

SPECIFICATION FOR INTERNAL ELECTRICAL WORK

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SECTION – 1

TECHNICAL SPECIFICATIONS – GENERAL

- 1.1 These specifications indicate the General requirements for internal electrical work including wiring system, panel boards, cable laying, earthing protection and other related works.
- 1.2 These specifications are drawn to indicate essential requirements and precautions to be taken regarding internal electrical installation for ensuring efficient, safe, economical and practicable use of electrical materials and equipment, in conformity with statutory regulations and easy maintainability of the installations.
- 1.3 Complete work shall be carried out conforming to the provisions of Indian Electricity Act and relevant Indian standard Specifications (ISS). Wherever these regulations are supplemented by the State Electricity Dept., Electricity Undertakings/Boards, Factory inspector and the Safety Engineering Dept. of AI, the installation shall also comply with these requirements. Wherever the specifications given in this booklet differs from those of the statutory regulations, these specifications shall be followed.
- 1.4 On completion of works, wiring diagram for complete installation shall be prepared by the contractor and 4 copies of the same shall be supplied to AI.
- 1.5 All wiring diagrams shall indicate clearly in plan the main switch board, distribution fuse board, the runs of various mains and sub mains and the position of points with their classifications and controls.

All circuits shall be indicated and numbered in wiring diagram and all points shall be given the same number as the circuit to which they are electrically connected. Distribution boards shall also be marked to indicate the circuit number controlled by them.
- 1.6 All materials issued by AI such as fans, equipments, cement etc. will be issued at the AI Stores and transportation to site will be contractor's responsibility. No separate payment will be made towards the transportation.

- 1.7 The Contractor shall prepare fabrication and detailed working drawings and obtain approval of Electrical Inspector, TAC and other local authorities before submitting them for approval of AI. All works shall be carried out only on approval of drawings. Approval of drawings, does not relieve the contractor of his responsibilities to meet the intents of specifications. Wherever service connections are to be obtained from the local supply company, the contractor shall process the application and obtain the power supply. All fees payable to the supply company and Electrical **Inspector** for such service connections will be paid by AI / reimbursed to the contractor as directed by EIC.
- 1.8 Location of panel boards, distribution boards, switch boards, light fittings, cable routes, conduit/ CTS wiring routes, earth pits etc. shall be marked at site and approval of Engineer-in-charge obtained before proceeding with the installation work.
- 1.9 Rated Power, Voltage and frequency of supply of current consuming devices and materials used in installation shall be suitable for the power and frequency of the supply to which these are to be connected.
- 1.10 **Accepted make of materials:**
- 1.10.1 In section 10 Accepted makes of various materials are indicated. Materials of these brand names only shall be utilised for this work.
- 1.11 **STANDARDS:**
- For all materials and equipments Indian standard Specifications shall apply. In the absence of ISS, relevant British Standards shall be applicable. All Specifications, publications mean the latest edition. A list of IS Specifications applicable for internal electrical works is given at Section 15.

SECTION – 2

TECHNICAL SPECIFICATIONS FOR CONDUIT WIRING

2.1 For all industrial premises, conduit system of wiring shall be provided. In case of commercial and domestic premise, conduit system of wiring shall be provided wherever specified.

2.2 Point Wiring:

2.2.1 Point wiring shall include all works necessary for complete wiring of a switch circuit of any length from the tapping point on the distribution circuit to the following through the switch.

- a) Ceiling rose or connector (in the case of ceiling/exhaust fan point).
- b) Ceiling rose (in the case of pendant except stiff pendant point).
- c) Back plate (in the case of stiff pendants and fittings with down rods)
- d) Socket and Outlets (in the case of socket outlets points)
- e) Lamp Holder (in the case of wall brackets, batten points, bulk head and similar fittings).
- f) Call Bell/ Buzzer (in this case the works Via the switch shall be red as “ Via ceiling rose, socket outlet or bell push where no ceiling rose/socket outlets is provided”).

2.2.2 The following shall be deemed to be included in the point wiring.

- a) Switch.
- b) Ceiling rose or connector as required
- c) Any special and suitable M. S. box for neatly housing the connector and covering the fan hook in case of fan point.
- d) Bushed conduit or porcelain where cable pas through walls, floors etc.
- e) Earth wire from the distribution boards to all current carrying apparatus through switch boards, M. S. Boxes etc.
- f) All metal blocks, boards, covers and M. S. Boxes, sunk or surface mounted including those required for mounting fan regulators but excluding those for fixing the distribution switch boards.
- g) All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.
- h) Connection to ceiling rose, connector socket outlets, Lamp holders, switch, fan regulator etc.
- i) Looping in the same switch board and inter connections between points on the same circuit.

- 2.2.3 All points in the distribution system shall be measured under point wiring irrespective of length of circuit from the distribution board.
- 2.2.4 In case of point with more than one light point controlled by the same switch, the complete items shall be considered as separate point and the rate shall be quoted accordingly.
- 2.2.5 A light point controlled by 2 Nos. of control switches shall be measured as one point from the switch to either side of the appliance viz. total of two points.
- 2.2.6 In case of call bell/buzzer point where a single call bell/buzzer is controlled from more than one place with a ceiling rose and bell push, ceiling rose where socket outlets is not provided, the length of point shall be from the call bell/buzzer to the closest bell push. The additional bell-push and wiring on the same point shall be separately quoted for.

2.2.7 **Sub-Main wiring**

- 2.2.8 The sub-main wiring shall mean the length of wiring from main building panel board/distribution switch board to another main/distribution switch board, measured along the run of wiring. Such wiring shall be measured on linear basis.

2.3 **System of Wiring:**

- 2.3.1 The wiring shall be carried out as per the system specified in the tender Schedule. Power wiring shall be kept separate and distinct from lighting and fan wiring. All conductors shall run as far as possible along the walls and ceiling so as to be easily accessible and capable of being thoroughly inspected. In all types of wiring due consideration shall be given for neatness, good appearance and safety.
- 2.3.2 The balancing of circuits in 3 wires on poly phase installation shall be arranged to the satisfaction of Engineer-in-charge. In large/important rooms light fans and socket outlet points shall be distributed over more than one circuit as directed by the Engineer-in-charge.

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2.4 **Flexible Cable:**

2.4.1 Conductor of flexible cable shall be of copper. The minimum permissible size of conductor for flexible cable shall be $16/0.2 \text{ mm} \approx - \text{mm}^2$. Unless the flexible cables and conduits are protected by armour PVC sheaths, these shall not be used in workshops and other places where they are liable to mechanical damage.

2.4.1 Three core flexible cables shall be used for connecting single phase appliance.

2.5 **Rating of lamps, fans etc. :**

2.5.1 For the purposes of connected load calculations, incandescent installations for residential and non residential building shall be rated at 100 W

2.5.2 Table fans shall be rated at 50/60W. Exhaust fans shall be rated according to their capacity.

2.5.3 5 Amp socket outlet point and 15 Amp socket outlet point shall be rated at 100W and 1000W respectively, unless the actual values of loads are known or specified.

2.6 **Joints and loop back :**

2.6.1.1 Unless otherwise specified, the wiring shall be done in the 'Looping system'. Phase or light conductor shall be looped at the circuit box and neutral connected shall be looped from the light, fan or socket outlet. In non residential buildings neutral conductor and earth continuity wire shall be brought to each circuit board, circuit switch in rooms and halls. These shall be terminated inside the switch board and shall be of adequate sizes to accommodate minimum of 1 No. 5 Amps socket outlet and control switch in future.

2.6.2 Wherever wires are to be connected together, mechanical connector of adequate ratings shall be made use of. Under no circumstances twisted joints shall be allowed.

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2.7 **Control at point of entry of supply.**

2.7.1 There shall be a linked main switch gear with fuse on each light conductor of the supply mains at the points of entry. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switch gear.

2.7.2 The neutral shall be distinctly marked.

2.7.3 The main switch gear shall be situated as near as practical to the termination of service line and shall be easily accessible without the use of any external aid.

2.7.4 On the main switch gear, where the conductors include earth conductor of a 2 wire system or on earthed neutral conductor of a multi wire system or a conductor which is to be connected thereto, the permanent indication shall be provided to identify the earthed neutral conductor (Rule 32 (i) of Indian Electricity Rules 1956 refers).

