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গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
বিদ্যুৎ, জ্বালানি ও খনিজ সম্পদ মন্ত্রণালয়
বিদ্যুৎ বিভাগ
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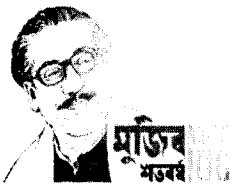


সংখ্যাঃ ২৭.০০.০০০০.০৭২.৩১.১৭.২০২১-৩৩৭

তারিখঃ ৩০ অগ্রহায়ণ ১৪২৮ / ১৫ ডিসেম্বর ২০২১

পরিপত্র

বিষয়ঃ Electrical Wiring in Residential Building & Specification of Electrical Cable, Fittings and Accessories বিষয়ক গাইডলাইন অনুসরণ প্রসঙ্গে।

বিদ্যুৎ বিভাগের আওতাধীন দপ্তর/সংস্থা/কোম্পানি কর্তৃক বহুল ব্যবহৃত সরঞ্জামাদির Specification Standardization এর জন্য বিদ্যুৎ বিভাগ কর্তৃক গঠিত কমিটির প্রস্তাব অনুসারে বৈদ্যুতিক ওয়্যারিং ইউনিফাইড সংক্রান্ত Electrical Wiring in Residential Building & Specification of Electrical Cable, Fittings and Accessories গাইডলাইনটি (কপি সংযুক্ত) অনুসরণ করার জন্য নির্দেশক্রমে অনুরোধ করা হলো।

০২। পরিপত্র জারীর তারিখ হতে Electrical Wiring in Residential Building & Specification of Electrical Cable, Fittings and Accessories বিষয়ক গাইডলাইনটি কার্যকর হবে।

০৩। যথাযথ কর্তৃপক্ষের অনুমোদনক্রমে এ পরিপত্র জারী করা হলো।

সংযুক্তিঃ বর্ণনামতে;

(মোহাম্মদ মোজাম্মেল হক) 20/12/2021
উপসচিব
ফোন: ৯৫৪০২১১
ই-মেইল: dev-2@pd.gov.bd

কার্যার্থে বিতরণ: (জ্যেষ্ঠতার ক্রমানুসারে নয়)

০১। চেয়ারম্যান, বাংলাদেশ জ্বালানি ও বিদ্যুৎ গবেষণা কাউন্সিল (বিইপিআরসি), ঢাকা।
০২। রেক্টর, বাংলাদেশ পাওয়ার ম্যানেজমেন্ট ইন্সটিটিউট (বিপিএমআই), ঢাকা।
০৩। চেয়ারম্যান, স্রেডা, ঢাকা।
০৪। চেয়ারম্যান, বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ড/বাংলাদেশ পল্লী বিদ্যুতায়ন বোর্ড, ঢাকা।
০৫। প্রধান বিদ্যুৎ পরিদর্শক, প্রধান বিদ্যুৎ পরিদর্শকের দপ্তর, ঢাকা।
০৬। মহাপরিচালক, পাওয়ার সেল, ঢাকা।
০৭। ব্যবস্থাপনা পরিচালক, ডিপিডিসি/ডেসকো/ওজোপাডিকো/নেসকো।
০৮। অতিরিক্ত সচিব (সকল), বিদ্যুৎ বিভাগ, বাংলাদেশ সচিবালয়, ঢাকা।
০৯। মাননীয় প্রতিমন্ত্রী মহোদয়ের একান্ত সচিব, বিদ্যুৎ, জ্বালানি ও খনিজ সম্পদ মন্ত্রণালয়, ঢাকা।
১০। সচিব মহোদয়ের একান্ত সচিব, বিদ্যুৎ বিভাগ, ঢাকা।
১১। সিস্টেম এনালিস্ট, বিদ্যুৎ বিভাগ, ঢাকা [গাইডলাইনটি ওয়েবসাইটে প্রকাশের অনুরোধসহ]।
১২। ----------

ELECTRICAL WIRING

IN

RESIDENTIAL BUILDINGS

&

SPECIFICATION OF ELECTRICAL CABLE, FITTINGS AND ACCESSORIES

Contents

ELECTRICAL WIRING

IN

RESIDENTIAL BUILDINGS

&

Specification of Electrical Cable, Fittings and Accessories

CHAPTER 1

1.1 INTRODUCTION

The provisions of the Guidelines cover the Electrical and Electronic Engineering Services for Buildings and other premises to ensure that the related installation work becomes perfect and safe for the persons residing in and around the building. The term safe means safe for the persons and safe for the properties. Provisions of the Specifications are to set minimum standards for Electrical and Electronic Engineering Installations in various Occupancy categories of buildings and premises. All the systems and equipment intended for the supply of normal power and standby power to all these places are covered by the provisions of these Guidelines. Electrical wiring/cabling form a major part in the above mentioned installation works. Electrical wiring/ cabling must be reasonably safe to persons and property. Installations, alteration, or extension of Electrical wiring/cabling systems conforming to the provisions of these Guidelines shall be deemed to be reasonably safe to persons and property.

These Guidelines are based on the BDS IEC 60364-1:2020 Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions Standard: Electrical Installations of Buildings and Bangladesh National Building Code (BNBC). The Guidelines were formulated through discussions with representatives from Power Division, Office of the Chief Electric Inspector, Power Cell, BSTI and Related Distribution utilities.

1.2 PURPOSE

The Guidelines for Electrical Wiring in Residential Buildings has been prepared as a wiring guide for all Wiremen and Electrical Contractors for undertaking electrical wiring in residential buildings. The Guidelines are prepared in a concise and compact manner to facilitate the electrical wiring of residential buildings to be done adequately and to ensure its safety of use while meeting basic wiring requirements. The Guidelines will also be useful for owners of residential buildings or wiring installations to recognize the requirements of safe and adequate electrical wiring. It is hoped that the Guidelines will ensure that electrical wiring will be based on correct safety procedures and regulations and to avoid possible electrical accidents. Safety requirements in electrical wiring works have to be met to eliminate/ prohibit accidents causing physical injuries and loss of life or property. These requirements are as stated in Appendix I.

1.3 REFERENCES

BDS IEC 60364-1
Low-voltage electrical installations –
Part 1: Fundamental principles, assessment of general characteristics, definitions

BDS IEC 60364-6
Low voltage electrical installations –
Part 6: Verification

Bangladesh National Building Code (BNBC).

CHAPTER 2

SUPPLY SYSTEM

2.1 Electricity Supply Specifications

The provisions of the Guidelines cover installations utilizing nominal voltage not exceeding 415 V AC between conductors or 240 V AC to earth. The nominal voltage in Bangladesh is 230 volts AC single phase and 400 volts AC 3 phase.

Electricity supplies for domestic consumers, according to IEC 60038 standards, meets the following specifications: -

i. Single phase supply with nominal voltage of 230V, range ±10%
ii. Three phase supply with nominal voltage of 400V, range ±10%
iii. Three phase supply with nominal voltage of 11kV, range ±10%
iv. Permitted frequency is 50Hz ± 1%;

All electrical equipment used must be suitable for operation with the stated electricity supply specifications.

CHAPTER 3

ELECTRICAL WIRING

3.1 Legal Requirements

As per Electricity Rule 2020 , No electrical installation work, including addition, alternation, repairs and adjustments to existing installation, except such replacement of lamps, fans, switches and other component parts of the installation as in no way alters its capacity or character shall be carried out upon the premises or on behalf of any consumer or owner, for the purpose of supply of energy to such consumer or owner, except by an electrical contractor licensed by the Government in this behalf and under the direct supervision of person holding a certificate of competency issued by the Government. All wiring or rewiring of an installation or extension to an existing installation, which shall be carried out by an Electrical Contractor have to obtain the approval in writing from an Electrical inspector following Model form as stated in Appendix II

3.2 Planning of Electrical Wiring Work

Prior to carrying out wiring work, the Engineer/ licensed contractor/ licensed wireman should plan and determine the tasks to be undertaken so that the work carried out is tidy, neat and safe to be used. The Engineer/ licensed contractor/ licensed wireman shall: -

i. Undertake a site visit;
ii. Determine the consumer load requirements;
iii. Calculate the maximum load demand;
iv. Prepare Electrical Layout and Installation Drawings and Single Line Diagram (SLD); and
v. Submit the plans, drawings and specifications to concerned authority for approval.

3.2.1 Site Visit

The purpose of the site visit is to determine: -

i. Electrical equipment suitable for use;

ii. Maximum load demand;

iii. Single or three phase incoming supply;

iv. Type of wiring; and

v. Equipment arrangement.

3.2.2 Determining Consumer Load Requirements

With the aid of the building floor plans, the installation requirements such as the proposed load, placement of electrical equipment and installation design plans can be determined.

3.2.2.1 Estimating the Load of a Building/Complex

Estimating the total load of a building has to be started with the listing of the connected loads in a building. The steps are to list the loads in each of the rooms, in each of the flats/offices of a floor, in each of the floors and the load of the total building. In this way an account of the total building area/the total complex has to be prepared. Loads of the Lift(s), water pump(s), bulk ventilating system in the basement and any other equipment installed in the building must also be added. For completing the load calculation, practical value of appropriate diversity factors will have to be applied at each stage.

Estimating the total load of a complex consisting of a number of buildings has to be started with the listing of the connected load of each of the buildings, they are lighting load, water pump and any other equipment installed in the complex. For completing the load calculation, practical value of appropriate diversity factors among the buildings will have to be applied.

3.2.2.2 Maximum demand and diversity

Two items need to be determined, which are: (i) Maximum demand and (ii) Diversity factor. These are needed in completing the load calculation and in the computation of current.

In determining the maximum demand of an installation or parts thereof, diversity shall be taken into account.

3.2.2.3 Estimation of load in kW, in kVA and in Amperes

An estimation of loads is necessary initially for design purposes and later for keeping a track of the growth of load. Estimation of loads means estimation of watts or kilowatts in small scale. In bigger scale the kVA is assessed together with the power factor. A calculation of current is then to be performed for the selection of breakers/fuses and the current carrying cables.

3.2.2.4 Estimation of electrical load in Watts

Energy efficient and energy saving should be considered in estimating the electrical load, the watts rating of individual equipment/fittings connected to the system need to be listed and added. Typical

watt ratings of some of the equipment/fittings are shown in following Table which may be used for estimation if the actual values are not known or specified.

Estimated Load for Different Fittings/Fixtures

Type of Fitting/Fixture	Ratings in Watts	Type of Fitting/Fixture	Ratings in Watts
CFL	5-65	15 A Socket outlets	1500
LED and Solar Panel Powered LED Security /Street Lights	10-60	Microwave Oven (domestic)	1200-1500
Fluorescent lamp with accessories:		Washing machine (domestic)	350-500
Nominal length 600 mm	20	Television (medium size)	120-200
Nominal length 1200 mm	40	Computer (without printer)	200
Photo copiers	1200-1500	Computer with printer	700-800
Ceiling fans	100 (Max)	Window type A.C. machine (12000 BTU/hr)	1500
Electric	1500	Split type A.C. machine (12000 BTU/hr)	1300
Table fans	85 (Max)	Geyser (water heater, domestic)	1000-1200
Pedestal fans	120 (Max)	Toaster (domestic)	800-1000
Exhaust fans	100 (Max)	Electric calendar	700-1000
5A socket outlets	300		

3.2.2.5 Calculation of current

For the calculation of current (for the selection of cables and breakers) of the fluorescent lamps the ratings are to be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation.

For the calculation of current (for the selection of cables and breakers) of the ceiling fans, table fans, pedestal fans, exhaust fans the ratings are to be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation.

For the calculation of current (for the selection of cables and breakers) of the small inductive loads (up to 1.0 kW) the ratings are to be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation. The factor shall be higher for higher rated motors.

3.2.2.6 Minimum load densities

While estimating the electrical load, the minimum load densities to be considered are those shown in following Table.

Minimum Load Densities

Type of Occupancy	Unit Load (Watts/m^2)	
	Non A/C	A/C
Residence/ Dwelling : Single family	20	40
Residence/ Dwelling : Multi-family (other than hotels)	20	75
Hospitals	32	80
Hotels, including apartment house (excluding any provisions for electric cooking)	24	75
Office and commercial multi-storeyed buildings	28	75
Industrial building (excluding the loads for machines)	16	-
Departmental stores	28	75
Banks	20	75
Restaurants (excluding any provisions for electric cooking)	16	75
Barber shops and beauty parlours	32	75
Schools and colleges	12	70
Parking area in commercial buildings	4	-
Warehouses, large storage areas	2	-

3.2.3 Calculating Maximum Load Demand

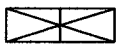
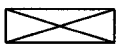
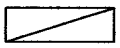
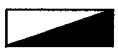
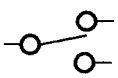
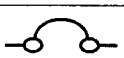
The estimate of the maximum load demand is for determining the specifications of the wiring equipment such as the cables and accessories and subsequently to prepare the electrical installation plans. According to clause 311 of IEC 60364 Part 1, to determine the maximum demand for each circuit while ensuring an economic and reliable design within the permitted

voltage drop limits. Diversity factors may be taken into account. The maximum current demand calculations for each circuit must be prepared. These details will show the current requirements, in amperes, for each phase and also assist in determining the cable sizes.

3.2.4 Electrical Layout and Installation Drawings

An electrical layout plan, Installation drawing and Single Line Diagram (SLD) shall be prepared after proper locations of all outlets for lamps, fans, fixed and transportable appliances, motors etc. have been selected. SLD will show all the MDB/DB/SDB/SB with proper rating. This is the beginning of the electrical distribution design work. This job must be done with due importance prior to starting the construction and installation work. Strong emphasis is given on this work in this document. The following symbols shall be used for Electrical layout drawing.

Symbols used for Electrical Drawings

Serial No.	Description	Symbol
1	Main Distribution Board (MDB)	
2	Floor Distribution Board (FDB)	
3	Distribution Board (DB)	
4	Sub-distribution Board (SDB)	
5	Branch Distribution Board (BDB)	
6	Switch Board (SB)	
7	Telephone Outlet (PSTN)	
8	Telephone Outlet (PABX)	
9	Change over switch	
10	Energy meter	
11	Ammeter	
12	Voltmeter	
13	Power factor meter	
14	Circuit breaker	
15	Fuse	
16	Ceiling mounted Incandescent light fitting	

Serial No.	Description	Symbol
17	Wall mounted bracket light fitting	
18	Ceiling fan	
19	Exit light pendant	EX
20	Exit light-wall mounted	EX
21	2 pin socket Outlet (single phase)	
22	3 pin 13A switched socket Outlet (single phase)	
23	Weatherproof and waterproof socket outlet	WP
24	SPST Single – pole, one-way switch	
25	DPST Two - pole, one-way switch	
26	TPST Three - pole, one-way switch	
27	SPDT Two – way switch	2
28	Push button switch	
29	Buzzer	
30	Single fluorescent lamp on ceiling	
31	Double fluorescent lamp on ceiling	
32	Double fluorescent lamp on wall	
33	Spot light	
34	Wall mounted bracket fan	
35	Exhaust fan	
36	Pull box	
37	TV socket outlet	TV
38	Fire Alarm bell	
39	Fire detector	FD

Serial No.	Description	Symbol
40	Smoke detector	
41	Speaker	
42	Microphone	
43	Conduit, concealed in ceiling or in wall	
44	Conduit, concealed in floor or through under ground	
45	Telephone conduit	
46	Television antenna conduit	
47	Earth Electrode	
48	Cable/Dish TV Socket outlet	
49	Broadband internet socket outlet	
50	Close Circuit Camera/TV	

3.2.4.1 Locating positions of the points on the plan of the building

At the beginning, the Light points, Fan points, Socket points, Switch Boards, BDBs, SDBs, FDBs. DBs and MDBs shall be located on each plan based on convention, suitability, application and safety view point. Conduit layout and cable layout shall then be shown on the drawing.

