

TECHNICAL SPECIFICATION

FOR

INTERNAL ELECTRIFICATION WORKS

FOR THE PROPOSED SBILIFE REGIONAL OFFICE AT VIJAYAWADA

Volume-1

SECTION: 1

INTERNAL ELECTRIFICATION WORKS

1.0 SCOPE

This specification covers the Supply, Installation, Testing and Commissioning of all electrical equipment of for the following works at project site

Any item not specifically mentioned in this specification but considered essential for satisfactory operation of the system shall be included by the tendered in his offer.

The installation shall be carried out in accordance with Indian Electricity Rules, relevant statutory requirements, this specification, design drawings and applicable Engineering Standards. Any variations or changes to be carried out at site shall be done with the prior approval of the Consultant/Clients representative.

2.0 SITE CONDITIONS

- | | | | |
|-----|---------------------|---|-----------------------------------|
| 2.1 | Ambient Temperature | : | Maximum 45°C
Minimum -1°C |
| 2.2 | Relative Humidity | : | Around 60% at maximum temperature |
| 2.3 | Altitude | : | Around 1000mm above MSL |
| 2.4 | Atmosphere | : | Polluted with industrial vapors |

3.0 ELECTRICAL SUPPLY PARTICULARS

- | | | | |
|-----|-----------------------------|---|--|
| 3.1 | System Voltage | : | LT 433V $\pm 10\%$
HT 11000V $\pm 10\%$ |
| 3.2 | Frequency | : | 50 c/s |
| 3.3 | Frequency variation limits | : | $\pm 3\%$ |
| 3.4 | Neutral earthing on LV side | : | Solidly earthed |

4.0 STANDARDS

- | | |
|-----|---|
| 4.1 | All equipment and installation shall generally confirm to the requirements of relevant India Standards and Codes of Practice. All materials supplied should be accompanied by total certifications. |
| 4.2 | All the materials shall preferably carry ISI mark. |
| 4.3 | The installation shall confirm to the requirement of latest editions of Indian Electricity Rules and supplementary regulations of local Authorities and State Electricity Board. |

4.4 The installation shall meet with the requirements of Fire Insurance Regulations and good engineering practice.

4.5 The standards shall include but not be limited to the following.

a. Indian Electricity Rules (1956) amended up to date.

b. National Electrical Code.

c. Indian Electricity Act 1910.

IS: 732 - Code of practice for Electrical Wiring Installation
(System Voltage below 650V)

IS: 2274 - Code of practice for Electrical Wiring Installation
(System voltage above 650V)

IS: 3043 - Code of Practice for earthing.

5.0 **DRAWINGS**

The following drawings will form a part of this specification:

5.1 Key plan

5.2 LIGHTING / CONDUIT LAYOUT

5.3 Cable routing layouts.

5.4 Illumination layouts.

6.0 **SCOPE OF WORK**

6.1 The scope of work covered in this specification shall not be limited to the following.

6.2 Arranging all necessary tools and tackles and testing instruments to ensure

6.3 Unhampered progress of work.

Day to day supervision of the installation work by a full time competent & experienced supervisor having minimum qualification of BE in Electrical Engineering with at least 5 to 6 years experience in similar installations and holding valid supervisory permit issued by the ELECTRICAL LICENSING BOARD.

6.9 Testing and commissioning of the installation in accordance with the provision of relevant Indian Standard Codes of Practice.

6.10 Preparation of as built drawings and submission of the same in triplicate to Clients.

7.0 **APPROVAL OF SAMPLES**

The Contractor shall submit samples of all discrete materials/components, like conduits, switches, wires, etc., for the approval of Client/ Consultant. The samples submitted shall confirm to the relevant specifications and makes specified.

8.0 **TESTING OF INSTALLATION**

All equipment included in contractor's scope of supply shall be tested at Manufacturer's Works, before delivery and necessary Test Certificates shall be submitted for approval of Consultant.

8.1 The Contractor shall carry out all performance tests after installation, in the presence of the Client/Consultant, as per specification. The Contractor shall bear all expenses for such tests.

8.2 The Contractor shall be responsible for executing the contract as per Indian Electricity Rules, Rules and Regulations of supply authorities and the Rules of the local Electrical Inspectorate. It shall be the contractor's responsibility to execute all works within the framework laid down by these Authorities. Any changes/modifications pointed out by the authorities shall be carried out immediately. The works shall be deemed to be complete only after the receipt of all-statutory approvals and approval of the Consultant/Client Engineer.

9.0 **TAKING OVER OF INSTALLATION**

- The equipment & installation shall be deemed to have been taken over by the Client, when concerned authority has certified that all contractual obligations have been fulfilled by the Contractor.
- All performance tests shall be carried out and the contractor shall furnish Test Certificates.
- The taking over of the installation shall be deemed to be complete, only when the contractor has carried out all tests in the presence of the Client and when the contractor has submitted the 'As Built' Drawings.

10.0 **GUARANTEE**

10.1 The equipment supplied and the client shall guarantee the installation for satisfactory performance and workmanship, for a period of 12 months from the date of handing over of all installations for use. The contractor shall replace free of cost all equipment or parts supplied by him and found defective within this period.

10.2 In case the contractor fails to replace or render services for defective materials & parts, the client reserves the right to get it rectified, at the contractor's risk and expenses without prejudice.

11.0 **FREE ISSUE EQUIPMENTS.**

No free issue equipment will be given from the client side. The scope of work covers the total Internal electrification system for the Proposed Disaster Recovery Centre.

12.0 **SPECIFICATION FOR ELECTRICAL EQUIPMENT**

All equipment and materials shall confirm to relevant IS specifications. Where specifications do not exist or the materials specified by the Consultant do not comply with the IS specification, the same shall be procured with prior approval of the Consultant/client.

12.7 **MCB DBs AND MCBs**

12.7.1 The MCB DBs shall be of the factory assembled type preferably manufactured by same manufacturer as the MCBs.

12.7.2 Unless otherwise specified all MCB DBs for lighting control shall be of the phase segregated TPN quadrant type, fabricated out of 16 SWG sheet steel and shall be of the totally enclosed dust proof type suitable for concealed rooms and slotted lid type for wall mounting.

The DBs shall have welded back and sides and gasketed front cover. Detachable gland plated shall be provided at the top and bottom with suitable gaskets for cable entry.

The enclosure shall undergo suitable pretreatment followed by 2 coats of synthetic stove enameled paint.

The phase segregated MCB DBs shall house the following:

- a. Incoming four pole of suitable current rating accommodated in one quadrant of the D.B. The incoming terminals shall be fully shrouded.
- b. Three phase segregated quadrants, each housing MCBs connected to one phase of the power supply system. Each of the quadrant shall have SP MCBs. This arrangement shall be applicable for all lighting DBs.
- c. In each quadrant a separate neutral bus shall be provided while a common earth bus shall be provided for the DB. While the neutral buses shall be connected to the neutral pole of the incoming ELCB/ MCB the earth bus shall be connected to the main earthing system.
- d. The number and ratings of MCB's to be provided shall be as per Single Line Diagram / Schedule of Quantities.
- e. The MCBs shall be of hydraulic magnetic/bimetallic magnetic type having of fault interrupting capacity of not less than 10000A at 240V.

The MCB DBs for power socket control shall be of the TPN type with slotted type screwed front cover. These shall be suitable to accommodate both single pole and triple pole MCBs side by side.

12.14.0 WIRING ACCESSORIES

a. WIRES

Wires for power sockets, lighting, and exhaust fan shall be 1100/660V grade PVC insulated, single core, multi strand copper. The size of wire for point wiring/circuit wiring and sub circuit wiring shall be as per the schedule of quantities. The smallest size of wire shall be less than 2.5sqmm for circuit wiring and 10 sqmm for earth and control. All wires shall be terminated with crimping type lugs.

The following color code shall be used for wiring system

- | | | |
|-----------------------------------|---|-----------------|
| 1. All phases and switch controls | - | Red/Yellow/Blue |
| 2. Neutral | - | Black |
| 3. Earth | - | Green |

b. CONDUITS & ACCESSORIES

Unless otherwise specified all conduits shall be of 2 mm This PVC Conduit. The minimum size of conduit shall be 20 mm.

The accessories including junction boxes, bends, ceiling rose, shall be of the approved type. Samples shall be produced for client's approval before installation.

c. LIGHTING SWITCHES AND SWITCH BOXES.

All lighting switches shall be of 5A Modular plate type suitable for flush mounting.

13.00 GALVANISING

All materials unless otherwise specified shall be hot dip galvanized with a zinc coating of not less than 600 gm/m. Laboratory test certification to establish the thickness of zinc coating shall be submitted.

14.0 INSPECTION

The responsibility of inspection of all the materials before delivery shall rest with the contractor. However the Client/Consultant shall have full authority to inspect the materials and accept/reject the same. Any material rejected shall be replaced free of cost by the Contractor.

15.0 SPECIFICATION FOR INSTALLATION

15.1 This section covers the requirement of the Electrical installation work associated with this assignment.

15.2 The Installation shall be carried out in accordance with the Indian electricity rules, recommendations of Indian standards codes of practice and the requirement stipulated by the local electrical inspectorate and any other applicable regulations.

16.0 DRAWINGS

The drawings lighting/power layout layout will be furnished to the contractor. These drawings are for the guidance only. The contractor shall if required prepare detailed working drawings and obtain the approval of the Consultant/client.

MCBs of various ratings shall be assembled in the lighting DBs. Circuit designation labels of individual circuit shall be fixed above each MCB in the distribution board.

Anodised aluminium engraved plate-inscribing designation, point of power supply & cable size shall be provided.

19.0 **POWER SOCKETS**

Power socket in sheet steel enclosure shall be surface/conceal mounted on the wall with suitable hardware as per site instructions. Power supply shall be tapped from panel either through cables on P.V.C. conduit. Wiring to all 15A and above sockets shall be through separate conduits.

