuit Breaker shall conform to IEC 61008. RCCB shall work on the principle of core balance transformer. The incoming shall pass through the toroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage; current sensitivity shall be of 30 / 100 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

It should provide full protection as envisaged by IE rules – 61-A, 71 – ee, 73 – ee, 1985 and also rule 50 of IE rule 1956.

ii. Mechanical Operation

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

iii. Neutral Advance Feature

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall break last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

MCB should be having an integrated label holder with dual side din rail locking facility. Incoming & Outgoing should have facility for termination of Busbar & Cable separately.

Cable termination facility should be up to 35 sq. mm.

iv. Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

1.4 Earthing

Earthing shall be provided as per IS: 3043-1987.

1.5 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

1.6 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

1.7 Testing

Testing of panels shall be as per following codes:

IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages up to and including 1000 VAC.

IS: 13947: 1993 Degree of protection

1.8 Wiring

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing

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E3. Medium Voltage Cables

1.1 Scope

This section shall cover supply of medium voltage cables.

1.2 Standards

The following standards and rules shall be applicable:

IS: 1554 PVC insulated electric cables (heavy duty).

IS: 1753 Aluminium conductors for insulated cables.

IS: 3961 Recommended current ratings for cables.

IS: 8130 Aluminium conductors for insulated cables

Indian Electricity Act and Rules.

1.3 Measurements

The cables will be measured in meters. The unit rate shall include cutting the cable into required lengths, packing, loading, unloading, insurance, transportation, delivery to stores/site as per work order, stocking in stores, testing of cables at stores etc. of medium voltage cable.

1.4 General

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in original drums with manufacturer's name, size, and type, clearly written on the drums.

1.5 Material

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC sheathed of 1100 volts grade aluminium or copper conductor, armoured and unarmoured heavy duty, conforming to IS : 7098 Part I IS : 1988 Part I. as asked for in the schedule of quantities.

1.5.1. All XLPE Aluminium/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows :

- a. Stranded Aluminium /Copper conductor of high conductivity up to 4 mm.² size, the conductor shall be solid and above 4 mm.², conductors shall be concentrically stranded as per IEC: 228.
- b. Cores laid up
- c. The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
- d. Armoring should be provided over the inner sheath to guard against mechanical damage. Armoring should be Galvanized steel wires or galvanized steel strips. (In single core cables

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used in A.C. system armouring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)

- e. The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-1984 extruded to form the outer sheath.

1.5.2. Conductor shall be of electrolytic Aluminium/Copper conforming to IS : 8130 and are compact circular or compact shaped.

1.5.3. Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.

1.5.4. In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.

1.5.5. Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.

1.5.6. Armouring shall be of galvanized steel wire/flat.

Galvanized steel flat strip / round wires applied helically in single layers complete with covering the assembly of cores.

For cable size up to 25 Sq. mm: Armour of 1.4 mm dia. G.I. round wire

For cable size above 25 Sq. mm: Armour of 4 mm wide 0.8 mm thick G.I. strip

1.5.7. Repaired cables shall not be used.

1.5.8. Current ratings of the cables shall be as per IS: 3961.

1.5.9. The XLPE insulated cables shall conform to latest revision IS read along with this specifications. The Conductor shall be stranded Aluminium/Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation as following.

Core identification:

| | | |
|-------------|---|-----------------------------|
| Two cores | : | Red and Black |
| Three cores | : | Red, Yellow and Blue |
| Four core | : | Red, Yellow, Blue and Black |
| Single core | : | Green, Yellow for earthing |

Black shall always be used for neutral.

1.5.10. The XLPE insulated 1100 Volts grade power cables shall conform to latest IS and shall be suitable for a steady conductor temperature of 70 degree centigrade. The conductor shall be stranded Aluminium/Copper as called for in the Schedule of quantities. The outer sheath shall be as per the requirement of type ST-2 of IS: 5831 of 1984.

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1.5.11. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.5.12. Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.

1.5.13. Cables shall be supplied in non returnable wooden drums as per IS: 10418.

Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

1.5.14. The product should be coded as per IS: - 7098 Part-I as follows:-

| | |
|--------------------------------------|----|
| Aluminium Conductor | A |
| XLPE Insulation | 2X |
| Steel round wire armour | W |
| Steel strip armour | F |
| Steel Double round wire armour | WW |
| Steel Double strip armour | FF |
| Non-magnetic (Al.) round wire armour | Wa |
| Non-magnetic (Al.) strip armour | Fa |
| PVC outer sheath | Y |

1.6 General

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

1.7 Testing

1.1.1 Finished Cable Tests At Manufacturer's Works

The finished cables shall be tested at manufacturer's works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of clients' representative.

a. Voltage test

Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.

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b. Conductor resistance test

The D.C. Resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20° c. to check the compliance with the values specified in IS 8130 - 1976.

Prior to dispatching cables and at the time of delivering the cables at stores, following tests shall be carried out:-

Insulation Resistance test between phases and phase to Neutral and phase to earth

Continuity test of all the phases, neutral and earth continuity conductor

Sheathing continuity test

Earth resistance test of all the phases and neutral

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Vendor shall provide necessary instruments, equipments and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the client and results shall be recorded in the prescribed forms.

1.8 Cable Marking

Embossing On Outer Sheath

The outer sheath shall be legibly embossed with following legend:

ELECTRIC CABLE: 1100 V, SIZE: 3.5 C x ----- mm ².

Manufacturer's Name & year of manufacturing.

1.9 Sealing, Drumming & Packing

After tests at the manufacturer's works, both ends of the cable shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall supply in length of 500 ± 10% meters on packed non-returnable drums of sufficiently sturdy construction.

Cables of length more than 250 meters shall also be supplied on non-returnable drums.

The spindle hole shall be 110 mm minimum diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

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E4. Cable Termination

Not Applicable

E5. Lighting Fixtures & Accessories

1.1 Luminaries :

Luminaries optical compartment should be IP 66 (SEAL Safe) / IP 65 with High photometric lux level with the reflector as specified in the BOQ.

The Luminaries should be guaranteed for the 5 years for the performance & against any visible ingress of the dust, moisture & Mosquitoes.

The control gear compartment should be confirmed to IP level as specified in the BOQ.

Following specification is mandatory specification, for the specific detail of the light fixture contractor should refer the BOQ.

1) Housing : Pressure die cast Alluminium, Non Corrosive

2) Lamp Compartment :

Reflector : an electrochemically brightened & anodized, high purity POT optics reflector with a specially designed ribbed profile

Cover : The lamp compartment should be with heat toughened, special curved glass bowl that should be sealed to the housing

Lamp Replacement: Should be from rear.

3) Lamp : Son T + PIA (For Sodium Vapour lamp)

| Lamp Wattage | Lumen Output | Minimum Initial luminous efficacy per watt | lumen maintenance at 5000 burning hours | lumen maintenance at 10000 burning hours | |
|--------------|--------------|--|---|--|--|
| 150 watt | 17500 | 115 | > 98 % | > 95 % | |
| 250 Watt | 33200 | 131 | > 98 % | > 95 % | |
| 400 Watt | 56500 | 139 | > 98 % | > 95 % | |

4) Ballast : Impregnated electromagnetic ballast of copper –iron construction for use of combination with an external ignitor for High Pressure Sodium Vapour (SON) lamps. Ballast construction from Orthocyclic winding process & Compact in size with Earthing Safety compliance with IEC 922 standard. Performance compliance with IEC 923 standard. Mains Current (with Power factor correction) >.85 Thermal – Tw 130 & ^t 75

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Ballast Watt Loss : for (Son Lamp)

150 watt : not more than 21 watts.

250 watt : not more than 32 watts.

400 watt : not more than 42 watts.

2.2 Manufacturer Selection Criteria :

The proposed decorative cum functional street light luminaries should have a proven and time – tested degree of protection for optical & Control gear compartment.

The Manufacturer should have global presence and expertise in supplying lighting products to similar projects world wide either directly or through associated group companies.

The Manufacturer should have successfully supplied lighting equipment worth Rs. 3.0 crores comprising luminaries & street light accessories for a single project during last three years.

The computerized lighting design has to be practically proven for ' initial lighting levels ' by installing at least six poles at a stretch on the actual project site before the award of the order, failing which the proposal should be rejected.

Power consumption calculation should be provided & has to be proved on site also.

2.3 Lighting Level Criteria :

Luminaries : Maintenance Factor : 0.8

Lux Levels, Uniformity should be achieved on the Road as under :

| | Average Lux Level | Uniformity : Min / Max | Uniformity : Min / Avg |
|---------------------------|--------------------------|-------------------------------|-------------------------------|
| | | | |
| Bus Lane | 40 - 45 Lux | 0.4 | 0.6 |
| Carriage Way | 35 – 40 Lux | 0.4 | 0.6 |
| Cycle track | 25 – 30 Lux | 0.45 | 0.6 |
| Activity Area | 22 - 27 Lux | 0.45 | 0.6 |
| Service lane | 25 – 30 Lux | 0.35 | 0.4 |
| Pedestrian pathway | 17 – 25 Lux | 0.3 | 0.4 |
| | | | |

Junction Should have more lux level & better uniformity than the roads. Junctions should be lit with the MH lamps. Where roads should be lit with the Son T + PIA Lamps.

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The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

2.4 Scope

Scope of work under this section shall include inspection at suppliers/manufacturer's premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

2.5 Standards

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaires :

- | | | |
|---|---|-------------------------|
| • Part-1 Tubular fluorescent lamps | - | IS – 1913 (Part-1) |
| • Industrial lighting fittings with metal reflectors | - | IS - 1777 |
| • Decorative lighting outfits | - | IS - 5077 |
| • Bayonet lamp holders | - | IS - 1258 |
| • Bi-pin lamp holders for tubular fluorescent lamps | - | IS - 3323 |
| • Electronic Ballasts for fluorescent lamps – | | |
| • General & Safety requirement | - | IS – 13021 (Part-1) |
| • Electronic Ballasts for fluorescent lamps – | | |
| • Performance requirement | - | IS – 13021 (Part-2) |
| • Ballast for HP MV lamps | - | IS - 6616 |
| • Tubular Fluorescent lamps | - | IS - 2418 (Part-1 to 4) |
| • Luminaries – General requirement | - | IS – 10322 (Part-1) |
| • Luminaries – Constructional requirement | - | IS – 10322 (Part-2) |
| • Luminaries – Screw and Screwless termination | - | IS – 10322 (Part-3) |
| • Luminaries – Methods of Tests | - | IS – 10322 (Part-4) |
| • Particular requirement – General purpose Luminaries | - | IS–10322 (Part-5/Sec-1) |
| • Particular requirement – Recessed Luminaries | - | IS–10322 (Part-5/Sec-2) |
| • Particular requirement – Luminaries for Road and Street lighting | - | IS–10322 (Part-5/Sec-3) |

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- Particular requirement – Portable General purpose Luminaries - IS-10322 (Part-5/Sec-4)
- Particular requirement – Flood Lighting - IS-0322 (Part-5/Sec-5)
- High pressure mercury vapour lamps - IS-9900 (Part-1)
- Tungsten filament general electric lamps - IS - 418

2.6 Light Fittings-General Requirements:

- a) Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.
- b) Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.
- c) All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Outdoor type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes.
- d) Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires up to 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.
- e) All hardware used in the fitting shall be suitably plated or anodized and passivated.
- f) Earthing: Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.
- g) Painting/Finish: All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.
- h) The housing shall be powder coated/stove-enameled or anodized as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia. mandrel.
- i) Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

2.7. Light Fittings – Special Requirements

LED Strips for Signage :

Rigid waterproof light bar 600 mm / 1200 mm.