2.8 **Switch Boards:**

2.8.1 Metal clad switch gear shall be mounted on wall, columns etc. by suitable mechanical means so as to ensure firm mechanical supports.

2.8.2 Hinged type boards shall consist of a box made of sheet metal clad, switch gear, distribution boards etc.

2.8.3 Hinged metal boards shall consist of a box made of sheet metal of 6 SWG gauge thick and shall be provided with hinged cover to enable board to be swung open for the examination of the wiring at the back. The joint shall be substantially welded.

2.8.4 All wires passing through metal boards shall be bushed.

2.8.5 No apparatus shall project beyond any edge of the panel. No fuse body shall be mounted within 2.5 cms of any edge of the panel.

2.8.6 Fixed type metal boards shall be provided for large switch boards where number of switch gears and/or higher capacity metal clad switch gears are to be mounted.

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- 2.8.7 Fixed type metal boards shall consist of an angle or channel iron frame fixed on the wall or on the floor and supported on the wall at the top. There shall be a clear distance of one meter in front of the switch board. The working distance of one meter behind the switch board is preferable.
- 2.8.8 The detailed design and drawings for metal boards and angle iron frame work including the disposition of the various mounting, which shall be systematically and neatly arranged for arriving at the overall dimensions shall be prepared and submitted before hand for approval of the Engineer-in-charge.
- 2.8.9 In case of convenience power outlets in industrial premises of 15/30 Amps the boxes shall be made out of sheet metal 16 gauge and of size 300 x 250 mm. The socket outlet shall be of Reyrolle type two pin and earth. A 30 Amps switch, double pole metal clad shall be provided for the socket outlet. For the socket outlets, protective cover with connecting chain shall also be provided.
- 2.8.10 In case of commercial and residential buildings or wherever specifically indicated power outlets with flush type 15 Amps socket outlet and 15 Amps control switch shall be provided.

2.9 Marking of Apparatus:

- 2.9.1 When a board is connected to voltage higher than 250 volts, all the terminals or leads of the apparatus mounted on it shall be marked in the following colours to indicate the different poles or phase to which apparatus or its different terminals may have been connected.

Alternating Current

Three phases-Red, Blue, yellow,
wires
Neutral - Black

Direct Current

Three Wire System 2 outer
Neutral - Black

- 2.9.2 Where a board has more than one switch gear, each such switch gear shall be marked to indicate which section of the installation it controls. The main switchgear shall also be suitably marked. Where there is more than one switch board in the building, each such switch board shall be marked to indicate which section of the installation and building it controls.
- 2.9.3 All marking required under this rule shall be clear and permanent.
- 2.9.4 In the cable boxes for all the switchgears, the size and number of cables connected to it shall be suitably marked.
- 2.9.5 All distribution boards shall be marked 'lighting' or 'power' & essential lighting / power as the case may be and also marked with the pressure and number of phases of the supply. Each distribution board shall be provided with a circuit list giving details of each circuit which it controls and the current rating of the circuit and size of the fuse element.
- 2.9.6 **Capacity of Circuits:**
- 2.9.7 Lights and fans may be wired on a common circuit. Such circuit shall not have more than a total of 8 points of light, fan and socket outlets or a load of 800 watts, whichever is less.
- 2.9.8 The power circuits shall be designed with one outlet per circuit unless otherwise specified, The circuits shall be designed based on the loading of the circuit. Where not specified, the load shall be taken as 2000 watts per circuit.
- 2.10 **Type and size of Conduit:**
- 2.10.1 Conduit pipe used in wiring system shall be of 16 gauge for sizes upto 32 mm and 14 gauge for sizes above 32 mm. Conduit pipes shall be solid drawn or formed by electric resistance welding (ERW) finished with galvanized or stove enameled surface. All conduit accessories shall be of thread type. Pin grip type or clamp grip type accessories shall not be used. The maximum number of PVC insulated 250 volts grade aluminium conductor cable that can be drawn in one conduit of various sizes is given in Table I and the number of cables per conduit shall not exceed this. Steel conduit of size less than 19 mm in diameter shall not be used.

2.11 **Bunching of cables:**

2.11.1 Cables carrying direct current may be bunched whatever their polarity, but cable carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

2.12 **Conduit Joints:**

2.12.1 Conduit pipes shall be jointed by means of screwed – screwed accessories only. In long distance straight run of conduit, inspection type completes at reasonable intervals shall be provided. In the latter case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipe in all cases shall be between 13 mm to 19 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have no sharp edges nor any burrs left to avoid damage to the insulation or conductors while pulling them through such pipes. After laying of the conduit the bare threaded portion shall be treated with two coats anti-corrosive preservative.

2.13 **Protection of conduit against rust:**

2.13.1 All the conduit pipes including accessories shall be given 2 coats of duco paint of white colour or any other colour if specified so as to avoid damage to conduit due to rust. It will be ensured that no bare threaded portion of conduit is allowed to be energized unless they are treated with anti corrosive preservative and painted.

2.13.2 Conduit shall be laid at a minimum distance of 100 mm from the pipes of other non electrical device.

2.14 **Fixing of Conduit:**

2.14.1 Conduit run on surface shall be supported on M.S. Spacers 3 mm thick, painted with 2 coats of anticorrosive primer, which in turn are properly screwed to the wall or ceiling. Rawl plugs or phil plug shall be used for fixing the spacers. Conduit pipes shall be fixed on the spacers using C. I. saddles of suitable size and heavy gauge (SWG). Saddles shall be at intervals of not more than 50 cm. Conduit shall be neatly run parallel or at right angle to the walls of the buildings.

- 2.14.2 Saddles shall not be less than 24 gauge for conduit upto 25 mm diameter and not less than 20 gauge for larger diameter.
- 2.14.3 Where conduit pipes are not to be laid along the trusses, steel joints etc., the same shall be secured by means of ordinary clips or girder clips as approved by the Engineer-in-charge. Where is not possible to drill holes in the truss members suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girder clips and clamps shall be approved by the Engineer-in-charge.
- 2.15 **Bends in Conduit:**
- 2.15.1 All necessary bends in the system including diversion shall be done by bending pipes or by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes whichever is most suitable. Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary solid type fittings shall be used. Radius of bends in conduit pipes shall not be less than 7.5 cm.
- 2.16 **Outlets:**
- 2.16.1 The switch or regulator boxes shall be made of metal on all sides. In case of office buildings Hylam sheets/bakelite sheets of 3 mm thickness and white colour finish may be used for the front side of the box. In Industrial buildings, the front side of the boxes shall also be of mild steel. In case of cast iron boxes, wall thickness shall be atleast 3 mm and in the case of welded mild steel sheet boxes the fabrication shall be carried out from 16 gauge sheet steel. The edges of the M.S. Boxes shall be folded inside to support bakelite/hylam sheet. In no case M. S. Boxes with corner pieces welded for supporting the hylam sheet shall be provided.
- 2.16.2 In case of M.S. Cover for the front side of the switch boards, all the four edges of these cover shall be folded inside for a depth of atleast 4 mm.
- 2.16.3 Clear depth of the box shall not be less than 50 mm and this shall be increased suitable to accommodate mounting of fans regulator in flush pattern.

- 2.16.4 Only a portion of the M.S. Boxes shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.
- 2.16.5 Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in sheet steel boxed with cover plates as specified. Chromium plated brass screws shall be used for fixing of switches.
- 2.16.6 Power Point wiring shall be distinctly separated for light Point wiring. Conduits not less than 25 mm and wires not less than 6 sq. mm aluminium or equivalent copper shall be used for power wiring.
- 2.17 **Earthing of Conduit:**
- 2.17.1 The conduit of each circuit or section shall be completed before conductors are drawn. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently specified in earthing system.
- 2.17.2 Bare earth wire of size not less than 12 gauge aluminium shall be run with each conduit and clamped along the run and specifically across threaded joints using copper earth clamps.
- 2.17.3 Gas or water pipe shall not be used as earth medium.
- 2.17.4 If conduit pipes are liable to mechanical damage they shall be adequately protected. In a conduit system, pipe must be continuous when passing through walls or floors.
- 2.18 **Flexible steel conduit:**
- 2.18.1 Flexible conduit shall be used only where absolutely unavoidable. Flexible conduits shall be formed from the continuous length spiral antilocked strip steel with fused zinc coating on both sides. The conduit shall be terminated in brass adapters.
- 2.18.2 All unused conduit entries shall be blocked off in an approved manner and where conduits are terminated in adapter boxes, all removable box covers shall be firmly secured to provide complete. enclosures.

