SECTION V (4)

ELECTRICAL TECHNICAL SPECIFICATIONS

INTERNAL ELECTRICAL WORK

A. General Requirements

A. Materials

All materials, fittings, appliances etc. used in electrical installations shall comply with the requirements of relevant Indian Standard specifications and shall be well finished. Materials for which Indian Standard specifications have not been indicated, shall conform in quality to the samples maintained by the Engineer-in-charge or as approved by him.

B. Conformity with Indian Electricity Act, Rules etc

All electrical work shall be carried out in conformity with the requirements of the Indian Electricity Act 2003 & Indian Electricity Rules 1956 framed there under and Fire insurance act as applicable and also the relevant regulations of Electric Supply authorities concerned as amended from time to time.

C. Execution of Work

Unless otherwise exempted under the rule of the Indian Electricity rules the work of electrical installation shall be carried out under the supervision of a person holding a certificate of competency issued by the recognized authority.

The workmen shall also hold certificate of competency. Good workmanship is an essential requirement for compliance with these specifications.

D. The work shall be executed in such sections and in a manner as directed by the Engineer-in-charge to suit the building operations or the convenience of users/occupants.

E. Testing-Generally

All electrical work shall be systematically tested by the Contractor in the presence of Engineer-in-charge to ensure compliance with the specifications laid down. Test results shall be recorded and signed by the Contractor and the Engineer-in-charge. If the test results are not acceptable, all repairs and replacements and extra work of removal and relaying or refixing shall be carried out by the Contractor at his expense

and installation retested, until test results indicate compliance with the prescribed requirements.

The Contractor shall supply the necessary apparatus, labour and instruments or equipment's required for testing.

F. Record of Installations

On completion of the work the Contractor shall submit to the Engineer-in-charge complete wiring diagram for each of the installations in the case of internal electrical works, schematic diagram of equi Engineer-in-charge ent's and connections and switch gear works and the route layout plans in case of underground cable work. Five sets of plans shall be submitted, and it shall be ensured that the plans indicate complete site data of the installations.

All circuits shall be clearly 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.

G. Safety Procedures and Practices

In all major electrical installations, cable networks; safety procedures instructions for working on low, medium and high voltage mains and apparatus and safety practices listed in IS 5216-1982 (first revision) Guide for safety procedures and practices in electrical works shall be followed to the extent applicable. The Contractor shall provide workmen with safety devices and appliances.

H. Fire Safety

All electrical equipment's shall satisfy the requirements laid down in IS 1646-1997 Code of Practice for fire safety of buildings (general) electrical installations Code of practice for fire safety of industrial buildings, electrical generating and distributing stations, to the extent applicable.

I. SCOPE OF WORK

Supply of various equipment to site, unloading, QC inspection at receiving point, storing, transportation to work site, handling, assembling, cleaning, mechanical erection, chipping of foundations, installation, alignment, testing and commissioning and handing over in working condition of all items covered below but not limited to it as detailed under Schedule of Quantities.

a) LT Power and Control Cables & END terminations.
b) Lighting and Power distribution boards, UPS DBs and Main DB Panels.

c) Lighting fixtures and outside building lighting accessories.
d) Ear thing system body earthing and neutral earthing.
e) Any other items specified in Schedule of Quantities.

J. Inspection

LT panel, Digital Numerical Relays, Load Managers,cables and other critical items shall be inspected at supplier firms premises as per IS relevant Specifications.

The Contractor shall arrange Inspection facilities at the Works Premises, and 10 days prior information shall be informed to Engineer-in-charge.

All testing Facility shall be made available at Works Premises.

a) Test certificates in original
b) Original purchase orders
c) Guarantee/ Warranty & approval from Engineer-in-charge
d) Approval of products will be taken by vendor from respective Engineer-in-charge before placing the order.
e) Inspection on site rep. of Engineer-in-charge as deputed shall visit the works site to certified the Technical specifications and witness the test before dispatch of product.

K. PERFORMANCE TEST

The Contractor shall establish to the satisfaction of the Engineer-in-charge for the operational capability of the equipment's at manufacturer facility to meet the standard output stipulated here under in the Tender Part of Technical Specification. After satisfying himself by confirming the equipment's has been installed properly and necessary operational capabilities shall be carried out to the satisfaction of Engineer-in-charge.

L. DOCUMENTATION

The Contractor shall supply 6 sets of relevant as-built drawings consisting of General Arrangement showing Location of Electrical Items in Drawing, Layout of Panels, Circuit Diagram, Wiring Diagram. The same shall be given in CD form also to the Engineer-in-charge after execution of work.
The relevant Test certificates of OEMs, Calibration Certificates traceable to National Standards shall be part of documents Catalogues, Technical Literatures, of Electrical Items shall be part of document

Instruction and Maintenances Manual of Electrical diagrams shall be part of Documents. Details of IC, Memory Chips of Proprietary in nature shall be furnished in Manuals.

M. TRAINING:

Training shall be imparted to Supervisors, Technicians, of Engineer-in-charge staff regarding Operation and Maintenances, UPS & other critical eqpt., Programming of Multifunction meters, Digital Numerical relays, Calibration of Multi-function Meters, and other relevant Instruments as deems necessary after completion of installation of Electrical and Mechanical works

N. MATERIALS

The materials listed under "APPROVED MAKE" only shall be used. Materials, equipment's, fittings, etc. used in the installation shall conform to the latest relevant IS. In case of materials for which standard specifications do not exist, the Engineer-in-charge shall approve the material before the start of work.

O. MINIMUM REQUIREMENT OF TECHNICAL STAFF: - (AT SITE)

One qualified and competent experienced Engineer – having license issued by License Board and with site experience in executing similar installations acceptable to the Engineer-in-charge /BRO to supervise works.
Diploma Holders with site experience one. Experienced Wireman- Detail manpower loading chart to be furnished.

P. CODE, REGULATIONS AND STANDARDS:

The installation shall conform in all respects to Indian Standard Code of Practice for Electrical Wiring Installation I.S.732-1982. It shall also be in conformity with the current Indian Electricity Rules Safety Codes and the Regulations and requirements of the Local Electrical Supply Authority. Wherever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations, this specification shall take precedence over the said regulations and standards.

Q. Indian Standards

The following Indian Standards apply to this section:

I.S. No.	***Subject***
280-2006	Specification for mild steel wire for general engineering purposes (Fourth revision).
371-1979	Ceiling Roses (Second revision).

613-2000	Specifications for Copper rods for electrical purposes (Third revision).
692-1994	Paper insulated lead sheathed cable for electricity supply (Third revision).
694-1990	PVC insulated cables for working voltages up to and including 1100 volts (Third revision).
732-1989	Code of Practice for electrical wiring installations. (Third revision)
1255-1983	Code of Practice for installation and maintenance of paper insulated power cables. (Second revision).
1258-2005	Bayonet lamp holders (Fourth revision).
1293-2005	Specification for plugs and sockets outlet of rated voltage up to and including 250 Volts and rates current up to and including 16 Amperes (Third revision).
1554-(Part 1) 1988	Specification for PVC insulated (heavy duty) electric cables. Part: 1 For working voltages up to and including 1100 volts (Third revision).