Min Lumen should be 1200 lumen.

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Each LED to be less than 0.3 w.

LED should be of Seoul/Nichia/Osram/Samsung make

Colour Temperature should be 6500k / 8000k

Waterproofing done with high quality clear epoxy resin

Viewing angle of led to be 120 degree to provide uniform illumination

LEDs should be mounted on automatic chip shooter machine to ensure accuracy and consistency.

Expected lifetime should be at least 50000 hours.

Driver should be 12 V constant voltage drivers with IP65 protection.

Input voltage 170 - 265 V AC.

Max output electrical current should be 16.66 A

Driver should have aluminium casing for better heat dissipation and should be made weatherproof with thermally conductive potting material.

Power supply should be CE rated.

Manufacturer should be a ISO9001 certified company & CE certified.

Assymetric Distribution Flood Light Fittings

Flood light fitting shall be provided with Housing made of die-cast aluminium with powder-coated finish for sturdiness and excellent corrosion resistance. The lamp compartment comprises of electrochemically brightened, high purity, pre-anodized aluminium reflector for long life and superior reflectivity. Outstanding glare suppression is secured by high grade asymmetric optics that achieve maximum intensity at around 60 deg with accurate beam control and uniform light distribution. There should be no direct light above the horizontal plane through the luminaire - As per the ICAO specs. Necessary supporting vertical grid calculations to be provided. Heat-resistant toughened front glass fixed to the housing with the help of specially designed stainless steel toggles with specially designed hinging mechanism for quick and easy lamp replacement, with no, sky Pollution. Hot dip Galvanized MS mounting bracket with calibrated disk for ease of mounting and aiming. Heat-resistant long life EPDM/Silicon gasket renders the luminaire dust tight and jet proof with ingress protection classification of IP 65. The twin lamp version offers switching facilities that permits tailoring to the user's needs while allowing energy savings. Rugged all weather construction designed for easy aiming, simple cleaning and speedy maintenance Horizontal mounting for optimum light distribution is recommended with maximum rotational adjustment of 12 from the horizontal.

Symmetric Distribution Flood Light Fittings

Extremely high efficiency due to the 'small' lamp in combination with the patented coated reflector system: to provide up to 35 % higher energy (W/m2) than other solutions. Excellent uniform light distribution with an asymmetric beam (A-) or a bi-directional beam (-BD) to create outstanding illuminances on vertically oriented objects. The CDM-TD 150 W with colour temperature 4200 K, in combination with the colour rendering of 96, creates a daylight impression. Safety and minimum glare are assured, as the observer's eyes are shielded from the burner by a patented louver system. More sparkle, because the bright, compact burner is reflected on cars or glossy merchandise. Silicone gasket bonded to the housing renders the luminaire. Should be dustproof and jet proof to IP65. Galvanised white-coated steel mounting frame, for

firm recessed fixing in cladding. Housing consists of an injection-moulded base plate, to which deep-drawn aluminium hood is connected. Thermally hardened glass, enclosed by an IP65 silicone-rubber sealing gasket. Finishing in white (WH)

2.8 Accessories For Light Fittings Reflectors

The reflectors shall be made of CRCA sheet steel/aluminium /Silvered glass/Chromium plated sheet copper as required. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enamelled/ vitreous enamelled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enamelled /mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches / blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

2.9 Lamps

2.9.1 Tld

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of 85. The lamp must comply with ROHS (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully re-cyclable. The lamp should be low on maintenance with life of 40 K hours in case of electromagnetic ballast and 65 K hours in case of HF ballast up to 10% failure. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Colour spectrum of light shall be equivalent to "PHILIPS colour 84 or colour 86 colour 82 or "OSRAM colour 21 or colour 11 or colour 41 (as required at site)".

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

T 5 – High efficiency eco-friendly lamps

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D standard lamp, 26% less than TL-D / 80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for operation with electronic gear and well suited for dimming. Maximum lumen output to be reached at approx 35°C in free burning position. T-5 lamp can be ignited from -15°C to + 50°C. Lamp should be fully recyclable and must comply with ROHS (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lux / W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

1.6.2 Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & starters and for HF electronic control gear. CFL lamp shall be non integral type of OSRAM / GE / PHILIPS/ Havells Sylvania only.

2.9.2 150 W CDM-TD Lamp

- Warm or cool white colour impression
- Colour rendering good to excellent > 96.
- Retrofit in double-ended luminaries for quartz metal halide lamps (MHN/W-TD), thereby allowing to reduce operating costs and improve colour quality
- Burning position horizontal +/-45°
- Initial Lumen Output not less than 13250 Lumens.
- Luminous efficacy should not be less than 84.

2.10 High Frequency Electronic Ballast

High frequency electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply with the following:

- IEC 927, IEC 928 for $\leq 10\%$ total harmonic distortion.
- EMI / RFI – Confirming to FCC / VDE Class A/B.
- Line Transient as per IEEE C62.41.
- Ballast Crest Factor $\leq 1.7\%$.
- No Stroboscopic Effect
- Constant Wattage / Light output between $240\text{ V} \pm 10\%$.
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- PF > 70 for fluorescent / T5 lamp and CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- RFI $< 30\text{ MHz}$ EN 55015
- Total Harmonic Distortion (THD) $\leq 10\%$
- Immunity to interference EN 61547
- Safety EN 60928 / IEC 928 / IS 13021 (Part I)
- Performance EN 60929 / IEC 929 / IS 13021 (Part II)
- Vibrations & Bump tests IEC 68-2-6 FC
- IEC 9001

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Electrical Works – Specifications and List of Make

- Quality Standard ISO 9001
- Environmental Standard ISO 14001
- DC Operation EN 60924
- Emergency Lighting Operation VDE 0108

Total System consumption (lamps + ballast) for

1 x 36 W TLD, shall not exceed 40 W

1 x 28 W T-5, shall not exceed 32 W

1 x 35 W T-5, shall not exceed 40 W

1 x 14 W T-5, shall not exceed 16 W

1 x 18 W CFL, shall not exceed 20 W

1 x 36 W CFL, shall not exceed 40 W

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E6. Earthing

1.1 Earthing

The system shall be TNS with four wire supply system (R, Y, B, N and 2 Nos. E) brought from the main L T Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

All earthing shall be in conformity with IS: 3043 1987, and the basic system of earthing shall be TNS.

1.2 Earthing Conductors

Earthing conductors shall be of copper / GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

1.3 Sizing Of Earthing Conductors

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits up to 15 amps shall be earthed with PVC insulated copper wire.

All 3 phase switches and distribution panels up to 60 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia. copper / GI wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia. copper / GI wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 nos. separate and independent 25 mm x 3 mm copper / GI tape.

1.4 Connection Of Earthing Conductors

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in

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effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

The plate/pipe electrode, as far as practicable, shall be buried below permanent moisture level but in any case not less than 2.5 M below finished ground level.

The plate/pipe electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall / column.

The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

19 mm. dia. G.I. pipes for watering shall run from top edge of the plate / pipe electrode to the mid level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth / ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors (Strips / Wires copper / hot dip G.I.) inside the building shall properly be clamped / supported on the wall with Galvanised Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

Earth Leads And Connections

Earth lead shall be bare copper or Galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. G.I strips buried in the ground shall be protected with bitumen and hessian wrap or polythene faced hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

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1.5 Prohibited Connections

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main L T panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

1.6. Earthing

The following must always be ensured in earthing system.

- All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.
- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

1.8 Resistance To Earth

The resistance of earthing system shall not exceed 1 ohm.

1.9 Specification For Hot Dip Galvanizing Process For Mild Steel Used For Earthing For Electrical Installation

General Requirements

I. Quality Of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

II. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

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The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

1.10 Chemical Earthing System – specification

Earthing system should offer a resistance of less than 2 ohms throughout the year. In places where Soil resistivity is more, total length of the earthing rod has to be increased by adding 1m length rods (one over the other) to achieve low and stable resistance value. In rocky places ,multiple earth rods have to be installed and inter-connected to get the required value.

Solid Copper coated rods are recommended as earth electrode than a pipe due to the fact that solid rods have much longer life and can be easily driven by electric/hydraulic hammers. Copper has much longer life than all other materials as explained in IS 3043. Deep driven rods provide more stable and less Earth Resistance. Doubling the length of the rod will reduce earth resistance up to 40 %, whereas doubling the diameter will reduce the resistance by only 10 %, but may increase the cost by 4 times.Lower earth resistance can also be achieved by increasing the number of earth rods. E.g. 40 % reduction in earth resistance is possible if the rods are increased from 1 to 2. The minimum spacing between earth pits should be equal to TWICE the length of the rod. Increasing the spacing between earth pits also reduces the earth resistance significantly.

Need and importance of Earthing:

- Human and Personnel safety.
- Equipment protection.
- Provides low impedance path for fault currents.
- To ensure good quality power.
- Protection against lightning and transient currents, noise reductions, Limitation of EMI.

References:

IEC 60364: Low Voltage Electrical Installations-Part 5-54: Selection & Erection of Electrical equipment- Earthing arrangement & protective conductors.

IEC 62561: Lightning Protection system Components. Part 1 to 7.

IEC 62305: Protection Against Lightning –Part 3: Protection of structures & life Hazards

IS 2309: Code of practice for protection of buildings & allied structures from lightning

IS 3043: Code of practice for earthing.

Components of earthing system:

- Earth electrode
- Connectors and fasteners

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- Inspection Chamber (Earth Pit)
- Earth enhancement material
- Connecting cable/tape/strip with accessories.

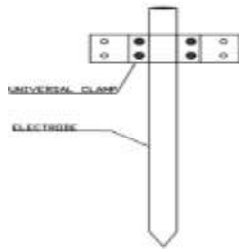
Earth Electrode:

Copper coated Solid steel Rods shall be made of high tensile low carbon steel rod, molecularly bonded with 99.9% electrolytic copper with minimum coating thickness of 250 microns as per IEC 62561 part -2: Requirement for Conductor & Earth Electrodes. The length of the earth rod shall be 1 meter so that driving into the ground is easier (scaffolding is not necessary). For dry areas, length of the rods can go up to several meters by driving the rods one over the other. Earth rods should be of diameter 20 mm. These rods should have facility to couple with hammer inserts so that they could be driven easily with an electric/hydraulic hammer. Additional rods should be added without external couplers. The earth rods should have peg & bore arrangement so that additional rods are added without external couplers.

Interconnecting Strips / Earthing Conductor: Copper coated steel strips / tapes should be used to interconnect different earthing rods as well as horizontal earthing (Ring earthing). These strips should have a coating thickness of minimum 70 microns.

Couplers / Connecting clamps:

Connectors/fasteners for connecting Electrode with Earthing conductor/strip should be of Stainless Steel as it is compatible with all other materials viz Copper, GI etc. Fasteners should be made of Stainless steel



Inspection Chamber :

Should have an inner dimension of 250 mmX 250 mm X 250 mm made of FRP material. Flush Mounted, removable cover of the earth pit should be able to withstand moderate loads. The area inside the inspection chamber should be such that, the UNIVERSAL CLAMP/EBB/Bus bars not too deep inside the inspection chamber or projecting out of inspection chamber. The chamber should have facility for marking earth resistance and latest testing date by paint at the cover and previous recorded values inside the cover.

