RENOVATION AND MODIFICATION OF SIM THEATRE & WITHERING THEATRE AT OLD OPD BLOCK, JIPMER, Puducherry

Volume- III

TECHNICAL SPECIFICATION

Tender No: HLL/IDD/CHN/19-20/029
Dated: 5th October 2019

HLL LIFECARE LIMITED
(A GOVT. OF INDIA ENTERPRISE)
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Technical specification:

Common Points:

Contractor should submit the shop drawing for all the works within 10 days of receipt of work order / LOA to Engineer – in - charge and should get prior approvals before executing any type of works along with coordination layout. The contractor should not deviate from the approved drawing at any point of time, in case of deviation while executing proper authorization should be obtained before proceeding further. Decision of HLL stands final.

The contractor should follow the following procedures:

1. MAR – Material Approval Request (Before procurement of any materials the contractor should submit MAR request along with necessary supporting documents to HLL Engineers and the makes should be as per list of approved makes specified in the tender document. Any materials procured without approval will be rejected at any point of time)

2. Sample Tag – After obtaining MAR, the contractor should submit sample tag along with samples (detailed specification can be submitted instead of samples for materials with high procurement values)

3. MIR – Material Inspection Request – After supplying of materials at site, the contractor should submit MIR request for verification of materials (the materials should be as per approved MAR and sample tag). Items deviating against authorized MIR will be rejected at any point of time.

4. IR – Inspection Request – The contractor should submit Inspection request on day to day basis for inspecting the works carried out.

5. Billing – Billing should be as based on the actuals executed at site and the contractor should submit the bills based on HLL billing format along with supporting documents (Dc copy, bill invoice, MAR, Sample tag, MIR, test reports, etc) for the items claimed in the respective bill. 3 sets of original bill and 2 sets of copy should be submitted.

6. All document formats pertaining to the work should be of HLL formats and the same can be issued on request.

7. 3rd party testes through NABL aggregated labs should be carried out for the necessary items executed at site by the contractor as per the direction of HLL without any additional costs. The Engineer -in-Charge shall have full power to get any material of work to be tested by an independent agency at contractor's expense in order to prove the soundness and adequacy.

8. 5 sets of following documents should be submitted during completion/ handing over of the project

1. As built drawings (Hard & Soft copy),
2. Inventory list,
3. Warranty certificates
4. Statutory approvals, if any
5. Manuals

9. Spares, keys or any other components related to the equipment/ materials installed should be handed over with a list along with separate tags.

10. Hindrance register should be maintained at site.

11. All the debris, remaining should be cleared from the same and disposed within

campus lead not more than 4 KM. And the completion certificate will be issued only after clearing the site and making it good.

12. Installation, Testing & Commissioning report for all the works should be provided as per HLL formats.

13. All equipments, tools for installation, testing & commissioning should be arranged by contractor without any additional costs.

Hot work permit:

Hot work permit must be obtained prior to the starting of work from concern department of JIPMER.

Supervision:

Contractor shall depute their team of engineer for the supervision of installation, testing, commissioning & handing over at site of work. List of Engineers along with their bio data should be submitted to project office before commencement of the works. And the team should maintain records of daily progress and report the same to HLL Engineers on regular basis. Prior permission for the works carried should be obtained from HLL. All the Engineers should be available at the site during execution of work until handing over without fail.

1. Civil Engineer-Degree holder – 1 no. with min 5 years' experience or Diploma Holders – 02 no's with min 8 years' experience.
2. Project Manager – Degree holder 1 no. with min 12 years' experience in same type of work.

Security & Storage:

The contractor is responsible for storage & security of all the materials, equipments, piping, wiring and all related accessories till the time of handing over to the customer.

Power & Water:

The contractor should make his own arrangement for electricity & water.

Working Hours & Damages of existing property:

As the work is being executed in running hospital building, at most care should be taken during execution of works. Damages caused to the existing property should be rectified at own risk and cost with war foot basis. Time Schedule for the works to be carried should be submitted prior to the work. The job specified and scheduled shall be completed and reported on daily basis, waste materials relating to the job should be cleared on daily basis.

Labour camp:

Labour camp will not allow inside the campus and the contractor should take sole responsibility for workers stay outside the campus. Workers should not use any type of alcohol/smoking related items inside the campus.

Co-ordination with Other Agencies

The contractor shall co-ordinate with all other agencies involved in the building work so that the building work is not hampered due to delay in his work.

Structural Alterations to Buildings

(i) No structural member in the building shall be damaged/altered, without prior approval from the competent authority through the Engineer-in-charge.

(ii) Structural provisions like openings, cutouts, if any, provided by the department for the work, shall be used. Where these require modifications, or where fresh provisions

are required to be made, such contingent works shall be carried out by the contractor at his cost.

(iii) All such openings in floors provided by the Department shall be closed by the contractor after installing the cables/ conduits/ rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-charge without any extra payment.

(iv) All chases required in connection with the electrical works shall be provided and filled by the contractor at his own cost to the original architectural finish of the buildings.

TECHNICAL SPECIFICATIONS AND CONDITIONS- CIVIL WORKS

1. BRICK WORK

a. Bricks used in the work shall be obtained from kilns to be got approved from the Engineer in charge and shall be best quality well burnt ground moulded bricks as available in the vicinity. They shall have a compressive strength of not less than 75 Kgs/sq.cm and an absorption percentage of not more than 15 (Fifteen) % of its dry weight when immersed in water for 24 hours. In all other respects they shall conform to the provision in Latest CPWD Specifications for works.

b. Both the face of wall of thickness more than 23cm shall be kept in the proper plane. Walls of half brick thickness or less shall be measured separately and paid in sqm.

c. Bricks wall beyond half brick thickness shall be measured in multiple of half brick (i.e. more than 115mm or equivalent) which shall be deemed to be inclusive of mortar joints. In all other respects they shall conform to the provision in relevant specifications of the work.

d. For mortar, use of PP Cement shall be preferred.

2. CEMENT PLASTER: -

The use of PP Cement shall be preferred.

3. WOOD WORK:

a. Timber required for manufacture of chowkhats and shutters for doors, windows, ventilators, partitions etc shall be Forest Stewardship council (FSC) certified wood and it shall be seasoned and preservative treated.

b. The moisture contents of the wood used in the work shall not be more than that stipulated in the relevant clause of Latest CPWD Specifications for works. The rate quoted for various items shall be inclusive of kiln seasoning and preservative treatment of wood. In all other respects the wood used in the work shall conform to the provision in latest CPWD specification for works.

c. The sample of species to be used shall be deposited by the contractor with the Engineer-in – charge before commencement of the work. The contractor shall produce cash voucher and certificate from standard kiln seasoning plant operator about the timber section to be used on the work having been kiln seasoned by them failing which it would not be so accepted as kiln seasoned.

d. Glass :-

i. Transparent sheet glass (Float glass) conforming to IS 1761 – 1970 shall be used.

ii. Minimum thickness shall be governed as under, unless otherwise specified in the item.

AREA of Glazing	Max. Unsupported length	Thickness
For glazing area up to 0.5 sqm	120 cm	4 mm
For glazing area more than0.5 sqm	120 cm	5.5 mm

iii. Glazing for toilet and in fixed ventilators shall be of frosted type.

e. Shutters:-

i. Factory made shutters, as specified shall be obtained from factories to be approved by the Engineer – in - charge and shall conform to IS 2202 (Part –I) 1977. The contractor shall inform well in advance to the Engineer – in – charge the name address of the factory from where the contractor intends to get the shutters manufactured.

ii. The contractor will place order for manufacture of shutters only after written approval of Engineer – in – charge in this regard is obtained. The contractor is bound to abide by the decision of the Engineer – in-charge. In case the factory already proposed by the contractor is not found competent to manufacture quality shutters, the Engineer – in – charge will recommend the name of another factory from the approved list.

iii. The contractor will also arrange stage wise inspection of the shutters at factory with the Engineer in charge or his subordinate authorized representatives. Contractor will have no claim, if the shutters brought at site are rejected by the Engineer in charge in part or in full lot due to bad workmanship / quality or damages caused during their shifting from factory to site. Such shutters will not be measured and paid and the contractor shall remove the same from the site of work within 7 days after the written instruction in this regards are issued by the Engineer in charge or his authorized representatives.

4. STEEL GRILL WORK:

a. All steel grills shall be according to the detailed drawings and obtained from approved suppliers. These shall conform to Latest CPWD Specifications for works.

b. In case of grills an approved quality priming coat of zinc chromate shall be applied over and above a shop coat of primer. Nothing extra shall be payable for providing shop coat primer, but the zinc chromate primer, if additionally required, will be paid for separately.

5. ALUMINIUM WORKS

A. The scope of the work is the fabrication, supply and erection at site of all types of Aluminium glazed doors, windows and ventilators in accordance with the drawings and specifications.

B. The supply and erection will include all parts such as but not restricted to frames, tracks, guides, mullions, styles, rails, couplers, transoms, rails, plates glazing bars, glass, hinges, arrangement, spring catches, cord and pulley arrangements, spring catches, cord and pulley arrangements door closers floor springs etc., required for the whole work whether the parts/ items are individually and specifically referred to in the schedules/ specifications/drawings or not provided that the supply and installation of such parts can be inferred there from and are necessary to make the work complete, unless separate provision is made in the bills of quantities for supply to such parts/items.

C. The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.

D. Materials:-

i. The members will be made out of aluminum alloy corresponding to IS:733 and will consist of extruded sections and of other shapes, and to sized gauges as shown in the drawings/ described in accordance with the relevant IS codes. The members shall be chosen to provide strength/ stability and maximum resistance to wear and tear.

ii. The Sections will be as per approved makes, extruded sections. As indicated in the drawings the tenderer should specifically mention which sections he is using. The weight of sections and the corresponding catalogue numbers are mentioned. The IS specifications are to be strictly adhered.

iii. The extruder using recycled materials may be preferred.

iv. The alloy of extruded aluminum should be BS or IS old HE9, Alcon 50 SWP. to this effect test certificate has to be provided for the extruder.

E. Finishing:

i. The extruded aluminum section has to be mechanically finished to remove all scratches; extrusion marks etc and subsequently thoroughly cleared in all alkali baths prior to anodizing.

ii. The polyester powder coating, as required, as per item of work, shall be of desired shade with minimum average thickness to 50 microns or other shades as required and to this effect the tenderer must have to produce test certificate from authorized institutions Bureau of Indian Standard.

iii. The polyester powder coated material should be properly wrapped in gummed tape before fabrication to avoid scratches during fabricated and erection shall be kept protected till handing over.

F. Fabrication:

i. Before commencing the fabrication the contractor shall submit to the Engineer – in - charge for their approval detailed shop drawings, based on the Architectural drawings and corresponding specification showing junctions, fittings, accessories such as hinges flush bolts, locks, latches, latching arrangements, peg stays, rotor arms, anodize pivots gaskets rubber packing door felts, mastic, sealant etc., including fixing and sealing arrangements . Type and method of scaffolding he intends to use, Fabrication is to be taken up only after approval by the Engineer – in - charge and in accordance with the approved drawings. Sections for fabrication of door/ window/ventilators etc shall be as per architectural drawings or as approved by the Engineer – in - charge.

ii. A sample of finished door / windows/ ventilator railing etc.shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication,

iii. The doors, window, ventilators and partitions shall be as per thickness given in the approved shop drawings, Polyester Powder coating shall be as specified in the item specifications.

iv. All materials shall conform to relevant IS. Codes and in the absence of IS code, they should correspond to the best engineering practice; decision of the the Engineer – in - charge shall be final and binding on the contractor.

v. Fabrication shall be done true to the drawing/ sample approved and in correspondence to the finished openings at the site. All joints shall be mitered at the corners, true right angles, and joints to be finished neatly to hairlines, with concealed fasteners, wherever possible joints shall be made in concealed locations.

vi. All fabricated/finished items shall be packed and carted properly to site to prevent any damage in transit. On receipt at site they shall be carefully stacked in protected storage to avoid distortion/damage.

vii. Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/ discoloration /damage to the finished items.

G. Glazing: Glazing shall be done with flawless sheet glass of best approved quality without waviness, distortion, coloration / discoloration, of specified thickness in sizes as shown in the drawings, fixed as required with special glazing clips, putty, neoprene/PVC gaskets. All glass

shall be cleaned thoroughly before they are fixed in position. Unless otherwise specified the minimum thickness shall be 5 mm thick.

6. FLOORING:

a. The flooring in the building shall be as per the approved floor finish drawings and laid in such a way that limits in floor levels would not exceed the limits provided in the latest CPWD specifications or manufactures specifications.

b. Wherever Vitrified Tile flooring is done, it shall be with multi grade/range 1st Quality tiles.

c. Slope in floors shall be provided as per architectural drawings, else the levels at any place when checked over a distance of one meters in any direction should not show variation in floor level more than 3 mm.

d. Rate for the items of flooring is inclusive of provision of sunken flooring and finishing edges of the same in bath kitchen, toilets, cutting holes for traps/ pipes etc., and nothing extra shall be paid on this account unless otherwise specified.

e. Protective layer to be provided of any type of flooring and nothing extra shall be paid on this account.

7. FALSE CEILING: -

a. False ceiling items in general are carried out as per the description of the item in the Bill of quantities and also as per the manufacturer's specifications / as directed by the Engineer – in – Charge.

b. Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of the Engineer – in - charge shall be obtained.

8. MINERAL FIBRE CEILING TILE

a. 16 mm Mineral Fibre ceiling Tile

i. Material

Ceiling tiles shall be of made of mineral fibre of dimension 595x595mm with 16 mm thickness humidity resistance 99% Thermal conductivity K = 0.052-0.057 w/mK colour white, fire performance UK Class 0/Class 1 (BS 476 pt -6&7) suitable for green building application (GRIHA Criteria 17 & 29 SWAGRIHA 12) with recycled content not less than 30 % and light reflectance not less than 85%. NRC of 0.55 to 0.6. The tile and grid should carry a limited warranty of one year against sag.

ii. Frame

The frame work shall consist of G.I. ' T ' Sections for Main runners 15x38x3000mm length, Cross runners of 15x32x1200mm & 15x32x600mm size, 0.33 mm thickness as specified in the item with galvanization of 120 gsm (minimum) and perimeter wall angle of 0.40mm (minimum) thick gauge having equal flanges of size 24x24mm made from precoated G.I. Coil length of 3.0m fixed to the wall with the help of plastic rawl plugs at 450mm centre to centre with 50mm long dry wall SS screws. The frame work shall be executed in a manner so as to form a grid of 600x600mm as specified in the item.

iii. Fixing of Ceiling Tiles

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also

having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 15x32mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200 mm & 600 mm cross Tees with a web height of 32 mm and load carrying capacity of 7.57Kgs/m2.

iv. Measurements

Length and breadth of superficial area of the finished work shall be measured correct to a centimetre. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made to openings of areas upto 40 square decimeter nor shall extra payment be made either for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction in measurements shall be made but extra payment will be made for any extra material or labour involved in making such openings.

v. Rate

The rate shall include the cost of all the materials and labor involved in all the operation described above including scaffolding etc, if any required.

9. LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING TILES

a. 15mm Tegular edged light weight calcium silicate false ceiling tiles

i. Material

Providing and Fixing 15 mm thick densified tegular edged eco friendly light weight calcium silicate false ceiling tiles of approved texture of size 595 x 595 mm in true horizontal level, suspended on inter locking metal grid of hot dipped galvanised steel sections (galvanising @ 120 grams per sqm including both side) consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38 mm made from 0.33 mm thick (minimum) sheet, spaced 1200 mm centre to centre, and cross "T" of size 24x28 mm made out of 0.33 mm (Minimum) sheet, 1200 mm long spaced between main'T' at 600 mm centre to centre to form a grid of 1200x600 mm and secondary cross 'T' of length 600 mm and size 24 x28 mm made of 0.33 mm thick (Minimum) sheet to be inter locked at middle of the 1200x 600 mm panel to from grid of size 600x600 mm, resting on periphery walls /partitions on a Perimeter wall angle pre-coated steel of size(24x24X3000 mm made of 0.40 mm thick (minimum) sheet with the help of rawl plugs at 450 mm centre to centre with 25 mm long dry wall screws @ 230 mm interval and laying 15 mm thick densified edges calicum silicate ceiling tiles of approved texture in the grid, including, cutting/ making opening"for services like diffusers, grills, light fittings, fixtures, smoke detectors etc.,herever required. Main 'T' runners to be suspended from ceiling using G.I. slotted cleats of size 25x35x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm G.I adjustable rods with galvanised steel level clips of size 85 x 30 x 0.8 mm, spaced at 1200 mm centre to centre along main 'T',bottom exposed with 24mm of all Tsections shall be pre-painted with polyster baked paint, for all heights, as per specifications, drawings and as directed by Engineer – in – charge.

Note :- Only calcium silicate false ceiling area will be measured from wall to wall. No deduction shall be made for exposed frames/opening (cut outs) having area less than 0.30 sqm.The calcium silicate ceiling tile shall have NRC value of 0.50(Minimum), light reflection > 85%, non- combustible as per B.S. 476 part IV, 100% humidity resistance and also having thermal conductivity <0.043 w/mK.

ii. Material

15mm thick integral densified micro edged light weight calcium silicate false ceiling tiles with integral densified calcium silicate reinforced with fibre and natural filler false ceiling

tiles of Size 595x595 mm of approved texture, design and patterns having NRC (Noise Reduction coefficient) of 0.50 (minimum) as per IS 8225:1987, Light reflectance of 85% (minimum). Non combustible as per BS: 476 (part-4), fire performance as per BS:476 (part 6 &7), humidity resistance of 100%, thermal conductivity <0.043 W/mK as per ASTM 518:1991.The tests shall have average density of 370 kg/m^3 (minimum) as per ECBC code 2007. The tile shall be primer coated on both sides and the fair surface shall be having a factory finish in two coats of white dispersion type solvent free paint.

iii. Frame

The frame work shall consist of G.I. ' T ' Sections of 25 micron hot dipped galvanised iron section of 0.40mm thick on Silhouette profile, rotary stitched double webbed white with 6mm reveal profile (white/black) compromising of Main runners 15x42x3000mm length, Cross runners of 15x42x1200mm & 15x42x600mm size to form grid module of size 600x600mm. Galvanised iron perimeter wall angle of size 22x19x0.4mm of length 3000mm to be fixed on periphery wall/partition with the help of plastic rawl plugs at 450mm C/C and 40mm long dry wall SS screws. The work shall be carried out as per specifications, drawing and as per direction of Engineer-in-Charge.

iv. Fixing of Ceiling Tiles

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 15x42mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200mm & 600mm cross Tees with a web height of 42 mm and load carrying capacity of 7.57Kgs/m^2.

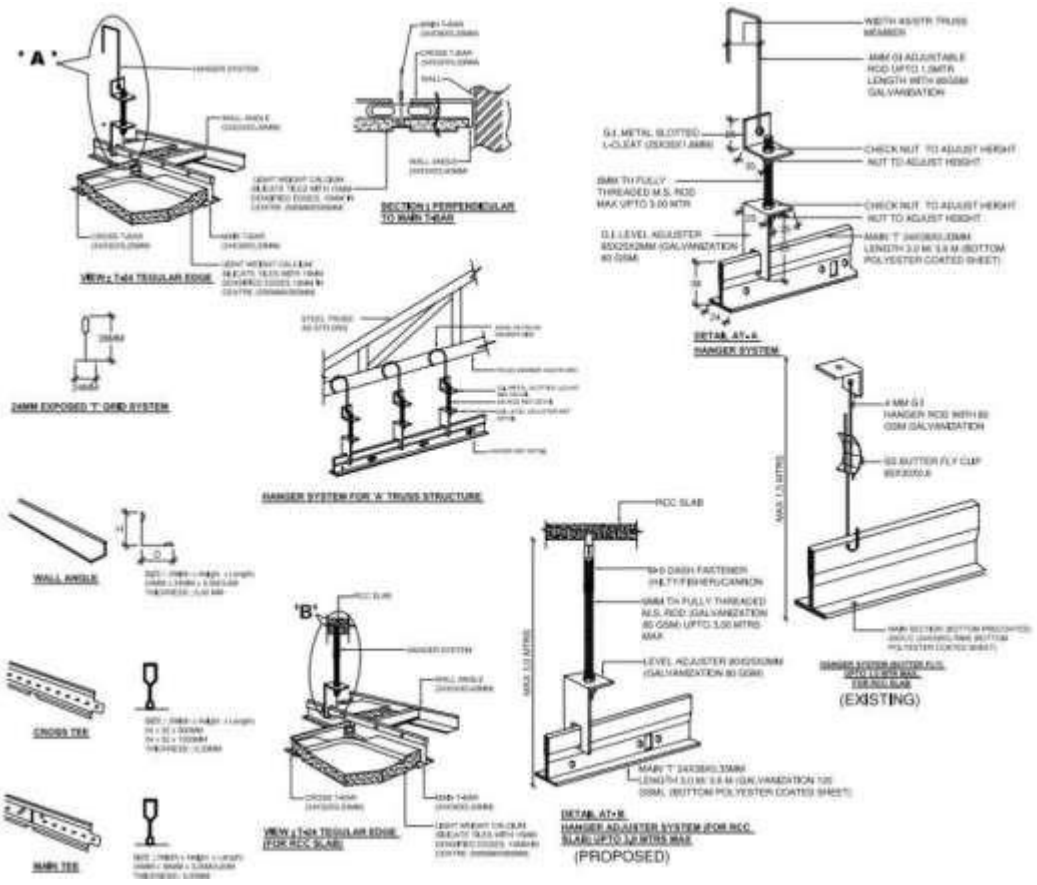
v. Measurements

Length and breadth of superficial area of the finished work shall be measured correct to a centimetre. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made to openings of areas upto 40 square decimeter nor shall extra payment be made either for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction in measurements shall be made but extra payment will be made for any extra material or labour involved in making such openings.

vi. Rates

The rate shall include the cost of all the materials and labor involved in all the operation described above including scaffolding etc, if any required.

15mm Tegular/integral densified micro edged Light weight calcium silicate false ceiling tiles


'A'
VIEW x T-24 TEGULAR EDGE
SECTION I PERPENDICULAR TO MAIN T-BAR
24MM EXPOSED 'T' GRID SYSTEM
HANGER SYSTEM FOR 'A' TRUSS STRUCTURE
WIDTH ASSTR TRUSS MEMBER
MM GI ADJUSTABLE ROD UPTO 1.0MTR LENGTH WITH 60GSM GALVANIZATION
G.I. METAL SLOTTED L-CLEAT (50X50X1.6MM)
CHECK NUT TO ADJUST HEIGHT
NUT TO ADJUST HEIGHT
8MM TH FULLY THREADED M.S. ROD MAX UPTO 3.00 MTR
CHECK NUT TO ADJUST HEIGHT
NUT TO ADJUST HEIGHT
G.I. LEVEL ADJUSTER 65X20X2MM (GALVANIZATION 80 GSM)
MAIN 'T' 24X38X0.33MM LENGTH 3.0 M/ 3.6 M (BOTTOM POLYESTER COATED SHEET)
DETAIL AT-A HANGER SYSTEM
4 MM G.I HANGER ROD WITH 60 GSM GALVANIZATION
GS BUTTER FLY CUP 65X30X0.6
MAIN SECTION (BOTTOM PRECOATED 24X38 (0.33MM) THK BOTTOM POLYESTER COATED SHEET)
HANGER SYSTEM (BUTTER FLY CUP) WITH MAIN T FOR RCC SLAB
(EXISTING)
WALL ANGLE
CROSS TEE
MAIN TEE
'B'
VIEW x T-24 TEGULAR EDGE (FOR RCC SLAB)
RCC SLAB
9×9 DASH FASTENER (NUT/ FISHER/CANNON
4MM TH FULLY THREADED M.S. ROD (GALVANIZATION 60 GSM) UPTO 3.00 MTRS MAX
LEVEL ADJUSTER 65X20X2MM (GALVANIZATION 80 GSM)
MAIN 'T' 24X38X0.33MM LENGTH 3.0 M/ 3.6 M (GALVANIZATION 120 GSM) (BOTTOM POLYESTER COATED SHEET)
DETAIL AT-B HANGER ADJUSTER SYSTEM (FOR RCC SLAB) UPTO 12 MTRS MAX
(PROPOSED)

10. SAMPLES OF MATERIALS:

a. Sample of all materials/ fittings and fixture to be used in the work such as doors, windows, tiles, sanitary, water supply, drainage fittings and fixtures shall be submitted well in advance by the contractor for approval from the Engineer-in charge of work in writing before placing orders for the entire quantity required for completion of work. Samples approved by the EIC shall be kept in Sample Room under the charge of Engineer-in-Charge and shall retain till completion of work.

b. Finished items in respect of typical portion of works of repetitive nature such as typical room, toilet, railing, door, window or any other work desired by the engineer-in- charge shall be prepared by the contractor to the satisfaction of Engineer-in – charge and got approved from him in writing before the commencement of these items for the entire work.

c. The requirements for preparation of samples shall be observed and fulfilled by the contractor well in advance to avoid any detriment to the general progress of work. In other words, this will not be allowed to have any effects on the general progress of work or on any of the terms and conditions of the contract. No claims of any kind whatsoever including the claims of extension of time will be entertained due to the incorporation of this requirement.

