

GENERAL COMMERCIAL / TECHNICAL

1.1 Scope:

- i) Electricity has become the lifeline of Modern society. Homes, Offices, Industry, Schools, Hospitals, Transportation, Communication, Road Lighting, Markets all depend on reliable Electric Supply. Life comes to a standstill without electricity. Electricity has become an integral and inevitable part of every body's life.

It is also necessary to remember that electricity becomes destructive and dangerous, if not handled with care, safety conforming to laid down safety standards and norms. In case of building fires, which often destroy property and lives causing sufferings to the affected people, the first culprit is often supposed to be 'Electric Short Circuit'

In the above context, the general specification for electrical works (Internal) aims to lay down general guidelines to ensure safe, efficient, reliable and economical use of electricity.

- ii) While these Specifications serve as general guidelines, appropriate technical sanctioning authority can depart from such guidelines to meet the particular requirements of any work or for other technical reasons.
- iii) This Chapter covers the general commercial and technical requirements applicable to works contract for execution of Internal Electrical Installation works.
- iv) These general Specifications are subject to revision from time to time.

1.2 Related Documents:

Each work has its own particular requirements. Therefore, in addition to the General Specifications, governing BIS, I.E. Rules, Standard Contract Conditions etc. there would be necessity of Additional conditions / Specifications for a particular work. In case of any discrepancy such additional conditions/ specifications will override these General Specifications.

1.3 Terminology:

The definition of terms shall be in accordance with IS: 732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit, and submain wiring, which are defined in this specification. Some of the commonly used terms are indicated in Appendix-A.

1.3.2 The conventional signs and symbols for technical work shall be as shown in Appendix-B.

1.4 Submission of Tenders:

1.4.1 The tender shall be submitted complete with the following: -

- i) Complete tender documents as purchased from CPWD duly filled in and signed. The price part of the tender shall be indicated only on the tender schedule of work.
- ii) Earnest Money Deposit in one of the specified forms.
- iii) Any other supplementary details required for the evaluation of the tenders such as drawings, technical literature / catalogues, data etc.

1.4.2 Where two part tendering system is proposed to be adopted in any particular work, the procedure for submission and opening of tenders shall be indicated in tender documents for that work.

1.5 Rates:

15.1 The work shall be treated as on works contract basis and the rates tendered shall be for complete items of work (except the materials, if any, stipulated for supply by the department) inclusive of all taxes (including works contract tax, if any), duties, and levies etc. and all charges for items contingent to the work, such as, packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials (including those, if any, supplied by the department) for the work at site etc.

15.2 Prices quoted shall be firm. Price adjustments shall however be governed by Clause 10C/10cc of the Conditions of Contract given in form CPWD 7 or 8 of the tender documents, for works executed under these forms. All relevant documents shall be produced by the contractor to the Engineer-in-charge, whenever called upon by him to do so, for working out such adjustments in rates.

1.6 Taxes and Duties:

1.6.1 Being an indivisible works contract, Sales Tax, Excise Duty etc. are not payable separately.

1.6.2 The works contract tax shall be deducted from the bills of the contractor as applicable in the State in which the work is carried out, at the time of payments.

1.6.3 Octroi shall not be paid separately for the materials supplied by the Contractor, but the Department, on demand, can furnish octroi exemption certificate. However, the Department is not liable to reimburse the octroi duty in case the concerned authorities do not honor such exemption certificates.

1.7 Mobilization Advance:

No mobilization advance shall be paid for the work, unless otherwise stipulated in tender papers for any individual works.

1.8 Completeness of Tender:

All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.

1.9 Works to be arranged by the Department:

Unless and otherwise specified in the tender documents, the following works shall be arranged by the Department:

- i) Storage space for all equipments, components and materials for the work.
- ii) Supply of materials to the contractor as stipulated in the tender documents.

1.10 Works to be done by the Contractor:

Unless and otherwise mentioned in the tender documents, the following works shall be done by the contractor, and therefore their cost shall be deemed to be included in their tendered cost: -

- i) Foundations for equipments and components where required, including foundation bolts.
- ii) Cutting and making good all damages caused during installation and restoring the same to their original finish.
- iii) Sealing of all floor openings provided by him for pipes and cables, from fire safety point of view, after laying of the same.
- iv) Painting at site of all exposed metal surfaces of the installation other than pre-painted items like fittings, fans, switchgear / distribution gear items, cubicle switchboard etc. Damages to finished surfaces of these items while handling and erection, shall however be rectified to the satisfaction of the Engineer-in-charge.
- v) Testing and commissioning of completed installation.

1.11 Storage and Custody of Materials

Suitable and lockable storage accommodation shall be provided by the Department free of cost to the contractor. However, their proper storage and safe custody shall be his responsibility till the final taking over the installations by the Department.

1.12 Electric Power Supply and Water

Unless and otherwise specified, power supply and water supply as may be required shall be arranged by the Contractor for installation and testing of the equipments at the site of work.

1.13 Tools for Handling and Erection

All tools and tackles required for handling of equipments and materials at site of work as well as for their assembly and erection and also necessary test instruments shall be responsibility of the contractor

1.14 Coordination with other Agencies

The contractor shall co-ordinate will all other agencies involved in the building work so that the building work is not hampered due to delay in his work. Recessed conduit and other works which directly affect the progress of building work should be given priority.

1.15 Care of Building

Care shall be taken by the Contractor to avoid damage to the building during execution of his part of the work. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost. He shall also remove at his cost all unwanted and waste materials arising out of his work from the site.

1.16 Structural Alterations to Buildings

- i) No structural member in the building shall be damaged / altered, without prior approval from the Competent Authority through the Engineer-in-Charge.
- ii) Structural provisions like openings, cutouts, if any, provided by the department for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent works shall be carried out by the Contractor at his cost.
- iii) All such openings in floors provided by the Department shall be closed by the Contractor after installing the cables/ conduits / rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-Charge without any extra payment.
- iv) All cases required in connection with the electrical works shall be provided and filled by the Contractor at his own cost to the original architectural finish of the buildings.

GENERAL AND TECHNICAL

1.0 Scope

This chapter covers the general technical requirements and measurement of the various components in Internal Electrical Installation works.

1.1 Terminology

1.1.1 The definition of terms shall be in accordance with IS: 732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit, and submain wiring, which are defined in clauses 2.2.1, 2.3.1 and 2.3.2 hereunder. Some of the commonly used terms are indicated in Appendix A.

1.1.2 The conventional signs and symbols for technical work shall be as shown in Appendix-B.

2.0 Point Wiring

2.1 Definition

A point (other than a socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch of MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit.

- a) Ceiling rose or connector (in the case of points for ceiling / exhaust fan points, pre-wired light fittings, and call bells).
- b) Ceiling rose (in the case of pendants excepts stiff pendants).
- c) Back plate (in case of stiff pendants).
- d) Lamp holder (in case of goose neck type wall brackets, batten holders and fittings which are not pre-wired).

Note: In the case of call bell points, the words "from the controlling switch or MCB" shall be read as "from the ceiling rose meant for connection to bell push".

2.2 Scope

Following shall be deemed to be included in point wiring.

- a) Conduit / casing and capping / batten as the case may be, accessories for the same and wiring cables between the switch box and the point outlet.
- b) All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.
- c) Mechanical protection of batten wiring upto 1.5m from floor and at locations where wiring is liable to be damaged.
- d) Metal or PVC switch boxes for control switches, regulators, sockets etc., recessed or surface type, and phenolic laminated sheet covers over the same.
- e) Outlet boxes, junction boxes, pull-through boxes etc., but excluding metal boxes if any, provided with switch boards for loose wires / conduit terminations.

- f) Any special block required for neatly housing the connector in batten wiring system.
- g) Control switch or MCB, as specified.
- h) 3 pin or 6 pin socket, ceiling rose or connector as required (2 pin and 5 pin socket outlet shall not be permitted).
- i) Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
- j) Interconnecting wiring between points on the same circuit, in the same switch box or from another.
- k) Protective (loop earthing) conductor from one metallic switch box to another in the distribution circuits, and for socket outlets. (The length of protective conductor run along with the circuits / submains is excluded from the scope of points).
- l) Bushed conduit or porcelain tubing where wiring cables pass through wall etc.