Earth Enhancement material:

This is a conductive mineral compound to provide low resistance to the earth termination system. Earth enhancing compound should contain minerals which in normal use is reliable and without creating any hazards to persons and the surroundings. The material shall be chemically inert to sub soil and shall not pollute the environment. It shall provide a stable environment in terms of physical and chemical properties and exhibit low resistivity. It shall not be corrosive to the earth electrode itself. The material should have a resistivity less than 50 Ohm meter

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Installation:

Dig a pit of 1m* 1m * 0.5m depth.

At the center of the pit, Earth rod of 1 m has to be hammered electrically or hydraulically.

The number of Earth rods can be added one over the other to get the required length.

Fill the dug up area with Earth enhancing compound mixed with water & soil to get slurry form in such a way that the earth inspection pit is in flush with the earth surface.

Connect the connectors with fasteners & connect the down conductors.

Close the lid of earth inspection pit.

Inspection & maintenance:

Maintenance of the earthing system has to be done at least once in 6 months, preferably before the monsoon period and a record should be maintained to verify earthing system conductors and components, electrical continuity, earth resistance value, re-fastening of components viz-nuts, bolts etc.

1.11 Test

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043.

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

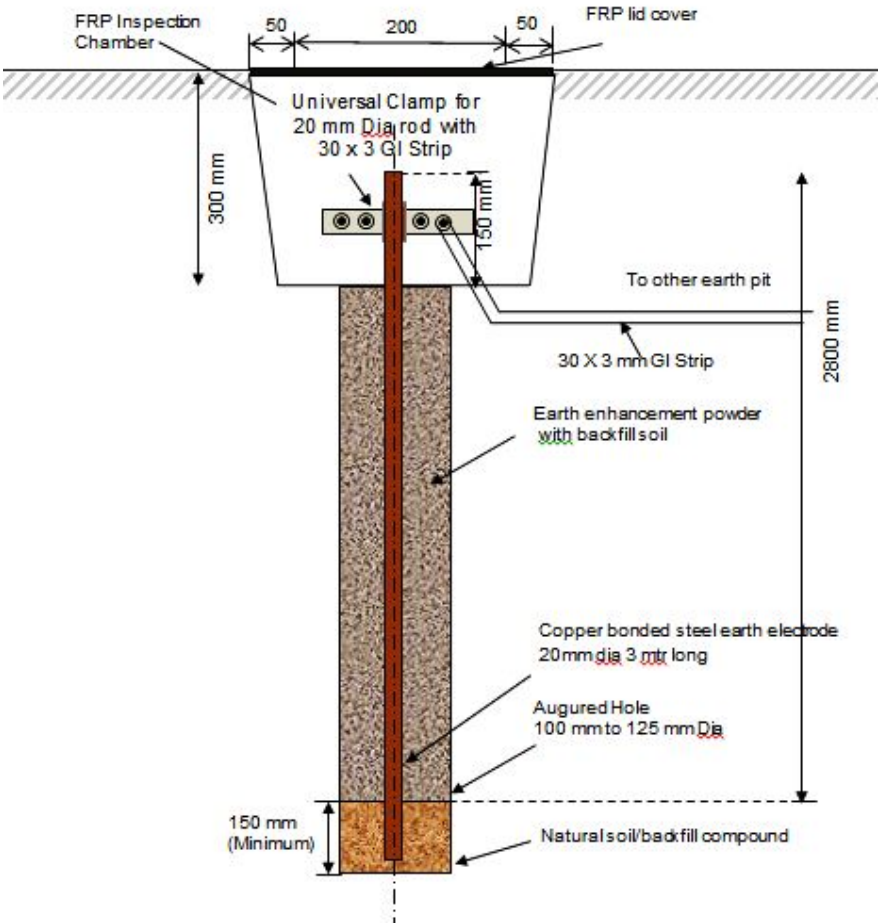
- 1) Each earthing station
- 2) earthing system as a whole
- 3) Earth continuity conductors
- 4) Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

All tests shall be carried out in presence of the client's representative.

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Earthing Auguring Method



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E7. Telephone & Data Distribution

1.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to furnish, and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labour, supervision, tooling, materials, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

1.2 Applicable Documents:

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

- 1) This Technical Specification and Associated Drawings
- 2) ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001
- 3) ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998
- 4) ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
- 5) ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

2.0 Conduits:

Conduits shall be as given below:

Indoor: medium gauge Rigid PVC conduit.

The conduit shall generally be as specified under section 'CONDUIT WIRING'.

3.0 Cables And Wires:

3.1. The type of cables and the services shall be as follows:

- Indoor Multi pair, PVC insulated sheathed armoured and sheathed.
- Inside Twin core PVC insulated with conduit twisted cores.

3.2. All multi core cables and wires shall be of tinned copper conductor of not less than 0.5 mm dia. and shall be colour coded twisted pairs with rip cord.

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- 3.3. The conductor resistance shall be less than 150 ohms per KM and the insulation resistance between the conductor's not less than 50 mega ohms and the nominal capacitance of about 0.1 micro farad per kilometre.
- 3.4. Cables lay underground or locations subject to dampness and flooding shall be filled with polyethylene compound and shall have sufficient protection against moisture and water ingress.
- 3.5. All armouring shall be of galvanized steel wires and protected against corrosion by an outer sheath of PVC in the case of indoor cables and polyethylene in the case of outdoor cables. Outer sheathing must be fire retarding and anti-termite.
- 3.6. All unarmoured single core cables and inner sheath of armored cables shall be provided with rip cord.
- 3.7. All single pair cables for final extension to the telephone outlet box shall be unarmoured tinned copper conductors of not less than 0.6 mm. diameter and shall be drawn in conduits. All telephone outlets shall consist of 2 A 2 pair polythene connector in G.I box with 6 mm perspex cover with bevelled edges and chromium plated brass hardware.

4.0 Tag Blocks

- 4.1. The telephone tag blocks shall be suitable for the multi core telephone cables and shall have two terminal blocks, cross connect type. All incoming and outgoing cables shall be terminated on separate terminal blocks and termination shall be silver soldered. The cross connecting jumpers shall be insulated wires of same diameter and screw connected.
- 4.2. The tag blocks shall be mounted inside fabricated sheet steel boxes with removable hinged covers and shall be fully accessible. The enclosure shall be painted with 2 coats of red oxide and stove enamelled.

5.0 Installation

- 5.1. The installation of conduits shall generally be as specified under section 'CONDUIT WIRING'.
- 5.2. All cables shall be on cable racks and neatly stitched together.
- 5.3. The connection at the tag blocks shall be silver soldered so as to achieve minimum contact resistance.
- 5.4. The final branch connections with single pair cables in conduits and the maximum number of cables in each conduit shall be as follows:

| Conduit diameter | | Max. No. of cables |
|------------------|-----|---------------------|
| inch | mm. | |
| 3/4" | 20 | 2 Nos. single pair |
| 1" | 25 | 6 Nos. single pair |
| 1¼" | 32 | 12 Nos. single pair |
| 1½" | 40 | 18 Nos. single pair |

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6.0 Mode Of Measurement

- 6.1. The main telephone cables shall include supply and laying of multi pair cables on ceiling/wall/on cable trays/racks including all supports and shall be measured and paid on running length basis. Cable trays/racks shall be paid for separately.
- 6.2. The multi pair tag blocks shall consist of two telephone connector's strips, jumpered interconnections silver soldered enclosure etc. and shall be measured and paid as one unit.
- 6.3. The conduit wiring for telephone shall include single pair 0.6 diameter cable in heavy duty rigid, PVC conduits and shall include junction boxes, pull boxes, 2 pair 2 A connector in GI box, Perspex cover etc. and shall from one point.

7.0 Cabling For Tv System

- 7.1. The Co-axial cable shall be of wideband type with operation capability up to 500 MHz
- 7.2. The ageing resistance of the co-axial cable shall comply with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz measured by artificial ageing (14 days at 80 deg. C)
- 7.3. Cables shall meet or exceed the following specifications.

| Construction | | RG-6 MATV Type | RG-11 MATV Type |
|--------------|------------------|--|---|
| a | Centre Conductor | 18 AWG tinned copper | 14 AWG tinned copper |
| b. | Dielectric | Foam Polyethylene Nom. dia. 0.180 | Foam Polyethylene Nom. dia. 0.280 |
| c. | Shield | Foil - 0.003 Al. Tape Braid - 34 AWG 4 end AL. 60% coverage dia. 0.212 | Foil - 0.003 Al. Tape Braid - 34 AWG 6 end AL.60%coverage dia. 0.314. |
| d. | Jacket | Black PVC flame-retardant dia. over jacket 0.272 ± 0.008 Min. spot 0.023 | Black PVC flame retardant dia. overjacket0.405±0.010 Min. spot 0.032. |

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Electrical Properties

| | | | |
|----|----------------------------|--|---|
| a. | Dielectric Strength | Conductor to shield 2000 VDC | Conductor to shield 1500 VDC |
| b. | Capacitance | 16.2 PF / FT, Nom | 16.2 PF / FT. Nom |
| c. | Impedance | 75.0 ± 3.0 ohms | 75.0 ± 3.0 ohms. |
| d. | Attenuation | DB/100 ft. 0.65 DB @ 5 MHZ 0.76 DB @ 10 MHZ 0.96 DB @ 20 MHZ 1.98 DB @ 100 MHZ 4.21 DB @ 450 MHZ 4.80 DB @ 550 MHZ 6.49 DB @ 1000 MHZ | DB/100 ft. 0.35 DB @ 5 MHZ 0.94 DB @ 50 MHZ 1.28 DB @ 100 MHZ 1.78 DB @ 200 MHZ 2.20 DB @ 300 MHZ 2.75 DB @ 450 MHZ 4.30 DB @ 1000 MHZ |
| e. | Velocity of Propagation | 82.0% Nom | 82.0% Nom |
| f. | DCR | 35.47 ohms / 1000 ft. | 14.29 ohms / 10000 ft. |
| g. | SRL | 30 DB (10 MHz to 300 MHz) 20 DB (5 to 450 MHz) | |

7.4. DIRECTIONAL COUPLERS

These shall be of Ultra Wideband type and of hybrid circuit design.

These shall have a near flat frequency response over the entire operating range.

These shall have aluminium cast housing for high frequency radiation resistance.

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Electrical Works – Specifications and List of Make

These shall have 'F' sockets for all input, output and branch ports.

The Tapoffs shall be available in one way, two way and four way configurations.

The splitters shall be available in two way, three way and four way configurations.

The Tapoffs shall be available in different tap values ranging from 11 dB, 15 dB, 20 dB, 25 dB and 30 dB.

These shall meet or exceed the following specifications

| | | Tap off | Splitters |
|----|------------------|----------|---------------|
| a. | Tap Loss | 11-30 dB | -- |
| b. | Through Loss | 0.5-4 dB | 4..0 - 8.0 dB |
| c. | Isolation | > 22 dB | > 22 dB |
| d. | Screening factor | > 50 dB | > 50 db |

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E8. Street Lighting Poles:

The street light poles shall be fabricated from heavy duty cold-rolled steel tubes conforming to IS: 1239 and hot dip galvanized or painted as specified.