20.0 **EXHAUST FAN**

The exhaust fan shall be mounted on a M.S.Ring which shall be fixed/grouted to the wall and shall be fitted in the opening, provided in the wall. The cowls shall be fixed outside the wall to protect against entry of rain, water & wind.

21.0 **SWITCH BOARDS**

The switch boards shall be conceal mounting type and shall be mounted on walls/partitions. All screws shall be of brass. Unless otherwise specified all switch boards shall be mounted at height of 850 mm from finished floor level.

22.0 **CONDUIT WIRING**

- a. Wherever conduits are required to be embedded in walls, the walls shall be chased to appropriate depth by the contractor. The conduit shall be fixed by means of saddles or pipe hooks in the walls at intervals of 600mm (horizontal). The contractor shall make good.
- b. The chasing by covering the same with the cement mortar. The top edge of the conduit shall be at least 30mm below the finished surface of the walls.

23.0 **DISTRIBUTION BOARDS**

Distribution Board shall be double door type with extended loose wire box at the top and suitable for flush installation. All distribution boards shall be of three phase (415 Volts) or single phase (240 volts) type with incoming isolator or MCB and/or ELCB as in Schedule of Quantities. Distribution boards shall contain plug in or bolted type miniature circuit breaker mounted on bus bars. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. MCB shall have thermal & magnetic short circuit protection. MCB shall conform with IS 8828-1978. Bus bars shall be of electrolytic copper. Neutral bus bars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. All distribution board enclosures shall have powder coated painting after metal treatment as listed in clause

No. 1.3. A circuit identification card in clear plastic cover shall be provided for each distribution board.

Distribution Board with single phase outgoings requirement shall be Horizontal type. Distribution Board with three phase outgoings requirement shall be Vertical type. Distribution Board installed in indoor dry locations shall conform to IP-42. Distribution Board installed in outdoor & wet locations shall conform to IP- 65.

Miniature Circuit Breakers for lighting circuits shall be of "B" series where as the circuits feeding discharge lamps (HPMV or HPSV) halogen lamps, all power outlet points, equipment/ machinery shall be of "C" series (Motor circuit) types. All miniature circuit breakers shall be of 10 KA rated rupturing capacity.

Distribution board shall be provided with isolator or MCB and/or earth leakage circuit breaker as mentioned in drawings and BOQ. Earth leakage circuit breaker shall be current operated type and of sensitivity not less than 30mA unless otherwise stated. ELCB shall be mounted within distribution board box. Distribution board box, Isolator, MCB's used shall be of one/same manufacturer. Standard size DB Box manufactured by approved manufacturer shall be used. In case size specified in BOQ is not standard size of manufacturer, in that case next standard size distribution board box shall be used with incoming & outgoing MCB as specified in BOQ. Additional cutout/space for outgoing MCB shall be plugged with blank plates.

SECTION – 2

POINT WIRING

1.0 SCOPE

This section covers the general technical requirements and measurement of the various component in Internal Electrical Installation Works.

1.1 TERMINOLOGY

The definition of terms shall be accordance with IS 732: 1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit and sub main wiring, which are defined in Clause 1.2, 1.3 and 1.3.2 hereunder.

1.2 POINT WIRING

1.2.1 Definition:

A point (other than socket outlet point) shall include all works necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, includes 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 case of pendants except stiff pendants)
- c) Back plate (in the case of stiff pendants)
- d) Lamp holder (in the case of gooseneck type wall brackets, batten holders and fittings which are not pre-wired.

1.2.2 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”.

1.2.3 Scope

- i) Following shall be deemed to be included in point wiring :
 - a) Conduit, accessories for the conduit and wiring cables between the switch box and point outlet, loop protective earthing of each fan/ light fixture.
 - b) All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.
 - c) Metal switch boxes for control switches, regulators, sockets etc. recessed or surface type and phenolic laminated sheet covers in case of piano type switches and outer & inner cover plates in case of modular type switches.

- d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/ conduit terminations.
- e) Control switch or MCB as specified.
- f) Ceiling rose or connector as required.
- g) Connections to ceiling rose, connector, lamp holder, switch etc.
- h) Interconnection wiring between points on the same circuit, in the same switch box or from another.
- i) 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/ sub mains is excluded from the scope of points)
- j) Based conduit or porcelain tubing where wiring cables pass through wall etc.
- ii) Following shall be deemed to be included in group control point wiring :

Conduit, accessories for the conduit and wiring cables between the Switchboard/ MCBDB to the first point or wiring cable between points forming a group including loop protective earthing of each fan/light fixture. (Providing MCB/Switch is not included in this scope and will be measured separately).

All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.

Junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with Switchboard/ MCBDB for loose wires/ conduit terminations.

Ceiling rose or connector as required.

Connections to ceiling rose, connector & Switch/ MCB etc.

Bushed conduit or porcelain tubing where wiring cables pass through wall etc.

1.3 **MEASUREMENT**

1.3.1 **POINT WIRING (OTHER THAN SOCKET OUTLET POINT)**

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.

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.

1.3.2 **POINT WIRING FOR SOCKET OUTLET POINTS**

- i) The light plug (5 / 6 Amp) point and power(15 / 16 Amp) point wiring shall be measured on linear basis, from the respective tapping point of live cable, namely, switchbox, another socket outlet point, or the Sub distribution board as the case may be, up to the socket outlet.
- ii) The metal box with covers, switch/ MCB, socket outlet and other accessories shall be measured and paid as separate item.
- iii) The power point may be 15/5 Amp or 16/6 Amp 6 pin socket outlet, where so specified in the Tender documents. (2 pin or 5 pin socket outlet shall not be permitted.)

1.3.5 **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.
- ii) No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

1.4 **CIRCUIT AND SUBMAIN WIRING**

1.4.1 **Circuit Wiring**

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

1.4.2 **Sub main Wiring**

Sub main wiring shall mean the wiring from one Main/Distribution switchboard to another. Measurement of circuit and sub main wiring.

- i) Circuit and sub main shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit 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 take to switch box or not.
- iii) When wires of different circuit are grouped in as single conduit the same shall be measured on linear basis depending on the actual numbers and sizes of wires run.
- iv) When circuit wires and wires of point wiring are run in the same conduit, circuit wiring shall be measured on linear basis depending on the actual number and sizes of wires run in the existing conduit. As far as, practicable circuit wiring and point wiring shall be drawn in different conduit.
- v) Circuit wiring and sub main shall not be run in the same conduit.
- vi) 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.

1.5 **OTHER WIRING WORKS**

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

1.6 **SYSTEM OF DISTRIBUTION AND WIRING**

The main distribution board and branch distribution board shall be controlled or provided with linked switch fuse unit or miniature circuit breaker (MCB) of specified rating on the phase or live conductor or combined phase and neutral control gear for incoming and outgoing as indicated in the BOQ.

Distribution of sub main and circuits.

As per final approved single line diagram.

1.6.1 **Balancing of Circuits**

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

1.6.2 **Wiring System**

- i) Unless and otherwise specified in the tender documents, wiring shall be done only by the “Looping System”. Phase of live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.
- ii) Lights, fans and call bell shall be wired in the ‘lighting’ circuits. 15/ 16 Amp socket outlets and other power outlets shall be wired in the ‘Power’ circuits. 5/ 6Amp socket outlets shall be wired in the ‘lighting circuits’.
- iii) The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear
- iv) The wiring shall be segregated as Essential and non-essential in all the building in the airports except in the case of residential quarters.

1.6.3 **Run of Wiring**

The type of wiring shall be as specified in tender document, i.e. conduit.

Surface wiring shall run, as far as possible, along the walls and ceiling so as to be easily accessible for inspection.

In no case, the open wiring shall be run above the false ceiling.

In all types of wiring, due consideration shall be given for neatness, good appearance and safety.

1.6.4 **Passing through walls or floors**

When wiring cables are to pass through a wall, these shall be taken through a protection (Steel) 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.

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

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

1.6.5 **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 submain 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.

1.7 **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 up to date.
- ii) The works shall also conform to relevant Indian Standard Codes of Practice shall be followed.

1.8 **GENERAL REQUIREMENTS OF COMPONENTS**

1.8.1 **Quality of Materials**

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

1.8.2 **Conformity of Standards**

- a) All components shall conform to relevant Indian Standard Specification, wherever existing. However, for conduits, wiring cables, piano switches and socket outlets, ISI marked materials shall only be permitted.
- b) The Indian Standards, including amendments or revisions thereof upto the date of tender acceptance, shall be applicable.

1.8.3 **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.

1.9 **CABLES**

1.9.1 **Wiring Cables**

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

Stranded aluminium conductor shall not be used in wiring cables up to and including 6 Sq. mm. size.

Unless and otherwise specified, copper conductor of size 1.5 Sq. mm. and above used for wiring shall be stranded.

1.9.2 **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/.0076" or 14/0.193 mm).
- ii) Only 3 core flexible cables shall be used for connecting single-phase appliances.
- iii) Unless armour, or tough rubber, or PVC sheath mechanically protects the flexible cables, 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.

1.10 **WIRING ACCESSORIES**

1.10.1 **Control Switches For Points**

- i) Combined switch cum socket shall not be permitted.
- ii) 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.

1.10.2 **Socket Outlets**

- i) 5/ 6Amp and 15/ 16Amp 6 Pin socket outlets shall be installed at the following positions, unless otherwise specified.
 - a) Kitchen/ Pantry 23 cm above working platform and away from the likely positions of stove and sink.
 - b) Toilets in non-residential building – 1.20 mt. above floor level.
 - c) At all other places – 850mm above floor level.

1.10.3 **Switch box covers**

For modular type switches/sockets suitable outer and inner cover plates as specified shall be provided over the standard box as recommended by the manufacturers of modular type switch/ sockets and no separate sheet cover is required to be provided.