2.3 Measurement

2.3.1 Point Wiring (other than socket outlet points)

- i) Unless and otherwise specified, there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on unit basis by counting and classified as laid down in 2.2.3.2
- ii) No separate measurement will be made for interconnections between points in the same distribution circuit and for the circuit protective (loop earthing) conductors between metallic switch boxes.

2.3.2 Classification

Points measured under 2.2.3.1 on unit basis shall be classified as under according to the type of building.

- i) **Residential building: -**
 - a) Group -Aø for point wiring for type I, type II and type III residential quarters and hostels.
 - b) Group -Bø for point wiring for type IV and above type of residential quarters and barracks.
- ii) **Non residential buildings: -**
Group -Cø for all types of non-residential buildings such as offices, hospitals, and laboratories, educational institutions, libraries etc.
- iii) For any other types of building, the group under which the points are to be classified shall be decided by the concerned Chief Engineer (Elec).

2.3.3 Point wiring for socket outlet points

- i) The light plug (5A/6A) point and power (15A / 16A) point wiring shall be measured on linear basis, from the respective tapping point if live cable, namely, switch box, another socket outlet point or the sub distribution

board as the case may be, upto the socket outlet.

- ii) The metal / PVC box with cover, switch/ MCB, socket outlet and other accessories shall be measured and paid as a separate item.
Note: There shall normally be no work on the board light plug point.
- iii) The power point outlet may be 15A/5A or 16A/6A six pin socket outlet, where so specified in the tender documents.

2.3.4 Group control points wiring

- i) In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e.(a) from the switch to the first point outlet as one point and classified according to 2.2.3.2 and (b) for the subsequent points, the distance from outlet to the next one and so on, shall be treated as separate point(s) and classified according to 2.2.3.2.
- ii) No recovery shall be made for non-provision of more than one switch in such case.

2.3.5 Twin control light points wiring

- i) A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side and classified according to 2.2.3.2.
- ii) No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

2.3.6 Multiple controlled call bell points wiring

- i) In the case of call bell points with a single call bell outlet controlled from more than one place, the points shall be measured in parts i.e. (a) from the call bell outlet to one of the nearest ceiling roses meant for connection to bell push, treated as one point and classified according to 2.2.3.2, and (b) from that ceiling rose to the next one and so on, shall be treated as separate point(s) and classified according to 2.2.3.2.
- ii) No recovery shall be made for non-provision of more than one ceiling rose or connector for connection to call bell in such cases.

2.4 **Circuit and Submain Wiring**

2.4.1 Circuit wiring

Circuit wiring shall mean the wiring from the distribution board upto the tapping point for the nearest first point of that distribution circuit, viz., upto the nearest first switch box.

2.4.2 Submain wiring

Submain wiring shall mean the wiring from one main / distribution switch board to another.

2.4.3 Measurement of circuit and submain wiring

i) Circuit and submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of wood batten or conduit or casing and capping as the case may be exclusive of interconnections inside the switchboard etc. The increase on account of diversion or slackness shall not be included in the measurement.

ii) The length of circuit wiring with two wires shall be measured from the distribution board to the first nearest switch box in the circuit irrespective of whether the neutral conductor is taken to switch box or not.

iii) When wires of different circuits are grouped in a single conduit / casing and capping, the same shall be measured on linear basis depending on the actual number and sizes of wires run.

iv) When circuit wires and wires of point wiring are run in the same conduit / casing and capping, circuit wiring shall be measured on linear basis depending on the actual number and sizes of wires run in the existing conduit / casing capping.

v) Protective (loop earthing) conductors which are run along the circuit wiring and the sub main wiring shall be measured on linear basis and paid for separately.

2.5 Other Wiring Works

i) Except as specified above for point wiring, circuit wiring and submain wiring, other types of wiring shall be measured separately on linear basis along the run of wiring depending on the actual number and sizes of wires run.

ii) **Rewiring**

The scope of work of the rewiring items provided in the Schedule of Rates (Part-I- Internal), 1994 includes only replacement of wires. Replacement of switches and other accessories shall be covered by the relevant and corresponding item in the Schedule.

2.6 System of distribution and Wiring

2.6.1 Control at the point of entry of supply

There shall be a linked switch with fuse or circuit breaker on each live conductor of the supply mains at the point of entry.

2.6.2 Distribution

i) The wiring shall be done on a distribution system through main and / or branch distribution boards. The system design as well as the locations of boards shall be as specified by the Engineer-in-charge.

ii) Main distribution board shall be controlled by a circuit breaker or linked switch with fuse. Each outgoing circuit shall be controlled by a switch with fuse, circuit breaker or only a fuse on the phase or live conductor (as in the case of a TPDB).

iii) The branch distribution boards shall be controlled by a linked switch fuse or circuit breaker. Each outgoing circuit shall be provided with a fuse or miniature circuit breaker (MCB) of specified rating on the phase or live conductor.

iv) Triple pole distribution boards shall not be used for final circuit distribution, unless specific approval of the Engineer-in-charge is obtained. In such special cases, the triple pole distribution boards shall be of HRC fuse type or MCB type only.

v) The loads of the circuits shall be divided, as far as possible evenly between the number of ways of distribution boards, leaving at least one spare circuit for future extension.

vi) The neutral conductors (incoming and outgoing) shall be connected to a common link (multiway connector) in the distribution board and be capable of being disconnected individually for testing purposes.

vii) Power wiring shall be kept separate and distinct from Lighting wiring, from the level of circuits i.e., beyond the branch distribution boards.

viii) Wiring shall be separate for essential loads (i.e., those through standby supply) and non-essential loads throughout.

2.6.3 Balancing of Circuits

i) The balancing of circuits in three wire or poly phase installations shall be arranged before hand to the satisfaction of the Engineer-in-charge.

ii) Circuits on opposite poles of a three wire D.C. system shall be kept apart unless they are enclosed in earthed metal casing, suitably marked to indicate the risk of shock due to the voltage between the conductors contained in them.

2.6.4 Wiring System

i) Unless and otherwise specified in the tender documents, wiring shall be done only by the "Looping system". Phase or live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.

ii) Where "joint box system" is specified in the tender documents, all joints in the conductors shall be made by means of approved mechanical connectors in suitable and approved junction boxes.

iii) Lights, fans and call bells shall be wired in the Lighting circuits. 15A/16A socket outlets and other power outlets shall be wired in the Power circuits. 5A/6A socket outlets shall be wired in the Lighting circuits in non-residential buildings and in the power circuit in residential buildings.

iv) The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of a linked switchgear.

2.6.5 Run of Wiring

- i) The type of wiring shall be as specified in tender documents, namely wood batten, casing and capping, or conduit.
- ii) Surface wiring shall run, as far as possible, along the walls and ceiling so as to be easily accessible for inspection.
- iii) In no case, the open wiring shall be run above the false ceiling without the approval of Engineer-in-charge.
- iv) In all types of wiring, due consideration shall be given for neatness, good appearance and safety.

2.6.6 Passing through walls or floor

i) When wiring cables are to be pass through a wall, these shall be taken through a protection (steel/PVC) pipe or porcelain tube of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipe shall be neatly bushed with porcelain, PVC or other approved material.

ii) Where a wall pipe passes outside a building so as to be exposed to weather, the outer end shall be bell mounted and turned downwards and properly bushed on the open end.

iii) Protection pipe shall be provided for batten wiring passing through floors as specified in clause 3.6 of these specifications.

iv) All floor openings for carrying any wiring shall be suitably sealed after installation.

2.6.7 Joints in wiring

i) No bare conductor in phase and / or neutral or twisted joints in phase, neutral, and / or protective conductors in wiring shall be permitted.

ii) There shall be no joints in the through-runs of cables. If the length of final circuit or sub main is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

iii) Termination of multi-stranded conductors shall be done using suitable crimping type thimbles.