The street light pole shall be fabricated as per the details and dimensions shown in the drawing.

The street light poles shall have base plate, a Junction Box, and necessary fixture mounting bracket at top.

The Junction box shall provide easy access to a multiway connector and MCB, to be mounted inside the pole. The access shall be specially fabricated with adequate reinforcement and weather protection gasket to prevent ingress of moisture and vandal proofed.

Poles shall have large diameter entries for incoming and outgoing cables and two earth studs & Spiral earthing.

The poles fabricated shall conform to the drawings and where such drawing is not available, the contractor shall make such drawing and have it approved before fabricated.

The pole shall house a multi way Wohner type terminal block and MCB as shown on the drawings. Poles shall have concrete coping.

1.00 SCOPE:

The scope of this specification covers the manufacture, transport, installation, testing and commissioning of the Raising and Lowering type of High mast Towers, Poles, including the Civil Foundation Works with all items required for the safe and efficient operation and maintenance of the lighting system, including the high mast, whether explicitly stated in the following pages or not, shall be included by the Contractor.

2.00 APPLICABLE STANDARDS:

The following shall be the Reference Standards for the loading of the High mast:

| <u>Code No.</u> | <u>Title</u> |
|-------------------------------|--|
| a). I.S.875 (Part III) 1987. | Code and practice for design loads for Structures. |
| b). BSEN 10025. | Grades of MS. Plates. |
| c). BS.ISO 1461. | Galvanizing. |
| e). TR. No.7 1996 of ILE, UK. | Specification for Mast and foundation. |

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2.1 LIGHTING POLES :

The street light poles shall be fabricated from heavy duty cold-rolled steel tubes conforming to IS:1239 and hot dip galvanized or painted as specified.

The street light pole shall be fabricated as per the details and dimensions shown in the drawing.

The street light poles shall have base plate, a Junction Box, and necessary fixture mounting bracket at top.

The Junction box shall provide easy access to a multiway connector and MCB, to be mounted inside the pole. The access shall be specially fabricated with adequate reinforcement and weather protection gasket to prevent ingress of moisture and vandal proofed.

Poles shall have large diameter entries for incoming and outgoing cables and two earth studs & Spiral earthing.

The poles fabricated shall conform to the drawings and where such drawing is not available, the contractor shall make such drawing and have it approved before fabricated.

The pole shall house a multi way Wohner type terminal block and MCB as shown on the drawings. Poles shall have concrete coping.

2.1.1 CONICAL POLES

Design

The Conical Poles shall be designed to withstand the maximum wind speed as IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3- 1:2000, pr EN-40-3-3.

Pole Shaft

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

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

Door opening

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

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

Material

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Conical Poles shaft : Conforming to grade S355JO.

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

Foundation Bolts : EN 8 Grade

Welding

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

Pole sections

The conical poles shall be in single section up to 12 mtr. There shall not be any circumferential weld joint.

Bracket Arm

The bracket will have a sleeve as cap of suitable diameter fitted with pinching bolts. The length of bracket shall be as per illumination design.

Galvanization

The poles shall be hot dip galvanised as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. **The galvanizing shall be done in single dipping.**

Fixing Type

The conical poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mountings

The galvanized mounting bracket shall be supplied along with the conical poles for installation of the luminaries

Pole Testing Facility

The manufacturing unit shall have in-house pole testing facility for validation of structural design data. The pole testing facility shall conform to BS EN 40-3-2-2000 part 3-2.

2.1.2 Octagonal Poles

Design

The Octagonal Poles shall be designed to withstand the maximum wind speed of 160 km / hr. The top loading i.e. the weight and the area of top luminaries are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.

Pole Shaft

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

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

Door opening

The octagonal Poles shall have door of minimum size of 250 mm X 65 mm at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be dust proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

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

Material

Octagonal Poles : Conforming to St 35 grade.

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

Foundation Bolts : 6.8 Gr. As per IS 1367

Welding

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

Pole sections

The Octagonal Poles up to the length of 11.5 meters **shall be in single piece with single longitudinal welding joint**. There shall not be any circumferential weld joint. However, the pole with length of 12 meters and above shall be of 2 sections with telescopic fitment with minimum overlap of 1.5 times the diameter.

Galvanization

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 65 micron. **The galvanizing shall be done in single dipping.**

Fixing Type

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mountings

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The galvanized double / single arm shall be supplied along with the Octagonal Poles for installation of the luminaries.

2.1.3 Polysteel Lamp Post

The lamp post shall suitable for use in outdoor applications such as street lighting and parking areas. The material shall be UV Stabilized, class one fire retarded polyester composite, with glass fiber reinforcement, for outer covering, over a hot dipped galvanized steel framing. Overall acceptable tolerances in thickness shall not exceed $\pm 10\%$ for GRP / FRP. The pole shall be lighter in weight as compared to an equivalent cast iron pole. Each pole shall have self coloured textured surface finish with scratch resistant aliphatic grade of UV stabilized poly urethane paint. The pole shall be supplied with a suitable base plate for mounting over a foundation of suitable design and size. Each pole shall be individually hand crafted and shall be supplied complete with necessary hardware made of stainless steel. Suitable Size Anchor fasteners shall be provided along with the pole for mounting the pole on RCC foundation of desired size.

The brackets shall also be made up of materials similar to pole and shall be suitable to mount luminaires in single arm/Double arrangement, approx. 450mm.

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E9. Medium Voltage Panel Board / Mv Switch Gear

1.1 Scope

This scope shall cover design, manufacture, check test, and supply, installation, testing (Scope to assist the Ele. Contractor for installation, all the sections of panels & Internal Control wiring should be done by panel vendor on site), testing and commissioning of various medium voltage Panel Board as described in Bills of quantities and drawings. The Panel manufacturer should have a design validated by CPRI / ERDA for breaking capacity of at least 100 KA for 1 Sec.

Medium voltage Panel Board will be installed indoor and is connected through the cables.

1.2 Service Conditions At Site

| | | |
|---------------------|---|--|
| Ambient Temperature | : | Max. / Min. = 45° C. / 6° C. |
| Design temperature | : | 50 Degree C. |
| Relative humidity | : | 95% max. |
| Voltage | : | 415+/- 10%, TPN |
| Frequency | : | 50 Hz. + 3% to -6% |
| Neutral | : | Solidly / earthed neutral. |
| Fault level | : | 15KA, Symmetrical at 415V solidly earthed. |

1.3 Documentation

1.3.1. Vendor shall furnish drawings

- General arrangement drawing indicating accessories and dimensions.
- Foundation plan and loading.
- Termination arrangement with dimensions.
- Three phase wiring diagrams
- SLD's and control schemes
- Terminal plans
- Bill of quantity for each panel.

1.3.2. Documents to be submitted after placement of order, before starting of the Fabrication of the Panels

- As per above for comments and approval for manufacture.

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- Schematic and sectional drawing.

1.3.3. Final documents - data and manuals in six sets along with equipment supplied.

- As built drawings with RTP (Reproducible Tracing Paper).
- Instruction and maintenance manual - Six copies.
- Test certificates - Six copies.

1.4 General Specifications

All the Panels shall be metal clad, totally enclosed, rigid, floor / wall mounting, air insulated, cubicle type suitable for operation on three phase / single phase, 415 V / 230 V / 240 V, 50 Hz., neutral effectively grounded at transformer and short circuit level as mentioned in the drawings.

Degree of protection for following type of distribution panel enclosure shall be as per IS: 13947-1993.

- a. IP 52 for indoor panels.
- b. IP 54 for kitchen and laundry panels.
- c. IP 55 for outdoor panels.

The painting of all the metal part shall be with seven tank process followed by powder coating as per the standard.

The Panels shall be designed to withstand the heaviest condition at site, with maximum expected ambient temperature of 50° c., 95% humidity.

1.5 Standards And Codes:

The Panels shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian standards shall be complied with:

| Standard no. | Particular |
|--------------|--|
| IS : 4237 | General requirements for switchgear and control gear for voltages not exceeding 1000 V A.C. or 1200 V D.C. |
| IS : 5578 | Guide for marking of insulated conductors. |
| IS : 11353 | Guide for uniform system of marking and identification of conductors and apparatus Terminals. |
| IS : 13947 | Low voltage switchgear and control gear. |
| IS : 8197 | Terminal marking for electrical measuring instrument and their accessories. |
| IS : 2551 | Danger notice plates |
| IS : 10118 | Code of Practice for selection, installation and maintenance of |

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| Standard no. | Particular |
|--------------|---|
| | switchgear and control gear. |
| IS : 8623 | Specification for factory built assemblies of switchgear and control gear for voltage up to and including 1000 V A.C. and 1200 V D.C. |
| IS : 8828 | Miniature circuit breakers. |
| IS : 9224 | HRC fuse links |
| IS : 2705 | Current transformer |
| IS : 3156 | Voltage transformer |
| IS : 3231 | Electrical relay for protection |
| IS : 1248 | Indicating instrument |
| IS : 722 | Integrating instrument |
| IS : 6875 | Control switches and push buttons |
| IS : 1822 | A.C. motor starters of voltage not exceeding 1000 V |

Indian Electricity Act and Rules (as amended up to date) and approval of FIA of India.

The Panels also require approval of the consultant at various stage of their manufacture such as design, selection, construction, testing, shipping etc.

1.6 Construction

1.6.1 Cubical Type Panels

A. Structure

The Panels shall be of compartmentalized design so that circuit arc / flash products do not create secondary faults and be fabricated out of high quality CRCA sheet, suitable for indoor installation having dead front operated and floor / wall mounting type. The type of construction shall be 4b.

All CRCA sheet steel used in the construction of Panels shall be 2 mm. thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

The Panels shall be totally enclosed, completely dust and vermin proof and degree of protection being not less than IP: 51 to IS: 2147. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed with foam rubber and /or rubber strips and shall be lockable.

All panels and covers shall be properly fitted and screwed with the frame and holds in the panel correctly positioned. Fixing screws shall enter into holes, taped into an adequate thickness of metal or provided with bolts and nuts. Self threading screws shall not be used in the construction of Panels.

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A base channel of 75 mm. x 40 mm. x 6 mm. thick shall be provided at the bottom. A clearance of 300 mm. between the floor of the Panels and the bottom of the lower most units shall be provided.

Panels shall be preferably arranged in multi-tier formation. The Panels shall be of adequate size with a provision of 20% spare space to accommodate possible future additional switchgear. The size of the Panels shall be designed in such a way that the internal space is sufficient for hot air movement and the electrical component does not attain temperature more than 50°C. If necessary, openings shall be provided for natural ventilation, but the said openings shall be screened with fine weld mesh. The entire electrical component shall be derated for 50°C.

Knock out holes of appropriate size and number shall be provided in the Panels in conformity with the number, and the size of incoming and outgoing conduits / cables.

Alternately, the Panels shall be provided with removable sheet steel plates at top and bottom to drill holes for cable / conduit entry at site.

The Panels shall be designed to facilitate easy inspection, maintenance and repair.

The Panels shall be sufficiently rigid to support the equipment without distortion under normal and under short circuit condition. They shall be suitably braced for short circuit duty.