1.10.4 **Ceiling Rose**

- i) A ceiling rose shall not be used on circuit the voltage of which normally exceeds 250 Volts.
- ii) Only one flexible cord shall be connected to 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.

1.10.5 **Lamp Holders**

- i) The standard constructional feature of manufacturers (ISI approved) of lamp holders is acceptable. Where the lamp holders are part of light fixtures the holders shall be suitable for the type of lamps used.

e light fittings shall be of Electronics type or as specified in BOQ.

1.12 **ATTACHMENT OF FITTINGS AND ACCESSORIES**

1.12.1 **Conduiting Wiring System**

- i) All accessories like switches, socket outlets, call bell pushed 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.
- ii) Brass screws shall be used to fix the accessories to their bases.

1.12.2 **Fixing of Walls and Ceiling**

- i) PVC sleeves/ dash fasteners should normally be used for fixing to walls or ceiling.
- ii) Plugging of walls or ceiling can be done in a better way where neatness is the first consideration. In all such cases, 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 workmanlike manner.

1.12.3 **FANS, REGULATORS AND CLAMPS**

1.12.3.1 **Ceiling Fans**

- i) Ceiling fans including their suspension shall conform to relevant Indian Standards.
- ii) Any additional hardware items required for installation of ceiling fans including fan hooks/ clamps as specified below shall be provided as specified in BOQ as a separate item.
- iii) 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.
- iv) 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 5 cm for each flat. Where there is 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 1.5 cm 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 'S' form.
- v) In the case of 'I' beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.

- vi) For concrete roofs, a 12mm dia. MS rod in the shape of 'U' 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.
- vii) In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub clause (vi) above cannot be used, or wherever specified, recessed type fan clamp inside a metallic box shall be used. The metallic box shall suitably be covered with 3mm thick phenolic laminated sheet.
- viii) Canopies on top of suspension rod shall effectively hide the suspension.
- ix) The leading in wire shall be of copper and nominal cross sectional area not less than 1.5 Sq.mm. and shall be protected from abrasion.
- x) All ceiling fans shall be hung at a height as directed by the Engineer-In-Charge.
- xi) In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5cm shall be ignored.
- xii) The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

1.12.3.2 **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 additional hardware items required for installation of ceiling fans including fan hooks/ clamps as specified below, shall be provided as specified in BOQ as a separate item.

1.12.3.3 **Regulators**

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

1.12.3.4 **Workmanship**

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.

The work shall be carried out under the direct supervision of an engineer, employed by the contractor, who shall rectify then and there the defects pointed out by the Engineer-In-Charge during the progress of work. The qualification of engineer or supervisor for over all supervision and to take instructions from the Engineer-In-Charge shall be as specified in the special conditions.

1.13 **TESTING OF INSTALLATION**

All the completed installations shall be tested as per specification for "Testing of Installation".

1.13.1 **Drawings**

- i) The work shall be carried out in accordance with the drawings enclosed with the tender documents and also in accordance with modification thereto from time to time as approved by the Engineer-In-Charge

or as per the drawing prepared by the contractor based on inventory and approved by Engineer-In-Charge.

- ii) All wiring diagrams shall be deemed to be 'Drawings' within the meaning of the term as used in the Conditions of Contract. They shall indicate the main switchboard, the distribution boards (with circuit numbers controlled by them), the runs of various mains and sub mains and the position of all points with their controls.
- iii) All circuits shall be indicated and numbered in the wiring diagram and all points shall be given the same number as the, circuit to which they are electrically connected.

1.14 **COMMISSIONING OF COMPLETION**

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

1.14.2 **Completion Plan and Completion Certificate**

- i) For all work completion certificate after completion of work as required by AAI shall be submitted to the Engineer-In-Charge.
- ii) Completion plan drawn to a suitable scale in tracing sheet with three blue print copies of the same shall also be submitted.
 - a) General Layout of the building.
 - b) Locations of main switchboard and distribution boards.
 - c) Position of all points and their controls indicating the circuit numbers controlled by them.
 - d) Types of fittings, viz. fluorescent, pendants, brackets, bulkhead, fans and exhaust fans etc.
 - e) Name of work, job number, accepted tender reference, actual date of completion, names of Division/Sub-Division, and name of the firm who executed the work with their signature.

SECTION – 3

SPECIFICATIONS FOR CONDUIT WIRING SYSTEM

1.0 SCOPE

This section covers the detailed requirements for wiring work in non metallic conduits. This section covers both surface and recessed types of works.

1.1 APPLICATIONS

Conduit system used shall be Rigid.

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

1.2 MATERIALS

1.2.1 Conduits:

- i) All rigid conduit pipes shall be of PVC and be ISI marked. The wall thickness shall be not less than 2 .0mm for conduits up to 32mm dia.
- ii) The maximum number of PVC insulated cables conforming to IS: 694-1990 that can be drawn in one conduit is given size wise in Table I., and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.
- iii) No PVC conduits less than 20mm in diameter shall be used.

1.2.2 Conduits Accessories:

- i) The conduit wiring system shall be complete in all respects, including their accessories.
- ii) 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.
- iii)
 - a) Saddles for surface conduit work on wall shall not be less than 0.55mm (24 gauge) for conduits up to 25mm dia and not less than 0.9mm (20 gauge) for larger diameter. The corresponding widths shall be 19mm and 25mm.
 - b) The minimum width and the thickness of girder clips used for fixing conduits to steel joints, and clamps shall be as per Table-II.

1.2.3 Outlets:

- i)
 - a) Outlet boxes for light/ power sockets shall be of standard size of manufacturer to accommodate required number of modular switches, socket outlet.
 - b) 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.
- ii) An earth terminal with stud and metal washers shall be provided in each DB/MS box for termination of protective conductor and for connection to socket outlet/ metallic body of fan regulator etc.
- iii) A metal strip shall be welded/ screwed, to the metal box as support if fan regulators are to be fixed herein.
- iv) Clear depth of the box shall not be less than 50mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.
- v) The fan regulators can also be mounted on the switch box covers, if so directed by the Engineer-In-Charge.

Spacing Requirements

The spacing between any edge of live terminal of Switch/ socket and the body shall not be less than 26mm at any point.

- vi) The size of the switch box in case of modular type switches shall be as per manufacturer's standard.

1.3 INSTALLATION

1.3.1 Common aspects for recessed and surface conduit works.

i) Conduit Joints

- a) The conduit work in each circuit or section shall be completed before the cables are drawn in.
- b) Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.
- c) The Engineer-In-Charge, with a view to ensuring that the above provision has 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 bending radius of not less than 7.5 cm., 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 to outlet.
- c) Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. 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 if any or as directed by the Engineer-In-Charge.

iv) **Painting after erection only for exposed conduits.**

After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes etc. shall be painted in compliance with the clauses under the painting specification.

1.3.2 Additional requirements for surface conduit works

- i) The outer surface of P.V.C conduit including all bends, unions, tees, junction boxes, etc. forming part of the conduit system.

ii) **Fixing Conduit on Surface**

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 30 cm from the centre of such fittings.

Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required by the Engineer-In-Charge.

In long distance straight run of conduit, inspected type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

1.3.3 Additional requirements for recessed conduit works

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 building under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.
- c) In chase of exposed brick/ rubber 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**

- a) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart, or by any other approved means of fixing.
- b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

iii) **Fixing Conduits in RCC work**

- 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 steel 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 all long radius, which all permit easy drawing in of conductors.

iv) **Fixing Inspection Boxes**

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary. The distance between inspection junction boxes shall not exceed 12.5 mts in straight run.

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.

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 : 2667-1977.

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.

vi) **Fish wire**

To facilitate subsequent drawing 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 outgoing and return cables are drawn into the same conduit.
- b) Where the distribution is for single phase loads only, conductors for these 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.

1.3.4 **Earthing Requirements**

- i) The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double check nuts at termination. The conduit shall be continuous when passing through wall or floors.
- ii) Protective (loop earthing) conductor (s) shall be laid along the runs of the conduit between the metallic switch boxes and the distribution boards/ switchboards, terminated thereto. The conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits along with the cables, or shall be laid drawn in outside the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.
- 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).

TABLE - I

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS: 694 - 1990

Nominal Cross-Sectional area of conductor in sq.mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

NOTE:

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

TABLE - II

Girder clips or clamps

Size of Conduit					Width	Thickness
i)	20 mm	-	-	-	19 mm	0.9mm (20 SWG)
ii)	25 mm	-	-	-	19 mm	0.9mm (20 SWG)
iii)	32 mm & above	-	-	-	25 mm	1.2mm (18 SWG)

1.4 **SPECIFICATION FOR PAINTING**

1.4.1 **SCOPE**

This section covers the requirements of painting work in internal electrical installations, carried out manually by brush. This does not cover spray painting work of factory made items.

1.4.2 **PAINTING WORK IN GENERAL**

1.4.2.1 **PAINTS**

Paints, oils, vanishes etc. of approved make, in original tin to the satisfaction of the Engineer-In-Charge shall only be use.

1.4.2.2 **PREPRATION OF THE SURFACE**

The surface shall be thoroughly cleaned and made free from dust or foreign matter before painting is started. The proposed surface may be inspected by the Engineer-In-Charge before the paint is applied.

1.4.2.3 **APPLICATION:**

- i) 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 in small containers, it shall be continuously stirred with a smooth stick, while painting work is taken up.
- ii) Primary coat of anti-corrosive paint shall be given in the case of steel work, after preparation the surface. In all cases of painting work, finishing shall be with 2 coats of paint in approved shade.
- iii) Each coat shall be allowed to dry out sufficiently before a subsequent coat is applied.

1.4.2.4 **PRECAUTIONS**

All furniture, fixture, glazing, floors etc. shall be protected by suitable covering. Al stains, smears splashing, dropping etc. shall be removed. While painting of wiring etc. it shall be ensured that the painting of wall and ceiling etc. is not spoiled in any way.

