1.0 SCOPE
The scope of this specification cover design, manufacture, assembly, testing at manufacturer’s works, packing & forwarding to site indoor type 415V, 3 phase 4 wire AC Distribution boards for power distribution to sub-station.

2.0 STANDARDS:
The AC Distribution boards offered under this specification shall conform to latest revision of relevant Indian Standard Specification.

3.0 PRINCIPAL PARAMETERS
3.1 The AC distribution boards shall be sheet steel enclosed self standing suitable for mounting indoors.

3.2 The AC distribution boards covered in this specification shall meet the general technical requirements furnished below, the makes of various components listed at Annexure-I.

4.0 GENERAL TECHNICAL REQUIREMENTS
4.1 Constructional Features
4.1.1 The board shall be sheet steel enclosed, indoor, floor mounted modular, self supporting type made up of the requisite vertical sections.

4.1.2 It shall be dust & vermin proof with a degree of protection of IP-52.

4.1.3 It shall be possible to extend the board on both sides by addition of vertical sections after removing the end covers.
4.1.4 A metal sill frame made of M.S. channel of 100 x 50 mm ISMC shall be provided as base frame, properly drilled for mounting the board. Necessary hardware shall also be provided for the same.

4.1.5 It shall be provided with cable entry at bottom with 3 mm removable gland plate.

4.1.6 The board shall be of uniform height of not more than 2450 mm and it shall be of single front execution. It shall be provided with busbars running at top along the length of the board in separate sheet steel enclosure. The board shall be provided with gasket all round including removable covers & doors. All the operating devices shall be provided only on the front of the board.

4.1.7 The height of the top most operating handle shall not be more than 1800 mm and that of the bottom most operating handle shall not be less than 300mm.

4.1.8 The board shall be divided into distinct sections comprising of
   a) metal enclosed busbar compartment running horizontally
   b) Individual feeder modules arranged in multitier formation.
   c) Enclosed vertical busbars serving all modules.
   d) Vertical cable alley covering entire height.

   Metal sheet shall be provided between two adjacent vertical sections running to full height of the board.

4.1.9 All equipment associated with a single circuit shall be housed in a separate module compartment. The compartment shall be sheet steel enclosed on all sides and rear. A plate cover with a slot to permit wiring connections shall be
provided on the side corresponding to the cable alley. The front of the compartment shall be provided with hinged door.

4.1.10 Only the handles of switches, push buttons knobs and cutouts for lamps & meters shall be arranged on front of the respective compartment to permit operation without opening the door. All cutouts shall be gasketed for dust proofing.

4.1.11 Cable alley shall be provided with suitable hinged door. Vertical bus bar compartments shall be provided with adequate shrouding & bolted covers.

4.1.12 Rear of the board shall be provided with removable panels.

4.1.13 All doors shall be provided with concealed type hinges and captive screws.

4.1.14 All identical equipment and corresponding parts of similar ratings shall be fully interchangeable.

4.2 **Sheet Metal Work:**

4.2.1 The board frame shall be fabricated using pressed & shaped CRCA sheet steel of minimum 2.5mm thickness.

4.2.2 The Board shall be enclosed by sheet steel of minimum 2.0 mm thickness smoothly finished & leveled. Doors & covers shall be made of 1.6 mm thick sheet steel. Adequate stiffeners shall be provided wherever necessary.

4.2.3 All panel edges and door edges shall be reinforced against distortion. Cut outs shall be true in shape and devoid of sharp edges.
4.2.4 The complete structure shall be rigid, self supporting free from vibration, twists & bends.

4.3 **Painting:**
All sheet steel work shall be phosphated in accordance with the following procedure.

4.3.1 Oil, grease, dirt and swan shall be thoroughly removed by emulsion cleaning.

4.3.2 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

4.3.3 After phosphating, through rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and over drying.

4.3.4 The panel then powder coated with an approved colour shade as per IS.

4.3.5 The final finished thickness of paint film on steel shall not be less than 50 microns, and shall not be more than 80 microns.

4.3.6 Finished painted appearance of equipment shall present an aesthetically, pleasing appearance, free from dents and uneven surfaces.

4.4 **Main Bus & Taps:**

4.4.1 The board shall be provided with three phase and neutral busbars.

4.4.2 Busbars shall be of uniform cross section throughout the length of the board and up to the incoming terminals of feeder circuit breaker/switch.
4.4.3 The busbars shall be made of high conductivity aluminium alloy of E91E grade.

4.4.4 Busbars shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Busbar supports shall be made of hylum sheets, glass reinforced moulded plastic material or cast resin.

4.4.5 Separate supports shall be provided for each phase of the busbars. If a common support is provided for all three phase, antitracking barriers shall be incorporated.

4.4.6 Busbar joints shall be complete with high tensile steel bolt and washers and nuts. Busbars shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

4.5 **Mounted case Circuit Breakers:**

4.5.1 Wherever specified moulded case Circuit Breakers shall be provided for circuit protection. They shall be suitable for over load and short circuit protection of the feeders.

4.5.2 The circuit breaker shall have switching mechanism, contact system, arc extinguishing device and a tripping unit contained in a compact moulded case and cover.

4.5.3 The insulating case and cover shall be made of high strength, heat resistant, flame retardant material.
4.5.4 The MCCB shall be provided with a quick make-quick break type of switching mechanism which a definite speed of travel of moving contacts is ensured.

4.5.5 The MCCB shall employ a maintenance free contact system designed to minimize the let through energies while handing abnormal currents.

4.5.6 An indicator showing ON, OFF and TRIPPED positions shall be provided.

4.6 **Air Break Switches**:

4.6.1 Air break switches shall be of the heavy duty, group operated load-break, fault-make type, complying with the requirements of applicable standards.

4.6.2 The switches shall be capable of withstanding the thermal stresses caused by overloads, and short circuit currents of values associated with protective relays settings and the let through current of the associated fuse.

4.6.3 The switches shall be capable of withstanding the mechanism stress caused by the peak short circuit current of value equal to the cut-off current of the associated fuse.

4.6.4 Whenever solid links are used for the connections between switches and fuses, such links shall be fitted with insulated sleeves.

4.6.5 All live parts of the switch shall be shrouded.

4.6.6 Switch operating handles shall be suitable for padlocking in ‘OFF’ position.

4.7 **Fuses**:
4.7.1 Fuses shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of not less than 80kA at 440V. Fuses up to 630A for distribution systems of medium short circuit levels may be of HRC cartridge screw-cap type, having a certified rupturing capacity of not less than 46kA at 440V and 16kA at 250V DC.

4.7.2 Fuses shall be provided with visible indication to show that they have operated.

4.7.3 Fuses shall preferably be mounted in moulded plastic carries and shall be complete with fuse bases.

4.8 **Current Transformers:**

4.8.1 Current transformers shall be dry type.

4.8.2 Current transformers shall have a short time withstand rating equal to the short time withstand rating of the associated board for one second.

4.8.3 Rated burden shall be as specified in the single line diagram.

4.8.4 All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformers insulation resistance.

4.9 **Indicating Instruments and Meters:**

4.9.1 Electrical indicating instruments shall be of minimum 144 sq.mm. size for incoming feeder and 96 mm size for outgoing suitable for flush mounting.
4.9.2 Indicating instruments shall have provision for zero adjustment outside the cover.

4.9.3 Instrument dials shall be parallax free with black numerals on a white dial.

4.10 **Indicating Lamps**
The indicating lamps shall be Cluster LED type having low watt consumption and shall be provided, translucent lamp cover of appropriate colour. The bulb & lens shall be easily replaceable from the front.

4.11 **Control & Selector Switches :**

4.11.1 The control & selector switches shall be adequately rated for the purpose intended and shall be rotary type. They shall be provided with ascutcheon plates clearly marked to show the position.

4.11.2 The selector switches shall be maintained contact stayput type. Further switches in ammeter circuit shall have make before break type contact & shall be provided with oval handles.

4.12 **Push Buttons :**
The push buttons shall be of momentary contact push to actuate type rated to carry 10A at 240V A.C. It shall be fitted with self reset, 2 No. & 2 NC contacts. It shall be provided with integrate plate marked with its function. Start, open, close, push buttons shall be green in colour & stop push button shall be red in colour. All other push buttons shall be black.

4.13 **Internal Wiring :**
4.13.1 Wiring inside the board shall be carried out with 1100/650V grade. PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits shall be 4 sq.mm. copper or stranded wires. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm. for CT circuits & 1.5 sq.mm. for other circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5 mm diameter respectively.

4.13.2 Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

4.13.3 Spare auxiliary contacts of all equipment forming part of the board shall be wired up to the terminal blocks.

4.13.4 Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable-lugs with nuts & washers/lock nuts.

4.14 **Terminal Blocks**

4.14.1 Terminal blocks (both for power and control circuits) shall be of reputed make specially for CT and PT circuits. It shall comprise finely threaded pairs of brass studs of at least 6 mm diameter, links between each pair of studs, washers, nuts and lock nuts. The studs, shall be accurately locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.

4.14.2 Terminal blocks shall be adequately rated to carry the current of the associated circuit Minimum rating of the terminal block shall be 10A.
4.14.3 Terminals shall be numbered for identification, Engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit.

4.14.4 Where duplication of a terminal block is necessary, it shall be achieved by solid bonding links.

4.14.5 Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

4.15 **Labels.**

4.15.1 All labels shall comprise white letters on a black background.

4.15.2 Labels shall be made of non-rusting metal or 3 ply lamicoid, or engraved PVC.

4.15.3 Labels shall be properly fixed, with provision to prevent distortion due to expansion.

4.15.4 Size of lettering shall be 6 mm., unless otherwise specified for incoming outgoing feeders.

4.16 **Earthing :**

4.16.1 Each Board, shall be provided with an earth busbar running along the entire length of the board. Material and size of the earth busbar shall be as specified. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and earthing conductor shall be provided for bolting Purchaser’s earthing conductor. In case the earth bus is provided near top of the Board,
one down comer at either end shall be provided for connection to the Owner’s earthing conductor.

4.16.2 Earth busbars shall be supported at suitable intervals.

4.16.3 Positive connection between all the frames of equipment mounted in the switchboard and earth busbar shall be provided by using insulated copper wires/bare busbars of cross section equal to that of the busbar.

4.16.4 All instrument and relay cases shall be connected to the earth busbar using 1100/650V grade, 2.5 sq.mm. stranded copper earthing conductor.

__________________ ________________________________
Signature of Tenderer Chief Engineer & General Manager (T)
Date : Date :
SPECIFICATIONS FOR EARTHING INSTALLATION

1.0 SCOPE
The intent of this specification is to define the requirements for the supply, installation, testing and commissioning of the Earthing System.

Note: The bidder shall have to design the earthing system required for the installation after measuring the soil resistivity & approvals.

2.0 EARTHING CONDUCTOR/ELECTRODE:
The main grid conductor shall be hot dip galvanized G.I. flat or PVC insulated aluminium conductor/copper conductor. Sizes for main conductors shall be marked on the drawings. Earth electrodes shall be as per IS standard. Thickness of hot dip galvanizing shall not be less than 75 microns.