1554-(Part 2) 1988	Specification for PVC insulated (heavy duty) electric cables. Part: 2 For working voltages from 3.3 KV upto and including 11 K.V. (Second revision).
1596-1977	Polyethylene insulated cables for working voltages up to and including 1100 volts (Second revision).
1646-1997	Code of practice for fire safety of buildings (general) Electrical installations (Second revision).
1944-(Part 1 & 2)- 1970	Code of practice for lighting of public thoroughfares (First revision).
2268-1994	Electric call bells and buzzers for indoor use (Third revision).
62305	Code of practice for protection of buildings and allied structures against lighting (Second revision).
2315-1978	Specification for Thimbles for wire ropes (First revision).
2412-1975	Link clips for electrical wiring (First revision).
2551-1982	Danger notice plates (First revision).

2667-1988	Fittings for rigid steel conduits for electrical wiring (First revision).
2675-1983	Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000volts (Second revision).
2713-(Part I to 3)- 1980	Tubular steel poles for overhead powerlines (Second revision)
3034-1993	Code of Practice for fire safety of industrial buildings-Electrical generating and distribution stations. (Second revision)
3043-1987	Code of practice for earthlings (First revision).
3070-(Part I)-1985	Specification for Surge arresters for Alternating Current systems, Part I-Non-linear resister type Surge arresters (Second revision).
3070-(Part 2)-1989	Lightning arresters for Alternating Current systems, Part 2 Expulsion type lightning arresters.
3070-(Part 3)-1993	Lighting arresters for AC system: Part 3 Metal Oxise arresters without gap.
3188-1980	Characteristics of string insulators (First revision).

3427-1997	AC Metal enclosed switchgear and control gear for rated voltages above 1 KV and up to and including 52 KV (First revision). Flexible steel conduits for electrical wiring.
3480-1966	
3553-1966	Watertight electric lighting fittings.
3837-1976	Accessories for rigid steel conduits for electrical wiring (First revision).
3854-1966	Switches for domestic and similar purposes.
4004-1985	Application guide for non-linear resister-type surge arrestors for Alternating Current systems (First revision).
4160-2005	Specification for Interlocking switch socket outlet (First revision).
4615-1968	Switch socket outlets (non-interlocking type).
4648-1968	Guide for electrical layout in residential buildings.

4710-1968	Switches and switch isolators above 1000 Volts but not exceeding 11000 Volts.
5039-1983	Specification for distribution pillars for voltages not exceeding 1000 Volts DC (First revision)
5216-1969 (Part 1)-1982	Recommendation safety procedures and practices in electrical works Part 1: General (First revision).
5216-(Part II)- 1982	Recommendation safety procedures and practices in electrical works Part II: life saving techniques (First revision).
5300-1969	Porcelain guy strain insulators.
5578-1984	Guide for marking of insulated conductors (First revision).
5820-1970	Precast concrete cable covers.
7098 (Part 1)-1988	Cross linked Polyethylene (XLPE) insulated PVC Sheathed Cables: Part 1 For working voltage up to and including 1100 Volts. (Second revision)
8061-1976	Code of practice for _design installation and maintenance of service lines upto and including 650 V
9385 (Part 2 & 3)- 1980	High voltage; Part 2 expulsion fuses and similar fuses; Part 3 Application guide
9537 (Part 2)-1981	Condition for electrical installation Part 2: Rigid steel conduit
9537 (Part 3)-1983	Condition for electrical installations Part 3 : Plain rigid conduit of insulating material.
9920 (Part 111)-1982	AC switches for voltages above 1000 volts. Part III Design and construction.
9921 (Part 1)-1981	Alternating current disconnections (isolators) and earthling switches for voltage above 1000 Volts. Part 1: General and Definitions.
9921 (Part 2)-1982	Alternating current disconnectors (isolators) and earthling switches for voltage above 1000 Volts. Part 2: Ratings.
9921 (Part 5)-1985	Alternating current disconnectors (isolators) and earthing switches for voltage above 1000 Volts. Part 5: Information to be given with tender enquiries &- orders.
9968 Part 1-1988	Specification for Elastomer insulated cables: Part 1 For working voltages up to and including 1100 Volts.

10118 (Part I)-1982	Code of Practice for selection, installation and maintenance of switch gears and control gears : Part 1: General
10118 (Part II)-1982	Code of Practice for selection, installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66): Part 2 Selection
10118 (Part III)-1982	Code of Practice for selection, installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66): Part 3 Installation
10118 (Part IV)-1982	Code of Practice for selection, installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66): Part 4 Maintenance
11353-1985	Guide for uniform system of marking and identification of conductor and apparatus terminals.
13703 Part 1 & Part 2	Low voltage fuses for voltage not exceeding 1000 V AC or 1500 V DC
13703 (Part 1 to 4) 1993	Specification for Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V PC
13947 - Part 1 1993	Specification for low voltage switchgear and control gear Part 1: General rules.
13947 - Part 3 1993:	Specification for low voltage switch gears and control gear- Part 3 switches, Disconnectors, switch disconnectors and fuse combination unit.
14772-2000	General requirements for enclosures for accessories for house hold and similar fixed electrical insulations.
IS 6665 :	Code. of practice for Industrial lighting
IS 1653	Specification for rigid steel conduits for electrical wiring
IS 2667	Specification for fittings for rigid steel Conduits for electrical wiring
IS 694	PVC insulated cables with copper conductors for voltages up to 1100 volts
IS 732	Code of practice for Electrical wiring installation (system voltage not exceeding 650 volts.)
IS 1646	General code of practice for fire safety of Buildings - Electrical Installation

IS 5216	Safety procedure and practice in electrical Works
IS 2268	Electrical call bells and buzzers for indoor Use
IS 2551	Danger notice plate
IS 5908	Electrical installation in building, method of measurements
IS 374	Fans and regulator, ceiling type electric (II Revisions).
IS 371	ceiling Rose
IS 4160	Interlocking switch socket outlet
IS 4615	Switch socket outlets (non-interlocking type.)
IS 1807	Specification for single pole 5A tumbler switches for AC/DC
IS 1293	Specification for three-pin plugs and socket outlets
`Indian Electricity Rules and Fire Insurance Regulations	

2.1 Cables, Cords and Earthing Leads

Cables and cords shall be from fresh stocks and shall be of approved make. Earthing lead shall of solid copper conductor of size 1.5 sqmm.

2.1.1 The point wiring / Sub main wiring shall be with PVC insulated unsheathed FRLS copper conductor Multistranded drawn in suitable size of PVC rigid non metallic conduit concealed / surface along with continuous earth wire.

2.1.2 The capacity of the current shall be as under:

The light and fans may be wired on a common circuit. Such circuit shall not have more than 8 total point of light, fan and light socket outlet or a load of 800 watts, whichever is less.

(a) The power circuit shall be designed with a maximum two outlets per circuit.

(b) Wherever the load to be fed is more than 1 KW, it shall be controlled by an isolator switch or miniature circuit breaker per circuit.