2.19 **Recessed conduit wiring system:**

2.19.1 Recessed conduit wiring system shall comply with all the requirements of surface conduit wiring and in addition shall also comply with following requirements.

2.19.2 **Making of chase**

The chase in the wall shall be neatly made and of ample dimensions to permit the flexing of conduit pipe in an approved manner. In case of building under construction, conduit shall be burried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick masonry work, special care shall be taken to fix the conduit and accessories in position alongwith the building work. In case of new construction the scope of work under the electrical contractor shall be responsible for providing chase in the wall, fixing up the conduits and finishing of the wall complete. However, final painting after plastering will be carried out by the agency.

2.19.3 **Fixing of conduit in case:**

The conduit pipe shall be fixed 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 possible and all curves maintained by bending conduit pipe itself with long radius which will permit easy drawing of conductors. All threaded joints of conduit pipes shall be treated with approved 'preservative compound' to ensure protection against rust.

2.19.4 **Inspection boxes:**

Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection to facilitate replacement of wires, if necessary. These shall be mounted flush with the suitable ventilating holes shall be provided in the inspection box covers.

2.19.5 **Types of accessories to be used:**

All outlets such as switches, wall sockets etc. may be either flush mounting type or surface mounting type as specified. The outlet box shall be efficiently earthed with conduit by an approved means of earth attachment.

To facilitate drawing of wire in the conduit G.I. fish wire of 10 SWG shall be provided along with laying of recessed conduit.

2.20 **Wires:**

- 2.20.1 All wires shall be PVC insulated single core copper or aluminium as specified and shall be any 660 volts grade.
- 2.20.2 Wires of single strand is permissible upto 2.5 sq. mm size. Beyond this size wires with stranded conductors only be used.
- 2.20.3 All wiring termination shall be with crimped lugs except in case of termination on piano type switches and piano type sockets outlets.
- 2.20.4 Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the Engineer-in-charge before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor chocked at the time of pouring the concrete. Suitable fish wires shall be drawn in all conduits before they are embedded.
- 2.20.5 No conduit shall be buried in concrete or plastered unless the work has been inspected and inspected and approved by the Engineer-in-charge.

2.21 **Mode of Measurement:**

- 2.21.1 Sub main wiring from main building panel or distribution panel to sub distribution panels shall be measured on linear basis and paid separately.
- 2.21.2 Wiring from distribution board to the ceiling rose or socket outlet through the switchboard shall be measured on point basis and shall include for all the items as indicated in the detailed specifications.
- 2.21.3 Socket outlets on the lighting distribution boards shall be measured and paid separately.
- 2.21.4 Building panel board, distribution boards, light fittings ceiling fans and exhaust fans shall also be measured and paid separately.
- 2.21.5 Incase of power point, the point wiring shall include for the wiring from distribution board right upto the power outlet including isolating switch, socket outlet etc. all as specified.

Table – I
 MAXIMUM PERMISSIBLE NUMBER OF 250 V GRADE SINGLE CORE
CABLES THAT CAN BE DRAWN INTO RIGID STEEL CONDUCTITS

Size of Cable													
Nomina l Cross Sectional Area mm ²	Number of Diameter in mm of Wires	20		25		32		40		50			
		S	B	S	B	S	B	S	B	S	B	S	B
1.5													
2.5												-	-
4												-	-
6												-	-
10								8	6			-	-
16								7	6			-	-
25								5	4	8	6	9	7
35								4	3	7	5	8	6
50								2	-	5	4	6	5
								2	-	5	4	6	5

* For copper conductors only.
 + For aluminium conductors only.

MAXIMUM PERMISSIBLE NUMBER OF 250 V GRADE SINGLE CORE
CABLES THAT MAY BE DRAWN INTO RIGID NON METALLIC
CONDUITS

Size of Cable		Size of Conduit (mm)				
Nominal Cross Sectional Area mm ²	Number & Diameter in mm of Wires	20	25	32	40	50
		(Number of Cables, Max)				
1.0	1/1.12*	7	13	20	--	--
1.5	1/1.40	6	10	14	--	--
2.5	1/1.80 3/1.06*	5	10	14	--	--
4	1/2.24 7/0.85*	3	6	10	14	--
6	1/2.80 7/1.06*	2	5	8	11	--
10	1/3.55+ 7/1.40*	-	4	7	9	--
16	7/1.70	-	2	4	5	12
25	7/2.24	-	-	2	2	6
35	7/2.50	-	-	-	2	5
50	7/3.00+ 19/1.80	-	-	-	2	3

* For copper conductors only

+ For aluminium conductors only.

SECTION – 3

TECHNICAL SPECIFICATIONS FOR CTS WIRING

- 3.1 CTS wiring is not permitted for industrial and office buildings. However, in case of residential buildings CTS wiring may be allowed for internal wiring.
- 3.2 Sub-main wiring from the supply company cut-out to the main switch in each flat shall be carried out in surface / concealed conduits only.
- 3.3 Wires used in CTS wiring shall be white colour 250 volts grade PVC insulated PVC sheathed aluminium single core stranded wires of size as specified in Schedule of Quantities.
- 3.4 Teakwood battens used shall be of good quality 12 mm thick well polished and without any burrs. Wooden bends shall be used in all corners.
- 3.5 Tinned brass clips of 34 gauge thickness and of proper size shall be used.
- 3.6 Wooden battens shall be fixed to the wall with rawl plugs/ quick adhesive paste and G.I. plated wood screws of size not less than 40mm shall be used for fixing battens. Fixing screws shall be provided at a distance of not more than 600 mm.
- 3.7 Wooden boards used shall be of good quality, workmanship and finish and varnished insided all polished outside. Full length hinges shall be used for the board. Clips for locking the board shall be of heavy design.
- 3.8 Rates quoted against point wiring shall include for switchboards of adequate size, complete wiring from main switch / D.B. as applicable, round blocks, ceiling rose, connector strips etc. all complete.
- 3.9 Twisted wires are not allowed for looping circuits. Mechanical connectors shall be used for this and the connectors will be fixed to the base of switch boards.
- 3.10 Earth leads of size as specified shall be used for the entire length of wiring.

- 3.11 Wherever wiring crosses walls/beams, PVC/Porcelain pipe sleeves shall be provided for the crossings.
- 3.12 Specifications laid down for conduit system of wiring shall be applicable for CTS wiring also in respect of layout, design of circuit, installation of switchboards etc.
- 3.13 In case of residential buildings, while laying out the wiring system care shall be taken to ensure that lighting circuits, junction of distribution boards are not located in areas where damages due to rain water, leakages from the bath rooms and toilets are likely to take place.
- 3.14 In case of stair case blocks, the junction boxes and control switches wherever provided shall be made flush with the wall.
- 3.15 Main switch board and meter boxes shall be located at the ground floor below the stair case or in a separate room as provided at site. While fixing the location of meter boxes care shall be taken to see that rain water does not flood the meter room during monsoon.
- 3.16 Wherever power supply is to be obtained from the supply company, provision of meter boxes shall be made as per requirements of local supply company.
- 3.17 For lighting point aluminium wires of 1.5 sq.mm or equivalent shall be used. For sub-main wiring sizes of wire shall be not less than 2.5 sq.mm. aluminium or equivalent copper. In case of power circuit 4 sq.mm aluminium shall be made use of. For specified applications like electrical heaters, geysers, cooking range, etc. proper size of conductor shall be selected taking in to consideration the load to be connected.
- 3.18 In case of residential flats where total connected loads exceeds 5 KW, 3 phases distribution board may be obtained depending upon the supply company regulations. In case where 3 phase power supply is obtained for residential premises, care shall be taken to ensure that the distribution of load among the 3 phases are more or less equal.

3.19 Mode of Measurements :

3.19.1 Sub main wiring from main building panel or distribution panel to sub distribution panels shall be measured on linear basis and paid separately.