3.2.4.2 Light and fan circuits must not be mixed with the socket circuits

In designing the wiring layout, power (socket) and heating (socket) sub-circuits shall be kept separate and distinct from light and fan sub-circuits.

All wiring shall be done on the distribution system with main and branch distribution boards placed at convenient positions considering both physical aspects and electrical load centre. All types of wiring whether concealed or surface, shall be as near the ceiling as possible. In all types of wiring due consideration shall be given to neatness and good appearance.

3.2.4.3 Balancing of circuits in three phase distribution boxes is a must

Balancing of circuits in three phase installations shall be arranged in the drawing and also must be done during physical connection.

3.2.4.4 Single phase socket outlets receiving connection from two different phases

Single phase socket outlets receiving connection from two different phases located in the same room is to be avoided. However, if it is essential to have such socket connection these must be located 2 m or more apart.

3.2.4.5 Electrical Layout drawings for industrial premises

Electrical layout drawings for industrial premises shall indicate the relevant civil structure/barrier/duct and mechanical equipment/duct.

3.2.4.6 Preparation of detailed circuit diagram

Circuit diagrams of each of the Light and Fan circuits must first be prepared based on the selection whether it is 5A or 10A circuit. The cable size of each of the circuit's size of the ECC must be shown in the drawing. The circuit diagrams of the BDBs, SDBs, DBs, FDBs, and MDBs etc. are then to be prepared and presented in the form of single line drawings indicating the cable sizes of each

interconnection and the sizes of the ECCs. The distribution of BDBs, SDBs, DBs, FDBs, MDBs etc. are two be shown in a distribution drawing indicating the cable sizes of each interconnection and the sizes of the ECCs.

3.2.4.7 Preparation &Submission of electrical plans and drawing by an experienced & professional Engineer

Electrical Distribution and Wiring Design drawing of building must be prepared by an eligible Engineer having ABC license as mentioned in the followings:

Building Category	Eligible Professional
kacha/ Semi paca/ Up to 2 stories building or 8 meter height (without basement) applicable only for areas beyond the jurisdiction of Development authority, City Corporation and Pourashava	BSc Engineer (EEE) / Diploma Engineer (Electrical) with 3 years experience/ Licensed Electrician with 6 years of experience by ELB.
Up to 5 stories building	BSc Engineer (EEE) with 2 years experience / Diploma Engineer (Electrical) with 5 years experience
Up to 10 stories building or 33 meter height for engineering design and supervision	BSc Engineer (EEE) with 4 years experience
Any height	BSc Engineer (EEE) with 8 years experience

3.3 Fittings, Fixtures and Accessories

Electrical wiring composes of electrical equipment such as cables, switch boards, main switches, miniature circuit breakers (MCB) or fuses, residual current devices (RCD), lighting points, power points, lightning arrestors, etc. The List of Service Connection Materials is annexed in Appendix IV.

Switch boards with back boxes and cover plates, ceiling roses, socket outlets with back boxes, plugs, light fittings, fans, pull boxes with cover plates have been put in this category, although there may be other items which may be included under electrical accessories related to electrical and electronic installations in buildings.

3.3.1 Switch boards

Tumbler switches should be used for surface wiring and piano switches should be used for concealed wiring. Now a day piano switches are also used with surface wiring. Piano switches are mounted on either a plastic back box or a metal back box. These piano switches are available in gangs. The other alternative is to have piano switches mounted on a Perspex or Ebonite sheet which is then mounted

on a metal back box. The Switches must conform to the relevant BDS IEC 60669-1standard. The minimum ampere rating of switch shall not be below 5 A.

Switches may be Single Pole Single Throw (SPST) or Single Pole Double Throw (SPDT) depending on the operation. For some application Double Pole Single Throw (DPST) and Double Pole Double Throw (DPDT) are also available. Usually the DPST switches are made for 10 A, 15 A and 20 A rating. The phase (Live) wire (Brown PVC insulated cable) connection to the point must go through the switch. The metal / sheet steel back boxes of a switch board must have an earthing terminal to terminate the Earth Continuity Conductor (ECC) coming from a BDB or an SDB.

3.3.2 Socket outlets and plugs

In general, all socket outlets must be switched (combined) and shuttered.

3.3.2.1 General requirements of socket outlets

Socket outlets shall be 13 A switched shuttered 3 pin flat pin type. All socket outlets must be switched (combined) and shuttered and shall be for 3 pin Flat pin type (rectangular cross section) 13 A plugs fitted with tubular fuse.

The corresponding plugs must be fitted with fuse. The maximum fuse rating shall be 13 A for 13 A Sockets. The fuse rating may be smaller depending upon the current rating of the appliances used.

The phase wire (Brown cable) shall be connected to the L terminal of the socket outlet through the combined switch and the neutral wire (Blue cable) shall be directly connected to the N terminal of the socket. Earth Continuity Conductor (ECC) (Yellow + Green bi-colour cable) for such a socket outlet shall be connected to the Earth terminal of the socket.

The plug for each 13 A socket outlet provided in a building for the use of domestic appliances shall be provided with its own individual fuse. The feed cables for such a circuit must have fuse or miniature circuit breaker (MCB) at the originating point in the Distribution Board or Sub-Distribution Board or Branch Distribution Board. For some high current applications, additional fuses/ circuit breakers adjacent to the sockets are recommended.

Each socket outlet shall also be controlled by a switch which shall normally be located immediately adjacent thereto or combined therewith. The phase (Live) wire (Brown PVC insulated cable) connection to the socket outlet must be through the switch.

Copper size of the Earth Continuity Conductor (ECC) for such a socket outlet shall not be smaller in size than 1.5 mm^2 PVC insulated cable.

3.3.2.215 A/20 A rated socket outlets

Round pin socket outlets of 15 A/20 A rating may be used for air conditioner outlets and water heater outlets under special circumstances, for air conditioner outlets (requiring 15 A or 20 A), 15 A/20 A rated socket outlets for round pin plugs may be used along with a circuit breaker or fuse protection in a box adjacent to the sockets..

Each 15 A/20 A socket outlet provided in a building for the use of domestic appliances such as air-conditioner, water cooler, etc. shall be provided with its own individual fuse. The feed cables for such a circuit must have fuse or miniature circuit breaker (MCB) at the originating point in the Distribution Board or Sub-Distribution Board or Branch Distribution Board. For some high current applications, additional fuses/circuit breakers adjacent to the sockets are recommended.

Each socket outlet shall also be controlled by a switch which shall normally be located immediately adjacent to the Socket or shall be combined with the Socket.

The corresponding plugs for 15 A should be fitted with fuse. The maximum fuse rating shall be 15 A for 15 A Sockets. For a 15 A rated socket outlet a 15 A rated fuse or a 15 A circuit breaker must be placed adjacent to the socket.

For a 20 A rated socket outlet a 20 A rated fuse or a 20 A circuit breaker must be placed adjacent to the socket.

Wiring for sockets shall be radial type of wiring. However, ring type wiring may be used by strictly following the rules given in IEE Wiring regulations BS 7671 and by using appropriate size of cable.

3.3.2.3 Earth Continuity Conductor (ECC) for a socket

The ECC for a socket outlet shall not be smaller in size than 1.5 mm^2 PVC insulated annealed copper cable. The colour of the ECC cable insulation shall be Yellow + Green bi-colour.

3.3.2.4 Mounting height of a three pin switched socket outlet

Three pin switched shuttered socket outlets shall be mounted on a wall at a height 250 mm above floor level. Switched shuttered socket outlets are essential for safety in particular for the safety of infants. For certain applications like computers, printers, UPS, IPS such sockets may be mounted at a higher level for the ease of operation.

3.3.2.5 Restriction on mounting socket outlets in wet places

No socket outlets shall be provided inside bath rooms/toilets or any other place where floor may remain wet.

3.3.2.6 5A rated 2 pin socket outlets

5 A rated 2 pin socket outlets may be used along with the light and fan switch boards only. Such sockets shall not be used as socket outlets at the skirt level.

3.3.2.7 Number of socket outlets in a room/in a building

The number of socket outlets in a building depends upon the specific requirements of occupants and the type of building. Adequate number of 13 A switched flat pin (rectangular cross section pin) shuttered socket outlets shall be provided and arranged around the building to cater to the actual requirements of the occupancy.

15 A round pin (rectangular cross section pin) socket outlets shall be provided for specially Air-conditioners and water heaters of such ratings only.

For residential buildings, the minimal guidelines given in Table 8.1.18 shall be used to determine the required number of 13 A switched flat pin (rectangular cross section pin) shuttered socket outlets, when actual requirements cannot be ascertained. All socket outlets shall conform to BDS IEC 60884 (Part-1), BDS IEC 60884 (Part 2- 1 to 7).

Minimum Number of 13 A flat pin Socket Outlets

Location	No. of Switch Socket Outlets
Bed room	2
Living room	3
Drawing room	3
Dining room	1
Toaster/Snack toaster	1
Kitchen	1
Bathroom	0
Verandah	1

Refrigerator	1
Air-conditioner	one for each room

3.3.2.8Restriction on installation of two socket outlets in room fed from two phases

Installation of two socket outlets in a room fed from two different phases should be avoided as far as possible. However, in unavoidable cases, the minimum distance between two such socket outlets in a room fed from two different phases must not be less than 2 m under any circumstances.

3.3.2.9Exterior/outdoor sockets

Socket outlets in exposed places where chances of dripping/falling rain water exist should not be placed. In case of necessity, weather proof/waterproof covered socket outlets may be mounted with appropriate precautions. In such a case the back box should preferably be of bakelite or Acrylic or plastic material.

3.3.2.10 Exterior/outdoor switches

Switches in exposed places where chances of dripping/falling rain water exist should not be placed. In case of necessity, weather proof/waterproof covered switches may be mounted with appropriate precautions. In such a case the back box should preferably be of bakelite or Acrylic or plastic material.

3.3.3Ceiling rose

A ceiling rose is needed for terminating the point wiring for a Light or a Fan in the ceiling. A ceiling rose shall not be installed in any circuit operating at a voltage normally exceeding 250 volts. Normally, a single pendant be suspended from only one ceiling rose using a flexible cord. A ceiling rose shall not be used for the attachment of more than one outgoing flexible cord unless it is specially designed for multiple pendants. A ceiling rose shall not contain a fuse terminal as an integral part of it. The ceiling rose shall conform to BDS 116.

Luminaire supporting couplers are designed specifically for the mechanical support as well as for the electrical connection of luminaires and shall not be used for the connection of any other equipment.

3.3.4Light fitting

Switches shall be provided for the control of every light fitting. A switch may control an individual light point or a group of light points. Where control at more than one position is necessary for a lighting fitting or a group of lighting fittings, as many two-way or intermediate switches may be provided as the required number of control positions.

In industrial premises light fittings shall be supported by suitable pipe/conduits, brackets fabricated from structural steel, steel chains or similar materials depending upon the type and weight of the fittings. Where a lighting fitting is to be supported by one or more flexible cords, the maximum weight to which the twin flexible cords may be subject are shown in the following table.

Maximum Permissible Weight to which Twin Flexible Cords may be Subject

Nominal Cross-sectional Area of Twin Flexible Cord (mm^2)	Number and Diameter (mm) of Wires	Maximum Permissible Weight (kg)
0.5	16/0.2	2
0.75	24/0.2	3
1.0	32/0.2	5

Nominal Cross-sectional Area of Twin Flexible Cord (mm^2)	Number and Diameter (mm) of Wires	Maximum Permissible Weight (kg)
1.5	48/0.2	5.3
2.5	80/0.2	8.8
4	128/0.2	14

For a Light fitting with shade, no flammable shade shall form part of the light fitting and the shade shall be well protected against all risks of fire. Celluloid shade or lighting fitting shall not be used under any circumstances.

3.3.5Lighting point

At each fixed lighting point one of the following accessories shall be used

(i) one ceiling rose conforming BS 67, BDS 116

(ii) one luminaire supporting coupler conforming BS 6972 or BS 7001

(iii)one batten lamp holder conforming BS 7895, BS EN 60238, BS EN 61184, BDS 1132(Part-1) & BDS 1132(Part-2)

(iv)one luminaire designed to be connected directly to the circuit wiring

(v) one suitable socket-outlet

(vi)one connection unit conforming BS 5733 or BS 1363-4. BDS IEC 60884 (Part-1), BDS IEC 60884 (Part 2- 1 to 7)

A lighting installation shall be appropriately controlled e.g., by a switch or combination of switches to BS 3676 and/or BDS IEC 60669-1 or by a suitable automatic control system, which where necessary shall be suitable for discharge lighting circuits.

3.3.5.1 Wires/cables used inside light fittings and any other fitting

Wires/cables used inside a light fitting or any other fittings are mostly flexible types. In some cases single core PVC insulated wiring cables mostly 1.5 mm^2 are used. In such cases the cables must be of high quality in terms of insulation and must have appropriate copper cross section. Such cables are usually terminated in a ceiling rose.

3.3.6 Fans

3.3.6.1 Ceiling fan

Ceiling fans including their suspension shall conform to BDS 818. With respect to the position of a lighting fitting, the positioning of a fan shall be such so that it does not throw any shadow on the working plane is not acceptable. The unit module area shall be so chosen that the required number of fans could be suitably located, to avoid creation of pockets receiving little or no air circulation.

In general, fans in large halls may be spaced at 3 to 3.5 m in both the directions in the horizontal plane. If building modules do not lend themselves to proper positioning of the required number of ceiling fans, other types of fans, such as air circulators or wall mounted bracket fans shall have to be installed for the areas uncovered by the ceiling fans. In such cases, necessary electrical outlets shall have to be provided for the purpose. The recommended areas to be served by different sizes of ceiling fans where the height of fan blades is at 2.5 m above the finished floor level.

Recommended Fan Sizes in Rooms

Room Area (m^2)	Fan Sweep
Up to 6	915 mm
Over 6 to 9	1220 mm

Over 9 to 12	1442 mm

Wiring for a ceiling fan outlet from the switch board up to the ceiling fan outlet shall be done through pre-laid 18 mm dia PVC conduits using 1.5 mm^2 PVC insulated 2 cables of Brown and Blue insulation. A high quality ceiling rose is to be installed at the ceiling fan point for the termination of the wiring and the connection of the two wires of the Fan. A fan hook is required to be placed during casting of the roof. The fan hook is to be made using a 12 mm dia MS rod having at least 600mm on both sides and shall be placed above the MS rod mesh of the roof slab.

3.3.6.1.1 Installation/mounting of ceiling fans

Ceiling Fans shall be suspended from Fan hooks that are to be placed in position during casting of the Roof.

3.3.6.1.2 Fan hooks

Fan hooks may be concealed (hidden) or may be exposed type. Fan hooks shall be made using MS rods of 12 mm diameter. The diameter of this rod shall not be below 10 mm under any circumstances.

3.3.6.1.3 Ceiling roses for fan points

Appropriate type of ceiling roses must be provided at the fan points for the termination of the Fan point wiring cables. Connection to the Ceiling Fans will go from the ceiling roses.