11. VARIATION IN CONSUMPTION OF MATERIALS:

The variation in consumption of material shall be governed as per CPWD specification and clauses of the contract to the extent applicable.

12. MISCELLANCEOUS:

Materials manufacture by reputed firms and approved by Engineer – in charge shall only be used. Only articles classified as “First Quality” by the manufactures shall be used unless otherwise specified. Preference shall be given to those articles which bear ISI certification marks. In case articles bearing ISI certification marks are not available the quality of sample brought by the contractor shall be judged by the standards laid down in the latest CPWD specifications. For items not covered by the latest CPWD specification, relevant ISI standards shall apply.

13. TESTS:

a. Materials brought at site of work shall not be used in the work before getting satisfactory test results for Mandatory tests as per relevant provisions in Latest CPWD Specifications for works. Normally, part rate payment shall be allowed in the running account bills only if the materials are tested and test results are found to be satisfactory to by the Engineer-in-charge. These tests shall be got done from laboratories approved by Engineer-in - charge or the laboratory set up by the contractor at site as per directions of Engineer-in - charge.

b. The Engineer-in - charge of work shall check the test results and satisfy himself before allowing any payment in the running /final bill.

HVAC system:

Drawing / design approval:

The contractor shall prepare and furnish all relevant shop drawings along with the sections after inspection at the site for approval to the Engineer-in-charge. The execution work shall commence only after the shop drawings/design are approved by the Engineer-in-charge and also responsible for the fitment of equipment and accessories. The contractor will submit shop drawing/ design to the project office, within 10 Days after getting LOA for approval. The list of shop drawings shall be as follows:

a. Detail plans for each area.
b. Refrigerant piping routes with sections.
c. Condenser / Evaporative unit location along with the location of MCB.
d. Electrical panel and control scheme.
e. Mounting stand & foundation details. (to be designed by structural engineer employed by the contractor and approved by HLL).
f. Any other detailed drawing required for the system.
g. Drain piping layout with section.
h. Control cabling detail along with sizes.
i. Power cable sizes and earthing wire sizes along with cable tray details.
j. Cu pipe support details.
k. Drain line clamp details.

Defect Liability Period (DLP):

The contractor shall guarantee the equipment against all defects of materials and workmanship for the period of twelve months from the date of commissioning & handing-over of the equipment to JIPMER as certified by the Engineer-in-charge. However, compressor will have the manufacturer warranty of five years. Any defects arising during the guarantee period shall be rectified and made good by the vendor at his own risk & cost to the satisfaction of HLL/JIPMER.

Inspection:

Routine performance testing of equipment shall be carried out at works in the presence of the HITES Engineers/ representatives.

Test:

The contractor will perform summer or monsoon and winter test and confirm the performance of units as specified in the design data. Along with this the contractor should perform 12 hours continuous test for the entire system in full load condition until the satisfaction of the HITES engineers and should submit a detailed test report of the same in HLL format.

Civil work:

Chasing, cutting and finishing of the brick work or floor for laying the drain pipe and copper pipe to be in contractor scope. Chasing, cutting will be carried out only by chase cutting machine. Chisel and hammer shall not be allowed. All the damages made during the work should be made good/ rectified at own risk and cost.

Technical specification:

Basis of design as specified by HITES Engineers

VRV / VRF system:

LIST OF BUREAU OF INDIAN STANDARDS CODES

IS : 554 – 1985 (Reaffirmed 1996)	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS: 659-1964 (Reaffirmed 1991)	Air Conditioning (Safety Code)
IS:660-1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS : 732-1989	Code of practice for electrical wiring
IS : 822-1970 (Reaffirmed 1991)	Code of procedure for inspection of welds.
IS : 1255-1983	Code of Practice for installation and maintenance of Power Cables up to and including 33KV rating (Second Revision)
IS : 1554 – 1988 (Part – I)	PVC insulated (Heavy Duty) electric cables for working voltages up to and including 1100 volts
IS : 2379 – 1990	Colour code for the identification of pipelines.
IS : 2551 – 1982	Danger notice plate
IS : 3043 – 1987	Code of practice for earthing
IS : 3103 – 1975 (Reaffirmed 1999)	Code of practice for Industrial Ventilation
IS : 3837 – 1976 (Reaffirmed 1990)	Accessories for rigid steel conduit for electrical wiring
IS : 4736-1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes
IS : 5133-1969 (Part-I) (Reaffirmed 1990)	Boxes for the enclosure of electrical accessories.
IS : 5424-1989 (Reaffirmed 1994)	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and identification of conductors
IS : 6392-1971 (Reaffirmed 1988)	Steel pipe flanges.
IS : 13947-1993 (Part – V)	Control Circuit Devices
BS : EN:779-1993	Filters

ASHRAE (American Society of Heating Refrigeration & Air-conditioning Engineers) Hand Books

Application 1999 Fundamentals 1997
Systems & Equipment 1996
ASHRAE Indoor air quality Standard 62-1982
IEC Relevant Sections

Equipment Selection Criteria:

(a). As per design conditions the apparatus dew point should be 51°F.
(b). The quantity of indoor units and outdoor units is fixed as provided space at site. The vendor has to check heat loads and accordingly select Indoor & Out door equipment after obtaining clearance from HITES Engineers. The vendor should be fully responsible to achieve the inside conditions as per design data.

INDOOR UNIT

General

The selection deals with supply installation testing commissioning of various types of indoor units confirming to general specifications. Each indoor unit has Electronic Expansion Valve which senses the temperature based on variation of the load and conveys the same for the outdoor modules to respond accordingly. The indoor unit shall be selected as per the dehumidified CFM.

1- Indoor units shall be either ceiling mounted cassette type or wall mounted type or other as specified in BOQ.
Each unit shall have electronic control valve to control the refrigerant flow rate respond to load variations in the rooms.

1.1 The address of the indoor unit shall be set automatically in case of individual and group control

1.2 In case of centralized control, it shall be set by liquid crystals remote Controller.

2- The fan shall be dual suction, aerodynamically designed turbo, multi-blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support from housing.

3- The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21 kg/sqm air pressure under water.

4- Unit shall have cleanable type filter fixed to an integrally molded plastic frame. The filter shall be slide away type and neatly inserted.

5- Each unit shall be provided with Electronic Expansion Valve for cooling and heating.

6- Each unit shall be with wireless LCD type remote controller. The controller shall be able to change the fan speed and angle of swing flap individually and changes in set temperature as per requirement.

Refrigerant piping

1- All refrigerant piping for the air-conditioning system shall be constructed from soft seamless upto 19.1mm and hard drawn copper refrigerant pipes for above 19.1mm with copper fittings and silver soldered joints. The refrigerant piping arrangements shall be in accordance with good practices within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

2- All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before jointing any copper pipe or fitting, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

3- After the refrigerant piping installation has been completed, the refrigerant piping shall be pressure tested using nitrogen as per HLL requirement. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700 mm Hg and held for 24 hours. The air-conditioning supplier shall be design sizes and erect proper interconnections of the complete refrigerant circuit.

4- The thickness of copper piping shall not be less than mentioned below:

Pipe Size in mm (OD)	Wall Thickness in mm
54.1	1.5
41.3	1.3
34.9	1.3
28.6	1.2
25.4	1.2
22.2	1.0
19.1	1.0
15.9	1.0
12.7	0.8

9.5	0.8
6.4	0.8

5- The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturers specified outside diameter. All refrigerant pipe shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets, and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

Drain piping

1- Shall be as per BOQ.
2- The IDU shall be connected to the drain pipe made of rigid heavy duty PVC min 20 MM dia meter. The pipe under floor should be 20 Kg/sq cm
3- The pipe shall be laid in proper slope for efficient draining of the condensate water.

Pipe insulation

1- Refrigerant Pipe Insulation:

(a). The whole of the suction and liquid line including all fitting , valves and strainers bodies etc. shall be insulated with 19 MM/13 MM respectively thick class Nitrile Rubber sleeve as per BOQ.
(b). The joint shall be properly sealed with R242 adhesive of polychloroprene to ensure proper bonding at the ends.
(c). Insulation of cold lines shall be carried out as per list of approved makes insulation sheets and tubes of appropriate thickness so that condensation does not occur.

2- Drain Pipe Insulation

(a). Drain pipe carrying condensate water shall be insulated with 12 MM thick class Nitrile Rubber.
(b). The joint shall be properly sealed with R242 adhesive of polychloroprene to ensure proper bonding at the ends.
(c). For proper drainage of condensate U-trap shall be provided in the drain piping (wherever required).
(d.) All pipe supports shall be of pre-fabricated and pre-painted slotted angle supports properly installed with clamps.

4 way cassette unit:

1- The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-Coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be aerodynamically designed diffuser turbo fan type.
2- Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grilles at center.
3- Each unit shall have high lift drain pump, fresh air intake provision (if specified) Low gas detection system and very low operating sound.
4- All the indoor units regardless of their differences in capacity should have same decorative panel size for harmonious aesthetic point of view. It should have provision of connecting branch ducts. Any fresh air requirement for the unit can be done as per site condition.

1. Cooling Capacity - 2 TR
2. Star rating – Min 3 star.
3. Electrical input 230V/50Hz/Single Phase
4. Noise level Indoor unit: ≤ 40 dB
5. Compressor type - Rotary type
6. Air flow rate as per design
7. Fan speed 3 Steps
8. Function modes Auto/Cool/Fan/Dry – shall have power saving mode, temperature setting option should be available
9. Body surface finish Powder coated/high quality paint finish

10. Air filtering unit - Dust proof and shall contain anti-bacteria filter
11. Length of tubing - 5 m or as per the installation requirement
12. Remote control - Wireless with LCD display & stand
13. Refrigerant type R-22 or R-410A or any other refrigerant as per current industry standard
14. Warranty 1 year warranty for the whole AC unit and five years for compressor unit (if any) from the date of Handing over.
15. Acceptance Criteria
    a. Split AC should conform to IS 1391(part 2)-1992, room AC specification or as per current IS standards.
    b. Contractor shall arrange for split AC installation on walls and operation at full capacity
    c. Operating and maintenance manual for Split AC unit should be provided.
16. Refrigerant
    1- Refrigerant should be only R-22 or R410A or any other refrigerant as per current industry standard.
    2- The entire condensing unit & evaporative unit should be factory assembled and tested. The units should come with an initial charge of referred R-22 or R410A or any other refrigerant as per current industry standard from the factory. Any additional required refrigerant shall be added at site free of cost & loss of refrigeration due to deflect in equipment or workmanship or workmanship shall also be filled up free of cost during execution and guarantee period.
17. Refrigerant piping - same as mentioned above
18. Drain Piping - same as mentioned above
19. Copper & Drain Pipe insulation - same as mentioned above.
20. Outdoor unit -
    • The outdoor shall be factory assembled weather proof casing constructed from heavy gauge MS panels and coated with baked enamel finish of color approved by architect. The unit should be completely factory wired tested with all necessary control.
    • The ODU shall be modular in design and should be allowed for side by side installation. The ODU unit should have anti-corrosive point free steel plate for easy mounting of the unit.
    • The ODU should be filled with low noise, aero-spiral design fan with grill for spiral discharge airflow to reduce pressure loss and should be fitted with DC Fan Motor to better efficiency. The unit should also be capable to deliver of adequate external static pressure.
    • Noise level shall not be more than 60 dB (A) at normal operation measured horizontally 1 M away and 1.5 M above ground.
    • Control Wiring from ODU to IDU shall be contractor's scope.
    • Necessary outdoor stand should be provided and should be fitted as per HITES Engineers direction.

ELECTRICAL & ELV Systems

1 **Drawing / design approval:**

The contractor shall prepare and furnish all relevant shop drawings along with the sections after inspection at the site for approval to the Engineer-in-charge. The execution work shall commence only after the shop drawings/design are approved by the Engineer-in-charge and also responsible for the fitment of equipment and accessories. The contractor will submit shop drawing/ design to the project office, within 10 Days after getting LOA for approval. The list of shop drawings shall be as follows:

a. Detail plans for each area.
b. Panel and control scheme.
c. Any other detailed drawing required for the system.
d. Power layout.
e. ELV Layout (including AV systems, PA systems, etc,.)
f. Lighting layout
g. Cable routing with cable tray.

2 **Defect Liability Period (DLP)**:

The contractor shall guarantee the items against all defects of materials and workmanship for the period of

twelve months from the date of commissioning & handing-over of the equipment to JIPMER as certified by the Engineer-in-charge. Any defects arising during the guarantee period shall be rectified and made good by the vendor at his own risk & cost to the satisfaction of HLL/JIPMER.

3 **Inspection:**

Routine performance testing of equipment shall be carried out at works in the presence of the HITES Engineers/ representatives.

4 **Testing & Commissioning:**

The contractor will perform all the tests & commissioning processes until the satisfaction of the HITES Engineers and should submit a detailed test report of the same in HLL format.

5 **Civil work:**

Chasing, cutting and finishing of the brick work or floor for laying the cables is in contractor scope. Chasing, cutting will be carried out only by chase cutting machine. Panel must concealed as per the direction of HLL. Chisel and hammer shall not be allowed. All the damages made during the work should be made good / rectified at own risk and cost to the satisfaction of the Engineer-in-charge..

6 **Technical specification:**

Basis of design as specified by HITES Engineers

7. Lighting Design

7.1 Interior Lighting

Proper lighting level is to be maintained. NBC 2005 specifies lux levels required for various applications. Lower lux level reduces efficiency of working.

Aged person requires higher lux level. For normal office working a middle-aged man requires 350 lux. A person of 55 to 60 years of age may require 500 lux. Proper designing is required for achieving satisfactory lux levels in conformity with NBC2005 (see Table 11).

7.1.1 Lighting Power Density

Lighting Power Density is the ratio of the total lighting load of a space to the total lit space area. The installed interior lighting power for a building shall not exceed the interior lighting power allowance determined in accordance with either Building Area Method or Space Function Method. The installed interior lighting power shall include all power used by the luminaires, including lamps and ballast.

Building Area Method

Determination of interior lighting power allowance (watts) by the building area method shall be in accordance with the following:

- Determine the allowed lighting power density from the table below for each building area type.
- Calculate the gross lighted floor area for each building area type.
- The interior lighting power allowance is the sum of the product of the gross lighted floor area of each building area times the allowed lighting power density for that building area types.

Interior Lighting Power Building Area Method

Building Area Type	*LPD (W/m²)*	*Building Area Type*	*LPD (W/m²)*
Automotive Facility	9.7	Multifamily Residential	7.5
Convention Centre	12.9	Museum	11.8
Dining : Bar Lounge/ Leisure	14.0	Office	10.8
Dining : Cafeteria/ Fast Food	15.1	Parking Garage	3.2
Dining : Family	17.2	Performing Arts Theatre	17.2
Dormitory/ Hostel	10.8	Police/ Fire Station	10.8
Gymnasium	11.8	Post Office/ Town Hall	11.8
Health care-Clinic	10.8	Religious Building	14.0
Hospital/ Health Care	12.9	Retail/ Mall	16.1
Hotel	10.8	School/ University	12.9
Library	14.0	Sports Arena	11.8
Manufacturing Facility	14.0	Transportation	10.8
Motel	10.8	Warehouse	8.6
Motion Picture Theatre	12.9	Workshop	15.1
In case where both a general building area type and a specific building area type are listed, the specific building area type shall apply.			

Source : Energy Conservation Building Code 2007, Table 7.1

Space Function Method

Determination of interior lighting power allowance (watts) by the space function method shall be in accordance with the following:

- Determine appropriate building type from table below and the allowed lighting power density.
- For each space enclosed by partitions 80% or greater than ceiling height, determine the gross interior floor area by measuring to the center of the partition wall. Include the floor area of balconies or other projections. Retail spaces do not have to comply with the 80% partition height requirements.

  The interior lighting power allowance is the sum of the lighting power allowances for all spaces. The lighting power allowance for a space is the product of the gross lighted floor area of the space times the allowed lighting power density for that space.

Interior Lighting Power Space Function Method			
Space Function	*LPD (W/m²)*	*Space Function*	*LPD (W/m²)*
Office-enclosed	11.8	Workshop	20.5
Office-open plan	11.8	Convention Centre - Exhibit Space	14.0
Conference/ Meeting/ Multipurpose	14.0	Library	
Classroom/Lecture/ Training	15.1	• For Card File & Cataloguing	11.8
Lobby	14.0	• For Stacks	18.3
• For Hotel	11.8	• For Reading Area	12.9
• For Performing Arts Theatre	35.5	Hospital	
• For Motion Picture Theatre	11.8	• For Emergency	29.1
Audience/ Seating Area	9.7	• For Recovery	8.6
• For Gymnasium	4.3	• For Nurse Station	10.8
• For Convention Centre	7.5	• For Exam Treatment	16.1
• For Religious Buildings	18.3	• For Pharmacy	12.9
• For Sports Arena	4.3	• For Patient Room	7.5
• For Performing Arts Theatre	28.0	• For Operating Room	23.7
• For Motion Picture Theatre	12.9	• For Nursery	6.5
• For Transportation	5.4	• For Medical Supply	15.1
Atrium-first three floors	6.5	• For Physical Therapy	9.7
Atrium-each additional floor	2.2	• For Radiology	4.3
Lounge/ Recreation	12.9	• For Laundry - Washing	6.5
• For Hospital	8.6	Automotive - Service Repair	7.5
Dining Area	9.7	Manufacturing Facility	
• For Hotel	14.0	• For Low Bay (<8m ceiling)	12.9
• For Motel	12.9	• For High Bay (>8m ceiling)	18.3
• For Bar Lounge/ Leisure Dining	15.1	• For Detailed Manufacturing	22.6
• For Family Dining	22.6	• For Equipment Room	12.9
• Food Preparation	12.9	• For Control Room	5.4
Laboratory	15.1	Hotel/ Motel Guest Rooms	11.8
Restrooms	9.7	Dormitory - Living Quarters	11.8
Dressing/ Lockers/ Fitting Room	6.5	Museum	
Corridor/ Transition	5.4	• For General Exhibition	10.8
• For Hospital	10.8	• For Restoration	18.3
• For Manufacturing facility	5.4	Bank Office - Banking Activity Area	16.1
Stairs-active	6.5	Retail	
Active Storage	8.6	• For Sales Area	18.3
• For Hospital	9.7	• For Mall Concourse	18.3
Inactive Storage	3.2	Sports Arena	
• For Museum	8.6	• For Rising Sports Area	29.1
Electrical/ Mechanical Facility	16.1	• For Court Sports Area	24.8

Space Function	*LPD (W/m²)*	*Space Function*	*LPD (W/m²)*
• For Indoor Field Area	15.1	Parking Garage - Garage Area	2.2
Warehouse		Transportation	
• For Fine Material Storage	15.1	• For Airport - Concourse	6.5
• For Medium/ Bulky Material		• For Air/ Train/ Bus-BaggageArea	10.8
Storage	9.7	• For Ticket Counter Terminal	16.1

Source : Energy Conservation Building Code 2007, Table 7.3.2

8. *False Ceiling Coordination*

False ceiling electrical layout will be coordinated with the Architect and the Civil Engineer so that reflected drawing provides for symmetrical and aesthetic layout of the following:

Fans

Light fittings A/C

Fire detectors

Sprinklers

Speakers etc.

9. *Functional Areas like Auditorium, Conference Hall, Computer Rooms, and Library*

Special attention to be paid for functional areas to meet the client's requirements, and functional requirements in coordination with the Architect and to provide for specialized services like Audio visual system, P.A. System, Sound reinforcement, Stage lighting, Conference system, Security needs, etc. It may be noted that provision of such services at a latter stage will not only mar the aesthetics of the building, also will compromise with efficiency of such services for want of proper space etc.

10. *Areas like Hospitals, Stadia*

Planning of such buildings require high degree of professionalism, for application of latest technology to provide efficient and effective installation.

11. *Outdoor Lighting, High Mast Lighting, Road Lighting, Security Lighting, Garden Lighting, Illuminated Fountains*

Present day modern buildings require highly aesthetic lighting making use of a variety of lighting design, themes and fixtures available. For proper aesthetic effect, high level of professional approach is needed based on computer aided design and calculations.

12. *Luminous Efficacy*

Luminous efficacy of the outdoor lighting assemblies used in the outdoor lighting system should be equal to or more than the luminous efficacy mentioned in the table below. The lighting assembly includes luminaire, lamp and ballast.

Luminous efficacy is defined as the ratio of lamp lumen output divided by the total input power which includes the lamp losses and power losses in ballast.

Luminous efficacy (lm/W) = {lamp lumen output (lm)}/{lamp wattage (W) + ballast power loss (W)}

Minimum luminous efficacy required to be maintained in lighting assemblies used in outdoor application	
Type of lamp lighting system	*Luminous efficacy (lm/W)*
CFL	65
T-5 Tubular fluorescent lamp	100
Metal halide lamp	75
High Pressure Sodium Vapour lamp	90
LED Warm Day Light	80
LED Cool Day Light	70

12.1. Lighting Power Density

The installed lighting power density for building exterior lighting applications mentioned in the table below shall not exceed the limits specified in the table below.

Exterior Lighting Applications	*Power Limits*
Building entrance (with canopy)	13 W/m^2 (1.3 W/ft^2) of canopied area
Building entrance (without canopy)	90 W/lin m (30 W/lin f) of door width
Building exit	60 W/lin m (20 W/lin f) of door width
Building facades	2 W/m^2 (0.2 W/ft^2) of vertical facade area

12.2 Night Sky Pollution & Light Tresspass

All exterior lighting should be designed to minimize night sky pollution. Only those areas shall be lighted that are required for safety and comfort. Installation of luminaires on site and building shall be such that no light tresspassing occurs on the neighbouring site and buildings.

For Interior Lighting

The angle of maximum candela from each interior luminaire as located in the building shall intersect opaque building interior surfaces and not exit out through windows.

For Exterior Lighting

All projects defined under the following zones shall follow the requirements for that specific zone as given below:

- *Dark (Park and Rural Settings)*

  Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.01 horizontal and vertical foot candles at the site boundary and beyond.

  Lighting Fixture: 0% of the total initial fixture lumens are emitted at an angle of 90 degree or higher from nadir.

- *Low (Residential Areas)*

  Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.10 horizontal and vertical foot candles at the site boundary and no greater than 0.01 horizontal foot candles 10 feet beyond the site boundary.

  Lighting Fixture: 2% of the total initial fixture lumens are emitted at an angle of 90 degree or higher from nadir.

- *Medium (Commercial/ Industrial, High Density Residential)*

  Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site boundary.