2.1.3 Cable for internal wiring for light, power and sub mains

Shall be with multi stranded copper conductors and shall be of the following types as indicated:

(i) Wiring in conduit, surface or concealed PVC rigid nonmetallic conduit.

(ii) Single core PVC insulated unsheathed cable up to 1100 volts grade conforming to IS : 694-1990

(i) For the purpose of colour coding in conduit wiring in particular the samples for

make and colour of insulation of wires shall be got approved before the wires/cables are procured and drawn into conduit. Red/yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used wiring in conduit without coding will not be acceptable. Wire/cables shall be 1100 volts grade single core conforming to IS :1596-1977 or IS: 694-1990.

2.1.4 Flexible Cords, Twisted, with Copper Conductors

Flexible cords for pendent light points three core, each with tinned annealed stranded copper conductor elastomer insulated and textile braided and twisted together, size nominal cross-sectional area 0.5 sq.mrn shall be as per IS :9968 (Part 1)-1988.

2.2 Conduit and Conduit Fittings

All conduit and conduit fittings and accessories shall be of rigid steel conduit or rigid non metallic PVC conduit as indicated and shall comply with the following Indian Standards. Rigid Steel conduits shall be solid drawn or seamed by welding and with stove enameled black or galvanized finish as indicated.

(a) IS 3837-1976 Specification for accessories for rigid steel conduit for electrical wiring.

(b) IS 2667-1988 Specification for fittings for rigid steel conduits for electrical wiring. The conduit fittings shall be made of steel, cast iron or malleable cast iron. Malleable iron casting shall be well annealed.

(c) IS 3480-1966 Specification for flexible steel conduit for electrical wiring.

(d) IS :4649-1968 Specification for adaptors for flexible steel conduits.

(e) IS :3419-1988 Specification for fittings for rigid non metallic conduits. Conduit fittings shall be of unplasticiscd PVC.

(f) IS 9537-1981 Part 2-Rigid steel conduit.

(g) IS 9537-1983 Part 3-Plain rigid conduit of insulating material.

2.2.1 Wooden plugs (Gutties) and Rawl plugs

All wooden plugs shall be seasoned hardwood not less than 5 cms long 2.5 cm square on inner face and 2 cms square on the outer exposed face. These shall be fixed securely as the work proceeds in the structure subsequently as indicated, cemented and finished flush with the surface. Rawl plugs or epoxy resin Phill plugs or metallic split hammered type plugs manufactured by number of proprietary firms may be used as alternative when so indicted and fixed as per manufacturer's instructions.

2.2.2 Screws and Fastenings

All screws shall be of alloy aluminium or cadmium plated iron unless otherwise indicated.

2.3 Ceiling Rose

Ceiling rose shall be surface type and shall comply with IS :371-1979, Specification for ceiling roses having three terminal plates and of outside diameter not less than 63.5. mm. Ceiling roses shall be provided, with means for gripping flexible cord which shall not damage the insulation and/or sheath of the cord and shall be such that the load on the cord is not transmitted to the terminals.

2.4 Shades

'Metal shades shall be well finished in vitreous enamel, blue or green or white outside and while inside. Glass shades shall be heat resistant frosted/opaque type and shall be true in shape, free from flaws, specks or bubbles and shall be uniform in thickness, free from sharp edges and uniform in colour.

2.5 Bulkhead Fittings

These shall be robust in construction, made from cast iron, pressed steel or cast aluminium and fitted with Porcelain lamp holder, vitreous enameled reflectors and hinged water tight front with key and wire or pressed metal guards.

2.6 BATTEN 40W LINEAR Connect Luminaire : Cat No. BRCS 40W LED 4F D WH Recess Linear Connect luminaire. • Well desgined extruded aluminium housing linear profile with Efficacy 110 lm/W and perfect optic controls. Make : BAJAJ / or its equivalent in Philips and Crompton.

2.6.1 GREEN LED BATTEN 40W WH LED : cat No. F210600 BCLAB 40W WH LED Passage, corridor lighting , Make : BAJAJ / or its equivalent in Philips and Crompton.

2.6.2 LED 15W DOWNLIGHTER : Recess Mounting Led Downlighter Cat No : G200401 BZSLOS nxt 15L LED WH SD (1.000), Make BAJAJ / or its equivalent in Philips and Crompton.

2.6.3 RECESS 34W LED LUMINAIRES : Cat No : BZRSQL 36L LED GX (1.000) Recess mounting LED luminaire suitable for interior illumination, Make BAJAJ / or its equivalent in Philips and Crompton.

2.6.4 LED15W DOWNLIGHTER : Recess Mounting Led Downlighter
Cat No : G200401 BZSLOS nxt 15L LED WH SD (1.000), Make : BAJAJ / or its equivalent in Philips and Crompton.

2.6.5 RECESS 36W LED LUMINAIRES : Cat No : BZSSQL 36L LED WH GX (1.000 Recess mounting LED luminaire suitable for interior illumination, Make BAJAJ / or its equivalent in Philips and Crompton.

2.6.6 LED 15W DOWNLIGHTER : Recess Mounting Led Downlighter
Cat No : BZSLO 15W WH Make : BAJAJ / or its equivalent in Philips and Crompton.

2.11 Socket outlets

Socket outlets, surface or flush type, 6 or 16 amp, 250 volts shall be three pin shuttered/non shuttered or interlocking type as indicated and shall comply with the following Indian Standards :

i. IS 1293-2005 Specification for 3 pin plugs and socket outlets,
ii. IS 4615-1968 Switch socket outlets (non interlocking type).
iii. IS 4160-2005 Specification for interlocking switch socket outlets.

2.12 Lamp Holders

Lamp holder shall be metal cased type or insulated type as indicated and shall comply with IS 1258-2005 Specification for bayonet lamp holders. Lamp holders shall be suitable for fixing in pendent or to bracket or angular as ordered.

2.17 MCB Distribution Boards

2.17.1 Distribution boards shall be factory made and conforming to IS : 8623 suitable for universal mounting copper busbar, Neutral bar, Earth bar, Standard DIN bar Rail and cable ties for cable management. Top and bottom shall have removable gland plates with knock outs.

2.17.2 SPN Distribution boards shall be suitable for provision for DP/SPN MCBs/ isolators as incomer and SP outgoings all as specified and shall be flush mounting type. The degree of protection shall be IP -42 protection with double door.

2.17.3 TPN Distribution boards shall be suitable for FP/ TPN MCBs/ Isolator as in corner and TPN/SP outgoings all as specified and shall comply with IP-42 protection with double door.

2.18 MCBs –

All MCBs shall be conforming to IS-8828 of 1996 and shall be ISI marked. These shall be suitable for 'C curve and 10 KA Breaking capacity and shall be provided with box terminal on top and bottom both suitable for adopting cable size up to 35 Sqmm. The enclosure of MCBs shall be of Moulded Self Extinguishing thermo set plastic and these shall be suitable for snap fixing on standard Din Rail.