SECTION – 5

SPECIFICATION FOR CABLE TRAY

1.0 CABLE TRAY

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel, sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted to the desired lengths. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 300mm x 50mm x 6mm as two longitudinal members, with crosses bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 100mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span .The sizes shall be specified considering the same.

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 300mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing .Flat type suspenders may be used for channels up to 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer-In-Charge, to take the weight of the cable tray with the cables.

The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth terminal of the switch boards at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

Cable laid on cable tray shall be clamped on the tray at suitable intervals as per CPWD specifications.

SECTION – 6

SPECIFICATIONS FOR CONDUITING & WIRING FOR TELEPHONE SYSTEM

1.0 GENERAL

Contractor shall supply & install conduit & wiring including Telephone Tag Blocks, telephone outlet, cover plate, outlet boxes etc. complete as required.

1.1 CONDUITING

Conduiting for telephone system shall be carried out in PVC duet. Separate conduit shall be provided for Telephone cables. Conduiting shall be carried out as per Section 3 of this specification.

2.0 WIRING

Each telephone outlet shall be wired in conduit with 0.61mm dia annealed tinned copper conductor PVC insulated and PVC sheathed unarmored cable from floor wise Telephone Tag Block. Main Telephone tag block shall be fixed on basement floor wise tag block shall be wired from Main telephone tag block with multipaired armoured 0.60mm dia annealed copper conductor PVC insulated & PVC sheathed cables.

3.0 OUTLETS

All telephone outlet shall be modular plate type accessories with RJ 11 Jack outlet. Cover plate shall match in shape & finish with other light and power accessories.

4.0 TELEPHONE DISTRIBUTION BOARD

Telephone Tag Block shall be fabricated G.I. Duly powder coated after metal treatment. Telephone Distribution Board shall be equipped with krone type tag block of size as mentioned in BOQ. Tag block shall be double jumpering type and shall be suitable for termination of extra pair provided in wiring/ cabling of each outlet. Box shall have hinged cover and finish shall match with aesthetic finish of the building.

SECTION – 7
SPECIFICATIONS FOR CONDUITING FOR
DATA /
TELEPHONE / TV SYSTEM

1.0 CONDUITING

Conduiting for TV System/ DATA/ Telephone shall be carried out in PVC Conduit. Conduiting shall be carried out as per Section-3 of this specification. Separate conduit shall be provided for each of above listed systems.

2.0 OUTLETS

All TV System outlets shall be provided with modular range of cover plate, box and coaxial outlet. Cover plate shall match in shape & finish with other light and power accessories.

3.0 JUNCTION BOX

Suitable size of metallic junction box shall be provided for termination of conduit. Box shall be made of 1.6mm thick MS Sheet and shall be treated before painting. Front of the junction box shall be provided with 3mm thick phenolic laminated sheet cover.

SECTION – 8

TESTING OF INSTALLATION

1.0 SCOPE

This section describes the details of test to be conducted in the completed internal electrical installation, before commissioning.

1.1 GENERAL:

1.1.1 TESTS

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

- i) Insulation resistance test.
- ii) Polarity test of switch.
- iii) Earth continuity test.
- iv) Earth electrode resistance test.

1.1.2 WITNESSING OF TESTS

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Engineer-In-Charge by the Contractor. All test results shall be recorded and submitted to the Department (AAI).

2.0 INSULATION RESISTANCE

The tests described below shall be made before the installation is permanently connected to the supply. For these tests large installations may be divided into groups of outlets, each containing not less than 50 outlets. For the purposes of this code the term 'outlet' includes every point and every switch except that a socket outlet, appliance or luminaries incorporating a switch is regarded as one outlet. The test voltage for insulation resistance measurement shall be 500 V.

When measured with all fuse links in place, all switches (including, if practicable, the main switch) closed and, all poles or phases of the wiring electrically connected together, the insulation resistance to earth shall be not less than 1 mega ohm.

When measured between all the conductors connected to any one phase or pole of the supply and, in turn, all conductors connected to each other phase or pole the insulation resistance shall be not less than 1 mega ohm. Wherever practicable, so that all parts of the wiring may be tested, all lamps shall be removed and all current-using equipment shall be disconnected and all local switches controlling such lamps or other equipment shall be closed. Where the removal of lamps and/or the disconnection of current-using equipment is impracticable, the local switches controlling such lamps and/or equipment shall be open. Particular attention shall be given to the presence of electronic devices connected in the installation and such devices shall be isolated so that the test voltage does not damage them.

Where equipment is disconnected for the tests prescribed above, and the equipment has exposed conductive parts required by these clauses to be connected to protective conductors, the insulation resistance between the exposed conductive parts and all live parts of the equipment shall be measured separately and shall

comply with requirements of the appropriate Indian Standard and the insulation resistance shall not less than 0.5 mega ohm.

3.0 **POLARITY TEST OF SWITCH**

In a two wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor, throughout, and such conductor, shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.

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 labeled, or marked for connection to one of the phase conductors of the supply.

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 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.

4.0 **TESTING OF EARTH CONTINUITY PATH**

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

5.0 **MEASUREMENT OF EARTH ELECTRODE RESISTANCE**

- 5.1 Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the test electrode. 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 'B' is measured. The resistance of the test electrode 'a' is then given by

$$R = V/I$$

Where,

R- Resistance of the test electrode in ohms

V- Reading of the voltmeter in volts

I- Reading of the ammeter in amps

- 5.1.1 i) Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.
- ii) 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.

- 5.1.2 At the time of test, the test electrode shall be separated from the earthing system.
- 5.1.3 The auxiliary electrodes shall be of 13mm diameter mild steel rod driven upto 1 m into the ground.
- 5.1.4 All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode C shall be placed at least 30 m away from it and the auxiliary potential electrode 'B' shall be placed mid-way between them.
- 5.1.5 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C up to 50 m, and each time placing the electrode B mid-way between them.
- 5.1.6 On these principles, "Megger Earth Tester" containing a direct reading ohm-meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

6.0 **TEST CERTIFICATE**

On completion of an electrical installation or an extension to an installation, a certificate shall be furnished by the Contractor, countersigned by the certificate supervisor under whose direct supervision the installation was carried out. The certificate shall be in the prescribed form in addition to test certificate required by the local Electricity supply authorities.

TECHNICAL SPECIFICATION FOR 415V PANEL BOARDS

1.) SCOPE: -

The scope covers the Design, Manufacture Inspection and testing at the vendors works and supply and delivery to the site as per the bill of quantity and single line diagram enclosed.

2.) CODES & STANDARDS: -

IS – 2516	-	Alternating Current Circuit Breakers.
IS – 1818	-	Alternating Current Isolators (Disconnectors and Earthing Switches.
IS – 4237	-	General Requirements for Switchgear and Control gear for Voltages not exceeding 1000 V.
IS – 8623	-	Factory Built assemblies of Switchgear and Control gear for Voltages upto and including 100 V AC and 11200 V DC.
IS – 2147	-	Degree of Protection provided by enclosure for low voltage Switchgear and Control gear.
IS – 4064	-	Air Break Switches and fuse – combination units for voltages not exceeding 1000 V.
IS – 2208 & 9224	-	Low Voltage Fuses.
IS – 1822	-	A. C. Motor Starters for Voltages not exceeding 1100 V.
IS – 2959	-	A. C. Contractors for Voltages not exceeding 1100 V.
IS – 2705	-	Current Transformers.
IS – 3156	-	Voltage Transformers.
IS – 6875	-	Control Switches and Push Buttons/
IS – 1248	-	Direct Acting Electrical Indicating Instruments.
IS – 722	-	A. C. Electricity Meters.
IS – 3231	-	Electrical Relays for Power System Protection.
IS – 5834	-	Electrical Timer Relays for Industrial Application.

3. COMPLETENESS OF SUPPLY:

- 3.1 It is not the intent to specify completely herein all details of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects.
- 3.2 Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble free operation and maintenance of the equipment shall be furnished without any extra charge to the Purchaser.
- 3.3 The Seller shall supply all brand new equipment and accessories as specified herein with such modification and alternation as agreed upon in writing after mutual discussion.
- 3.4 The Equipment specified herein shall be packaged for transportation so as to meet the space and weight limitations of transport facilities, especially along the road right-of-way.

4. DESIGN CRITERIA:

- 4.1 All equipment will be installed indoors in a clean but hot humid and tropical atmosphere and equipment ratings shall be based on an ambient air temperature at 45 °C.
- 4.2 All 415 V equipment shall be capable of continuous operation satisfactorily under the following conditions.

(a) The voltage varying $\pm 10\%$ of rated voltage.

- (b) Frequency varying $\pm 5\%$ of nominal value of 50 Hz. and
- (c) Combined voltage & Frequency variation of $\pm 10\%$

- 4.3 For continuous operation at specified ratings, temperature rise of the various equipment and components thereof shall be limited to the permissible values stipulated in the relevant standards and / or this Specification.
- 4.4 The equipment and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current listed in the annexures without any damage or deterioration of material.
- 4.5 For connection between dissimilar metals bimetallic connectors shall be provided whenever required.
- 4.6 The minimum safe clearance of all live parts of the equipments shall be as per relevant standards.
- 4.7 There shall be no radio interference when the equipment are operated at maximum service voltage.