  Lighting Fixture: 5% of the total initial fixture lumens are emitted at an angle of 90 degree or higher from nadir.

- *High (Major City Centre, Entertainment Districts)*

  Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.60 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site boundary.

  Lighting Fixture: 10% of the total initial fixture lumens are emitted at an angle of 90 degree or higher from nadir.

12.3 LED Lighting

12.3.1 Features of LED Lighting:

(i) Energy saving

(ii) Long Life

(iii) Rugged and Durable

(iv) Smaller lighting Fixture

(v) Environment friendly – no mercury

(vi) Instant starting

(vii) Dimmable for automation

(viii) Available in different colours

12.3.2. Challenges of LED Lightings:

(i) LEDs are not manufactured in India.

(ii) Quality control.

(iii) Expensive.

(iv) Still in development stage. Efficiency of LED luminaries is continuously being upgraded.

(v) No. of electronic items in LED luminaries like driver, PCB, power supply etc. affect LED life.

(vi) Quality of phosphor coating on LED.

(vii) Diffuser used in LED luminaries, reduces its lumen output.

(viii) Heat Management.

(ix) Junction temperature v/s lumen output.

12.3.3. Design Parameter for selecting source of lighting while designing lighting of building/ campus :

Following important parameters be kept in view while deciding the suitable light source for indoor lighting:-

(i) CRI of the source.

(ii) Usable lumen per watt of fitting

(iii) Glaring index of fixture

(iv) Life of the lamp

12.3.4 The present practice in CPWD while designing indoor lighting is to use T5 lamp in rooms and CFL lamp in corridors and other common areas due to keeping good CRI and to maximize usable lumen per watt. HPSV lamp and Metal Halide lamp are being used for outdoor lighting.

12.3.5 Following technical parameters of LED,T5, CFL, HPSV and Metal halide lamp are brought out:-

	LED (Warm White)	*LED (Cool White)*	*T5 Lamp*	*CFL Lamp*	*HPSV Lamp*	*Metal Halide Lamp*
CRI	80-85	75	85	85	22	60-90
Efficacy in lm/w	80	132	90	70	95-110	65-70
Usable lm/w	55-65	>100	75-85	50-60	55-65	35-40
Life (Hrs.)	50k+	50k+	30k	8-10k	24k	10k-20k

12.3.6 LED lighting has become efficient (luminous efficacy) and with good CRI over HPSV lamp as well as metal halide lamp, hence it can be used for outdoor lighting applications which are being done by HPSV and Metal halide lamps.

12.3.7 In indoor applications for down lighters, task lighting etc. where CFL luminaires are being used, the luminous efficacy of the LED luminaires is comparable and due to higher life can be used for such applications.

12.3.8 Since light output and life of LED is dependent on the driver current and junction temperature, Indian standards for the LED are now available and luminaires efficacy and life cycle of T5 lamp selectively for indoor applications in business/ institutional building only with prior approval of Chief Engineer concerned as consideration of CRI in these areas is of prime importance. Chief Engineer may approve the type and make of LED fittings keeping in view of the specific applications and IS

CHAPTER 1

ELECTRIC POWER DISTRIBUTION AND WIRING

1.1 Introduction

The electric power will be received and distributed in a building, through following means:-

(i) Cabling and switchgear to receive power.

The building is divided into convenient number of parts, each part served by a rising main system to distribute power vertically/horizontally.

(ii) Power flows from rising main through tap-off box to floor main board to final DBs and then to wiring.

(iii) Dedicated circuit for different loads such as lighting, HVAC, power plug loads shall be provided, wherever possible.

(iv) Rising main, which takes care of general lighting and power outlet load of the building, should have independent cables for lighting as well as power, wherever possible. Other loads like lifts, water pump sets, other motor loads are fed by independent cables of suitable capacity fed from properly designed essential/ non- essential LT power panels with suitably designed switchgear having necessary control and safely features.

(v) Therefore the distribution/wiring system essentially consists of provision of cables, switchgear, rising main, bus-ducting, earthing, laying of pipes/ conduits etc. (in surface or recess) based on proper detailed designing to decide on various sizes/ capacities of these components and various controls and safeties involved, to provide an efficient, reliable, safe and adequate electrical distribution and wiring system.

(vi) A typical schematic diagram of power distribution of a building is enclosed. (See Fig. 3)

1.2 System of Distribution and Wiring

(vii) The wiring shall be done from a distribution system through main and/or branch distribution boards. The system design and location of boards will be properly worked out.

(viii) Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker/linked switch with fuse. Each outgoing circuit shall be controlled by a

circuit breaker/switch with fuse.

(ix) For non-residential and residential buildings as far as possible DBs shall be separate for light and power.

(x) Only MCCB/MCB/HRC fuse type DBs shall be used. Rewirable type fuses shall not be used.

(xi) Three phase DBs shall not be used for final circuit distribution as far as possible.

(xii) 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate.

(xiii) Essential/non-essential/UPS distribution each will have a completely independent and separate distribution system starting from the main, switchboard upto final wiring for each system. As for example, conduit carrying non-essential wiring shall not have essential or UPS wiring. Wiring for essential and UPS supply will have their own conduit system. No mixing of wiring is allowed.

(xiv) Generally, no switchboard will have more than one source of incoming supply. More than one incoming supply will be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.

(xv) Each MDB/DB/Switch Board will have reasonable spare outgoing ways for future expansion.

(xvi) Balancing of 3-phase circuit shall be done.

1.3 Wiring

1.3.1 Submain & Circuit Wiring

(a) Submain Wiring

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

(b) Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board to the 1st tapping point inside the switch box, from where point wiring starts.

1.3.2 Measurement of Submain and Circuit Wiring

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

(ii) The length of circuit wiring with two wires shall be measured from the distribution board to the nearest switch box from which the point wiring starts. Looping of switch boxes also will be counted towards circuit wiring, measured along the length of conduit/channel.

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

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

Note: Conduit carrying submain will not carry circuit/point wiring. Similarly conduit carrying circuit wiring will not carry submain/point wiring. Conduit carrying point wiring will not carry submain/circuit wiring.

1.3.3 Measurement of Other Wiring Work

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

1.4 Point Wiring

1.4.1 Definition

A point (other than socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB.

(c) Ceiling rose or connector (in the case of points for ceiling/exhaust fan points, prewired light fittings, and call bells).

(d) Ceiling rose (in case of pendants except stiff pendants).

(e) Back plate (in the case of stiff pendants).

(f) Lamp holder (in the case of goose neck type wall brackets, batten holders and fittings which are not prewired).

1.4.2 Scope

Following shall be deemed to be included in point wiring:

(g) Conduit/channel as the case may be, accessories for the same and wiring cables between the switch box and the point outlet, loop protective earthing of each fan/ light fixture.

(h) All fixing accessories such as clips, screws, Phil plug, rawl plug etc. as required.

(i) Metal or PVC switch boxes for control switches, regulators, sockets etc, recessed or surface type, and phenolic laminated sheet covers over the same.

(j) Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/conduit terminations.

(k) Control switch or MCB, as specified.

(l) 3 pin or 6 pin socket, ceiling rose or connector as required. (2 pin and 5 pin socket outlet shall not be permitted.)

(m) Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.

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

(**Note*:*** In areas where false ceiling are provided, termination of wires should be at the fittings. Flexible conduits from ceiling junction box to the fittings shall be provided duly coupled at both ends. This shall be included within the scope of point wiring.)

(o) Interconnecting wiring between switches within the switch box on the same circuit.

1.4.3 Measurement

(p) Point Wiring (other than socket outlet points)

(i) Unless and otherwise specified, there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on

unit basis by counting, and classified as laid down in 3.4.4.

1.4.4 Classification

Points measured under 3.4.3 on unit basis shall be classified as under according to the type of building:

(q) Residential Buildings

(i) Group 'A', for point wiring for type I, type II and type III residential quarters and hostels.

(ii) Group 'B', for point wiring for type IV and above type of residential quarters and barracks.

(r) Non-residential Buildings

Group 'C' for all types of non-residential buildings such as offices, hospitals, laboratories, educational institutions, libraries etc.

(s) For any Other Type of Building

The group under which the points are to be classified shall be decided by the concerned Chief Engineer (Elect.).

1.4.5 Point Wiring for Socket Outlet Points

(i) The light plug (6 A) point and power (16 A) point wiring shall be measured on linear basis, from the respective tapping point of live cable, namely, switch box, another socket outlet point, or the sub-distribution board as the case may be, up to the socket outlet.

(ii) The metal/PVC box with cover, switch/MCB, socket outlet and other accessories shall be measured and paid as a separate item.

Note: There shall normally be no "on the board" light plug point.

(iii) The power point outlet may be 16 A/6 A six pin socket outlet, where so specified in the tender documents.

1.4.6 Group Control Point Wiring

(i) In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e. (a) from the switch to the first point outlet as one point and classified according to 3.4.4, and (b) for the subsequent points, the distance from that outlet to the next one and so on, shall be treated as separate point(s) and classified according to 3.4.4.

(ii) No recovery shall be made for non-provision of more than one switch in such cases.

1.4.7 Twin Control Light Point Wiring

(i) A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side and classified according to 3.4.4.

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

1.4.8 Multiple Controlled Call Bell Point Wiring

(i) In the case of call bell points with a single call bell outlet, controlled from more than one place, the points shall be measured in parts i.e.

(a) from the call bell outlet to one of the nearest ceiling roses meant for connection to bell push, treated as one point and classified according to 3.4.4, and

(b) from that ceiling rose to the next one and so on, shall be treated as separate point(s) and classified according to 3.4.4.

(ii) No recovery shall be made for non-provision of more than one ceiling rose or connector for connection to call bell in such cases.

1.5 Wiring System

(i) Wiring shall be done only by the looping system. Phase/live conductors shall be looped at the switch box. For point wiring, neutral wire/earth wire looping for the 1st point shall be done in the switch box; and neutral/earth looping of subsequent points will be made from point outlets.

(ii) In wiring, no joints in wiring will be permitted any where, except in switch box or point outlets, where jointing of wires will be allowed with use of suitable connector.

(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) Light, fans and call bells shall be wired in the 'lighting' circuits. 15A/16A socket outlets and other power outlets shall be wired in the 'power' circuits. 5A/6A socket outlets shall also be wired in the 'power' circuit both in residential as well as non- residential buildings.

(v) Colour Coding

Following colour coding shall be followed in wiring:

Phase	:	Red/Yellow/Blue.(Three phase wiring) Live
	:	Red (Single phase wiring)
Neutral	:	Black
Earth	:	Yellow/Green.

(vi) Termination of Circuit into Switchboard

Circuit will consist of phase/neutral/earth wire. Circuit will terminate in a switch board (first tapping point, where from point wiring starts) in following manner:

Phase wire terminated in phase connector. Neutral wire terminated in neutral connector. Earth wire terminated in earth connector.

The switchboard will have phase, neutral and earth terminal connector blocks to receive phase/ neutral/ earth wire.

See Fig 4.

1.6 Run of Wiring

(i) The type of wiring shall be as specified in the tender documents namely, surface conduit/recessed conduit, steel/PVC, channel.

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

(iii) Above false ceiling, in no case, open wiring shall be allowed. Wiring will be done in recessed conduit or surface steel conduit.

(iv) In recessed conduit system, routes of conduit will be planned, so that various inspection boxes provided don't present a shabby look. Such boxes can be provided 5 mm above plaster level, and they can be covered with plaster of paris with marking of junction boxes.

(v) Where number of electrical services like electrical wiring, telephone wiring, computer cabling, pass through corridors, it may be proper to plan such service with properly designed aluminium/PVC channels duly covered by a false ceiling, so that subsequently such service can be maintained and additional cables can be provided.

(vi) Generally conduits for wiring will not be taken in floor slabs. When it is unavoidable special precaution to be taken to provide floor channels with provision for safety and maintenance. Alternatively false flooring can be provided.

1.7 Passing through Walls or Floors

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

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

1.8 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 multistranded conductors shall be done using suitable crimping type thimbles.

1.9 Ratings of Outlets

(to be adopted for design).

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

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

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

1.10 Capacity of Circuits

(i) Lighting circuit shall feed light/fan/ call bell points. Each circuit shall not have more than 800 Watt connected load or more than 10 points whichever is less. However, in case of CFL points where load per point may be less, number of points may be suitably increased.

(ii) Power circuit in non-residential building will have only one outlet per circuit.

(iii) Each power circuit in residential building can feed following outlets:

(a) Not more than 2 Nos. 16A outlets.

(b) Not more than 3 Nos. 6A outlets.

(c) Not more than 1 No.16A and 2 Nos. 6A outlets.

(iv) Load more than 1 KW shall be controlled by suitably rated MCB and cable size shall be decided as per calculations.

(v) Power Wiring with Bus Trunking

It is permitted to meet large-scale power requirement in a hall, or floor, with use of single phase or 3 phase bus bars running inside a metal enclosure. This will be provided with careful design and use of factory fabricated bus-trunking of reputed make, conforming to relevant BIS standards and with standard accessories like End feed unit, tap off with necessary safety features like over current, short-circuit and earth fault protection. Such trunking will be of specified breaking KA rating.

1.11 Socket Outlets

(i) Socket outlets modular type shall be 6A 3 pin, 16 Amp 3 pin or 16/6 Amp 6 pin. 5 pin socket outlets will not be permitted.

The third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.

(ii) Conductors connecting electrical appliances with socket outlets shall be of flexible type with an earthing conductor for connection to the earth terminal of plug and the metallic body of the electrical appliance.

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

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

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

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

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

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

(c) *Bathroom* – No socket outlet is permitted for connecting a portable appliance thereto. MCB/IC switch may be provided above 2 m for fixed appliances, and at least 1 m away from shower.

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

(vii) Unless and otherwise specified, the control switches for the 6A and 16A socket outlets shall be kept along with the socket outlets.

1.12 Cables

(i) Copper conductor cable only will be used for submain/ circuit/ point wiring.

(ii) Minimum size of wiring:

Light Wiring	:	1.5 sq.mm.
Power Wiring	:	4.0 sq.mm.
Power circuit rated	:	More than 1 KW, Size as per calculation.

(iii) Insulation : Copper conductor cable shall be PVC insulated conforming to BIS Specification.

(iv) Multi stranded : Cables are permitted to be used.

1.13 Flexible Cable

(i) Conductor of flexible cables shall be of copper. The cross sectional area of conductor for flexible cable shall be as per design.

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

(iii) Unless the flexible cables are mechanically protected by armour, or tough rubber, or PVC sheath,

these shall not be used in workshops and other places where they are liable to mechanical damage.

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

1.14 Wiring Accessories

(a) Control Switches for Point

(i) Control switches (single pole switch) carrying not more than 16A shall be modular type. The switch shall be 'On' when the knob is down.

(ii) (a) In type I, II & III quarters, Barracks & school buildings (except principal's & staff rooms) etc. Piano type switches shall be provided (unless specifically asked for by the user department / Architect.)

(b) Modular type switches to be provided for remaining types of buildings i.e. in all types of remaining non-residential buildings & residential buildings of type IV & above & Transit hostel or as may be decided by the Architect/ user department. (**Note**: Provision is meant for new constructions and in existing buildings during rewiring if the building work renovation is also in progress in the area. Otherwise existing type of piano switches will be continued.)

(iii) It is recommended to provide double pole MCB in proper enclosure as power outlet for window type AC units, geysers etc.

(b) Switch Box

(i) Switch box shall be hot dip galvanized, factory fabricated, suitable in size for surface/ recess mounting and suitable in size for accommodating the required number of switches and accessories (where required to be used for applications other then modular switches/ sockets).

(ii) Switch box also can be of non-metallic material. The technical sanctioning authority will approve specified makes of reputed quality and specifications.

(c) Switch Box Covers (for application other than modular type)

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

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

(d) Ceiling Rose

(i) A ceiling rose shall not be used on a circuit, the voltage of which normally exceeds 250V.

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

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

(e) Lamp Holders

(i) Lamp holders may be batten, angle, pendant or bracket holder type as required. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal external pressure. There should be sufficient threading for fixing the base to the

lamp holder part so thatthey do not open out during attention to the lamp or shade.

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

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

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

(f) Fittings

Types **:** The type of fittings shall be as specified in tender documents.

Indoor Type Fittings

(i) Where conductors are required to be drawn through tube or channel leading to the fitting, 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 sheathing. As far as possible all such tubes or channels should be of sufficient size to permit looping back.

(ii) Wires used within prewired fittings shall be flexible with PVC insulation and 14/0.193 mm (minimum) copper conductors. The leads shall be terminated on built-in-terminal block, ceiling rose or connector, as required.

(iii) Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

(iv) Fittings shall be installed such that the lamp is at a height of 2.4m above floor level, unless otherwise directed by the Engineer-in-charge.

(v) Fittings made of CRCA shall be phosphatized and powder/epoxy painted. For coastal areas and humid area like toilets, kitchen, for prolonging the life of such fittings, corrosion free materials like engineering plastic, aluminium, stainless steel etc. should be used.

Outdoor Fittings

Outdoor fittings shall have suitable IP protection. It is preferable that street light fittings are of cast aluminium body of IP 65, for reducing recurring maintenance cost and improved performance. Where required IP 66 fittings also can be provided for reducing maintenance frequency and cost.

Other fittings, which are not available with tested IP 65/54 protection, can be properly fabricated with weatherproof features, proper gasketing etc. As far as possible corrosion free material like cast aluminium, stainless steel, engineering plastics may be used for fabrication of such fittings, to prolong life of such fittings. There should not be any exposed wiring in such outdoor fittings.

1.15 Attachment of Fittings and Accessories

(a) Conduit Wiring System

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

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

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

(b) Fixing to Walls and Ceiling

(i) Wooden plugs for fixing to wall/ceiling will not be allowed. Fixing will be done with the help of PVC sleeves/Rowel plugs/ dash fasteners as required.

(ii) Drilling of holes shall be done by drilling machines only. No manual drilling of hole will be allowed.

1.16 Fans, Regulators and Clamps

(a) Ceiling Fans

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

(ii) The capacity of a ceiling fan to meet the requirement of a room with the longer dimension D meters should be about 55 D m^3/min.

(iii) The height of fan blades above the floor should be (3H + W)/4, where H is the height of the room, and W is the height of the work plane.

(iv) The minimum distance between fan blades and the ceiling should be about 0.3 meters.

(v) When actual ventilated zone does not cover the entire room area, then optimum size of ceiling fan should be chosen based on the actual usable area of the room, rather than the total floor area of the room.

(vi) The number of fans and the optimum sizes for rooms of different dimensions are given in the following table:

Optimum Size/Number of Fans for Rooms of Different Sizes

Room Width	*Room Length*										
m	*4m*	*5m*	*6m*	*7m*	*8m*	*9m*	*10m*	*11m*	*12m*	*14m*	*16m*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
3	1200/1	1400/1	1500/1	1050/2	1200/2	1400/2	1400/2	1400/2	1200/3	1400/3	1400/3
4	1200/1	1400/1	1200/2	1200/2	1200/2	1400/2	1400/2	1500/2	1200/3	1400/3	1500/3

5	1400/1	1400/1	1400/2	1400/2	1400/2	1400/2	1400/2	1500/2	1400/3	1400/3	1500/3
6	1200/2	1400/2	900/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
7	1200/2	1400/2	1050/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
8	1200/2	1400/2	1200/4	1200/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
9	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1500/4	1400/6	1400/6	1500/6
10	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1500/4	1400/6	1400/6	1500/6
11	1500/2	1500/2	1500/4	1500/4	1500/4	1500/4	1500/4	1500/4	1500/6	1500/6	1500/6
12	1200/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1200/7	1400/9	1400/9
13	1400/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9
14	1400/3	1400/3	1400/6	1400/6	1400/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9

Note : This table is indicative only. Case specific design should be done by field officers based on site conditions & constraints.

(vii) Energy Efficient fans with BEE 3-5 star rating or complying with IS 374: 1979, shall be used. The minimum service value of fans shall be 3.5 m^3/min/W and air delivery 200 m^3/min.

The values of service factor and air delivery for ceiling fans with 1200 mm sweep are given in the table below:

Star Rating Index Calculation for Ceiling Fans (1200 mm sweep)

Star Rating	*Service Value for Ceiling Fans**
1 Star	> 3.2 to < 3.4
2 Star	≥ 3.4 to < 3.6
3 Star	≥ 3.6 to < 3.8
4 Star	≥ 3.8 to < 4.0
5 Star	≥ 4.0

* Where x is the base service value as per IS 374 : 1979. BEE has proposed a base service value of 3.2 at present and would upgrade it to higher value once the BIS value is finalised.

* The BIS has proposed from the year 2010 the service value of 3.5.

* All ceiling fans covered under this standard shall comply with minimum air Delivery of 210 m^3/min.

For other fan size (mm) the following table may be considered

Standard Power with Air Delivery of Fan as per the IS 374 Code

Fan Size	*Type*		*Minimum Air Delivery*	*Minimum Service Value*	*Maximum Power Input*
(mm)			*m^3/min*	*m^3/min/W*	*W*
900	Capacitor	AC	130	3.1	42
		DC	130	3.4	38
1050	Capacitor	AC	150	3.1	48
		DC	150	3.4	44
1200	Capacitor	AC	200	4	50
		DC	200	4.6	44
1400	Capacitor	AC	245	4.1	60
		DC	245	4.8	51
1500	Capacitor	AC	270	4.3	63
		DC	270	5.1	53

Note: Air delivery values are on the basis of air velocity measurements up to 15m/ min.

(viii) Step Type Electronic regulators should be used instead of resistance type regulators for controlling speed of fans.

(ix) 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.

(x) For wooden or steel joists and beams, the suspension shall consist of GI flat of size not less than 40 mm x 6 mm, 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 1.5 cm 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.

(xi) 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.

(xii) For concrete roofs, a 12 mm dia. MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19 cm on either side, and bound to the top reinforcement of the roof shall be used, as shown in Fig. 5.

(xiii) In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub-clause (v) above cannot be used, or wherever specified, recessed type fan clamp inside metallic box, as shown in Fig. 6 shall be used.

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

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

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

(xvii) 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 5 cm shall be ignored.

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

(b) Exhaust Fans

(i) Exhaust fans shall conform to relevant Indian Standards.

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

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

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

(c) Regulators

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

1.17 Marking of Switch Boards

(i) Schematic Diagram

First a comprehensive schematic diagram for each building is to be prepared, starting from Main LT Panel, rising main, submain boards, DBs, etc. and the manner in which they are connected. This will include essential, non-essential and UPS systems. Sizes of interconnecting main/submain cables shall be indicated.

(ii) Marking of each Main Board

Each main board/submain board shall be marked indicating rating of each incoming/ outgoing switch and the details of load/area it feeds. Detail/size of incoming and outgoing cable also shall be marked indicating from where the incoming cable has originated.

(iii) Marking of Distribution Board

Each Distribution Board shall be marked indicating detail of incoming switch (Size of cable and from where it is fed) and marking of each outgoing MCB indicating the area it feeds. Suitable marking sticker will be suitably fixed to indicate such details.

(iv) Marking of Power/Light DBs

Power/light DBs shall be marked 'P' and 'L' respectively.

(v) Marking for Non-essential/Essential/UPS/Switch Boards

Each switchboard shall be marked essential/non-essential/UPS to indicate the nature of such switchboards.

(vi) Marking of Main Earthing Terminal

Main arthing terminals in main/submain switchboard shall be permanently marked, as "Safety Earth – Don't Remove".

1.18 LT Distribution Switchgear

Only following type switchboards will be used:

(a) Main/Submain switchboard of cubicle type.

(b) DBs – Conventional DBs of reputed makes can also be used with the approval of technical sanctioning authority in addition to prewired DB.

(c) Specially designed switchboards.

Also specially designed switchboards can be used with detailed specification and fabrication drawings approved by the technical sanctioning authority.

(d) Specifications of cubicle panel and pre-wired DB are given in Clause 7.1.2 of Chapter 7.