2.7 Ratings of Outlets (to be adopted for design)

i) Incandescent lamps in residential and non-residential buildings shall be rated at 60W and 100W respectively.

ii) Ceilings fans shall be rated at 60W, Exhaust fan, fluorescent, tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps etc. shall be rated according to their capacity. Control gear losses shall be also considered as applicable.

iii) 5A/6A and 15A/16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.

2.8 Capacity of Circuits:

i) "Lighting" circuit shall not have more than a total of 10 points of light, fan and socket outlets, or a total connected load of 800W, whichever is less.

ii) "Power" circuit shall be designed with only one outlet per circuit in nonresidential buildings. The circuit shall be designed based on the load. Where not specified, the load shall be taken as 1KW per outlet.

iii) "Power" circuit in residential buildings shall be designed for not more than two outlets (15A/16A and/or 5A/6A) per circuit. The ratings for load calculation purposes shall however be taken as per type of outlets.

iv) Load more than 1KW shall be controlled by an isolator or miniature circuit breaker.

2.9 Conformity to IE Act, IE Rules, and Standards:

i) All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 1910 and Indian Electricity Rules, 1956 amended upto date.

ii) The works shall also conform to relevant Indian Standard Codes of Practice (COP) for the type of work involved.

iii) In all electrical installation works, relevant safety codes of practice shall be followed.

2.10 **General Requirements of Components:**

2.10.1 Quality of Materials

All materials and equipments supplied by the contractor shall be new. They shall be of such design, size and material as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

2.10.2 Ratings of components

a) All components in a wiring installation shall be of appropriate ratings of voltage, current, and frequency, as required at the respective sections of the electrical installation in which they are used.

b) All conductors, switches and accessories shall be of such size as to be capable of carrying the maximum current which will normally flow through them, without their respective ratings being exceeded.

2.10.3 a) All components shall conform to relevant Indian Standard Specification, wherever existing. Materials with ISI certification mark shall be preferred. However, for conduits, wiring cables, piano/tumbler switches and socket outlets, ISI marked materials shall only be permitted.

b) A broad list of relevant Indian Standards is given in Appendix D. These Indian Standards, including amendments or revisions thereof upto the date of tender acceptance, shall be applicable in the respective contracts.

2.10.4 Interchangeability

Similar parts of all switches, lamp holders, distribution fuse boards switchgears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

2.10.5 Categorization of components

a) Makes of certain items of materials are categorized from time to time by the Department and included in Schedule of rates; only those makes of items under the category indicated in tender documents shall be used in the work.

b) For items of materials for which makes are approved by the Department, only such approved makes shall be permitted in the work.

2.10.6 Special risks

Special forms of construction such as flame proof enclosures shall be adopted where there is risk of fire, or explosion and wherever indicated in the tender documents.

2.11 Cables

2.11.1 Wiring Cables

i) a) Conductors of wiring cables (other than flexible cables) shall be of aluminium or copper, as specified.

b) The Government of India in the Gazette notification issued vide order dated 07.05.91 of the Department of Industrial Development under the Ministry of Industry has withdrawn its earlier ban on the use of copper in the manufacture of PVC and VIR wires of domestic type. Consequently, it is left to the discretion of the technically sanctioning authority to use either aluminium or copper wiring in any building or installation. However, wiring for socket outlets in all residential buildings shall be done by using copper conductor cables only.

ii) The smallest size of conductor for lighting circuits shall have a nominal cross sectional area of not less than 1.5sq.mm. The minimum size of conductor for power wiring shall be 4sq.mm.

iii) Standard aluminium conductor shall not be used in wiring cables up to and including 6sq.mm. size.

2.11.2 Flexible cables

i) Conductor of flexible cables shall be of copper. The minimum cross sectional area of conductor for flexible cable shall be 0.0006 sq.inch (14/0.0076 or 14/0.193mm)

ii) Only 3 core flexible cables shall be used for connecting single phase appliances.

iii) Unless the flexible cables are mechanically protected by armour, or tough rubber, or PVC sheath, these shall not be used in workshops and other places where they are liable to mechanical damage.

iv) Flexible cable connection to bell push from ceiling rose shall be taken through steel conduit / metallic casing and capping.

2.12 Wiring Accessories

2.12.1 Control Switches for points

i) Control switches (single pole switches) carrying not more than 16A may be of tumbler or piano type, as specified, and the switch shall be ON when the knob is down.

ii) Control switches of 15A/16A rating may preferably be only of tumbler type. If however, piano type switch is used for controlling a socket outlet, combined switch cum socket shall not be permitted.

iii) The type and current rating of switch controlling a group of points, or discharge lamps, or a single large load, shall be suitable for the respective loads and as specified in the tender documents.

iv) Power (15A/6A) outlets shall be controlled by single pole tumbler type switches or by MCBs, where specified. Only MCBs shall be used for controlling industrial type socket outlets, and power outlets above 1KW.

v) Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

2.12.2 Socket outlets

i) Socket outlets shall be of the same type, namely, piano type or tumbler type, as their control switches. These shall be rated either for 5A/16A. Combined 5A/15A, or 6A/16A six pin socket outlet may be provided in "Power" circuits only where specified.

ii) a) In an earthed system of supply, socket outlets and plugs shall only be of 3 pin type; the third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.

b) Conductors connecting electrical appliances with socket outlets shall be of flexible twin cord with an earthing cord, which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.

iii) Sockets for the power outlets of rating above 1KW shall be of industrial type with associated plug top and controlling MCB.

iv) Where specified, shutter type (interlocking type) of sockets shall be used.

v) A socket outlet shall not embody fuse terminal as integral part of it. But the fuse may be embodied in plug, in which case the plug shall be non-reversible and shall be so arranged and connected that the fuse is connected to phase, or live conductor, or the non earthen conductor of the circuit.

vi) Every socket outlet shall be controlled by a switch or MCB, as specified. The control switch/MCB shall be connected on the "live" side of the line.

vii) Outlet boxes for socket outlets (both 15A/16A and 5A/6A) points in residential buildings shall be of size 175mm X 100mm.

viii) 5A/6A and 15A/16A socket outlets shall be installed at the following positions, unless otherwise specified.

a) Non residential buildings-23cm above floor level.

b) Kitchen-23cm above working platform and away from the likely positions of stove and sink.

c) Bathroom-No socket outlet is permitted for connecting a portable appliance thereto. MCB/IC switch may be provided above 2.1m for fixed appliances, and atleast 1 m away from shower.

d) Rooms in residences 23cm above floor level, or any other / level in special cases as desired by the Engineer-in-charge.

ix) Unless and otherwise specified, the control switches for the 5A/6A and 15A/16A socket outlets shall be kept alongwith the socket outlets.

2.12.3 Switch box covers

Phenolic laminated sheets of approved shade shall be used for switch box covers. These shall be of 3mm thick synthetic phenolic resin bonded laminated sheet as base material and conforming to grade P-I of IS: 2036-1974.

Note: - Specification for switch boxes is covered in the chapters on the various types of wiring.

2.12.4 Ceiling rose

i) A ceiling rose shall not be used on a circuit, the voltage of which normally exceeds250V.

ii) Only one flexible cord shall be connected to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

iii) A ceiling rose shall not embody fuse terminal as an integral part of it.

2.12.5 Lamp holders

i) Lamp holders may be of batten, angle, pendant or bracket holder type as required. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal external pressure. There should be sufficient threading for fixing the base to the lamp holder part so that they do not open out during attention to the lamp or shade.

ii) Lamp holders for use on brackets and the like shall have not less than 1.3 cm nipple, and all those for use with flexible pendant shall be provided with cord grips.

iii) All lamp holders shall be provided with shade carriers.

iv) Where center contract Edison Screw lamp holders are used, the outer or screw contact shall be connected to the middle wire or the neutral conductor of the circuit.

2.13 Equipments and Fittings

2.13.1 The type, rating, the required features, location of fixing etc. are indicated in the Schedules. The schedule includes all other required accessories, fasteners, small wiring etc., fixing, aligning, connecting, testing and commissioning. The materials shall be of good quality acceptable to Engineer-in-Charge and to be fixed in position as directed by him.