2.19 Plug and Socket DBs –

Plug and socket Distribution Boards including SP/DP MCBs for protection of appliances like window type/Split type Air conditioners shall only be provided. All these plug and socket DBs shall be of Universal mounting type.

2.21 Telephone Connection and LAN

Socket with concealed conduit and telephone cable up to the external wall of buildings. PVC insulated PVC sheathed unarmored annealed tinned copper conductor with tape and thread as per ITD. G/ WIR -06/02,0.50mm dial two pair telephone cable shall be provided.

2.21.1 All multicore cables and wires shall be of tinned copper conductor of not less than 0.61 mm dia. and shall be colour coded twisted pairs with rip cord.

2.21.2 The telephone tag blocks shall be suitable for the multicore telephone cables and shall have two terminal blocks, cross connect type. All incoming and outgoing cables shall be terminated on separate terminal blocks and terminations shall be silver soldered. The cross connecting jumpers shall be insulated wires of same diameter and screw connected.

2.21.3 The tag blocks shall be mounted inside fabricated sheet steel box or teakwood board with removable hinged covers and shall be fully accessible. The enclosure shall be painted with 2 coats of red oxide and stove enamelled.

2.21.4 The installation of conduits shall generally be as specified under section "CONDUIT WIRING". Cables laid on cable racks shall be neatly stitched together. The connection at the tag blocks shall be silver soldered so as to achieve minimum contact resistance. The final branch connections with 2 / 5 pair cables in conduits and the maximum number of cables in each conduit shall be as follows:

2.22 Meter Boxes/Switch Boxes

MS sheet type meter boxes/switch boxes shall be used. No wooden component shall be provided in these boxes.

2.23 Exhaust Fan

300mm sweep, 900rpm, 230v, 50Hz, single phase fresh air fans with limit in wire mesh/louvers shall be provided as indicated.

2.25 SUB SECTION B-INTERNAL ELECTRICAL WORK

2.26 Setting of Electrical Equipment

The setting of cable and conduit runs, controls, distribution boards fittings and accessories, etc., shall be as laid down in IS 4648-1968. Guide for electrical layout in residential buildings or as directed by the Engineer-in-charge. The location of fittings etc., shall be marked in advance on walls, etc, and approved by the Engineer-in-charge.

2.27 Systems of Wiring

2.27.1 Wiring shall be carried out in any of the following systems as indicated: -

(a) PVC insulted and PVC sheathed or Polyethylene insulated and PVC sheathed wiring system in Conduit wiring system recessed or surface type.

All conductors as far as possible shall run near walls and ceiling so as to be easily accessible and capable of being thoroughly inspected. 'Power' wiring shall be kept separate and distinct from 'Light' wiring. In all types of wiring due consideration shall be given for neatness, good appearance and safety. Diagonal runs will not be permitted.

2.27.2 The balancing of circuits in three wire or polyphase installation shall be arranged beforehand. Circuits on different phase of a polyphase system shall be kept apart at a minimum distance of 2 m unless they are enclosed in earthed metal casing suitably marked to indicate the risk of dangerous shock due to the voltage between the conductors contained in them. In large or important rooms, light and socket outlet points shall be distributed over more than one circuit on different phases where possible. •

2.27.3 Medium pressure wiring shall be carried out as specified in IS-732-1989 Code of practice for electrical wiring installations (system voltage not exceeding 650 volts).

2.27.4 All ceiling fans shall be wired to a ceiling rose and further connection to fan to be done by flexible wire. The fans should be suspended from a hook shackle or clamp and insulated from the same with an insulating reel of proper size. All joints in the suspension rod shall be screwed and secured by means of split pin. Wherever specified, the hooks for fans shall be fixed by the contractor to ceiling rigidly welded to reinforcement and finished properly.

2.27.5 All runs of wiring and the exact positions of all points and switch boxes shall be first marked on the building and approved by the Engineer-in-charge. before actual commencement of the work.

2.27.6 The contractor shall thoroughly study the structural and architectural arrangements of the buildings and wherever necessary, shall in consultation with Engineer-in-charge at site, make suitable adjustments in the conduit routing, earthing arrangements and location of boxes, fittings etc. with a view to avoid interference with any part of the building, structure, equipment or any other work in the building or to effect any improvement in the arrangement.

All civil works in connection with installation of conduits, switch and plug boxes, switch boards cables and clamps etc. has to be carried out by electrical contractor. The contractor should ensure that wherever all, roof, floor, cable trench are finished neatly to the same surface as finished by civil contractors. Inside false ceiling, he should ensure that frame for supporting recess fixtures are installed in co-ordination with the work of civil contractors. To avoid damage to false ceiling, conduits and all electrical installation work inside false ceiling has to be done carefully to prevent damage to false ceiling frame and finished asbestos / Plaster of Paris sheet. Damage if any done to the above should be made good by Electrical contractor at his cost.

2.28 Pressure and Frequency of Supply

All current consuming devices shall be suitable for the pressure and frequency of the supply to which these are to be connected.

2.29 Controls at Point of Entry of Supply

2.29.1 There shall be linked main switchgear with fuse on each live conductor of the supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear. No fuse should be inserted in the earthed neutral. The neutral shall also be distinctly marked. In this connection Rule 32(2) of the Indian Electricity Rules 1956 shall be referred.

2.29.2 The main switchgear shall be situated as near as practicable to the termination of service line and shall be easily accessible without the use of any external aid.

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

2.29.4 Termination of all wiring in to MCBs/ MCCBs/DBs shall be through copper/lugs/ thimbles of adequate capacity.

2.30 Main Switchgears, Switch Board and their Location

2.30.1 All main switchgears shall be of metal clad and shall be fixed at close proximity to the point of entry of supply.

2.30.2 Open type switch boards shall be placed only in dry situation and shall not be placed in the vicinity of storage batteries or exposed to chemical fumes.

2.30.3 Main switch boards shall be installed in rooms or cupboards having provision for locking arrangement.

2.30.4 Switch boards shall not be erected above gas, stoves or sinks or within 2.5 m of any washing unit i.e. the washing rooms to laundries or in the bathrooms, lavatories, toilets or kitchens.

2.30.5 Switch boards, where indicated, shall have weatherproof outlet casing, and shall be provided with glands or bushings or adopters to receive screwed conduit according to the mariner in which, cables are run. PVC double flanged bushes shall be fitted in the holes of the switches for entry and exit of wires.

2.30.6 A switch board shall be installed so that its bottom is not within 1.25 m above the floor unless the front of the switch board is completely enclosed by a door.

2.30.7 Switch boards shall be recessed in the wall, if so specified. The front shall be fitted with hinged panel as indicated, with locking arrangement; the outer surface of door being flush with the walls unless otherwise indicated. Ample room shall be provided at the back for connections and at the front between the switchgear mountings and the door.

2.30.8 Equipment which are on the front of a switch board shall be so arranged that inadvertent personal contact with live parts is unlikely during the manipulation of switchgears, changing of fuses or like operations.

2.30.9 No holes other than the holes by means of which the switch board panel is fixed shall be drilled closer than 13 mm from any edge of the panel.