3.0 EARTHING NETWORK:
3.1 The entire earthing installation shall be done in accordance with the earthing drawings, specifications and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and rules framed thereunder. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation confirm to the Indian Electricity Rules at no extra cost. The exact location of earth conductors, earth electrodes and earthing points on the equipment shall be determined in field, in consultation with the Engineer or his authorized representative. Any changes in the methods, routing, size of conductors etc. shall be subject to approval of the Owner/Engineer before execution.
3.2 Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

3.3 The resistance between the earthing system and the general mass of earth shall be as per IS code of practice. The earth loop impedance to any point in the electrical system shall not be in excess of 5.0 ohm, in order to ensure satisfactory operation of protective devices.

3.4 The main earth loop shall be laid at a depth of 300 mm below grade level. Wherever cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleated to the walls or run of trays when run in concrete lines trenches. The earthing strip shall be protected against mechanical damage.

3.5 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

3.6 Joints and tappings in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covering with hessian tape. All joints above ground shall be by means of connectors/lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Where aluminium cable risers are to be connected to the underground GI earth bus, the aluminium cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable then a G.I. risers shall be brought above grade and a bolted joint shall be made between this GI
riser shall be protected applying two coats of bituminous paint/bitumen on the exposed portion.

3.7 Conduits in which cables have been installed shall be effectively bonded and earthed. Cable armoured shall be earthed at both ends.

4.0 **EARTHING ELECTRODES:**

4.1 Earth pipe electrodes shall be installed as shown in the earthing layout drawings and in accordance with the standard drawings of reference and IS:3043. Their location shall be marked to enable accurate location by permanent markers.

4.2 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as lightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrode.

4.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance. In such a case the distance between two electrodes shall not be less than twice the length of electrode.

4.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

4.5 The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer,
depending on the soil strata and resistivity, to meet the ohmic values prescribed in clause 4.3.

4.6 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically.

5.0 **CONNECTION:**

5.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to main earthing ring. The earthing ring will be connected via links to several earth electrodes. The cable armour will be earthed through the cable glands.

5.2 The following shall be earthed.

1. Transformer neutrals (Double Earthing).
2. Transformer Housing.
3. All switchgear and their earth buses.
5. Non-current carrying metallic parts of electrical equipment such as switchgear, switch rocks, panel boards, motor control centers, lighting, power and instrument panels, push button stations, cable trays, pipes conduits, terminal boxes etc.
6. All fences/enclosures housing electrical equipment.
7. All still structures, rails etc. including bonding between sections.
8. Shield Wire.
9. Structural steel Columns of building etc.
10. Loading racks.

5.3 System shall be earthed by two distinct conductors directly connected to independent earth electrodes which in turn, shall be connected to the earth
loop. The earth connection shall be properly made. A small flexible aluminium cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is lightning surge, high voltage surge or failure of the bushings.

5.4 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors shall be spaced such that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

5.5 The shield wire shall be connected with the main grid solidly and net through supporting steel structures.

5.6 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

5.7 All hardware used for earthing installation shall be hot dip galvanized for zinc passivated. Spring washers shall be used for all earthing connections of equipment having moving parts and for all the connections subject to vibrations etc.

5.8 Lighting fixtures shall be earthed through the extra core provided in the lighting cable this purpose.

6.0 TESTING
Earthing system/connections shall be tested as follows:
6.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.
6.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid and generally the test value shall conform to IS:3043 code of practice unless otherwise specified.

6.3 The resistance to earth shall be measured at the following:

a) At each electrical system earth or system at the following.
b) At each earth provided for structure lightning protections.
c) At one point on each earthing system used to earth electrical equipment enclosures.
d) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.
e) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

Signature of Tenderer

Date :

Chief Engineer & General Manager (T)

Date :
TECHNICAL SPECIFICATION FOR
G.I. PERFORATED TRAYS/ CABLE SUPPORTS

1.0 SCOPE
The scope of this specification covers design, manufacture, inspection and testing at manufacturer’s works packing & dispatch of M.S. galvanized perforated trays for use in sub-station for cable laying in trenches, on structures, on walls etc.

2.0 STANDARDS
The cable trays fittings and accessories including all bolts nuts screws shall be hot dip galvanized as per IS:2629. The G.I. sheet used for fabrication shall conform to IS:226.

3.0 PRINCIPAL PARAMETERS
The perforated trays shall be 100 mm, 150 mm and 300mm wide and 75 mm deep. The trays shall meet the general technical requirement furnished below.

4.0 GENERAL TECHNICAL REQUIREMENT
4.1 The perforated trays shall be fabricated out of 2.0 mm thick G.I. formed into a trough 75mm deep and shall be 100mm, 150mm & 300 mm wide.

4.2 Each section of tray shall be 2.5 m long & shall be provided with two side coupler plates & associated nut bolts & washers.

4.3 The side coupler shall be fabricated out of 3 mm thick G.I. plate with four circular & four elliptical holes.
4.4 All trays & coupler plates, bolts, nuts & washers shall be hot dip galvanized after fabrication. The galvanizing shall be uniform. The amount of zinc deposit shall not be less than 615 gram per square metre of surface area. The thickness of zinc deposit at any spot shall not be less than 75 microns. The amount of zinc deposit over threaded portion of bolts, nuts shall not be less than 300 grams per square meter.

4.5 The cable trays shall be generally as per enclosed drawing.

5.0 INSTRUCTION MANUAL, TECHNICAL INFORMATION, SHOP DRAWINGS AND GUARANTEE:

The contractor shall submit immediately after the work is awarded, three copies of the complete instructions for installation, operation, maintenance and repairs, circuit diagrams, foundation and trench details for the transformer proposed to be purchased.

The contractor shall also furnish the information regarding complete dimensions and total weight of the transformer, minimum room height required to house and transformer and no load and load losses of the transformer.

The contractor shall furnish shop drawings for the approval of the Engineer before commencing manufacturing/fabrication of the equipments. Shop drawings shall be based on the specifications as laid down. The manufacturing shall be taken up only after approval of the shop drawings by EE(Electrical), CIDCO.
The equipments supplied shall be guaranteed against bad design or workmanship, improper transport, handing, storage, erection and commissioning, for a period of 18 months from the date of receipt of materials at site or 12 months from the date of commissioning whichever is earlier. The contractor shall replace/repair the damaged equipments without any extra cost.

Signature of Tenderer
Date:

Chief Engineer & General Manager (T)
Date:
SPECIFICATIONS FOR L.V./M.V. DISTRIBUTION PILLARS

The intent of these specifications is to give general guidelines for the equipments/materials proposed to be used and best efforts are made to cover all requirements and specifications. However, if any changes, modifications or additions are to be done as indicated by CIDCO, the same shall be done without any extra cost or financial implications.

1.0 SCOPE

This specification covers design, manufacture, testing at works, transportations to site including transit insurance, complete supply, testing and commissioning at site.

2.0 SYSTEM

Distribution pillars are to be used in underground distribution system with normal system voltage of 415V, 50 Hz, 3 phase, 4 wire system.

3.0 6 WAY ACB L.T. FEEDER PILLAR/4 WAY L.T. FEEDER PILLAR:

3.1 Indoor type 6 way distribution pillar with 1000 Amp Air Circuit Breaker pillar shall be suitable for 3 phase neutral, 50 Hz, 415V AC system and shall confirm to IS:5039.

3.2 The feeder pillar shall be fabricated out of Galvanised angle iron 35 x 35 x 5 mm frame and 10 SWG sheet steel with slanting roof top and adequately ventilated by providing louvers with stainless steel wire mesh from inside. The feeder pillar shall be provided with degree of protection as per IS:2417. The overall arrangement shall be vermin proof and also water proof.

3.3 The bottom skirt of the pillar shall be fabricated out of 10 SWG G.I. sheet steel with the louvers on front and back with stainless steel wire mesh from inside as per the drawings. After carrying out necessary anticorrosive treatment the
feeder pillar shall be painted with synthetic enamel paint with post office red colour and bottom skirt shall be painted with black colour.

3.4 The front and back doors shall be provided with double heavy duty brass hinged with stainless steel pin and sleeves and galvanized handle for opening the door. Each door should open by minimum 135 degrees. Latch type locking arrangement with centrally operated three position locking shall be provided for doors. The doors shall have self latch locking arrangement with Godrej type lock and with duplicate keys shall be provided with each pillar.

3.5 Asbestos sheet lining shall be provided on inner side of the door. Inside the pillar two compartments shall be formed by used of 4/6mm thick asbestos sheet separators. Rear part will be used for cable entry and cable connections. Front portion will be used for future replacement.

3.6 Electrolytic Aluminium busbars suitable for 1000 Amps & 630 Amp (4 way)/(6 Way) 1 No. per phase and duly painted with epoxy paint red, yellow, blue for R, Y, B phases shall be used. For neutral one electrolytic Aluminium busbar of size 30 x 5 mm shall be used with black epoxy paint. The busbars shall be mounted on porcelain insulators fixed to the main body/frame.

3.7 For incoming 630 Amp porcelain fuse bases (3 Nos.) with solid links of removable type and of electrolytic copper shall be used. For outgoing 400 Amps. Porcelain fuse bases with silver plated, copper contacts suitable for standard HRC fuses shall be used. The rating of the HRC fuses shall be 400A or as directed. For 4 way distribution pillar the No. of outgoing shall be 3 Nos. per phase i.e. total of 9 Nos.

3.8 Fuse bases will be mounted on G.I. channels of size 60 x 20 x 3.15 mm fixed horizontally and which in turn will be supported on angle iron 40 x 20 x 3.15
fixed vertically. The pillars shall be provided with HRC fuses of various rating.

3.9 Split phase busbars shall be connected through solid links removable type on incoming side of the porcelain fuse bases. Electrolytic Aluminium strips 2 Nos. of 40 x 5 mm size, shall be used as jumpers between outgoing of fuse bases and cable terminal for each outgoing circuit. These jumpers shall be supported on 12 mm thick backlite strips which in turn will be supported on necessary angles. The jumper ends on the cable terminal side shall have 2 Nos. of holes suitable for connecting outgoing cables by means of 2 Nos. of nutbolts for each crimping type copper lugs.

3.10 G.I. base plate 3 mm thick and detachable type shall be provided with 4/6 Nos. knockouts of suitable size for cable entry. Flanged type brass cables glands as required shall be provided. The base plate shall have the louvers with wire mesh fitted to them to provide proper ventilation. One illuminating lamp shall be provided inside the pillar and the lamp shall be provided inside the pillar and the lamp shall be switched ON when the panel door is opened. The pillar shall display danger board on front and back doors.

3.11 Two Nos. of earthing terminals with G.I. threaded stud welded to the body on opposite sides, shall be provided on inner side of the pillar for connecting earthing strips from earthing stations.

3.12 All nutbolts, washers and fastners used for electrical connections shall be stainless steel and all other nutbolts shall be G.I.

3.13 For fixing the foundation bolts (of size 12.5mm x 25 mm long) the pillar bottom frame shall be provided with 4 Nos. of 18 mm dia. holes. The foundations bolts shall be provided with spring and plain washers and locknuts
and the bolts shall be grouted in the foundation concrete block 600mm above ground level all as per IS specifications and requirements.