3.3.6.2 Wall mounted bracket fan

For Wall mounted bracket fans shall be mounted on the wall using appropriate rowel bolts. Wiring for a Wall mounted bracket fan outlet from the switch board up to the Wall mounted bracket fan outlet shall be done through pre-laid 18 mm dia PVC conduits using 1.5 mm^2 PVC insulated 2 cables of red and black insulation. A high quality ceiling rose is to be installed at the ceiling fan point for the termination of the wiring and the connection of the two wires of the Fan.

3.3.6.3 Pedestal fans and table fans

These items are movable and no fixed connections are necessary. Sockets will be used to energize these fans.

3.3.6.4 Installation/mounting of ventilating fans or exhaust fans

Exhaust fans are necessary for spaces, such as toilets, kitchens, canteens and godowns to provide the required air changes. Since the exhaust fans are located generally on the outer walls of a room, appropriate openings in such walls shall be provided right from the planning stage. The sizes and the rpm of the exhaust fans will vary according to the application and the volume for which a fan used. In some applications (such as some industries, big size gas generator room etc.) high rpm fans are essential. In all cases appropriate types of fan need to be chosen and appropriate arrangement need to be made so that rain water cannot get inside the rooms.

3.3.6.5 Cutout box/circuit breaker box

If the BDB or the SDB from which a 3-pin switched shuttered socket receives power is at a significant distance away and the load connected to the socket needs special care an additional cutout box or a circuit breaker box may be placed adjacent to the socket. Such a cutout Box or a Circuit Breaker box shallbe placed inside a 18SWG Sheet Steel (coated with two coats of synthetic enamel

paint) of appropriate size with appropriate Perspex cover plate. Such a box may be surface fitted or may be concealed fitted. The box shall havea brass terminal for the termination of the ECC.

3.4.0 Distribution Wiring in a Building

3.4.1.1 General

Loads are separated into known and unknown loads.

General illumination is a known load, whether derived from detailed lighting layout, or developed from watts per square meter calculation. Similarly fans are also known loads. Besides these two types, there may be some other known loads.

Number, rating and layout of outlets for general illumination, fans and other known loads should accurately be distributed among a number of branch circuits. These branch circuits should then be carefully loaded with due regard to voltage drop, operating voltage and possible increase in lighting levels in future. On the other hand the sockets are unknown loads. Socket loads will be determined from projections based on the utility of the building and type of applications.

Every installation shall be divided into small circuits (following the rules given in this document) to avoid danger in case of a fault, and to facilitate safe operation, inspection, maintenance and testing. For the establishment of the circuits appropriate type of wiring is needed and appropriate terminations/connections/junctions of these circuits are needed. At the same time appropriate types of protection against faults must be given at different levels. These are to be achieved through installation of appropriate distribution wiring in the building.

3.4.1.2 Distribution board

A Distribution Board is the junction point of the incoming line and the outgoing lines for the distribution of Electricity throughout the building. The incoming as well as theoutgoing lines must have Circuit Breaker protection or Fuse protection. The junctions and terminations of the incoming and outgoing cables are made through copper bars containing bolts and nuts for cable lugs known as bus-bars. A Distribution board may be named as MDB or FDB or DB or SDB or BDB.

(a) MDB stands for Main Distribution Board. This is the distribution box where the main incoming cable enters and terminates from the main service feed connection of a large building. The FDBs get feed from MDB.

(b) FDB stands for Floor Distribution Board located in each of the floors of a multistoried building. The DBs get feed from FDB. Usually, more than one FDB are needed.

(c) DB is the abbreviation for Distribution Board. This may be the box where the main incoming cable enters and terminates from the main service feed connection. The SDBs get feed from a DB.

(d) SDB is used to represent Sub- Distribution Board. This board is located in the same floor of a building and connected to the DB. Usually more than one SDB are needed. The BDBs get feed from SDB.

(e) BDB stands for Branch-Distribution Board located in the same floor of a building and connected to the SDB. Usually more than one BDB are needed.

(f) EDB, EFDF, ESDB, EBDB Sections of DB, FDB, SDB, BDB receiving feed from the Emergency Bus-bar which in turn is getting feed from standby generator through changeover switch. These may be separate DBs placed by the corresponding normal supply DBs.

Each of these distribution boards must have bus bars for Line, neutral and earthing for a single phase box. A 3-phase distribution board must have bus bars for Line1, Line2, and Line 3, neutral and earthing.

These boxes shall be made with sheet steel of not less than 18 SWG thicknesses and must be appropriately paint finished to match the wall paint.

3.4.1.3 Circuit wiring

3.4.1.3.1 Separate branch circuits for separate control

Separate branch circuits shall be provided for different parts of a building area which need to be separately controlled. A branch circuit should be independently working and should not be affected due to the failure of another branch circuit.

The number of final circuits (also termed as sub-circuits or circuits) required and the points supplied by any final circuits shall comply with

(i) the requirement of over-current protection,

(ii) the requirement for isolation and switching, and

(iii) the selection of cables and conductors.

All final circuits shall be wired using loop wiring system; no joint box shall be used.

Sufficient number of 18 SWG sheet steel made (painted with two coats of grey synthetic enamel paint) pull boxes, with ebonite/perspex sheet cover plate, must be given on the walls near the ceiling. If brick walls are not available, pull boxes must be given in the ceilings.

3.4.1.3.2 For domestic and office buildings

5A Light/Fan Circuits must be used for all Domestic and Residential buildings. 5A Light / Fan Circuits are also to be used for Office and commercial Buildings. The corresponding circuit wire in the BDB/ SDB/ DB then shall be not less than 1.5 mm^2.

3.4.1.3.3 For office and commercial buildings having large open floor areas

Under unavoidable circumstances, in case of difficulties in forming 5A light/fan circuits for office and commercial buildings having large open floor areas, 10 A light/fan circuits may be used. The corresponding circuit wire in the BDB/SDB/DB then shall be not less than 2.5 mm^2. However, use of 5A light/fan circuits is still emphasized.

3.4.1.3.4 For industrial/factory buildings having large open floor areas

For industrial/factory buildings having large open floor areas, 10A light/fan circuits may be used.

3.4.1.3.5 For industrial/factory buildings/warehouses having too large open floor areas

For industrial/factory buildings/warehouses having large open floor areas, efforts should be given to use circuits not exceeding 10A. The corresponding circuit wire in the BDB/SDB/DB then shall be not less than 2.5 mm^2.

For Industrial/Factory Buildings having very large open floor areas, 15 A light/fan circuits may be used as exceptional cases only. The corresponding circuit breaker in the BDB/SDB/DB then shall be not less than 4 mm^2.

Increase in the sizes of the above mentioned cables may be required if the distance is too long. Voltage drop calculation will give the guidance in that case.

3.4.1.3.6 Separate branch circuits from Miniature Circuit Breaker (MCB)

Separate branch circuits shall be provided from miniature circuit breaker (MCB) of a BDBD/SDB or fuse of the fuse distribution boards (FDB) for light/fan.

Separate branch circuits shall be provided from miniature circuit breaker (MCB) of a BDBD/SDB or fuse of the Fuse distribution boards (FDB) for automatic and fixed appliances with a load of 500 watt or more and socket outlets. Each automatic or fixed appliance shall be served by a protected socket circuit.

3.4.1.3.7 Less than 50% loading of circuits with more than one outlet

Circuits with more than one outlet shall not be loaded in excess of 50% of their current carrying capacity.

3.4.1.3.8 Branch circuits must have spare capacity to permit at least 20% increase in load

Each branch circuit running between a DB and a SDB, between a SDB and a BDB must have spare capacity to permit at least 20% increase in load before reaching the level of maximum continuous load current permitted for that circuit.

3.4.1.3.9 One spare circuit must be allowed in the distribution board for each five circuits in use

At least one spare circuit must be allowed in the distribution board for each five circuits in use. Additional space for a circuit breaker along with the provision for connecting a pair of outgoing cables shall be kept.

3.4.1.3.10 Each final circuit shall be connected to a separate way in a distribution board

Where an installation comprises more than one final circuit, each final circuit shall be connected to a separate way in a distribution board. The wiring of each final circuit shall be electrically separate from that of every other final circuit, so as to prevent unwanted energization of a final circuit.

3.4.1.3.11 Size of cables in a branch circuit shall be at least one size larger than that needed for the computed load current

Size of cables to be used in a branch circuit shall be at least one size larger than that computed from the loading if the distance from the over-current protective device to the first outlet is over 15 m.

3.4.1.3.12 4 mm^2 (7/0.036) and 6 mm^2 (7/0.044) wiring cable for a 15A socket outlet branch circuit

The minimum size of wiring cable used for a 15A socket outlet branch circuit shall be 4 mm^2 (7/0.036). When the distance from the over-current protective device to the first socket outlet on a receptacle circuit is over 30 m the minimum size of wire used for a 15A branch circuit shall be 6 mm^2 (7/0.044).

3.4.1.3.13 Length of a lighting circuit

The length of a lighting circuit shall be limited to a maximum of 30 m, unless the load on the circuit is so small that voltage drop between the over-current protective device and any outlet is below 1 percent.

3.4.1.3.14 Use of common neutral for more than one circuit is prohibited

Each circuit must have its own neutral cable. Use of common neutral cable for more than one circuit is not permitted.

3.4.1.3.15 Following the appropriate new colour codes of cables

During wiring, correct colour codes of the insulation of the cables must be used.

Previously, for a single phase circuit red colour insulation was used for the live wire and the black colour insulation for the neutral and green + yellow bi-colour insulation was used for the ECC. Previously, for a three phase circuit red colour was used for the live (L1), Yellow colour for the live (L2), Blue colour for the live (L3) cable and the black colour for the neutral and green + yellow bi-colour for the ECC. This colour code of cables shall now be replaced by the current BDS 900 cable colour code standards by the following Table. The current BDS 900 code is recommended to be followed in Bangladesh.

New introduced Colour Codes of Cables Following Standards

Item	Pre-1977 IEE	Pre-2004 IEE	BDS 900
Protective earth (PE)	Green	Green/yellow bi-colour	Green/yellow bi-colour
Neutral (N)	Black	Black	Black
Single phase: Line (L) Three-phase: L1	Red	Red	Red
Three-phase: L2	Yellow	Yellow	Yellow
Three-phase: L3	Blue	Blue	Blue

3.4.1.3.16 Balancing of circuits in three phase SDBs, DBs, FDBs, and MDBs.

In a 3 phase distribution system special care must be taken during wiring to obtain balancing of loads among the three phases.

In a 3 phase SDB, DB, FDB, MDB connections of the circuits to the bus-bars must be made in such a way so that the load current remains balanced among the three lines during low load as well as full load. After completing the installation balancing should be checked by clamp meter current measurement of each phase.

The above mentioned current balancing must be indicated in the SDB (if 3 phase), DB, FDB, and MDB circuit diagram of design drawing. This should also be mentioned in the specification.

3.5.0 Electrical Wiring in the Interior of Buildings

3.5.1.1 Surface wiring or exposed wiring

Wiring run over the surface of walls and ceilings, whether contained in conduits or not, is termed as surface wiring or exposed wiring.

Single core PVC insulated copper/Aluminium through PVC channels or through PVC conduits or through GI pipes of approved quality may be used for surface wiring.

Surface wiring using twin core flat PVC insulated copper/Aluminium on wooden battens used to be used long back. This is almost discontinued and discouraged now a day.

PVC conduits or GI pipes, when used for surface wiring, shall be clamped with saddles at a spacing not exceeding 600 mm, to the wall or ceiling using plastic rowel plugs with countersunk galvanized screws.

3.5.1.1.1 Surface wiring using wood battens

The wood batten used in this method shall be of good quality wood with a minimum thickness of 12 mm. They shall be installed exposed and run straight on the ceiling or wall surfaces. Battens on walls shall be run either horizontally or vertically, and never at an angle. Battens on ceilings shall run parallel to the edges in either orthogonal direction, and not at an angle, they shall be fixed to the wall or ceiling by rowel plugs and countersunk galvanized screws. Cables shall be fixed to the battens by using galvanized steel clips or brass link clips or PVC clips of required size at a spacing not exceeding 100 mm.

3.5.1.1.2 Surface wiring using PVC conduits

PVC conduits or GI pipes, when used for surface wiring, shall be clamped with saddles at a spacing not exceeding 600 mm, to the wall or ceiling using plastic rowel plugs with countersunk galvanized screws.

The conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

3.5.1.1.3 Surface wiring using PVC channels

Surface wiring may be done using single core PVC insulated cables placed inside surface fixed PVC channels of appropriate size. Fixing of channels must be done using screws in rowel plugs inserted into drilled holes on the walls/ceilings. The channels must be placed in a straight line with adequate number of screws so that no sag is observed. Cables must not be stressed in the bends. Adequate space must exist inside the channel to put the cables in position without difficulty.

Surface wiring using flexible chords, clips and nails shall not be used in general.

3.5.1.1.4 Surface wiring using Round core flexible cable with plastic clips and nails

Surface wiring using exposed Round core flexible cable with plastic clips and long nails have been used for extending a point wiring, for extending a socket wiring due to shift, for add a circuit wiring.

This is not recommended for regular wiring. Instead of using this method, one should go for the recommended surface wiring using single core PVC cables with PVC channels or single core PVC cables with PVC conduits as mentioned above in this document.

For a length of not exceeding 1 m this may be used only for shifting an existing Light/Fan point or for shifting an existing socket point only under unavoidable circumstances.

3.5.1.2 Concealed wiring

The wires in this type of wiring shall be placed inside GI conduits or PVC conduits that are buried in roofs and in brick/concrete walls. The conduits in the walls shall be run horizontally or vertically, and not at an angle.

Conduits in concrete slabs shall be placed at the centre of thickness and supported during casting by mortar blocks or 'chairs' made of steel bars or any other approved means. All conduits shall be continuous throughout their lengths.

Appropriate planning should be made in which there shall be adequate spare capacity in the conduits placed in roof slabs so that unforeseen situation during execution of the installation can be taken care of. Conduits will run through the roof and then bend downward for going up to the outlets, DBs, switch boards, sockets.

In a column structure building having no permanent walls, switch boards and socket boards, pull boxes shall be placed in columns and must be done during the casting of columns.

Concealed wiring through floors and upward mounting of PVC/GI pipes from the floor is strongly discouraged because of the occurrence of condensation and accumulation of water from condensation eventually leading to damaging of the simple PVC insulated cable insulation. This method should not be followed as a general practice.

Underground cables for electrical distribution in the premises/garden/compound of the building shall be encased in GI or PVC pipes and laid in earth trenches of sufficient depth. Armoured cables need not be encased in conduits except for crossings under road, footpath, walkway or floors.

The conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

3.5.1.3 Wiring inside suspended ceilings (false ceilings)

Wiring inside suspended ceilings (false ceilings) shall be surface wiring through conduits or through PVC channels mentioned under the heading of surface wiring methods.

- Cables shall not be placed loosely and haphazardly on the suspended ceilings. Placing naked cables inside the suspended ceiling is not permitted.

Cable joints with PVC tape wrapping is not allowed for connection of a fitting from the ceiling rose or from a junction box inside the gap space.

3.5.1.4 Wiring through cable tray

Wiring for connections to some machines may be carried through a cable tray suspended from the ceiling. This is very rare for a domestic building. However in a commercial / office or industrial building this technique may be needed. In special circumstances Cables may be pulled through pre laid GI/ PVC pipes under the floor where there will be no chances of water accumulation in the floor or condensation.

3.5.1.5 Mounting height of light and fan switch boards

Light and fan switch boards shall be placed 1220 mm above floor level in the residential buildings (i.e, the clearance between the floor and the bottom of the switch board shall be 1220 mm).