1.19 Location of Switchboards

(i) Switchboards are to be located in common areas like corridors, lobby etc. and not to be located in locked room.

(ii) Switchboard shall be located only in dry situation and in well-ventilated space. They shall not be placed in the vicinity of storage battery or exposed to chemical fume.

(iii) Switchboards shall not be erected above gas stove, or sinks or within 2.5 meterof any washing unit in washing rooms of launderings or in the bath rooms, toilets, or kitchen.

(iv) As far as possible main boards shall not be located in basement. Such main boards can be located in ground floor.

(v) It is preferable to locate floor main boards in rising main shafts of adequate size, with steel doors (having ventilation) or in suitable room.

(vi) Similarly DBs can be in suitable nitches in corridor walls having doors.

(vii) Locating main boards under staircase or standing open in corridor is not a desirable practice, besides being highly unaesthetic.

(viii) The main switchboard, which receives power to the building, should be invariably located in a switch room, having round the clock access, for emergency attendance to the switchboard.

1.20 Guidelines for Planning Residential Areas

(i) U.G. System of Power Distribution, Street Lighting, Telephone Cabling and TV Cabling

For long-term economical maintenance, better reliability of service, safety, protection against heavy rains, storm, wind etc. and aesthetics, under ground cable system will be generally followed. Also considering the high cost of land, under ground system results in better economic utilization of land area, otherwise substantial land route has to be earmarked for overhead lines.

(ii) Efficient working of street lights and staircase lighting is required for security of the colony and safety and convenience of the residents. Therefore adequate street lighting, staircase lighting is to be provided. Generally back lanes of residential blocks remain dark. Such areas are also to be covered by basic street lighting for security.

(iii) Kitchen

(i) Exhaust fans opening with one point outlet to be provided irrespective of yardstick of provision of exhaust fans.

(ii) In addition to one 16 A 6-pin power outlet for kitchen, one 3 pin 6 Amp. outlet to be provided for water filter.

(iv) Washing Machine

Location to be finalized in consultation with the Architect. A power outlet plus water supply/drainage to be coordinated with Architect/Civil Engineer.

(v) Meter Board

(For a Block of Quarters)

Generally for a block of quarters of 2/3/4 storied, electric supply for each block is received in a meter board, where a cubicle meter panel is provided with system of power distribution to each quarter.

(See Fig. 7)

At present such meter boards are invariably located under staircase. This is not a desirable practice from technical/aesthetic viewpoint.

It is technically desirable to coordinate with Architect to provide separate meter room for each block of quarters or a number of blocks.

(vi) Stair Case Lighting

Stair case lighting is to be treated as an extension of street lighting, for security and convenience of the residents. CFL (1 x 11 Watt) type stair case lighting may be provided to reduce load. As for example, need of 200 quarters can be met with 100 CFL fitting (each of 11 watt), with connected load of 1.5 KW only. Incandescent stair case lighting and bulk head fittings should not be provided, in view of excessive energy consumption and low burning hours.

(vii) Emergency Electric Supply

For ensuring essential water supply and security lighting, a D.G. set to be provided for each colony to take care of water supply pump set, street lighting and essential load requirement of buildings like CGHS Dispensary, Community Center etc.

(viii) Fittings

Subject to limit of yardstick of fittings for various types of quarters following guidelines to be provided:

(i) Every room to be provided with one fluorescent fitting for energy saving.

(ii) Kitchen to be provided with a fluorescent fitting, tapped from a batten holder (through an adopter), so that in case of need batten holder can be used with bulbs.

(iii) Incandescent bulkhead fittings not to be used.

(iv) Quality fittings of reputed make to be used.

(ix) Main Board of Each Quarter

It shall be MCB type with provision of ELCB with the incoming MCB. It shall be located in a nitch with ventilated door cover, in the room connecting to the entry of the quarter. MCB DB shall be pre-wired type, for trouble free service.

(x) Corrosion Free Fittings

Coastal areas and humid areas like kitchen, toilet are subject to corrosion, which substantially reduces the useful life of such fittings, besides giving an ugly look on account of rusting.

Therefore for coastal areas, and other humid areas corrosion free type of fittings (like aluminium, stainless steel, engineering plastic) should be used, for ensuring long life of such fittings and to achieve life cycle economy, after taking into account recurring expenditure on account of painting of fittings.

(xi) Telephone Wiring

Telephone wiring is to be provided for each quarter. One outlet up to type III quarters,

two outlets up to type IV quarters and three outlets above type IV quarters. Such telephone wiring to be brought to a tag-block at a suitable point in ground floor. Provisions shall be kept for suitable entry-pipe for laying incoming telephone cable.

(xii) TV Cabling

Internal TV cabling shall be provided, with two outlets up to type III quarters and three outlets for type IV quarters and above. Similarly, from suitable point at ground floor, TV cabling shall be provided. With use of suitable splitters, such TV cabling to be connected to each quarter.

(xiii) Lighting for Parks

Colonies are provided with parks. Such parks should be provided with adequate lights to include area lights, pathway lights etc. so that the parks can be effectively used by the residents and they remain secure during night time.

(xiv) External Pipe Network for Laying Telephone and TV Cabling for the Colony

Starting from a suitable room, pipe network may be provided to lay telephones/TV cables for the colony. Suitable road cross pipe and manholes to be provided for drawing such cables and their maintenance.

(xv) Preliminary Estimate to Take Care of Telephone/TV Cabling in a Colony

At present, such services are provided in a very crude manner making use of existing poles and hanging cables. Apart from making colonies shabby, such services are subject to damages and unsatisfactory service. Therefore preliminary estimate should provide for such TV/Telephone cabling for the colony.

(xvi) Other Allied Services

Modern residential colonies require support services like CCTV (for Gate and house security), intercom system, basic security system etc. for the safety and convenience of the residents. Therefore, preliminary estimate should provide for basic provisions for such safety/security systems. Most of these services pay for themselves within 3 / 4 years of installation, besides providing security, which sometimes amount to life saving instances.

1.21 Guidelines for Planning Office Buildings

(i) The main objective is to avoid possible fire hazards, which calls for sound detailed designing and use of quality equipments and materials executed with sound workmanship and supervision.

(ii) All control LT Panels, controlling power supply to the entire building will be located in a centralized room, from where centralized control and monitoring of the entire power supply system can be made.

(iii) Earth fault protection shall be provided for each individual building at the LT receiving point i.e. Main LT Panel. ELCB shall not be provided as a matter of routine in distribution boards. These can be provided, if required, by the Chief Engineer (E), in charge.

(iv) Office buildings are prone to fire hazard during night hours. Therefore, after office hours, all the LT Panels should be switched off. Based on need of the building, only the specified LT panel to be kept 'ON' which feed the loads during night hours. Such panel, called common service panel, may feed following loads, which are normally used after office hours:-

(a) Some specified lifts.

(b) Staircase/ Corridor/ Compound light.

(c) Fire protection loads.

(d) Pump Sets.

(e) Other loads which are kept 'ON' after office hours.

(v) Reliability of Power Supply

Minimum two transformers to be provided to provide certain redundancy. Also a smaller size transformer may be provided to take care of reduced load during 'after office' hours to have energy saving of transformer, after proper technical evaluation.

(vi) It is preferable to plan for a separate service building, to combine all electrical and mechanical services of the building, so that the services can be maintained comprehensively at a lower cost and also reducing the overall area requirement. Such service building can combine electric sub-station, DG Sets, UPS, Air- conditioning Plant, water supply pump sets, etc.

(vii) While planning, maintainability of various services to be ensured, like providing facilities like access, approachability of various equipments, maintenance space etc.

CHAPTER 2

METALLIC CONDUIT WIRING SYSTEM

2.0 Scope

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

2.1 Application

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

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

2.2 Material

2.2.1 Conduits

(i) All rigid conduit pipes shall be of steel and be ISI marked. The wall thick- ness shall be not less than 1.6 mm (16 SWG) for conduits upto 32 mm dia and not less than 2 mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface.

(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 steel conduit less than 20 mm in diameter shall be used.

2.2.2 Conduit Accessories

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

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

(vi) 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.

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

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

2.2.3 Outlets

(viii) The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 3 mm and in case of welded mild steel sheet boxes, the wall thickness shall not be less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection as per chapter 15 of these Specifications.

(ix) (a) Outlet boxes shall be of one of the size, covered in the Schedule of Rates (Elect.), 2012

(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.

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

(xi) A metal strip shall be welded/screwed, to the metal box as support if tumbler type of control switches, sockets and/or fan regulators in flush pattern.

(xii) 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.

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

(xiv) Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause 3.14(c) shall be fixed on the front with brass screws, or aluminium alloy/ cadmium plated iron screws as approved by the Engineer-in-charge.

2.3 Installation

2.3.1 Common Aspects for Recessed and Surface Conduit Works

(xv) Conduit Joints

(a) The conduit work of each circuit or section shall be completed before the cables are drawn in.

(b) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

(c) 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.

(d) 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.

(e) No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

(xvi) Bends in Conduit

(a) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 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.

(xvii) Outlets

(a) All outlets such as switches, wall sockets etc. may be either flush mounting type, or of surface mounting type, as specified in the Additional Specifications.

(b) All switches (except piano type switches), socket outlets and fan regulators shall be fixed on metal strips which shall be screwed / welded to the box. Piano type switches and accessories shall be fixed on the phenolic laminated sheet covers in flush pattern.

(xviii) Painting after Erection

After installation, all accessible surfaces of conduit pipes, fittings, switch and regulator boxes etc. shall be painted in compliance with the clauses under Chapter 15 “Painting”.

2.3.2 Additional Requirements for Surface Conduit Work

(xix) Painting before Erection

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of the conduit system, shall be adequately protected against rust when such system is exposed to weather, by being painted with 2 coats of red oxide paint applied before they are fixed.

(xx) Fixing Conduit on Surface

(a) Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the center of such fittings.

(b) 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.

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

(xxi) Fixing Outlet Boxes

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

2.3.3 Additional Requirements for Recessed Conduit Work

(xxii) Making Chase

(a) The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired.

(b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

(c) In case of exposed brick / rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

(xxiii) 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.

(xxiv) 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 a long radius, which will permit easy drawing in of conductors.

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

(xxv) Fixing Inspection Boxes

(a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection

and to facilitate replacement of wires, if necessary.

(b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667 : 1988.

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

(xxvi) Fixing Switch Boxes and Accessories

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

(xxvii) Fish Wire

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

(xxviii) 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.

2.3.4 Earthing Requirements

(xxix) 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 terminations. The conduit shall be continuous when passing through walls or floors.

(xxx) A protective (loop earthing) conductor(s) shall be laid inside the conduit between the metallic switch boxes and distribution switch boards and terminated with proper earth lugs/ terminals. Only PVC insulated copper conductor cable of specified size green in colour shall be allowed.

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

(xxxii) 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

[Clause 4.2.1 (ii)]

Nominal cross sectional area of conductor in sq.mm	*20 mm*		*25 mm*		*32 mm*		*38 mm*		*51 mm*		*64 mm*	
	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 4.25 m 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

[Clause 4.2.2 (iv) b]

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

CHAPTER 3

NON-METALLIC CONDUIT WIRING SYSTEM

3.0 *Scope*

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

3.1 *Application*

3.1.1 Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc. and where recessed work may not be possible to be done. The type of work shall be as specified in individual works.

3.1.2 Flexible non-metallic conduits shall be used only at terminations, wherever specified.

3.2 *Special Precautions*

(i) If the pipes are liable to mechanical damages, they should be adequately protected.

(ii) Non-metallic conduit shall not be used for the following applications:-

(a) In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.

(b) In places where ambient temperature is less than 5 degrees C.

(c) For suspension of fluorescent fittings and other fixtures.

(d) In areas exposed to sunlight.

3.3 Materials

3.3.1 Conduits

(iii) All non-metallic conduit pipes and accessories shall be of suitable material complying with IS 2509 : 1973 and IS 3419 : 1989 for rigid conduits and IS 9537 (Part 5) : 2000 for flexible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

(iv) The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic conduits are given in Table III.

(v) No non-metallic conduit less than 20 mm in diameter shall be used.

(vi) Wiring Capacity

The maximum number of PVC insulated aluminium/copper conductor cables of 650/1100 V grade conforming to IS 694 : 1990 that can be drawn in one conduit of various sizes is given in Table I under clause 4.2.1 (ii). Conduit sizes shall be selected accordingly.

3.3.2 Conduit Accessories

(vii) The conduit wiring system shall be complete in all respect including accessories.

(viii) Rigid conduit accessories shall be normally of grip type.

(ix) Flexible conduit accessories shall be of threaded type.

(x) 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.

(xi) Saddles for fixing conduits shall be heavy gauge non-metallic type with base.

(xii) The minimum width and the thickness of the ordinary clips or girder clips shall be as per Table IV.

(xiii) For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter.

3.3.3 Outlets

(xiv) The switch box shall be made of either rigid PVC molding, or mild steel, or cast iron on all sides except at the front. The regulator boxes shall however be made only of mild steel or cast iron.

(xv) PVC boxes shall comply with the requirements laid down in IS 14772 : 2000. These boxes shall be free from burrs, fins and internal roughness.

The thickness of the walls and base of PVC boxes shall not be less than 2 mm. The clear depth of PVC boxes shall not be less than 60 m.

(xvi) The specifications for metallic boxes shall be as per requirements of clause 4.2.3.

(xvii) 3 mm thick phenolic laminated sheet covers for all types of boxes shall be as per requirements of clause 3.14(c).

3.4 Installation

3.4.1 Common Aspects for Both Recessed and Surface Conduit Works

(xviii) The erection of conduits of each circuit shall be completed before the cables are drawn in.

(xix) Conduit Joints

(a) All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

(b) 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.

(xx) Bends in Conduit

(a) All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

(b) Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(c) Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

(xxi) Outlets

All switches, plugs, fan regulators etc. shall be fitted in flush pattern. The fan regulators can be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.

(xxii) Painting

After installation, all accessible surfaces of metallic accessories shall be painted in compliance with clauses under Chapter 15 “Painting”.

3.4.2 Additional Requirements for Surface Conduit Work

(xxiii) Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the centre of such fittings. Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.

(xxiv) Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer- in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.

(xxv) If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

3.4.3 Additional Requirements for Recessed Conduit Work

(xxvi) Making Chase

Requirements under clause 4.3.3 (i) shall be complied with.

Fixing Conduits in Chase

(a) The conduit pipe shall be fixed by means of staples, or by means of non- metallic saddles, placed at not more than 60 cm apart, or shall be fixed by any other approved means of fixing.

(b) At either side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the centre of the bends.

(xxvii) Erection in RCC Work

Requirements under clause 4.3.3 (iii) shall be complied with.

(xxviii) Fixing Inspection Boxes

Requirements under clause 4.3.3 (iv) shall be complied with.

(xxix) Fixing Switch Boxes and Accessories

Requirements under clause 4.3.3 (v) shall be complied with.

(xxx) Fish Wire

Requirements under clause 4.3.3 (vi) shall be complied with.

(xxxi) Bunching of Cables

For ease of maintenance, cables carrying direct current or alternating current shall always be bunched so that the outgoing and return cables are drawn in the same conduits.

3.4.4 Earthing Requirements

(xxxii) A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DBs.

(xxxiii) Gas or water pipe shall not be used as protective conductors (earth medium).

TABLE III

Dimensional Details of Rigid Non-metallic Conduits

[Clause 5.2.1(ii)]

(All dimensions in mm)

S. No.	*Nominal Outside Diameter (in mm)*	*Maximum Outside Diameter (in mm)*	*Minimum Inside Diameter (in mm)*	*Maximum Permissible Eccentricity (in mm)*	*Minimum Permissible Ovality (in mm)*
1.	20	20 + 0.3	17.2	0.2	0.5
2.	25	25 + 0.3	21.6	0.2	0.5
3.	32	32 + 0.3	28.2	0.2	0.5
4.	40	40 + 0.3	35.8	0.2	0.5
5.	50	50 + 0.3	45.0	0.4	0.6

TABLE IV

Ordinary Clips or Girder Clips

[Clause 5.2.2(vi]

Size of Conduit	*Width*	*Thickness*
(1) 20 mm & 25 mm	19 mm	20 SWG (0.9144 mm)
(2) 32 mm & above	25 mm	18 SWG (1.219 mm)

CHAPTER 5

TRUNKING CABLE MANAGEMENT SYSTEM

5.0 Scope

This chapter covers the requirements of mini trunking (casing wiring) and adaptable metallic or PVC trunking ("otherwise also called wire ways").

5.1 Adaptable trunking shall be used for power cables and data cables to run parallel in two different compartments with partition.

5.1.1 Mini Trunking is suitable for surface wiring work indoors where necessitated, either due to aesthetics or technical requirements, such as case of extension of existing wiring, avoidance of recessed wiring in RCC columns etc. PVC insulated cables and / or other approved insulated cables conforming to IS 694 : 1990 shall be used in this type of work.

Wherever data cables are used for information outlets, adaptable trunking shall be used.

5.1.2 (i) This system using PVC trunking shall be adopted in residential buildings, or office building where there is a need of tidy wiring system.

(ii) PVC trunking for distribution of Voice Data and Power should be used for cable management and should accept RJ45 Data socket and Power socket or other wiring accessory like switches, indicators etc.

(iii) Where the trunking has to be necessarily adopted in situations under (i) above, PVC trunking shall be used.

(iv) Preferred size of the mini trunking should be 25 x 16 mm, 32 x 16 mm, 40 x 25 mm, 40 x 40 mm and for adaptable trunking it should be 100 x 34 mm or 100 x 50 mm or 160 x 50 mm or 200 x 50mm for making upto four isolated compartments.

(v) Trunking should be equipped with rail on its surface on which clip-on partition can be clipped which should accept frames/plates for wiring devices upto 6/8 modules.

(vi) Trunking should have insulation rating of 5 mega Ohm. Trunking should have the following fire resistance characteristics:

- Operating temperature between – 40 Deg to 60 Deg. C
- Glow wire test 960 Deg. C
- Oxygen index – 50 ± 5
- UL94 – VO

5.2 Material

5.2.1 The mini trunking and adaptable trunking shall be of the same material, viz. either PVC or anodized aluminium in extruded sections.

5.2.2 The mini trunking shall have a square or rectangular body. The trunking cover shall be "CLIP-ON" type with double grooving in the case of PVC wire-ways, and CLIP-ON type for the metallic wire ways. All surfaces shall have smooth finish inside and outside. The top of the side walls of the body shall be suitable for the above types of fixing arrangement of trunking. PVC trunking or Aluminium trunking should have uniform thickness throughout its length and shall be of factory finish.

5.2.3 PVC trunking shall be of good quality PVC, free from defects like deformation, unevenness, blisters, cavities etc.

5.3 Dimensions

(i) The sizes of mini trunking for the various sizes of cables and the maximum number of 650/1100 V grade PVC insulated aluminium / copper conductor cables that can be carried in one trunking are given size wise in Table V.

(ii) The thickness of the mini trunking & adaptable trunking shall be 1 mm minimum.

(iii) When mini trunking cover is clipped onto the trunking body, cover should completely overlap on the base (casing).

5.4 Outlet Boxes

The outlet boxes such as switch boxes, regulator boxes and their phenolic laminated sheet covers shall be as per requirements.

5.4.1 Installation

5.4.2 Attachment to Wall and Ceiling

(iv) The mini trunking and adaptable trunking shall be fixed by means of suitable screws to approved type of asbestos or fibre fixing plugs, at intervals not exceeding 60 cm for all sizes for mini trunking. In case of Adaptable trunking, the screwing distance shall be such that the weight of the trunking & cable hold firmly on the wall or ceiling. On either side of the joints, the distance of the fixing arrangement shall not exceed 15 cm from the joint.

(v) All trunking body shall be fixed directly on wall or ceiling as above.

(vi) Trunking shall be used only on dry walls and ceiling, avoiding outside walls as far as possible and shall not be buried in walls not fixed in proximity to gas, steam or water pipes or immediately below the heater.

(vii) Adaptable trunking shall be with pill off cover for protection against dust. Pill off cover shall be removed only on completion of painting of walls.

5.4.3 Passing through Floors or Walls

When conductors pass through floors, the same shall be carried in an approved PVC conduit, or heavy gauge steel conduit properly bushed at both ends. The conduit shall be carried 20 cm above floor level and 2.5 cm below ceiling level and neatly terminated into the casing. Steel conduit pipes wherever accessible shall be securely earthed.

5.4.4 Joints in Casing and Capping

(viii) The wire ways in straight runs should be in single piece as far as possible so as to avoid joints. Trunking shall be of 2 m or 3 m standard length for the ease of installation.

(ix) All joints shall be scarfed or cut diagonally in longitudinal section, and shall be smoothed down by filing to make the joints a very close fit as far as possible and without burrs. They shall be screwed at joints with two or more screws as would be necessary.

(x) Joints arising out of bends or diversion shall be done using standard accessories like Internal angle, External angle, Flat angle (elbows), Flat junction (T) and end caps. For the separation of data and power cables there shall be partition in both trunking and accessories. Internal and external angle shall have variable angle for the alignment at the wall corners. In no case the radius of curvature of the cables inside a bend shall be less than 6 times their overall diameter.

5.4.5 Trunking should be of white colour in case of PVC trunking and of white or grey colour in case of Aluminium trunking.

(xi) Mini Trunking attached to ceiling shall be carried completely across the ceiling/ wall whenever required by the Engineer-in-charge, instead of being stopped at an outlet location and in all such cases, dummy mini trunking must be provided.

5.4.6 Attachment of Capping

(xii) Wherever required by the Engineer-in-charge, capping shall not be fixed until the work has been inspected with the wires in position and approved. The inspection will be done from time to time as the work progresses.

(xiii) Cover shall be attached to body after all the insulated wires are laid inside.

(xiv) No screws or nails shall be used for fixing PVC cover to the body.

(xv) Aluminium cover shall be fixed by using cadmium plated flat head / round head screws with an axial spacing not exceeding 30 cm.

5.4.7 Installation of Cables

(xvi) For ease of maintenance, cables carrying direct current or alternating current shall always be bunched so that the outgoing and return cables are drawn in the same trunking.

(xvii) Mini trunking shall be of such a design that it holds the wires inside the trunking body (casing) at suitable intervals, so that at the time of opening of the trunking cover (capping), the wires may remain in position in the trunking body (casing) and do not fall out.

5.4.8 Earth Continuity

(xviii) A protective (earth continuity) conductor shall be drawn inside for earthing of all

metallic boxes of the installations as well as for connections to the earth pin of the socket outlets.

(xix) In the case of metallic trunking there shall be a metallic link between adjacent trunking covers with screw connections, and also connections from the end casing to the earth terminal of metallic boxes / outlets / switch boards as per the case may be, for the complete body earthing of the system.

TABLE V

Maximum Number of PVC Insulated 650/1100 Volt Grade Aluminium/Copper Conductor Cable conforming to IS 694 : 1990 *[Clause 6.2.4(i)]*

Nominal Cross Section Area	*10/15 mm x 10 mm*	*20/15 mm x 10 mm*	*25/15 mm x 16 mm*	*32 mm x 16 mm*	*40 mm x 25 mm*	*40 mm x 40 mm*
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15
4	2	3	4	5	8	12
6		2	3	4	6	9
10		1	2	3	5	8
16			1	2	4	6
25				1	3	5
35					2	4
50					1	3
70					1	2

Note : Dimensions shown above are outer dimensions of mini turnking.

CHAPTER 6

M.V. PANEL, D.B., RISING MAINS, BUS TRUNKING AND OVERHEAD BUS BAR SYSTEM

6.0 Scope

This covers supply/ erection/ testing and commissioning of the equipments suitable for 415 Volt, 3 Phase, 50 HZ 4 wire system.

6.1 Requirements

(i) For each equipment, required IP rating and short circuit rating capacity will be specified. Governing BIS also will be specified.