3.14 The overall arrangements shall be in line with the drawings and before manufacturing the pillar it is mandatory for the contractor to submit the detailed shop/floor drawing of manufacturer for approval of CIDCO.

3.15 Two Nos. of pipe type earthing has to be provided with 25 x mm GI earth strips.

3.16 The feeder pillars has to be erected on the ’C’ type cement concrete foundation plinth.

4.0 MINIPILLAR

4.1 Outdoor type minipillar shall be suitable for 3 phase & neutral, 50 Hz, 415V, C.D. system and shall confirm to IS 5039 and shall have a Aluminium busbars of size 50 x 10 mm and 50 x 5 mm for neutral and 3 Nos. 400 A HRC fuses on incoming side. The aluminium busbars shall be adequately supported by porcelain insulators.

4.2 The pillar shall be fabricated out of 14 SWG sheet steel and shall have a pedestal made out of G.I. angle of size 50 x 50 x 6 mm. The bottom shirt of the panel shall be with 10 SWG G.I. sheet with louvers on all sides. After carrying out anticorrosive treatment the pillar shall be painted with synthetic enamel paint or red colour for the top and bottom skirt shall be with black colour.

4.3 For fixing the foundation bolts (of size 12.5 mm x 250 mm long) the pillar bottom frame shall be provided with 4 Nos. of 18 mm dia. holes. The foundations bolts shall be provided with spring washers and locknuts and the
bolts shall be grouted in the foundation concrete block 600 mm above ground level all as per specifications and requirements.

4.4 Two Nos. of earthing terminals shall be provided on inner side of the pillar for earthing & pipe type earthing has to be provided for earthing with 2 Nos. 25 x 3 mm GI earth strips.

4.5 The front door shall be provided with double G.I. hinges with panel type locking arrangement and duplicate keys shall be provided with each pillar. The pillar shall be provided with a detachable back door, bolted to the main frame. The pillar shall be provided with slanting roof top and shall be adequately ventilated by providing gap between pillar body and main body as well as pedestal.

4.6 Detachable 10 SWG thick gland plate shall be provided at the bottom with required number of knockouts of suitable size for cable entry.

4.7 Brass cable glands suitable for required number of incoming and outgoing cables shall be provided. One number extra gland and future use shall be provided. The pillar shall display danger board.

4.8 The overall arrangement shall be in line with the drawings and before manufacturing the pillar it is mandatory for the contractor to submit the detailed shop floor drawing of manufacture for approval of CIDCO.

4.9 The minipillar has to be erected on cement concrete foundation `C’ type plinth.

5.0 GUIDELINES FOR WELDING, ASSEMBLY & POWDER COATING OF PANELS:
Following procedures have to be adopted:
5.1 Components are punched as per drawing & after punching dimensional check is done, tolerance 10.1 mm as sample from the set for every new setting.

5.2 Before bending all the components, 10% of components from the sets are checked & tolerance is 10.1 mm to 10.5 degree.

5.3 The parts which are to be welded will be sent for pre-treatment (7 tank process) to remove the seales & getting coat of phosphating to avoid the possibility of corrosions at joints.

5.4 After getting phosphated parts, they are welded as per the requirement & then final inspection of components is done before given to power coating.

5.5 a) Before doing powder coating process, again phosphating is done to get the phosphating coat wherever phosphating is damaged because of welding, grinding & in handling.

b) After phosphating, it is immediately followed by a hot run before powder to avoid the corrosion.

c) Powder coating thickness to measure before giving the components for assembly & which should be 50 microns. Tolerance ± 10 microns unless otherwise specified.

Signature of Tenderer
Date :

Chief Engineer & General Manager (T)
Date :
TECHNICAL SPECIFICATIONS FOR
LT CONTROL CABLES

1.0 SCOPE

The scope of this specification covers design, manufacture, inspection, testing at works, packing and forwarding of 1100 V grade control cables.

2.0 STANDARDS

The cables offered shall conform to the latest revision of relevant Indian Standard Specifications. Come of these standards are listed below.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Indian Standard Spec. No.</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>1554</td>
<td>PVC insulated heavy duty electrical cables for working voltages upto 1100 V.</td>
</tr>
<tr>
<td>2.</td>
<td>8130</td>
<td>Conductors for insulated electric cables and flexible cords</td>
</tr>
<tr>
<td>3.</td>
<td>5831</td>
<td>PVC insulation &amp; sheath of electric cables.</td>
</tr>
<tr>
<td>4.</td>
<td>3975</td>
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3.0 PRINCIPAL PARAMETERS
3.1 The Control cables shall be used indoors/outdoors, directly buried or in open racks in the plant premises.

3.2 They shall meet the requirements of IS specifications listed above and the general technical requirement detailed below.

4.0 GENERAL TECHNICAL REQUIREMENT:

4.1 The cables shall be brand new. They shall be suitable for laying on trays, in trenches, ducts, conduits.

4.2 All the control cables shall be 1100 V grade with aluminium conductor, PVC insulated, inner sheathed, over all PVC sheathed.

4.3 The construction of the conductors shall be stranded for aluminium cables. Conductors of nominal area of 25 sq.mm. shall be circular. Those above may be circular or oval shaped.

4.4 The core insulation shall be with PVC compound applied over the conductor by extrusion only & shall conform to the type a compound of IS 5831. Control cables having 6 cores or above shall be identified with prominent and indelible white coloured Arabic numerical on the outer surface of the insulation at every 500 mm.

4.5 The inner sheath shall be applied over the laid up cores by extrusion and shall be of PVC confirming to the requirements of type ST1 PVC compound. The extruded inner sheath shall be of uniform thickness of 0.5 mm upto 16 sq.mm. 0.8 mm upto 120 sq.mm. & 1.0 mm above 120 sq.mm. conductor size.
4.6 The outer sheath of the cables shall be applied by extrusion and shall be PVC compound. Suitable chemicals shall be added to the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

4.7 The dimensions of the insulation outer sheath materials shall be governed by IS 1554.

Signature of Tenderer ______________________________

Date :

Chief Engineer & General Manager (T) ______________________________

Date :
TECHNICAL SPECIFICATIONS FOR
L.T. XLPE POWER CABLE

1.0 GENERAL

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

They shall be designed to withstand all mechanical electrical and thermal stresses under steady state and transient operating conditions. The XLPE cables shall withstand without damage a three-phase fault current of at least 26.2 kA for at least 0.5 second. The armour for these power cables shall be capable of carrying 26.2 kA for at least 0.5 second without exceeding the maximum allowable temperature of outer sheath.

The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250 degree C during a short circuit without any damage.

The aluminium wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All aluminium used in the cables shall be of H2 grade.

The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperatures of the cable.

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

The cable shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250 degree C.
All the cables shall pass fire resistance test as per IS:1554 (part-1)

Repaired cables shall not be accepted.

Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

2.0 XLPE POWER CABLES
The XLPE insulated cables shall be of FR type, C1 category conforming to IS:7098 (part-1) and its amendments read along with this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC to type ST-2 of IS:5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC to Type ST-2 of IS:5831 for all XLPE cables.

3.0 CABLE DRUMS:
Cable shall be supplied non-returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.

Standard lengths for each size of power and control cables shall be 500/1000 metres. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of plus or minus 2%. 
A layer of waterproof paper shall be applied to the surface of the drums and over the outermost cable layer.

A clear space of at least 40 mm shall be left between the cables and the lagging.

Each drum shall carry the manufacturer’s name, the purchaser’s name, address and contact number and type, size and length of the cable, net and gross weight stenciled on the both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which is should be rolled.

Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

4.0 TESTS
All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

All power cables shall meet the requirements of the following additional test and type test may be conducted to prove their capabilities.
1. Short time current test of conductors.
2. Short time current test on armours.

Signature of Tenderer                          Chief Engineer & General Manager (T)
1.0 **SCOPE**
This is to define the requirements for the installation, testing and commissioning of the cabling system.

2.0 **CABLE SPECIFICATIONS**

2.1 **Power Cables**
Power cables for use on 415V system shall be of 1100 Volts grade, aluminium conductor, XLPE insulated, PVC sheathed single wire armoured and overall PVC sheathed. Power cables for HV system shall be aluminium conductor, XLPE insulated screened, PVC bedded galvanized steel flat armoured and PVC sheathed cable.

All L.T. cables conform to the relevant sections of IS:1554 Part-I and H.T. cables shall conform to IS:7098 (Part-II).

Unarmoured cables will be used wherever specified on the cable schedule.

2.2 **Control Cables**
Control cables shall be 1100 Volt Grade, 2.5 sq.mm. copper conductor, PVC insulated, PVC sheathed with an overall PVC sheath as per IS:1554 (Part-I).

2.3 **Communication Cables**
Communication cable shall comprise 1 pair unarmoured, 2 pair, 5 pair and multipair armoured cables of sizes as specified in the cable schedule. Minimum size shall be 0.5 mm dia for telephone system and 1 for plant communication system.
3.0 MISCELLANEOUS MATERIALS

3.1 Connectors
Cable terminations shall be made with aluminium crimped type solderless lugs of M/s Dowells make or approved equivalent for all aluminium conductors and stud type terminals.

3.2 Cable Identification
Cable tags shall be of 2 mm thick aluminium strap of suitable size to contain cable number, equipment number etc.

3.3 Ferrules
Ferrules shall be of self sticking type and shall be employher to designate the various cores of control cable by the terminal numbers to which the cores are connected for ease in identification and maintenance.

3.4 Cable Glands
Cable glands to be supplied shall be brass single/double compression type as per the directions of Engineer. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations.

3.5 Cable Trays
Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/m running length of tray. Minimum thickness of sheet steel/galvanized shall be 3 mm/86
microns. Cable trays fabricated from standard rolled sections shall used 50 x 50 x 6 /ISMC 100 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32 x 6 mm flat 25 x 25 x 6 mm angle for widths up to 500 mm/ more than 500 mm respectively. If unit rate not included in schedule of rates then cable trays if required shall be fabricated/installed at site as per the per tonne rate for electrical structural supports etc.

4.0 CABLE LAYING

4.1 Cable network shall include power, control lighting cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be the responsibility of the contractor. Cable routing shall be checked in the filed to avoid interference with structures, piping or air-conditioning duct and minor adjustments shall be done to suit the filed conditions wherever deemed necessary without any extra cost.

4.2 High voltage, medium voltage and other control and communication cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays, as applicable.

4.3 All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut form the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works.
4.4 Cables as far as possible shall be laid in complete, uncut lengths from one termination to the other.

4.5 Cables shall be neatly arranged in the trenches/trays in such manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trench/trays shall be the responsibility of the contractor.

4.6 All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminium straps (2 mm thick) securely fastened to the cable and strapped around it. Alternatively cable tags shall be circular in construction to which cable numbers can be conveniently punched. Each underground cable shall be provided with identify tags of lead securely fastened every 30 m of its underground length with atleast one tag at each end before the cable enters the ground. In unpaved areas, cable trenches shall be identified by means of markers as per standard drawing. These posts shall be placed at location of changers in the direction of cables and at intervals of not more than 30 m and at cable joint locations.

4.7 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead olloy.