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

2.30.11 The arrangement of the switchgears shall be such that they shall be readily accessible and their connections to all instruments and apparatus shall also be traceable.

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

2.30.13 No fuses, other than those in instrument circuit, shall be fixed on the back of or behind a switch board panel or frame.

2.30.14 All the metal switchgears and switch boards shall be painted prior to erection with one coat of anti-rust primer. After erection they shall be painted with two coats of approved enamel or aluminium paint as directed on all sides where accessible.

2.30.15 All switch boards connected to medium voltage and above shall be provided with "Danger Notice Plate'.

2.33 Marking of Apparatus

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

AC	DC
Three Phases-Red, Blue and Yellow Neutral-Black	Three Wire System-2 Outer Wires-Red and Blue Neutral-Black

2.33.2 Where four wire there phase wiring is done the neutral shall preferably be in one colour and the other three wires in other colors. For the purpose of colour coding in conduits wiring particulars of the sample for make and colour of insulation of wires shall be got approved before the wires/cables are procured and drawn into conduit Red/yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used for wiring in conduit without coding will not be acceptable. Wire/cables shall be 1100 volts grade single core conforming to IS 1596-1977 or IS 694-1990.

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

2.33.4 All markings required under this rule shall be clear and permanent.

2.33.5 All distribution boards shall be marked 'Lighting' or 'Power' as the case may be and also marked with the pressure and number of phases of the supply. Each shall be provided with circuit list giving details of each circuit which it controls, the current rating of the circuit and size of the fuse element.

2.34 Main and Branch Distribution Boards and their Location

2.34.1 Unless otherwise specified, main and distribution fuse boards shall be of the metal clad type.

2.34.2 Main distribution boards shall be controlled by a linked switch fuse or circuit breaker. Each outgoing circuit shall be provided with a fuse on the phase or live conductor.

2.34.3 Branch distribution boards shall be controlled by a linked switch fuse or a circuit breaker. Each outgoing circuit shall be provided with a fuse on the phase or live conductor. The earthed neutral conductor shall be connected to a common link and be capable of being disconnected individually for testing purposes.

2.34.4 The distribution fuse boards shall be located as near as possible to the centre of the load they are intended to control.

2.34.5 The distribution fuse boards shall be fixed on suitable stanchion or wall and shall be accessible for replacement of fuses.

2.34.6 These shall be or metal clad type but if exposed to weather or damp situations they shall be of the weatherproof type and if installed where exposed to explosive dust vapour or gas they shall be flameproof type.

2.34.7 Where two or more distribution fuse boards are connected at different phases these distribution boards shall be:

(a) Fixed not less than 2 metre apart or

(b) Arranged so that two cannot be opened at a time, such as they are interlocked, and metal case is marked 'Danger 415 volts'.

2.35 Wiring of Distribution Boards

2.35.1 In wiring a branch distribution board the total load of the consuming devices shall be divided as far as possible evenly between the numbers of ways of the board, leaving the spare circuit for future extension.

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

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

2.35.4 All bare conductors shall be rigidly fixed in such a manner that a clearance of at least 25 mm is maintained between conductors of opposite polarity or phase and between the conductors and any material other than insulating material.

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

2.35.6 Where indicated a pilot lamp shall be fixed and connected through an independent single pole switch and fuse to the bus bars of the board.

2.36 Joints and Looping Back

Unless otherwise indicated, looping back system of wiring shall be done without any junction or connector boxes on the line. Where joint box system is indicated all joints in conductors shall be made by means of approved mechanical connectors in suitable and approved joint boxes.

2.36.1 In any system of wiring, no bare or twist joints shall be made at intermediate points in the through run of cables; unless the length of a final sub-circuit, sub-main or main is more than the length of the standard coil as given by the manufacturer of the cable. If any jointing become unavoidable such joint shall be made through proper cut-outs, or through proper junction boxes open to easy inspection but in looping back systems no such junction boxes shall be allowed.

2.38 Passing through Walls and Floors

2.38.1 Where conductors pass through walls and floors, the following methods shall be employed. Care shall be taken to see that wires pass freely through

protective pipe or box and that the wires pass through in a straight line without any twist or cross in wires on either ends of such holes:

(a) The conductor shall be carried either in a rigid steel conduit or a rigid non-metallic conduit or in a porcelain tube of such a size which permits easy drawing in. The ends of conduit or tube shall be neatly and securely bushed.

(b) 'Insulated conductors while passing through floors shall be protected from mechanical injury by means of rigid steel conduit to a height not less thanl.5 metre above the floors and flush with the ceiling below.
This steel conduit shall be earthed and securely bushed.

2.38.2 Where a wall tube passes outside a building so as to exposed to weather the outer end shall be bell-mouthed and turned downwards and properly bushed on the open end or shall be sealed to prevent entry of water.

2.39 Fittings

2.39.1 Where conductors are required to be drawn through tube or channel leading to the fittings, the tube or channel must be free from sharp angles or projecting edge and of such size as will enable them to be wired with the conductors used for the final circuit without removing the braiding or tapping. As far as possible all tubes or channels should be of sufficient size to permit of looping back.

The lighting fixtures shall be of the type specified in the drawing. The mounting height and location shall be as specified in the drawing. Unless otherwise specified, the mounting height shall not be less than 2.5 m.

The lighting fixtures shall be controlled either individual or in groups as specified in the drawing. The lighting fixtures shall be either supported vertically or mounted on bracket or suspended by down rods as required and approved by Engineer-in-Charge.

(a)All the luminaries shall be commercial/industrial type as per specific requirement. Specification for the various types of incandescent, mercury vapour, sodium vapour and fluorescent fittings mentioned in the schedule of quantities shall be followed. All the lighting fixtures shall be complete with all parts,
Accessories for efficient performance whether specifically asked in the specification or in the schedule of items or not.

(b) Individual light fittings shall be provided with suitable arrangements for G.I. threaded conduit entry of 19 mm dia unless otherwise specified. Terminals of all fittings shall be suitable for taking 2.5 sq.mm. flexible, copper conductor PVC insulated, PVC sheathed cable.

(c) Fittings shall be supplied with all interconnections made and fully wired upto the terminal block.

(d) All live parts shall be provided with suitable sleeves to prevent accidental contacts. The earthing terminal in the fitting shall effectively earth the body of the entire luminaries.

(e) The clearance between the live parts and the enclosures, earthing and other safety factors shall be governed by the latest revision of the relevant IS specification and IE rules.

(f) Dust and vapour tight fittings shall have the enclosures suitably designed to withstand the heating effect.

(g) The fixing arrangement of various components and lamps shall be in such a way that the maintenance and replacement jobs can be easily carried out.

(h) The luminaries shall be suitably designed to provide economically the required level of illumination on the working plane when mounted at normal standard height in accordance with the type of fixtures.

(i) The luminaries shall be suitable for operating at normal supply voltage of 240V single phase, 50 HZ with voltage variation of +/-5%.