(ii) All the equipments will be factory fabricated in an approved factory having modern fabrication and testing process. It shall have seven tank pre-treatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatising, rinsing and passivation followed by powder coat painting having a

paint thickness of 60 microns or as specified. The powder paint will be subjected to oven-heated process. All panels will be provided with suitable gasket to make it dust/ vermin proof.

6.1.1 Specification of LT Cubicle Panel

(i) Cubicle panel shall be floor mounted (on a base frame) totally enclosed and extensible type. The general construction shall conform to IS 8623 : 93. The design shall include all provisions for safety of operating and maintenance personnel. Degree of IP protection shall be IP-42 for indoor application and IP-54 for outdoors, unless otherwise specified.

(ii) The panel shall be compartmentalized type having space and arrangement for incoming cable/ bus ducting, incoming switchgear/ switchgears, bus coupler, insulated and properly supported compartmentalized bus bars, outgoing compartmentalized switchgear, bus bar supports, joint shrouds, cable alleys of suitable size for cabling routing, support and terminations, inter-connection between bus bars and switchgear with auxiliary bus bars/ insulated conductors/ strips etc. Also the panel will be provided with necessary instrumentation like CTs, PTs, Ammeters, Voltmeters, phase indicating lamps, other required instruments, wiring, fuses etc.

(iii) It shall be fabricated out of CRCA sheet not less than 2.0 mm thick for load bearing members and 1.6 mm for doors of LT panels. The framework may be Angle Iron/ Channel/ Bolted type construction. General constructions shall employ the principle of compartmentalization and segregation of each circuit. Unless otherwise approved, incomer and bus section panels shall be separate and independent and shall not be mixed with sections required for feeders. Each section of the rear accessible type board shall have hinged access door at the rear. Operating handle of the highest unit shall be at a height not more than 1.7 mt. Overall height of the board shall not exceed 2.3 metre.

(iv) Arrangement for Incoming/Outgoing Cable Termination

Cable entries shall be provided either from the rear or from the front through cable alleys of suitable size. Removable gland plate to be provided for each cable entry. Cable support arrangement to be provided inside cable alley so that cables are neatly arranged and fixed. From each outgoing switch, insulated strip/ conductor of suitable size to be provided up to suitable terminal block, which will receive incoming/ outgoing cable termination. It is desirable that cables are not terminated directly to switchgear, but terminated through proper terminal blocks.

(v) Specification of Cable Terminal Block

Terminal block of reputed make shall be used. The housing material shall be polyamide having unbreakable and fire-retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be 'Din' or 'G-rail' type. Screws shall be self captive type. No protection cover is required, and the block should be touch proof.

(vi) Bus bars/ Supports/ Clearances

The bus bar system may comprise of a system of main/ auxiliary bus bars run in bus bar alleys.

For bus bar material, ratings, current density, insulation, supports, bus bar clearances and joints see para 7.2 (iii).

(vii) Earthing

2 Nos. 20 x 3 mm copper strip for LT panel upto 400 Amp. capacity or 2 Nos. 20 x 5 mm copper strip for LT panel of higher capacity shall be fixed all around the panel connected to 2 Nos. earth bus copper strips connected to incoming earth conductors.

(Typical Cubicle Panel is explained in Fig. 8)

(viii) Commissioning

After erection, the LT panel will be commissioned after:

(a) Tightening of all nuts and bolts.

(b) Closing any left out holes to ensure the entire panel is insect proof.

(c) Megger testing.

(d) Earth testing.

6.1.2 Specification of Prewired DB

As a general practice only prewired MCB/HRC type DBs shall be used, on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Rewirable fuse type DBs shall not be used.

Prewired DBs shall have following features:

(ix) Recess/ Surface type with integral loose wire box.

(x) Phase/ neutral/ earth terminal blocks for termination of incoming & outgoing wires.

(xi) Din Channel for mounting MCBs.

(xii) Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required.

(xiii) Copper Bus bar.

(xiv) Earthing terminals.

(xv) Wiring from MCBs to phase terminal block.

(xvi) Interconnection between terminal block/ incoming switch/ bus bar/ neutral terminal block/ earth terminal connector with specified size of FRLS preinsulated copper conductor cable duly fitted with copper lugs/ thimbles.

(xvii) Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.

(xviii) Terminal block shall be made of flame retardant polymide material.

(xix) Colour terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.

(xx) Prewired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits. (This is an optional feature.)

(xxi) The prewired DB shall have peelable poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.

(xxii) Detachable plate with Knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pre-treated, phosphatized with powder coated finish.

Where specified it shall be of double door construction provided with hinged cover in the front. (See Fig. 9)

Note: Prewired DB will be factory manufactured by reputed manufacturer of MCB DBs.

6.2 Rising Mains

(i) Application

(a) The rising mains are essentially used in electrical distribution system in building 2 storied and above. These are only for indoor applications. For vertical power distribution, this is a preferred method, compared to rising cable system and is more reliable and safe from point of view of fire hazard.

(b) Tap-off arrangements shall be provided on the rising mains with tap-off boxes.

(c) The rising main shall comprise of sheet metal enclosure, bus bars, tap-off points, tap-off boxes, end feed units, fire barriers, expansion joints, thrust pads, end covers and fixing brackets etc.

(d) The rising main shall conform to IS 8623 and IEC 439 and shall be suitable for 415 V, 3 phase, 50 Hz supply and insulation of rising mains shall be capable of withstanding the voltage of 660 volt AC. Degree of IP protection and short circuit rating shall be specified.

(ii) Enclosure

The enclosure shall be made from sheet steel of 1.6 mm thickness.

(iii) Bus bars

(a) Rating

Bus bars shall be made of wrought aluminium or aluminium alloy, or electric grade copper, conforming to relevant Indian Standard, as specified. The ratings of the bus bars shall be 100A, 200A, 300A, 400A, 500A, 600A, or 800A as specified.

(b) Current Density

Bus bars shall be of sufficient cross-section so that a current density of 130A/ sq.cm (800A/sq.inch) is not exceeded at nominal current rating for aluminium bus bars, and 160A/sq.cm (1000A/sq.inch) for copper bus bars. The minimum sizes of sections of bus bars are given in Table VI.

(c) Cross Section of Bus Bars

The cross section of the neutral bus bar shall be the same as that of the phase bus bar for bus bars of capacities upto 200A; for higher capacities, the neutral bus bar must not be less than half the cross-section of that of the phase bus bar.

(d) Insulation

Each bus bar shall be suitably insulated with PVC sleeves/ tapes.

The insulation of the rising mains shall be capable of withstanding the voltage of 660 V of AC.

(e) Bus Bar Supports

Bus bar support insulators shall be class F insulators made of non- hygroscopic, non-

combustible, track resistant and high strength FRP/ SMC/ DMC material, and shall be of suitable size and spacing to with-stand the dynamic stresses due to short circuit currents. The spacing between two insulators should be provided by the manufacturers according to the design approved by CPRI for their bus bar supports.*Bus Bar Clearances*

(i) The minimum clearance to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as follows:

Between	Min. Clearances
Phase to earth	26 mm
Phase to phase	32 mm

Note: For strip connection from bus bars to switchgear, the above clearances don't apply.

(ii) (a) Bus bar joints shall be thoroughly cleaned and a suitable oxidizing grease shall be applied before making the joint.

(b) High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.

(c) The overlap of the bus bars at the joints shall be not less than the area of the cross section of the bus bars.

(f) Bus Bar Marking

Bus bars and main connections shall be marked by color or letter as per Table VII.

(iv) Expansion Joint

Expansion joint made of aluminium/copper strips shall be provided wherever necessary, to take care of expansion and contraction of the bus bars under normal operating conditions. This shall be invariably provided whenever the length of the rising mains exceeds 15 m.

(v) Thrust Pads

(a) The bus bars shall be provided with thrust pads so that the expansion of the conductors is upwards only.

(b) The bus bar clamps and insulators shall be designed to withstand the forces due to short circuit current. They shall also permit free vertical movement of the bus bars during expansion and contraction.

(vi) Mounting

(i) Incoming cable will be connected to the rising main through an end feed unit, consisting of switch fuse unit with HRC fuse/ MCCB/ ACB of required capacity and cable end box.

(ii) Tap-off boxes at specified intervals and height shall be provided on rising main to tap power. The box shall consist of set of HRC fuses or MCCB/ Switch fuse unit, so that power from rising main can be switched ON/OFF and provided with suitable overload/ short circuit protection.

(vii) Distribution boards/ switch boards will not be mounted on rising main. Such boards will be separately erected on floor/ wall and connected to tap-off box with suitable copper conductor cable.

(viii) Construction Features

(a) The rising mains shall be manufactured in convenient sections to facilitate easy transportation and installation. The sections shall be connected to form a vertical run at site. Each section shall be provided with suitable wall straps at convenient intervals for fixing to the wall.

(b) The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

(c) The front covers shall be detachable. Neoprene gaskets shall be provided between the covers and the side channels.

(d) The enclosure shall have a degree of protection not less than IP 42.

(e) The rising main shall be designed for temperature rise not exceeding 40 degree C over ambient temperature of 45 degree C.

(f) Built-in fireproof barriers having 2 hr. fire rating shall be provided to restrict the spread of fire through the rising mains from one section to the adjacent section.

(g) Necessary provisions for ventilation shall be made at suitable intervals. These shall be complete with welded non-ferrous metallic mesh to prevent entry of vermin.

(h) Two numbers of copper earth strips of 20 x 3 mm (for Rising Main upto 400 Amp.) and 20 x 5 mm (for Rising main above 400 Amp. and upto 800 Amp.) shall be provided along side the rising mains enclosure, and shall be bolted to each section of the rising mains.

(ix) Installation of Rising Mains

(i) Rising mains shall be installed on walls, to which the foundation bolts shall be suitably grouted (in a shaft of adequate size for rising main and floor distribution panel). The foundation bolts shall be provided by the contractor without extra payment.

(ii) (a) No structural member in the building shall be damaged/ altered, without prior approval from the competent authority through the Engineer-in- charge.

(b) Structural provisions like openings, cutouts, if any, provided by the department for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent works shall be carried out by the contractor at his cost.

(c) All such openings in floors provided by the Department shall be closed by the contractor after installing the cables/ conduits/ rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-charge without any extra payment.

(d) All chases required in connection with the electrical works shall be provided and filled by the contractor at his own cost to the original architectural finish of the buildings.

(x) Commissioning

Before connecting mains supply after installation, pre-commissioning checks comprising megger test, checking the tightness of connections, body earth connection etc. shall be carried out and recorded.

6.3 Bus Trunking

6.3.1 Application

These are generally provided for interconnections between the transformers of 400 KVA and above and DG sets 300 KVA and above and their switch board panels, and also for interconnections between large switch board panels where specified, thereby avoiding use of large sizes of cables for such interconnections.

6.3.2 Materials
6.3.2.1 Enclosure

Sheet steel of minimum 2 mm thickness shall be used for fabricating the enclosure.

6.3.2.2 Bus Bars and Supports

Bus bars and their supports shall comply with clauses 7.2 (iii) of these specifications. The current rating shall be as specified in individual cases.

6.3.2 Construction
6.3.2.1 Enclosure

(i) The enclosure shall be of bolted type, box type, welded type or any other type as per the manufacturer's standard practice, and shall be made out from sheet steel of minimum 2 mm thickness. The front cover only shall be detachable. The section of the bus duct shall be rectangular. The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

(ii) The bus trunking enclosure shall be fabricated in convenient sections for easy transportation and installation. The sections shall be connected to form horizontal and vertical runs as required at site. The enclosure shall be provided with flanged ends with drilling arrangements to suit the flanges at the switchgear and transformer terminals. All flanges shall be provided with gaskets, nuts, bolts, washers etc.

(iii) The entire bus trunking enclosure shall be designed for dust and vermin proof construction. The enclosure for outdoor installation shall be additionally in weatherproof construction. The enclosure shall have a degree of protection not less than IP 42 for indoor application, and IP 54 for outdoor application in accordance with IS 2147.

(iv) Bus trunking, if required to be installed outdoors, shall be provided with a metallic protecting canopy of adequate size above the bus trunking, fabricated as part of the enclosure.

(v) Neoprene gaskets shall be provided to satisfy the operating conditions imposed by temperature, weather etc. and durability.

(vi) Provisions for ventilation shall be made as per clause 7.2 (vii) (g) of these specifications.

(vii) Two numbers of Copper earth strips of appropriate size shall be provided alongside the bus trunking enclosure and shall be bolted with each section of the bus trunking (See Table VIII).

6.3.2.2 Expansion Joint/ Flexible Termination

(viii) Flexible connections shall be provided by braided or multi-leafed conductors for terminations at transformer bushing and switchgear.

(ix) Expansion joints shall be provided as per clause 7.2 (iv) of these specifications.

6.3.3 Installation

(i) Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/ channels. The runs shall be neat and the route shall be as directed by the Engineer-in-charge.

(ii) The bus trunking shall be supported such that its weight does not come on the terminations.

(iii) Danger notice boards shall be provided on the bus trunking enclosure at suitable intervals in every room through which it passes.

(iv) The earthing strips shall be properly terminated to the earth bars at both ends.

(v) Pre-commissioning checks shall be conducted.

6.4 Overhead Bus Bar System

6.4.1 Application

The overhead bus bar system is generally used for distribution of power to a number of distributed power loads, such as motors, as in a workshop. This system has an in-built flexibility for meeting additional loads without much change in the distribution system. These specifications cover indoor application only.

6.4.2 Materials
6.4.2.1 Enclosure

Sheet metal used for fabrication of side channels shall be 1.6 mm thick and the top and bottom covers 1.2 mm thick.

6.4.2.2 Bus Bars and Supports

(i) The bus bars shall comply with clause 7.2 (iii) of these specifications. The bus bars shall however be rated for 200A, 300A or 400A as specified. Each bus bar shall be individually insulated by means of PVC sleeves.

(ii) The bus bar supports shall comply with clause 7.2 (iii)(e) of these specifications.

6.4.3 Construction

(i) The enclosure shall be sturdy to withstand the internal and external forces resulting from the various operating conditions. The enclosure shall have a degree of protection not less than IP 42 in accordance with IS 2147.

(ii) The top and bottom cover plates shall be detachable, and shall complete with gaskets to make the enclosure totally dust and vermin proof.

(iii) The enclosure shall be fabricated in convenient sections for easy transportation and installation. The bus sections shall be jointed together with flanges and tie bolts. Each section of the enclosure shall be suspended from the ceiling slab with suitable and rigid MS suspenders and brackets as required. Detachable blank sheet steel covers shall be provided for enclosing the free ends of the bus bar run.

(iv) Two numbers of Copper earth strips of appropriate size shall be provided for the complete run of bus bar enclosure and shall be bolted to each section of the bus bar enclosure. Suitable provision should be made to enable earth connection to the plug-in box, when plugged in.

6.4.4 Plug-in Boxes

(i) Each section of the bus bar enclosure shall have plug-in points spaced at intervals of approximately 600 mm for the insertion of plug-in boxes.

(ii) The plug-in boxes shall be fabricated as compact sheet steel boxes with hinged doors and shall house the fuse holders/ MCCB/ MCB. The fuse holders/ MCCB/ MCB shall be solidly connected to high conductivity copper clip-on contacts and reinforced by spring steel strips. These clip-on contacts shall plug-in directly on to the bus bars at the plug-in points.

(iii) Two earth points shall be located at the ends of the plug-in boxes. While inserting these boxes into the plug-in points, the earth points shall engage first in the special earth bushes provided on the underside of the bus bar enclosure before the main contacts are made. While withdrawing these boxes, the earth contact is maintained even after the main contacts are isolated.

(iv) The plug-in boxes after insertion into the plug-in points shall be fastened by wing nuts.

(v) Each plug-in box shall be fitted with a brass compression gland suitable for the size of the cable specified. It should be possible to provide this gland in any position,
i.e. left hand side, right hand side or lower side of the plug-in box.

(vi) The unused plug-in points shall be blanked with detachable sheet steel covers.

6.4.5 Installation

(i) The bus sections shall be jointed together with flanges and tie bolts. Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/ channels as required.

(ii) Bus trunking shall be suspended at a uniform height of about 2.4 m above floor level. The layout shall be got approved from the Engineer-in-charge before erection.

The runs shall be straight, except at points of changes in direction.

(iii) A connector assembly shall be supplied loose with each section of the enclosure for coupling two sections, and it shall comprise a rubber locating ring, bus bar insulating tube and a connector insulating tube.

6.4.6 Earthing

The Copper earth strips of the bus duct shall be connected to the earth bus/ earth terminal(s) of the switchboard controlling the bus ducts, by appropriate protective conductors, notwithstanding the connection by the armouring of the feeder cable.

6.4.7 Danger Notice Board

These shall be provided on the enclosure at suitable intervals and not exceeding 5 m.

6.4.8 Pre-commissioning checks shall be conducted.

TABLE VI

Aluminium/ Copper Bus Bar Sections

[Clause 7.2 (iii)(b)]

Current Ratings in	*Recommended Rectangular Cross-section*

amps. upto	*Aluminium*		*Copper*	
	No. of Strips/ Phase	*Size in mm*	*No. of Strips/ Phase*	*Size in mm*
100	1	20 x 5	1	20 x 3
200	1	30 x 5	1	25 x 5
300	1	50 x 5	1	40 x 5
400	1	50 x 6	1	50 x 5
500	1	75 x 6	1	60 x 5
600	1	80 x 6	–	–
800	1	100 x 6	–	–
1000	1	100 x 10	–	–
1200	1	125 x 10	–	–
1600	2	100 x 10	–	–
2000	2	125 x 10	–	–
2500	3	125 x 10	–	–

Note:

(i) In larger bus bars of sizes above 1000 amps, the sections can be accepted in other rectangular cross-sections and numbers also, provided the total cross- sectional area offered is not less than the total cross-sectional area shown in the above table against the respective bus bar rating.

(ii) With aluminium bus bars, only aluminium wire/ solid bar connections shall be made for incoming/ outgoing mountings on the switchboards.

(iii) With copper bus bars, only copper wire/ solid bar connections shall be made for incoming/ outgoing mountings on the switchboards.

TABLE VII

[Clause 7.2 (iii)(g)]

(i) *Marking for A.C. Bus Bars & Main Connections*

	Bus Bar and Main Connections	*Colour*	*Letter/Symbol*
(i)	Three Phase	Red, Yellow, Blue	R.Y.B.
	Two Phase	Red, Blue	R.B.
	Single Phase	Red	R

(ii)	Neutral connection	Black	N
(iii)	Connection to earth	Green	E
(iv)	Phase variable (such as connections to reversible motors)	Grey	Gy.

(ii) For D.C. Bus Bars and Main Connections

	Bus Bar and Main Connections	*Colour*	*Letter/Symbol*
(i)	Positive	Red	R, or plus
(ii)	Negative	Blue	B, or minus
(iii)	Neutral connection	Black	N
(iv)	Connection to earth	Green	E
(v)	Equalizer	Yellow	Y
(vi)	Phase variable (such as connections to reversible motors)	Grey	Gy

Note: In the wiring diagram, positive and negative should be indicated by '+' and '-' respectively.

TABLE VIII

[Clause 7.3.3.1(vii)]

A: Earth Continuity Strip for Protective Earthing of Sub-Station Equipment

S.No.	*Type of Installation*	*Earth Electrode*	*Earth Strip from Earth Electrode to Earth Bus and Loop Earthing of Equipment*
1.	Indoor sub-station with HT panel, Transformer capacity up to 1600 KVA, LT panel, Generating set.	Copper Plate	25 x 5 mm Copper Strip
2.	Indoor sub-station with HT panel, Transformer capacity above 1600 KVA, LT panel, and Generating set.	Copper Plate	32 x 5 mm Copper Strip
3.	HT Outdoor sub-station	Copper Plate	25 x 5 mm Copper Strip
4.	LT Indoor sub-station with generator	Copper Plate	25 x 5 mm Copper Strip
5.	LT switch room having Main LT Switch Board	Copper Plate	20 x 3 mm Copper Strip

B: Earth Continuity Strip for Bus Trunking and Rising Main

S.No.	*Type of Installation*	*Material of Main Conductor*	*Earth Strip*
1.	Bus trunking up to 2500 Amp capacity	Copper/ Aluminium	2 Nos. 25 x 5 mm copper strip
2.	Bus trunking above 2500 Amp capacity	Copper/ Aluminium	2 Nos. 32 x 5 mm copper strip
3.	Bus trunking for connecting generating set and LT panel	Copper/ Aluminium	2 Nos. 25 x 5 mm copper strip
4.	Rising main up to 400 Amp capacity	Copper/ Aluminium	2 Nos. 20 x 3 mm copper strip
5.	Rising main above 400 Amp and up to 800 Amp capacity	Copper/ Aluminium	2 Nos. 20 x 5 mm copper strip

C: Neutral Earthing of Transformers and Generators

S.No.	*Equipment*	*Earth Electrode*	*Earth Strip from Earth Station to Neutral*
1.	Transformer of capacity up to 1600 KVA	Copper plate	25 x 5 mm Copper strip
2.	Transformer of capacity above 1600 KVA	Copper plate	32 x 5 mm Copper strip
3.	Generating set of all capacity	Copper plate	25 x 5 mm Copper strip

CHAPTER 7

EARTHING

7.0 Scope

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

7.1 Application

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

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

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

(iv) Application for Internal E.I.

(a) Every sub-main will have earth continuity conductor to run along with sub-main wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.

(b) Every circuit will have its earth continuity conductor to run alongwith circuit wiring. In case of 3-phase circuit two earth continuity conductors shall be provided.

(c) Looping of earth is allowed only in case of point wiring.

(d) When 2/3 power outlets are looped to one circuit, earth looping of these outlets is permissible.

7.2 Types of Electrodes & Material

7.2.1 Earth Electrodes

7.2.1.1 Types

The type of earth electrode shall be any of the following, as specified. (For selection criteria in designs, Appendix F may be referred to).

(a) Pipe earth electrode.

(b) Plate earth electrode.

(c) Strip or conductor earth electrode.

7.2.1.2 Electrode Materials and Dimensions

(i) The materials and minimum sizes of earth electrodes shall be as per Table IX (revised).

(ii) GI pipe electrodes shall be cut tapered at the bottom, and provided with holes of 12 mm dia, drilled not less than 7.5 cm from each other upto 2 m of length from the bottom.

(iii) The length of the buried strip or conductor earth electrode shall be not less than 15 m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-charge shall be taken for any such increase in length.

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

7.2.2 Earthing Conductor & Sizes

(i) The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.

(ii) The size of earthing conductor shall be specified, but this shall not be less than the following (For calculating the size of the earthing conductor in design, Appendix F para 3.5.1).

(a) 4 mm dia. (8 SWG) copper wire,

(b) 25 mm x 4 mm in the case of GI strip, or

(c) 20 mm x 3 mm in the case of copper strip.

(iii) Earthing conductor larger than the following sectional areas need not be used, unless otherwise specified.

(a) 150 sq.mm. in case of GI, or

(b) 100 sq.mm. in case of copper.

7.2.3 Earth Continuity / Loop Earthing Conductor & Sizes

(i) The material and size of protective conductors shall be as specified below (for criteria in design of these Appendix F may be referred to):

Size of phase conductor	*Size of protective conductor of the same material as phase conductor*
Upto 4 sq.mm.	Same size as that of phase conductor Same
Above 4 sq.mm. up to 16 sq.mm. Above	size as that of phase conductor 16 sq.mm.
16 sq.mm. up to 35 sq.mm. Above 35	Half of the phase conductor
sq.mm.	

7.3 Location for Earth Electrodes

(i) Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Engineer-in-charge.

(ii) The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

7.4 Installation

7.4.1 Electrodes

7.4.1.1 Various Types of Electrodes

(i) (a) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in Fig. 11 (revised).

(b) In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be of reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.

(ii) Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3.0 m below the ground level. The installation shall be carried out as shown in Fig. 12 (revised).

(iii) When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

(iv) (a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.

(b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point.