4.8 RCC cable trenches with insert plates shall be provided by the contractor. Cable shall be laid in 3 to 4 tiers in these trenches.
4.9 Directly buried cables shall be laid underground in excavated cable trenches where specified and layout drawings. Trenches shall be of minimum 0.9 mtr. depth and suitable width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design. Depth of burying shall allow minimum 900 mm soil cover for low voltage and 1000 mm for 11KV cables.

L.T. cables shall be laid in trenches as above stated depth. Before cables are placed, the trenches bottom shall be filled with layer of sand. This sand shall be leveled and the cables laid over it. The cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and leveled.

As each row of cables is laid in place and before covering with sand every cables shall be given an insulation test in the presence of Engineer/Owner. Any cable which proves defective shall be replaced before the next group of cables are laid.

All wall openings shall be effectively sealed after installation of cables to avoid leakage of water.

4.10 Where cables rise from trenches to motor, control, station, lighting panels etc., they shall be taken in G.I. pipes for mechanical protection upto a minimum of 300 mm acboe grade or as shown in the standard drawings.

Cable ends shall be carefully pulled through the conduits to prevent damage to the cable. Where required, approved cable lubricant shall be used for this
purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following guide of the pipe fill shall be used for sizing the pipe size:-

a) 1 Cable in pipe : 53% full
b) 2 Cables in pipe : 31% full
c) 3 or more cables : 43% full
d) Multiple cables : 40% full.

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/PUTTI for sealing purpose. Alternatively G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be done.

4.11 Where cables pass through foundation wall or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical contractor shall determine their location and obtain approval of the Engineer before cutting is done.

4.12 At road crossing and other places where cable enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after back filling.

4.13 Drum number of each cable from which it is taken shall be recorded along with the cable number in the cable schedule.
4.14 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls or columns.

Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

4.15 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 16 SWG GI saddles on 25 x 6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account.

They shall be rightly supported on structural steel masonry, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

Cables shall be supported so as to prevent unsightly sagging, in general distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia.

4.16 All G.I. pipes shall be laid as per site requirements. Before fabrication of various profiles of pipe by hydraulically operated, bending machine (which is to be arranged by the contractor), all the bars from the pipes shall be removed. G.I. pipes bury in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. pipes shall be undertaken well before paving is completed and necessary co-ordination will paving agency shall be the responsibility of Electrical contractor. The open ends of pipes shall be suitably plugged with
G.I. plugs after they are laid in final position G.I. plugs shall be supplied by the contractor at no extra cost.

4.17 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. saddles/clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

4.18 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous alluminium paint.

5.0 TERMINATION:

5.1 All PVC cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable lugs of aluminium. They shall have a gland of screwed nipple with conduit electrical threads and check nut.

5.2 Power cables shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections are made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the switchgear/control panels and control switches.

5.3 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules, or self sticking cable markers. Wire numbers shall be as per schematic/wiring/inter-connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work.
5.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost.

5.5 The cable shall be through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the center line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

5.6 Cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors as manufactured by M/s. Dowell Electro Works or approved equivalent.

Crimping shall be done by hand crimping/hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

5.7 11, 6.6 and 3.3 KV cables terminations/joints shall be done byu skilled and experienced jointers duly approved by the owner, if included in the contract.
6.0 **TESTING**

6.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.

Where splices or terminations are required in circuits rated above 600 Volts, measure insulation resistance of each length of cable before splicing and or/terminating. Repeat measurement after splices and/ or terminations are completed.

6.2 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back filling.

7.1 **CABLE TRENCHES (EXCAVATED):**

7.3.1 The cable trenches shall be excavated 1000 mm below the finished ground level and shall have a minimum width of 300 mm. for laying of single cable. When more than one cables are laid in the same trench, the width of the trench shall be increased such that the spacing between the cables is 25 cms. and the end cables are at minimum 15 cms. from the side of the trenches. At the turning of the cable route the trench shall be dug with radius equal to 15 times the cable diameter.

7.3.2 The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed and leveled. The bottom of the cable trench shall be prepared with 100mm. sand bed for laying the cables.
7.3.3 The cables shall be laid in trenches over the rollers. After the cable is laid and straightened it shall be covered with sand, and RCC half round/semi circular pipe of appropriate strength & size.

7.3.4 The cable trench then shall be refilled with excavated materials after removing the stones and other sharp materials and the refilled materials shall be compacted with light ramming.

7.3.5 Approved cable markers made of G.I. with 15 cms crown shall be provided along the route of cables at a spacing of 40 – 50 meters and also at both ends of road crossings or at the cable turning points. The class, type and No. of cables shall be indicated on the markers.

7.3.6 Cable shall be laid in hume pipes at all road crossings and in GI pipes at the wall entries.

7.4 CABLE JOINTING:

7.4.1 Cable jointing shall be done as per the recommendations of the cable manufacturer. Jointing shall be done by qualified cable jointer. The location of the cable joint shall not be where the cable takes a bend also where the soil is loose and shows signs of subsidence.

7.5 TESTING OF CABLE BEFORE LAYING AND COMMISSIONING:

7.5.1 All tests shall be carried out in accordance with relevant IS codes of practice, IE rules.

7.5.2 100% cable drums shall be checked for continuity and cross continuity tests to ensure that there is no internal damage to the cable during transportation.
7.5.3 Installation resistance shall be measured with 1000 V megger between the cores and all the cores to earth (armour) and results shall be recorded.

7.5.4 Before cable jointing is done, cable shall be tested for presence of moisture by dipping a piece of insulation of cable in hot compound of paraffin was at temperature between 120 –140 degree centigrade. The presence of moisture is indicated by the formation of bubbles. Only a single strip of insulation gripped by a pair of tweezers should be used.

7.5.5 After the cables are installed before commissioning it shall be tested for high DC voltage test. The recommended volts and duration of the test shall be as per I.E. rules & regulations. However the test voltage and duration shall be in conformity with standards of local supply authorities. During high voltage tests all electrical equipments related to the cable installation must be earthed and adequate clearance shall be maintained from the other equipments and from work to prevent flash over.

__________________ ________________________________
Signature of Tenderer Chief Engineer & General Manager (T)
Date : Date :
TECHNICAL SPECIFICATIONS FOR LIGHTING FIXTURES

1.0 **SCOPE:**
The scope of this specification covers providing, testing at works, inspection before dispatch, packing and forwarding of industrial lighting fittings and accessories.

2.0 **STANDARDS:**
It is not the intent to specify herein all the details of the design and construction of the equipment. However, the equipment shall conform in all respects to standards, engineering, design and workmanship.

3.0 **PRINCIPAL PARAMETERS:**
The lighting fixtures shall conform to the General Technical requirement furnished below:-

4.0 **GENERAL TECHNICAL REQUIREMENT:**

4.1 **Constructional Features**
4.1.1 The lighting fittings shall be supplied with lamps and all other accessories to make the fittings complete in all respects.

4.1.2 The fittings comprising reflectors, housing shall be made of single piece alluminium die cast.

4.1.3 The fittings shall be suitable for ambient condition of dusty and humid atmosphere. Outdoor fittings such as street light fitting & floor light fitting shall have IP 55 enclosure.
4.1.4 The fittings shall be provided with sufficient space inside to permit repair and reassembly of replaceable components with ease and without impairing safety.

4.1.5 The street light fitting shall have a cut off or semi cut off, lighting distribution by adjusting the position of lamp holder by adjusting the position of lamp holder.

4.1.6 The control gears of the flood light fittings shall be suitable for mounting at the base of the lighting tower on which the flood light fitting is mounted.

4.1.7 Lighting fittings with discharge lamps shall be provided with power factor improving capacitors.

4.1.8 All the components of the lighting fittings shall be duly wired with PVC insulated flexible copper conductor wires of adequate size not less than 0.5 sq.mm. The insulation thickness shall not be less than 0.6 mm. The conductor insulation shall be capable of withstanding the maximum temperature to which it will be subjected to in normal use. The internal wiring shall be terminated on tough, non-hygroscopic, non-inflammable & non tracking terminal block suitable for accepting 2 cores of 4 sq.mm. aluminium conductor for power supply to the fitting.

4.1.9 The fitting shall be provided with suitable cable entry arrangement for 3 core aluminium conductor PVC insulated cable.

4.1.10 All the lighting fittings shall be provided with suitable mounting arrangement.
4.1.11 The lighting fitting shall be provided with an earthing terminal of adequate size. The earthing terminal shall be marked with the symbol on or adjacent to this terminal.

4.1.12 All hardware material used in the fitting shall be corrosion resistant zinc passivated or cadmium plated bolts nuts & washers only shall be used.

4.2 Components

4.2.1 Holders for Lamps & Starters
The holder shall be so designated and constructed so as to be mechanically robust and free from any operational difficulties. It shall be designed to ensure safe & easy functioning under normal condition. It shall be so constructed as to be capable of withstanding shock during normal transportation, installation & in use. It shall be adequately resistant to heat. All metal parts likely to be affected by atmospheric condition shall be adequately protected to prevent corrosion.

4.2.2 Lamps
a) High pressure sodium vapour lamp shall be tubular shaped with diffusing powder coating. The lamp shall have external ignitor.
b) The fluorescent tube light shall be 1200mm long 36 W rating cool day light type.

4.2.3 Ballasts Ignitor & Starter
a) The ballast shall be copper wound polyster filled & shall be mechanically robust and so designed & constructed as to minimize effect of atmospheric moisture & of temperature changes during use.
b) HPSV lamp ballasts shall be provided with necessary tappings for the specified voltage range.
c) The ballast, ignitor & the discharge lamp shall be designed to be on perfect matching with each other.

d) The fluorescent lamp starter capsule shall be made of aluminium with brass pins.

4.2.4 **Capacitors**

a) Every fitting shall be provided with a power factor improving capacitor. The power factor shall be least be 0.9.

b) The capacitor shall be provided with discharge resistor for safety.

4.3 **Painting**

a) All the fitting housing, reflectors, gear trays etc. shall be thoroughly cleaned & shall undergo 7 tank process & then two coats of epoxy base primer shall be applied.

b) After the preparation of surfaces, the fitting shall be powder coated.

c) Sheet steel reflector shall be store enameled & aluminium reflector shall be anodized.

4.4 **Following Types of Lighting Fixtures are envisaged.**

4.4.1 **1 x 40 W Industrial Type Fluorescent Fitting**

The luminaire shall be fabricated from CRCA sheet steel with white powder coating. The CRCA sheet shall not be less than 0.7 mm thick. The reflector shall be stove enameled light dove grey outside & reflecting white inside. A channel cover shall be provided. The luminaire shall be prewired & shall be provided with power factor improvement capacitor, vacuum pressure impregnated copper holders and main connector. An elegant acrylic transparent cover damped to the fixture shall also be provided. The fixture shall be provided with light source also. The lighting fixture shall be TKC 24/136 Philips make or equivalent.
4.4.2 **2 x 40 W Mirror Optic Fitting**

The luminaire shall be fabricated from CRCA sheet steel with epoxy powder white coating from inside & outside. The CRCA sheet shall not be less than 0.7 mm thick. The reflector shall be stove enameled light dove grey outside & reflecting white inside. The luminaire shall be wired & provided with power factor improvement capacitor, vacuum pressure impregnated copper wound ballast, bipin pushfit type lamp holders & mains connector. The fixture shall be provided with light source also. The lighting fixture shall be similar to TBS 50/136 of Philips make or equivalent.