2.13.2 Box/Rail type Fluorescent Light Fittings.

Both single and twin tube assemblies shall be of standard fittings made out of cold-drawn sheet steel, stove enameled, the box finished in gray colour and its cover plates in white colour complete with copper chokes, starters, starter holder, tube holders, lamps and earth terminal etc.

2.13.3 Decorative Type Fluorescent Light Fittings

Similar to 2.13.2 with opal acrylic diffuser.

2.13.4 Mirror Optics Type Fluorescent Light Fittings.

Both single and twin tube assemblies shall be of standard fittings made out of cold-drawn sheet steel, stove enameled, the box finished in gray colour and its cover plates in white colour complete with copper chokes, starters, starter holder, tube holders, lamps and earth terminal etc. with mirror reflector.

2.13.5 Corrosive Resistant Type Fittings.

Similar to 2.13.2 with FRP body complete with copper chokes, starters, starter holder, condensers, earth terminal suitable lamp holders, lamp etc. assembled and wired neatly.

2.13.6 Compact Fluorescent Type Light Fittings.

Compact fluorescent fittings with 2X11 Watts lamps, holders, stainless steel reflector with housing and OPEC acrylic diffuses etc.

2.13.7 Bulk Head Fittings.

The fittings shall be made of pressed Aluminum body, outside finished in gray stove enamel and inside white, provided with prismatic glass, covers, rubber gaskets, BC lamp holders, earthing terminal wire nets and lamps.

2.13.8 Street Light (TFL) Fittings.

The fittings shall be weather proof type fluorescent street light fittings. The fittings shall be made of Aluminium sheet and finished outside in hammertone gray colour, stove enameled and white inside, complete with copper wire chokes, starters condensers, suitable lamp holders, lamps, assembled and wired neatly and provided with clear acrylic moulded cover held by spring loaded hooks against sponge rubber gaskets to make the whole unit dust, vermin and waterproof.

2.13.9 Post- Top Luminaries

The Post- top luminary is to be provided at Gate Pillars and in garden. Necessary pipe shall also be supplied.

2.13.10 The fans have to be suspended normally from the ceiling. These shall be single phase AC 230V, 50Hz and of sizes indicated in the Schedule. However, if adequate vertical clearance is not available due to low ceiling wall-bracket fans will have to be provided. Fans shall include choke type / electronic type regulators with hard rubber bushes, condensers, suspension couplings, terminal blocks, suitable top and bottom canopy (covers) etc. Ceiling fans shall be of double ball-bearings type conforming to IS:374 in all respects. Fans should be supplied of approved make.

2.13.11 Exhaust Fans.

Heavy / Light duty fans are required for exhaust ventilation in buildings. The fans shall be suitable for AC, single phase, 50Hz, 230V supply. These must be of robust construction having very low noise level. All exhaust fans shall be impeller type with ring mounting arrangements for fixing on walls. The exhaust fans shall conform to IS:3588 in all respects. Capacity and size of fans will be specified in Schedules.

2.13.12 Metal Clad Switch Socket Unit

All the switch-socket units shall be made on non-corroding pressure-cast Aluminium alloy and these must be dust, vermin, water and rust proof. Switch-socket units shall be provided with interlocking arrangement for switch and plug HRC fuses, Neon-indicator lamps, terminal blocks and pin-top. The units shall be suitable for both flush and surface mounting. Switch sockets units shall comply with IS:4160

2.13.13 Installation of ceiling fan:

Unless otherwise specified, all ceiling fans shall be hung 2.75 M(9 ft.) above floor. The suspension rod and clamp shall be painted with approved paint without involving extra cost.

2.13.14 Installation of Flurescent light fitting:

In case of suspension from ceiling by two rods, each fixing to the ceiling shall be capable of sustaining at least 1.1Kg. Of dead weight. The down rods and accessories shall be painted with approved paint without involving extra cost. Unless otherwise specified, these should be suspended 2.60M (8'-6") above floors.

2.13.15 The D.B s shall generally be installed at a height of 2.13 Mts. (7 ft) from floor level

2.13.16 All fan clamps will have to be provided from R.C. ceiling as per approved design.

2.13.17 Control switches for lights, fans, call bells, Exhaust fans etc. shall be of rating 6 Amps. 230V, Piano-type flush mounted, cream colour conforming to relevant Indian Standards. Ceiling roses also shall be of 6 Amps. Rating 230V cream colour deluxe conforming to the relevant IS-Specification. Switches of 16Amp capacity and associated 16A socket would also be required to provide facility of connection of power load upto 1

KW. Alternatively. Industrial type plug-socket board may be used in specific cases. Cable used for power load should be of suitable capacity.

2.14 Switchgear and Control gear- General aspects.

i) All items of switchgear and distribution boards (DBs) shall metal clad type, except those forming part of cubicle type switch boards, in which case that board design shall be such as not to permit direct contact.

ii) The types, ratings and/or categories of switchgear and protective gear shall be as specified in the tender Schedule of work.

iii) RCDs (ELCBs) where specified, shall conform to the requirement of current rating, fault rating, single phase or three phase configuration and sensitivity laid down in the tender documents.

iv) While each outgoing way of Distribution Board (DB) shall be of fuse, or miniature circuit breaker (MCB) as specified, and of suitable rating. On the phase conductor, the corresponding earthed neutral conductor shall be connected to a common neutral terminal block and shall be capable of being disconnected individually for testing purposes.

v) Independent earth terminal block.

vi) Every distribution board (single phase as well as 3 phase) shall have an earth terminal block identical to, but independent from neutral terminal block, to enable termination of protective (loop earthing) conductors (incoming as well as outgoing) individually by screwed connection and without twisting.

vii) Earthing terminal (1 for single phase and 2 for 3 phase) shall be provided on the metal cladding of switches and DBs for body earthing. These shall be suitable marked.

viii) Knock out holes, with or without end plates as per standard design of manufacturers, shall be provided in the metal cladding of switches and DBs for termination of conduits/cables.

ix) 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 the size of the fuse element.

2.15 MCB type distribution boards (MCBDB)

i) MCBDBs may be of single phase, 3 phase (horizontal type) suitable for feeding single phase loads, or 3 phase (vertical type) suitable for feeding single phase as 4 phase loads, as specified. These shall be complete with accessories, but without MCBs, which shall be specified as a separate item in the tender documents.

ii) The current ratings and the number of ways shall be as specified. Blanking plates shall be provided to close unused ways. These shall be indicated as a separate item in the Schedule of work.

iii) DB with integral incomer.
Where it is proposed to install the controlling MCB/MCB type isolator/both, the total number of outgoing MCBs will be reduced by one or two numbers corresponding to SP or SP&N at the incoming, since the total number of ways are fixed in MCBDBs. Busbars in such units shall also be correspondingly shorter. The inter connections shall be done between the incomer and outgoing as part of the DB in the works.

iv) MCBDBs shall be of surface/ flush mounting pattern according to the requirement of their location, and shall be suitable to accommodate MCBs and MCB type isolators and RCD (ELCB) at incoming in single pole or multiple configuration, as required.

v) MCBDBs shall be dust and vermin proof conforming to IP 42 and shall be fabricated out of CRCA sheet steel, 1.6mm thick, with stove enameled paint finish.

vi) MCBDBs shall have removable type end plates with knock-outs at the bottom and top. And shall have hinged covers with locking arrangement.

vii) Only the knobs of the MCBs shall protrude out of the front covers through openings neatly machine made for the purpose.

viii) The busbars used shall be solid electrolytic copper of appropriate sections.

ix) DIN bar(s) shall be provided for mounting the MCBs.

2.16 Miniature Circuit Breakers (MCB's)

i) L₀ series MCBs shall be used only for normal lighting circuits.

ii) G₀ series MCBs shall be invariably used for motor loads, halogen lamp fitting, sodium/mercury discharge lamps and all power circuits.

iii) Ratings (A as well as KA), number of poles, type as MCB of isolator, etc. shall be as specified in the tender documents.