This above mentioned height shall be 1300 mm above floor level in the office buildings, commercial buildings and industrial buildings. However, the minimum height shall not be below 1220 mm.

3.5.1.6 Restriction on the use of plastic/PVC insulated flexible cords/cables

Plastic/PVC insulated flexible cords/cables shall not be used for wiring of light/fan points or for wiring of sockets, or for wiring of any sub circuits.

3.5.1.7 Cable joints and cable joint boxes in concealed and surface wiring

Both the Brown (L) and Blue (N) cables of a final circuit shall run from a BDB/SDB up to the switch board without a joint. Similarly, both the Brown (L) and Blue (N) cables of a point shall run from the point up to the switch board. Cable joints are to be made in the switch board back box. Where the above methods are not implementable, joints shall be made using approved cable joint methods.

3.5.2 Methods of Point Wiring and Circuit Wiring

3.5.2.1 Methods of Point Wiring

Wiring between a light/fan point and its corresponding switch board is termed as Point Wiring. The load of such a point is not in excess of 100 watts in general, and in special cases this may be up to 200 watts. Wiring for a light/fan point shall be made using one of the following two methods: (i) Surface wiring or (ii) Concealed wiring. For wiring of a point one brown and one blue PVC insulated copper cable shall run between a point and its switch board. Cable joints inside conduits or within channels are forbidden. The current carrying capacity for such a circuit shall not be more than 5A for a residential or a commercial (business/mercantile) building. The minimum size of a cable for such wiring shall be 1.5 mm^2.

Common neutral shall not be used under any circumstances.

3.5.2.2 Methods of Circuit Wiring

Wiring between a switch board and a BDB/SDB/DB will be called Circuit Wiring. Circuit wiring shall be done with a live cable a neutral cable and an ECC cable for a single phase circuit. Sometimes this circuit is also referred to as sub-circuit.

An ECC must be provided with each circuit. The ECC at the switch board end shall be terminated in the earth terminal of the metal part of the switch board using a brass screw/bolt and a nut. The BDB/SDB/DB end of the ECC shall be terminated in the earthingbusbar of the BDB/SDB/DB.

The ECC in this case shall be PVC insulated copper cable of appropriate size but with yellow + green bi-colour insulation.

For each circuit, the live cable must be drawn using brown colour insulated PVC cable and the neutral cable shall be drawn using blue colour insulated PVC cable.

Common neutral shall not be used under any circumstances.

The minimum sizes of cable for various uses shall be as follows:

(a) For a 5 A circuit protected by a 5 A circuit breaker or fuse shall not be below 1.5 mm^2

(b) For a 10 A circuit protected by a 10 A circuit breaker or fuse shall not be below 2.5 mm^2.

(c) For a 15 A circuit protected by a 15 A circuit breaker or fuse shall not be below 4 mm^2.

(d) For a 20 A circuit protected by a 20 A circuit breaker or fuse shall not be below 6 mm^2.

The above mentioned sizes must be increased for long cables as mentioned elsewhere in this document.

In general, the minimum size of cable for a particular circuit shall depend on the rating of the fuse or circuit breaker used for the protection of that circuit. A voltage drop check is to be made for each length of the circuit to ensure that the voltage drop at the farthest end of the load from the main distribution point does not exceed 2.5 percent.

Sockets shall get direct connection from the BDB/SDB through breaker/fuse protection. Depending on the assessed requirements sockets may be grouped/looped at the socket end. Such grouping shall not exceed 3 numbers of sockets in one circuit.

3.5.3 Feeder Wiring between SDB and BDB, DB and SDB, FDB to DB, MDB to FDB etc.

Wiring between a BDB and an SDB, an SDB and a DB, a DB and an FDB, an FDB and an MDB needs special attention and the rules are similar to Circuit Wiring. ECC must be present for each of the feed connections. The ECC in this case also shall be PVC insulated cupper/Aluminum cable of appropriate size but with Green+ Yellow bi-colour insulation.

At both ends the ECC must be terminated at the earthing bus bar.

Appropriate cable lugs/cable sockets must be used for terminating the L1, L2, L3, N and E connections on the bus bars of both the boards. The sizes of the cables must be chosen to match with the rating of the circuit breaker/fuse ratings as mentioned above.

Circuit breakers/fuses must be provided at the outgoing and incoming sides of each of the bus bars of each BDB/SDB/DB/FDB boxes.

3.5.4 Conduits, Channels, Cables, Conductors and related Accessories

Conduits, Cables, Conductors and Accessories are important parts of an electrical distribution installation.

3.5.4.1 Conduits and conduit fittings

Cables of an electrical distribution installation are drawn through electrical conduits. For the installation of conduits various types of fittings are needed. For the two types of commonly used conduits,PVC and Metal,fittings should be as under.

3.5.4.1.1 PVC conduits

(i) PVC conduits and conduit fittings shall be of heavy wall water grade type. All bends shall be large radius bends formed by heat or by mechanical bending machine. The cross-section of the conduit shall remain circular at the bend and the internal diameter shall not be reduced due to bending. PVC pipe fittings shall be sealed with PVC solvent cement or adhesive for PVC of approved quality.

(ii) Conduits installed in floors, if installed, shall have a slope of at least 1:1000 towards floor mounted pull box or cable duct.

(iii)Conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

(iv) Water grade PVC conduits must be used for both concealed and surface wiring. Water grade PVC conduits of different diameters shall be used as per necessity.

(v) Appropriate high grade bends and circular boxes must be used with the PVC pipes.

(vi) 18SWG metal sheet made and synthetic enamel paint coated quality boxes of matching sizes shall be used as pull boxes and junction boxes. Appropriate pull-box covers of ebonite or perspex sheet shall be fitted with GI machine screw and washer.

(vii) The PVC conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

3.5.4.1.2 PVC channels

PVC channels should be used only for extension work in an already installed building. A design drawing should not show use of such wiring except inside a false ceiling. Even inside the false ceiling this item should be used for lengths. For long distances PVC conduits should be used. High quality PVC channels of sufficient thickness should be used and fixed in a neat manner. For large number of cables and for thick cables PVC channels should not be used.

3.5.4.1.3 PVC flexible pipes/conduits

PVC flexible conduits shall be used with surface wiring only and only in places where PVC bends cannot be used. Except special circumstances flexible PVC conduits shall not be used.

3.5.4.1.4 Metal/steel conduits

Galvanized Iron (GI) conduits shall be made using at least 16 SWG sheet. The conduits shall have seamless joint along the length and must be suitable for making bends. No projections are allowed inside the conduits. Metal conduits must be threaded for end to end joints using sockets. In case of necessity, threads will be cut at the end of short pieces. Sharp edges at the ends must be properly treated so that cable injury does not take place during cable pulling.

3.5.4.1.5 Pull boxes

(i) Pull boxes/Joint boxes must be placed closed to the ceiling where conduits from the ceiling are going downward toward a switch box or are going toward a socket box or are going toward a BDB/ SDB/ DB / FDB.

(ii) Pull boxes are extremely essential for pulling the cables without injuring the cables and thus should not be avoided under any circumstances. These are also essential for future maintenance and extension work.

(iii) Pull boxes/Joint boxes must be placed in the ceiling of office/factory building where conduits are running over a long distance between two walls (terminal points) and where fixed walls are not available and also where heavy beams are used. In case of big cross section beams pull boxes/joint boxes shall be placed closed to the beams.

(iv) Pull boxes/Joint boxes must be made with 18 SWG GI sheet or with 18 SWG MS sheet but coated with two coats of Grey Synthetic Enamel paint.

(v) Covers of pull boxes should be ebonite or perspex sheet of not less than 1/8 inch thickness.

3.5.4.1.6 Metal Boxes for Switch Boards

Metal Boxes for Switch Boards must be made with 18 SWG GI sheet or with 18 SWG MS sheet but coated with two coats of Grey Synthetic Enamel paint. A Switch Board Metal Box must have a small Copper / Brass earthing busbar for terminating the ECCs.

3.5.4.1.7 Switches for operating light and fan points

Switches for operating Light and Fan points must be of 5A rating. These switches are usually SPST type. However, for special applications like stairs and some other places these may be SPDT type.

Switches for operating Light and Fan points may be of Gang type or may be isolated type. The isolated types are to be mounted on an ebonite top plate which is again fitted on the above mentioned Metal boxes for Switch Boards.

3.5.4.1.8 Mounting regulators of ceiling fans

Metal Boxes for Mounting Inductor Regulators of Ceiling Fans must be made with 18 SWG GI sheet or with 18 SWG MS sheet but coated with two coats of Grey Synthetic Enamel paint. Metal Boxes for mounting regulators of ceiling fans must have a small copper/brass earthingbusbar for terminating the ECCs.

However, such regulators may be placed inside the 18 SWG GI sheet or MS sheet made Metal Boxes for Switch Boards. In such a case arrangements must be made so that the PVC insulated point and circuit wiring cables and their joints inside the switch board do not touch a regulator. This may be done by appropriately dressing the cables and fastening the cables by using polymer cable fasteners.

3.5.4.2 Cables and conductors

For application in building wiring, PVC insulated stranded cables shall be used for Live and Neutral Wires for single phase and 3-lines (L1, L2, L3) and one neutral for 3-phase. For ECC also PVC insulated stranded cables shall be used. As a result, use of bare conductors is non-existent.

Selection of Wiring Cable Type

The selection of the cable size has to take into consideration the following:-

i. All wiring cables must be PVC or PVC/PVC insulated with copper or aluminum conductors. Conductors with cross sectional areas of 16mm^2 or less must be of copper or aluminum.
ii. The selected cable must be capable of delivering the electrical energy efficiently;
iii. The cable size allows it to carry the current without heating the cable;
iv. The voltage drop must not exceed 4% of the supply voltage.
v. The cable insulation must be suitable for the surrounding conditions of the installation, such as the ability to withstand the surrounding temperatures and the ability to provide mechanical protection;
vi. Each conductor in the installation must be protected from overcurrent by means of overcurrent protection devices needed to prevent damage to the cable insulation.

3.5.4.2.1 Cables

Conductors of BYA/BYM/NYY/ FR PVC insulated cable, thin or thick, shall be copper. Cable containing Aluminum conductors may be used for thick cable of size more than 35mm^2 but copper is always preferred.

Cables for power and lighting circuits shall be of adequate size to carry the designed circuit load without exceeding the permissible thermal limits for the insulation. The voltage drop shall also be within the specified limit of 2.5 percent from a distribution point up to their farthest end of the load point. Recommended sizes (in mm^2) of copper conductors are as follows:

1, 1.5, 2.5, 4, 6, 10, 16, 25, 35, 50, 70, 95, 120, 150, 185, 240, 300, 400, 500, 630, 800, 1000

For final circuit/sub-circuit and for Light/fan point wiring the cable nominal cross-section of the cable shall not be less than 1.5 mm^2 for copper conductors.

Standard copper conductor sizes of cables which should be used for electrical installations/distribution in buildings are given below. Conductors of sizes other than the sizes listed below are not recommended.

3.5.4.2.2 Phase and neutral cables shall be of the same size

In the wiring of the sub-circuit/circuit and all other circuits inside a building the Phase cable and the neutral cable shall be of the same size.

3.5.4.2.3 Flexible cables/flexible cords

The minimum cross-sectional area of conductors of flexible cables/flexible cords shall be 0.5 mm^2 for copper conductors. Flexible cable or cords shall not be used as fixed wiring unless contained in an enclosure affording mechanical protection.

Flexible cables/flexible cords may be used for connections to portable equipment. For the purpose of this regulation an electric cooker of rated input exceeding 3 kW is not considered to be portable. The flexible cord shall be of sufficient length so as to avoid undue risk of damage to the outlet, cord or equipment and of being a hazard to personnel.

3.5.4.2.4 Treatment of cable ends/cable terminations

All stranded conductors must be provided with cable sockets/cable lugs of appropriate size fitted using appropriate hand press tool or hand crimp tool or hydraulic press tool depending on the size of the cable. This is necessary for termination of the cable ends on bus-bars. Earthing/grounding cable connection shall be ensured to each 3 pin socket.

3.5.4.2.5 Jointing of cables in wiring

Cable joints for the PVC insulated cables used in circuit wiring (thin cables) are to be made through porcelain/PVC connectors with PIB tape wound around the connector before placing the cable inside the box joint/pull box.

3.5.5 Conduits through the Building Expansion Joints

Conduits shall not normally be allowed to cross expansion joints in a building. Where such crossing is found to be unavoidable, special care must be taken to ensure that the conduit runs and wiring are not in any way put to strain or are not damaged due to expansion/contraction of the building structure. In unavoidable situations, PVC conduit through an oversize flexible PVC conduit may be used with pull boxes on both sides of expansion joints.

3.5.6 Types of Electrical Wiring for Exterior Lighting and other exterior purposes

3.5.6.1 Electrical wiring for garden lighting

For garden lighting PVC insulated PVC sheathed underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. However, in case of necessity, metal sleeve cable ferrule joints using Crimp Tool or hydraulic press and heat shrink insulated sleeve shall be used on top.

3.5.6.2 Electrical wiring for street lighting

For street lighting PVC insulated PVC sheathed underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. However, in case of necessity, metal sleeve cable ferrule joints using Crimp Tool or hydraulic press and heat shrink insulated sleeve shall be used on top. Joining the cables at the bottom of a street pole must be done inside a metal joint box located sufficiently above the street level so that water cannot reach the box even during the worst rain/flood situation.

3.5.6.3 Electrical wiring for boundary light

For boundary lighting PVC insulated PVC sheathed underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. However, in case of necessity, metal sleeve or cable ferrule joints using Crimp Tool or hydraulic press and heat shrink insulated sleeve shall be used on top. However, for the portion of the cable running concealed through a wall, PVC insulated cables through PVC conduits may be used.

3.5.7 Branch Distribution Boards, Sub-distribution Boards, Distribution Boards, FDBs and MDBs

3.5.7.1 Enclosure/box

Enclosures for sub-distribution boards located inside the building shall be dust-proof and vermin-proof using sheet steel fabrication of a minimum thickness of 20 SWG. The boards shall be safe in operation and safe against spread of fire due to short circuit.

3.5.7.2 Size of the enclosure of a BDB/SDB/DB/FDB/MDB

The following table provides a guidance of sizes of enclosures for SDB containing miniature circuit breakers or fuses. However, the size will depend on the number and size of the circuit breakers or the fuses the number of outgoing cables and their sizes, the size of the busbars and the type of insulators used for the busbars.

Recommended Enclosure Sizes for MCB's and Fuses

Dimensions (mm)			No. of MCB's or Fuses
Height	Width	Depth	
350	390	120	up to 12
480	390	120	up to 24
610	390	120	up to 36
740	390	120	up to 48

3.5.7.3 Location

A Sub-distribution board (SDB) shall be located as close as possible to the electrical load centre for that SDB. This is also applicable for determining the locations of FDBs, DB and BDBs. These boards shall never be located on water soaked or damp walls.

3.5.7.4 Wiring of sub-distribution boards

(a) In wiring a sub-distribution board, total load of the consuming devices shall be distributed, as far as possible, evenly between the numbers of ways of the board, leaving the spare way(s) for future extension.

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

(c) Cables shall be connected to terminals only by soldered or welded lugs, unless the terminals are of such form that it is possible to securely clamp them without cutting away the cable strands.