4.4.3 **1 x 40 W Corrosion Proof Industrial Fixtures**

The luminaire shall be fabricated from CRCA sheet steel with white powder coating and corrosion proof. The CRCA sheet shall not be less than 0.7 mm thick. The reflector shall be stove enameled light dove grey outside & reflecting white inside and corrosion proof. A channel cover shall be provided. The luminaire shall be prewired & shall be provided with power factor improvement capacitor, vacuum pressure impregnated copper holders and main connector. An elegant acrylic transparent cover clamped to the fixture shall also be provided. The fixture shall be provided with light source also. The lighting fixture shall be similar to TDC 10 Philips make or equivalent.
SPECIFICATION FOR ELECTRICAL WORK
MEDIUM VOLTAGE DISTRIBUTION SYSTEM

1. **Internal Wiring for lighting and power**
   This specification covers, system and method of wiring, definition of point wiring, and supply, installation, connection, testing and commissioning of point wiring for light points, fan points, convenience socket outlet points, power socket outlet points, bell outlet points, etc. Wiring shall be with copper conductor PVC insulated wires drawn in PVC conduits, concealed in or surface erected on wall, ceiling etc. or in surface erected PVC casing and caping.

   Wiring shall be from meter rooms to distribution boards, from D.B. to switch boards and from switch board to outlet points. The method of wiring for this particular work shall be as mentioned under paras of work and Bill of Quantities.

2. **System of wiring**
   Medium voltage distribution system shall be applicable for wiring three phase, 4 wire, 415 V, 50 Hz, AC supply and single phase, 2 wire, 230 V, 50 Hz, AC supply.

3. **Applicable Standards**
   1. IS:732 Code of Practice for Electrical wiring installation (System voltage not exceeding 650 V).
   2. IS:1646 Code of Practice for fire safety of buildings (General) Electrical Installation.
   3. IS:9537 Rigid steel conduits for electrical wiring.
      Part II
4. IS:2667 Fittings for rigid steel conduits for electrical wiring.
5. IS:3480 Flexible steel conduits for electrical wiring.
6. IS:3837 Accessories for rigid steel conduit for electrical wiring.
7. IS:694 PVC insulated cables.
8. IS:2509 Rigid non-metallic conduits for Electrical wiring.
10. IS:6946 Flexible (Pliable) non-metallic conduits for electrical installation.
11. IS:12S3 3 pin plugs and sockets.
12. IS:8130 Conductors for insulated electric cables and flexible cord.
14. IE : Rules Indian Electricity Act
15. IS:5133 Boxes for enclosure of electrical accessories.
   Part-I : Steel and CI boxes.
16. IS:371 Ceiling roses (Second revision)
17. IS:4615 Switch socket outlets (Non interlocking type)
18. IS:3854 Switches for domestic and similar purposes.

4. **General Requirements** :

4.1 **Drawings**

a. Prior to laying of conduits, the contractor shall submit the shop drawing for layout of conduits for approval. The drawing shall indicate the route and the no. and sizes 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.

b. Only after the drawings are approved, the contractor shall proceed with the work of laying of conduits and/or erection of PCVC casing caping. The owner reserves the right to modify or alter or reject the shop drawings.
and the contractor is responsible to resubmit the revised / modified
drawing for approval.

4.2 **Site Layout**
Before the conduits are installed, the exact route shall be marked at the site for
approval and the actual work shall be undertaken only after approval.

4.3 **Load Balancing**
Balancing of circuits in three phase installation shall be planed before the
commencement of wiring and shall be strictly adhered to.

4.4 **Definition of Point Wiring**
A point shall consist of the branch wiring from the switch board together with a
switch and point control boxes as required, as far as and including the wiring
accessories such as ceiling fan box or socket outlet point or suitable
termination. A point shall include, in addition, the earth continuity
conductor/wire form the switch board to the earth pin/stud of the outlet/switch
box.

5 **Scope of Work**
The medium voltage distribution system wiring shall be carried out in the
under mentioned manner.

a. Supply, installation, fixing of conduits and PVC casing/caping with
necessary accessories, switch boxes, outlet boxes and pull/junction boxes.

b. Supplying and drawing of wires of required size including earth
continuity wire.

c. Supply, installation and connection of switches; sockets, cover plates,
switch plates, concealed fan hook boxes / fan hooks as specified etc.
d. The point shall be complete with the branch wiring form the switchboards to the outlet point, PVC casing caping with accessories, control switch, socket outlet boxes, ceiling roses, batten/angle holder, connector etc.

6. **Wiring System with PVC Casing Caping**

6.1 This wiring system shall not be used in location which are exposed to sun and rain.

6.2 The PVC casing and caping and its accessories shall be push fit type with fine polished surface both inside and outside. The standard accessories from the same manufacturer as that of casing shall be used for jointing. For reducing the size of a casing a standard reducer junction box shall be used.

6.3 The size of the casing shall be selected as per manufacturers recommendation and in the absence of which selection shall be based on criteria of accommodating required number of wires without over crowding.

6.4 Ceiling and outside walls shall be totally avoided. Also it shall not be buried under plaster or fixed in proximately to gas, steam or water pipes or below the same. For typical locations as indicated above the casting shall be terminated and the wiring extended as directed either in PVC/MS conduits.

6.5 Casing shall be fixed to wall or ceiling by means of suitable flat head screws to plugs at both ends of the casing and at an interval not exceeding 50 cms. Screw heads shall be countersunk type within the casing thickness and shall not protrude out to damage the wires laid inside.
6.6 The casing shall be fixed flat to wall and shall not sag out of the wall surface or there shall be no visible gap between wall and casing at any point.

6.7 All joints shall be made through standard PVC casing coupler to avoid any gaps and to firmly connected two casing caping ends in straight lines.

6.8 Layout of casing wiring shall be such as to avoid corners as far as possible and avoid crossing of conductors inside casing. Where casing and caping have to cross corners and take ends, accessories such as standard elbow caps, right angle corners, external angles, internal angle, three or four way box shall be used. The jointing accessories shall be of same width as that of casing.

6.9 Casing and caping shall be run in lengths as long as possible. All joints shall be cut diagonally in longitudinal section and smoothened down by filing to make a smooth and very close fit. Both ends of the joints shall be screwed and joints in casing shall not be over the joints casing and shall be staggered.

6.10 Casing shall be press fit type and attached to the caping, after all wiring are laid inside the casing. The wires shall be held with wire clips at suitable spacing.

7. **Surface conduit wiring system with rigid steel conduits**

7.1 All conduit pipes shall confirm to IS:1653 and shall have finishing with over baked enamel painting as directed and specified. All conduit accessories shall be of threaded type and minimum dia of the conduits used shall be 25 mm. The wall thickness of conduits shall be 16 SWG for 25 mm dia conduits and 14 SWG for 32 mm and above dia unless specified otherwise.

7.2 The conduit shall have uniform wall thickness and uniform cross section throughout. The welding (ERW) shall be uniform and good such that welded
joints do not yield when subjected to a flattening wt. The conduits shall be free from welding burr. Welded joints shall not break when threaded or bend at an angle. Conduits shall bear the name and trade mark of the manufacturer on earth length. The conduits shall be delivered to the site in original bundles.

7.3 Conduit accessories such as bends, inspection bends, inspection tees, elbows, draw boxes, junction boxes etc. shall confirm in all respects to IS:3837. Boxes shall have internally tapped spouts. Junction boxes and inspection boxes shall be provided with suitable covers.

7.4 Insulated conductors of AC supply and DC supply shall not be bunched in the same conduit. All conduits shall be installed so as to avoid steam and hot water pipes. A separation of 200 mm shall be maintained between electrical conduits and hot water lines in the building.

7.5 Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. In long distance strength runs of conduit, inspection type couplers or draw-in points/boxes at maximum 8 M interval shall be provided. Threads on conduits pipes shall a between 11 mm to 27 mm long and sufficient accommodate pipes in to full threaded portion of couplers or accessories. In case of screwed coupler joints the threads of conduit and coupler shall be free from grease and oil and shall be thoroughly cleaned before making the joints.

7.6 Cut ends of conduits pipes shall have no sharp edges nor any burr left, so as to avoid damage to the installation of conductors while pulling them through such pipes. All conduits ends shall be bushed with wooden bushes.

7.7 The outer surface of conduit pipes including all bends, tees, junction boxes, unions etc. which form part of the conduit system shall be adequately protected
against rust. No bare threaded portion of the conduit shall be allowed unless such are threaded portion is treated with anti corrosive preservative or covered with plastic compound. After the wires are drawn in caudate it shall be painted with enamel paint of shade as directed.

7.8 Conduit pipe shall be fixed by heavy gauge. GI saddles fixed on MS spacers (Galvanized) secured to wall, ceiling with wood plugs or any other approved plugs with screws and all in an approved manner. The spacers and saddles shall be provided at a distance of not more than one meter. However, saddles shall be fixed on either side of couplers or bends or similar fittings at a distance of not more than 300 mm from the center of such fittings.

7.9 All necessary bends in the system including diversions shall be done by bending conduits by pipe bending machine or any other suitable device as far as possible. Bends which cannot be negotiated by pipe bend shall be achieved by inserting suitable solid or inspection type normal bends, elbows or similar fittings or by fixing cast iron inspection boxes which ever is suitable.

Conduit fittings shall be avoided as far as possible on conduits system exposed to weather, however, where necessary, solid type fittings shall be useful. Radius of bend in conduit pipes shall be not less than 75 mm. No length of conduit shall have more than two right angle bends nor deviation from the straight run.

7.10 All outlet for fittings, switches, etc. shall be boxes of suitable metal or any other approved outlet boxes for either surface mounting or flush mounting system.
7.11 In order to minimize condensation or sweating inside the conduits, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects, etc.

7.12 Fixing between conduit and boxes, outlet boxes, switch boxes and the like must be provided with entry spouts and smooth PVC bushes. Joints between conduit and any type of boxes shall be effected by means of conduit couplers in to each of which shall be coupled smooth PVC bush from inside the box. Conduits shall be rigidly connected to the box/boards with check nuts on either side of the entry to ensure proper electrical and mechanical continuity. In any case all the joints shall be fully water tight.

7.13 All screwed and socket connections shall be adequately made fully water tight by the use of proper jointing materials.

7.14 Conduits shall be so arranged as to facilitate easy drawing of wires through them. Entire conduit layout shall be done in such a way as to avoid additional junction boxes other than light points. The wiring shall be done in a looping manner. All the looping shall be done in either switch boxes or outlet box. Looping in junction or pull boxes is strictly not allowed. Where conduits cross building expansion joints, adequate expansion fittings or other approved devices shall be used to take care of any relative movement.

7.15 The conduit layout of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth, conforming to the requirement specified, by means of special approved type earthing clamp efficiently fastened to conduit pipe for a perfect continuity between earth wire and conduit. Gas or water pipes shall not
be used as earth medium. If conduit pipes are liable to mechanical damage they shall be adequately protected.