A1. Structure & Construction for IP 65 Panel / Feeder Pillar

Feeder Panels shall be lockable IP65 & 3 mm thick sheet steel with FRP / GRP Lining cabinet for Outdoor installation, dead front, floor mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 3 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channels of 75 mm x 40 mm x 5 mm thick & Suitable Size Stand with the 3 mm Sheet Cover the bottom for floor mounted panels. Minimum clearance of 450 mm shall be provided between the floor of Distribution panels and the lowest unit.

The Internal electrical switchboard (panel) shall be made up of high quality polycarbonate thermoplastic, shock proof, anti-corrosive, acid & chemical resistant, fire retardant, self extinguishing, highly impact resistant, halogen free, silicon free, recyclable, having internally embedded gasket. The switchboard (panel) shall have provision for future expansion & shall be modular in construction. The bus bars shall be connected with C type clamps without any drilling on the bus bars. The panel shall be in accordance with IEC 60 439 – 1 (Fully TTA). The Degree of Ingress Protection shall be in accordance with IEC 60 529. Panel Enclosure (Internal) has to be thermoplastic polycarbonate or of the material which has equivalent or exceeds the inherent features of thermoplastic polycarbonate. Said enclosures, in addition to containing the devices and components that constitute the electrical panel, must have certain properties and characteristics that are specific for their practical use; for e.g. they must provide a suitable degree of electrical insulation, have sufficient structural strength, be easy to handle, ensure adequate resistance to

the aggression of chemical and atmospheric agents, be self extinguishing, etc. It should be clean and aesthetically appreciable.

Internal panel should be totally insulated FEEDER PILLAR PANEL made out of Modular Panel Box System, Degree of Protection IP 65, in accordance with IEC 60 529, type tested in accordance with IEC 60 439 – 1.

The manufacturer of board/panel shall submit a copy of CPRI test report of Degree of Ingress Protection IP 65 in accordance with IEC 60529. The gasket material shall be Polyurethane; while the gasket shall be internally embedded.

The manufacturer of board / panel shall submit a copy of type test report of a board made out of Polycarbonate thermoplastic panel in accordance with IEC 60439-1. The report shall have mention of following tests performed and passed out satisfactorily:

1. Temperature Rise.
2. Dielectric Properties.
3. Short circuit withstand current – Rated peak & short time withstand current and Rated Conditional Short Circuit Current.
4. Effectiveness of Protective Circuits.
5. Clearance & Creep age Distance.
6. Mechanical Operation

For better safety the Polycarbonate encl shall be fire retardant & self extinguishing in accordance with IEC 60 695-2-11, DIN VDE 0304 Part 3, UL Subject 94 for Flammability V-2. It should be tested at Glow Wire test for 960 deg. Cent.

The impact strength of polycarbonate enclosures / boards i.e. the Degree of Protection against Mechanical load shall be in accordance with EN 50298-98 for IK 08.

The lid closing and opening shall be done by quick fastening spring mechanism latches.

Compactness of the boards is main criteria due to space constraints. The board / panel should be made compact meeting the technical requirements in accordance with relevant standards and also keeping adequate space for technicians to work. The MCB/ RCCB switching operations / accessing the MCB dolly should be preferably by opening of a window flap. Window flap must be integral part of body of the box. Window flap Additional screwing by cutting the front of the box for MCB or any accessories will not be acceptable.

Note: The board manufacturer must submit the copy of type test reports for Polycarbonate Thermoplastic Board only with final arrangements as per approved GA. Test Reports submitted of other material of construction like MS, SS will not be applicable. Each Board shall have individual routine test report of the manufacturer.

Internal Insulated enclosures of protection class II shall be made out of environment friendly, recyclable polycarbonate thermoplastic, UV Resistant, halogen & silicon free, highly impact resistant, Anti Acid, Anti corrosive : Resistant against demands caused by rains, water and corrosive atmosphere, Degree of Protection against mechanical load IK 08 in acc. with DIN EN 50 102, Color Gray RAL 7032, fire retardant, Glow Wire Tested at 960 deg. cent in acc. with IEC 60 695–2-1, DIN VDE 0304 Part 3. UL Subject 94, V – 2, Flame Retardant, Self Extinguishing, with transparent / opaque lids having tool operated / sealable / hand operated / lockable quick fastening mechanism. Modular panel box doors especially for circuit breakers should be the integral part of the top cover, Additional flap mounted on the box shall not be allowed.

Incoming & Outgoing Cable from all the directions....

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Mounting Type: Free Standing Type with Canopy of 3 mm thick CRCA Sheet.

Protection Measure: Totally Insulated

Degree of Protection: IP 65 in acc. with IEC 60 529

Rated Voltage: 690 / 1100 V

Bus Bar System: electrolytic grade square type copper bus bars as per description with insulated supports.

Interconnection between solid bus bars and equipment shall be connected by means of bus bar connectors to avoid tapings on solid bus bars...

Temperature Resistance: - 40 deg. cent to + 120 deg. cent.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Switches shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable / conduit connections. Removable sheet steel plates shall be provided at the Bottom to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

| Sr. No. | Criteria / Parameter | Required specification | Vendor specification |
|----------------|---|--|-----------------------------|
| 1. | Material of Construction of Main Feeder Pillar Panel | Polycarbonate | |
| 2. | Degree of Ingress Protection | IP 65 in accordance with IEC 60 529 | |
| 3. | Gasket Material of enclosure | Polyurethane | |
| 4. | Test Report The Polycarbonate Panel manufacturer shall submit the test report | <p>The Polycarbonate Panel manufacturer shall submit the test report for following type tests.</p> <ol style="list-style-type: none">1. Temperature Rise.2. Dielectric Properties.3. Short circuit withstand current – Rated peak & short time withstand current and Rated Conditional Short Circuit Current.4. Effectiveness of Protective Circuits.5. Clearance & Creepage Distance. | |

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| | | 6. Mechanical Operation | |
|----|--|---|--|
| 5. | Fire Retardant & Self-Extinguishing Test | The PC Enclosures shall be tested for Glow Wire Test at 960 deg. cent. in accordance IOEC 60 695 – 2 – 11 | |
| 6. | Impact Test | The PC Enclosure shall be rated for IK 08 for mechanical impact test in accordance with EN 50298-98 | |

B. Protection Class

All the indoor Panels shall have protection class of IP : 51

All the outdoor Panels shall have protection class of IP : 65

C. Painting

The painting shall be seven tank process followed by powder coating for Indoor panels.

For out door panels / Feeder Pillar panels : Enclouser should be provided with FRP / GRP Lining. (lining should be applied after the passivation process.)

D. Circuit Compartments

Each circuit breaker and switch fuse unit shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in 'ON' and 'OFF' position.

The door shall not form an integral part of draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

E. Instrument Compartments

Separate adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors / relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the switchgear / control gear, busbar and connections.

F. Busbars

The busbar shall be air insulated and made of high quality, high conductivity, and high strength Aluminium / Copper.

The busbar shall be of 3 phases and neutral system with separate neutral and earth bar. The size of neutral busbar in all main panels or lighting panels and feeders for LDB shall be equal to phase busbar. The busbar and interconnection between busbars and various components shall be of high conductivity Aluminium / Copper. The busbar shall be of rectangular cross-section designed to withstand full load current for phase busbars and half rated current for neutral busbars in case of APFCR panels only and shall be extensible on either side. The busbar size shall be as per drawing. The busbar shall have uniform cross-section throughout the length.

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The busbars and interconnections shall be insulated with epoxy coated bus sleeves. The busbar shall be supported on bus insulators of SMC/DMC type at sufficiently close intervals to prevent busbars sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 15 KA RMS symmetrical for 1 sec.

The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm. thick Bakelite sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearance between the busbar is maintained as below:

| | | |
|----------------------------|---|----------------|
| Between phases | : | 27 mm. minimum |
| Between phases and neutral | : | 27 mm. |
| Between phases and earth | : | 27 mm. |
| Between neutral and earth | : | 20 mm. minimum |

All busbar connections shall be done by drilling holes in busbars and connecting by chromium plated or tinned plated brass bolts and nuts. Additional cross-section of busbar shall be provided in all Panels to cover up the holes drilled in the busbar. Spring and flat washers shall be used for tightening the bolts.

All connections between busbars and circuit breakers / switches and cable terminals shall be through aluminium / Copper strips of proper size to carry full rated current. These strips shall be insulated with insulating tapes.

Panel to panel entry of bus bar shall be effectively sealed by electrical and thermal insulation barriers so that products of flashover do not travel from one panel to another panel creating multiple faults.

Busbar shall be calculated on 50 deg. C. ambient temp. and 85 deg. C. for continuous and short time rating. Busbar surrounding air temp. shall be considered 70 deg. C. for busbar calculation

All joint shall have non-flammable insulation shrouds for secondary insulation purpose

G. Electrical Power And Control Wiring Connection:

Terminal for both incoming and outgoing cable connections shall be suitable for 1100 V grade, aluminium / copper conductor PVC insulated and PVC sheathed, armoured cable and shall be suitable for connections of solderless sockets for the cable size as indicated on the appended drawings for the Panels.

Power connections for incoming feeders of the main Panels shall be suitable for 1100 V grade aluminium conductor (PVC) cables.

Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance.

Both control and power terminals shall be properly shrouded.

Clip on type terminals shall be provided up to 10 sq.mm conductor and above 10 sq.mm bolt type terminals shall be used.

10% spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block, so that not more than one outgoing wire is connected per terminal.

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Terminal strips for power and control shall preferably be separated from each other by suitable barriers of enclosures.

Wiring inside the modules for power, control, protection and instruments etc. shall be done with use of 660 / 1100 V grade; PVC insulated copper conductor wires conforming to IS: 694 & 8130 Power wiring inside the starter module shall be rated for full current rating of respective contactor, but not less than 4.0 sq.mm. cross-section area. For current transformer circuits, 2.5 sq.mm. copper conductor wire shall be used. Other control wiring shall be done with 1.5 sq.mm. copper conductor wires. Wires for connections to the door shall be flexible. All conductors shall be crimped with solderless sockets at the ends before connections are made to the terminals.

Control power supply to modules through the control transformer only. Control power wiring shall have MCB for circuit protection. All indicating lamps shall be protected by MCB.

Particular care shall be taken to ensure that the layout of wiring is neat and orderly. Identification ferrules shall be fitted to all the wire termination for ease of identification and to facilitate checking and testing.

Spring type washers shall be used for all copper and aluminium connections.

Final wiring diagram of the Panels power and control circuit with ferrules numbers shall be submitted along with the Panels as one of the documents against the contract.

H. Terminals

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers for instruments metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming or outgoing cables to internal components of the distribution board is permitted and only one conductor may be connected in one terminal.

I. Wireways

A horizontal / vertical metal / Al. wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

J. Cable Compartments

Cable compartments of minimum **300 mm** size shall be provided in the Panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate supports shall be provided in the cable compartments to support cables. All outgoing and incoming feeder terminals shall be brought out to terminal blocks in the cable compartment.

K. Earthing

Copper earth bars of 25 mm × 6 mm shall be provided in the Panels for the entire length of the panel. The frame work of the Panels shall be connected to this earth bar. Provisions shall be made for connection from this earth bar to the main earthing bar coming from the earth pit on both sides of the Panels.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp, and the clamp shall be made for connection from this earth pit on both sides of the Panels.

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The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp, and the clamp shall be ultimately bonded with the earth bar.

L. Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

M. Name Plate

A name plate with the Panel's designation in bold letters shall be fixed at top of the central panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartments, the electrical components, equipments, accessories like switchgear, control gear, lamps, relays etc. shall suitably be identified by providing stickers.