3.19.2 Wiring from distribution board to the ceiling rose or socket outlet through the switch board shall be measured on linear basis and paid separately.

3.19.3 Socket outlets on the lighting distribution boards shall be measured ++and paid separately.

3.19.4 Building panel board, distribution boards, light fittings, ceiling fans and exhaust fans shall also be measured and separately.

3.19.5 In case of power point the point wiring shall include for the wiring from distribution board right upto the power outlet including isolating switch, socket outlet etc. all as specified.

SECTION – 4

TECHNICAL SPECIFICATIONS FOR CABLE LAYING

- 4.1 All cable shall be PVC insulated, sheathed end steel armoured with an outer PVC protective sheath. Cables shall have high conductivity stranded aluminium conductors and cores shall be colour coded as per Indian Standards.
- 4.2 All cables shall be without any kinks or visible damage.
- 4.3 Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the basis of actual site measurements.
- 4.4 Cable laid directly in ground shall be at a depth of 60 cms for (L.T. Cables) and laid on a bedding of sifted earth sand. After the cables are laid over the sand bedding, burnt bricks shall be placed across the cables and for the entire length of cable. Laying of bricks along the cable shall not be accepted under any circumstances. In case of H.T. cables concrete tiles of approved design and with suitable markings shall be placed above the cables. Road crossings and concreted areas shall be negotiated through buried C.I. / RCC pipes. Cable shall be bent to a radius of not less than 8 diameters, leaving sufficient slack for soil subsidence and loops at both ends. Loops shall be provided at both ends of the cable and near straight through joints as directed by the Engineer-in-Charge. Wherever more than one cable is buried in one trench, non-corroding identification tags shall be provided on each cable at 10 M intervals. In addition suitable galvanized cable markers shall be provided above ground over behinds, loops crossings at every 30 M interval on straight runs.
- 4.5 Cables shall have twin continuous aluminium/G.I. conductors as specified against each item along the entire length of cable for continuous earthing. Cables shall be earthed at both ends.

- 4.6 All cables shall be properly terminated with glands, tinned copper lugs and cables identification tags and shall be properly crimped or soldered with lugs as directed.
- 4.7 All the indoor cables shall be laid on walls, ceilings, inside shafts, with suitable supports. Distance between supports shall not be more than 50 cms.
- 4.8 Cables shall be laid indoors by using 3 mm thick M.S. spacers with G.I. saddles and screws.
- 4.9 Cables laid directly in existing trenches shall be properly supported by M.S. Clamps.
- 4.10 Straight through joints shall not be permitted where the route length does not exceed one full drum length. In case of routes where the length exceeds on full drum length, minimum number of straight through joints as approved by the Engineer-in-charge shall be provided. However, no separate payment will be made for such straight through joints.
- 4.11 Cables shall be tested before laying and after laying but definitely before connecting up to the switch gears.
- 4.12 After the cable installation is complete, the entire installation shall be tested with 500 V insulation resistance tester and following reading established.
- (i) Continuity on all phases
 - (ii) Insulation resistances between conductors, conductors and ground.
- All test readings shall be recorded and handed over to Engineer-in-Charge.
- 4.13 In case of High Tension cables the insulation test shall be carried out using 2000 V meggar. In addition to this pressure test shall be carried out on the H.R. Cables as specified in IS:1255 – Code of Practice for installation & maintenance of paper insulated power cables.

4.14 **Mode of Measurements :**

- 4.14.1 All cabling shall be measured on the basis of unit length and the cost per unit length shall include cost of cable, cost of supports, clamps, labour for installations, testing & commissioning all complete.
- 4.14.2 In the case of cables laid in ground/duct, excavation sand cushioning, brick covering & back filling shall also form part of the cabling.
- 4.14.3 While all cable supporting clamps are to be included in the unit cost of cables, cable trays or cable racks wherever specifically indicated shall be paid extra on unit rates.
- 4.14.4 Cable terminations shall be measured per set and the cost shall include cost of tinned copper lugs, brass glands, all jointing materials, bolts and nuts, M.S. plate support labour and any other incidental items not specifically indicated above.

SECTION – 5

TECHNICAL SPECIFICATIONS FOR ELECTRICAL FITTINGS, FIXTURES AND FANS

- 5.1 Fluorescent Light Fittings :
- 5.1.1 All fixtures shall be complete with accessories and fixing necessary for installation completed in all respects. Fixtures connected to emergency lighting systems shall have distinct red markings.
- 5.1.2 Fixtures shall be installed at mounting heights as detailed on the drawings or instructed at site by the Engineer-in-charge.
- 5.1.3 Fixtures and/or fixture outlets boxes shall be provided with hangars to adequately support the weight of the fixture. Design of hangars and method of fastening shall be as approved by Engineer-in-charge unless otherwise specified in the drawings and tender specifications.
- 5.1.4 Pendant fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Provision for adjustment of height during installation shall be made.
- 5.1.5 Flush mounted recessed fixture shall be installed so as to completely eliminate light leakage within the fixture & between the fixture and adjacent finished surface.
- 5.1.6 Fixture mounted on outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Extension pieces shall be installed where required to facilitate proper installation.
- 5.1.7 Fixture shall be completely wired and constructed so as to comply with the ISS and IE Regulations for Electric Light Fixtures. Fixtures shall bear manufacturer's name & the Factory Inspection Labels.
- 5.1.8 Wherever specific make of fixtures are indicated in the Tender Specifications, the entire fixture shall be Factory Assembled from the manufacturers. Locally assembled fittings with components from primary manufacturers shall not be accepted.
- 5.1.9 Wiring within the fixture and for connection to the branch circuit wiring shall be with wire of size not less than 1.5 sq.m. copper for 250 Volts applications. Insulation of the wire shall suite the temperature conditions inside the fixtures.

- 5.1.10 Sheet metal used for manufacturing of lighting fixtures shall not be less than 22 SWG or heavier if so required to comply with the specification or standards. Sheet Steel reflectors shall have a thickness of not less than 20 SWG. The parts of the fixtures shall be completely free from burrs and tool marks. Soldering shall not be used as mechanical fastening device on any part of the fixture.
- 5.1.11 Ferrous metal shall be given corrosion resistant phosphate treatment or other approved rust inhibiting primer coat to provide a rust-proof base before application of final coat of finish.
- 5.1.12 Non reflecting surface such as fixture, frame, etc. shall be finished with baked enamel paint.
- 5.1.13 Light reflecting surface shall be finished baked white enamel having a reflection factor of not less than 80%. All parts of reflector shall be completely covered by the baked enamel finish and shall be free from irregularities in surface. After the finish coat is applied and cured, it should be capable of withstanding a 6mm radius bend without showing signs of cracking, peeling or loosening from the base metal. Finished surface shall be capable of withstanding 72 hours exposure to an ultra-violet sun lamp placed 10 cm from the surface without discoloration, hardening or warping and retain the same reflection factor after exposure.
- 5.1.14 Fixtures with visible frames shall have concealed hinges and catches. Pendant fixtures and lamp holders shall be provided with ball type aligners or similar approved means for adjustments. Recessed fixture shall be constructed so as to fit an acoustic tile ceiling or plaster ceiling without distorting either the fixture or the ceiling. Plaster rings shall be provided for plaster ceilings. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving.
- 5.1.15 Detailed catalogue and technical data for all fixtures or wherever desired by the Engineer-in-charge, Sample fixtures shall be submitted for approval to the Engineer-in-charge before orders for the fixtures are placed. Shop drawings for non-standard fixture types shall be submitted for approval to the Engineer-in-charge.
- 5.1.16 Recessed fixtures shall be constructed so that all components are replaceable without removing housing from the ceiling.