7.16 The entire conduit system including boxes shall be thoroughly cleaned after completion of escalations and before drawing of wires. Conduit system shall be erect and straight as far as possible. The where water may accumulate from condensation are to be avoided and if unavoidable, suitable provision for draining the water shall be made.

7.17 Conduits shall be installed in such a way that the junction deviation and pull boxes shall always be accessible for repairs and maintenance work. The location of junction/pull boxes shall be marked on the shop drawings.

8. **Concealed/recessed conduit wiring system with rigid steel conduit**

8.1 In addition to the requirements as specified for surface conduits wiring system, the recessed conduit wiring system shall conform to the following requirements.

8.2 All the conduits including bends, unions, junction boxes etc. shall be cleaned and painted with two coats of bitumen pant, if specifically called for, before they fixed in position.

8.3 Conduits embedded in concrete shall be installed on the prepared shuttering work before pouring concrete. The conduits shall be installed above the bottom reinforcing bars, and shall provide positive wire fastening of the conduit to reinforcing rods at an interval of not more than one meter. But on either side of couplers or bends or outlet/pull/junction boxes or similar fittings, proper hold fast shall be fixed at a distance of 30 cm from the center of such fittings.
8.4 Before conduits are laid in the ceiling the positions of outlet points, point control, junction boxes shall be set out dearly so as to minimize off-sets and bends. The conduit shall be properly threaded and screwed into sockets, bends, junction boxes, outlet boxes and shall be made watertight by using bituminous hemp yam at the screwed ends.

8.5 Conduits embedded in the wall shall be fixed inside the chase. The chase in the wall shall be neatly made and be of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under constriction, chases shall be provided in the wall, ceiling, etc. at the time of their construction and shall be filled up neatly with cement mortar after erection of conduit and brought to the original finish of the wall. Cutting of horizontal chases in walls is not recommended.

8.6 The conduit pipe shall be fixed inside the chase by means of staples or by means of saddles not more than 60 cm apart. Fixing of standard bends or elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with along radius which will permit easy drawing-in of conductors. All the threaded joints of rigid steel conduit shall be treated with some approved preservative compound to secure protective against rust. The ends of pipes shall be bushed and sealed with compound after the wires are drawn-in to prevent ingress of moisture.

8.7 The outlet boxes, point control boxes, inspection and draw-in boxes shall be fixed as and when conduit is being laid. The recessing of conduits in wall shall be so arranged as to allow at least 12 mm plaster cover on the same.
8.8 Suitable cast iron or mild steel inspection boxes as specified shall be provided to permit periodical inspection and to facilitate removal of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers.

8.9 All outlets, such as boxes for fixing switches and wall sockets, may be either of flush mounting type or of surface mounting type as specified.
   a. Flush mounting type: All flush mounting outlets shall be of cast iron or mild steel boxes with a cover of approved insulating materials or shall be a box made of a suitable insulating material. The switches and other accessories shall be mounted on such boxes as would be approved. The metal box shall be efficiently earthed with conduit by an approved means of earth attachment.
   b. Surface mounting type: If surface mounting type outlet box is specified, it shall be of any approved insulating material and all accessories mounted in approved manner.

8.10 Where conduits pass through expansion joints in the building, adequate expansion fittings or other approved devices shall be used to take case of any relative movement.

9. **Surface and/or recessed/concealed conduit wiring system with rigid PVC conduit**

9.1 All non metallic PVC conduits used shall conform to IS:2509. The conduit may be either threaded type or plain type as specified in IS:2509 and shall be used with corresponding accessories as per IS:3419. PVC conduits shall be rigid, unplasticised, heavy gauge having wall thickness as per IS. The accessories shall be of same make as that of the conduit. Standard circular boxes shall be used at junctions, lighting points, draw in points etc.
9.2 All boxes shall have tapped brass inserts within the pillars. In damp or exposed situations box cover shall be fitted with neoprene rubber gaskets. All box covers shall be fitted to boxes with greased brass cheese head screws.

9.3 Caution shall be exercised in using the PVC conduits in location where ambient temperature is 50 degree Celsius or above. Use of PVC conduits in places where ambient temperature is more than 60 degree C. is prohibited.

9.4 Conduits shall be joined by means of screwed or plain couplers depending on whether the conduits are screwed or plain. Where there are long runs of straight conduit, inspection type couplers/pull boxes shall be provided at intervals. In case of screwed coupler joints, the threads of conduit and coupler shall be free from grease and oil and shall be thoroughly cleaned before making the joints. In case of plain coupler joints, proper jointing material like a vinyl solvent cement (gray in colour) or any material as recommended by the manufacturer shall be used.

9.5 Conduit pipes shall be fixed by heavy gauge GI saddles fixed on MS spacers (galvanized) secured to wall, ceiling with wood plugs or any other approved plugs with screws and all in al approved manner. The spacers and saddles shall be provided at a distance of not more that 60 cms. However, saddles shall be fixed on either side of couplers or bends or similar fittings at a distance of not more than 30D mm from the center of such fittings. PVC spacers and saddles shall be used if specified.

9.6 Wherever necessary, bends or diversions may be achieved by bending the conduits or by employing normal bends. No bends shall have radius less than 2.5 times outside diameter of the conduit. Bending spring of the correct size
shall be used to form all bends in conduits. All bends in conduits shall be slow hand made bends. Factory made bends, elbows, tees, and other fittings shall be avoided as far as possible.

9.7 Conduit fittings shall be avoided as far as possible in outdoor installation.

9.8 The other requirement shall be as specified for conduit wiring system with rigid steel conduits.

9.9 Sockets or couplings shall be of heavy duty type and shall not in any circumstances be cut. Female bushes shall be of the smooth bore type externally threaded.

9.10 No draw wires shall be left in conduit during erection of conduit. Conduits shall be arranged for the drawing system and wiring shall not commence until all ceiling and walls are plastered.

9.11 Concealed conduits shall be run in chase cut in block work or brickwork, fixed by crampets or saddles at intervals of not more than 1.0 metre and deep enough to allow for at least 12 mm of plaster or other rendering cover.

9.12 Conduit in in-situ concrete shall be installed in the center of the slab thickness and fixed to the shuttering and reinforcing bars before the concrete is poured. Conduit boxes for in-situ concrete slab shall be of the deep type to allow the box to fit hard onto the shuttering. Conduit boxes shall be packed with an easily removable materials prior to fixing to the shuttering to prevent ingress of concrete during pouring. Extension rings shall be fitted to boxes after shuttering is struck to allow for the finished face of the ring to be flush with the
plaster surface. At expansion joints in the structure a suitable expansion coupling shall be provided.

Conduit boxes shall normally be fitted at light points only. The approved shall be obtained if the contractor require additional conduit boxes to be fitted in the ceiling. Fan hook boxes shall be used for the fan points. Positions of all lighting points shall harmonize with ceiling pattern. The contractor shall ensure that all light points fit in with the architectural ceiling pattern prior to fixing any points. All conduits boxes under boarded floors shall be readily accessible for maintenance purposes.

Where a surface mounted accessory such as an isolating switch, bell etc. is fixed to a concealed conduit, a flush fitting conduit box shall be fitted behind the accessory to obviate conduit bending out of plaster wall surface, the surface having a bushed or grommeted entry in the back for this purpose.

All the concealed conduits shall be cleaned and proved by drawing a mandrel of slightly less diameter than the conduit immediately after de-shuttering. A draw wire shall be laid in the conduit for pulling the cable in the conduit at later stage.

All the conduits, junction boxes, switch boxes, pull boxes etc. shall be cleaned immediately before pulling in the cables.

10. **Boxes**

10.1 **Junction Boxes**

All the boxes for junction boxes, pull boxes used in conduit wiring system shall be fabricated from 1.5 mm thick mild sheet steel with two coats of enamel paint of approved shade. The boxes shall have smooth external and internal
finished surface. Separate screwed earth terminal shall be provided in the box for earthing purpose. AH boxes shall have adequate no. of knock out holes of required diameter for conduit entry.

The boxes shall be provided with a minimum of four fixing lugs located at the corners for fixing the covers. All fixing lugs shall have tapped holes to take machined brass screws. The boxes shall be sufficiently strong to resist mechanical damage under normal service conditions. Wherever different phase conductors are brought into the same enclosure, phase barriers shall be provided. The boxes shall have removable covers at the top and bottom if specified.

10.2 Switch boxes and outlet boxes
Switch boxes to receive switches, socket outlets, power cutlets, Telephone outlets and fan regulators etc. shall be GI boxes as manufactured by the switch manufacturer for erection of plate type switches.

The depth of the switch board boxes shall be 50 mm and the size shall be selected so as to accommodate required number of switches, sockets and fan regulators without overcrowding the box.

10.3 Fan Regulator
Fan regulators shall be incorporated in the front plate of switchboard and shall form a single unit under one front plate in case of plate type switches erected on GI boxes.

11. Cables
11.1 All cables wires used for internal wiring shall be PVC isolated single core, stranded conductor as specified and of 1100 volts grade and with copper conductors.

11.2 The conductors shall be plain annealed circular copper conductor. The minimum number and diameter of wires for circular stranded conductor shall be as per relevant IS specifications. The insulation shall be PVC compound complying with the requirements of IS specifications and the thickness of PVC insulation shall be as set out in the relevant standards.

11.3 All wires shall be colour coded as follows:

- Single Phase - Red
- Three Phase - Red, Yellow, Blue
- Neutral - Black
- Earth - Green or Green/Yellow (insulated)
- Control (if any) - Grey

11.4 The wires shall be supplied in sealed coils of 100 mtrs. length and bear the manufacturers name, trade mark, ISI mark, voltage grade etc.

11.5 Bunching of Cables

1. Wires carrying current shall be so bunched in the conduit that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit.

2. The number of insulated wires/cables that may be drawn into the conduits shall be as per the following table. In any case conduits having less than 20 mm diameter shall not be used.

3. Bunching of cables is rigid PVC conduits
Maximum permissible number of single core cables that may be drawn in to rigid PVC conduits.

<table>
<thead>
<tr>
<th>Cable size in sq.mm.</th>
<th>Size of conduits (MM)</th>
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<tbody>
<tr>
<td></td>
<td>20</td>
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<td>2.5</td>
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<td>10.0</td>
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4. **Bunching of cables in rigid steel conduits**

Maximum permissible number of single core cables that can be drawn into rigid steel conduits.

<table>
<thead>
<tr>
<th>Cable size in sq.mm.</th>
<th>Size of conduits (MM)</th>
</tr>
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<tr>
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<td>16.0</td>
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</table>

12. **Drawing of conductor**
12.1 No wire shall be drawn into any conduit, until all work of any nature that may cause injury to wire is complete. 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. The drawing and joining of copper conductor or wires shall be executed with due regard to the following precautions.

12.2 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 in the conduit system.

12.3 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.

12.4 Wire ends before connection shall be properly soldered (atleast 15 m length) with special ALCAP soldering flux/copper solder, for copper conductor as the case may be. All strands of wires shall be soldered at the end before connection. The connecting brass-screws shall have flat ends.