2.39.2 Enclosed type fittings shall be provided with a removable glass receptacle and of such size or construction as to prevent undue heating of the lamp, or if the position of fittings be such that the glass receptacle is liable to mechanical damage, the glass shall be protected by a suitable wire guard.

2.39.3 The leads of pre-wired fixture shall be terminated on ceiling rose or connector.

1. Robust design made of CRCA sheet steel powder coated housing & cover
2. Powder coated reflector
3. Engineering plastic end cap and snap fit polycarbonate holder
4. High frequency electronic ballast pre-wired up to terminal block suitable for lamp
5. Confirms to IS10322 Part5/Sec 1 1987
6. All type of fittings/ fixtures shall have earth terminal with proper earthing connection.

2.40 Accessories

2.40.1 Switches

All switches shall be placed in the live conductor of the circuit and no single pole switch or - fuse shall be inserted in the earth or earthed neutral conductor of the circuit. Single pole switches (other than for multiple control) carrying not more than 15A may be of the tumbler type or flush type as indicated and the switch shall be 'ON' when the handle or knob is 'DOWN'.

2.41 Call bell / Buzzer

The call bell/buzzer shall be with pleasant sound and shall be decorative. Lumi sound indicator for bell shall be provided.

2.42 Attachment of Fittings and Accessories

2.42.1 In domestic accommodation, where indicated, terminal points for power plugs, switches etc. of internal surface type wiring shall terminate in recessed cast iron boxes as for concealed wiring fitted flush with the wall surface.

2.42.2 In case of conduit wiring, all accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside metal boxes. Accessories like ceiling roses, brackets, battens, stiff pendants, etc. shall be fixed on metal outlet boxes.

2.42.3 Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their boxes or as indicated.

2.43 Fan Regulators and Clamps

2.43.1 All ceiling fans shall be wired to ceiling roses or to special connector boxes and suspended from hook or shackles with insulators between hooks and suspension rods. There shall be no joint in the suspension rod. Motor is made of superior grade copper wire and low-loss silicon steel stampings. Coated with a special anticorrosive enamel paint in Brown or White colour. Fans shall be confirming to ISI specification. Suitable rating of capacitor. Double ball bearing. Blades are aerodynamically designed and made of heavy gauge aluminium sheets.

2.43.2 For wooden joists and beams, the suspension shall consist of MS flat of size not less than 40x6 mm secured on the sides of the joists or beams by means of two coach screws of size not less than 50 mm for each flat. Where there is space above the beam, a through bolt of size not less than 15 mm 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 15 mm 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 '5 form.

In the case of I beam, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut. As regards RCC roofs,, a 10 cm dia CI box with a bent hook shall be provided.

2.43.3 Canopies on to top of suspension rod shall effectively hide the suspension.

2.43.4 The lead in wire shall be of nominal cross sectional area not less than 1.5 sq mm with Multistranded copper conductor and shall be protected from abrasion.

2.43.5 Unless otherwise indicated, all ceiling fans shall be hung 2.75 metre, above the floor.

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

2.44 Bends on Wiring

The wiring shall not in any circumstances be bent so as to form an abrupt right angle but must be rounded of corners to a radius not less than six times the overall diameter of the cable.,

2.45 Protection of Wiring from Mechanical Damage

In cases there are chances of any damage to the wiring, such wiring shall be covered with a sheet metal covering (not less than 1.63 mm) the base of which being flush with the plaster or brick-work as the case may the wiring shall be drawn through a metal conduit pipe by complying with all the requirements of conduit wiring as directed. Such protective covering' shall in all cases be fitted on all down drops within 1.5 metre from the floor level up to the switch board whichever is less.

2.46 Passing through Floors

All cables taken through floors shall be enclosed in an insulated heavy gauge steel conduit extending 1.5 metre above the floor or up to the switch board whichever is less and flush with the ceiling below or by means of any other approved type of metallic covering. The ends of all conduits or pipes shall be neatly bushed with porcelain, wood or other a materials. The conduit pipes, wherever accessible shall be securely earthed.

2.47 Passing through Walls

The conductor shall be carried in steel conduit or porcelain tube of such a size that it permits easy drawing in. of conduit shall be neatly bushed with porcelain, wood or other approved material in such a case there shall be conduit for every twin core cable or two runs of single core cable and the conduits shall be neatly arranged so cables enter them straight without bending.

2.48 Stripping of Outer Covering

While cutting and stripping of the outer covering of the cable care shall be taken that the sharp edge of the instrument does not touch the inner insulation of the conductors. The protective outer covering of the cables stripped off near connecting terminal and this protective covering shall be maintained up to the close prox connecting terminals as far as practicable. Care shall be taken to avoid hammering on link clips with any metal instrument after the cables are laid. Where junction boxes are provided, they shall be made moisture-proof with a plastic compound.

2.49 Identification of cables/wires and painting of surface wiring if so required to match the surrounding finish walls/ceilings etc.

(a) Where colour coding is not followed and only one single colour cables/wires used in wiring the cables/wires shall be in identified by taping colored PVC tapes in the terminal boards/switch board the cables/ wires terminal ends for easy identification for the wires/cables. Red/yellow/blue colour for phases and black for neutral shall be used.

(b) If so required the wiring after installation shall be painted with enameled paint and neatly finished match the surrounding finish on the walls etc. as directed.

Surface Metallic and Non-Metallic Conduit Wiring System

2.50 Bunching of Cables

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 drawn into the same conduit.

2.51 Conduit and Conduit fittings

The number of cables allowed in the steel and non-metallic PVC rigid conduits shall be as given in the following tables:-

(A) Maximum permissible number of 1100 Volts grade single core aluminium cables that may be drawn into rigid steel conduits

Table 2 Maximum Permissible Number of PVC Insulated 650/1 100 V Grade Aluminium/Copper Cable Conforming to Accepted Standard [8-2(3)] that can be Drawn into Cable Trunking/Cable Ways
{Clause 6 11)

SI No.	Nominal Cross-Sectional Area of Conductor mm'	10/15 mm ^ 10 mm	20/15 mm • 10 mm	25/15 mm ^ 16 mm	32 mm ^ 16 mm	40 mm ^ 25 mm	40 mm ^ 40 mm
(i)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	1.5	3	5	6	8	12	18
ii)	2.5	2	4	5	6	9	15
iii)	4	2	3	4	5	8	12
IV)	6		2	3	4	6	9
v)	10		i	2	3	5	8
VI)	16			i	2	4	6
VII)	25				1	3	5
viii)	35					2	4
tX)	50					i	3
X)	70					i	2

Note 1: The table shows the maximum capacity of conduits for the simultaneous drawing in of cables. The columns headed 'S' apply to runs of conduit which have distance not exceeding 4.25 metre between drawn-in boxes and which do not deflect from the straight by an angle of more than 15°. The column head 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15°

Note 2: In Case an inspection type drawn-in box has been provided and if the cable is first drawn through one straight conduit through the drawn-in box and then through the second straight conduit such system may be considered as that of straight conduit even if the conduit deflect through the straight by more than 15°

(B) Maximum permissible number of 1100 Volts grade single core aluminium cables that may be drawn into Rigid Non-metallic conduits