- 5.1.17 Lamp shall be supplied and installed in all lighting fixtures provided under this contract. Lamps used for temporary lighting service shall not be used in the final lamping of fixtures. Lamps shall be of wattage and type as shown on the drawings. Wherever not shown, the details shall be ascertained from the Engineer-in-charge before procurement. Lamps for permanent installation shall not be placed in the fixtures until so directed by the Engineer-in-charge and this shall however be accomplished immediately before the building portions are ready for occupation.
- 5.1.18 Only single and or two lamp ballast shall be used in any one fixture. Ballasts shall be completely enclosed inside sheet steel casing, and shall have a corrosion resistant finish. Ballasts shall contain a thermosetting type compound not subject to softening or liquefying under any operating conditions or upon ballast failure. Compound shall not support combustion. All ballasts shall be copper wound and shall be of high power factor compensated to above 0.9 P.F. Ballast temperature and sound rating rise shall be specified by the manufacturer and guaranteed. Ballasts shall be for operation at the voltages and frequencies indicated and under temperature conditions prevailing in the various locations of the premises.
- 5.1.19 All fluorescent fixtures shall be provided with separate wiring channel with cover plate and an earth terminal. All screws shall be chromium brass screws. Lamps and starter holders shall be out of tough mounted plastic with spring loaded rotor type contactors rendered shock and vibration proof. Condensers shall be of low oil paper impregnated hermetically sealed type complying with ISS. Internal wiring is passing by the ballast in a suitable heat resistant barrier or sleeve shall be provided.
- 5.1.20 Surface mounted fixture longer than two feet shall have one additional point of support besides the outlet box fixture stud when installed individually. Pendants for individually mounted fixtures of 1.2m long and small shall be provided with twin stem/conduit hangars. Stems shall have ball aligners or similar devices and provision for a minimum of 25 mm vertical adjustment.
- 5.1.21 Stems shall be of appropriate length to suspend fixtures at required mounting height.
- 5.1.22 Lamps, starters and ballasts provided with each fittings shall match the lamp specified.

- 5.2 Incandescent Fittings :
- 5.2.1 Incandescent fittings shall be of the type specified in the drawings and schedule. Contractor shall submit samples to Engineer-in-charge and obtain approval in writing before procurement of fittings.
- 5.2.2 Incandescent fixtures shall be equipped with porcelain, ceiling rose and B.C. type sockets for lamps upto and including 200 watts and screw type base for lamps 300 watt and over.
- 5.2.3 Re-lamping the fixture shall be possible without removing the fixtures from its location.
- 5.2.4 Incandescent lamps shall be inside frosted or clear type as specified by the Engineer-in-charge.
- 5.3 Highbay/Street light fittings :
- 5.3.1 Highbay/street light fittings shall be with HPMV/SON/HALOGEN/MLL Lamps as specified in the schedule.
- 5.3.2 Rates quoted against light fittings shall include for the complete light fittings, control gear, bulb etc. all complete in factory wired and assembled condition. Locally assembled fittings and control gear shall not be accepted. Rate shall also include for fixing arrangement for the fittings and control gear. Fixing arrangements shall have prior approval from Engineer-in-charge.
- 5.3.3 In case of street light fittings, rates quoted against fittings will be excluded from the arm over the pole, but will include for lead wire from pole mounting box and all other hardware necessary to complete the work.
- 5.3.4 Street light poles shall be of M.S. ERW Type conforming to IS 2713-1969. Pole size and other fixing arrangements shall be as per Drawing No.CWP/STD/EM-48D, CWP/STD/EM-51B, CWP/STD/EM-29C or CWP/STD/EM-50B whichever is applicable
- 5.3.5 Sample of the pole shall be submitted and approval of Engineer-in-charge obtained in writing before order is placed for the full quantity.

- 5.3.6 Rate quoted against pole item shall include for excavation, concrete foundation, pole earthing studs, arm for fitting, fixing bracket for control gear, pole cap etc. all complete.
- 5.3.7 Poles shall be erected absolutely vertical.
- 5.3.8 All buried portions of the poles shall be given a primer coat and two coats of bituminous paint. All exposed portions shall be given one primer coat and two coats of aluminium paint before erection. In addition, one more coat of aluminium paint shall be given after the fittings are erected and work completed.
- 5.4 Fans, Regulators and Clamps :
- 5.4.1 Ceiling fans including their suspension shall conform to relevant ISS with secondary safety device incorporated against free fall of fans from their hooks.
- 5.4.2 All ceiling fans shall be wired to ceiling roses or to special connector boxes and suspended from hooks or shackles. There shall be no joints in the suspension rod.
- 5.4.3 In case of "I" beams, the suspension arrangements fabricated out of M.S. plates shall be shaped suitably to catch the flanges and shall be held together by means of laying bolts, nuts, check nut and split pin.
- 5.4.4 For concrete roofs, ceiling fans hooks shall be got buried in the concrete during construction.
- 5.4.5 Fan hooks made of M.S. rods of 15mm diameter shaped in 'U' form with their legs projecting horizontally on the top at least 19 cm on either side and tied over the top reinforcement of the roof shall be laid in the concrete slabs.
- 5.4.6 The suspension arrangement for the fans shall be so designed that the fans canopies shall completely hide suspension element.
- 5.4.7 Unless otherwise specified all ceiling fans shall be hung 2.75M above the floor.
- 5.4.8 In the case of measurement of extra down rod for ceiling fans including wiring, the same shall be measured in units of 10 cms &

length less than 5 cm shall be ignored. The cost of wiring for extra down rod shall be paid as per supplying and drawing cable in existing conduits.

- 5.4.9 Exhaust fans shall conform to relevant ISS.
- 5.4.10 Exhaust fans shall be erected at the places indicated by the Engineer-in-charge. For fixing exhaust fans a circular opening shall be provided in the wall to suit the size of the frame, which would be fixed by means of rag bolts, embedded in the walls, opening shall be neatly plastered to the original finish of the wall. The exhaust fan shall be wired as near to the opening as possible by means of flexible cord. Care being taken that the blades rotate in the proper direction.
- 5.4.11 The exhaust fan for installation in corrosive atmosphere shall be painted with special PVC paint or chlorinated rubber paint. Installation of exhaust fan in kitchen, dark room and such other special locations shall be carried out giving due consideration for the specific requirements.
- 5.4.12 The body of the ceiling fan, exhaust fan and fan regulator shall be connected to the earthing system by proper earth leads.
- 5.5 Mode of Measurements :
- 5.5.1 each lamp, fixtures, shall be measured as a unit complete with all accessories, lamps, mounting, wiring, connection, earthing etc. all complete.
- 5.5.2 Each street light pole shall be measured as a separate unit complete including excavation, erection of pole, pole cap, bracket etc. all as specified and in conformity with the drawing and specifications.
- 5.5.3 Exhaust fan and ceiling fans shall be measured as a complete unit including fixing up and connecting the fans, regulator, earthing arrangement, blanking opening in the wall, in case of exhaust fan etc.

SECTION – 6

TECHNICAL SPECIFICATIONS FOR CIRCUIT BREAKERS, PANEL BOARDS AND DISTRIBUTION BOARDS

- 6.1 Circuit Breakers :
- 6.1.1 Circuit breakers shall preferably be air break horizontal type fully interlocked and meeting the requirements of IS:2516 or BS:3659. Breakers shall be rated for a medium voltage of 600 V and rated full load amperes as indicated on drawings. Breakers shall be capable of making and breaking system short circuits.
- 6.1.2 Breakers shall be manually operated complete with panel operating handle, isolating plug with safety shutters, mechanical ON/OFF indicator, silver plated arcing and main contact arc chutes and tripfree operation. Breakers shall be capable of being racked out into 'Testing', 'Isolated' and 'Maintenance' positions and kept locked in any of the positions.
- 6.1.3 Over current releases shall be triple pole direct acting trips and all such tripping devices/shall be capable of discriminating with MCCB's down stream. External relays shall be with AC series trips and where shunt trips are incorporated necessary DC source power shall also be provided with associated charger, cabling etc. as forming part of the circuit breaker cost.
- 6.2 Switch Fuse Units :
- 6.2.1 Switch fuse units shall have quick-make, quick break silver plated preferably double break contacts with operating mechanism suitable for rotary operation in the case of cubicle mounting. All Switches shall be rated according to the Schedule of work or drawings and shall withstand the system fault current. Cam operated rotary switches with adequate terminal adaptors upto 25A are acceptable but for all higher rating switch fuse units shall be heavy duty type conforming to I.S.4047.
- 6.2.2 Fuses shall be HRC Cartridge type conforming to I.S.2208 with a breaking capacity corresponding to system fault level. Fuses shall be link type with visible indication. Screw type fuses are not acceptable for any ratings. Fuses shall be provided only in the phase conductors even in case of double pole switches, Neutral, wherever provided, shall have suitable links only.