(c) If the electrode cannot be laid in a straight length, it may be laid in a zigzag manner with a deviation upto 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1 m or a polygon.

7.4.1.2 Artificial Treatment of Soil

When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal / coke and salt as indicated in Fig. 11 and 12. In such cases, excavation for earth electrode shall be increased as per the dimensions indicated in these figures.

7.4.1.3 Watering Arrangement

(v) In the case of plate earth electrodes, a watering pipe 20 mm dia. Medium class pipe shall be provided and attached to the electrodes as shown in Fig. 11 and 12. A funnel with mesh shall be provided on the top of this pipe for watering the earth.

(vi) In the case of pipe electrodes, a 40 mm x 20 mm reducer shall be used for fixing the funnel with mesh.

(vii) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 30 cm.

(viii) A cast iron / MS frame with MS cover, 6 mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

7.4.2 Earthing Conductor (Main Earthing Lead)

(i) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.

(ii) In the case of pipe earth electrode, wire type earthing conductor shall be secured as indicated in Fig. 11 using a through bolt, nuts and washers and terminating socket.

(iii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized “C” shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.

(iv) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by 40 mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

(v) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:

(a) Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and

(b) Bolt, nut and washer in case of strip conductor.

In the case of sub-stations or alternators, the termination shall be made on the earthing terminal of the neutral point on the equipment and/or the earth bus, as the case may be.

7.4.3 Loop Earthing/ Earth Continuity Conductor

(i) Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/ terminal of the upstream switch board by protective conductor(s).

(ii) Two protective conductors shall be provided for a switchboard carrying a 3-phase switchgear thereon.

(iii) Loop earthing of individual units will not be however necessary in the case of cubicle type switchboards.

(iv) The earth connector in every distribution board (DB) shall be securely connected to the earth stud/ earth bar of the corresponding switch board by a protective conductor.

(v) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are of non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.

7.5 Earth Resistance

(i) The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.

(ii) Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-charge.

7.6 Marking

(i) Earth bars/terminals at all switch boards shall be marked permanently, either as “E” or as

(ii) Main earthing terminal shall be marked “SAFETY EARTH – DO NOT DISCONNECT”.

7.7 *Use of Residual Current Devices (RCDs)*

An extract on selection and application of RCDs (also known as RCCBs) from IS 12640: 1988 is given at Appendix G. Provision of RCD shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30 mA, 100 mA, 300 mA, or 500 mA, as specified.

TABLE IX (Revised)

Materials and Sizes of Earth Electrodes

[Clause 8.2.1.2(i)]

Type of Electrodes	*Material*	*Size*
Pipe	GI medium class	40 mm dia 4.50 m long (without any joint)
Plate	(i) GI (ii) Copper	60 cm x 60 cm x 6 mm thick 60 cm x 60 cm x 3 mm thick
Strip	(i) GI (ii) Copper	100 sq. mm section 40 sq. mm section
Conductor	(i) Copper	4 mm dia (8 SWG)

Note : Galvanisation of GI items shall conform to Class IV of IS 4736 : 1986.

CHAPTER 8

SAFETY PROCEDURE

8.1 While the Indian Electricity Rules 1956, as amended upto date, are to be followed in their entirety, particular attention is drawn to the various clauses indicated in Appendix 'C'. Any installation or portion of installation, which does not comply with these rules, should be got rectified immediately.

8.2 The detailed instructions on safety procedures given in B.I.S. Code No. 5216 : 1982 "Code of Safety Procedures and Practices in Electrical Works" shall be strictly followed.

8.3 *(a) Schematic Diagram*

It shall be responsibility of the JE (E)/AE (E) to ensure that for each building, a comprehensive schematic diagram is prepared starting from the main board upto the final DBs. All such boards are to be duly marked and numbered.

Similarly, for each campus consisting of sub-station/ sub-stations and a number of buildings, a comprehensive power distribution schematic diagram for the entire campus shall be prepared.

Based on additions/ alterations such diagrams should be updated from time to time.

(b) Keep Premises Clean

Premises like sub-stations, switch rooms, pump house, generating rooms etc. shall be kept clean. Such premises should not be used to store broken furniture, dismantled materials, waste material, packing boxes etc.

(c) Keep all Electrical Shafts Clean and Locked

Such shafts should not be used for dumping floor malba etc.

(d) Protected Premises

All premises like sub-station, pump house etc. to be maintained as protected area, admission allowed to authorized persons only.

(e) Also, the frontage of such areas shall be kept free and parking etc. in front shall not be allowed.

8.4 No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act.

8.5 Rubber or insulating mats should be provided in front of the main switchboards or any other control equipments of medium voltage and above.

8.6 Protective and safety equipments such as rubber gauntlets or gloves, earthing rods, linemen's belt, portable artificial respiration apparatus etc. should be provided in each sub-station, service center/enquiry office and important installations. Where electric welding or such other nature of work is undertaken, goggles shall also be provided.

8.7 Necessary number of caution boards such as "Man on Line, Don't switch on" should be readily available in each sub-station, enquiry office and important installations.

8.8 Standard first aid boxes containing materials as prescribed by the St. John Ambulance Brigade or Indian Red Cross should be provided in each sub-station, enquiry office and important installations and should be readily available.

8.9 Periodical examination of the first aid facilities and protective and safety equipments provided at the various installations shall be undertaken for their adequacy and effectiveness and a proper record shall be maintained.

8.10 Charts (one in English and another one in the regional language) displaying methods of giving artificial respiration to a recipient of electrical shock should be prominently displayed at appropriate places.

8.11 A chart containing the names, addresses and telephone numbers of nearest authorized medical practitioners, hospitals, fire brigade and also of the officers in executive charge shall be displayed prominently along with the First Aid Box.

8.12 Executive Engineers should take immediate steps to train supervisory and authorized persons of the Engineering staff viz. A.Es, J.Es, Head Electricians, Foremen, Electricians and Wiremen in the First Aid Practices, including various methods of artificial respiration with the help of local authorities such as Fire Brigade, St. John Ambulance Brigade, Indian Red Cross or other recognized institutions equipped to impart such training, as prompt rendering of artificial respiration can save life at times of electric shock.

8.13 All new recruits should be given such First Aid Training immediately after appointment.

8.14 All supervisory and authorized persons of the Engineering staff should be deputed for refresher course in First Aid Training after every two years.

8.15 Details of preventive maintenance to be undertaken shall be in accordance with the chapter 14 of these specifications. All preventive maintenance works shall be pre- planned as far as possible and names of persons who are assigned to this work should be entered in a logbook.

8.16 Electrical wiring and control switches should be periodically inspected and any defective wiring, broken parts of switches which will expose live parts, should be replaced immediately to make the installations safe for the user.

8.17 Reports indicating details of preventive maintenance works done should be kept in a register by each Junior Engineer (E) and should bear signatures of Assistant Engineer and Executive Engineer by way of checks.

8.18 No work shall be undertaken on live installations, or on installations, which could be energized unless another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.

8.19 No work of live L.T. switch board in the sub-stations should be handled by a person below the rank of a Wireman and such a work should preferably be done in the presence of the Junior Engineer (E) in charge of the work.

8.20 When working on or near live installations, suitably insulated tools should be used, and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.

8.21 The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled by them.

8.22 Before starting any work on the existing installation, it should be ensured that the electric supply to that portion in which the work is undertaken is preferably cut off. Precautions like displaying “Men at Work” caution boards on the controlling switches, removing fuse carrier from these switches, and these fuse carriers being kept with the person working on the installation, etc. should be taken against accidental energisation. “Permit to Work” should be obtained from the Junior Engineer-in-charge. No work on

H.T. main should be undertaken unless it is made dead and discharged to earth with an earthing lead of appropriate size. The discharge operation shall be repeated several times and the installation connected to earth positively before any work is started.

8.23 Before energizing on an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc., any earthing connection made for doing the work has been removed, “Permit to Work” is received back duly signed by the person to whom it was issued in token of having completed the work and the installation being ready for re-energising and “Men at Work” caution boards removed.

8.24 In case of electrical accidents and shock, the electrical installation on which the accident occurred should be switched off immediately and the affected person should be immediately removed from the live installation by pulling him with the help of his coat, shirt, wooden rod, broom handle or with any other dry cloth or paper. He should be removed from the place of accident to a nearby safe place and artificial respiration continuously given as contained in B.I.S. Code and Standard prescribed by St. John Ambulance Brigade or Fire Brigade.

8.25 While artificial respiration on the affected person is started immediately, help of Fire Brigade and Medical Practitioner should be called for and artificial respiration should be continued uninterrupted until such help arrives.

8.26 These instructions should be explained in Hindi/local language to those staff that does not understand English.

8.27 Executive Engineers should take particular care to ensure that these instructions are imparted to the existing staff and as well as to the new entrants.

CHAPTER 9 FIRE HAZARDS

9.1 The main pre-requisites of a fire hazard free building are: -

(a) Installation based on sound design and use of quality materials and equipments.

(b) Good house keeping.

(c) Proper maintenance based on skilled personnel, proper supervision and preventive maintenance.

(d) Periodic inspection from fire hazard point of view by a qualified engineer.

9.2 Following instructions should be followed. Besides, based on the requirement of a particular building, other instructions may be issued for avoidance of possible fire hazard.

(i) No over loading of main board, DB, submain, wiring.

(ii) No loose wiring.

(iii) One socket outlet to feed one appliance only and do not use multiple outlets.

(iv) The AE (E) in charge will have an annual inspection of the building and list out deficiencies and report to the EE who will take necessary remedial action.

(v) Only MCB type DBs to be provided, so that overload, short circuit currents are interrupted immediately. Rewirable type fuses not to be used.

(vi) Change old/ outlived wiring, switchboard, and appliance.

(vii) Extension to wiring/ EI only after proper design and capacity of augmentation of the existing installation (Para 1.18).

(viii) **Record Room** – No power outlet / switches should be provided inside the room. Use flameproof electrical fittings. In case it is a must to provide switches / outlets in a record room, they should be flameproof.

(ix) Fire Protection

(a) The building should have a comprehensive fire protection system in conformity with CFO's requirement, backed by proper manning and maintenance.

(b) Important building will have a fire control room, for monitoring and control of fire safety of the building.

(c) Local fire extinguishers for various electrical Switchgears Locations, Lift Machine Room, Electrical Sub-station, Generating Rooms, Pump Houses etc.

(d) Get CFO's annual inspection of the building done.

(e) Organize fire drill periodically, at least once in six months.

(x) Maintenance

Maintenance by qualified/ licensed (as applicable) personnel. When maintenance is done by contract system, only properly prequalified and skilled contractors to be deployed. Such contract should have preventive maintenance items.

(xi) Only quality and genuine material should be used.

(xii) When repairs are needed, act immediately, don't postpone repairs.

(xiii) Keep telephone/ address details of Fire Station/ Police/ Hospital/ Departmental Officials/Client Department Officials, both Office and Residence (in case of emergency).

(xiv) All switch rooms/ electrical shafts to be kept clean and duly locked. All locks will have common key, with keys available to all authorized personnel.

(xv) Keep appliances 'OFF' after office hours. Instruction to be issued, so that all switches and appliances are 'OFF' after office hours.

CHAPTER 10 ENERGY CONSERVATION

Energy is very costly. Guidelines for energy conservation:

10.1 *Lighting and Controls*

10.1.1 Lighting Design

Lighting design to be done in such a way that it achieves the required visual comfort at working plane and is energy efficient. Visual comfort can be defined in terms of lux level at the working plane and energy efficiency can be defined in terms of lighting power density (Watt/m^2). The recommended lux levels and lighting power densities have been specified in Chapter 2 Section 2.9.

Wherever possible, a combination of task lighting and general lighting shall be provided to get desired lighting levels. In addition to general lighting, local task luminaires shall be provided for adequate lighting level and quality in the task areas.

For general lighting, lux levels required for circulation and other non-critical applications should be maintained.

10.1.2 Efficient Lamp Selection

Selection of lamp is the most important criterion for lighting design. The lamp selection should be on the basis of efficacy and good colour rendering index (CRI).

Lamps used for general lighting scheme should comply to the following:

- *Point Light Source* – All the point light sources installed in the building for general lighting should be CFL or LED based with minimum lamp efficacy of 50 lm/W.
- *Linear Light Source* – All the linear light sources installed in the building for general lighting should be T-5 or at least 5 Star BEE rated TFLs.

Table 9 lists the Wattage, luminous flux, efficacy and CRI of different types of lamps. Incandescent lamps should not be used at all.

New high frequency electronic ballasts should be used instead of traditional magnetic ballasts.

10.2 *Lighting Controls*

10.2.1 Automatic Lighting Shutoff

Interior lighting systems in buildings larger than 500 m^2 (5000 ft^2) shall be equipped with an automatic control device. Within these buildings, all office areas less than 30 m^2 (300 ft^2) enclosed by walls or ceiling-height partitions, all meeting and conference rooms, all school classrooms, and all storage spaces shall be equipped with occupancy sensors.

For other spaces, this automatic control device shall function on either :

- A scheduled basis at specific programmed times. An independent program schedule shall be provided for areas of no more than 2500 m^2 (25000 ft^2) and not more than one floor,

  Or

- Occupancy sensor that shall turn the lighting off within 3 minutes of an occupant leaving the space. Light fixtures controlled by occupancy sensors shall have a wall mounted, manual switch capable to turning off lights when the space is occupied.

  Exception to above: Lighting systems designed for 24-hour use.

10.2.2 Space Control

Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. Each control device shall be activated either manually by an occupant or automatically by sensing an occupant. The maximum coverage area for each control device is given in the table below:

Space Area and Lighting Control

Sl. No.	*Space Area (m^2)*	*Maximum Coverage Area for each Control Device (m^2)*
1	≤ 1000	250
2	> 1000	1000

Each control device shall be capable of overriding the required shut off control for no more than 2 hours. It should be readily accessible and located such that theoccupant can see the control.

Exception to above: The required control device may be remotely installed if required for reasons of safety or security. A remotely located device shall have a pilot light indicator as part of or next to the control device and shall be clearly labeled to identify the controlled lighting.

10.2.3 Day-lighting Controls

Luminaires in day lighted areas greater than 25 m^2 (250 ft^2) shall be equipped with either a manual or automatic lighting control device that is capable of reducing lighting output of the luminaires in the day lighted areas by at least 50% and controls only the luminaires located entirely within the day lighted area.

10.2.4 Exterior Lighting Control

Lighting for exterior applications shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available or the lighting is not required.

10.2.5 Lighting Control Devices

Following is a description of different types of control devices available for controlling the lighting:

Timers: These are the simplest type of controls and are most popular. Some areas in buildings may require lighting for specific durations like security lighting, landscape lighting or building floodlighting. Timers allow this type of control by switching 'on' and 'off' as per preset times. These can have one setting (same time) for the whole year or several (seasonal/ weekly/daily) settings to take care of the changing sunset times.

Photocell Lighting Control: These measure the amount of natural light available and suitable for both indoor and outdoor applications. When available light falls below a specified level, a control unit switches the lights on (or adjusts a driver to provide more light). Photocells can be programmed so that lights do not flip on and off on partially cloudy days.

Occupancy Sensors : These devices – also known as 'motion detectors' – turn lights off and on in response to human presence. Once sensitivity and coverage area is established, sensors are selected from two predominant technology types.

Passive Infrared Sensors : These detect the motion or heat between vertical and horizontal detection zones. This technology requires a direct line of sight and is more sensitive to lateral motion, but it requires layer motion as distance from the sensor increases. The coverage pattern and field of view can also be precisely controlled. It typically finds its best application in smaller spaces with a direct line of sight, such as restrooms.

Ultrasonic Sensors : These detect movement by sensing disturbances in high-frequency ultrasonic patterns. Because this technology emits ultrasonic waves that are reflected around the room surfaces, it does not require a direct line of sight. It is more sensitive to motion towards and away from the sensor and its sensitivity decreases relative to its distances from the sensor. It also does not have a definable coverage pattern or field of view. These characteristics make it suitable for use in layer-enclosed areas that may have cabinets, shelving, partitions, or other obstructions. If necessary, these technologies can also be combined into one product to improve detection and reduce the likelihood of triggering a false on or off mode.

10.3 Efficient Motors

Motors shall comply with the following:

- All permanently wired poly-phase motors of 0.375 kW or more serving the building and expected to operate more than 1500 hours per year and all permanently wired polyphase motors of 50 kW or more serving the building and expected to operate more than 500 hours per year shall have a minimum acceptable nominal full load motor efficiency not less than IS 12615 for Energy Efficient motors.
- Motors of horsepower differing from those listed in the table shall have efficiency greater than that of the listed kW motor. See Table 14.
- Motor horsepower ratings shall not exceed 20% of the calculated maximum load.
- Motor nameplates shall list the nominal full load motor efficiencies and the full load power factor.

- Motor users should insist on proper rewinding practices for rewound motors. If the proper rewinding practices cannot be assured, the damaged motor should be replaced with a new, efficient one rather than suffer the significant efficiency penalty associated with typical rewind practices.
- Certificates shall be obtained and kept on record indicating the motor efficiency. Whenever a motor is rewound, appropriate measures shall be taken so that the core characteristics of the motor is not lost due to thermal and mechanical stress during removal of damaged parts. After rewinding, a new efficiency test shall be performed and similar records shall be maintained.
- Motors should be installed with soft start energy savers and Variable Speed drives based on the application required.

10.4 *Metering*

- Services exceeding 1000 KVA shall have permanently installed electrical metering to record demand (kVA), energy (kWh), and total power factor. The metering shall also display current (in each phase and the neutral), voltage (between phases and between each phase and neutral), and total harmonic distortion (THD) as a percentage of total current.
- Services not exceeding 100 kVA but over 65 kVA shall have permanently installed electric metering to record demand (kW), energy (kWh), and total power factor (or kVARh).
- Services not exceeding 65 kVA shall have permanently installed electrical metering to record energy (kWh).
- Electrical meters shall be installed to measure the energy units generated on site through DG/ GG sets.
- Separate electrical sub-meters shall be installed to measure energy consumption by HVAC plant, AHU fans and indoor lighting.
- BTU meters* shall be installed for each chiller at the entry and leaving points to measure the cooling generated by chillers.
- BTU meter* shall be installed on the chilled water loop to measure the building's total cooling demand.

***BTU Meter:** BTU is the acronym for British Thermal Unit, which is a traditional unit of energy. BTU meters are used for thermometric billing as they measure heat in terms of BTU. These meters are used for measuring energy consumption of heating and cooling systems. By installing BTU meters at individual chillers, cooling generated by individual chillers can be measured and by installing the BTU meter on the chilled water loop, building's total cooling demand can be measured.*

CHAPTER 11

PAINTING

11.0 *Scope*

This chapter 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.

11.1 *Painting Work in General*

11.1.1 Paints

Paints, oils, varnishes etc. of approved make in original tin to the satisfaction of the Engineer-in-charge shall only be used.

11.1.2 Preparation 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.

11.1.3 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 smaller containers, it shall be continuously stirred with a smooth stick, while painting work is taken up.

(ii) Primer coat of anti-corrosive paint shall be given in the case of steel work, after preparing 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.

11.1.4 Precautions

All furniture, fixtures, glazing, floors etc. shall be protected by suitable covering. All 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.

11.1.5 Repainting

(i) Painting on old surface in indoor situations will not include primer coat except where specially mentioned in the tender documents. However, where rust has formed on iron and steel surfaces, the spots will be painted with one anti-rust primer coat, after preparing the surface.

(ii) In cases of repainting, the old paint shall be removed by first scrapping, or by applying a suitable solvent, and thereafter a fresh coat of the paint shall be applied.

11.2 *Painting of Conduits and Accessories*

(i) Requirement of painting of metallic conduits before installation on surface shall be met as per clause 4.3.2 (i).

(ii) Requirement of painting of metallic boxes shall be as per clauses 4.2.3 (i) and 4.3.1 (iv).

(iii) After installation in surface or recess, all accessible surface of metallic conduit pipes and fittings, switch boxes and regulator boxes etc. shall be painted with two coats of enamel paint of approved shade.

11.3 *Repainting of Ceiling Fan by Spray Painting*

The spray painting of ceiling fan shall be done as per following procedure:

(i) Clean the surface free from all foreign and harmful materials as dirt, moisture, greasy dirt, salts, rust etc. by means of any suitable detergent as required and dry the surface.

(ii) Rub down lightly with waterproof emery paper, if required in case surface is rusty and wipe off the surface using a piece of clean and dry soft cloth.

(iii) Apply one coat of finishing enamel conforming to IS 2932 : 1974 uniformly by spraying and allow it to dry.

CHAPTER 12 TESTING OF INSTALLATION

12.0 *Scope*

This chapter describes the details of tests to be conducted in the completed internal electrical installations, before commissioning.

12.1 *General*

12.1.1 *Tests*

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

(1) Insulation resistance test.

(2) Polarity test of switch.

(3) Earth continuity test.

(4) Earth electrode resistance test.

12.1.2 *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.

12.1.3 *Test Instruments*

All necessary test instruments for the tests shall be arranged by the contractor if so required by the Engineer-in-charge.

12.2 *Insulation Resistance*

12.2.1 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 of not less than twice the working pressure, provided it need not exceed 500 volts for medium voltage circuits. Where the supply is derived from a three wire D.C., or a polyphase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

12.2.2 The insulation resistance shall also be measured between all the conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductors of the supply with all the lamps in position and switches in "off" position, and its value shall be not less than that specified in sub-clause 16.2.3.

12.2.3 The insulation resistance in mega ohms measured as above shall not be less than 12.5 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 1 mega ohm.

12.2.4 Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 mega ohm, is acceptable.

12.2.5 A preliminary and similar test may be made before the lamps etc. are installed, and in this event the insulation resistance to earth should not be less than 25 mega ohms for the wiring with PVC insulted cables, subject to a minimum of 2 mega ohms.

12.2.6 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.

12.2.7 Control rheostats, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that event the insulation resistance between the case or frame work, and all live parts of each rheostat, appliance and electric sign, shall be not less than that specified in the relevant Indian Standard Specifications, or where there is no such specification, shall be not less than one mega ohm.

12.3 *Polarity Test of Switch*

12.3.1 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.

12.3.2 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 phase conductors of the supply.

12.3.3 The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in "on" position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

12.4 *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. 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.

12.5 *Measurement of Earth Electrode Resistance*

12.5.1 Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the test electrode (see Fig. 13). 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:

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

Where, I

R - Resistance of the test electrode in ohms, V

- Reading of the voltmeter in volts,

I - Reading of the ammeter in amps.

12.5.2 (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.

12.5.3 At the time of test, the test electrode shall be separated from the earthing system.

12.5.4 The auxiliary electrodes shall be of 13 mm diameter mild steel rod driven upto 1 m into the ground.

12.5.5 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.

12.5.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C upto 50 m, and each time placing the electrode B midway between them.

12.5.7 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.

12.6 *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 certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as given in Appendix 'E' in addition to the test certificate required by the local Electric Supply Authorities.