2.17 Switch boards- application and types.

i) All items of switchgear and distribution boards (DBs) shall be installed on switch boards.

ii) Where specified by the Engineer-in-charge, only MCBDBs may be permitted to be installed correctly recessed in wall without a switch board. In such cases, the metal cladding of the DB shall be suitable for recess mounting.

2.18 Switch board locations.

2.18.1 General aspects

i) Switch boards shall be located as per drawings.

ii) As far as practicable, the boards should be accessible from common areas like corridors, lobby areas, etc.

iii) Switch boards shall be located only in dry situations and in well ventilated spaces. They shall not be placed in the vicinity of storage batteries and exposed to chemical fumes.

iv) Switch boards shall not be erected above gas stoves, or sinks or within 2.5m of any washing unit in the washing rooms of laundries, or in the bath rooms, toilets or kitchens.

2.18.2 i) Main switchboards shall be situated as near as practicable to the termination of service line, and shall be easily accessible without the use of any external aid to quickly disconnect the supply in case of emergencies.

ii) Main switchboards shall be installed in rooms, or cupboards, or suitable enclosed space having provisions for locking arrangement as to safeguard against operation by unauthorized personnel.

2.18.3 Distribution Switch Boards.

i) The distribution boards shall be located as near as possible to the center of the load they are intended to control. These boards shall be fixed on suitable stanchion or wall, and shall be accessible for attention to fuses/ MCBs.

ii) Where two or more distribution boards feeding low pressure circuits are fed from a supply at medium voltage, these distribution boards shall be: -

- a) Fixed not less than 2 m apart; or
- b) Arranged so that two cannot be opened at a time, namely, they are interlocked, and the metal case is marked "Danger-400V", or
- c) Installed in a room or enclosure accessible to only authorized persons.

2.19 Construction of Switch board:

2.19.1 Cubicle type L.T. Switch Boards, Dist Boards & Sub-Dist Boards:

i) LT, AC switch boards shall be of CRCA sheet steel (min. 2mm thick) construction, floor mounted, totally enclosed conforming to IP-51 degree of protection for indoor use of IP-55 for outdoor use.

ii) Bus Bars shall be of high conductivity electrolytic grade aluminium conforming to IS:5082, Bus bars shall be located in air insulated enclosures and segregated from all other compartments of the board.

iii) The incoming feeders of main L.T. switchboard shall have MCCB / ACB and the outgoing feeders shall be switch fuses. Sub-distribution boards will comprise of Isolator and Fuse-switch units for incoming and outgoing feeders respectively. Ratings of Isolators / MCBs / Fuse-switch units shall be as indicated in respective single line diagrams. Lighting Sub-distribution boards shall have MCB inlets and outlets and shall be of wall/ structure mounting design for indoor use and pedestal mounting type for outdoor use.

iv) The incomers of PDBs shall have voltmeter with selector switch and also ammeter with selector switch, necessary CT's phase healthy lamps (R,Y,B) as indicated in the single line diagrams.

v) All feeders shall be provided with door interlocking mechanism with defeat facility.

vi) Terminals for power cables and gland plates for cables shall be provided in the cable alleys. All cable alleys shall have provision for cable entry from bottom. Incomers may have cable entry directly from bottoms of respective compartments.

vii) All operating handles/knobs shall be located between 250mm-1800mm height from ground level.

viii) Control and instruments wiring shall be with stranded copper wires of size not less than 2.5sq.mm.for C.T. circuits and 1.5sq.mm. for other circuits.

ix) Indicating instruments, lamps and selector switches shall be mounted on front of switchboards.

x) Floor mounting Boards shall be supplied with base channel of size ISMC 75 and wall mounted boards shall have suitable lugs / brackets with fixing holes.

xi) Lifting hooks shall be provided on each shipping section of floor-mounted switchboards.

xii) Colour of final paint- Shade no. 61 of IS:5

2.19.2 Bus bars:

i) Three phase and neutral electrolytic grade aluminium main busbars (neutral-50% of phase bus) and GI earth bus shall be provided.

ii) Rating of main horizontal buses shall be in line with nominal and short circuit ratings specified in the SLD ϕ and vertical runs shall be so as to match loads of outgoing switch ratings in respective feeder columns. Busbars of aluminium shall be mounted on non-hygroscopic FRP insulators.

iii) Temperature rise of bus bars shall not be more than 40°C above ambient of 45°C.

iv) Bus bars shall have coloured phase identification and heat-shrink type PVC sleeving.

2.19.3 Current Transformers:

i) Type-Bar primary type.

ii) Insulation-Tape insulated ring type construction.

iii) Secondary-5A

iv) Minimum burden-5VA

v) Accuracy class-1.0 for measuring

vi) Mounting-busbars side of each incoming feeder

vii) Rated primary current-As per feeder requirement (as shown in SLD ϕ s)

viii) Short time rating-In line with short time rating of busbars.

ix) Polarities shall be marked on C.T. ϕ s and on terminal blocks.

2.19.4 Air Circuit Breakers:

Triple pole Air Circuit Breakers shall conform to IS:2516 Part I&II. The incoming feeders shall be provided with separate neutral contractor. The ACB ϕ s shall have minimum short circuit breaking and withstand capacity of 50KA and 50KA for 1 sec respectively.

The ACB ϕ s be manually operated fixed tube and equipped with magneto-thermal release, overload, short circuit, earth fault, CTs, auxiliary contacts etc. The ACBs are suitable for operational voltage of 415V A.C.

2.19.5 Moulded Case Circuit Breakers:

i) Triple pole moulded case circuit breakers shall conform to IS:2516. Incoming feeders shall be provided with separate neutral contractor. The MCCBs shall have minimum short circuit breaking and withstand capacity of 50KA & 50KA for 1 sec. respectively.

ii) The MCCBs shall have manual independent closing mechanism by means of operating handles projecting outside the compartment doors. The handles shall be duly interlocked with the respective compartment door having interlock defeat facility.

iii) The MCCBs shall be provided with direct acting type adjustable overload and short circuit releases.

2.19.6 Miniature Circuit Breakers:

i) Miniature Circuit Breakers, used for sub-lighting distribution boards, shall be either single pole or triple pole as per requirements laid out in the single line diagrams. They shall have a systematical breaking capacity of 9KA rms.

ii) The MCBs shall have knobs for manual operation. The knobs shall be protruding out through the cutouts on the front hinged doors of the respective SLDBs. The cutouts made for this purpose shall be duly gasketed to prevent entry of dust.

iii) The distribution boards shall have proper shrouds inside the front doors such that accidental contact with live parts on opening the doors is prevented.

2.19.7 Switch and Switch Fuses:

i) Load break Switches and Switchfuses shall be AC-23 duty, triple pole with neutral air break type with independent manual quick make and quick break arrangement. All TPN switches shall have removable link in neutral. Switch-fuses and Switches should withstand the fault current envisaged for the 415V system, till rupturing of respective fuses or tripping of up-stream MCCBs / ACBs as the case is.

ii) All switches shall be interlocked with their respective compartment doors such that the doors cannot be opened when the switches are in ON position or the switches cannot be switched ON when the doors are open. However interlock defeat facility shall also be provided.

2.19.8 Indicating Instruments:

i) Size: Incomer of Main Switch Board- 144mm square and for others- 95mm square

ii) Mounting: Flush in front of the panels.

iii) Accuracy class: 1.0

iv) Ammeters shall be compatible with CTs of 5A secondary and read actual currents as per the SLDs.

v) Voltmeters and phase healthy lamps shall have protective HRC fuses.

2.19.9 Earthing Terminals:

Two suitable earth terminals shall be provided on all switchboards for terminating earthing GI conductors of size 50mm X 6mm. For sub-distribution boards the earthing conductor size shall be 8 SWG wires.

2.19.10

- i) Type Test certificates for the following tests shall be furnished:
 - a) Short circuit withstand test on bus-bars,
 - b) Temperature rise test on bus-bars,
 - c) Verification of degree of protection.