5. CONSTRUCTIONAL FEATURES:

- 5.1 Switchgear shall be:
 - a) Of the metal enclosed, indoor, floor mounted modular type
 - b) Made up of the requisite vertical sections
 - c) Of dust and vermin proof construction
 - d) Provided with a degree of protection of IP 54,
 - e) Easily extendable on both sides by the addition of vertical sections after removing the end covers.
 - f) Provided with a metal steel frame made of structural steel channel section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be Zinc plated and passivated.
 - g) Provided with labels on the front and rear indicating the switchgear designation.
 - h) Provided with cable entry facilities at bottom with 3-mm thickness removable covers.
 - i) Of uniform height of not more than 2250 mm.
 - j) Of single or double front execution as per the requirement.
 - k) Provided with gaskets all round the perimeter of removable covers and doors of the Panels.
 - l) Provided with busbars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet enclosure.
- 5.2 Operating devices shall be incorporated only in the front of the switchgear. Minimum height of the operating Switchgear above the ground level shall be 300mm.
- 5.3 The switchgear shall be divided into distinct vertical sections each comprising:
 - a) Individual feeder modules arranged in multitier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at side.
 - b) Enclosed vertical busbars serving all modules in the vertical section. For safety isolation of the vertical busbars, insulating barrier with cutouts shall be provided.
 - c) A horizontal separate enclosure for all-auxiliary Power & Control buses, as required. These shall be arranged in a sequence of R, Y, B, N, PH & N from front to rear so as to enable easy identification, maintenance and segregation from the main power maintenance and segregation from the main power buses. Tap-off connections, from these buses.
- 5.4 Each vertical section shall be equipped with space heaters, which may be located in the cable chamber.
- 5.5 One metal sheet be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.
- 5.6 All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with a slot to permit wiring connections on the rear side corresponding to the angle with a hinged door.

- 5.7 Circuit breaker control circuits, protective relays shall be mounted on the withdrawable chassis. All cutouts shall be provided with gaskets for the purpose of dust proofing.
- 5.8 Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker control circuits shall be mounted on the fixed portion of the compartment.
- 5.9 In breaker compartments, external cable connections shall be carried out in separate cable compartments for power and control cables.
- 5.10 After isolation of power and control connections of a circuit, it shall be possible to safely carry out maintenance in the compartment with the busbars and adjacent circuits live.
- 5.11 Cable chamber shall be provided with suitable hinged doors. It shall be possible to safely carry out maintenance work on cable connections to any one circuit with the busbars and adjacent circuits live. Adequate number of slotted cable support arms shall be provided for the cables.
- 5.12 All doors shall be provided with concealed type hinges and captive screws.
- 5.13 The components housing feeder control and motor control equipment shall be of fixed type.

6.0 FABRICATION

- 6.1 The switchgear frame shall be fabricated using suitable cold rolled sheet steel of thickness not less than 2.0 mm.
- 6.2 Frames shall be enclosed by sheet steel of thickness not less than 2 mm cold rolled, smoothly finished, leveled, and free from flaws. Doors shall be made of sheet steel of thickness not less than 2.0 mm and partition and the covers shall be of 1.6 mm thickness. Stiffeners shall be provided whenever necessary.
- 6.3 All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.
- 6.4 The complete structure shall be rigid, self-supporting, free from vibration, twists and bends.

7.0 MAIN BUS BAR

- 7.1 Switchgear shall be provided with three phase and neutral bus bars.
- 7.2 Bus bars shall be of uniform cross section throughout the length of the Panel, and unto the incoming terminals of the incoming feeder circuit breaker / switch.
- 7.3 The bus bars shall be made of high conductivity Copper / Alluminium alloy of E91E grade.
- 7.4 Bus bars shall be provided with at least a 25mm of minimum clearances in air as per applicable standards for a 500 V, 3 phase system.
- 7.5 All bus bars, bus-taps shall be insulated with close fitting sleeve of smooth, dust and dirt free plastic insulation of high dielectric non-inflammable and self extinguishing and in fast colours to indicate phases. The joints shall be insulated in such way as that there should be easy accessibility of contact bolts for maintenance. Joints shall be covered with removable moulded shrouds, the dielectric strength and properties of the shrouds shall hold good for the temperature range.
- 7.6 Bus bars shall be adequately supported and brace to withstand the stresses due to the specified short circuits currents for the associated switchgear. Bus bar supports shall be made of glass reinforced moulded plastic material, or cast resin.
- 7.7 Separate supports shall be provided for each phase of the busbars. If a common support is provided for all three phases, antritracking barriers shall be incorporated.
- 7.8 Busbar joints shall be complete with high tensile steel bolts, washers and nuts. Bus bars shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

8.0 AUXILIARY BUSES

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately support and sized to suit specific requirement. The

material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Supply transformer(s), auxiliary busbars and necessary connections to the supply transformers and associated circuits shall be in the BIDDERS scope.

9.0 INTERNAL WIRING:

- 9.1 Wiring inside the switchgear shall be carried out with 1100/650V grade, PVC insulated, stranded conductor wire. Minimum size of conductor for power circuits is 4Sq.mm. copper control circuits shall be wired with copper conductor of at least 2.5Sq.mm for CT circuits and other circuits the number and size of strands shall be 7 to 0.67mm and 0.5mm diameter respectively.
- 9.2 Engraved identification ferrules, marked to correspond with the working diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.
- 9.3 Wires forming a part of tripping circuits of circuit breaker shall be provided with an additional red ferrule marked 'T'.
- 9.4 Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.
- 9.5 Spare and unassigned modules shall be complete with in terminal wiring.
- 9.6 Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts and washer/lock nuts.
- 9.7 Not more than two connections shall be made on any one terminal.

10.0 TERMINAL BLOCKS:

- 10.1 Terminal blocks (Both for power and control circuits) shall be of reputed make especially for CT and VT circuits. It shall comprise finely threaded pairs of brass studs of at least 6mm diameter, links between each pair of studs, washers, nuts and lock nuts. The studs shall be surely locked within the mounting base to prevent their turning. Insulated barrier shall be provided between adjacent terminals.
- 10.2 Terminal for circuit with voltage exceeding 125V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.
- 10.3 Terminal blocks shall be adequately rated to carry the current of the associated circuit minimum rating of the terminal block is 10A
- 10.4 Terminals shall be numbered for identification as per enclosed drawings engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit.
- 10.5 Where duplication of the terminal block is necessary, it shall be achieved by solid bonding links.
- 10.6 Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks.
- 10.7 Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5Sq.mm size.

10.8 All Terminal blocks and cable chambers shall be suitable for the cable sizes as specified in the single line diagram.

11.0 LABELS:

11.1 All labels shall comprise white letters on a black back ground.

11.2 Labels shall be made of non-rusting metal or 3-ply lamicaid or engraved PVC

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

11.4 Size of lettering shall be 6mm, unless otherwise specified.

12.0 PAINTING:

12.1 All sheet steelwork shall be phosphate in accordance with the following procedure and also in accordance with applicable standards.

12.2 Oil, grease, dirt and swarf are thoroughly removed by emulsion cleaning.

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

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

12.5 The phosphate coating shall be sealed by the application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.

12.6 After application of the primer, two coats of IS-5, 631 shade (light grey) enamel paint shall be applied, with each coat followed by stoving. The second finishing coat for the external of panels shall be applied after completion of tests.

12.7 Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.

12.8 The final finished thickness of paint film on steel shall not be less than 100microns, and shall not be more than 150microns.

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

13.0 DRAWINGS, DATA AND MANUALS:

The supplier shall submit the following drawings/data and documents for approval

13.1 General arrangement drawing – Plan, section and foundation details.

13.2 Single line diagram of each panel with ratings of components specified.

13.3 Control circuit diagram for the individual typical starter feeder.

- 13.4 Bill of quantity with makes specified.
- 13.5 Terminal block arrangement
- 13.6 A copy of test certificates.
- 13.7 Operational and maintenance manuals for the major critical equipment/ components.

14.0 TESTS:

- 14.1 The panels shall be subjected to the following types of tests.
1. Physical inspection test
 2. Electrical operation test
 3. Dielectric test (HV testing) at 3 kV for one minute.
 4. Electrical continuity test (Meggaring) before and after HV test.
 5. Verification of clearance and creepage distances.
 6. Mechanical /operation test
 7. Temperature rise tests on power circuits
- 14.2 BIDDERS shall submit available type test reports of temperature rise and short circuit tests of similar panels tested at any Lab / Institution (CPRI/NTH). Also calculations of temperature rise shall be submitted for approval.
- 14.3 Routine tests shall be carried out on all associated equipment supplied with panel, as per relevant standards. Type test certificates of all associated equipment shall be furnished.
- 14.4 Certified copies of all type and routine test certificates shall be submitted for the PURCHASER'S approval before dispatch of the panels.

Specifications Detail of AIR CIRCUIT BREAKER

1. General:

- The circuit breakers shall comply with IEC60947 & IS 1347 part 2.
- The breaking capacity performance certificates shall be available for category B to the above-mentioned standards. The test shall be carried out with a breaking performance during operation (ICS), admissible short time with stand (Icw) & ultimate breaking capacity (ICU). Certificate for sequence 1, sequence 2 and sequence 3 should be available in case there is no combined test.
- All circuit breakers can be reverse fed without reduction in performance.
- All circuits breakers shall have a rated operational of 660V AC (50/60Hz).
- The rated insulation voltage shall be 1000 V AC (50/60Hz)
- The circuit breakers shall comply with the isolating function requirements of IEC 6047-2 section 7.1.2.

- Breaking capacity should be minimum 50 KA up to 1250A, 80KA up to 2000A and 95KA up to 5000A.

2. Construction:

- The air circuit breakers rating shall be from 800 to 3200A.
- All air circuit Breakers should be designed for trip free mechanism.
- They should be draw with 3- poles or 4 poles versions.
- In 4- pole version, the neutral pole shall have same current rating as the other poles from 800 up to 3200A.

3. Operating mechanism:

- The operating mechanism should be O.C.O stored energy spring type with a closing time of less than or equal to 40 ms.
- Charging facilities should contain.
 - Either hand charged spring where the spring are wound only by hand:
 - Motor charged spring, where the springs are automatically charged by an electric motor.
- It should be possible to close manual ACB remotely.
- In case of ACB contact are welded inside and trip command given, ACB should not indicate OFF position from the front mechanical indicator.
- Indication of ACB tripped due to fault should be available on front as mechanical indicator.

4. Arc chutes and arcing contracts:

- Arc chutes should be removable type.
- Arcing contacts should have of 5000Nos of operation.