APPENDIX D IMPORTANT INDIAN STANDARDS

[Clause 1.22.4]

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 732:1989	Code of practice for electrical wiring installations (third revision)	March 2010	
(2)	IS 4648:1968	Guide for electrical layout in residential buildings	August 2012	
(3)	IS 8061:1976	Code of practice for design, installation and maintenance of service lines upto and including 650 V	March 2011	
(4)	IS 8884:1978	Code of practice for the installation of electric bells and call systems	August 2012	

(5)	IS 5578:1984/ IEC 60391(1972)	Guide for marking of insulated conductors (first revision)	March 2011	
(6)	IS 11353:1985/ IEC 60445 (1973)	Guide for uniform system of marking and identification of conductors and apparatus terminals	July 2012	
(7)	IS 13234:1991/ IEC 60909: 1988	Guide for short circuit current calculations in three-phase ac systems (superseding IS 5728)	August 2012	
(8)	IS 7752 (Part 1): 1975	Guide for improvement of power factor in consumer installation: Part 1 Low and medium supply voltages	March 2011	
(9)	IS 3646 (Part 1): 1992	Code of practice for interior illumination: Part 1 General requirements and recommendations for working interiors (first revision)	March 2008	
(10)	IS 3646 (Part 2): 1966	Code of practice for interior illumination: Part 2 Schedule of illumination and glare index	March 2008	
(11)	IS 3646 (Part 3): 1968	Code of practice for interior illumination: Part 3 Calculation of coefficients of utilization by the BZ method	March 2008	
(12)	IS 4347:1967	Code of practice for hospital lighting	May 2010	
(13)	IS 6665:1972	Code of practice for industrial lighting	May 2010	
(14)	IS 2672:1966	Code of practice for library lighting	May 2010	
(15)	IS 10118 (Part 1):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear : Part 1 General	March 2011	
(16)	IS 10118 (Part 2):1982	Code of practice for selection, installation and maintenance of Switchgear and controlgear : Part 2 Selection	March 2011	
(17)	IS 10118 (Part 3):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear : Part 3 Installation	March 2011	
Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(18)	IS 10118 (Part 4):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear : Part 4 Maintenance	March 2011	
(19)	IS 4146:1983	Application guide for voltage transformers (first revision)	September 2011	
(20)	IS 4201:1983	Application guide for current transformers (first revision)	September 2011	
(21)	IS 5547:1983	Application guide for capacitor voltage transformers (first revision)	September 2011	
(22)	IS 2309:1989	Code of practice for protection of buildings and allied structures against lightning (second revision)	March 2010	1
(23)	IS 3043:1987	Code of practice for earthing	March 2011	2
(24)	IS 5216 (Part 1):1982	Recommendations on safety procedures and practices in electrical work: Part 1 General (first revision)	March 2010	
(25)	IS 5216 (Part 2):1982	Recommendations on safety procedures and practices in electrical work: Part 2 Life saving techniques (first revision)	March 2010	

ELECTRIC FANS

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 555:1979	Electric table type fans and regulators (third revision)	July 2010	2
(2)	IS 1169:1967	Electric pedestal type fans and regulators (first revision)	Mar 2009	6
(3)	IS 374:1979	Electric ceiling type fans and regulators (third revision)	September 2010	6
(4)	IS 2997:1964	Air circulator type electric fans and regulators	July 2010	8
(5)	IEC: 60665 (1981) IS 2312:1967	Propeller type ac ventilating fans (first revision) Draft Standard issued in wide circulation	July 2010	8
(6)	IS 3588:1987	Electric axial flow fans (first revision)	August 2009	1
(7)	IS 3963:1987	Roof extractor units (first revision)	August 2009	3
(8)	IS 4283:1981	Hot air fans (first revision)	August 2009	3
(9)	IS 6272:1987	Industrial cooling fans (man coolers) (first revision)	August 2009	2
(10)	IS 4894:1987	Centrifugal fans (first revision)	August 2009	3
(11)	IS 11037:1984	Electronic type fan regulators	August 2010	3
(12)	IS 12155:1987	General and safety requirements for fans and regulators for household and similar purposes		

LOW VOLTAGE SWITCH GEAR AND CONTROL GEAR CODES OF

PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 4237:1982	General requirements for switchgear and controlgear for voltages not exceeding 1000 volts ac or 1200 volts dc (first revision) [superseded by IS 13947 (Part 1):1993]		
(2)	IS 6875 (Part 1): 1973	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac & 1200 V dc: Part 1 General requirements [superseded by IS 13947 (Part 5/Section 1)]		
(3)	IS 6875 (Part 2): 1973	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc: Part 2 Push-buttons and related control switches [Superseded by IS 13947 (Part 5/Section1)]		
(4)	IS 6875 (Part 3): 1980	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc : Part 3 Rotary control switches [superseded by IS 13947 (Part 5/ Section 1)]		
(5)	IS 10027:2000	Composite units of air-break switches and rewirable type fuses for voltages not exceeding 650 volt ac - Specification (first revision)	March 2010	
(6)	IS 4064 (Part 1): 1978	Air-break switches, air break disconnectors, air-break switch disconnectors and fuse-combination units for voltages not exceeding 1000 V ac or 1200 V dc: Part 1 General requirements (revised) [superseded by IS 13947 (Part 3): 1993]		
(7)	IS 2675:1983	Enclosed Distribution Fuse Boards and Cut Outs for voltages not exceeding 1000 V A.C. or 1200 V D.C.	March 2011	
(8)	IS 8828:1996	Circuit-breakers for over current protection for household and similar installations (second revision)		
(9)	IS 13032:1991	Miniature circuit breaker boards for voltage upto and including 1 000 Volt ac	March 2011	1
(10)	IS 12640 (Part 1): 2008	Residual current operated circuit-breakers for household and simililar uses : Part 1 circuit-breakers without integral over current protection (RCCBs) (First Revision)		
(11)	IS 12640 (Part 2): 2008	Residual current operated circuit-breakers for household and similar uses: Part 2 circuit breakers with integral over current protection (RCBOs) (First Revision)		
(12)	IS 2959:1985	Contactors for voltages not exceeding 1000 V ac or 1200 V dc (first revision) [superseded by IS 13947 (Part 4/ Section 1)]		
(13)	IS 12021:1987	Specification for control transformers for switchgear and controlgear for voltages not exceeding 1000 Volt AC	March 2010	2

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(14)	IS 5039:1983	Distribution pillars for voltages not exceeding 1000 volts (first revision)	March 2011	2
(15)	IS 8623 (Part 1): 1993/ IEC 60439-1 (1985)	Specification for low voltage switchgear and controlgear assemblies: Part 1 Requirements for type-tested and partially type tested assemblies (first revision).	March 2008	2
(16)	IS 8623 (Part 2):1993/ IEC 60439-2 (1987)	Specification for low voltage switchgear and controlgear assemblies: Part 2 Particular requirements for busbar trunking systems (busways)-(first revision)	March 2008	2
(17)	IS 8544 (Part 1): 1977	Motor starters for voltages not exceeding 1000 V: Part Direction line ac starters [superseded by IS 13947 (Part 4/Section 1): 1993]		2
(18)	IS 8544 (Part 2): 1977	Motor starters for voltages not exceeding 1000 V : Part 2 Star-delta starters [superseded by IS 13947 (Part 4/ Section 1): 1993]		
(19)	IS 8544 (Part 3/ Sec 1): 1979	Motor starters for voltages not exceeding 1000 V : Part 3 Rheostatic motor starters, Section 1 General requirements [superseded by IS 13947 (Part 4/Section 1):1993]		
(20)	IS 8544 (Part 4): 1979	Motor starters for voltages not exceeding 1000 V: Part 4 Reduced voltage ac starters: two step auto-transformer starters [superseded by IS 13947 (Part 4/Section 1): 1993]		

POWER CABLE

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 694:1990/ IEC 60227- 1 to 5 (1979)	PVC Insulated cables for working voltages upto and including 1100 V	February 2010	5
(2)	IS 694: 2010	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages upto and including 450/750 V : Part 1 General requirements (fourth revision)		1
(3)	IS 1554 (Part 1): 1988/ IEC 60502 (1983)	PVC insulated (heavy duty) electric cables: Part 2 For working voltages upto and including 1100 V (Third revision)		
(4)	IS 3961 (Part 1): 1967	Recommended current ratings for cables: Part 1 Paper insulated lead sheathed cables	November 2011	
(5)	IS 4288:1988	PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages upto and including 1100 V (second revision) (withdrawn)		
(6)	IS 4289 (Part 1): 1984/ IEC 60245-5	Flexible cables for lifts and other flexible connections: Part 1 Elastomer insulated cables (first revision)		

ELECTRIC WIRING ACCESSORIES CODES OF

PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 9537 (Part 1): 1980/ IEC 60614-1 (1978)	Conduits for electrical installations: Part 1 General Requirements	November 2010	(1)
(2)	IS 9537 (Part 2): 1981	Conduits for electrical installations: Part 2 Rigid steel conduits (superseding IS:1653)	May 2012	(2)
(3)	IS 3480:1966	Flexible steel conduits for electrical wiring	May 2012	(1)
(4)	IS 2667:1988	Fittings for rigid steel conduits for electrical wiring (first revision) [Superseded by IS 14768 (Part 2): 2003]	February 2008	
(5)	IS 3837:1976	Accessories for rigid steel conduits for electrical wiring (first revision)	May 2012	(1)
(6)	IS 9537 (Part 4): 1983	Conduits for electrical installations: Part 4 Pliable self-recovering conduits of insulating materials	May 2012	
(7)	IS 9537 (Part 5): 2000/ IEC 60614-2-3 (1990)	Conduits for a electrical installations: Part 5 Pliable conduits of insulating material [Superseding IS 6946]	June 2010	
(8)	IS 3419:1989	Fittings for rigid non-metallic conduits (second revision)	May 2012	
(9)	IS 14772:2000/ IEC 60670-1 (1989)	Enclosures for accessories for household and similar fixed electrical installations [Superseding IS 5133 (Part 1 and 2)]	May 2010	
(10)	IS 2412:1975	Link clips for electrical wiring (first revision)	May 2012	(2)
(11)	IS 371:1999	Ceiling roses (third revision)	March 2010	(4)
(12)	IS 3854:1997/ IEC 60669-1 (1998)	Switches for domestic and similar purposes (second revision)	July 2012	(6)
(13)	IS 4615:1968	Switch-socket outlets (non-interlocking type) (Withdrawn)		
(14)	IS 4160:2005/ IEC 60884-2-6 (1997)	Interlocking switch socket outlets - Specification (first revision)	June 2010	
(15)	IS 1293:2005/ IEC 60884-1 (2002)	Plugs and socket outlets of rated voltage upto and including 250 volts and rated current upto and including 16 amperes - Specification (third revision)	June 2010	(5)

ELECTRICAL LAMPS AND THEIR AUXILIARIES

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 418:2004/ IEC 60064 (1993)	Tungsten filament lamps for domestic and similar general lighting purposes (fourth revision)	March 2009	(4)
(2)	IS 2418 (Part 1): 1977/ IEC 81 (1974)	Tubular fluorescent lamps for general lighting service: Part 1 Requirements and tests (first revision)	December 2010	(8)
(3)	IS 9900 (Part 1): 1981 / IEC 188 (1974)	High pressure mercury vapour lamps: Part 1 Requirements and test [Superseding IS 2183 and IS 7023]	October 2012	(4)
(4)	IS 9974 (Part 1): 1981/ IEC 662 (1980)	High pressure sodium vapour lamps : Part 1 General requirements and tests	October 2012	(4)
(5)	IS 1258:2005/ IEC 61184 (1997)	Bayonet lamp holders (fourth revision)	June 2010	(3)
(6)	IS 3323:1980/ IEC 60400 (1972)	Bi-pin lamp holders for tubular fluorescent lamps (first revision)	October 2012	(1)
(7)	IS 3324:1982/ IEC 400 (1972)	Holders for starters for tubular fluorescent lamps (first revision)	June 2008	
(8)	IS 2215:2006/ IEC 60155 (1993)	Starters for fluorescent lamps (third revision)	Jun 2010	
(9)	IS 1534 (Part 1): 1977 / IEC 82 (1973)	Ballasts for fluorescent lamps: Part 1 For switch start circuits (second revision)	July 2011	(5)
(10)	IS 1569:1976/ IEC 566	Capacitors for use in tubular fluorescent	July 2011	(1)
(11)	IS 6616:1982/ IEC 262 (1969)	Ballasts for high pressure mercury vapour Lamps (first revision)	July 2011	(1)

LIGHT FITTINGS AND LUMINAIRES

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 1913 (Part 1): 1978	General and safety requirements for luminaires: Part 1 Tubular fluorescent lamps (second revision)		
(2)	*IS 10322 (Part 1) :1982 / IEC 598 - 1(1979)	Luminaires: Part 1 General requirements	May 2010	
(3)	IS 10322 (Part 2): 1982 / IEC 598 - 1(1979)	Luminaires: Part 2 Constructional Requirements	May 2010	

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(4)	IS 10322 (Part 5/ Sec. 2):2012	Luminaires: Part 5 Particular requirements, Sec 2 Recessed luminaires (First Revision)	March 2012	
(5)	IS 10322 (Part 5/ Sec. 3):2012/ IEC 60598-2-3 (1979)	Luminaires: Part 5 Particular requirements, Sec 3 Luminaires for road and street lighting (First revision)	March 2012	
(6)	IS 10322 (Part 5/ Sec 4):1987/ IEC 60598-2-4 (1979)	Luminaires: Part 5 Particular requirements, Section 4 Portable general purpose	May 2010	1
(7)	IS 10322 (Part 5/ Sec 5):1987/ IEC 60598-2-5	Luminaires: Part 5 Particular requirements, Section 5 Flood lights [superseding IS 1947]	May 2010	(1)
(8)	IS 3287:1965	Industrial lighting fittings with plastic reflectors		
(9)	IS 1777:1978	Industrial luminaires with metal reflectors (first revision)		
(10)	IS 2206 (Part 1): 1984	Flameproof electric lighting fittings: Part 1 Well-glass and bulkhead types (first revision)		
(11)	IS 3528:1966	Waterproof electric lighting fittings	May 2010	
(12)	IS 3553:1966	Watertight electric lighting fittings	May 2010	
(13)	IS 8030:1976/ IEC 162 (1972)	Luminaires for hospitals	March 2008	
(14)	IS 7537:1974	Road traffic signals	March 2008	
(15)	IS 9583:1981/ IEC 598-2-22 (1980)	Emergency lighting units	March 2008	

ELECTRICAL APPLIANCES

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 302 (Part 1): 2008/ IEC 60335-1 (2006)	Safety of household and similar electrical appliances: Part 1 General requirements (sixth revision)		(1)
(2)	IS 2268:1994	Electric call bells and buzzers for indoor use (second revision)	March 2009	
(3)	IS 3412:1994	Electric water boilers (second revision)	March 2009	

ELECTRICAL INSTRUMENTS

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 6236:1971/ IEC 60258 (1968)	Direct recording electrical measuring Instruments	January 2010	
(2)	IS 1248(Part 1): 2003/ IEC 600 51-1 (1997)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 1 General requirements (fourth revision)	Sep 2008	
(3)	IS 1248(Part 2): 2003/ IEC 600 51-2 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 2 Ammeters and voltmeters (third revision)	Aug 2008	
(4)	IS 1248(Part 3): 2003/ IEC 600 51-3 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 3 Wattmeters and varmeters (third revision)	Aug 2012	
(5)	IS 1248(Part 4): 2003/ IEC 600 51-4 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 4 Frequency meters (third revision)	Aug 2008	
(6)	IS 1248 (Part 5): 2003/ IEC 600 51-5 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 5 Phase meters, power factor meters and synchroscope (third revision)	Aug 2008	
(7)	IS 722(Part 1): 1998	AC electricity meters : General requirement and tests		
(8)	IS 722 (Part 2): 1977	AC electricity meters: Part 2 Single-phase whole-current watt-hour meters, Class 2 (first revision)		
(9)	IS 722 (Part 3): 1988	AC electricity meters: Part 3 Three-phase whole current and transformer operated and single-phase transformer operated watt-hour meters, class 2 (second revision)		
(10)	IS 722 (Part 5): 1980	AC electricity meters: Part 5 Volt-ampere hour meters for restricted power factor range, class 3.5 (first revision)		
(11)	IS 722 (Part 7/Sec 1): 1987	AC electricity meters: Part 7 Volt-ampere hour meters for full power factor range, Section 1 General requirements (first revision)		
(12)	IS 722 (Part 8): 1972	AC electricity meters: Part 8 Single-phase 2-wire whole current watt-hour meter (class 1.0)		
(13)	IS 722 (Part 9): 1972	AC electricity meters: Part 9 Three-phase whole current and transformer operated watt-hour meters and single- phase two-wire transformer operated watt-hour meters (class 1.0)		
(14)	IS 8530: 1977 IEC 60211:1966	Maximum demand indicators (class 1)		
(15)	*IS 2992:1987	Insulation resistance testers, hand operated (magneto generator type) (second revision)	Jan 2010	

INSTRUMENT TRANSFORMERS

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 2705 (Part 1): 1992/ IEC 60185 (1966)	Current transformers: Part 1 General requirements (second revision)	Aug 2012	(1)
(2)	IS 2705 (Part 2): 1992/ IEC 60185 (1966)	Current transformers: Part 2 Measuring current transformers (second revision)	Aug 2012	
(3)	IS 2705 (Part 3): 1992/ IEC 60185 (1966)	Current transformers: Part 3 Protective current transformers (second revision)	Aug 2012	
(4)	IS 2705 (Part 4): 1992/ IEC 60185 (1966)	Current transformers: Part 4 Protective current transformers for special purpose applications (second revision)	Aug 2012	
(5)	IS 6949:1973	Summation current transformers	Sep 2011	

FUSES

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 9224 (Part 1): 1979	Low voltage fuses: Part 1 General requirements [superseded by IS 13703 (Part 1):1993]		
(2)	IS 9224 (Part 2): 1979	Low voltage fuses: Part 2 Supplementary requirements for fuses for industrial applications (superseding IS 2208) [superseded by IS 13703 (part 2/Section 1):1993]		
(3)	IS 2086:1993	Carriers and bases used in rewirable type electric fuses for voltages upto 650 V (third revision) [Superseding IS 8724]	Mar 2009	(1)
(4)	IS 9926:1981	Fuse wires used in rewirable type electric fuses upto 650 volts	Mar 2011	
(5)	IS 8187:1976/ IEC 269-3 (1973)	D-type fuses		

MISCELLANEOUS

CODES OF PRACTICE GUIDE

Sl.No.	*Standard*	*Title*	*Reaffirm Date*	*Amdt.*
(1)	IS 2551:1982	Danger notice plates (first revision)	Mar 2010	
(2)	IS 2448 (Part 1): 1963	Adhesive insulating tapes for electrical purposes: Part 1 Tapes with cotton textile substrates	Oct 2010	(5)

ELECTROTECHNICAL VOCABULARY

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 1885 (Part 1): 1961	Electrotechnical vocabulary: Part 1 Fundamental Definitions	Jul 2012	(2)
(2)	IS 1885 (Part 9): 1992/ IEC 60050 (446):1983	Electrotechnical Vocabulary: Part 9 Electrical relays (second revision)	Jul 2012	
(3)	IS 1885 (Part 11): 1966	Electrotechnical vocabulary: Part 11 Electrical Measurements	Jul 2012	
(4)	IS 1885 (Part 16/ Sec 1):1968	Electrotechnical vocabulary: Part 16 Lighting, Section 1 General aspects	Jul 2012	
(5)	IS 1885 (Part 16/ Sec. 2):1968	Electrotechnical vocabulary: Part 16 Lighting, Section 2 General illumination, lighting fittings and lighting for traffic and signaling	Jul 2012	
(6)	IS 1885 (Part 16/ Sec. 3):1967	Electrotechnical vocabulary: Part 16 Lighting, Section 3 Lamps and auxiliary apparatus	Jul 2012	
(7)	IS 1885 (Part 17): 1979	Electrotechnical vocabulary: Part 17 Switchgear and controlgear (first revision)	Jul 2012	
(8)	IS 1885 (Part 32):1993/ IEC 60050 (461): 1984	Electrotechnical Vocabulary: Part 32 Electric cables (first revision)	Mar 2009	

SAFETY

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 4770:1991	Rubber Gloves for electrical purposes		
(2)	IS 5424:1969	Rubber mats for electrical purpose (Superseded by IS 15652:2006)	April 2011	(2)

EARTHING

[Clause 8.0]

F.1 *General*

This Appendix indicates details useful in the design of earthing as applicable to the installations generally encountered in the Department. For complete details, IS 3043: 1987 shall be referred to. This Appendix shall supplement the requirements laid down in Chapter 8 of these specifications.

F.2 *Earthing Requirements*

F.2.1 *Statutory Requirement*

(i) All medium voltage equipments shall be earthed by two separate and distinct connections with earth. In the case of high and extra high voltages, the neutral points shall be earthed by not less than two separate and distinct connections with earth, each having its own electrode at the generating station or sub- station, and may be earthed at any other point, provided no interference is caused by such earthing. If necessary, the neutral may be earthed through suitable impedance.

(ii) Necessary protective device shall be provided against earth leakage.

F.2.2 *Supply System Requirement*

"System Earthing" is provided to preserve the security of the supply system. This is done by limiting the potential of live conductors with reference to earth, to such values as consistent with the level of insulation applied. Earthing the neutral point of the transformer ensures reasonable potential to earth, including at the time when the HV supply is impressed on the transformer. Earthing also ensures efficient operation of protective gear in the case of earth faults. Earthing may not give protection against faults that are not essentially earth faults. For example, if a phase conductor on an overhead spur line breaks, and the part remote from the supply falls to the ground, it is unlikely that any protective gear relying on earthing, other than current balance protection at the sub-station, will operate, since the earth fault current circuit includes the impedance of the load that would be high relative to the rest of the circuit.

F.2.3 *Installation Protection Requirement*

"Equipment Earthing" is provided to ensure that the exposed conductive parts in the installation do not become dangerous by attaining a high touch potential under conditions of faults. It should also carry the earth fault currents, till clearance by protective devices, without creating a fire hazard.

F.2.4 *Special Requirements*

F.2.4.1 "Static Earthing" is provided to prevent building up of static charges, by connections to earth at appropriate locations. Example, operation

theaters in hospitals. (For details, please refer to IS 7689 : 1974 and the National Electrical Code).

F.2.4.2 "Clean Earth" may be needed for some of the data processing equipments. These are to be independent of any other earthing in the building. (For details, please refer to IS 10422 : 1982 and IS 3043 : 1987).

F.2.4.3 Earthing is essentially required in protection of buildings against lightning. (For details, please refer to Chapter 9 and Appendix I of these Specifications).

F.3 Types of System Earthing

F.3.1 The various types of system earthing in practice are indicated below, out of which TN-S and T-TN-S systems are generally applicable to installations in the Department.

F.3.1.1 TN-S System

Neutral is earthed at source. In addition to the phase and neutral conductors, an independent protective earth (PE) conductor connected to the source earth is also run with the supply line. All the exposed conductive parts of an installation are connected to this PE conductor via the main earthing terminal of the installation. Independent earth electrode is also necessary within the consumer premises at the main earthing terminal.

F.3.1.2 TN-C System

Neutral is earthed at source. No separate PE conductor is run with the supply line, nor in the internal installations, since neutral and PE are on a common conductor. All exposed conductive parts of an installation as well as the neutral line are connected to this PE & N conductor. (A CNE cable is used for wiring such installations). Additional earth electrode has to be provided for this conductor locally for 3 phase consumers.

F.3.1.3 TN-C-S System (Also called Protective Multiple Earthing – PME system)

Supply is as per TN-C system. The arrangement in the installations is as per TN-S system, i.e. The PE and N are combined in one conductor at supply line. This is earthed at source as well as at frequent intervals. There will be independent protective conductor in the installation. Consumer also normally provides earth electrode terminating on to main earth electrode in his installation, and this is in turn "linked" to the PE & N conductor from supply line.

All the exposed conductive parts in the installation are connected to the PE & N conductor, through protective conductors and this main earthing terminal link.

F.3.1.4 T-TN-S System (for 6, 6.6 or 11 KV bulk supply)

No earth is provided with HV supply line, which is terminated in delta connected transformer primary. Neutral of the transformer (star

connected) secondary is earthed. Independent earth electrodes and bus are provided for the body earthing. Protective conductors are run throughout the LT distribution from the same for equipotential bonding.

F.3.1.5 TT System

Neutral is earthed only at source and no PE conductor is given with supply line. All the exposed conductive parts of the installation are connected to an earth electrode at consumer end, which is independent of the source earth, electrically.

F.3.1.6 IT System

The source has either no earth or is earthed through high impedance. All the exposed conductive parts of the installation are connected to an earth electrode, which is independent of the source earth, electrically.