3.6.0 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables and L.T. Busbar Trunking

3.6.1.1 Vertical service shaft for electrical risers

For buildings over six-storey or 20 m high there shall, in general, be a minimum of one vertical electrical service shaft of (200 mm x 400 mm) size for every 1500 m^2 floor area. The electrical service shaft shall exclusively be used for the following purposes:

(a) Electric supply feeder cables or riser mains
(b) Busbar Trunking
(c) telephone cables
(d) Data Cables
(e) fire alarm cables
(f) CCTV cables

(g) Other signal cables

(h) Area fuse/circuit breakers

(i) Floor Distribution board/sub-distribution boards for individual floors.

The construction of the floors of the duct area shall be constructed in such a way so that the remaining empty open space after putting the cables/busbartrunking/pipes/conduits in position is filled up with RCC slab(s) or any other non-inflammable material so that fire or molten PVC cannot fall from one floor to the next lower floor(s). For this purpose arrangements need to be made during floor casting.

Free and easy access to the electrical shaft room in each floor must be available for operation, maintenance and emergency shut downs.

Vertical cables other than electrical cables shall be placed at a sufficient distance from the nearest electrical cable. A vertical separating brick wall between electrical and non-electrical wall is preferable.

Vertical Service Shaft for Electrical Risers as mentioned above must not be placed adjacent to the Sanitary Shafts. They should be placed at significant separation in order to ensure that the Vertical Service Shaft for Electrical Risers remains absolutely dry.

3.6.1.2 LT Riser main cables

(a) For low rise building riser main cables will serve to bring L.T. connection to the floor distribution boards (FDBs) of each floor from the main distribution board. For a 5 storied building or lesser having a floor space of less than 600 m^2in each floor the riser cables may be PVC insulated cables through PVC or GI pipes.

(b) For bringing the riser main cables a common vertical wall and holes or slots in the floors must be given by the building construction people.

(c) However, for larger floor area or for higher buildings PVC insulated PVC sheathed underground cables must be used with protection and spacing.

(d) For more than 9 storied building Busbar preferably sandwiched copper busbartrunking should be used for safety reasons.

(e) PVC insulated PVC Sheathed underground cables must be used as Riser Main Cables. These cables shall beplaced in or pulled through a PVC pipe of higher diameter so that the cable can be easily pulled through it. The PVC pipes must be fixed vertically in a straight line on the wall of the shaft using appropriate saddles. However, in some cases PVC insulated PVC Sheathed underground cables may be directly fixed on the wall using appropriate saddles with 37mm spacing between two adjacent cables. Sheet metal made Joint Boxes (with ebonite cover plates) must be placed at each floor tapping point.

(f) The cable work shall be done neatly so that no suspended cables are seen around the place and no suspended flexible pipes are seen.

(g) Each riser cable must have appropriate fuse or circuit breaker protection at the source busbar junction and also at the tap off point.

3.6.1.3 LT Busbar Trunking

For high rise buildings, LT (0.4KV TP&N) busbar trunking sytem is used instead of riser main cables to minimize space in the vertical electrical shaft, to minimize the risk of spreading of fire from one floor to another due to electrical short circuit in one of the cables or sparks, to have a neat distribution system. Most part of the Busbar Trunking shall be installed vertically. The horizontal portion of the Busbar Trunking shall usually connect the vertical portion with the Substation LT panel. The LT Busbar Trunking system should comply IEC standard.

(a) Busbar Trunking are especially useful to minimize space and to minimize risks of spreading fire (during accidents) which may happen with bundles of insulated cables. The conductors supported by insulators inside the busbar trunking shall be copper of solid rectangular cross-section. The copper bars are insulated. A busbar trunking system shall be laid with minimum

number of bends for distribution system. Typical rating of feeder busbartrunking for 3-phase-3-wire or 3-phase- 4-wire system shall range from 200 amperes to 3000 amperes although lower amperes are not impossible.

(b) Horizontal busbartrunking of suitable size may be provided along the roads for a group of buildings to be fed by a single substation but with heavy weather (moisture and water) protection and covered with appropriate weather resistant water proof material. Extreme care need to be taken in these cases for protection against moisture, water and outside weather.

(c) Busbartrunking must not be placed in a place which is even slightly exposed to weather/moisture/spray or sprinkle of water.

3.6.1.4 LT Bus ducts

In certain applications, especially in factory lighting and factory power distribution of large area factories Busducts are used. In most cases, these Busducts are suspended from ceiling. Busducts offer safe, reliable, neat distribution system in these cases. The choice will depend on the floor area, type of machineries, type of jobs and other factors.

Appropriate circuit protection using adequate number of circuit breakers of appropriate rating is needed. In most cases these bus ducts are horizontally mounted/ suspended. The busbars shall be copper. The rating shall depend on the current on each segment and the current carried by each segment.

3.7.0 L T Main Incoming Cable and Service Connection

(a) Overhead service connection to a building shall be achieved with PVC/ XLPE insulated Cables with GI support wire (similar to catenary) or catenary wire (mainly for single phase consumers)as per specification of concern utility. The overhead service connection shall be led into buildings via roof poles or service masts made of GI pipe at least 38 mm in diameter having a goose neck bend at the top and installed on the outer wall. The alternative is to have underground cable connection.

(b) Underground FR PVC/ FR XLPE/ MDPE insulated PVC sheathed water proof cablesas per specification of concert utility shall be placed in underground cable trench or pulled through a PVC pipe of higher diameter placed in a cable trench so that the cable can be easily pulled through it. PVC insulated stranded annealed copper ECC cables matching with the main cable size shall run along the Main incoming cable with termination at the earthingbusbar at both end.

Each of the PVC pipes must have 18 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

(c) For main incoming thick underground cables joints are strongly discouraged and should be avoided as far as possible. However, for unavoidable cases joints must be made through sleeve or ferrule of appropriately matched size fitted with hydraulic press following neat processing of the cable ends. Appropriate fusible heat shrink cover must be used over such junction.

For thick cables running through conduits as vertical risers, these joints must be put inside metal joint/pull boxes with covers.

(d) Special forms of construction, such as flame proof enclosures, shall be adopted where risk of fire or explosion exists near a place where thick incoming cable or riser cables are placed.

(e) The Underground service cable shall be laid in conformity with the requirements of Sec 3.10.5 titled "Laying of LT underground Cables", of this Chapter.

(f) The power and telecommunication or antenna cables must be laid separately maintaining sufficient distance.

(g) The fire alarm and emergency lighting circuits shall be segregated from all other cables and from each other in accordance with BS 5839 and BS 5266. Telecommunication circuits shall be segregated in accordance with BS 6701 as appropriate.

(h) Where a wiring system is located in close proximity to a non-electrical service both the following conditions shall be met:

- The wiring system shall be suitably protected against the hazards likely to arise from the presence of the other service in normal use, and
- Appropriate protection against indirect contact shall be taken.

A wiring system shall not be installed in the vicinity of a service which produces heat, smoke or fume likely to be detrimental to the wiring, unless protected from harmful effects by shielding arranged so as not to affect the dissipation of heat from the wiring.

(j) Where a wiring system is routed near a service liable to cause condensation (such as water, steam or gas services) precautions shall be taken to protect the wiring system from deleterious effects.

(k) No cable shall be run in a lift (or hoist) shaft unless it forms part of the lift installation as defined in BS 5655.

3.7.1 Temporary Electrical Connection for a Building Construction Site

Temporary connections are needed for a building construction site. A Fuse Distribution board containing incoming cut out fuse, outgoing cutout fuses plus bus bars or a Distribution boards containing in coming circuit breakers, outgoing circuit breakers plus bus bars of appropriate rating must be installed for such connections. Such boards shall be installed in a dry place so that rain water or waters coming from a construction zone cannot reach such boards.

3.7.2 Temporary Electrical Connection for an Outdoor Concert

Temporary connections are needed for an outdoor concert stage for special lighting, for various display systems, for high power audio systems. A Fuse Distribution board containing incoming cut out fuse, outgoing cutout fuses plus bus bars or a Distribution board containing in coming circuit breakers, outgoing circuit breakers plus bus bars of appropriate rating must be installed for such connections. Such boards shall be installed in a dry place and shall be mounted at a safe height above ground so that rain water or waters coming from anywhere cannot reach such boards. Such boards shall not be installed near flammable materials.

Cables of appropriate types and appropriate ratings must be used for such applications.

Appropriate type of sockets, preferably flat 3-pin switched shuttered 13A sockets should be used for distribution.

3.8.0 11 kV/ 0.4 kV Electrical Substation in a Building

3.8.1.1 General

According to the rule of the distribution companies of Bangladesh, 11 kV/ 0.4 kV Electrical substations shall be required for a building if the load requirement of the building exceeds 50 kW. In most cases, substations are required for Multi-storied residential, Multi-storied Commercial buildings, Multi-storied Office building and Industries.

To determine the rating of the substation required, a load factor of at least 80% shall be applied to the estimated load of the building. The future expansion requirements should definitely be taken into consideration.

3.8.1.2 Location of an electrical substation

In a multi-storied building, the substation shall preferably be installed on the lowest floor level, but direct access from the street for installation or removal of the equipment shall be provided. The floor level of the substation or switch room shall be above the highest flood level of the locality. Suitable arrangements should exist to prevent the entrance of storm or flood water into the substation area.

The location of a substation will depend on (i) the feed point of the 11 kV Supply Authority line and (ii) the location of the LT vertical riser cables.

It is preferable to locate the air-conditioning plant room (if any) adjacent to the electrical substation in such a way that the distance from the controlling switchboard of the air-conditioning plant rooms and corresponding switches in the electrical substation are kept minimum.

In case of a building complex, or a group of buildings belonging to the same organization, the substation should preferably be located in a separate building and should be adjacent to the generator room, if any. Location of substation in the basement floor and on the floors above ground floor level (GFL) preferably be avoided. If Sub-Station it to be installed on the basement floor or the floors above ground floor level (GFL) special safety measures is to be taken by the user or owner. Measures are as follows:

(i) No objection certificate stating the Sub-Station safe by the Fire Service and Civil Defense Department.

(ii) Certification of the building consultant stating safe, proper ventilation, easy entrance and exit and safe load bearing capacity of the floors above the ground floor level (GFL).

(iii)Proper undertaking of the Sub-Station user or owner as the case may be, Stating safety and liability will be ensured by them.

In case the electric substation has to be located within the main building itself for unavoidable reasons, it should be located on ground floor or assessment floor or the floors above the ground floor (GFL) with easy access from outside.

3.8.1.3 Height, area, floor level and other requirements of a substation room

(a) The minimum height of a substation room should be 3.0 m to 3.6 m depending upon the size of the transformer.

(b) The recommended area required for substation and transformer rooms for different capacities are given in the following Table for general guidance. Minimum recommended spacing between the transformer periphery and walls should be :

(i) 0.75m for Transformer installed in a room with wall on two sides.

(ii) 1.0m for Transformer installed in a room with wall on three sides.

(iii)1.25m for Transformer installed in an enclosed room.

(iv) 1.5 m distance from one to another transformer for multiple transformers in room for 11 kV voltage level and 2.5 m distance for higher level of voltage.

(c) For transformers having large oil content (more than 2000 litres), soak pits are to be provided.

The areas given in following Table hold good if they are provided with windows and independent access doors in accordance with local regulations.

All the rooms shall have significant ventilation. Special care should be taken to ventilate the transformer rooms and where necessary louvers at lower level and exhaust fans at higher level shall be provided at suitable locations in such a way that cross ventilation is maintained. Fans should be provided so that the transformer gets air supply from the fans.

The floor level of the substation should be high. Arrangement shall be made to prevent storm water entering the transformer and switch rooms through the soak pits, if floor level of the substation is low.

Substation of higher voltage may also be considered to the basement floor having proper and safe building design.

Area Required for Transformer and Recommended Area for Substation of Different Capacities

Capacity of Transformer (kVA)	Transformer Area (m^2)	Total Substation Area (with HT, LT Panels & Transformer Room but without Generators), (m^2)
1 × 150	12	45
1 × 250	13	48
2 × 250	26	100
1 × 400	13	48
2 × 400	30	100
3 × 400	40	135
2 × 630	26	100
3 × 630	40	190
2 × 1000	40	180
3 × 1000	45	220

3.8.1.4 11kV/0.4kV Distribution transformer for the substation of a building

An 11 kV/0.4kV indoor distribution Transformer is a major part of an indoor substation. These Substations may be installed inside the building itself or may be housed in a separate building adjacent to the building.

For small to moderate power rating up to 2 MW, two types of indoor transformers have been widely used in recent years. These are (i) Oil Type Natural Cooled transformer and (ii) Cast Resin Dry Type Natural Cooled transformers.

In most cases Oil Type Natural Cooled transformer may be used for substations if adequate space is available to accommodate the transformer.

Cast Resin Dry Type Natural Cooled transformers should be used (i) in places where stringent protection against spread of fire is needed and (ii) in places where space saving is of utmost importance.

Choice of oil type or dry type transformers

Dry type transformer should be installed where risk of spreading of fire is high and where flammable materials are to be kept around the substation.

For Hospital buildings, Multistoried Shopping Centers Dry type transformers should be used to for minimizing fire risks.

An Industrial buildings containing inflammable materials, Chemical and having the substation in the same building Dry type transformers should be used for minimizing fire risks.

3.8.1.5 Type of connection between a substation transformer and its LT panel

Connection between a substation transformer and its LT panel can be established a) by using NYY underground LT Cables or b) by using Ceiling Suspended Busbar Trunking. For small size transformers the first method should be used although there is no restriction in using the second method. However, for big substations the second method is safer and at the same time gives a neat solution.

3.8.1.6 Ventilation of a substation

In an electrical substation significant amount of forced ventilation is very much needed apart from natural ventilation. Exhaust fans (minimum 450 mm dia) must be provided in sufficient numbers on all sides of the substation above the lintel level. Grill fitted windows having window panes must be provided on all sides for natural ventilation. The windows must have sun sheds so that no rain water can enter inside the substation.

If due to space constraint or due to any other difficulties, sufficient number of windows and ventilating fans cannot be installed, high velocity forced ventilation using ducts must be provided.

3.8.1.7 Layout of a substation

(a) In general, substation HT to LT transformer shall be placed in one corner of the room so that the HT side remains away from the passage of the persons.

(b) The HT metering panel shall be located near the exterior of the substation room near the exit gate and also shall be convenient for the HT cable entry.

(c) The HT Panel shall be located near the exterior, just after or adjacent to the HT panel.

(d) LT panel shall remain at a sufficient distance from the transformer but not too far away from the transformer. On the other hand, the location of the LT panel should such that the riser main cable can have their way upward or outward within very short distance.

(e) In allocating the areas within a substation, it is to be noted that the flow of electric power is from supply company network to HT room, then to transformer and finally to the low voltage switchgear room. The layout of the rooms shall be in accordance with this flow.

(f) All the rooms shall have significant ventilation. Special care should be taken to ventilate the transformer rooms and where necessary louvers at lower level and sufficient number of high speed exhaust fans at higher level shall be provided at suitable locations in such a way that cross ventilation is maintained. Sufficient numbers of ceiling fans must be provided so that the transformer gets air supply from ceiling fans.

(g) The 11 kV/0.4 kV substation shall not be placed in a basement.

(h) The substation shall preferably be placed in ground floor. Placing a substation on any other floor other than ground floor shall be avoided.

(i) The substation room and the areas adjacent to cable routes must have adequate fire alarm and fire extinguishing/fighting system appropriate for extinguishing fire due to electrical system, cable burning and oil burning.