Table 1B Maximum Permissible Number of 250 V Grade Single-Core Cables that may be Drawn into Rigid Non-Metallic Conduits

[Clauses 6.7.1(a) and 6.10.3.2]

SI No.	Sizes of Cable		Size of Conduit mm					
	Nominal Cross-Sectional Area mm^2	Number and Diameter (in mm) of Wires	16	20	25	32	40	50
			Number of Cables, *Max*					
(i)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	1.0	1/1.12[1])	5	7	13	20		
ii)	1.5	1/1.40	4	6	10	14		
iii)	2.5	(1/1.80) [3/1.06]	3	5	10	14		
iv)	4	(1/2.24) [7/0.85']	2	3	6	10	14	—
v)	6	(1/2.80) [7/1.40']	—	2	5	9	11	—
vi)	10	[1/3.55[2]] [7/1.40']			4	7	9	
vii)	16	7/1.70		—	2	4	5	12
viii)	25	7/2.24				2	2	6
ix)	35	7/2.50				—	2	5
x)	50	7/3.00[2])				—	2	5
		19/1.80				—	2	3

[1] For copper conductors only.

[2] For aluminium conductors only.

2.52 Conduit Joints

Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Where there are long runs of straight conduit, inspection type couplers shall be provided at suitable intervals or running threads with couplers and jam nuts shall be provided. In the latter case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes, in all cases, shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have neither sharp edges nor any burrs as otherwise these may damage the insulation of conductors while drawing them through such pipes.

2.53 Protection against Dampness

The layout of conduits should be such that any condensation or sweating inside conduit is drained out. Suitable precaution shall be taken to prevent entry of insects inside the conduit.

2.54 Protection of Conduit Against Rust

All steel conduit screwed connections shall be metal to metal and exposed screwed threads in parts, where the galvanizing or enameling has been damaged,

shall be thoroughly cleaned and painted with two coats of anti-corrosive paint; such painting shall be done as the work proceeds.

2.55 Fixing of Conduit

Conduit pipes shall be fixed by heavy gauge saddles and spacing plates secured to suitable wood plugs or other approved plugs with screws A_ an approved manner, at an interval of not more than one metre. In case of the couplers or bends or similar fittings saddles shall be fixed at a distance of 300 mm from the centre of such fittings. The saddle shall comply with the requirements of IS: 3837-1976.

2.55.1 Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of ordinary clips or girder clips as required. Where it is not permitted to drill holes in the truss members, suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girder clips shall not be less than as given in the following table:-

Sl.No	Size of conduit	Width of ordinary	Thickness of ordinary
	Mm	mm	mm
1	20	20	0.90
2	25	20	0.90
3	32 and above	25	1.25

2.56 Bends on Conduit

All necessary bends in the system including diversion shall be done by bending conduit pipes or by inserting suitable solid or inspection type normal bends, elbows or similar fillings or by fixing cast iron inspection boxes as approved by EIC. Conduit fittings shall be avoided as far as possible on conduit system exposed to weather and where considered necessary solid type fittings shall be used. Radius of bends in conduit pipes shall not be less than 75 mm.

2.57 Outlets

The switch or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes, the wall thickness shall be not less than .1.22 mm for boxes up to a size of 200x300 mm; and above this size 1.63 mm thick mild steel boxes shall be used. Except where otherwise stated 3 mm thick phenolic laminated sheets shall be fixed on the front with brass screws. Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern. All fittings shall be fitted in flush pattern.

Only a portion of the outlet box shall be sunk in the wall: the outer portion being projected out for suitable entry of conduit pipes into the box.

The outlet box shall be mounted flush with wall. The metal box shall be efficiently earthed with conduit.

2.58 Erection and earthing of Conduit

The conduit of each circuit or section shall be fixed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements specified for earthing. Gas or water pipe shall not be used as earth medium. If conduit pipes are liable to mechanical damage, they shall be adequately protected. In a conduit system, conduit pipe shall be continuous when passing through walls or floors.

2.59 Recessed Conduit Wiring System

2.59.1 General

Recessed conduit wiring system shall comply with all the requirements of surface conduit wiring system except with regard to fixing of conduits and in addition the requirements specified in the following clauses shall also be complied with.

2.59.2 Making of Chases

Chases in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the desired manner. In the case of buildings under construction, conduits shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/ rubble masonry work special care shall be taken to fix the conduit and accessories in position along with the building work.

2.59.3 Fixing of Conduit In Chase

Conduit pipe shall be fixed by means of staples or by means of saddles not more than 600 mm apart. Fixing of standard bends or elbows shall be avoided as far as practicable and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors. All threaded joints of conduit pipes shall be treated with approved preservative compound to secure protection against rust.

2.59.4 Fixing of MS/Cast lion Conduit Boxes In Walls

Conduits boxes of mild steel or cast iron shall be fixed in the walls with cement and sand mortar 1:2. No screwing of conduit boxes shall be required when fixed in recessed conduit wiring system.

2.60 Inspection Boxes

Inspection boxes shall be provided to permit periodical inspection and to facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers.

2.61 To facilitate drawing of wires in the conduit, galvanised iron fish wire of 3.25 mm diameter shall be provided along with laying of recessed conduit.

2.65 Earthing

Earthing shall be carried out as described in IS 3043-1987, Code of practice for earthing.

2.65.1 Pipe Earth Electrode

Galvanised steel pipe electrode shall be of medium grade 40 mm dia and 2.5 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.

2.65.2. 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.

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.

2.65.3 Strip or Conductor Electrode

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

2.65.3.1 Strip electrodes shall not be less than 25x3 mm in case of galvanised iron or steel and 20x3 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.

2.65.3.2 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.

2.65.3.3 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.

2.66 Method of Installing Watering Arrangement

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.

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

27.67 Location for Earth Electrode

2.67.1 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 affects the foundations, the distance of electrode from the building shall be increased.

2.67.2 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.

2.68 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.

2.69 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 iron or steel wire so as to ensure minimum resistance. Preferably the main earthing lead shall be galvanized iron or steel in case of galvanised pipe electrode; galvanised iron wire 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.

2.70 Size of Earth Continuity Conductor

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.

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

2.71 Method of Connecting Earthing Lead to Earth Electrode

In the case of plate earth electrode the earthing lead shall be securely bolted to the 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 electrodes, 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 provided 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.

2.72 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.

2.73 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.

2.74 Testing

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

2.74.1 Insulation Resistance

2.74.1.1 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.

2.74.1.2 The insulation resistance shall' also be measured between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the 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.

2.74.1.3 The insulation resistance in mega ohms measured as above shall be not less than 50 mega ohms divided by the number of outlets in the circuit

2.74.1.4 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.

2.74.1.5 A preliminary and similar test may be made before lamps etc. are installed, and in this event the insulation resistance to earth should be not less than 100 mega ohms divided by the number of outlets or 25 mega ohms divided by the number of outlets when PVC insulated cables are used for wiring.

2.74.1.6 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.

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

2.74.2 Polarity Test of Switch

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

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

2.74.2.3 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.