Name plate shall be engraved in Gujarati language be of 3 ply, (Red-White-Red or Black-White-Black) lamicold sheet. However, black engraved perpex sheet name plates shall also be acceptable. Engraving shall be done with square groove cutters.

Name plate shall be fastened by counter send screws and not by adhesives.

N. Danger Notice Plates

The danger notice plate shall be affixed in a permanent manner on operating side of the Panels.

The danger notice plate shall indicate danger notice both in Hindi and English and with a sign of skull and bones.

The danger notice plate, in general, meets the requirements of local inspecting authorities.

Overall dimensions of the danger notice plate shall be 200 mm. wide x 150 mm. high.

The danger notice plate shall be made from minimum 1.6 mm. thick mild steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

The letters, the figures, the conventional skull and bones etc. shall be positioned on plate as per recommendation of IS: 2551-1982.

The said letters, the figures and the sign of skull and bones shall be painted in signal red colour as per IS: 5-1978.

The danger plate shall have rounded corners. Location of fixing holes for the plate shall be decided to suit design of the Panels.

The danger notice plate, if possible, is of ISI certification mark.

O. Internal Components:

The Panels shall be equipped complete with all types of required number of MCCB's, contactors, relays, fuses, meters, instruments, indicating lamps, push buttons, fittings, busbars, cable connectors etc. and all

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the necessary internal connections / wiring as required and as indicated on relevant drawings. Components necessary for the proper and complete functioning of the Panels but not indicated on the drawings shall be supplied and installed on the Panels.

All parts of the Panels carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at the part of the Panels.

All units of the same rating and specifications shall be fully interchangeable.

1.7 Components

1.7.1 General

The type, size and rating of the components shall be as indicated on the relevant drawings.

While selection of the capacity of the components resulting from the prevailing conditions like ambient temperature shall be allowed for the thermal and magnetic trip rating shall be compensated for the ambient temperature.

The rating indicated on the drawing is ratings anticipated at prevailing site conditions.

1.7.2 Air Circuit Breaker

A. Construction

The ACBs shall have following features:

- Motorized with 230 V A.C. motor.
- 230 V A.C closing and shunt trip coil
- Drawout type with "service", "test", "isolated" and "maintenance" position.
- Safety shutter of Fibre glass / polycarbonate sheet of 2mm thickness shall be provided
- Mechanically trip free plus antipumping feature is to be provided.
- Electrical trip free plus anti pumping shall be provided with relay ONLY and not by contactors.
- Electrical/Mechanical operation counter shall be provided.
- Door interlock with defeat features to be provided.
- ACB shall be lockable in isolation position.

B. Release

- Microprocessor based release shall be direct acting type, tripping ACB mechanically.
- Short circuit, overload and earth fault protection shall be provided.
- Vendor to suggest release type for feeders of supply range characteristic and accuracy.

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C. Acb Performance

- ACB performance inside panels at ambient 50 Degree.
- The Symmetrical breaking, 50KA
- Making capacity peak 87.5 KA
- Short time rating , 1sec. 50KA

D. Incomer Acbs

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent, (DG set only)
- Reverse power (DG set only)
- Phase sequence reversal (DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered .
- Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF

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- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion

E. O/G Acbs

All **O/G** ACBs shall have following functions.

Protection

- The ACB control unit shall offer the following protection functions as standard:
- Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay;
- Instantaneous (INST) protection with an adjustable pick-up and an OFF
- Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively
- On a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- A LED bargraph shall simultaneously display the load level on the three phases.
- A maxi meter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

Safety Features

- i. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- ii. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- iii. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

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- iv. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- v. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- vi. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.
- vii. The insulation material used shall conform to Glow wire test as per IEC60695.
- viii. The ACB shall provide in built electrical and mechanical anti-pumping.
- ix. All EDO ACB's Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

1.7.3 Moulded Case Circuit Breaker

The moulded case circuit breaker (MCCB) shall be air break type and having quick make - quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

Operating handle of the MCCB shall be in front and clearly indicate ON/OFF/TRIP positions.

The electrical contacts of the circuit breaker shall be of high conducting non deteriorating silver alloy contacts.

The MCCB shall be provided with thermal / magnetic type bi-metal overload release and electromagnetic short circuit protection device. All the releases shall operate on common trip busbar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB wherever called for in the appended drawings shall provide an earth fault relay.

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date.

The electrical parameters of the MCCB shall be as per the description given in the appended drawings.

Draw out type MCCB shall be provided for the feeder indicated in the single line diagram. The MCCB shall be provided with 230 V A.C motor for closing and tripping / switching off for the feeders if indicated in single line diagram.

MCCB should be with following:

- i. Free Alarming for O/L, Healthiness check of the Breaker, Fault Differentiation on front of the MCB from Display / LED.
- ii. All MCCB should be Communicable & have all kind of communication accessories with in built metering should support open / Modbus protocol.
- iii. MCCB should provide switch board display unit for panel cutout.

1.7.4 Fuse

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with IS: 2000-1962 and having high rupturing capacity of not less than 15KA at 415 V. The back-up fuse rating for each motor / equipment shall be so chosen that the fuse does not operate on starting of motors / equipment. HRC fuses shall be of the make as specified in Make of Material.

1.7.5 Miniature Circuit Breakers

Miniature Circuit breakers shall be current limiting type conformed with British standard BS: 3871 (Part I) 1965 and IS: 8828. The housing of MCBs shall be heat resistant and having high impact strength. The fault current of MCBs shall not be less than 10KA at 230 V. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical 'ON' and 'OFF' indications.

The circuit breaker dollies shall be of the trip free pattern to prevent closing the breaker on a faulty circuit.

The MCB contacts shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCBs shall be provided with magnetic fluid plunger release for over current and short circuit protection. The overload or short circuit device shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCBs shall be tested and certified as per Indian Standards, prior to installation.

1.7.6 Contactors

The contactors shall meet with the requirements of IS: 13947 and BS: 771.

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC3 and shall be suitable for minimum Class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

1.7.7 Voltmeter

Voltmeter shall be digital. The dial of the meter shall be square in shape of 96 x 96 mm.

The voltmeter selector switch shall be arranged to provide line to line voltage reading and line neutral voltage.

1.7.8 Ammeter

Ammeter shall be digital. The dial of the ammeter shall be square in 96 x 96 mm. Separate current transformer shall be provided for all ammeters.

1.7.9 Current Transformer

Where ammeters are called for C.T.s shall be provided for current measuring. Each phase shall be provided with separate current transformer of accuracy Class I and suitable VA burden for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 - 1992 as amended up to date.

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1.7.10 Push Buttons

The push button unit shall comprise of the contact element, a fixing holder, and a push button actuator. The push button shall be momentary contact type. The contacts shall be of silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall of standard type and colour as per its usage for ON, OFF and TRIP. Wiring for Remote ON, OFF push button is to be required.

1.7.11 Indicating Lamps

Indicating lamps assembly shall be screw type with built in resistor having non fading color lens. **LED** type lamps are required. Wiring for Remote ON, OFF, TRIP indicating lamp is required.

Colour shade for the indicating lamps shall be as below:

| | | |
|---------------------------|---|-----------------------|
| ON indicating lamp | : | Red |
| OFF indicating lamp | : | Green |
| TRIP indicating lamp | : | Amber |
| PHASE indicating lamp | : | Red, Yellow, and Blue |
| TRIP circuit healthy lamp | : | Milky |

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B. Power Factor Correction System With Detuned Filter

1.1 Scope

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below:

1.2 Standard

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

1.3 Rating

50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

1.4 Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

1.5 Apfc Relay / Controller

Microprocessor based IPFC relay (Intelligent VAr controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features:

- Digital settings from all the 3 phases for parameters like PF, Switching time delay, Step limit etc.
- Indication of PF, preset parameters.
- Minimum threshold setting of 1% of CT current.
- No-volt release.
- Protective shut down in case of harmonic overload.

- Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

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1.6 Construction

Each basic unit of mixed dielectric extra low loss / All Poly Propylene (APP) / GAS Filled capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyester paint coated finish. Each standard unit shall be provided with internal fuses (operation co-ordinate with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of up to 5% on voltage and current waveforms shall not affect the life of capacitors. $660 \pm 10\%$ variation in line voltage shall not affect the life of the capacitors.

1.7 Capacitors

- General specifications: 3 phase, delta connected, 50 Hz.
- Voltage: Must be designed to withstand system over voltage, increased voltage due to series reactor and harmonics.
- Capacitor type: Super heavy duty with double side metalized capacitor tissue paper. Gas Filled and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnecter in each individual capacitor cell.
- Over voltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
- Over current : $2.5 \times I_n$
- Peak Inrush current withstand : $350 \times I_n$
- Total watt-losses including discharge resistors: $\leq 0.45 \text{ W / k V Ar}$.
- Temperature category: -25 deg. C to 70 deg. C.
- Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.
- The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

1.8 Discharge Resistance

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

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1.9 Terminals

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.

1.10 Earthing

Two separate earthing terminals shall be provided for earth connection of each bank.

1.11 Low Voltage Filter Reactor

Filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 76. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature class H operation. The reactor coils shall be wound with high grade aluminum / copper and termination shall be provided with suitably designed copper bars.

1.12 Testing

The reactor shall be tested using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

1.13 Series Reactor

Application

LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks.

Construction, Testing & Protection

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC 60076/3.

The permitted tolerance of inductance shall be + 3% of rated inductance value.

Reactor tuning factor shall be **13%** and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows $1.2 \bullet \sum I_n$ with $L = 0.95 L_N$

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

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1.14 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating. Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

1.15 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia., mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

1.16 Testing

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

1.17 Installation

Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

All interconnections in the control panel shall be checked before commissioning.

Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

15 mm thick rubber matting of an approved make over a 100 mm high Timber platform shall be provided in front of the full length of the capacitor bank and control panel.

1.18 Testing And Commissioning

- i. Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.

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- ii. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.
- iii. Each discharge resistor shall be tested for its working.

C Lightning And Surge Voltage Protection

1.1 Scope

The work required under this section shall include all material, labour and auxiliaries required to furnish and install complete Surge Protection Devices at main LT Panel incoming feeders (Stage I / Class B) & Distribution Boards (Stage II / Class C) for the protection of Building electrical and Electronics system from the effect of Lightning discharges, line induced transient surge voltage or switching surges as per the details.

1.2 Codes & Standards

The following standards & publications as referred in the various parts of this Specification shall apply.

- IEC-61643-11, IEC-61643-12
- IEC 60 364 – 5 – 53
- IEC 62 305 - 4

1.3 Product Specifications

1.3.1 Surge Protector At Stage I / Class B (L T Panel Protector)

The Surge Protection Device (SPD) manufacturer shall offer a complete line of Surge Protection Devices to support the requirements for Main LT Panel Incoming feeders. The surge protector at this stage shall be provided to protect the downstream electrical and electronics against any lightning discharges surges that may enter into the system through Mains panel.

The Protection unit shall be based on single arc spark gap technology and shall be able to withstand 10/350 microsecond surge currents associated with external lightning discharges.

1.3.2 Protection Network Configuration

The work required under this section consists of furnishing, installing and connecting SPD device as specified and as asked for in BOQ. The SPD device shall be installed in a NETWORK configuration, consisting of one set of SPD panel device at the service entrance of switchboard. All SPD devices in this network configuration shall be of same manufacturer. All SPD devices shall be modular, mountable on 35 mm DIN rail.