5. Draw out mechanism:

General

- The draw out operation should be through a closed door.
- Three position indication to be provided.
 - 1) Services position – all auxiliary and main circuits should engaged.
 - 2) Test position – all auxiliary circuits should engaged and main circuits disconnected.
 - 3) Isolated position - all circuits disconnected.

Also a 4th position should be desirable.

- 4) Maintenance position – circuit breakers should be possible to be taken out totally from the panel.
- All three positions should be indicated on the chassis.
 - Safety shutter to be provided as standard.

Safety requirements:

- A door interlock should be provided so that it should open the door and the air circuit breaker moving part shall be in the disconnected position.
- In case breaker is closed and being drawn from service position, it should trip before getting disengaged.
- Insulated safety shutters at isolated position shall be provided.
- An inter locking shall be provided to prevent insertion of a circuit breaker in place of higher rating breakers with lower ratings breakers.

6. Electrical auxiliaries:

- All electrical auxiliaries including the motor spring charging mechanism shall be field adaptable with out adjustment calibration.
- It shall be possible to connect the electrical auxiliaries from the front face of the air circuit breaker.
- Shunt release and closing coil should be continuous rating.

7. Mechanical indicator:

- Mechanical indicator on the front of the air circuit breaker shall be provided to indicate the following:
 1. Main contacts closed “ON”
 2. Main contacts open “OFF”
 3. Spring charged.
 4. Springs discharge.
 5. ACB spring charge but ACB cannot be closed (anti-pumping)
 6. Circuit breaker in “service” closed position (draw out only).
 7. Circuit breaker in “test” closed position (draw out only).
 8. Circuit breaker in “isolated” closed position (draw out only).

8. Installation:

- A detailed installation manual to be provided for installation.
- ACB should have lifting handle.
- There should be option various types of termination like horizontal, vertical, front type etc.

9. Characteristics of release (electronic):

- Electronic release should provide options for over load, short circuit and earth fault protections.
- Release should be providing electromagnetic compatibility.
- Release should provide separate fault indications.
- Release should have testing facility at site through a test terminal and kit.
- Short circuit setting of the release should be done w.r.t overload setting.
- Over load setting range should be 90-100% of nominal current. Short-circuit rating 2 to 10.
- Times of rated current.
- Earth fault rating 20 to 60% of nominal current.

MCCB

Up to 800A

Typical specifications

1. General:

- The circuit breakers shall comply with IEC60947 standard.
- All circuit breakers shall have a rated operational voltage of 600V AC (50/60Hz)
- The rated insulation voltage shall be 600V and 660V at 50/60Hz for low breaking capacity and high breaking capacity MCCBs respectively.
- The breaker shall be maintenance free and fully tropicalized.
- It shall either be 3 poles or 4 poles (switched neutral)

2. Construction:

- Operating mechanism shall be of the quick break type, and mechanically trip free from the operating handle. The operating mechanism shall be constructed to operate all poles in a multi-pole breaker simultaneously during opening, closing and tripped conditions.
- The trip unit shall be of full magnetic (dash-pot) or thermal magnetic type. It shall not require any external power supply to operate the tripping mechanism.
- The breakers shall clearly indicate the three fundamental positions ON, OFF and TRIPPED.
- The breaker shall be equipped with rotary handles.

3. Characteristics:

- The protection unit shall have as required.
 - i) Adjustable setting for overload release to avoid tampering at site.
 - ii) Short circuit settings should be adjustable at $10I_n \pm 20\%$ as specification in IEC947 an IS 1947part2
 - iii) Earth fault protection.

4. Operation:

- The breaker shall be provided with the facility for padlocking and door interlocking.
- The electrical and mechanical endurance of the moulded – case circuit breakers should be as per IEC 947-2 standard.
- The moulded – case circuit breakers should be equipped with a “push to trip” button front to test operation and the opening of the poles.
- The circuit breaker rating, the “push to trip” button, out going circuit identification and the contract position indication must be clearly visible and accessible form the front, through the front panel or the door of the switch board.

4. Options:

Facilities to combine the following functions into the circuit breakers.

Earth fault protection.

Remote indication off circuit breaker trip condition and operational conditions (ON/OFF).

Auxiliary contacts, alarm contact should be available if required.

5.Interlocking features on Main LT panel.

Interlocks must be provided to ensure proper operation, prevent dangerous situations and maloperation.

5.0 SPECIFICATIONS FOR ERECTION, TESTING & COMMISSIONING OF 415 VOLTS SWITCHGEAR PANELS

5.1 SCOPE

Receiving Inspection, Unloading Storage, transportation, Installation, Testing and Commissioning of the Switchgears shall be in accordance with the specified code of practice and manufacturer's instructions. The panels shall be aligned properly and bolted, to the flooring by at least four bolts for each division of Transport. The cable shall be terminated into the panel through glands fixed to bottom /top plate. The panel shall be bonded to the earth by connecting leads to the panel earth bus.

5.2 HANDLING/UNLOADING

Switchgears and all its accessories shall be handled/unloaded carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear. While using jacking pads utmost care shall be taken in proper application of jacks. Where switchgears is dragged or pulled on sleeper or rollers of the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles. Unloading from the lorry shall be carried out using a mobile crane or tripod with chain pulley block or rolling over to a platform.

5.3 STORAGE

Equipment's shall be stored under shelter in a well-ventilated, dry place and covered by suitable polythene or tarpaulin covers for protection against moisture.

5.4 ERECTION

Panels shall be installed over a trench. The panel shall be bonded to the earth by connecting earthing leads to the panel earth bus.

5.5 TESTS

The following preliminary checks and Pre-commissioning tests shall be carried out before commissioning the Switchgears in the presence of Buyer/Architect's representatives.

5.5.1 PRELIMINARY CHECKS

- a) Check nameplate details according to specification.
- b) Check for physical damage.
- c) Check tightness of all bolts, clamps and connecting terminals.
- d) Check earth connections.
- e) Check the cleanliness of insulators and bushings, arc chambers.
- f) Check that all moving parts are properly cleaned and lubricated.

5.5.2 PRECOMMISSIONING CHECKS

- a) Check alignment of breaker trucks for free movement. Check correct operation of shutters.
- b) Check control wiring for correctness of connections, continuity and IR values.
- c) Manual operation of breakers.
- d) Power closing/opening operation manually and electrically.
- e) Breaker closing and tripping time.
- f) Trip free and anti pumping operation.

- g) Check electrical and mechanical interlocks provided.
- h) Check on C.Ts

- i) All functional checks with the relays, meters, Alarm Scheme, interlock as Per scheme with primary injection kits.
- j). High voltage tests on Control and Power circuits (2.5 KV)

5.0 SPECIFICATION FOR SUPPLY & LAYING OF LOW TENSION CABLES

5.1 SCOPE

This specification covers the technical requirements of supply, laying, testing and commissioning of Heavy duty medium voltage cables upto 1100 Volts for power, control and lighting application for efficient and trouble free operation.

The cable shall be properly packed for transportation, supply and delivery at site.

5.2 CODE AND STANDARDS

The materials covered by this specification shall unless otherwise stated as designed, constructed, manufactured and tested in accordance with latest revisions of the relevant Indian Standards.

IS 7098 (Part I) : XLPE insulated cables for working voltages upto
and including 1000 V.

IS 5831 - 1984 : PVC insulation confirming to requirement of ST2
compound for Outer sheath of electric cables.

IS 8130 - 1984 : Conductors for insulated electrical cables.

5.3 RATING

The cable shall be rated for a voltage rating of 1100 Volts.

6.0 SPECIFICATION FOR INSTALLATION OF L.T. CABLES.

6.1 Installation of L.T. Cables in Outdoor Trenches:

Cables shall be laid in outdoor trenches excavation of trench all type of soil. The depth of the trenches shall not be less than 0.75 cms.. The width of the trenches shall not be less than 0.35cm. A spacing of not less than the cable diameter shall be allowed between the cables. The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed level. Cable unreeling from drums shall be done only with the help of cable drum rolling supports. The cables shall be laid in trenches over the rollers placed inside the trench. The cable drum shall be rolled in the direction

of the arrow for rolling. Wherever cables are bent, the minimum-bending radius shall not be less than 12 times the diameter of the cable. 8cm thick layer of sand cushioning to be provided full of stones and pebbles. Cable shall be taken lifted and placed over this and cushion. The cable shall then be covered with a 17cm thick sand cushion, where cable is laid in rocky situation. Extra thick cushioning of sand as may be required/ decided by the Project Manager/Architects shall be done without extra charge. Over this, a course of cable protection tiles or brick shall be provided to cover the cables by 5cm on either side. Unless otherwise specified, the cable shall be protected by brick placed on top of the trench breadth wise for the full length of the cable. Trench shall be back filled with earth and consolidated. Cables shall be laid in hume pipes at all road crossings and in GI pipes / PVC pipes at the wall entries. Approved cable markers made of concrete blocks indicating the voltage grade and the direction of run of the cables shall be installed at regular intervals of 20 Mtrs. The depth of concrete blocks shall be atleast 300 mm below ground and 50 mm above ground.

CHAPTER-
TECHNICAL SPECIFICATION FOR EARTHING

1.0 SCOPE

This specification covers the supply, installation testing and commissioning of Earthing system as detailed under Bill of Quantities.

1.1 STANDARDS

IS 3043	:	Code of Practice for earthing
Indian Electricity Rules	:	1956
Indian Electricity Act	:	1910
CEIG Regulations.		

1.2 GENERAL REQUIREMENTS

The plant shall be provided with complete earthing system comprising earth electrodes in conjunction with earth grid.