2.74.3 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.

LIST OF MAKES

Internal Electrification work		
S.No.	**Details of Materials / Equipment**	**Manufacturer's Name**
A.	**MEDIUM VOLTAGE EQUIPMENT**	
1	Final Distribution Board	Schneider Electric / SIEMENS / Legrand / L&T
2	Bus Duct	Schneider/ ABB/ Siemens / L&T/ Legrand
	a. Air Insulated Type	Schneider/ ABB/ Siemens / L&T/ Legrand
	b. Sandwiched Construction	Schneider/ ABB/ Siemens / L&T/ Legrand

3	Air Circuit Breaker	Schneider/ ABB/ Siemens/ Legrand / L&T
4	Molded Case Circuit Breaker (MCCB)	Schneider Electric / ABB / Siemens /Legrand / L&T
5	Miniature Circuit Breakers (MCB)	Schneider Electric / ABB/ Siemens / Legrand / L&T
6	Residual Current Circuit Breaker (RCCB)	Schneider Electric/ ABB/ Siemens/ Legrand / L&T
7	Power/Aux. Contactor	Schneider/ ABB/ Siemens/ Legrand / L&T
8	Change Over Switch	Schneider/ ABB/ Siemens/Anchor/Panasonic
9	Control Transformer/Potential Transformers	Automatic Electric /Indcoil /NEWTEK ELECTRICALS
10	Current Transformer (Epoxy Cast Resin)	Automatic Electric /Indcoil /NEWTEK ELECTRICALS
11	Protection Relay	
	a. Numeric Type	SCHNEIDER / ABB/ SIEMENS / Legrand / L&T
	b. Electromagnetic Type	SCHNEIDER / ABB/ SIEMENS / Legrand / L&T
12	Indicating Lamps LED type and Push Button	SCHNEIDER / ABB/ SIEMENS / Legrand / L&T
13	Overload relays with built in Single Phase preventer	SCHNEIDER / ABB/ SIEMENS / Legrand / L&T
	a. Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED Display	SCHNEIDER / ABB/ SIEMENS / L&T
	b. Electro Magnetic Meters	SCHNEIDER / ABB/ SIEMENS/NEWTEK ELECTRICALS
14	Static Power Meter & Logger (SPML)	SCHNEIDER / ABB/ SIEMENS
15	Power Capacitor	SCHNEIDER / ABB/ SIEMENS / L&T
16	Autoamtic Power Factor Correction Relay (Numeric Type)	SCHNEIDER / ABB/ SIEMENS / L&T / Legrand
17	PVC insulated XLPE aluminium/copper conductor armoured MV Cables up to 1100 V grade	POLYCAB/ FINOLEX / HAVELLS / KEI
18	LT Jointing Kit / Termination	Raychem/Safe Kit
19	Cable Glands Double Compression with earthing links	Baliga Lighting Ltd./ Sudhir/Comet
20	Bimettalic Cable Lug	Dowell's (Biller India Pvt. Ltd.)/Comet

21	PVC insulated copper conductor stranded flexible wires (FRLS / ZHFR)	Polycab/ Finolex/Anchor/RR CABLES/ KEI
22	Mettalic / GI Conduit (ISI approved)	BEC/GB/AKG
23	Accessories for Metallic /GI Conduit (ISI approved)	Sharma Sales Corporation/Prakash Engineering Works
24	PVC Conduit & Accessories (ISI approved)	BEC/Anchor/ Sudhakar/ Precesion
25	Switch & Socket	Schneider/ ABB/Anchor / L&T / Havells
26	Industrial Socket	
	a. Splash Proof	Schneider/ ABB/ Legrand / L&T / Havells
	b. Metal Clad	Schneider/ ABB/ Siemens / Legrand / L&T
27	Ceiling Fan	Crompton greaves/Anchor/Usha
28	Lighting Fixture LED (Not applicable for special interior lighting)	
	a. Fluorescent	Bajaj/Crompton/Philips
	b. Incandescent / Halogen / PL / Metal Halide)	Bajaj/Crompton/Philips
	c. External Lighting Fixture LED	Bajaj/Philips/Crompton
29	Electronic Ballast for Fluorescent (To be selected as per fixtures' manufacturer)	Philips/Panasonic/Wipro (Sigma)
30	Electronic Dimmer	Lutron/Polaron Controls (UK)
31	50 W Halogen Light Transformer (Encapsulated Transformer)	Philips/Reiz
32	Selector Switch/,Toggle switch	Salzer (Larsen & Toubro)/Kaycee
33	Shaver Socket	ABB/Anchor/Panasonic/Siemens
34	Timer	ABB/ L&T/ Legrand/Schneider Electric (Telemechanique)
35	Batteries Lead Acid	Exide/Standard
36	Sealed Maintenance Free Batteries (VRLA)	Shinkobe/Exide
37	Battery Charger	Volstat/Crompton Greaves
38	LT Servo Automatic Voltage Stabilizer	Recon/Automatic Electric
39	Cable Trays (Factory Fabricated) / Raceways	Profab Engineer/Patny/Classic/Rico Steel

40	Lighting Poles	Bajaj/Laasma
41	Fire Sealant & Fire Retardant Paint	Birla 3 M/HILTI
	External Electrification	
	LIST OF APPROVED MAKES OF MATERIALS	
Sl.No.	***Equipments***	***Makes***
1	11KV VCB Panels	Schneider/ Siemens/ ABB/ L&T
2	Transformer	Schneider/ Siemens/ ABB/ Volt amp
3	LT Panels Type Tested	Schneider/ Siemens/ ABB/ Legrand / L&T
4	ACB's / MCCBs	Schneider/ Siemens/ ABB/ Legrand
5	MCB /RCBO	Schneider/ Siemens/ ABB/ Legrand
6	Contactors & O/L Relay	Schneider/ Siemens/ ABB/ Legrand
7	Capacitor' banks	Schneider/ Siemens/ ABB/ Legrand
8	CTs & PTs	Kappa / Altran /NEWTEK ELECTRICALS
9	Control Switches/ Protective relays	L&T/ Kaycee / Salzer / Siemens
10	FRLS Wires	Finolex / Havells / POLYCAB/Anchor
11	Load Manager	Conzerv / NIPPEN/ Siemens/ L&T
12	Ammeter/ Voltmeter/ Other metering device	Conzerv / NIPPEN/ Siemens/ L&T
13	HT & LT cables	POLYCAB/ Universal / Havells / Finolex
14	H.T cable termination kits	Raychem/ Mseal
15	Luminaires	Bajaj/ Philips/ Crompton
16	Battery charger	HBL SABNIFE / Any ISI make
17	Batteries	Exide / HBL
18	Bus Duct	Siemens/ ABB/ Schneider/ Legrand/ L&T
19	DG Set	KIRLOSKAR/ CUMMINS/ Perkin
20	Street Light Poles	BAJAJ/ Laasma
21	Light fixtures & lamps	BAJAJ/ Crompton/ Philips/

22	11KV Load Break Switch	Megawin/ Schneider/ ABB / L&T