3.9.0 Standby Power Supply

3.9.1.1 Provision for standby power supply

Provision should be made for standby power supply, in buildings, where interruption of electrical power supply would cause significant discomfort, result in interruption of activities, major production loss, cause hazard to life and property and cause panic. The standby power supply may be a petrol engine or diesel engine or gas engine generator or an IPS or a UPS.

3.9.1.2 Installation of an IPS or a UPS

(a) For safety purpose size of a UPS should be kept as small as possible.

(b) For the installation of a 200 - 600 VA IPS a 5A circuit must be made with the light points and fan points of different rooms to be brought under the control of the IPS. This circuit must have 3A Fuse protection using fuse cutout box. Wiring and connection has to be made following the wiring rules given in the wiring sections of this document. Cables of appropriate size must be used for wiring.

(c) For the installation of a 600 - 700 VA IPS a 5A circuit must be made with the light points and fan points of different rooms to be brought under the control of the IPS. This circuit must have 5A fuse protections or 5A circuit breaker protection. Wiring and connection has to be made following the wiring rules given in the wiring sections of this document. Cables of appropriate size must be used for wiring.

(d) For the installation of an IPS of higher capacity, a BDB with multiple outgoing circuits each not exceeding 5A shall be used with cutout - fuse protection at both incoming and outgoing sides. Cables of appropriate size must be used for wiring of each circuit.

(e) Battery maintenance (checking water level, temperature rise and the condition of the terminals) should be done at least every 15 days. Connection of the Battery terminals should be made properly and checked periodically for loose connection and deposition of sulphate. Battery of an IPS must be kept in a safe place so that short circuit between the battery terminals does not occur. Inflammable materials must not be kept in the vicinity of the IPS or battery.

(f) Safety issues must be taken into consideration in placing an IPS in a room.Same points shall apply for the installation of an UPS.

3.9.1.3 Installation of a solar photovoltaic system on top of a building

Building should be provided with solar photovoltaic system. For installation of a solar photovoltaic system, necessary precaution needs to be taken. Separate wiring and protection system must also be ensured.

Installation of solar water heaters on the roof tops of the residential and commercial buildings:

Buildings or apartments where hot water will be required,use of solar water heaters instead of electric and gas water heaters should be made mandatory. Flat plate heat collectors or vacuum tube solar water heaters of various capacities are available in the market.

The integral parts of a conventional solar photovoltaic system are:

(a) Solar photovoltaic panel(s)
(b) Battery charge controller
(c) Inverter
(d) Cables between the solar photovoltaic panel(s) and the battery charge controller
(e) Cables between the battery and the battery charge controller
(f) Cables between the inverter and the distribution board (DB/SDB/BDB)
(g) Other cables and accessories.

For the installation of a solar photovoltaic system of higher capacity, a DB with multiple outgoing circuits each not exceeding 5A shall be used with cutout - fuse protection at both incoming and outgoing side. Copper cables of appropriate size must be used for wiring of each circuit.

Battery maintenance (checking water level, temperature rise and the condition of the terminals) should be done at least every 15 days. Connection of the battery terminals should be made properly and checked periodically for loose connection and deposition of sulphate.

Batteries of a solar photovoltaic system must be kept in a safe place so that short circuit between the battery terminals does not occur. Inflammable materials must not be kept in the vicinity of the IPS or battery. In most cases for roof top solar panels, the battery room shall be placed inside a roof top room with adequate natural ventilation and forced cooling using ceiling fans. Because of the roof top location of the Solar panels, the room temperature is expected to be higher.

Safety issue must be taken into consideration in placing the batteries of a solar photovoltaic system.

For a residential flat system building, one or two circuits for each flat shall come from the DB of the photo-voltaic source at roof top to each flat depending on the requirement. Connection to load in each flat will be done through a changeover switch for each circuit.

For a commercial/office building, one or two circuits for each office/office area shall come from the DB of the photo-voltaic source at roof top to each flat depending on the requirement. Connection to load in each flat will be done through a changeover switch for each circuit.

Conduit based riser system must carefully be installed, separately for this system only, during the construction of the building to bring down the cables from the roof top DB room up to each flat/office/office area. Special care must be taken during installation so that rain water can under no circumstances get into the conduit and cable system.

3.9.1.4 Installation of a Solar Photovoltaic System on the exterior Glass of a Building having Large Glass area Facade

For semitransparent solar panels mounted on exterior glass of multistoried building similar process and precautions mentioned above must be followed.

3.10.0 Electrical Distribution System

3.10.1.1 Design, selection and choice of the type of connection

(a) In the planning and design of an electrical wiring installation, due consideration shall be given to prevailing conditions. Advice of a knowledgeable and experienced electrical design engineer must be sought from the initial stage up to the completion of the installation with a view to have an installation that will prove adequate for its intended purpose, and which will be safe and will be efficient.

(b) All electrical apparatus shall be suitable for the voltage and frequency of supply of this country mentioned earlier.

(c) The number and types of connection required e.g., single-phase two-wire AC or three-phase four-wire AC shall be assessed, both for the supply source and for the internal circuits needed within the installation.

(d) The following characteristics of the supply shall be ascertained :

(i) nominal voltage(s)

(ii) current and frequency

(iii) prospective short circuit current at the origin of the installation

(iv) type and rating of the over-current protective device acting at the origin of the installation

(v) suitability for the requirements of the installation, including the maximum demand

(vi) expected maximum value of the earth loop impedance of that part of the system external to the installation.

(e) In case of connected loads of 50 kW and above, HT 11 kV three-phase supply line with substation must be installed because of the requirement of the distribution companies although the use of HT supply will involve higher expenses due to installation of a distribution transformer, HT metering Panel, HT panel and LT Panel at the consumer's premises.

In this respect, the rules of the electrical distribution authorities will be the ultimate deciding factor.

3.10.1.2 Equipment and accessories

(a) High Voltage Switchgear

The selection of the type of high voltage switchgear for any installation should consider the following:

(i) voltage of the supply system,

(ii) the prospective short circuit current at the point of supply,

(iii) the size and layout of electrical installation,

(iv) the substation room available, and

(v) the types machineries of the industry (if applicable).

(b) Guidelines on Various Types of Switchgear Installation

(i) Banks of switchgears shall be segregated from each other by means of fire resistant barriers in order to prevent the risk of damage by fire or explosion arising from switch failure. Where a bus-section switch is installed, it shall also be segregated from adjoining banks in the same way.

(ii) In the case of duplicate or ring main supply, switches with interlocking arrangement shall be provided to prevent simultaneous switching of two different supply sources.

(c) Low Voltage Switchgear

(i) Switchgear and fuse gear must have adequate breaking capacity in relation to the capacity of the transformers.

(ii) Isolation and protection of outgoing circuits forming the main distribution system may be effected by means of circuit breakers, or fuses or switch fuse units mounted on the main switchboard. The choice between alternative types of equipment will take the following points into consideration:

(iii) In certain installations supplied with electric power from remote transformer substations, it may be necessary to protect main circuits with circuit breakers operated by earth leakage trips, in order to ensure effective earth fault protection.

(iv) Where large electric motors, furnaces or other heavy electrical equipment are installed, the main circuits shall be protected by metal clad circuit breakers or conductors fitted with suitable instantaneous and time delay overcurrent devices together with earth leakage and backup protection where necessary.

(v) In installations other than those mentioned above or where overloading of circuits may be considered unlikely, HRC type fuses will normally afford adequate protection for main circuits separately as required; the fuses shall be mounted in switch fuse units or with switches forming part of the main switch boards.

(vi) Where it is necessary to provide suitable connection for power factor improvement capacitors at the substation bus, suitable capacitors shall be selected in consultation with the capacitor and switchgear manufacturer and necessary switchgear/feeder circuit breaker shall be provided for controlling the capacitor bank(s).

3.10.2 Transformers

(a) Where two or more transformers are to be installed in a substation to supply an LT distribution system, the distribution system shall be divided into separate sections each of which shall normally be fed from one transformer only unless the LT switchgear has the requisite short circuit capacity.

(b) Provision may, however, be made to interconnect Busbar sections through bus couplers to cater for the failure or disconnection of one transformer which need to be executed with much care using locking system.

(c) The transformers, which at any time operate in parallel, shall be so selected as to share the load in proportion to their respective ratings. Appropriate protection must be provided and appropriate arrangements need to be made.

(d) When a step-up transformer is used, a linked switch shall be provided for disconnecting the transformer from all poles of the supply, including the neutral conductor.

3.10.3 Precautions regarding Rotating Machines

(a) All equipment including cables, of every circuit carrying the starting, accelerating and load currents of motors, shall be suitable for a current at least equal to the full load current rating of the motor. When the motor is intended for intermittent duty and frequent stopping and starting, account shall be taken of any cumulative effects of the starting periods upon the temperature rise of the equipment of the circuit.

(b) The rating of circuits supplying the rotors of slip ring or commutator of a motor or an induction motor shall be suitable for both the starting and loaded conditions.

(c) Every electric motor having a rating exceeding 0.376 kW shall be provided with control equipment incorporating means of protection against overcurrent.

(d) Every motor shall be provided with means to prevent automatic restarting after a stoppage due to drop in voltage or failure. This requirement does not apply to any special cases where the failure of the motor to start after a brief interruption of the supply would be likely to cause greater danger. It also does not preclude arrangements for starting a motor at intervals by an automatic control device, where other adequate precautions are taken against danger from unexpected restarting.

3.10.4 LT Energy Meters

LT energy meters shall be installed in residential buildings at such a place which is readily accessible to the owner of the building and the Authority. Installation of digital energy meters at the users' premises is a requirement of the distribution Companies.

LT energy meters should be installed at a height where it is convenient to note the meter reading but should not be installed at a level less than 1.5 meter above the ground.

The energy meters should either be provided with a protective covering, enclosing it completely except the glass window through which the readings are noted, or shall be mounted inside a completely enclosed panel provided with hinged or sliding doors with arrangement for locking. Earthing terminal must be provided if a metal box is used. Such an earthing terminal must be connected to the ECC.

3.10.5 Laying of LT underground Cables

PVC-PVC NYY underground LT cables shall be laid using one of the three methods.

(a) In the first method, brick wall prepared 900 mm deep trenches with cover plates shall be used for placing the cables at the bottom of the trench.

(b) In the second method, 900 mm deep trenches prepared by ground excavation (underground direct burial method) shall be used for placing the cables on top of a 75mm sand layer. In this second method (underground direct burial method), two layers of brick on top, marking tape and then back filling the trench will have to be done. The depth of the trench in general shall be 900 mm.

(c) In the third method, pre-laid PVC pipes having sufficient clearance compared to the cable size (s) may be required at places. The PVC pipes must be laid in trenches of the 900 mm depth. For pre-laid PVC pipe ducts, brick wall made underground inspection pits will be required at an interval of at least 10 m for cable pulling and future extensions or alterations.

3.10.6 Laying of HT Underground Cables

The HT underground armoured cables shall be laid using one of the three methods.

In the first method (i) brick wall prepared 900 mm deep trenches with cover plates shall be used for placing the cables at the bottom of the trench.

In the second method, 900 mm deep trenches prepared by ground excavation (underground direct burial method) shall be used for placing the cables on top of a 75mm sand layer. In this second method (underground direct burial method), two layers of brick on top, marking tape and then back filling the trench will have to be done. The depth of the trench in general shall be 900 mm.

In the third method, pre-laid PVC pipes having sufficient clearance compared to the cable size(s) may be required at places. The PVC pipes must be laid in trenches of the 900 mm depth.

For pre-laid PVC pipe ducts, brick wall made underground inspection pits will be required at an interval of at least 10 m for cable pulling and future extensions or alterations.

PVC pipe having sufficient clearance may be used for bringing the cable up to the trench of the metering panel or HT panel.

The PVC pipes must have 18 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

Methods of installation of cables and conductors in common use are specified in Table 8.1.25.

3.10.7 Main Switch and Switchboards

3.10.7.1 Metal clad enclosed type

All main switches shall be either metal clad enclosed type or of any other insulated enclosed type and the circuit breakers shall be fixed at close proximity.

3.10.7.2 Circuit breakers on each live conductor

There shall be circuit breakers or miniature circuit breakers or load break switch fuses on each live conductor of the supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in the neutral wire in the form of a switch or fuse unit or otherwise.

3.10.7.3 Location

(a) The location of the main board shall be such that it is easily accessible for firemen and other personnel to quickly disconnect the supply in case of emergencies.

(b) Main switchboards shall be installed in boxes or cupboards so as to safeguard against operation by unauthorized personnel.

(c) Open type switchboards shall be placed only in dry locations and in ventilated rooms and they shall not be placed in the vicinity of storage batteries or exposed to chemical fumes.

(d) In damp situation or where inflammable or explosive dust, vapour or gas is likely to be present, the switchboard shall be totally enclosed or made flame proof as may be necessitated by the particular circumstances.

(e) Switchboards shall not be erected above gas stoves or sinks, or within 2.5 m of any washing unit in the washing rooms or laundries.

(f) In case of switchboards being unavoidable in places likely to be exposed to weather, to drip, or in abnormally moist atmosphere, the outer casing shall be weather proof and shall be provided with glands or bushings or adapted to receive screwed conduit.

(g) Adequate illumination shall be provided for all working spaces about the switchboards, when installed indoors.

3.10.8 Mounting of Metal clad switchgear

A metal clad switchgear shall be mounted on hinged type metal boards or fixed type metal boards.

(a) Hinged type metal boards shall consist of a box made of sheet metal not less than 2 mm thick and shall be provided with a hinged cover to enable the board to swing open for examination of the wiring at the back. The joints shall be welded. The board shall be securely fixed to the wall by means of rag bolt plugs, or wooden plugs and shall be provided with locking arrangement and an earthing stud. All wires passing through the metal board shall be protected by a rubber or wooden bush at the entry hole. The earth stud should be commensurate with the size of the earth lead(s).

(b) Fixed type metal boards shall consist of an angle or channel steel frame fixed on the wall at the top, if necessary.

(c) There shall be a clearance of one meter at the front of the switchboards.

3.10.9 Wooden Boards as Main Boards or Sub-Boards Containing Fused Cutouts and Main Switches

Use of Wooden Board is discouraged because of the fear of break out of fire from a spark or from an overheated cable.However, for small installations, not exceeding 15A SP, connected to a single-phase 230 V supply, wooden boards may be used as main boards or sub-boards containing fused cutouts and main switches of appropriate ratings may be used. Such a board shall be made using seasoned teak or other approved quality timber.

3.10.10 Location of Distribution Boards

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

(a) They shall be fixed on suitable stanchion or wall and shall be accessible for replacement of fuses, and shall not be more than 2 m from floor level.

They shall be fixed on suitable stanchion or wall and shall be accessible for replacement of fuses. All switches and circuit breakers used as switches shall be located so that they may be operated from a readily accessible place. They shall be installed such that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than2.0 m (6 ft 7 in.) and the bottom of the panel shall be more than 0.45m or 18 inches above the floor or working platform.

(b) They shall be either metal clad type, or all insulated type. But if exposed to weather or damp situations, they shall be of the weather proof type and if installed where exposed to explosive dust, vapour or gas, they shall be of flame proof type. In corrosive atmospheres, they shall be treated with anticorrosive preservative or covered with suitable plastic compounds.

(c) Where two or more distribution fuse boards feeding low voltage circuits are fed from a supply of medium voltage, these distribution boards shall be:

(i) fixed not less than 2 m apart, or

(ii) arranged so that it is not possible to open two at a time, namely, they are interlocked, and the metal case is marked "Danger 415 Volts" and identified with proper phase marking and danger marks, or

(iii) installed in rooms or enclosures accessible to authorized persons only.