1.3 DETAILS OF EARTHING SYSTEM

Unless otherwise specified main earthing shall not be less than 50X6mm GI. flat.
The minimum size of earthing conductor of various equipment shall be as follows:

a. Main Earth Grid	-	50 x 6mm GI Flat
b. LT Panels / SSB's	-	25 x 6mm GI
c. DBs	-	8SWG GI Wire
d. Equipment Earthing		
a. upto 5KVA	-	8SWG GI Wire
b. 5KVA - 100KVA	-	25 x 3mm GI Flat
c. 101 - 150KVA	-	25 x 6mm GI Flat
d. above	-	50 x 6mm GI Flat
e. Interconnection Earth pit to Earth Pit	-	25 x 3mm GI Flat

1.4 EARTH ELECTRODE

40mm dia, GI Pipe, 4.5M long, shall be used as earth electrode. Suitable funnel arrangements shall be made at the mouth of the pipe for watering.

A suitable plate shall be fixed on to the rod for making necessary connections to the earth flat. The electrode shall be enclosed in a concrete earth pit with suitable cast iron / RCC covers. Each earth electrode shall have provision for individually testing the electrode.

Coke / Charcoal / Salt shall be used to achieve the necessary earth resistance.

Earth electrodes shall be erected 1.5 Mts. away from the building edge and minimum spacing between the electrodes shall be maintained as per IS: 3043

1.5 EARTHING LAYOUT

Earthing conductors in outdoor areas shall be buried atleast 600mm below finished grade level unless stated otherwise.

Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, etc. it shall be laid minimum 300 mm below and shall be re-routed in case it fouls with equipment structure foundations.

Tap-connections from the earthing grid to the equipment/structure to be earthed shall be terminated on earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid, otherwise, "earth riser" shall be provided near the equipment foundation/ pedestal for future connections to the equipment earthing terminals.

Earthing conductors along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable cleating at intervals of 750 mm. Earthing conductors along cable trenches shall be cleated to the wall nearer to the equipment. Cable trays and supports shall be connected to the earth mat at every 30 meters interval. Wherever it passes through walls, floors, etc. GI sleeves shall be provided for the passage of the conductor.

Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.

1.6 EQUIPMENT EARTHING

All electrical power items shall be earthed by two separate and distinct earth connections from main earth bus.

Earthing pads shall be provided by the supplier of the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by short and direct earthing lead free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with the Engineers Incharge.

Whether specifically shown in drawings or not, steel/RCC columns metallic stairs etc. shall be connected to the nearby earthing grid conductors by two earthing leads.

Electrical continuity shall be ensured by bonding the different sections of hand-rails and metallic stairs.

Metallic pipes, and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

Metallic conduits shall not be used as earth continuity conductor.

Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, pipes etc. and steel reinforcement in concrete, it shall be bonded to the same.

Cable end boxes, glands, etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points.

The metallic screens of the single core cable shall be connected to earth at one end only.

1.7 JOINTING

Earthing connections with equipment earthing pads shall be bolted type. Contact surface shall be free from scale, paint enamel, grease, rust or dirt. Two bolts shall be provided for making each connections. Bolted connections, after being checked and tested shall be taped with PVC tape.

Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

1.8 GENERAL

Excavation and refilling of earth necessary for laying of under ground earth bus and earth pipes shall be the responsibility of the Contractor.

All earth electrodes shall be tested for earth resistance by means of standard earth resistance tester.

Earthing resistance of the main bus shall be measured after connecting all the electrodes to the bus and the resistance shall not exceed one(1) ohm. If required, additional earth pits, shall be provided by the contractor, to achieve the required earth resistance.

The exact location of Earth Bus/conductor, earth electrodes and earthing points on the equipment shall be determined at site in consultation with owner. Any change of methods, routing, size of conductor shall be subject to approval of Engineer Incharge.

1. Pipe Earth Electrode

Galvanised steel pipe electrode shall be of medium grade 40 mm dia and 4.5 metre in length. Pipe electrodes shall be cut tapered at the bottom and provided with 12 mm holes (staggered) at 75 mm Centre to centre upto 2 metre of length from bottom. The electrode shall be buried in the ground vertically with its top not less than 1.25 metre below ground level. Typical illustration of pipe earth electrode is given in Electrical Plate No. 4.

2. Plate Earth Electrode

Plate electrode where made of 600x600x3.15 mm if of copper as indicated.

2.1 The electrode shall be buried in ground with the faces vertical and its top most edge not less than 1.5 metre below ground level as shown in plate No.5. The use of plate, electrode is recommended where current carrying capacity is the

prime consideration, for example; the earthing of equipment in Generating Station and power distributing substations. Where necessary, Plate electrode shall have a galvanised iron water pipe of 50 mm internal dia bore buried directly vertical and adjacent to the electrode.

2.2 One end of such pipe shall be 5 to 10 cms above the ground level and the other end shall be near the centre of the plate electrode but in no case it shall be extended more than the bottom edge of the plate electrode.

3. Maintenance Free Earthing System

Supply, Installation and testing of Permanent Maintenance Free Earth Pit, installation work includes, digging pit, digging trench, back filling and construction of suitable brick chamber.

Each Earth Pit consists of:

1. Ground Resistance Improvement Powder (40Kg)
2. Copper Tape (10 mts)
3. Copper Bonded Ground Rod 16mm x 1500mm (3)
4. Ground Rod Clamp (3 Nos.)

4. Strip or Conductor Electrode

4.1 Such rocky strata where excavating earthing pits is difficult without blasting and blasting is prohibited or for minimising the earth resistance of a lightning protective network in rocky area.

4.2 Strip electrodes shall not be less than 25x4 mm in case of galvanised iron or steel and 25x1.6 mm in case of copper. If round conductor are used as electrodes, the cross sectional area of such conductor shall not be less than 3.0 sq.mm in case of copper and 6.00 sq.mm in case of galvanised iron or steel wire.

4.3 The length of buried strip or round conductor shall not be less than 15 metres. This length of the electrode shall be increased if necessary on the basis of soil resistivity so that the required earth resistance is obtained.

4.4 The electrode shall be buried in trench not less than 500 mm deep. If conditions necessitate use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, preferably in a single straight or circular trench or in a number of trenches radiating from one point.

5. Method of Installing Watering Arrangement

5.1 In the case of plate earth electrodes a watering pipe of 20 mm dia and of galvanised iron, shall be provided up to the electrode. A funnel with wire mesh pipe shall be provided on the top of this pipe. In the case of pipe electrode a

40x20 mm reducer shall be used for fixing the watering pipe to the electrode. The funnel attachment shall be housed in concrete enclosure as shown in plate No. 4.

5.2 A cast iron mild steel frame with cover having locking arrangement shall be suitably embedded in the masonry enclosure, finished flush with Ground level.

6. Location for Earth Electrode

6.1 Normally an earth electrode shall not be situated less than 1.5 metre from any building. Care shall be taken that the excavations for earth electrode may not affect the column footings or foundation of the building; in cases where excavation affect the foundations, the distance of electrode from the building shall be increased.

6.2 The location of the earth electrode shall be such where the soil has reasonable, chance of remaining moist. Entrances, pavements and roadways shall be avoided for locating the earth electrode.

7. Artificial Treatment of Soil

In case there is no option of site and earth electrode resistance is high, the earth electrode resistance shall be reduced by artificial chemical treatment of the soil. For this purpose the most commonly used substances are sodium chloride (common salt), calcium chloride, sodium carbonate, copper sulphate, salt and soft coke and salt and charcoal in suitable proportions, unless otherwise indicated, the electrode shall be surrounded by charcoal/coke and salt.

8. Main Earthing Lead

The main lead shall be either stranded or solid bars or flat rectangular strips and may be bare provided due care is taken to avoid corrosion and mechanical damage to it and shall not be more than 15 metres in length for minimum resistance. The length may be increased with proportional increase in cross section in case of copper or galvanised strip in case of earth electrode of galvanised plate or strip or rod and copper wire or strip in case of copper plate or strip or rod earth electrode. For all electrical installations except substations and generating stations the size of earthing lead shall not be less than half of the largest conductor carrying current to be protected. The size of earthing lead shall not be greater than 100 sq mm for copper conductors and 150 sq mm for galvanised iron conductors. The minimum size of earthing lead in any earthing shall not be less than 3.00 sq.mm cross section in case of copper and 6 sq.mm in case of galvanised iron wire. For equipment earthing in substation and generating station or lightning protection system it shall not be less than 20x3 mm copper strip or 25x4 mm galvanised iron strip. However the actual size will depend on the maximum fault current which earthing will require to carry safely. Protection against mechanical damage/pilferage shall remain the concern.

9. Size of Earth Continuity Conductor

9.1 The minimum cross sectional area of an earth continuity conductor not contained within a cable or flexible cord shall be 1.5 sq mm for copper and 2.5 sq mm for aluminium. As regards the size of the galvanised iron, it may be equal to the size of the current carrying conductors with which they are used.

9.2 For flexible cables the size of the earth-continuity conductors should be equal to the size of the current-carrying conductors.

10. Method of Connecting Earthing Lead to Earth Electrode

In the case of plate earth electrode the earthing lead shall be securely bolted to plate with two bolts, nuts, check nuts and washers. In the case of pipe earth electrode, it shall be connected by means of a through bolts, nuts and washers and cables socket as indicated. All materials used for connecting the earth lead with electrode shall be galvanised iron in case of galvanised iron pipe and galvanised iron plate earth electrode, and of tinned brass in case of copper plate electrodes. The earthing lead shall be securely connected at the other end to the main board. Loop earthing shall be provide for all mountings of main board and other metal clad switches and distribution fuse boards with not less than 2.5 sq.mm for copper or 4 sq.mm aluminium wire.

11. Protection of Earthing Lead

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a 15 mm dia medium quality galvanised iron pipe in case of wire and by 40 mm dia pipe in case of strip. Portion of this protection pipe within ground shall be buried at least 300 mm deep (to be increased to 600 mm in case, of road crossing and pavement). The portion within the building shall be recessed in walls and floors to adequate depth.

12. Protection Against Earth Leakage

All metal work, shall be isolated in such a way that they cannot come in contact with any live part or earthed metal work.