- ii) Following Routine Tests shall be carried out (in presence of the customer's representative, if so desired):
 - a) High Pressure withstand test at 2500 volts for 1 min.,
 - b) Insulation test by 1000V megger both before and after H.F. Test
 - c) Checking of equipment ratings and physical verifications.

All the test certificates shall be furnished by the manufacturer in triplicate for customer's record. Vendor shall also furnish test certificates for major proprietary brought out items like MCBs, MCCBs, Switch fuses, Meters, CTs etc. from respective manufacturer.

2.19.11 Drawing & Documents:

The manufacturer shall furnish sufficient copies of the following documents and drawings. The supply shall not be considered complete unless the same are submitted in proper time as demanded. Manufacturing shall be taken up only after approval of drawings submitted by the manufacturer.

- i) Detailed dimension drawings and foundation plans,
- ii) Detailed circuit and wiring diagrams along with bill of equipment and accessories, mentioning the makes and ratings.
- iii) Test certificates as mentioned above,
- iv) Installation and Maintenance manual.

2.19.12 Performance Guarantee:

All supplies made shall be guaranteed against faulty design and or defective Material or Workmanship for a period of 12 months from the date of commissioning or 18 months from the date of delivery, whichever is earlier.

2.19.13 Common requirements for all types of switch boards:

- i) Switch boards, if unavoidably fixed in places likely to be exposed to weather to drip, or to dampness, their outer casing shall be weather proof and shall be provided with glands or bushings or adopted to receive screwed conduits according to the manner in which the cables are run. PVC and double flanged bushes shall be fitted in the holes of the switches for entry and exit of wires.

- ii) When it is unavoidable to install in a situation where inflammable or explosive dust, vapour or gas is likely to be present, the switch boards shall be totally enclosed, or made flame proof as may be necessitated by the particular circumstances.

- iii) The various live parts, unless they are effectively screened by substantial barriers of non hygroscopic, non-inflammable, insulating material, shall be so spaced that an arc cannot be maintained between such parts and with earth.

- iv) In every case in which switches and fuses are fitted on the same pole, these fuses shall be so arranged that the fuses are not alive when their respective switches are in the 'off' position.

- v) No fuses, other than fuses in instrument circuit, shall be fixed on the back or, or behind a switch board panel, or frame.
- vi) Equipments which are on the front of a switch board shall be so arranged that inadvertent personal contact with live parts (direct contact) is unlikely during the manipulation of switchgears, changing of fuses, or like operations.
- vii) The arrangement of the gear shall be such that they shall be readily accessible, and their connections to all instruments and apparatus shall be easily traceable.
- viii) Interconnections of the various mountings on the boards shall be done using PVC insulated conductors, or solid strips with PVC taping / sleeving, of appropriate sizes. Terminations shall be made such that local heating is avoided.
- ix) No holes, other than the holes by means of which the panel is fixed, shall be drilled closer than 1cm from any edge of the panel.
- x) All the metalwork of switch boards shall be painted prior to erection with one coat of anti-rust primer. After erection, they shall be painted with two coats of appropriate enamel, or aluminium plant as required, on all sides wherever accessible.
- xi) All switch boards shall be provided with "Danger Notice Plate" conforming to relevant Indian Standards. If required in the tender specifications, a pilot lamp shall be fixed and connected through an independent single pole switch and fuse to the busbars or the board.

2.20 Switch Board Installation

- i) Unless and otherwise specified in the tender documents, a switch board shall not be installed so that its bottom is within 1.25m above the floor, unless the front of the switch board is completely enclosed by a door, or the switch board is located in a position to which only authorized persons have access.
- ii) The switch board inside a residence shall be installed such that the operating knob/handle of the incomer is at a height of about 2m for ease of operation at times of emergency.
- iii) There shall be a clear space of 1m in front of the switch boards. The space behind the switch boards shall be either less than 20cm or more than 75cm. If there are any attachments or bare connections at the back of the switch board. Rule 51(c) of the Indian Electricity Rules shall apply.
- iv) Hinged type boards shall be securely fixed on wall by means of rag bolts, Fixed type boards shall be installed by suitably grouting the framework on the wall and/or floor as required. Cubicle type boards shall be installed by suitable foundation bolts grouted in the floor, or alternatively, over masonry cable trenches on necessary channel sections, duly grouted as required.
- v) Cubicle type switch boards shall be recessed in the wall if so specified in the tender documents. The front shall then be fitted with hinged panel with locking arrangement, the outer surface of door being flush with the wall. Ample room shall be provided for wiring / cable connections at the side and at the front between the switchgear mountings and the door.
- vi) a) The connections between the switchgear mounting and the outgoing cable upto the wall shall be enclosed in a protection pipe.

b) Where it is required to terminate a number of conduits on a board, it may be convenient to provide a suitable MS adaptor box for the purpose. Such boxes shall be provided with the prior approval of the Engineer-in-charge and this will be paid for separately.

vii) All wires to the boards shall be bushed at the entries to avoid damage the insulation.

viii) No apparatus shall project beyond any edge of the panel, fuse body shall be mounted within 2.5cm of any edge of the panel.

ix) Busbars and interconnecting strips in fabricated boards shall be PVC taped or sleeved in Red, Yellow and Blue for phases, and Black for neutral. The interconnecting cables shall also follow this colour coding.

x) All unused holes in the boards and the mountings shall be plugged suitably to avoid entry of insects.

2.21 Wiring of Switch Boards and Distribution Boards:

i) All connections between pieces of apparatus or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangement of the apparatus mounted thereon, avoiding unnecessary crossings.

ii) Cables shall be connected to terminals either by crimped or soldered lugs, unless the terminals are of such a form that they can be securely clamped without cutting away of cable strands.

iii) All bare conductors shall be rigidly fixed in such a manner that a clearance of at least 2.5cm is maintained between conductors of opposite polarity of phase, and between the conductors and any material other than insulating material.

iv) In a hinged type board, the incoming and outgoing cables shall be neatly bunched and shall be fixed in such a way that the door shall be capable of swinging through an angle of not less than 90 degrees.

2.22 Marking of Apparatus:

i) Marking of earthed neutral conductor

On the main switchgear, where the conductors include an earthed conductor of a two wire system, or an earthed neutral conductor of a multi-wire system, or a conductor which is to be connected thereto an indication of a permanent nature shall be provided to identify the earthed neutral conductor. In this connection Rule 32(1) of Indian Electricity Rules 1956 shall be referred to. The neutral conductor shall be black in colour.

ii) Main Earthing Terminal

The main earthing terminal in the main switch board shall be permanently marked as "SAFETY EARTH-DO NOT REMOVE".

iii) Where a board has more than one switchgear, each such switchgear shall be marked to indicate which section of the installation it controls. The main switchgear shall be marked as such. Where there is more than one main switch board in the building, each such switch board shall be marked to indicate which section of the installation and building it controls.

iv) All distribution boards shall be marked -LØ for lighting, or -PØ for power, and -EØ for essential as the case may be.

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

A.C.

Three phases-Red,

Blue & Yellow

Neutral- Black

D.C.

Three wire system

2 outer wires- Red & Blue

Neutral- Black

vi) Where a four wire, three phase wiring is done, the neutral shall preferably be in one colour and the outer three wires in another colour.

vii) All marking required under this rule shall be clear and permanent.

2.23 Attachment for Fittings and Accessories

Conduit Wiring System:

i) All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch / regulator boxes. Accessories like ceiling roses, brackets, batten holders, stiff pendants, etc. shall be fixed on metal outlet boxes. The fan regulators may also be fixed on metal outlet boxes, if so directed by the Engineer-in-charge.

ii) Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases

iii) The switch box / regulator box shall normally be mounted with their bottom 1.25m from floor level, unless otherwise directed by the Engineer-in-charge.