Unit status indicator shall be provided to indicate the status of complete Protection unit.

Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.

Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 V.

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The Protection shall be provided with safety MCB's to be connected in series between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.

Protection shall be a fail-safe type device, shall have a follow through current quenching capacity up to 25 KA r.m.s., shall have repeated surge capability state, shall be self restoring and be fully automatic in all mode of operation.

Protection shall comply with IEC 61643 and shall be approved for the location in which they are listed.

Protection shall have an operating temperature ranges from -20°C to 60°C.

1.3.3 Protection Criteria

- The maximum continuous operating voltage (Rated Voltage) for SPD devices connected to phase-neutral shall not be less than the values shown in table:

| Nominal Voltage Rating per phase | Maximum Continuous Operating Voltage |
|----------------------------------|--------------------------------------|
| (Vrms) | (Vrms) |
| 240 | 320 |

- Listing
- The surge protective device and associated hardware must comply with IEC 61643-11.
- The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

| Service Voltage / per phase | Protection Voltage @ In (Nominal discharge current) / Protection Level |
|-----------------------------|--|
| 240 V | < 2.5 k V (between Line to Neutral) 1.5 kV (between Neutral to Earth) |

- Surge protective device application at Low Voltage AC main LT Panel incoming feeder surge impulse current withstanding capacity as shown in table below.

| Application Panel Location | Max. Single Withstand Surge Current (of 10/350 μ s Impulse) |
|----------------------------------|--|
| Service Entrance (Main LT Panel) | 25 KA, 10/350 μ s (between Line to Neutral) 100 KA, 10/350 (between neutral to Earth) |

- Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.
- Response time of stage-I class –B arrester should not be < 100 ns.

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1.3.4 Surge Protector At Stage II / Class C (Final Distribution Board Protector)

- The surge Protection manufacturer shall offer a complete line of surge Protection product to support the requirements for the Distribution Board. The surge protector at this stage shall be provided to protect the downstream electrical and electronics against any induced switching surges that may be passed on to the downstream electrical & electronic system.
- The Protection unit shall be based on Single High Capacity Metal Oxide Varistors (MOV), capable of handling 8/20 μ s surges and shall be able to give an indication in the event module failure and be pluggable to facilitate the in-service replacement without distributing the lines. One extra set of replacement module shall be furnished to the job site.
- Protection Network Configuration - The work required under this section consists of furnishing, installing and connecting SPD device as specified and as shown in the drawings. The SPD device shall be installed in a NETWORK configuration, consist of one set of SPD panel device at the service entrance of switchboard. All SPD devices in this network configuration shall be of same manufacturer. All SPD devices shall be modular, mountable on 35 mm DIN rail and be field replaceable without interruption of electrical distribution circuit.
- Unit status indicator shall be provided to indicate the status of complete Protection unit on the product as well as provision for remote indication must be provided.
- Protection shall be manufactured for the specific type and voltage of the electrical Service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.
- Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS Line voltage of 240 VAC.
- The Protection shall be provided with internal safety fusing if required, to be connected in parallel between Line/s to neutral & neutral to earth as per the TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.
- Protection shall be a fail-safe type device, shall have no follow through current shall have repeated surge capability, shall be solid state, shall be self restoring and be fully automatic in all mode of operation. It shall have thermal disconnection and indication against overloading of the device.

Protection shall comply with IEC 61643 standards.

Protection shall have an operating temperature ranges from -20°C to + 60°C.

Protection Criteria

The maximum continuous operating voltage (Rated voltage) for SPD devices connected to phase-neutral shall not be less than the values as shown in table below:

| Nominal Voltage Rating per phase | Maximum Continuous Operating Voltage |
|----------------------------------|--------------------------------------|
| (Vrms) | (Vrms) |
| 120 | 150 |

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Electrical Works – Specifications and List of Make

| | |
|-----|-----|
| 240 | 320 |
| 350 | 440 |
| 480 | 600 |

Listing

The surge protective device and associated hardware must comply with IEC 61643-11.

The Protection voltage of the complete rail mount surge protective device shall be type test to the figures as indicated in table below, which must not exceed the values shown.

| Service Voltage / per phase | Protection Voltage @ In (Nominal discharge current) / Protection Level |
|-----------------------------|--|
| 240 V | 1500 V |

Nominal Withstand Surge Current.

Surge Protective device (including all fusing and over current protection) for application at sub-Distribution Panels shall have a Nominal surge current withstand capacity as shown in table below. The failure or operation of any fuse / over – current device during the test is not permissible.

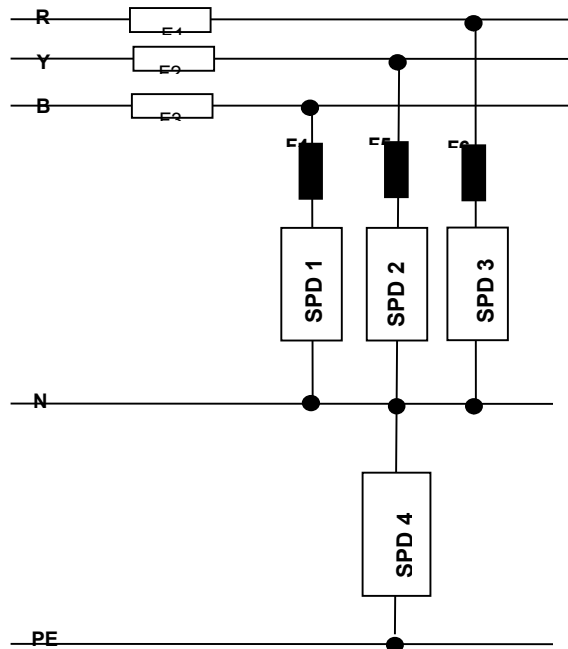
| Application Panel Location | Max. Single Withstand Surge Current Of 8/20 μ s Impulse) |
|----------------------------|---|
| Sub-Distribution Panel | 10KA for 8 / 20 μ s (between Line to Neutral) |
| Final Distribution Board | 25 KA for 10/350 μ s (between Neutral to Earth) |

Compliance to this specification must be provided in the form of a certificate from an independent testing laboratory.

Response time of Class C arrestor should not be <25 ns.

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Connection diagram for SPD for 3 phase 4 wire network



F1, F2, F3 -: Incoming ACB/MCCB/SFU

F4, F5, F6 -: Back up fuse / MPCB / MCB for Surge Arrester

R, Y, B and N -: RYB and N Bus bar or looping after the incomer

PE -: Earth Bus bar in the panel

SPD1, 2, 3 -: Surge Arrester to connect between Line and Neutral

SPD 4 -: SPD to connect between Neutral and Earth.

1.8 Shop Drawings

Prior to fabrication of the Panels the supplier / contractor shall submit for consultant's approval the shop / vendor drawing consisting of G.A. drawing, sectional elevation, single line diagram, bill of material etc. and design calculations indicating type, size, short circuiting rating of all the electrical components used, busbar size, internal wiring size, Panels dimension, colour, mounting details etc. in 6 sets.. The contractor shall also submit manufacturer's catalogues of the electrical components installed in the Panels along with the drawing.

The following shall be furnished as part of the Tender:

- a) General arrangement showing plan, elevation and typical sectional views.

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- b) Technical literature on the various equipments.
- c) The following shall be furnished after award of contract for Purchaser's approval :
 - i. General arrangement showing plan, elevation and typical section views.
 - ii. Foundation plan showing location of fixing channels, floor opening etc.,
 - iii. Schematic wiring drawings for each feeder.

1.8.1 DOCUMENTATION :

1.8.1.1 Vendor shall furnish drawings, data and manuals in six sets along with equipment supplied.

- General arrangement drawing indicating accessories and dimensions.
- Foundation plan and loading.
- Termination arrangement with dimensions.
- Three phase wiring diagrams
- SLD's and control schemes
- Terminal plans
- Bill of quantity for each panel.

1.8.1.2 Documents to be submitted after placement of order.

- As per 2.1 above for comments and approval for manufacture.
- Schematic and sectional drawing.

1.8.1.3 Final documents

- As built drawings with **RTP (Reproducible Tracing Paper)**.
- Instruction and maintenance manual - Six copies.
- Test certificates - Six copies

1.9 Inspection

At all reasonable times during production and prior to transport of the Panels to site, the supplier / contractor shall arrange and provide all the facilities at their plant for inspection.

1.10 Test Certificates

Testing of Panels shall be carried out at factory and at site as specified in Indian standards in the presence of consultant. The test results shall be recorded on a prescribed form. The test certificate for the test carried out at factory and at site shall be submitted in duplicate to the consultant for approval.

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Part B: Testing

1.1 General

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Owner's site representative.

- Wiring continuity test.
- Insulation resistance test.
- Earth continuity test.
- Earth resistivity test.
- Test as per Appendix 'E' of IS:732 -1989

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

1.2 Testing Of Wiring

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

1.3 Insulation Resistance Test

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit; the whole installation shall have an insulation resistance greater than one mega ohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one a mega ohms. All equipments, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix 'E' of IS: 732-1989 shall be done and all record to be maintained.

1.4 Testing Of Earth Continuity Path

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

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1.5 Testing Of Polarity Of Non-Linked Single Pole Switch

In a two wire installation a test shall be made to verify that all non-linked single pole switches have been connected to the same conductor throughout, and such conductor shall be labelled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Owner's site representative as well as the local authorities.

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Part C: Erection, Testing & Commissioning Of Electrical Installations

1.1 Scope

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical system like transformer, M.V panels, Cables, earthing network, Internal and External lighting, Light fixtures etc. Requirement of this project shall be as specified in bill of quantities / approved drawings / general specifications or as per the battery limits fixed by the owner / consultant.

1.2 Standards

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specification / codes of practice of the Indian Standards Institution, approved drawings and the instructions issued by the authorised representative, from time to time. Some of the relevant Indian Standards are listed elsewhere in this tender document.

In addition to the standards mentioned in 2.1, all works shall also conform to the requirement of the following:

- Indian Electricity Act and Rules framed there under.
- Fire Insurance Regulations.
- Regulations laid down by the Chief Electrical Inspector of the State / State Electricity Board / Union Territory.
- Regulations laid down by the Factory Inspector of the State / Union Territory.
- Any other regulations laid down by the local authorities.
- Installation & operation manuals of original manufacturers of equipment.

1.3 Equipment, Material And Accessories Specifications

This defines specifications and requirements mainly for the equipment and accessories, which are generally supplied by the erection agency.

All materials, accessories, consumable to be supplied by the contractor shall be selected from the list of specified make of material in consultation with the Client/Architect/Consultant without any extra cost and shall conform to the specification given here under. The equipment shall be manufactured in accordance with current Indian Standard specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification & if any item not mentioned in the make of the material & anywhere else, the materials shall be as approved by the owner / consultant or his authorised representative in writing manner.

All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be furnished by him as per the pro forma given in elsewhere in this tender document. Tenderer should have to specify the list of makes considered in the tender while quoting the rates in the tender, in covering letter of separate letter enclosure. However, the final decision for accepting make specified by tenderer would be of client/Architect/Consultants.

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Within a week of work order, the contractor shall submit the sample of each item / component of above mentioned approved make for the approval of the Client/Architect/Consultant.