13. Testing

On completion of installation and also after carrying out additions/ alterations to an existing installation, the following tests shall be carried out.

14. Insulation Resistance

14.1 The insulation resistance shall be measured by applying between earth and the whole system of conductors or 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 or voltage of not less than twice the working pressure or voltage provided it does not exceed 500 volts for medium voltage circuits. Where the supply is derived from the three wire (AC or DC) or poly phase AC system, the neutral pole of which is connected to earth either direct or through added resistance, the working pressure or voltage shall be deemed to be that which is maintained between the outer or phase conductor and the neutral.

14.2 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 middle wire or to the neutral or to the other pole of phase conductor of the supply with all lamps in position and switches in off position.

14.3 The insulation resistance in meg-ohms measured as above shall be not less than 50 meg-ohms divided by the number of outlets in the circuit.

14.4 Where insulation is being tested, a lower value than that given by the relevant formula, subject to a minimum of 1 mega ohm should be acceptable.

14.5 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 25 meg-ohms divided by the number of outlets when PVC insulated cables are used for wiring.

14.6 The term outlet includes every point along with every switch except that a switch combined with a socket outlet appliance or lighting fitting is regarded as one outlet.

14.7 Control rheostats, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that case the insulation resistance between the case or framework and all live parts of each rheostat appliances and electric sign shall be not less than half a meg-ohm.

15. Polarity Test of Switch

15.1 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 the phase conductor or to the non-earthed conductor of the supply.

15.2 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 outer or phase conductor of the supply.

15.3 The installation shall be connected to the supply for testing. The terminals of the 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.

16. Testing of Earth Continuity Path

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 along with the earthing lead but excluding any added resistance or earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

FORM OF COMPLETION CERTIFICATE

I/We certify that the installation detailed below has been installed by me/us and tested and that best of my/our knowledge and belief it complies with Indian Electricity Rules 1956, as well as the Contract Specifications.

Electrical Installation at _____

Voltage and system of supply _____

1) **Particulars of work:-**

a) **Internal Electrical Installation**

	No.	Total Load	Type or system of wiring
i)	Light point		
ii)	Fan point		
iii)	Plug point		
	a) 3 pin 5 Amp		
	b) 3 pin 15 Amp		
	c) Others		

b) **If the work involves installation of underground cable**

- i) Total length of underground cable & its size.
- ii) No. of Joints: _____ End Joint: _____
- Tee Joint: _____
- St. through joint: _____

II) **Earthing :-**

- i) Description of earth electrodes.

ii) Number of earth electrodes.

iii) Size

III) **Test Results of Wiring:-**

a) **Insulation resistance.**

i) Insulation resistance of the whole system of conductors to earth _____ Mega ohms

ii) Insulation between the phase conductor and neutral

Between phase R and neutral Mega ohms

Between phase Y and neutral Mega ohms

Between phase B and neutral Mega ohms

iii) Insulation resistance between the phase conductors in case of poly phase supply

Between phase R and neutral Mega ohms

Between phase Y and neutral Mega ohms

Between phase B and neutral Mega ohms

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 earth lead ohms.

d) **Earth electrodes resistance**

Resistance of each earth electrode

i) Ohms

ii) Ohms

iii) Ohms

iv) Ohms

e) Lightning Protective System

Resistance of the whole of lightning protective system to earth before any bonding is effected with earth electrodes and metal in/on the structure..... ohms.

CAPACITY OF LIGHT AND POWER CIRCUIT

- 1) Lighting circuit shall not have more than 10 points of light, fan, socket outlet or connected load of 800 W whichever is less.
- 2) Power circuit shall be designed based on load where specified, otherwise the norm of one KW per circuit is to be followed.
- 3) Not more than two power outlet shall be connected to one circuit.
- 4) Power outlets in common areas shall be two power outlet per circuit. One outlet shall be looped from other outlet.

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S.No.	Details of Materials / Equipment	Manufacturer's Name
A. MEDIUM VOLTAGE EQUIPMENT		
1.	Power Distribution Panel and Motor Control Centre	Tricolite Adlec Control System
2.	Final Distribution Board	Schneider Electric (MG) ABB
3.	Bus Duct	
	a. Air Insulated Type	Tricolite Adlec Control System
	b. Sandwiched Construction	Godrej (Henikwon) Schneider Electric (Telemecanique)
4.	Air Circuit Breaker	Schneider Electric (MG) Larsen & Toubro (U-Power)
5.	Molded Case Circuit Breaker (MCCB)	Schneider Electric (MG) Larsen & Toubro (D-Sine)

6.	Miniature Circuit Breakers (MCB)	Schneider Electric (MG) Hager (L&T)
7.	Residual Current Circuit Breaker (RCCB)	Schneider Electric (MG) ABB
8.	Power/Aux. Contactor	Schneider Electric (Telemecanique) Larsen & Toubro
9.	Change Over Switch	Larsen & Toubro H H Elcon
10.	Control Transformer/Potential Transformers	Automatic Electric Indcoil
11.	Current Transformer (Epoxy Cast Resin)	Automatic Electric Indcoil
12.	Protection Relay	
	a. Numeric Type	Alstom Asea Brown Boveri
	b. Electromagnetic Type	Alstom Easun Reyrolle
13.	Indicating Lamps LED type and Push Button	Schneider Electric (MG) Larsen & Toubro (ESBEE)
14.	Overload relays with built in Single Phase preventer	Schneider Electric (Telemecanique) Larsen & Toubro
15.	a. Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED Display	Enercon System Pvt. Ltd. CG Schlumberger Superior Product Industries Automatic Electric
	b. Electro_Magnetic Meters	Automatic Electric Rishabh (L&T)
16.	Static Power Meter & Logger (SPML)	Enercon System Pvt. Ltd. CG Schlumberger
17.	Power Capacitor	Meher (Larsen & Toubro) GE Power Controls
18.	Autoamtic Power Factor Correction Relay (Numeric Type)	BELUK (Germany) Enercon System Pvt. Ltd.
19.	PVC insulated XLPE aluminium/copper conductor	Cable Corp. of India Universal

armoured MV Cables up to 1100 V grade

20.	LT Jointing Kit / Termination	Raychem Safe Kit
21.	Cable Glands Double Compression with earthing links	Baliga Lighting Ltd. Comet
22.	Bimettalic Cable Lug	Dowell's (Biller India Pvt. Ltd.) Comet
23.	PVC insulated copper conductor stranded flexible wires (FRLS / ZHFR) -	Finolex Polycab
24.	Mettalic / GI Conduit (ISI approved)	BEC AKG
25.	Accessories for Metallic /GI Conduit (ISI approved)	Sharma Sales Corporation Prakash Engineering Works
26.	PVC Conduit & Accessories (ISI approved)	BEC Precision
27.	Switch & Socket	Legrand (Mosiac) Crabtree
28.	Industrial Socket	
a.	Splash Proof	Legrand Schneider Electric
b.	Metal Clad	Legrand Schneider
30.	Ceiling Fan	Crompton greaves Usha
31.	Lighting Fixture (Not applicable for special interior lighting)	
a.	Fluorescent	Philips Wipro
b.	Incandescent / Halogen / PL / Metal Halide)	Philips Wipro
c.	External Lighting Fixture	Philips Wipro

32.	Electronic Ballast for Fluorescent (To be selected as per fixtures' manufacturer)	Philips Wipro (Sigma)
33.	Electronic Dimmer	Lutron Polaron Controls (UK)
34.	50 W Halogen Light Transformer (Encapsulated Transformer)	Philips Reiz
35.	Selector Switch, Toggle switch	Salzer (Larsen & Toubro) Kaycee
36.	Shaver Socket	Clipsal M K India
37.	Timer	Schneider Electric (Telemechanique) ABB
38.	Batteries Lead Acid	Exide Standard
39.	Sealed Maintenance Free Batteries (VRLA)	Shinkobe Exide
40.	Battery Charger	Volstat Crompton Greaves
41.	LT Servo Automatic Voltage Stabilizer	Recon Automatic Electric
43.	Cable Trays (Factory Fabricated) / Raceways	Profab Engineer Rico Steel
44.	Lighting Poles	Keselec Bombay Tubes and Poles Classic Poles Inida
45.	Fire Sealant & Fire Retardant Paint	Birla 3 M HILTI
46.	IP PHONES	HTEK
47.	IP PBX	ZYCOO
46.	MOTION SENSORS	SCHNEIDER

47.	CAMERAS	HIK VISION
48.	ACCESS CONTROL	MATRIX
49.	Training room and Conference hall:	
	SONY VPL-CH370 3LCD PROJECTOR	SONY
	REVERB MOTORIZED SCREEN 16:10	REVERB SCREEN
	GM305 GOOSENECK MICROPHONES	BAYERDYNAMIC MICS
	YAMAHA MG 16XU MIXER	YAMAHA
	APART AUDIO PA 2240 BP DUAL CHANNEL POWER AMPLIFIER	POWER AMP (APART)
	APART AUDIO MASK 6T WALL MOUNTED SPEAKERS	WALL SPEAKERS (APART)
	PODIUM, COLLAR AND CORD LESS MICS	SHURE
	HDMI CABLES	DAC HDMI CABLES
	SPEAKER CABLE SPK 16	DAC CABLES
	AUDIO CABLE	NT CABLES
	KRAMER PRESENTATION SCALER VP461	KRAMER
	LOGIC CABLE CUBBIES (AUDIO CABLES)	LOGIC
	UNIVERSAL CEILING MOUNT KIT	UNIVERSAL
	4x2 HDMI SWITCHER VS482	ATEN
	4x4 VGA/AUDIO SWITCHER VM0404	ATEN
	AVB CI EXTERNAL CODEC CONFERENCING	BIAMP TESIRA FORTE
	AMP -A 460H AMPLIER	BIAMP
	NVR 8-CH NVR 8 CHANNEL NET VIDEO RECORDER	HIKVISION