- 6.2.3 All disconnectors shall consists of switch units quick make, quick break type with silver plated contacts. The switches shall preferably have double breaks. All switches shall be mounted in steel sheet enclosure, which in turn is mounted on suitable angle iron frame work. All switches shall have cast iron enclosure except for ratings where manufacturers do not make switches with cast iron enclosure. For such ratings switches with sheet steel enclosure, supplied by manufacturer as a complete unit shall be supplied. Disconnectors shall have a minimum breaking capacity of 5 KA at 415 volts.
- 6.3 Cubicle Boards :
- 6.3.1 All boards shall be combination 14 and 16 SWG sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle, flush dead front and modular construction suitable for 3 phase 440 V 4 wire 50 Hertz system. All Boards shall be accessible from the front for the maintenance of switch fuses, bus bars, cable terminations, meters, etc. Cables shall be capable of entering the board both from top as well as bottom. All panels shall be machine pressed with punched openings for meter etc. All sheet steel be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panel shall be finished with two coats of red oxide primer and finished with two coats of synthetic enamel paint of approved shade. Engraved plastic labels shall be provided indicating the feeder details, capacity and danger signs.
- 6.3.2 The boards shall accommodate air insulated bus bars, circuit breakers, switch fuse units with HRC fuses, starters, necessary meters, relays, contactors etc. as required and shown on drawings and arranged in suitable tiers.
- 6.3.3 The switch board shall be fully compartmentalized in vertical tiers housing the feeder switches in different totally enclosed independent compartments. Each compartment shall be self-sufficient with switch unit fuses, contactors, relays, indicating lamps and inter-locked door with facility for padlocking. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25 A and cable lugs for higher rating. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with I.S. 2147. Feeder connections shall be out of solid

insulated copper wires or strips with bimetallic clamps wherever required. Internal wiring, bus bar markings etc. shall conform to I.S.S. 375. Internal wiring shall have terminal ferrules. Main switch should be at easily accessible height and the highest switch operating handle should not be over 1.75 M from floor level. Cable glands shall not form part of the switch board, as the cost of glands will form part of the cable termination.

- 6.3.4 Bus bars shall be three phase and neutral and of tinned copper rated for a temperate rise of 35°C over the ambient temperature specified based on bare conductor ratings. Current density shall not exceed 130 Amp/Sq.cm for aluminium and 160 Amp/Sq.cm for copper. Neutral bars may be of one half the size of the phase bars. The main bus bars shall be of uniform cross section and rated for 50% above the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and inter-connections shall be taped with PVC colour coded tape to prevent bar to bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover and shall be supported on non-hydroscopic insulator blocks to with-stand thermal and dynamic overloads during system short circuits. An earth bus of 50% of the phase bar shall be provided subject to the following minima and maxima.

	<u>Copper</u>	<u>Aluminium</u>
Minimum	6.5 sq.mm	10 sq.mm
Maximum	65 sq.mm	120 sq.mm

Individual switch components shall be connected with the earth bus through copper wire/ strips; size of connecting wire being as above. All wire connections to bus bars shall be through lugs, bolts, and nuts and spring washers.

- 6.4 Panel Boards :
- 6.4.1 All the panels shall consist of ammeter, volt-meter of adequate ranges and indicating lamps.
- 6.4.2 Bus bar chamber shall have removable end covers and bus bars shall have bolt holes provided at both ends to enable future extension of panels on either side.

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- 6.5 Industrial Panel Bards :
- 6.5.1 The frame shall be fabricated out of 50mmx 50mm x 6mm M.S. angles and horizontal supports of M.S. flats not less than 50mm x 6mm size. The frame shall be welded, and shall be floor mounting, self supporting type.
- 6.5.2 The bus bar chamber shall be of 14 SWG sheet steel, extensible, totally enclosed, dust tight, vermin proof cubicle, flush dead front and construction suitable for 3 phase 415 V 4 wire, 50 Hertz system. The bus bar chamber shall accommodate bus bars complying with the Technical Specifications given in this section.
- 6.5.3 The switches should be at easily accessible height and the heighest switch operating handle should not be over 1.75 M from floor level.
- 6.5.4 All the interconnections shall be solid copper links and shall be taped properly as per the colour code.
- 6.5.5 Engraved plastic labels shall be provided indicating the feeder details, capacity and cable sizes.
- 6.5.6 'DANGER' sign board shall be fixed on the front cover.
- 6.5.7 The complete frame and bus bar shall be painted to match the switches.
- 6.5.8 Arrangements for terminating earth strip shall be provided on the frame.
- 6.5.9 Cable entry boxes shall be provided for all incoming and outgoing cables.
- 6.5.10 The panel shall be grouted in the floor with all the necessary hardwares.
- 6.5.11 The sub-panels should be mounted on suitable M.S. frames and job includes grouting the same on the wall/ floor with all the necessary hardware.

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6.5.12 Bus bar chamber shall be completely compartmentalized openings made at top and bottom for switches shall be blocked with bakelite sheets and bushed openings provided for interconnecting leads.

6.6 Testing and Inspection :

6.6.1 All switch boards shall be subject to factory inspection before finishing and despatch, unless inspection is waived by Engineer-in-Charge.

6.6.2 Certificates for all routine and type tests for circuits breakers in accordance with the I.S.S. 2516 shall be furnished. In addition, all panels shall be meggered phase to phase and phase to neutral using a 1000 V meggar with all switch gear in closed position. Meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

6.6.3 All meters and relays shall be calibrated and tested at site by contractor before commissioning through secondary injection tests. Tests shall be carried out in the presence of Engineer-in-Charge or his authorized representative.

6.6.4 All secondary wiring and apparatus connected therewith shall withstand 2000 V for one minute.

6.6.5 All field tests shall be witnessed by Engineer-in-Charge and recorded.

6.7 DISTRIBUTION BARDS :

6.7.1 LIGHTING DISTRIBUTION BOARDS :

6.7.1.1 Lighting Distribution Boards shall be either 6, 8 10 outgoing ways or 12 ways as specified in the Schedule of Quantities with isolators.

6.7.1.2 The capacity of each way shall be 5/10/15 amps and only miniature circuit breaker shall be used.

6.7.1.3 30 amps single pole and neutral isolator shall be used at incoming point of lighting distribution boards.

6.7.1.4 The number of points per way shall not exceed eight or the total connected load per way shall not exceed 800 watts.

- 6.7.1.5 All the miniature circuit breakers, isolators shall be housed in a specially fabricated M.S. box of 16 gauge size. The front side shall have detachable flush type door. Box shall be painted with one coat of primer and two coats of DUCO paint of approved colour. Complete distribution boards shall be factory assembled by the manufacturer.
- 6.7.1.6 All the circuit wires shall be properly crimped with lugs and connected to terminals.
- 6.7.2 POWER DISTRIBUTION BOARDS :
- 6.7.2.1 The power distribution boards shall be suitable for 3 phase 440 volts supply 4 ways/ 6 way/ 8 way with 32 amps with neutral bar.
- 6.7.2.2 All the outlets shall be provided with HRC fuse links of 30 Amps capacity.
- 6.7.2.3 Main switch shall be of IC three phase and neutral.
- 6.7.2.4 The capacity of main switch shall be as follows :
For 4 way PDBS 63 Amps
For 6/8 way PDBS 100 Amps
- 6.7.2.5 All the interconnections between distribution board and the switch shall be of solid jumpers / stranded copper wire of suitable capacity.
- 6.7.2.6 All the circuit wires shall be properly crimped with lugs and terminated as per colour codes.
- 6.7.2.7 Only one outlet shall be connected per circuit.
- 6.7.2.8 All the phase strips and neutral links shall be housed in dust proof M.S. Boxes. Complete distribution board shall be factory assembled by Manufacturer.
- 6.7.3 MOUNTING :
- 6.7.3.1 Both lighting and power distribution boards shall be properly mounted on angle iron frame.