12.5 Strands of wires shall not be cut for connecting to the terminals. The terminals shall have adequate cross section to take all the strands.

12.6 All looped joints shall be soldered and connected through terminal block / connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.
12.7 Conductors having nominal cross section area exceeding 4 sq.mm. shall always be provided with crimping type cable sockets.

12.8 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.

12.9 Only certified wiremen and cable jointers shall be employed to do jointing work.

12.10 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.

12.11 Circuit wiring shall be provided with printed PVC identification ferrules at either end bearing the circuit number and designation.

12.12 General wiring installation shall be as under.
   a. **Sub-main wiring**
   
   Wiring from meter room to the distribution boards in individual tenements shall be in concealed rigid PVC conduits.

   b. **Circuit wiring**
   
   Wiring from DB’s to point control boxes for lighting, fan, 5 A sockets call bells etc. and from DS to the power sockets in the case of power wiring.

12.13 The sub-main wiring shall be either three phase, four wire or single phase, two wire system. Each sub-main wiring circuit shall also have its own earth continuity wire. The no. and size of earth continuity wire shall be as per detailed drawings.
12.14 The circuit wiring shall generally be in single phase system. However, a maximum of 3 to 4 single phase circuits belonging to the same pole/phase could be installed in the same conduit or raceway. Each circuit wiring shall be provided with suitable earth continuity conductor as per standard specifications.

12.15 No more than 10 light point/fan points shall be grouped on the one lighting circuit. The load per circuit shall not exceed 800 watts. The minimum size of conductor for wiring of lighting circuit shall not be less than 1.5 sq.mm. power circuit wiring shall not have more than two sockets connected to one circuit.

13. **Joints in the Wiring**

The wiring shall be by looping 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. Conductors shall be continuous from outlet to outlet. For unavoidable joints due to any reason prior permission shall be obtained before making such connections. Joints by twisting conductors are prohibited.

14. **Switches, socket and accessories**

14.1 **Switches**

a. Switches shall confirm to IS:3854, IS:1293 and IS:4615. Switches shall be single pole, single or two way as shown on the drawings.

b. The switches shall be rocker operated with a quite operating mechanism with bounce free snap action mechanism endorsed in an arc resistant chamber. The switches shall have coated silver and silver cadmium contacts. 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.
c. Switches at the same location shall be ganged to form a single unit under cover plate. Where fan regulators are to be provided with the switchboards the same shall be incorporated.

14.2 **Socket**

a. The sockets shall conform to IS:1293. Each socket shall be provided with control switch of appropriate rating. The socket shall be molded type, rated for 250 volts, and either of full 6 Amp or 16 Amp capacity as mentioned.

b. Sockets shall be of three pin type, the third pin being connected to earth continuity conductor. The socket shall be flush modular type. The sockets installed in machine room, plant room or wet/damp areas shall be metal or weather proof type. The socket shall have fully spring socket contacts and solid brass shrouded terminal to ensure positive electrical connections.

c. If specified, the sockets shall be provided with automatic shutters, which opens only when earth pin of the plug inserts in the sockets and provided with three pin plug top suitable to the socket and of the same make as socket.

d. All 6 A sockets, 16 A switched sockets, DP switches, connector boxes etc. shall be as specified and with the finishing and make same as fighting switches. These shall be erected on the boxes as specified in drawings.

14.3 **Industrial type sockets**

Industrial type sockets shall be provided wherever specifically called for, industrial sockets shall be totally metal dad with porcelain base incorporating the pins. Sockets shall have 3 pins for single phase applications and 4 pins and
scrapping earth for 3 phase applications. The sockets shall be provided with suitable metal clad plug top suitable for cable entry. Sockets shall have metal covers with chain. Industrial type sockets shall be provided with a suitable sheet steel housing made of 16 gauge with the socket mounted in flush with cover of the housing.

14.4 **Lamp holder, ceiling roses etc.**

Accessories for light outlets such as lamp holders, ceiling roses, etc. shall be white in colour and in conformity with requirements of relevant IS specification. Ceiling roses shall be 3 plate type wherever specified. Angle holder and batten holder shall be erected on the junction boxes erected on wall / ceiling.

14.5 **Installation of switch, socket and accessories**

a. Connection to be made only after testing the wires for continuity, cross phase etc. with the help of a megger.

b. The switch controlling the light point or fan shall be connected on to the phase wire of the circuit and neutral shall be continuous, having no fuse or switch installed in the line except at the D.B. the third pin of the socket shall be connected to the earth continuity conductor of the circuit.

c. Outlets shall be terminated into ceiling rose for ceiling mounted points. For other wall light points the outlets shall be connected in to a angle holder. For wall plug sockets the conductors may be terminated directly into the switches and sockets.

d. The position of all outlets, point control boxes etc. shall be set out as shown on the drawing but before fixing these, the contractor shall obtain the prior clearance from the engineer with regard to their proper location.

e. The switch boxes, installed back to back in the same wall shall be offset from each other, 150 mm horizontally.
15. **Earthing**

15.1 All earthing systems shall be in accordance with IS: 3043 code of practice for earthing. The type and size of earthing wire shall be as specified separately and in Schedule ‘A’ and drawings.

15.2 The earth continuity conductor shall be similar to circuit cables and shall be drawn through conduit along with other circuit cables. Separate circuit shall run for each water heater, kitchen equipment, window air conditioner and similar outlets at location as shown on drawings.

16. **Testing and Commissioning of installation**

Before a completed installation is put into service, the testing of the installation shall be done as per IS:732.

16.1 **Insulation Resistance**

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

2. 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 circuits provided that the whole installation shall be required to have an insulation resistance greater than one mega ohms.

3. The insulation resistance shall be measured between
   a. Earth to Phase
   b. Earth to Neutral
   c. Phase to Neutral

16.2 **Earth continuity path**
The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earth 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 1 ohm.

16.3 Polarity of single pole switches

1. A test shall be made to verify that every non linked, single pole switch is connected to one of the phase of the supply system.

2. In a two wire installation a test shall be made to verify that all non linked single pole switches have been fitted in the same conductor throughout and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non earthed conductor of the supply.

3. In a three wire or four wire installation a test shall be made to verify that every non linked single pole switch is fitted in a conductor and which shall be labeled or marked for connection to one of the outer or phase conductor of the supply.

16.4 Completion certificates

1. All the above tests shall be carried out in presence of the Engineer in charge and the results shall be recorded in the 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 forms shall be submitted to the Engineer in charge for approval.

2. 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 authorities.
Signature of Tenderer
Date:

Chief Engineer & General Manager (T)
Date:
MCB DB, MCB & RCCB

1. **Miniature Circuit Breaker Distribution Boards**

1.1 Miniature Circuit Breaker Distribution Boards shall conform to IS:2675, IS:8623 and shall be suitable for operation on three phase, 4 wire, 415 V, 50 Hz, AC supply or single phase, 2 wire, 230 V, 50 Hz, AC supply.

1.2 The MCB distribution board shall be in sheet steel endorses with removable type cover with additional acrylic door for procting accidental operation. All the MCB type distribution boards shall be similar to MDS sleek model series 3000 with 100 A busbar capacity.

1.3 Endorser and door shall be made out of 2 mm thick CRCA sheet steel and two tone power coated and of approved shade. The interior shall be of white finish. The DB shall be totally enclosed with dust and vermin proof construction and shall be of domestic pattern.

1.4 Where distribution boards are specified to be complete with an isolator as incomer, the isolator shall be double pole for SP and N distribution boards and 4 pole for TP and N distribution boards.

1.5 Where distribution boards are specified to be complete with MCB+ELCB as incomer, the MCB + ELCB shall be double pole for SP and N distribution boards and 4 pole for TP and N distribution boards.

1.6 Bus bars shall be tinned copper rated 100 Amp. The internal connections in the DB shall be by using stranded copper conductor, PVC insulated wire with copper lugs crimped at both ends. Neutral busbar and earth busbars shall also
be provided in the enclosure. Neutral busbar shall have equal rating of phase busbars.

1.7 Distribution boards shall be provided with circuit identification by means of directory on the front cover. Upon completion of the works, the contractor shall provide and fix accurate framed circuit lists for all distribution boards. These shall consist of Perspex envelopes, fixed securely by an approved method on the inside face of each distribution board front cover into which shall be inserted a neatly typed list of circuits, indicating the number of circuits, phase, cable, size, number of points connected, circuit rating and the loading.

The contractor, shall also provide and fix by means of brass screws tapped into the DB cover, labels, with black letter on a white background with black letter on a white background for all distribution boards, MCB + ELCB, isolators etc. The engraving on the labels and the inscription on the circuit lists shall be approved by the Consultants before the work is carried out.

1.8 All incoming terminals shall be fully shrouded.

1.9 The conduit entry plates shall be removable type and shall be provided at top and bottom. All the conduits shall be properly terminated using Glands, grips, check nuts, female adapters with bush etc.

1.10 Wiring shall be terminated properly using crimping type copper lugs / sockets, identification ferrules shall be provided on all wires.

1.11 2 no. earth terminals shall be provided on each Distribution Board.
1.12 Distribution boards shall be installed surface mounted or recessed mounted as specified and erected at the locations shown.

Surface mounted DB shall be mounted on a suitable size frame made out of angle iron. The hole fasts of the angle iron frame shall be grouted in the wall with cement mortar and the frame shall be painted with two coats of red oxide and two coats of enamel paint of approved shade. The DB shall be mounted on this frame with proper size nut bolts.

Recessed molded DB shall be erected in the chase/cut portion of the wall. The cutting of the walls shall be done while constructing the wall and shall be of adequate size to comfortably accommodate the DB. The cut portion shall be smoothened and made plain and shall be of fine finished. The DB shall be fixed in this chased portion with suitable damps and bolts. The top cover of the DB cabinet shall be projecting out of the wall surface and free from any obstruction so as to open the same smoothly.

2. **Miniature Circuit Breakers**

2.1 MCB’s shall be manufactured in accordance with IS:8828 having a short circuit breaking capacity category M9-9000 Amps at both 240 volts 50 Hz and 240/415 V, 50 Hz and complying with the test requirements for both reference calibration temperatures of 20 degree C and 40 degree C.

2.2 All miniature circuit breakers shall be rated to withstand the fault currents of the circuits they protect without causing any interference in any other protective device associated with the distribution system. At the same time the design of Ca circuit breakers shall be such that, it will protect the circuit for which it is intended and not cause or allow other protective devices to operate when fault conditions apply.
2.3 Miniature circuit breakers shall be capable of carrying its full rated current continuously without tripping out.

2.4 All the miniature circuit breakers shall be fitted with a magnetic undelayed tripping mechanism.

3. **Residual Current Operated Circuit Breakers (RCCB)**

3.1 RCCB’s shall be manufactured in accordance with IS : 12640 and IS : 8828 having a short circuit breaking and earth fault protection up to 9 KA at both 240 Volts 50 Hz and 240/415 V, 50 Hz and complying with the test requirements as per IS : 2640.