Bidder to submit authorization letter for supply of light fixtures and lamps only from regional sales manager/director-sales of lighting company with duly signed and stamped with mentioning the name of project, total quantity, type of light fitting etc. The letter should be submitted with valid proof and original documents to consultant. These authorizations are to be obtained prior to supply of material and should be approved by electrical consultant/architect.

1.3.1 Control Cables

Control cables for use on 415 V system shall be of 1100 volts grade, copper conductor, PVC insulated, PVC sheathed, armoured and overall PVC sheathed, strictly as per IS: 1554 (Part-I) 1976. Unarmoured cables to be used only if specifically mentioned in schedule of quantities.

The size of these cables shall be as specified in bill of quantities or as per approved drawing. The minimum conductor size shall be 2.5 sq.mm. (Cu.).

1.3.2 Cable Trays

These shall be channel type, fabricated from structural steel, hot dip galvanised, complete with all accessories such as bends, tees and reducers. Only aluminium flat clamps with G.I. / Chrome plated bolts, nuts/screws to be used for clamping cables. Sizes of these trays shall be as specified in bill of quantities or approved by client.

1.3.3 Cable Glands

Cable glands shall be heavy duty compression type of brass, chrome plated. These shall have a screwed nipple with conduit electrical thread and check nut. These shall be suitable for armoured/Unarmoured cables, which are being used.

1.3.4 Cable Connectors

Cable connectors, lugs/sockets, shall be of copper/aluminium alloy, suitably tinned, solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

1.3.5 Cable Indicators

These shall be self sticking type of 2 mm. thick lead strap for overall cable. PVC identification number, ferrules shall be used for each wire.

1.3.6 G.I. Pipe For Cables

For laying of cables under floor, G.I. class "A" pipes shall be used. M.S. conduits are not acceptable for this purpose. All accessories of pipes shall be threaded type. Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. NO G.I. pipe less than 40 MM. I.D. shall be used for this purpose. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

1.3.7 Push Button Stations

These shall be floor / wall mounted type as specified in bill of quantities. These shall be fabricated from 1.6 mm. thick stainless steel sheets (SS 304). In case of floor mounted station, these shall be supported on 51

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mm. "A" class G.I. pipe. Front cover shall be removable type with suitable rubber gaskets to make them dust vermin and moisture proof.

Each feeder shall be provided with "ON" (green) push button, "OFF" (red) push button, name plate (white bakelite), indication lamp etc. Green & red push buttons shall have contact elements having 1NO + 1NC. "OFF" push button shall be provided with lockable (key operated) arrangements to prevent accidental starting. No. of feeders shall be specified in bill of quantities. The indication lamp can be combined with "ON" push button.

1.4 Erection

The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. Equipment shall not be removed from packing cases unless the floor has been made ready for installing them. The cases shall be opened in presence of the client / consultant or his authorized representative. The empty packing cases shall be returned to the stores and any document if found with the equipment shall be handed over to the client's representative. Any damage or shortage noticed shall be reported to the client / consultant in writing immediately after opening of packing cases.

1.5 General Notes For Street Lighting

For supplying and laying of cables, technical specification (wiring) shall be applicable reference shall be made under heading Cable Work elsewhere in the tender.

For street light poles along roads, nearest finished road level shall be taken as ground level and for poles along compound wall / away from roads, existing ground / finished ground shall be taken as ground level.

Distance of 1 mtr. shall be maintained between centre of pole and centre of kerb of road. For compound wall poles, distance between compound wall and poles shall be 3 mtrs.

A loop of 1.5 mtr. of cable shall be provided near each street light pole for all incoming and outgoing cable.

1.6 Completion Tests

After supply and installation of complete project or a particular building / area, following tests shall be carried out by the contractor before switching on the power to installation and the results shall be recorded and submitted to the Site-Engineer. If results are not satisfactory / as per standards set herewith, the contractor shall identify the defects / short coming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.

1.6.1 Insulation Resistance To Earth

This is to be measured with all fuse links in place, all switches ON, all lamps and appliances in position by applying a voltage not less than twice the working voltage (subject to a limit of 500 V). Insulation resistance of the whole or any part of the installation to earth must not be less than 50 mega-ohms divided by the number of outlets (points and switch positions) except that it need not exceed one mega-ohm for the whole installation.

1.6.2 Insulation Resistance Between Conductors:

Tests to be made between all the conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply. For this test, all lamps shall be removed and all switches put ON. The result of the test must be 50

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mega-ohms divided by the number of outlets (points and switch positions) but need not exceed 1 mega-ohm for the whole installation.

1.6.3 Polarity Of Single Pole Switches:

Tests shall be made to verify that all non-linked single pole switches are on phase conductor (live) and not on neutral or earth conductor. This can be done by connecting test lamps between two terminals of switch and earth. If the lamp lights up when switch is ON and either terminal is touched, the switch is correctly installed.

1.6.4 Resistance Of Metal Conduits / Sheets (Earth Continuity Test):

In case of cables encased in metal whether conduit of metallic sheathing, the total resistance of the conduit or sheathing from the earthing point any other position in the completed installation shall not exceed 2 ohms. This can be carried out by following circuit:

One end of the lead is connected to the ECC and its connection with the electrode and the other to the farthest point of the ECC. First, current through the circuit is measured with the resistance of 2 ohms short circuited by the link. Next, current is measured through the two ohms resistance by disconnecting the two leads from the ECC and joining them together. If current is more in the first case, the resistance of ECC is less than 2 ohms.

1.7 Handing Over / Taking Over:

After completion of works and tests specified above, the various installations of the project can be taken over by the employer as and when these are ready in all respects. The defect liability period of 24 months shall start from the date, when all the installations of the project have been executed, tested as described above, successfully commissioned and handed over.

The Contractor has to produce the Final As – Built drawings duly signed by Engineer In charge, Consultant, Architect & Client before finalizing the Final bill. The cost for as built drawing to be borne by the contractor.

Final bill will not be considered if as built drawings not provided by contractor as following.

Process of as built Drawings:

1 set of Hard copy & editable soft copy should be submitted to Engineer In charge.

After incorporating the comments received from Engineer in charge Final As built documents as mentioned to be submitted.

Final As built documents

As built drawings with RTP (Reproducible Tracing Paper). : 1 Set

As built drawings with Coloured Print out: 4 Sets

Editable Soft Copy of the same: 6 Copies

Instruction and maintenance manual - Six copies.

Test certificates - Six copies.

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Part - D: List Of Approved Make For Electrical Materials

| S. No. | Item | Approved Make |
|--------|---|---|
| 1) | Rigid PVC Conduit (FRLS only) | Precision Plastic Industries, Nihir, Finolex |
| 2) | Accessories for conduit | Same make as of pipe. |
| 3) | Flexible Copper Wires (FRLS) | Finolex, Polycab, RR Kable, KEI, Hawells, Gloster. |
| 4) | Switches Use different colour switch & Accessories for Raw & UPS Power IP66 Box and Switches | Legrand (Myrius), MK (Blenze), Schneider (Vivanc-BF), Norisys Legrand, Scame |
| 5) | Main Switch fuse upto 60 Amps - AC 23 duty | Schneider MG, L&T |
| 6) | Above 60 Amps-A.C. 23 Duty | Schneider MG, L&T |
| 7) | HRC Fuses | Schneider MG, L&T |
| 8) | MCBs/ELCBs/ELMCBs / Contactor | Legrand (MDS-DX3), Schneider MG (Acti 9), Siemens (Beta Guard), C& S |
| | Time Switch (Timer) | |
| 9) | Distribution boards- TPN & SPN DB (IP 65), | Hensel, Spelsberg, Legrand (Plexo 3) |
| | VTPN DB (IK 43) | Legrand (MDS-Ilexic), Schneider MG Factory fabricated. double door type, PPI only with additional JB on both side |
| 10) | Rewireable Porcelain Fuse | CPL, KEW. |
| 11) | PVC tape | Steel grip, Anchor |
| 12) | Main Cables down Stream | XLPE armoured cable for 1.1 KV as per ISI 1554. Finolex, Polycab, RR Kable, KEI, Gloster, Hawells. |
| 13) | Glands | Compression type, Heavy duty and deep threading with rubber ring and double washers. HMI, Raychem |
| 14) | Cable Lugs | Dowells, 3-D, Raychem. |
| 15) | Metal Clad Plugs | Indoor –Legrand, Scame, Hensel. Outdoor - Legrand, Scame, Hensel. |
| 16) | Connectors | Hensel, Wohner. |
| 17) | Button holder, Angle holder, ceiling rose | Anchor, CPL |
| 18) | M.S. Boxes | Fabricated out of 16 gauge continuously welded (sample to be approved) with Powder coating. |
| 19) | MCCB | Schneider MG (NSX) , Legrand, Siemens (3VA), ABB (TMAX), C & S |
| | With all kind of communication accessories | |
| 20) | Meter (Analog Only) | Rushabh, L &T,Conzerv, Schneider |
| | Digital Meter | Schneider, Conserve, Secure Meter, L&T |

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Electrical Works – Specifications and List of Make

| Sr.No | Item | Approved Make |
|-------|--------------------------------------|--|
| 21) | Steel Wire Rain Forced | Flaxi - Hose |
| | PVC Flexible Hose | |
| 22) | Panel Fabricators - TTA Panels | Rittal (Ri4power), Schneider (Blockset), Siemens (Siepan), ABB (Artu k). |
| 23) | IP65 Panel | Peaton Electric, Hensel, Spelsberg. |
| 24) | Changeover Switch | On load type – HPL, C &S, Havell's (Euroload) |
| 25) | DIGITAL meters, Load Manager | Schneider, Conserve, Secure Meter, L&T |
| | | |
| 26) | Light Fixture Outdoor | Phlips, Crompton, Bajaj, Kselec |
| 27) | Lamps | Philips, Osram |
| 28) | Ballast | Philips, Vossloh |
| 29) | Chemical Type Earthing | LPI, Ashlok, OBO Betterman. |
| | (Copper Road only) | |
| 30) | Energy Meter | L &t, Conserve, Schneider, Secure Meter |
| 31) | CT | AE, Ashok, Kappa, C&S |
| 32) | DWC Pipe(Anti Rodent Type Only) | Tirupati Plasto, REX, Duraline, Gemini. |
| 33) | Junction Box (PVC / Polycarbonate) | Gewiss, Hensel, Spelsberg |
| 34) | Contactor | Telemecanique, L & T, Schneider, Legrand |
| 35) | Panel Accessories | Telemecanique, L &T, Siemens |
| 36) | Water tight Plugs enclouser | Gewiss, Hensel, Spelsberg, Scame, Legrand |
| 37) | Timers | Theben, Legrand, Schneider |
| 38) | Octagonal / Conical Poles | Bajaj, Schreder, Philips, Transrail, Valmont. |
| 39) | Capacitor (MPPH Gas Filled Type) | L & T, Epcos, Neptune, Electronicon, Ducati. |
| | Thyristors, Reactors | |
| 40) | Relay | Alsthom, Siemens, Schneider, ABB, L&T. |
| 41) | IPFC Relay | Conserve, Secure, Schneider, BCH, Ducati, Electronicon. |
| 42) | PLC | Schneider, Siemens, ABB, Allen Bradley |
| 43) | Surge Protector | Emerson, Obo Betterman, ESCO |

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