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- 6.7.3.2 The angle iron frames shall be grouted on wall with suitable bolts.
- 6.7.3.3 All the distribution boards shall be clearly marked to indicate the various load locations and cable sizes.
- 6.8 MODE OF MEASUREMENTS :
- 6.8.1 Each panel complete with various components, earthing etc. shall be treated as one unit for purposes of measurement and payment.
- 6.8.2 Outgoing feeder termination will be paid for at unit rates separately under cable termination and hence cable glands need not be provided with switch boards unless otherwise specified.

SECTION – 7.0

TECHNICAL SPECIFICATION - FOR EARTHING

7.1 EARTHING :

7.1.1 Earthing Pits :

An earthing pit of 1m x 1m x 2.5 m deep installed with galvanized cast iron plate of 600 mm x 6 mm thick shall be provided. Twin earth leads of G.I. size 25 mm x 3 mm shall be connected to the earth plate by means of tinned copper lugs and brass nuts and bolts. The plaster shall be covered with mixture of charcoal and salt for thickness of 15 cms all around and remaining area filled with general mix of sand & soil. G.I. pipe of 37 mm dia class 'C' shall be installed in the earth pit starting from 15 cms above the earth plate and brought to ground level and shall be provided with a manhole of brick masonry 12" x 12" x 9" (300 mm x 300 mm x 225 mm) around the pipe at ground level with hinged cast iron cover. A bolted and removable link connecting main earth bus outside the pit and portion leading to plates shall be accommodated in this manhole for testing.

7.1.2 Normally an earth pit shall not be situated less than 1.5 mtrs. from any building. Care shall be taken that the excavations for earthing may not affect the footing of the foundations of the buildings.

7.2 The earthing lead shall be securely bolted and soldered to plate. The lead shall be connected by means of cable socket with bolts & nuts.

7.3 The earthing lead shall be suitably protected from mechanical injury.

7.4 No earth electrodes installed shall have a greater ohmic resistance than one ohm as measured by an approved earth testing apparatus.

7.5 The twin strips of size 25 mm x 3 mm of aluminium or G.I. strip shall be connected from earth station to nearest switch gear.

7.6 The cost towards provision and erection of earth station shall include all labour for excavation in soft soil/ hard rock/ concrete apron, back filling of the excavated portion, resurfacing to the original finish including provision of all materials, sundries, consumables and test link.

- 7.7 The entire work shall be carried out conforming to IS 3043-1966.
- 7.8 all connections on the earthing system shall be by means of brass nuts and bolts.
- 7.9 The earth bus and individual earth connecting strips running inside the building shall be suitably supported on wall/columns/under ceiling with proper non-ferrous clamps spaced not more than 900 mm.
- 7.10 SUB EARTHING :
- 7.10.1 From main panel, earthing conductor in twin shall be laid along with the cables for continuous earthing. Sizes of earth wire shall be as specified in the schedule of quantities upto the distribution board.
- 7.10.2 The earth conductors shall be earthed at both ends using properly sized lugs, either by crimping or soldering. Twisted joints are not allowed anywhere in the earthing system.
- 7.10.3 The earth conductors shall be properly fastened to the cables throughout the run.
- 7.10.4 All the conduits either surface or concealed shall be laid with 12 SWG bare aluminium earth conductors along the run of conduits.
- 7.10.5 The copper earthing clamps shall be fastened at threaded joints to ensure proper earthing and all the threaded joints shall be painted with black bituminous paint.
- 7.11 EQUIPMENT EARTHING :
- 7.11.1 Metallic Conduit :
- Bare aluminium earth continuity conductor clamped at one metre intervals shall be provided throughout the length of conduit. Size of conductor shall be 12 SWG aluminium or equal and copper earth clamps shall be used for fixing. Binding wires are not acceptable.
- 7.11.2 Non Metallic Conduit :
- Same as above but with insulated wire drawn inside.

- 7.11.3 Armoured cable :
Two distinct dearth connections to armouring at both ends of size equivalent to 50% of the phase conductor or minimum of No.8 SWG copper or maximum of 65 MM² copper or equivalent shall run throughout the length of cable.
- 7.11.4 Three Ph. Power Panels and Distribution Boards :
Two distinct earth connections of same size as per cable sizes.
- 7.11.5 Single phase DB's :
One earth connection of size shown or as per incoming cable sizes.
- 7.11.6 Isolating Switch (3 Ph) :
Two distinct earth connections of same size as per cable sizes.
- 7.11.7 Isolating Switch (1 Ph) :
One earth connection of size shown or as per incoming cables sizes.
- 7.11.8 3 Ph Motors and other 3 Ph. Apparatus :
Two distinct earth connections of size 50% of connecting cable or No. 8 SWG/ copper or equivalent whichever is higher.
- 7.11.9 1 Ph. Motors, Light Fittings and other Apparatus :
One earth connection of 14 SWG copper or equivalent.
- 7.11.10 Street Lights :
As per detailed drawing.
- 7.12 Mode of Measurement :
- 7.12.1 Earthing pit shall be measured as a complete unit including provision of earth electrode (Pipe or plate), Earth leads upto the ground level, chamber, excavation refilling with coal and salt, water arrangements etc. all complete.

- 7.12.2 Earthing leads beyond the removable link from manhole chamber to the nearest main switch board shall be measured and paid separately on a unit length basis.
- 7.12.3 Earthing leads from power panel, distribution panels etc. shall be measured independently on length basis or measured along with cable or conduit lines depending upon the description given in the schedule of quantities.
- 7.12.4 Earthing connection to the various fixtures and appliances shall be included as part of the installation rate quoted for the concerned item. No separate payment for earth connection to these appliances and fixtures shall be made.

SECTION - 8.0

TECHNICAL SPECIFICATION FOR PAINTING

- 8.1 General : The scope of this section covers 'Painting' to be carried out at Site.
- 8.1.1 Paints : Paints, oils, varnishes etc. of approved make in original tin to the satisfaction of the Engineer-in-Charge shall only be used.
- 8.1.2 Preparation of the surface : The surface shall be thoroughly cleaned and dusted before painting is started. The proposed surface shall be inspected by the Engineer-in-Charge or his authorized agent and shall have received the approval before painting is commenced.
- 8.1.3 Application : Paint shall be applied with brush. The paint shall be spread as smooth and even as possible. Particular care shall be paid to rivets, nuts, bolts, and over lapping. Before drawing out, it shall be continuously stirred in the smaller containers with a smooth stick while it is being applied. Each coat shall be allowed to dry out sufficiently before a subsequent coat is applied.
- 8.1.4 Scope : Painting on old surface in indoor situations will not include primer coat except where specially mentioned in the Schedule of Work or Special Specification. However, where rust has formed on iron and steel surfaces the spots will be painted with one anti-rust primer coat.
- 8.1.5 Precautions : All furniture, fixtures, glazing, floors, etc. shall be protected by covering. All stains, smears, splashings, dropping of every kind shall be removed. While painting of wiring etc., it shall be ensured that paintings of wall and ceiling etc. is not spoiled in any way.
- 8.2 Painting of wiring on wood batten :
The wiring shall after erection be neatly painted with two coats of oil less non-cracking paint of suitable colour to match the surroundings to the satisfaction of the Engineer-in-charge.
- 8.3 Painting of conduit and accessories :
After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes, etc. shall be painted with two coats of approved enamel paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

SECTION 9.0

TECHNICAL SPECIFICATION FOR TESTING

9.1 General

On completion of an installation the following tests shall be carried out:-

1. Insulation Resistance Test.
2. Polarity Test.
3. Earth continuity Test.
4. Earth Electrode Resistance Test.

9.1.1 Insulation Resistance

- 9.1.1.1 The insulation resistance shall be measured by applying between earth and the whole system of conductors of any section thereof with all fuses in place and all switches closed, and except in earthed concentric wiring all lamps in position or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it need not exceed 500 volts for medium voltage circuits. Where the supply is derived from the three wire D.C. or a poly phase A.C. system, the neutral pole of which is connected to earth either direct or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.
- 9.1.1.2 The insulation resistance shall also be measured between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the neutral or to the other pole or phase conductors of the supply with all lamps in position and switches in 'off' position and its value shall not be less than that specified in sub-Clause 9.1.1.3.
- 9.1.1.3 The insulation resistance in Meg Ohms measured as above shall not be less than 50 Meg Ohms divided by the number of outlets or when PVC insulated cables are used for wiring 12.5 Meg Ohms divided by number of outlets outgoing circuits.