F.3.2 Concept of Protection Against Indirect Contact

F.3.2.1 The most commonly and successfully used method of protection against indirect contact is by "Earthed Equipotential bonding and automatic disconnection of supply" details of which are elaborated in IS 732 : 1989 and IS 3043 : 1987. All the exposed conductive parts are connected through protective (loop earthing) conductors to the main earthing terminal. All the extraneous conductive parts, which are simultaneously accessible with the exposed conductive parts, are also bonded to the main earthing terminal through main bonding conductor so that there is no dangerous potential between the exposed and the extraneous conductive parts. The earth fault loop impedance (EFLI) and the characteristics of the tripping devices are coordinated such that the faulty circuit is automatically disconnected before there is a persistent touch voltage at the exposed conductive part over a period of time, causing a shock hazard. If the disconnecting time is not satisfactory due to large EFLI, supplementary bonding between the exposed and the extraneous conductive parts is provided. Alternatively, use of RCDs becomes very relevant in most such situations. (See Appendix H for information on selection of RCDs). For more details, IS 3043 : 1987 may be referred to.

Note: Decision regarding the providing of RCD (RCCB) shall be taken in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCD, requirements of the local Electric Supply Companies etc.

F.3.2.2 Earthing (comprising the electrode, earthing conductor, main earthing terminal etc.) and protective conductors in an installation are thus vital components in this system of protection against shock hazards. The concept is indicated diagrammatically in Fig. 14 & Fig. 15 indicates the method of ensuring the same, as envisaged in these specifications.

F.3.2.3 Rule 61A of I.E. Rules, 1956 calls for protective devices against earth leakages for certain loads. This should be complied with.

F.3.2.4 The following exposed conductive parts are exempted from bonding to earth:

(i) Overhead line insulator, wall brackets or another metal connected to them, provided they are out of arm's reach.

(ii) Inaccessible steel reinforcement in RCC poles.

(iii) Exposed conductive parts that cannot be gripped or contacted by a major surface of the human body provided a protective conductor connection couldn't be readily made, or reliably maintained.

(iv) Fixing screws of non-metallic parts provided there is no risk of them contacting live parts.

(v) Short lengths of conduits or similar items which are not accessible.

(vi) Metal enclosure for mechanical protection of double insulated equipments.

F.3.3 Selection of Type of Electrodes

Following are general guidelines for the selection of the type of electrodes.

Type of electrode	*Application*
GI pipe	Internal electrical installations like Distribution Board and Meter Boards (in residential quarters), feeder pillars and poles etc.
GI plate	(i) For Fire fighting pumps and water supply pumps. (ii) Lightning conductors.
Copper plate	Neutral earthing of transformers/ generating sets. Strip/
Conductor	Locations where it is not possible to use other types.

F.3.4 Number of Earth Electrodes

(i) In all cases, relevant provisions of Rules 33, 61 and 67 of the Indian Electricity Rules, 1956 as amended, shall be complied with.

(ii) Non-current carrying metal parts of all apparatus utilizing power supply at voltage exceeding 250 volts shall be earthed by two separate and distinct connections to the earth bus, or to two separate and distinct earthing sets.

(iii) The number of earthing electrodes for sub-stations and generating sets shall be as under:-

For neutral earthing of each transformer	-	2 sets
For body earthing of all the transformers, HT/LT Panels and other electrical equipments in the Sub-station/ power house	-	2 sets

For neutral earthing of each generating set	-	2 sets
For body earthing of all the generating sets, LT panels and other electrical equipments in the generator room	-	2 sets

Where the generator and sub-station equipments are located together in the same building, the body earthing can be common for all the electrical equipments in the building.

(iv) Separate earth electrodes shall be provided for lightning arrester/ lightning conductors.

F.3.5 Size of Protective Conductor

F.3.5.1 The cross section of a protective conductor may be calculated by either of the following 2 methods, the second one being used for designs in general, and the first one for checking purposes.

(i) $S \geq \sqrt{\frac{I^2t}{K}}$

Where, S = Cross sectional area of protective conductor in sq.mm.

I = Earth fault (Leakage) current in Amp.

t = Total tripping time of the device in sec. (not exceeding 5 sec)

K = Factor dependent on the material of the protective conductor insulation if any thereon, and initial and final temperatures.

$I = \frac{U_o}{Z_s}$ where, U_o = Nominal phase voltage to earth.

Z_s = Earth fault loop impedance, (considering its 5 seconds value).

Note 1 : Values of Z_s are available in Tables in IEE Wiring Regulations, U, K, dependent on tripping devices. Alternatively, this can be calculated.

Note 2 : Values of K for different materials are given in IS 3043 for various parameters.

(ii) The minimum cross section of a protective condutor shall be as per the following:

Size of phase conductor	*Size of protective conductor of the same material as phase conductor*
S upto 16 sq.mm.	S sq.mm. S =
16 to 35 sq.mm.	16 sq.mm. S
> 35 sq.mm	S/2 sq.mm.

Note: If the material of the protective conductor is different from that of the phase conductor, the size as per the above should be multiplied by K1/K2 where K1 is the K factor for phase conductor material, and K2 is K factor for the protective conductor material. As a rough guide, the following values can be taken.

K1/K2 for

Copper
= 1.20 to 1.24

Aluminium (Insulated) Copper

Steel wire (Insulated) Copper
= 2.17 to 2.25

Steel (Conduits/Trunking)

= 2.31 to 2.45

The minimum acceptable size of a protective conductor shall be 2.5 sq.mm. if protected mechanically, and 4 sq.mm. if otherwise.

F.3.6 Size of Earthing Conductor

F.3.6.1 The earthing conductors shall comply with the provisions of clause F.3.5 above, except that the minimum cross sectional area shall be 16 sq.mm. (Copper or steel) when protected against corrosion, and 25 sq.mm. copper, or 50 sq.mm. steel when not protected against corrosion.

F.3.6.2 For determining the size of earthing conductor for sub-stations and generating sets, IS 3043 : 1987 may be referred to.

F.3.7 Size of Bonding Conductor

The main bonding conductor should be half the size of the earthing conductor, subject to a minimum of 6 sq.mm. and maximum of 25 sq.mm. copper, or equivalent sizes for other materials. This is applicable for TN-S and TN-C-S system only.

F.3.8 Details for Contract Purposes

While this Appendix provides information on design considerations, the sizes of the conductors, types of electrodes etc. shall be as laid down in the tender documents of individual works, and as directed by the Engineer-in-charge.

1. *SHAFTS*

(a) Shaft Details:

(i) ***Electrical rising main shaft:*** 2.2 x 0.8 m for accommodating normal & essential supply rising mains.

(ii) ***Wet riser shaft:*** 1.2 m * 0.8 m.

(iii) ***Telephone shaft:*** 0.6 m * 0.3 m

(iv) ***Fire alarm shaft:*** 0.6 m * 0.3 m.

(v) ***Computer cabling shaft:*** 0.6 m * 0.3 m.

Please see Annexure VIII & IX.

(b) Door for Shafts:

Door for Wet riser shaft may be provided as per Annexure XI. Provide steel door frame & steel doors with locking arrangement for other shafts. Doors to open towards corridor.

Please see Annexure XI & Annexure XII.

Note: No wooden doors shall be used since they pose fire risk.

(c) Location of Shafts:

(i) ***Fire Alarm Shaft:*** It shall be located in the lift lobby/common area and preferably can start from fire control room.

(ii) ***Telephone Shaft:*** Preferable to start from telephone room.

(iii) Shaft shall be in common area and not inside any room, so that they are accessible to service personnel even after office hours.

(iv) Away from water/ drainage shafts. Not to be exposed to rains etc.

2. *CABLE ENTRY PIPES*

Provide For:

(a) Cable entry into sub-station.

(b) Sub-station to rising main shafts.

(c) Cable entry into telephone room.

(d) Wet riser pump to wet riser shafts.

3. *S.D.Bs*

Shall be recessed in walls nearest to load and nitches for the same are not required.

4. *FALSE CEILING IN CORRIDOR*

When services like telephone/ computer/ electrical cables have to be taken in the corridor, it is better to provide false ceiling, so that the service cables are properly covered and don't present a shabby look. Also it helps in laying additional cables in later years.

5. *FALSE CEILING IN ROOMS*

Light fittings, AC diffusers, fire detectors, P.A. speakers will be fixed on false ceiling. Therefore it is necessary to locate all these fixtures to give a symmetrical and aesthetic look. False ceiling materials should be of fire resistance type.

CHAPTER 12

ELV SYSTEMS

(AV systems, PA systems, etc)

Equipment Racks

(i) Audio visual equipment is typically mounted in racks specified in BOQ. Racks must be provided with a minimum clearance to the front, rear and one side of 36 inches unless wall mounted. All equipment, where possible, will have rack ears for mounting. If equipment is not suitable for rack mounting a minimum of a 1RU cantilevered shelf will be provided to appropriately support each piece of equipment.

(ii) Rack design must allow for only a maximum of 75% fill to accommodate future growth. For example, if it is a 10U rack, only 7U may be used for design fill.

(iii) A suitable number of 120V AC rack mounted power conditioners with power overload switches will be provided as required. Power conditioners will have no more than 80% of load designed so that a 15A unit will have a maximum 12A load and so on. Load calculations are to be included in with all project designs along with BTU calculations for each rack assembly.

(iv) Where racks must be installed in cabinetry, rear access, in the form of a lockable door is to be provided, the lock will be the AV standard key. All cabinets and rack barrels will be keyed alike and at least 2 keys for each install will be provided to JIPMER during handing over.

(v) Where rear access cannot be provided, the cabinet must allow for a sliding rack to be easily mounted for servicing. There must be sufficient width and depth (clear of obstructions such as hinges) for the rack and loop of cables.

(vi) Ventilation Regardless of location, there must be sufficient ventilation (air flow) to prevent unacceptable temperature rise. Ventilation, air flow and equipment operating temperature will require consideration when designing the physical layout of the active equipment in the AV rack to prevent unacceptable temperature rise. Recommended ventilation is an air inlet grill in the front and rear doors and an outlet grill in the cabinet top, mounted to the rear of the compartment. Should an outlet grill in the cabinet top not be possible, in consultation with HLL, a grill shall be mounted as high as possible on either side of the rack cabinet suitable with provision for an internal fan. Mechanical devices that contain moving parts, such as fans, that are located at a lectern or close to teaching positions, should be quite enough not to distract users of the space. Noise should be no louder than 30 dB at 1m from the AV Rack so not to interfere with any teaching or recording.

Projection Surfaces

(i) The data projector images/screens are to be centered as close as practically possible to the room center line and positioned either flush with ceiling or above the whiteboard assembly as close to the ceiling as possible, to allow uninterrupted viewing from anywhere in the room. As necessary the audio visual contractor is to supply the wall mounting brackets to allow for the screen to drop down in front of wall mounted whiteboards.

(ii) Typically dual-screen projection will have the projection screens mounted as close as practically either side of the room center line and positioned either flush with ceiling or above the whiteboard assembly as close to the ceiling as possible, to allow uninterrupted viewing from anywhere in the room. As necessary the Contractor is to supply six inches off the wall mounting brackets to allow for

the screen to drop down in front of wall mounted whiteboards. Final screen position will be determined during the design consultation process.

Multimedia Projector Ceiling Mount

(i) Multimedia projector ceiling mounts must be of a suitable high quality professional grade universal product. Final choice of bracket will be at the discretion of HLL. The provided mount is to have a white powder coat finish with a locking arm that secures the projector to the base plate, the locking arm being secured by padlocked or key locking system. Two keys should be provided for any locking mechanism. The projector mounts adjustable settings are to be firmly tightened. Projector ceiling brackets must be mounted in accordance with the manufacturers' specifications

Cabling

(i) All cabling must be neat and secure. Where equipment is mounted on slides, sufficient cable length must be provided to enable the item to be withdrawn to the limit of the slides while remaining fully operational and without stress on cables or connectors.

(ii) Any in-ceiling cabling must be suspended above ceiling tiles on J-hooks or cable tray

(iii) All connections must be to industry standard. Connectors terminated on site are to be of a high quality and professional standard.

Cable Labeling

(i) All cables must be labeled within 2inches of the connector with a printed self-laminating label indicating where it is/should be connected.

(ii) For example, VGA input A of a projector should be labeled 'Input A'. Output 3 of VDA2 should be labeled 'VDA2 Out 3 to PROJ Input A'.

(iii) Masking tape, insulation tape and hand written with permanent pen must not be used for labels and will not be accepted.

(iv) On completion of the works, an accurate cable schedule must be provided to HLL.

General Guidelines

The audio visual integrator is to install all equipment for the teaching space audio visual system as outlined throughout this scope of works/specification. All works are to be completed to a high standard with a fully functioning audio visual system handed over at completion of the project:

(i) In accordance with AV industry best practices, all mounting hardware load calculations will use a minimum 5x safety factor so that each fastener can carry the load of the object by itself plus the redundant anchors. Utilize fasteners that are rated for overhead use where appropriate. Prior to installation, all anchors shall have their specifications sheets approved by the engineer-in-charge.

(ii) Audio is to be free of any buzz, hum and any other undesired noise. Exact speaker positions are to be based on a practical determination of best sound coverage from the front of house (key decision factors being careful consideration of room layout, possible sound obstructions, and dispersion properties of speakers)

(iii) Video/Data projection is to be free of any hum bars, shimmer, flicker, ghosting, or any other undesired artifacts, up to the native input resolution of the projection device.

(iv) Installed plates, controller, screen, duct or conduit, speaker brackets, projector bracket and wall equipment cabinet are all to be installed square, flush and level. The mounting screws/washers/bolts

used to fix a specific item are all to be as per standards or better and be matching for that specific item type.

(v) Audio visual integrator provided ceiling cutouts for a projector ceiling mount pole are to be neatly cutout with a diameter no greater than 0.25inch of that of the pole itself.

Operator Training

(i) The contractor must provide a structured training session for JIPMER & HLL on system operation. This training session is to take place at the final handover stage of the project.

Testing & Commissioning

(i) The contractor must provide the University with a commissioning schedule/program before commencement of the project. This schedule will be approved by HLL before the contractor fully commissions the system/systems. All necessary equipment used by the contractor to competently test and commission the system is to be outlined in its provided commissioning schedule/program.

(ii) Testing & Commission reports must be provided in HLL formats.

Fire Alarm System:

The system contains Design, supply, installation, testing & commissioning of Addressable Fire Alarm Control panel with battery backup for 8 hours normal operation and 15 minutes alarm operation. The Panel Shall be 5 loop capacity. The panel shall consisting with 80 character LCD display, RS 485 for networking, loop cards, network cards, in built battery, power supply unit etc.

Drawing / design approval:

The contractor shall prepare and furnish all relevant shop drawings along with the sections after inspection at the site for approval to the Engineer-in-charge. The execution work shall commence only after the shop drawings/design are approved by the Engineer-in-charge and also responsible for the fitment of equipment and accessories. The contractor will submit shop drawing/ design to the project office, within 10 Days after getting LOA for approval. The list of shop drawings shall be as follows:

a. Detail plans for each area.
b. Panel and control scheme.
c. Any other detailed drawing required for the system.
d. Control cabling detail along with sizes.
e. Loop drawings
f. Location of panel, detectors (above and below ceiling), response indicator, fault isolator module, control module, interface module, Manual pull station, hooters, etc with all clamping and fixing details.

Defect Liability Period (DLP):

The contractor shall guarantee the equipment against all defects of materials and workmanship for the period of twelve months from the date of commissioning & handing-over of the equipment to JIPMER as certified by the Engineer-in-charge. Any defects arising during the guarantee period shall be rectified and made good by the vendor at his own risk & cost to the satisfaction of HLL/JIPMER.

Inspection:
Routine performance testing of equipment shall be carried out at works in the presence of the HITES Engineers/ representatives.

Testing & Commission :
The contractor will perform all the tests & commissioning processes until the satisfaction of the HITES Engineers and should submit a detailed test report of the same in HLL format.

Civil work:
Chasing, cutting and finishing of the brick work or floor for laying the cables is in contractor scope. Chasing, cutting will be carried out only by chase cutting machine. Panel must concealed as per the direction of HLL. Chisel and hammer shall not be allowed. All the damages made during the work should be made good / rectified at own risk and cost.

Technical specification:
Basis of design as specified by HITES Engineers

Note:
1. The contractor should be competently and credibly experienced in the Design, Installation, Commissioning, Training and Maintenance of the Tendered System
2. The offered components of the FAS (e.g. panels, detectors, manual call points, sounders, flashers, etc.) shall conform to the latest applicable IS/BS standards unless otherwise specified in tender.
3. All components and devices of FAS shall be either products of a single manufacturer or else their compatibility shall be guaranteed by the bidder. Accessories like SMF batteries and cables etc. can be of other make but those should be approved by the OEM of FAS.
4. The OEM shall certify that the supplied components / products have been newly manufactured & tested in compliance with the relevant parts of NBC 2016/IS standards and the components are free from defects in design, material & workmanship. The reference of vendor's order on OEM and purchaser's order on the vendor in this regard shall be mentioned on the certificate.
5. Wherever applicable, compliance/conformance certificates shall be supplied with all the components and devices.
6. The required electrical power to operate the system is 240 VAC (±10%) and 50Hz (±3%). Being an Emergency System, to allow for enough time to set right the system against any power failure, the system shall have backup battery power for at least 8 hours. The batteries shall be Sealed Maintenance Free type. The battery charger shall be inbuilt inside the FACP.
7. The electronic circuits used in the system shall have proper coating to have resistance to humidity and corrosion which prevents the operation from being impaired by dust and dirt.
8. The wiring should be Class-A. A single fault (either short circuit, or open circuit, or ground fault etc.) in the cable loop shall not inhibit its function. Inbuilt short circuit isolators in all the loop devices are necessary. Proper protection shall be provided in the FACP for overvoltage

and short-circuit.
9. The FAS should have provisions to avoid false alarms, and therefore the system should have programmable sensing levels of detectors, adjustable/adaptable against the change in environment (dust level, temperatures etc.). Individual detectors in the same loop shall be able to be set at different sensing levels.
10. The System should have display in the FACP for the exact identification of location and nature/
type of fire incidence/ circuit fault/ emergency (the manual call point) to enable quick response to the incidence (fire or fault). Therefore the system components (detectors, MCP's etc.) shall be intelligent individually addressable type (in-built microprocessors) and each device shall have in-built isolator.
11. The detectors shall be of universal type for all kinds of smoke and shall be equipped with suitable locking devices. Detectors shall be intelligent, individually addressable type (microprocessor controlled). The detector shall be software controlled for setting the various threshold levels and changes in the sensitivity. It shall be possible to exchange the detectors without any need to reprogram the control unit.
12. The software shall be user friendly and menu driven with self-checking i.e. all the routines shall be checked periodically for their proper functioning and integrity.
13. Fire Exit signage for individual halls should be provided for each halls without additional cost.

Fire Extinguisher:
1. The Fire Extinguisher should be clamped properly in wall with necessary clamps along fire extinguisher signage above it.

List of Approved Makes:

List of Approved makes		
S.No	**Details of Materials/Equipments**	**Manufactures name**
1	Wiring Cables FRLS	Polycab, Finolex, RR Cables, Havells
2	Modular Switch, Socket & GI Box	Legrand, MK, Wipro, Anchor
3	DBs, MCBs & MCCBs	Legrand, Schnider, Siemens, ABB, L&T
4	PVC conduit	Avon Plast, Precision, Clipsal
5	Fan	Bajaj, Usha, Orient, Havells
6	Light Fixtures	Philips, Bajaj, Wipro, Havells
7	Cable Gland & Lugs	Comet, Dowels, Hex
8	LT cables (XLPE)	Polycab, Universal, Havells
9	Joining Kit	Reychem, 3M, Xicon
10	Terminal connector	Connectwell, Elmex
11	Outdoor Type Box	Sintex, Legrand, Hensel, Rittal
12	MS & GI pipes	TATA, Jindal, SAIL
13	Addressable Fire Alarm Panel/Detectors/ Hooters/ Manual Call Point UL Listed/ Talkback/ Control Module/ Monitor Module/ Control relay Module/ Short Ckt. Isolator/Interface Module/ Fault Isolator Module/ Horn/strobe/ Response Indicator	Honeywell-Notifier/ Siemens/ Schneider/ Bosch/ GE Edwards/Tyco
14	Fire Survival Cable	Skytone/ Fusion Polymers/KEI/ RR Cable/ Bonton/ Havells/ Polycab/ Finolex
15	Fire Extinguisher	Ceasefire/ Exflame/ Minimax/ Life Guard/ Safex
16	Amplifier/ Zone selector/ Digital Signal Processor	Bosch/ Honeywell/Bose/JBL
17	DVD cum USB Player	Sony/ Philips/ Samsung/ Bose
18	Speaker Wire	Bonton/Delton/Polycab
19	Equipment Rack	Rittal/ Netrack/ Cisco/MTS/APW/Valrack
20	Microphone	Sennheiser/Bosch/ Honeywell/Bose
21	CAT 6 / Telephone cable	Legrand/ Havells/ Anchor
22	Video Projector	Christie/ Sony/ Panasonic/Philips/ Epson
23	Projection Screen	Draper/ Da-Lite/ Grandview/ Harkness/ Logic
24	Copper refrigerant pipes & accessories	Mandev, Totaline, Rajco
25	Insulation - Nitrile Rubber	K-Flex/Superlon/Armacell/Supreme/Armaflex
26	PVC pipe for drain	Polypack/ Supreme/Astral/Finolex
27	Split AC Units (I/D & O/D)	Hitachi/ Carrier/ Bluestar/ Mitsubishi/Voltas
28	Stabilizer	V-Guard/ Microtek/ Everest/ Bluestar
29	Sprinkler Heads (Sidewall/ Upright/ Pendant)	Tyco/ Viking/ HD
30	Steel Flexible extension	Eversafe/ Newage/ Viking/ Tyco
31	Cement	ACC / Ultra tech / JK Cement / Dalmia/ Coromandel
32	Paints - Other Paints / Primer	ICI Dulux/ Asian/ Berger/ Nerolac
33	Sand	M-sand after approval of Engineer - in - charge

34	Brick/ stone slabs	Samples to be approved by Engineer - in - charge
35	Stainless Steel	TATA, Jindal, SAIL, TISCO
36	Paints - Oil Bound Distemper / Acrylic Washable Distemper	ICI Dulux/ Asian (Tractor)/ Berger (Bison)/ Nerolac (Super Acrylic), ICI (Maxlite)
37	Paints - Plastic Emulsion Paint (exterior)	Asian (Apex Ultima)/ Berger (Weathercoat all Guard)/ ICI (Dulux weathershield max)
38	Paints - Synthetic Enamel Paints	ICI Dulux (Gloss), Berger (Luxol Gold), Asian (Apcolite), Goodlas Nerolac (Full gloss hard drying), Jenson & Nicholson (Borolock)
39	Curtain Rod/ Drapery Rod/ Venetian Blinds	ISI make with prior approval of Engineer - in - charge
40	False Ceiling / Frame	Armstrong, Gyproc or Equivalent as approved by Engineer - in - charge
41	Acoustical Wall Paneling	Armstrong/ Anuton/ Equivalent as approved by Engineer - in - charge
42	Tiles: Vitrified Tiles	Kajaria / Somany/RAK/CERA/ Johnson
43	Sink / Washbasin	Paryware/ CERA/ Neycer/ Jaguar
44	Tap	SS/ Jaguar/ CERA
45	Mirror	CERA/ Saint gobin/ Golden fish/ AtUF Equivalent as approved by Engineer - in - charge
46	Pipes & Fittings: CPVC	Flowguard/ Astral/ Ashrivad/ AKG/Supreme
47	Aluminium Fittings and Hardware	Classic/ Crown /EBCO /Earl Bihari
48	Aluminium	JINDAL/ HINDAL/ HINDALCO

END OF VOLUME - III