(d) All distribution boards shall be marked "Lighting" or "Power", as the case may be, and also be marked with the voltage and number of phases of the supply. Each shall be provided with a circuit list giving diagram of each circuit which it controls and the current rating for the circuit and size of fuse element.

(e) Distribution boards must be easily accessible for the ease of maintenance and switching off during accidents.

3.10.11 Over-current and Short Circuit Protection of Circuits

(a) Appropriate protection shall be provided at the distribution boards for all circuits and sub-circuits against short circuit and over-current. The installed protective devices shall be capable of interrupting any short circuit current that may occur, without causing any danger. The ratings and settings of fuses and the protective devices shall be coordinated so as to obtain absolute certain discrimination of the faulty area only during a fault.

(b) Where circuit breakers are used for protection of main circuit and the sub-circuits, discrimination in operation shall be achieved by adjusting the protective devices of the sub-main circuit breakers to operate at lower current settings and shorter time-lag than the main circuit breaker.

(c) A fuse carrier shall not be fitted with a fuse element larger than that for which the carrier is designed.

(d) The current rating of fuses shall not exceed the current rating of the smallest cable in the circuit protected by the fuse.

3.10.12 Fire Alarm and Emergency Lighting Circuits

Fire alarm and emergency lighting circuits shall be segregated from all other cables and from each other in accordance with BS 5839 and BS 5266. Telecommunication circuits shall be segregated in accordance with BS 6701 as appropriate.

3.10.13 Earthing

3.10.13.1 General

Earthing refers to connecting the exposed conductive part of electrical equipment and also the extraneous conductive parts of earthed bodies like water pipe to the general mass of the earth to carry away safely any fault current that may arise due to ground faults.The object of an earthing system is to provide a system of conductors, as nearly as possible at a uniform and zero, or earth, potential. The purpose of this is to ensure that, in general, all parts of equipment and installation other than live parts shall be at earth potential, thus ensuring that persons coming in contact with these parts shall also be at earth potential at all times.

3.10.13.2 Earthing used in electrical installation for buildings

The usual method of earthing is to join the exposed metal work to earth via a system of earth continuity conductors (ECC) connected to an earth electrode buried in the ground through a system of earth lead wires. In conjunction with a fuse, or other similar device, this then forms a protective system.

Thus, if a live conductor accidentally comes into contact with an exposed metal, the fuse or protective device operates. As long as the overall resistance of the protective system is low, a large fault current flows which blows the fuse. This cuts off the supply and isolates the faulty circuit, preventing risk of shock, fire, or damage to equipment/installation.

In Electrical installation for buildings, following types of earthing systems are required to be installed:

3.10.13.2.1.1 L.T. circuit/system earthing,

3.10.13.2.1.2 Equipment earthing (LT side),

3.10.13.2.1.3 Substation neutral earthing,

3.10.13.2.1.4 Substation LT system earthing, and

3.10.13.2.1.5 H.T. circuit earthing for a substation.

The purpose of L.T. circuit/system earthing is to limit excessive voltage from line surges, from cross-overs with higher voltage lines, or from lightning, and to keep noncurrent carrying enclosures and equipment at zero potential with respect to earth.

Earthing the system helps facilitate the opening of overcurrent protection devices in case of earth faults. Earthing associated with current carrying conductors is normally essential for the protection and safety of the system and is generally known as circuit/ system earthing, while earthing of non-current carrying metal work and conductor is essential for the safety of human life, animals, and property and it is generally known as equipment earthing.

3.10.13.3 Arrangements of earthing systems:

(a) The value of resistance from the consumer's main earthing terminal to the earthed point of the supply, or to earth, is in accordance with the protective and functional requirements of the installation, and expected to be continuously effective.

(b) Earth fault currents and earth leakage currents likely to occur are carried without danger, particularly from the point of view of thermal, thermo-mechanical and electromechanical stresses.

(c) Where a number of installations have separate earthing arrangements, protective conductors running between any two of the separate installations shall either be capable of carrying the maximum fault current likely to flow through them, or be earthed within one installation only and insulated from the earthing arrangements of any other installation.

3.10.13.4 Integral parts of an earthing system

The integral parts of an Earthing System are:

(a) Earth electrode(s) buried under the ground

(b) Earth lead cables/wires connecting the earth electrode(s) with the earthing busbar system. Earth lead cables/wires are also need to interconnect the earth electrodes when there are more than one earth electrode.

(c) Earth continuity conductors (ECC) for linking earthing busbar at the substation LT panel or main distribution DB of a building.

(d) Earth electrode clamp.

Connections of (i) Earth continuity conductors (ECC), (ii) Earth lead cables/wires and (iii) Earth electrode(s) must be made in appropriate and long lasting manner because poor connection or loss of connection will render the earthing system ineffective.

3.10.13.5 Earth continuity conductors (ECC)

ECC runs along the circuits/sub-circuits, socket circuits, interlinking circuits between a BDB and a SDB, between a SDB and a DB, between a DB and a FDB, between a FDB and a MDB, between a MDB and the LT panel earthing busbar of the substation. At each point an ECC shall be terminated in a copper earthing busbar. In metal switch boards back boxes and in metal socket back boxes appropriate copper or brass bolt nut termination shall be provided.

ECC of an earthing system joins or bonds together all the metal parts of an installation. PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation shall be used as ECC.

The minimum size of the ECC shall be 4.0mm^2 PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation.

3.10.13.6 Earth lead cable/wire

Earth Lead cable/wire runs between an earth electrode and the earthingbusbar of the MDB/DB or between an earth electrode and the LT panel earthingbusbar of the substation.

Often more than one earth electrodes are needed. In such a case duplicate earth lead cables/wires from each earth electrode must be brought to the MDB/DB or to the LT panel earthingbusbar of the substation and properly terminated. In addition, in the case of multiple earth electrodes, they must be interlinked by additional earth lead cables/wires.

PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation shall be used as earth lead wire. At both ends of the earth lead cable/wire, copper cable lugs must be fitted using crimp tools or hydraulic press.

The minimum size of the earth lead wire shall be 2 numbers of 1.5mm^2 PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation.

The ends of the earth lead wires shall be terminated using crimp tool fitted cable lugs for fitting on the bus bar or with the Earth Electrode Clamp.

(a) An earth lead cable/wire establishes connection between the main earthingbusbar and the earth electrode(s). The earth lead wire shall be brought to one or more connecting points, according to size of installation; the copper wire earthing leads shall run from there to the electrodes. Usually more than one earth lead wires are needed for one earth electrode to make sure that this link never fails.

(b) Earth lead cable/ wires shall one of the following types:

  (i) PVC insulated cable

  (ii) stranded copper cables without insulation

  (iii) copper strips (copper bars)

  (iv) PVC insulated cable is preferable in most cases.

  (v) Earth lead wires shall run through PVC pipe from the earth electrode up to the earthingbusbar of the MDB/DB or LT Panel.

(c) Earth lead cables/ wires shall run, at least, 2 in parallel (at least) down to the earth electrode so as to increase the safety factor of the installation. The two cables shall be terminated in two seperate cable lugs and bolts at both ends. Copper wire used as earthing lead must not be smaller than single core stranded 2 × 4mm^2 PVC insulated cables (i.e. 2 nos. of single core 4mm^2 PVC insulated cables in parallel). Depending on the current capacity of the Main incoming line the size will have to be raised.

Earth lead cables/wires shall be pulled from the earth electrode up to the terminating earthingbusbar through PVC conduits or GI pipes of appropriate dimension.

Minimum Cross-sectional Area of Copper ECCs in Relation to the Area of Associated Phase Conductors

Cross-sectional Area of Phase Conductor(s)(mm^2)	Minimum Cross-sectional Area of the Corresponding Earth Conductor(mm^2)
Less than 16	Same as cross-sectional area of phase conductor
16 or greater but less than 35	16 mm^2
35 or greater	Half the cross-sectional area of phase conductor

3.10.13.7 Earth electrodes and their installation

The earth electrode shall, as far as practicable, penetrate into moist soil (which will remain moist even during the dry season) preferably below ground water table. The resistance of an earthing system after measured after the installation of earth electrodes (individually or combined as a single group) shall be around one ohm.

The types of earth electrodes are to be used for earthing of electrical installations of a building and their sizes shall be as under:

(a) Copper rod earth electrode: shall have a minimum diameter of 12.5 mm of minimum length of 3.33m. Multiple copper rod earth electrodes may have to be installed to achieve an acceptable value of earthing resistance not exceeding 1 ohm (≤ 1 ohm).

(b) Copper plate earth electrodes: shall be 600 mm x 600 mmx 6 mm minimum in size. The copper plate shall be buried at least 2 m below the ground level. Multiple Copper plate earth electrodes may have to be installed to achieve an acceptable value of earthing resistance not exceeding 1 ohm (≤ 1 ohm).

(c) Galvanized Iron (GI) pipes: GI pipe earthing shall have a minimum diameter of 38 mm and of minimum length of 6.5m. Multiple GI pipes Earth Electrode may have to be installed to achieve an acceptable value of earthing resistance not exceeding 1 ohm (≤ 1 ohm).

Schematic drawings of typical earthing systems are shown in Figures 1 to 3For the installation of the earthing system the following points shall be considered.

(a) For installing a copper rod earth electrode, a 38mm GI pipe shall be driven below ground up to a depth of 5m and shall be withdrawn. The 12 mm dia copper rod earth electrode of 4m length shall then be easily driven into that hole up to a depth of 3.6m and 0.33 m shall be left for placing inside the earthing pit described below.

(b) For installing a 600 mm x 600 mmx 6 mm Copper plate 2 m below the ground level earth excavation will have to be done. The earth lead wire shall come via an earthing pit.

(c) GI pipe earth electrodes driven by tube well sinking method are suggested. For this purpose 38 mm dia GI pipes are recommended for domestic buildings. For large plinth area buildings and multi-storied buildings 50 mm dia GI pipes are recommended. The length of GI pipe to be driven below the ground level depends on the earthing resistance which in turn depends on the availability of water table during the dry season in this country. However, except the high land and mountains, this depth varies between 12 m to 25 m.

(d) Multiple numbers of GI pipe earth electrodes need to be used and connected in parallel in order to lower the earthing resistance measured with an earth resistance measuring meter. This is applicable for copper rod earyhing and plate earthing also.

(e) If multiple rod, pipe, or plate electrodes of one grounding system are installed to meet the earth resistance requirements, they shall not be less than 1.8 m (6 ft) apart. Two or more grounding electrodes that are bonded together shall be considered a single grounding electrode system.

(f) If multiple rod, pipe, or plate electrodes of one grounding system are installed to meet the earth resistance requirements, they shall not be less than 1.8 m (6 ft) apart. Two or more grounding electrodes that are bonded together shall be considered a single grounding electrode system.

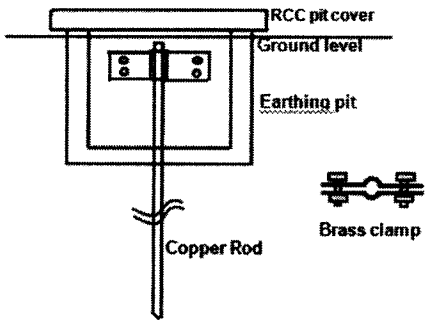


Figure 1 Copper Rod Earthing

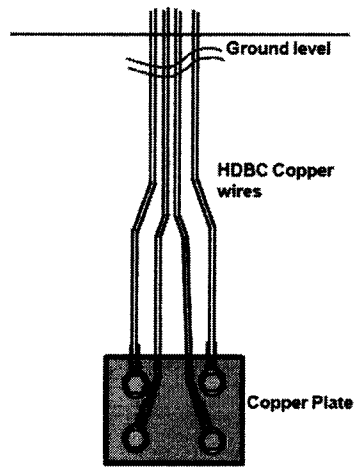


Figure 2 Copper Plate Earthing

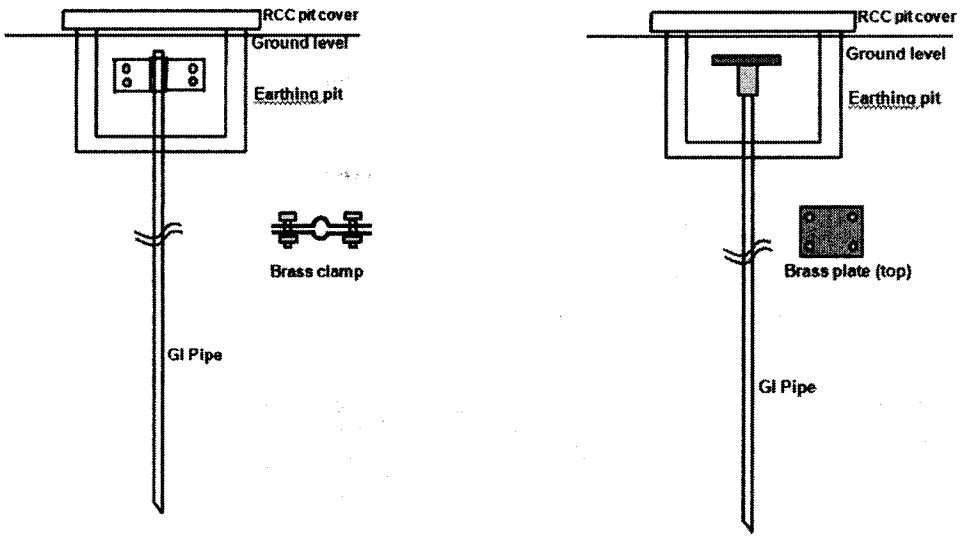


Figure 3 Pipe Earthing; (a) Type 1; (b) Type 2

3.10.13.8 Brass clamps/terminals on earth electrodes (earth electrode clamp)

(a) A brass clamp must be fitted on top of a GI pipe earth electrode to terminate the earth lead wire and to maintain electrical contact with the earth electrode and also to terminate the earth lead wire coming from the earthing bus bar of the LT panel/ MDB/DB. This is needed to establish long lasting and firm connection between the earth electrode and earth lead wire, which in turn means connection between the earth electrode and earthingbusbar of an LT panel or MDB/DB.

(b) The Brass clamp shall be made using at least 9.5mm thick and at least 50 mm wide Brass plate bent and shaped properly to fit tightly around the GI pipe earth electrode and shall have sufficient length (at least 35mm) on both sides for fixing bolts and cable lugs. This clamp shall have two hexagonal head 9.5 mm bolts on one side and two hexagonal head 9.5mm bolts on the other side, Figure 8.1.4(a). Sufficient space should be available for fixing the cable lugs of the earth lead wires. After fitting the lugs of the earth lead cables the brass clamp and the GI pipe head should be coated with two coats of synthetic enamel paint on top of one undercoat paint layer.

(c) An alternative to this clamp is to use a 9.5mm (at least) thick brass plate having 4 holes for fitting four hexagonal brass bolts on the four corners for fitting the cable lugs of the earth lead wires as shown in Figure 8.1.4(b). The brass plate is welded to a GI pipe socket and threaded on top of the earth electrode (pipe).

3.10.13.9 Earthing busbars

A copper earthing busbar shall be provided inside the LT Panel or MDB/DB of a building. The earth lead wire coming from the Earth Electrode (s) shall be terminated on this bus bar using cable lugs (cable lugs must be fitted using crimp tools or hydraulic press) and brass bolts and nuts.