3.2 RCCB shall be designed to interrupt the circuit during and earth fault, overload or short circuit. All RCCB shall be high sensitive and calibrated to trip the power supply when the residual current is more than 50% of its calibrated rating. This means that a 30 MA sensitivity RCCB should trip when the residual current is in the range of 15 to 30 mA and a 300 mA RCCB should trip open the residual current is in the range of 150 to 300 mA.

3.3 The RCCB’s shall be truly current operated, which means that it shall be totally independent of the mains voltage for tripping. RCCB must operate for nominal voltage well below the maximum safe value of 10 volts. RCCB shall interrupts the circuit within 30 mS at a leakage current of 30 mA.

3.4 RCCB shall be provided with a neutral advance mechanism. RCCB shall be functioning even in the event of failure of neutral and/or any one or two of phase supply conductor. RCCB shall be provided with trip free mechanism ensuring that the device cannot be reclosed/reset if the fault persists. RCCB
shall be functioning even in the case interchange of load and supply side connections.

3.5 Test button shall be provided to check the correct operation of the unit.

3.6 RCCB shall be designed for a very long life of a minimum of 20,000 operations and shall be capable of withstanding inrush current of 4 to 8 times the rated current. For the proper functioning the RCCB should not require any connection of earthing on the device.

3.7 The device should have high tripping accuracy of less than 5% of rated tripping current. The RCCB shall be provided with dear indication to show whether the tripping is due to current leakage or overload/short circuit.

3.8 The MCB section of RCCB shall be provided with arc chambers and vents are also to be provided to release the arcing products in the atmosphere, so as to increase contact lift and to prevent damage to the insulation. The self extinguishing thermo set plastic material shall be used for body and shall have a modular construction. The device should be vibration proof.

Signature of Tenderer
Date:

Chief Engineer & General Manager (T)
Date:
1. **Scope**
   This specification covers supply of necessary materials, and erection at site, of complete earthing system including earth pits at the locations indicated, earth conductors from earth pit to the respective equipments, switchgears, pillars etc. and making connections, testing at site, commissioning and handing over.

2. **Applicable standards**
   The entire work of earthing system, shall conform to IS: 3043, Indian Electricity Act and Rules and relevant regulations.

3. **General requirements**
   3.1 The earthing shall generally be carried out in accordance with the requirements of Indian Electricity Rules 1956 as amended from time to time and relevant regulations. The following IE rules are particularly applicable I.E. Rule Nos. 32, 51, 61, 62, 67, 69, 88(2) and 90.

   3.2 All earth connections shall be carefully made, visible for inspection, and the testing of individual earth electrode shall be possible.

   3.3 All materials, fittings etc. used in earthing shall conform to IS specifications and in the absence of which the approval of competent authority shall be obtained.

   3.4 The earthing electrode shall be at a minimum distance of 2 meters away from the outer face of the building wall. A minimum durance of twice the depth of the electrode shall be maintained between two earthing station.
3.5 A brick masonry chamber to facilitate easy identification and for carrying out periodical tests and inspection shall be constructed on top of the earth pit.

3.6 All metal conduits, trucking, cable sheets, HT and MV switchgears, Transformers, distribution boards, meters, light fixtures, fans, and all other metal parts forming part of the work shall be bonded together and connected to earthing network as specified.

3.7 Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passage of fault currents.

3.8 Joints shall be soldered, tinned and double riveted. All the joints shall be mechanically, electrically continuous and effective. Joints shall be provided against corrosion.

4. **Earth Electrodes**

4.1 The materials of earth electrode and earth conductors shall be galvanized iron unless specified otherwise in Schedule ‘A’, specifications or drawings.

4.2 The earth electrodes shall be free from paint, enamel, grease etc.

4.3 The earth electrode shall be embedded as far as practicable in a moist soil and below permanent moist level.

4.4 The earth electrode shall not be installed in the proximity of a metal fence.

5. **Types of Earth Electrodes**

The earth electrodes shall be either a pipe electrode or plate electrode, the details of which are as given in the following sections of specifications, drawings and Schedule ‘A’
6. **Pipe Electrodes**

6.1 Pipe electrodes shall consist of 2.5 meter long single piece G.I. pipe of min. 40 mm dia as specified and shall be cut tapered at the bottom. 12 mm dia holes shall be drilled with 75 mm spacing between the holes and in a staggered manner as indicated in IS:3043.

6.2 The electrode shall be buried vertically in a specially prepared earth pit of size 35 cm x 35 cm and the earth pit shall be filled with ultimate layers of charcoal, salt and fine washed sand for a minimum thickness of 150 mm. A funnel with wire mesh inside shall be fixed to the top of the GI pipe for watering purpose.

6.3 The earth conductor of 25 x 3 mm GI strip shall be connected to the electrode just below the funnel with proper terminal Lugs and check nuts and the other end of earth conductor shall be connected to the equipotential bus of the equipment.

6.4 A masonry chamber with a cast iron cover hinged to the cast iron frame embedded in the top portion of the masonry shall be constructed on the top of the G.I. pipe to house the funnel and the earth connection. The approximate size of the chamber shall be 300 mm x 300 mm and 300 mm deep.

6.5 The earth conductor from electrode shall be taken out of the masonry chamber through a protecting pipe embedded in masonry.

6.6 The top of the masonry chamber shall be 50 mm above the finished ground level.
7.0 **Plate Electrode**

7.1 The plate electrode shall consist of either copper plate of size 60 cm x 60 cm x 3.15 mm or G.I. plate of size 60 cm x 60 cm x 6.3 mm, and as specified in the schedule ‘A’ of drawing.

7.2 The electrode shall be buried vertically in a specially prepared earth pit which shall be dug upto 2.5 m depth, from the ground level. The earth plate shall be laced in the earth pit with its faces vertical and embedded in the alternate layers of coal and salt for a minimum thickness of 15 cms.

7.3 The earth conductor shall of same material as of the earth electrode. For copper earth electrode copper strips shall be provide as conductor and for GI earth electrode GI strips shall be used as earth conductor.

The size and material of the earth conductor shall be as specified separately in the Schedule ‘A’ or drawings. The earth conductors shall be connected to the earth electrode (Plate) with G.I. nut bolts, check nuts and washers and welded at the edges and shall be brought up in the masonry chamber at the ground level.

7.4 The earth conductor shall be extended via the earth link provided in the masonry chamber. This link shall be corrected to earth conductors from the earth plate and earth conductor going to equipment with two nos. of nut-bolts, check nut and washers (all of G.I.) make secured connections. This link can be removed in the chamber for testing the earthing.

7.5 A 20 mm dia GI pipe shall be provided from the masonry chamber to the top of the earth plate for watering purpose. The GI pipe shall be provided with a funnel at the top with wire mesh inside.
7.6 A masonry chamber with a cast iron cover hinged to the cast iron frame embedded in the top portion of the masonry shall be constructed on top of the GI pipe to house the funnel and the earth connection. The approximate size of the chamber shall be 300 mm x 300 mm and 300 mm dep.

7.7 The earth conductor from electrode shall be taken out of the masonry chamber through a protecting pipe embedded in the masonry.

7.8 The top of the masonry chamber shall be 50 mm above the finished ground level.

8. **Earth Conductor**

All earthing conductors shall be high conductivity copper and or GI as specified and shall be protected against mechanical injury or corrosion. The connection of earth continuity conductors of earth bus and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable damps made of non ferrous metals.

8.1 The cross-sectional area of earthing conductor shall not be smaller than half that of the largest current carrying conductor, subject to the minimum size being not less 1.5 sq.mm. for copper and 2.5 sq.mm. for aluminum conductors and the upper limit being 10 sq.mm. for copper and 120 sq.mm. for aluminum. The size of the galvanized iron earth continuity conductors may be equal to the size of the current carrying conductors with which they are to be used.

8.2 As a guide line the following sizes of earth continuity conductors shall be used for earthing installation.
8.2.1 Size of earth conductors for lighting and power circuits.

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<thead>
<tr>
<th>Cross sectional area of current carrying conductor copper</th>
<th>Cross sectional area of earth continuity conductor Copper</th>
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<tr>
<td>Size in Sq.mm.</td>
<td>Size in Sq.mm.</td>
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8.2.2 Size of earth conductors from main switch board to sub-main switches or distribution boards.

<table>
<thead>
<tr>
<th>Cross sectional area of current carrying conductor copper/Alum.</th>
<th>Cross sectional area of earth continuity conductor Copper</th>
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<tr>
<td>Size in Sq.mm.</td>
<td>Size in Sq.mm.</td>
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<td>70</td>
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</table>
8.2.3 The size of an earth continuity conductor contained in a flexible cable or flexible cord shall be equal to that of the current carrying conductor.

9. **Earth Connection**

9.1 All metal clad switches and other equipment carrying single phase current shall be connected to earth by a single connection. All metal clad switches carrying three phase medium voltage and high voltage shall be connected with earth by two separate and distinct connections.

9.2 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. Earthing conductors outside the building shall be laid 600 mm below the finished ground level.

9.3 The overlapping of strips at joints where required shall be minimum 75 mm. The joints shall be reverted in an approved manner. Lugs of adequate capacity and size shall be used for all termination of wires above 6 sq.mm. size and bare copper wire above 2.5 mm dia lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance and properly tinned.

10. **Connection of Earthing Conductor**

The earthing conductors are broadly divided in the following categories.

10.1 Main earthing conductor shall be taken from the earth electrode to the earth bus/connection at the main switch board.

10.2 Sub-main earthing conductor shall run from the main switch board to the sub-distribution boards.
10.3 Final earthing conductor shall run from the sub-distribution boards to the final distribution boards.

10.4 Circuit earthing conductor shall run from the final distribution board to the exposed metal of the equipment to be earthed. This may run directly from final distribution boards or through earth leakage circuit breaker.

10.5 Metal conduits, cable sheathing and armoring shall be earthed at the ends adjacent to switch boards at which they originate or at the commencement of the run by the earthing conductor.

10.6 Earthing conductor endorsed with the current carrying conductors within the flexible cord shall be used only incase of equipments connected by flexible cord.

10.7 Lighting fittings, switches and accessories shall also be provided with an earthing conductor even though they may be rigidly secured/fixed with metallic conduit.

10.8 The electrical resistance of earthing conductors shall be low enough to permit passage of fault current necessary to operate a fuse, protective device or a circuit breaker.

11. **Prohibited Connection**

Use of following as earth conductor is not recommended, and strictly prohibited for earthing an installation or even as a link in an earthing system. Neutral conductor, sprinkler pipes or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures or armour of
cables and conductors, metallic conduits and lighting protection system conductors are all prohibited to be used as earth conductor.

12. **Earth Resistance**
   The earth resistively of the soil where the earthing stations are located shall be submitted to the owner before the earthing work starts and the approval of the owner shall be taken. If the earth resistance is too high and multiple electrode earthing does not give adequate low resistance to earth, then the soil resistively immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, calcium chloride, sodium carbonate.

13. **Testing**
   On completion of the entire installation, the earthing network shall be tested for their resistance to earth in accordance with IS:3043. All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in triplicate to the owners for approval. The following tests shall be conducted.

1. Earth resistance of electrodes
2. Independence of earth continuity conductors.
3. Effectiveness of earthing

__________________ ________________________________
Signature of Tenderer Chief Engineer & General Manager (T)
Date : Date :