2.24 Fixing to walls and ceiling:

i) Wooden plugs for ordinary walls or ceiling shall not be used in view of the ban on use of timber in Govt. works. However, where so specified, these shall be of well seasoned teak or other approved hard wood not less than 5cm long by 2.5cm square on the inner end, and 2cm square on the outer end. They shall be cemented into walls within 6.5mm of the surface, the remainder being finished according to the nature of the surface with plaster of lime punning.

ii) PVC sleeves / dash fasteners should normally be used for fixing to walls or ceiling.

iii) Plugging of walls or ceiling can be done in a better way where neatness is the first consideration. In all such case, an approved type of asbestos or fiber fixing plug (rawl or phil plug) with correct size of tools shall be used and done in a workman like manner.

2.25 Fans Regulators and Clamps

2.25.1 Ceiling Fans

i) Ceiling fans including their suspension shall conform to relevant Indian Standards.

ii) All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

iii) For wooden or steel joists and beams, the suspension shall consist of MS flat of size not less than 40mm X 6mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5cm for each flat. Where there is a space above the beam, a through-bolt of size not less than 1.5cm dia. shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5cm dia. shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of SØ form

iv) In the case of IØ beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.

v) For concrete roofs, a 12mm dia. MS rod in the shape of UØ with their vertical legs bent horizontally at the top at least 19cm on either side, and bound to the top reinforcement of the roof shall be used.

vi) In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub clause (v) above cannot be used, or wherever specified, recessed type fan clamp inside a metallic box shall be used.

vii) Canopies on top of suspension rod shall effectively hide the suspension.

viii) The leading in wire shall be of nominal cross sectional area not less than 1.5sq.mm. and shall be protected from abrasion.

ix) Unless otherwise specified, all ceiling fans shall be hung 2.75m above the floor

x) In the case of measurement of extra down rod for ceiling including wiring, the same shall be measured in units of 10cm length less 5cm shall be ignored.

xi) The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

2.25.2 Exhaust fans

i) Exhaust fans shall conform to relevant Indian Standards.

ii) Exhaust fans shall be erected at the places indicated by the Engineer-in-charge. For fixing an exhaust fan, a circular hole shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the hole as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.

iii) Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.

iv) Installation of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration; any special provisions needed shall be specified.

2.25.3 Regulators

The metallic body of regulators of ceiling fans / exhaust fans shall be connected to earth by protective conductor.

2.26 Workmanship:

i) Good workmanship is an essential requirement to be complied with. The entire work of manufacture / fabrication, assembly and installation shall conform to sound engineering practice.

ii) The work shall be carried out under the direct supervision of a first class licensed foreman, of a person holding a certificate of competency issued by the State Govt. for the type of work involved, employed by the contractor, who shall rectify then and there the defects pointed out by the Engineer-in-charge during the progress of work.

2.27 Commissioning on completion

Before the workman leaves the work finally, he must make sure that the installation is in commission, after due testing.

2.28 Completion Plan and Completion Certificate

i) For all works completion certificate after completion of work as given in Appendix-B shall be submitted to the Engineer-in-charge.

ii) As-built Drawing to be submitted along with Completion Certificate.

PVC CONDUIT WIRING SYSTEM

3.0 Scope

This chapter covers the detailed requirements for wiring work in PVC conduits. This chapter covers both surface and recessed types of works.

3.1 Application

i) Recessed conduit is suitable generally for all applications. Surface conduit work may be adopted in places like workshops, plant rooms, pump rooms, wiring above false ceiling / below false flooring, and at locations where recessed work may not be possible to be done. The type of work, viz. surface or recessed, shall be as specified in the respective works.

ii) Flexible conduits may only be permitted for interconnections between switchgear, DBs and conduit terminations in wall.

3.2 Material

3.2.1 Conduits

i) All rigid conduit pipes shall be of PVC and be ISI marked. The wall thickness shall be not less than 1.6mm (16 SWG) for conduits upto 32mm dia. And not less than 2mm (14 SWG) for conduits above 32mm dia.

ii) The maximum number of PVC insulated cables conforming to IS:694-1990 that can be drawn in one conduit is given sizewise in Table 3.1 and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

iii) No PVC conduit less than 20mm in diameter shall be used.

3.2.2 Conduit accessories

i) The conduit wiring system shall be complete in all respects, including their accessories.

ii) All conduit accessories shall be of threaded type and under no circumstances pin grip type or clamp grip type accessories shall be used.

iii) Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works.

iv) a) Saddles for surface conduit work on wall shall not be less than 0.55mm (24 gauge) for conduits upto 25mm dia. And not less than 0.9mm (20 gauge) for larger diameter. The corresponding widths shall be 19mm & 25mm.

b) The minimum width and the thickness of girder clips used for fixing conduits to steel joists and clamps shall be as per Table 3.2.

v) The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 3mm and in case of welded mild steels sheet boxes, the wall thickness shall not be less than 1.2mm (18 gauge) for boxes upto size of 20cm X 30cm, and above this size 1.6mm (16 gauge)

thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection.

vi) Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

vii) An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

viii) A metal strip shall be welded/screwed, to the metal box as support if tumbler type of control switches, sockets and/ or fan regulators are to be fixed therein.

ix) Clear depth of the box shall not be less than 60mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

x) The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if directed by Engineer-in-charge.

xi) Except where otherwise stated, 3mm thick phenolic laminated sheets shall be fixed on the front with brass screws, or aluminium alloy / cadmium plated iron screws as approved by the Engineer-in-charge.

3.3 Installation:

3.3.1 Common aspects for recessed and surface conduit works.

- i) Conduit joints:
 - a) the conduit work of each circuit or section shall be completed before the cables are drawn in.
 - b) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13mm to 19mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.
 - c) Fixing ends of conduit pipes shall have no sharp edges which have been affected to avoid damage to the insulation of the conductors while pulling them through such pipes.
 - d) The Engineer-in-charge, with a view to ensuring that the above provisions have been carried out, may require that the separate lengths of conduit etc. after they have been prepared, shall be submitted for inspection before being fixed.

- ii) Bends in conduit:
 - a) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5cm, or alternatively by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.
 - b) No length of conduit shall have more than the equivalent of four quarter bends from outlet.
 - c) Conduit fittings shall be avoided as far as possible on conduit system exposed to weathers. Where necessary, solid type fittings shall be used.

- iii) Outlets:
 - a) All outlets such as switches, wall sockets etc. may be either flush mounting type, or of surface mounting type, as specified in the Additional Specifications.
 - b) All switches (except piano type switches), socket outlets and fan regulators shall be fixed on metal strips which shall be screwed / welded to the box. Piano type switches and accessories shall be fixed on the phenolic laminated sheet covers in flush pattern.
- iv) Painting after erection:

After installation, all accessible surfaces of conduit pipes, fittings, switch and regulator boxes etc., shall be painted in compliance with the clauses under Chapter 10-öPaintingö.

3.3.2 Additional requirements for surface conduit work.

- i) Painting before erection:

The outer surface of conduit including all bends, unions, tees, junction boxes, etc. forming part of the conduit system, shall be adequately protected against rust when such system is exposed to weather, by being painted with 2 coats of red oxide paint applied before they are fixed.
- ii) Fixing conduit on surface:
 - a) Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30cm from the center of such fittings.
 - b) Where conduit pipes are to be laid along the trustees, steel joints etc. the same secured by means if saddles or girder clips or clamps as required by the Engineer-in-charge.
 - c) In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jammuts shall be provided.
- iii) Fixing outlet boxes:

Only a portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

3.3.3 Additional requirements for recessed conduit work

- i) Making chase:
 - a) The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.
 - b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.
 - c) In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.
- ii) Fixing conduits in chase:

The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60cm apart, or by any other approved means of fixing.
- iii) a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steels reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.

c) Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

iv) Fixing inspection boxes:

a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667-1997.

c) Suitable ventilating holes shall be provided in the inspection box covers.

v) Fixing switch boxes and accessories:

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

vi) Fish wire:

To facilitate subsequent drawings of wires in the conduit, GI fish wire of 1.6mm/1.2mm (16/18 SWG) shall be provided along with the laying of the recessed conduit.

vii) Bunching of cables:

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

b) Where the distribution is for single phase loads only, conductors for phases shall be drawn in one conduit.

c) In case of three phase loads, separate conduits shall be run from the distribution boards to the load points, or outlets as the case may be.