- 9.1.1.4 Where an entire installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 Meg Ohm is acceptable.
- 9.1.1.5 A preliminary and similar test may be made before/lamps etc are installed , and in this event the insulation resistance to earth should be not less than 100 meg ohms divided by the number of outlets or when PVC insulated cables are used for wiring 25 meg ohms divided by number of outlets.
- 9.1.1.6 The term "outlet" includes every point alongwith every switch except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.
- 9.1.1.7 Control rheostats, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that event the insulation resistance between the case or frame work, and all live parts of each rheostat, appliance and sign, shall be not less than that specified in the relevant India Standard Specification or where there is no such specification shall be not less than half a megohm.
- 9.1.2 **Polarity test of switch:**
- 9.1.2.1 In a two wire installation a test shall be made to verify that all switches in every circuit have been fitted in the same conductor throughout and such conductor shall be labelled or marked for connection to phase conductor or to the non earthed conductor of the supply.
- 9.1.2.2 In a three wire or a four wire installation a test shall be made to verify that every non linked single pole switch is fitted in a conductor which is labelled or marked for connection to one of the phase conductor of the supply.
- 9.1.2.3 The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in "ON" position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

9.1.3 Testing of earth continuity path :

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

9.1.4 Measurement of earth electrode resistance :

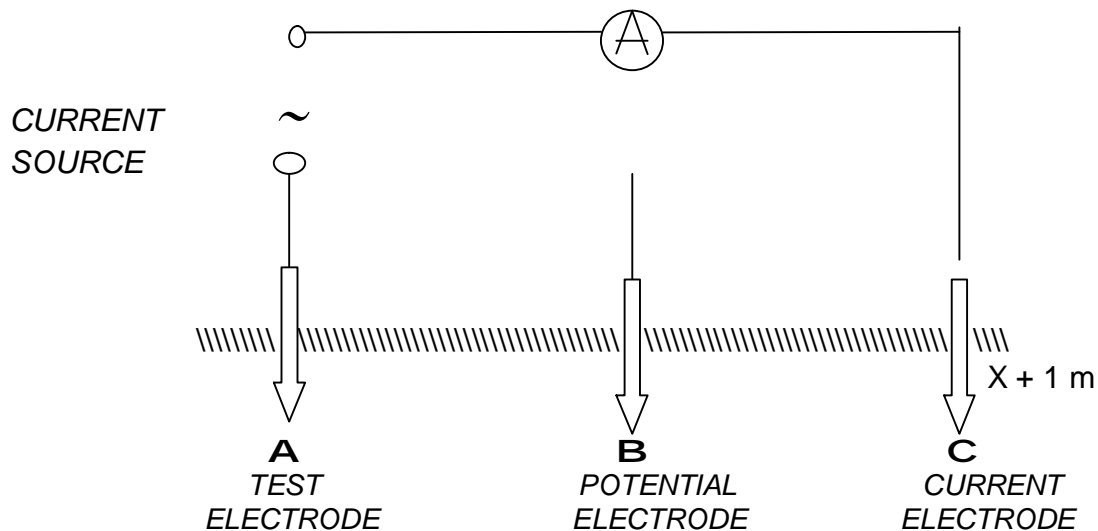
9.1.4.1 Two auxiliary earth electrodes besides the test electrode are placed at suitable distance from the tests electrode (see figure). A measured current is passed between the electrode 'A' to be tested and an auxiliary current electrode 'C' and the potential difference between the electrode 'A' and auxiliary potential electrode 'B' is measured.

The resistance of the test electrode 'A' is then given by –

$$R = \frac{V}{I}$$

Where,

- R - Resistance of the test electrode in ohms.
- V - Reading of the voltmeter in volts.
- I - Reading of the ammeter in amps.



- 9.1.4.2 (a) Stray currents flowing in the soil may produce serious errors in measurement of earth resistance. To eliminate this, hand driven generator is used.
- (b) If the frequency of the supply of hand driven generator coincides with the frequency of stray current there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.
- 9.1.4.3 At the time of test, the test electrode shall be separated from the earthing system.
- 9.1.4.4 The auxiliary electrodes shall be of 13 mm diameter mild steel rod driven upto 1 m into the ground.
- 9.1.4.5 All the three electrodes shall be so placed that they will be independent of the resistance area of each other.
- 9.1.4.6 If the test electrode is in the form of rod, pipe or plate, the auxiliary current electrode "C" shall be placed at least 30m away from it and the auxiliary potential electrode 'B' shall be placed mid way between them.
- 9.1.4.7 Unless three consecutive readings of test electrode resistance agree the test shall be repeated by increasing the distance between electrodes A and C upto 50 m and each time placing the electrode 'B' midway between them.
- 9.1.4.8 On these principles "Megger Earth Tester" containing a direct reading ohm meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading on earth resistance of electrodes.
- 9.1.5 On completion of an electric installation (or an extension to an 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 the prescribed form as given in Appendix 'A', in addition to the test certificate required by the local Electric Supply Authorities.

SECTION 10.0

ACCEPTED MAKES OF MATERIALS

Sr.No.	Articles / Items	Approved Makes
1.	PVC Wires/ conductors	Finolex, Polycab, Sundep
2.	Conduits	VIMCO / BEC
3.	Cables	Gloster, Asian, Polycab, CCI (until 95 sq.mm.)
4.	Switches, Sockets 5 Amps / 15 Amps	Standard, Anchor
5.	15/30 Amps. ICDP switches	Stanley, KEW
6.	I.C.T.P.N. Switches	KEW, GE, L&T, Siemens
7.	Lighting Distribution Boards – MCB type	Morarjee Dormans, Legrand
8.	Power Distribution Boards	GE, Legrand
9.	All light fittings	Crompton / GEC / Philips
10.	Any other item	Sample to be sent for Approval of E.I.C
11.	Change over switches	L&T, KEW

APPENDIX 'A'

FORM OF COMPLETION CERTIFICATE

I/We certify that the installation detailed below has been installed by me/us and tested and that to the best of my/our knowledge and belief, it complies with Indian Electricity Rules, 1956, as well as IS:732 – Code of practice of Electrical wiring Installations (system voltage not exceeding 650 volts)

Electrical Installation at _____

Voltage & system of supply _____

1. Particulars of Works :

(a) Internal Electrical Installation

	No.	Total Load	Type of system Of wiring
(i)	Light point		
(ii)	Fan point		
(iii)	Plug point		
	(a) 3 pin 5 amp		
	(b) 3 pin 15 amp		

(b) Others

	Description	HP / KW	Type of starting
(a)	Motors	(i)	
		(ii)	
		(iii)	
(b)	Other plants :		

(c) If the work involves installation of over headline and/ or under ground cable.

- [a] (i) Type & description of overhead line
- (ii) Total length and No. of spans
- (iii) No. of street light and its description.

- [b] (i) Total length of underground cable & its size.
- (ii) No. of joints End Joint :
Tea Joint :
St. through Joint :

Earthing :

- (i) Description of earthing electrode
- (ii) No. of earth electrodes.
- (iii) Size of main earth lead.

Test Results :

(a) Insulation Resistance

- (i) Insulation resistance of the whole system of conductors to earth Megohms

- (ii) Insulation resistance between the phase Conductor & neutral -

Between phase R and neutral Megohms
Between phase Y and neutral Megohms
Between phase B and neutral Megohms

- (iii) Insulation resistance between the phase Conductors in case of poly phase supply

Between phase R and phase Y Megohms
Between phase Y and phase B Megohms
Between phase B and phase R Megohms

- (b) Polarity Test
Polarity of non linked single pole branch switches.
- (c) Earth continuity test
Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead Ohms
- (d) Earth Electrode Resistance
 - (i) Ohms
 - (ii) Ohms
 - (iii) Ohms
 - (iv) Ohms
- (e) Lighting Protective System
Resistance of the whole of lighting protective system to earth before any bonding is effected with earth electrode and met-1 in/on the structure ... Ohms

Signature of the Supervisor

Signature of Contractor

Name and address

Name and address