3.3.4 Earthing requirements

i) The entire system of conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double checking at terminations.

ii) Protective (loop earthing) conductor(s) shall be laid along the runs of conduit between the metallic switch boxes and distribution boards / switch boards, terminated thereto. These conductors shall be of such size and material as specified.

iii) The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

iv) Gas or water pipe shall not be used as protective conductor (earth medium)

EARTHING

4.0 Scope

This chapter covers the essential requirements of earthing system components and their installation. This shall be read with Appendix G which lays down criteria for their design. For details not covered in these Specifications, IS Code of Practice on Earthing (IS: 3043-1987) shall be referred to.

4.1 Application

i) The electrical distribution system in the Department is with earthed neutral (i.e., neutral earthed at the transformer / generator end.) In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal / external electrical installations.

ii) Earthing system is also required for lightning protection, computer installations and hospital operation theaters, etc. for functional reasons.

iii) Earthing requirements are laid down in Indian Electricity Rules, 1956 as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

iv) Though this chapter and appendix G form part of the Specifications for Internal EI works, these requirements shall be complied within works of earthing for other applications also.

4.2 Materials

4.2.1 Earth Electrodes

4.2.1.1 Types

The type of earth electrode shall be any on the following, as specified.

- a) Pipe earth electrode.
- b) Plate earth electrode.
- c) Strip or conductor earth electrode.

4.2.1.2 Electrode materials and dimensions

- i) The materials and minimum sizes of earth electrodes shall be as per Table 4.1
- ii) GI pipe electrodes shall be cut tapered at the bottom, and vided with holes of 12mm dia, drilled not less than 7.5cm from other upto 2m of length from the bottom.
- iii) The length of the buried strip or conductor earth electrode shall be not less than 15m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-charge shall be taken for any such increase in length.

4.2.2 Earthing Conductor

- i) The earthing conductor (protective conductor from earth electrode upto the main earthing terminal / earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.
- ii) The size of earthing conductor shall be specified, but this shall not be less than the following.
 - a) 5mm dia (6 SWG) for GI, or 4mm dia (8 SWG) for copper wire,
 - b) 25mm X 4mm in the case of GI strip, or,
 - c) 20mm X 3mm in the case of copper strip.
- iii) Earthing conductor larger than the following sectional areas need not to be used, unless otherwise specified.
 - a) 150sq.mm. in case of GI, or
 - b) 100sq.mm. in case of copper.

4.2.3 Earth Bus

- i) Two copper strips, each of size 50mm X 5mm shall be provided as earth bus in a 11KV sub-station and / or diesel generating station irrespective of the capacity of the transformer / panel / generating set, etc. shall be connected to these two strips of earth bus. The two strips of the earth bus shall be bonded together.
- ii) The neutral earth leads of the transformer and / or generator alternator shall not be connected to this earth bus. They shall be connected directly to individual earth electrodes.

4.2.4 Hardware Items

All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

4.2.5 Protective (Earth continuity / Loop earthing) Conductor

- i) The material and size of protective conductors shall be as specified.
- ii) The minimum cross sectional area of a protective conductor (not contained within a cable or flexible cord) shall be: -
 - a) 2mm dia (14SWG) in case of copper,
 - b) 2.5mm dia (12 SWG) in case of GI, or,
 - c) 2.24mm dia (13 SWG) in case of aluminium.
- iii) Unless otherwise specified, GI conductor should not be ordinarily used as protective conductor within any circuit, beyond a DB downstream.

4.3 Installation

- i) Normally an earth electrode shall not be located closer than 1.5m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building, in such cases, electrodes may be located further away from the building, with prior approval of the Engineer-in-charge.
- ii) The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far possible. Entrances, pavements and road, ways, should be avoided for locating earth electrodes.

4.3.1 Electrodes

4.3.1.1 Various types of electrodes

- i) a) Pipe electrode shall be buried in the ground vertically with its top at not less than 20cm below the ground level. The installation shall be carried out as shown in Drawing.
 - b) In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.
- ii) Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3m below the ground level. The installation shall be carried out as shown in Drawing.
- iii) When more than one electrode (plate / pipe) is to be installed, a separation of not less than 2m shall be maintained between two adjacent electrodes.
 - a) The strip or conductor electrode shall be buried in trench not less than 0.5m deep.
 - b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in number of trenches radiating from one point.
 - c) If the electrode cannot be laid in a straight length, it may be laid in a zig-zag manner with a deviation upto 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1m or polygon.

4.3.1.2 Artificial treatment of soil:

When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal/ coke and salt as indicated in Drawing. In such cases, excavation for earth shall be increased as per the dimensions indicated in these figures.

4.3.1.3 Watering arrangement

- i) In the case of plate earth electrodes, a watering pipe 20mm dia. Medium class of pipe shall be provided and attached to the electrodes as shown in Drawing. A funnel with mesh shall be provided on the top of this pipe for watering the earth.
- ii) In the case of pipe electrodes, a 40mm X 20mm reducer shall be used for fixing the funnel with mesh.
- iii) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30cm X 30cm X 360cm.
- iv) A cast iron/MS frame with MS Cover, 6mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

4.3.2 Earthing Conductor (Main earthing lead)

- i) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, checknuts and washers.
- ii) In the case of pipe earth electrode, wire type earthing conductor shall be secured as indicated in Drawing using a through bolt, nuts and washers and terminating socket.
- iii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanised C shaped strips, bolts, washers, nuts and checknuts of adequate size shall be used for the purpose.
- iv) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15mm dia. GI pipe in the case of wire, and by 40mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30cm deep (to be increased to 60cm in case of road crossing and pavements). The proportion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.
- v) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:
 - a) soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and
 - b) Bolt, nut and washer in case if strip conductor.

In the case of substations or alterations, the termination shall be made on the earthing terminal of the neutral point on the equipment and / or the earth bus, as the case may be.

4.3.3 Earth Bus and Main Earthing Terminal

- i) In the case of substations and generating stations, two numbers copper/GI (as specified) earth bus shall be provided, duly connected to two numbers of independent electrodes, exclusively for equipment (body) earthing of substation or generating station equipments.
- ii) In all other installations, main earthing terminal shall be provided at the main switch board. This may be in the form of earth stud or single earth bar depending on the type of switch board.
- iii) Following conductors shall be terminated on to the main earthing terminal.

- a) Earth connection from electric supply company (where provided)
- b) Earthing conductor from electrode.
- c) Protective conductors.
- d) Equi-potential bonding conductors.

4.3.4 Protective (Loop earthing / earth continuity) conductor

- i) Earth terminal of every switch board in the distribution system shall be bonded to the earth bar / terminal of the upstream switch board by protective conductors(s)
- ii) Two protective conductors shall be provided for a switch board carrying a 3 phase switchgear thereon.
- iii) All the mountings of industrial type switch boards shall be bonded to the earth stud / earth bar using a protective conductor looping from one to another. Loop earthing of individual units will not be however necessary in the case of cubicle type switchboards.
- iv) The earth conductor in every distribution board (DB) shall be securely connected to the earth stud / earth bar of the corresponding switchboard by a protective conductor.
- v) All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor (also called circuit protective or loop earthing conductor), looping from one box to another up to the DB.
- vi) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are on non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.
- vii) Double earthing strips in rising mains, bus trunking etc. shall be securely connected to the earth bar / earth stud at the sending and switch board. In the case of overhead busbar systems, protective conductors shall be provided in addition to feeder cable armouring connections.

4.4 Earth Resistance

- i) The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be upto 8 ohms.
- ii) Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, so such additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-charge.

4.5 Marking

- i) Earth bars / terminals at all switch boards shall be marked permanently, either as "E" or as symbol.
- ii) Main earthing terminal shall be marked "SAFETY EARTH-DO NOT DISCONNECT".

4.6 Use of Residual Current Devices (RCDs)

Application of RCDs (also known RCCBs) IS:12640-1988 shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30mA, 100mA, 300mA or 500mA as specified.