Copper earthing busbar shall also be provided inside the DBs, FDBs, SDBs and BDBs. Hexagonal head brass screw, nuts and washers are needed for fixing the ECC and earth lead cables with this busbar

3.10.13.10 Earthing pit

An earthing pit shall be constructed around the top of the Earth Electrode, below the ground level using 250 mm brick walls on a CC floor with a 150 mm thick RCC slab cover on top having lifting hooks. The top of the earth electrode (in

case of pipe earthing) shall remain 375 mm above the top of the bottom CC floor of the pit. The minimum inside dimension of the earthing pit shall be 600mm × 600 mm × 600mm. The outside as well as the inside of the walls of the pit and the floor of the pit shall be cement mortar plastered. The inside shall be net cement finished. The top of the RCC slab pit cover shall remain 38mm above the ground level. The pit shall be made in such a way that water cannot get in to the pit. One earthing pit is needed for one earth electrode.

3.10.14 Lightning Protection of Buildings

Whether a building needs protection against lightning depends on the probability of a stroke and acceptable risk levels. Assessment of the risk and of the magnitude of the consequences needs to be made.

3.10.14.1 Degree of Isolation

The relative exposure of a particular building will be an element in determining whether the expense of lightning protection is warranted. In closely built-up towns and cities, the hazard is not as great as in the open country.

3.10.14.2 Type of terrain

In hilly or mountainous areas, buildings are more susceptible to damage due to lightning than buildings in the plains or flat terrain. In hilly areas, a building upon high ground is usually subject to greater hazard than one in a valley or otherwise sheltered area.

3.10.14.3 Height of structure

Height of the structure is an important factor for the purpose of lightning protection. Taller structures are subject to greater hazards than smaller structures and, therefore, lightning protection is more desirable for tall structures.

3.10.14.4 Lightning prevalence

The number of thunderstorm days in a year varies in different parts of a country. However, the severity of lightning storms, as distinguished from their frequency of occurrence, is usually much greater in some locations than others. Hence, the need for protection varies from place to place, although not necessarily in direct proportion to the thunderstorm frequency.

3.10.14.5 Integral parts of a lightning protection system

A smallest complete lightning protection system shall consist of (i) An air spike or air terminal, (ii) Adown conductor, (iii) Aroof conductor and (iv) An earth electrode.

An air spike or air terminal is that part which is intended to intercept lightning discharges. It consists of a vertical thick conductor of round cross section mounted on the highest part of the building to protect the required area. However, in general there may be more than one air spike or air terminal. In such a case roof conductors (made with copper strips or PVC insulated Annealed Stranded copper cables) need to be used to interconnect the Air Spikes or Air Terminals. Usually, for each Air Spike or Air Terminal there shall be one down conductor (made with copper strips or PVC insulated Annealed Stranded copper cables) going down up to the Earth Electrode pit and connected to the Earth Electrode. In all junctions, appropriate type of copper or brass junction plates or brass clamps must be used to ensure low resistance, firm and long lasting connection.

(a) Air spike/air terminal

An air spike or air terminal shall be made with copper rod of minimum 12mm diameter with tin coating on top. The terminal shall have a copper/brass base plate for mounting on top of roof, column, parapet wall using rowel bolts. The minimum dimension of such a base plate shall be 152mm x 152mm x 13mm. The length and width may need to be increased depending on the number of connection of the down conductors and the roof conductors. Such connections are to be made using hexagonal head brass bolts and nuts of 10mm diameter with brass washers.

(b) Down conductor

A Down Conductor shall be made with copper strip or Stranded PVC insulated annealed copper cable.

(c) Roof conductor

A Roof Conductor shall be made with copper strip or Stranded PVC insulated annealed copper cable. This shall run along the periphery of the roof to link all air spikes and all down conductors installed on top of a building. The joints shall be made using clamps made of copper strips (of 1/8 inch minimum thickness) and appropriate brass bolts and washers of 3/8 inch minimum diameter.

(d) Earth electrode

The Earth Electrode is exactly of the same type as the Earth Electrode of the Electrical Distribution (Electrical Installation for Buildings) system described earlier in this document. Considering the practical situation in this country and Pipe Earth Electrodes are suggested. For each Air spike one Earth Electrode is an ideal solution.

(e) Earth inspection boxes

A 18 SWG GI sheet made Earth Inspection Box must be provided for each down conductor 1000mm above the plinth level of the building (concealed inside the wall) which will contain a copper strip made clamp on the insulation peeled down conductor to check the continuity of the Earth Lead Down Conductor and the Earth Electrode and also to measure the Earth Resistance of the system. The box shall have a GI sheet made cover plate.

(f) Earthing pit

Earthing pits shall be provided as described in the earthing topic above.

3.10.14.6 Number of lightning arrestors required and their installation

Number of Lightning Protection Air Spikes in a building will depend on the nature of the roof top, on the total area of the roof top, on the height of the building, height of the adjacent buildings, height of the nearby towers or other similar structures. However, as a thumb rule, for every 80 m^2 area at least one air spike should be chosen at the beginning. During placement of the air spikes the total number may have to be increased or adjusted.

3.10.14.7 Protection zone

The zone of protection is the space within which an air spike provides protection by attracting the stroke to itself. It has been found that a single vertical conductor attracts to itself strokes of average or above average intensity which in the absence of the conductor would have struck the ground within a circle having its centre at the conductor and a radius equal to twice the height of the conductor. For weaker than average discharges the protected area becomes smaller. For practical design it is therefore assumed that statistically satisfactory protection can be given to a zone consisting of a cone with its apex at the top of the vertical conductor and a base radius equal to the height of the conductor.

3.10.14.7.1 When there are several parallel horizontal conductors the area between them has been found by experience to be better protected than one would expect from the above considerations only. The recommended design criterion is that no part of the roof should be more than 9 m from the nearest horizontal conductor except that an additional 0.3 m may be added for each 0.3 m or part thereof by which the part to be protected is below the nearest conductor.

3.10.14.7.2 The earth termination is that part which discharges the current into the general mass of the earth. In other words, it is one or more earth electrodes. Earth electrodes for lightning protection are no different from earth electrodes for short circuit protection systems. The total resistance of an electrode for a lightning protection system must not exceed 10 ohms for buildings up to 10 storied and 2 ohms for high rise buildings.

3.10.14.7.3 The down conductor is the conductor which runs from the air termination to the earth termination. A building with a base area not exceeding 100 m^2 shall be provided with one down conductor. For a larger building, there shall be one down conductor for the first 80 m^2 plus a further one for every 100 m^2 or part thereof in excess of the first 80 m^2. Alternatively, for a larger building one down conductor may be

provided for every 30 m of perimeter. Ideally, every air spike should have a down conductor going down up to the earth electrode.

3.10.14.7.4 The material used for lightning conductors must be copper. The criterion for design is to keep the resistance from air termination to earth electrode to a negligible value.

3.10.14.7.5 External metal on a building should be bonded to the lightning conductor with bonds at least as large as the conductor.

3.10.14.7.6 When a lightning conductor carries a stroke to earth, it is temporarily raised to a potential considerably above that of earth. There is, therefore, a risk that the discharge will flash over to nearby metal and cause damage to the intervening structure. This can be prevented by either, (i) providing sufficient clearance between conductor and other metal or (ii) by bonding these together to ensure that there can be no potential difference between them.

$$D = 0.3R + \frac{H}{15n}$$

Where,

D= Clearance in metres
R= Resistance to earth in ohms
H= Height of building in metres
n= Number of down electrodes

Since it is often impracticable to provide the necessary clearance, the alternative technique of bonding is preferred.

3.10.14.7.7 Surge arrester selection

A surge arrester is a protective device for limiting surge voltages by discharging, or bypassing, surge current through it. It also prevents continued flow of follow-through current while remaining capable of repeating these functions. It is used to protect overhead lines, transformers and other electrical apparatus mostly in an outdoor substation from lightning voltages traveling through the overhead lines.

3.10.14.7.8 Horn-gap lightning arresters

Horn-gap lightning arresters are commonly used for low and medium voltage overhead lines. The rating of the surge arrester shall be equal to or greater than the maximum continuous phase to ground power frequency voltage available at the point of application.

3.10.14.7.9 Design of lightning arrester using rolling sphere rule

Lightning arrester can also be designed and installed by using rolling sphere rule following NFPA 780.

3.10.15 Telecommunications in Buildings

3.10.15.1 General

Placing concealed 2 pair indoor cables is needed to get (ii) telephone lines of the wired telephone companies inside rooms of a building and (ii) to get the PABX lines of the building /offices in the building to the respective rooms under the PABXs. In addition to this, 10/20/50 pair telephone cables are required to be brought in to the PABX room(s) of the building. Conduits are to be installed for both of these two categories. For the entry of 10/20/50 paircables, conduits through straight and easy path (in most cases, through one side of the vertical electrical duct) need to be brought in.

3.10.15.2 Concealed telecommunication cable wiring

2 pair PVC insulated PVC sheathed annealed copper telecommunication cable shall be drawn through sufficient number of pre-laid 19/25/38mm PVC conduits to establish telecommunication network inside a building. A clearance of at least 40 percent must be maintained inside the PVC conduits. Sufficient number of 18SWG GI sheet made pull boxes (with Perspex sheet / ebonite sheet cover plates) at all suitable places must be placed for the ease of pulling these cables.

2 pair PVC insulated PVC sheathed annealed copper telecommunication cable shall be used for wiring between a Telephone DP/Patch panel and a telecommunication outlet. The extra pair shall remain for future maintenance. The minimum size of the copper wire of this cable shall be 0.5mm. The copper shall be preferably tinned.

3.10.15.3 Surface telecommunication cable wiring

Surface wiring should not be a choice during designing a building wiring. However, if the building is already constructed or under compulsory conditions or for extension of an existing network one may go for surface wiring. The same 2 pair PVC insulated PVC sheathed annealed copper telecommunication cable shall be used for this purpose. Wiring shall be done either by using channels or by using PVC conduits following the power line surface wiring methods mentions earlier.

3.10.15.4 Telecommunications outlets

Wall mounted Telecommunication outlets shall contain RJ11 or RJ45 connectors/jacks (shuttered). For simple telephone connection RJ11 shuttered jacks are sufficient. The outlet box shall have a back-box which may be made of the same polymer material as the front panel or shall be made using18 SWG GI sheet or 18 SWG MS sheet but painted with two coats of synthetic enamel paint.

3.10.15.5 Telephone DP room, patch panel room and digital PABX room

Telephone DP room, Patch Panel Room and PABX room should be located near the vertical riser duct of the building so that the incoming 50/100 pair underground telephone cable can be terminated in the DP/MDF or patch panel for distribution among the flats of a multistoried residential building or among the offices of a multistoried commercial/office building.

If a digital telephone PABX is to be installed then this can be installed in the same room. A separate earth electrode with earth lead wire will be required for the PABX.

3.10.16 Television Antennas/Cable Television system

In a multistoried residential/office building, television antennas shall be placed at one suitably sited antenna location on roof top and connect these to individual flats/residences/offices in the same building by coaxial cables through concealed conduits.

3.10.16.1 Cable work for television antennas/cable television system

Vertical duct and easy entry to each flats/ offices must be provided as sharp bending of these cables is difficult and harmful to the cables. These cables must not be placed in the same conduit with power cables. A distance of at least 350mm must be maintained if a portion runs in parallel with the power cable conduits.

RF and Video cables shall be PVC sheathed Co-axial Cables shall be made with solid Copper centre conductor, foamed polythene insulated and further sealed Aluminum foil taped and Copper wire braided.

3.10.16.2 Television antenna outlets/cable television system outlets

Wall mounted television coaxial cable outlets shall contain high quality coaxial connectors/jacks. The outlet box shall have a back-box which may be made of the same polymer material as the front panel or 18 SWG GI sheet or 18 SWG MS sheet made but painted with two coats of synthetic enamel paint.

3.10.17 Data Communication Network for LAN and Internet Services inside a Building

Data Communication Network for LAN and Internet Services inside a Building may be installed using Cat 6 unshielded twisted pair (UTP) cables in a concealed manner following the concealed wiring power cables installation procedure mentioned in the wiring methods section of this document. Each of the cables will be terminated at one end at the 8P8C (RJ45) connector based data socket outlet board in the required rooms at the power socket level. On the other end, the cable will be terminated in the patch panel. From the patch panel up to the data socket outlet the cable shall be in one piece i.e., no joints will be allowed. As a result the concealed conduit work needs to be done carefully to have a straight line path and without any bend in the roof slab. Sufficient pull boxes will be required in the roof slab.

Pull box will also be needed close to the vertical bend near the bend and ceiling at any downward drop of the conduit. The conduits must have 20 SWG GI pull wires during laying for pulling the cables later.

Because of the nature of these cables more clearances are needed inside the PVC conduits compared to the power cables.If the conduits are running parallel to the power cables then there should be at least a distance of 410mm between these two.

Recently Cat. 7 cables are emerging as a better choice in place of Cat. 6 cables.

3.10.18 Fire Detection and Alarm System inside a Building

The major parts of a Fire Detection and Alarm System inside a Building may be listed as

(a) A number of different types of Fire Detectors/ detection devices wired in a number of radial circuits
(b) Manual callpoints
(c) A central control panel for fire detection
(d) A number of alarm sounders/alarm devices wired in a number of radial circuits
(e) Cables for wiring the fire detectors/detection devices
(f) Cables for wiring the alarm sounders/alarm devices

Control Panel

The control panel will indicate in which detection circuit (zone) an alarm or fault condition has been generated and will operate common or zonal sounders and auxiliary commands (for example door release or fire brigade signaling).

Detectors

A number of types of detectors (smoke detectors, heat detectors, ionization smoke detectors, optical beam smoke detectors, opto-heat detectors) for the installation

Alarm Devices

Alarm devices fall into two types, audible and visual. The audible types are most common, with a variety of types being available from bells to all kinds of different electronic sounders including those containing pre-recorded spoken messages. The choice of device is dependent on local preference, legal requirement and the need to have a tone distinct from all other building audible alarms.

Speech alarms or links to PA systems overcome some of the complacent responses to warning tones and can be used to good effect when carrying out regular fire tests in buildings where there are many people unfamiliar with the regular routines - such as hotels. Finally visual alarms are to be used where the hard of hearing may be occupying a building or where the ambient noise is such (above 90dBA) that audible warning may not be heard, where hearing protectors are in use or where the sounder levels would need to be so high that they might impair the hearing of the building occupant.

Audible and Visual Alarm Devices

The audible types are most common, with a variety of types being available from bells to all kinds of different electronic sounders including those containing pre-recorded spoken messages. The choice of device is dependent on local preference, legal requirement and the need to have a tone distinct from all other building audible alarms.

Cables for Fire Detectors

BS 5839-1 introduced more onerous requirements for the types of cables used in fire detection and alarm systems. Fireproof cables should now be used for all parts of the system and enhanced fire resistance cables should be used where there is a requirement to ensure cable integrity over a longer period of time. For example when connecting to alarm sounders or where connection between sub-panels provides any part of alarm signal path.

Fire alarm cables should be segregated from the cables of other systems; they should be clearly marked, preferably coloured red and should be routed through parts of the building that provide minimum risk. This latter point is particularly relevant where the use of the building is being changed - for example if a fuel store is being moved.

Specific Areas of Application for Fire Detection and Alarm Equipment

The BS5839 suite of standards relate to specific areas of application for fire detection and alarm equipment. Specifically part 1 relates to public premises and part 6 relates to residential premises. BS5839-1 is a comprehensive code of practice for fire detection and alarm systems, the requirements relate to both life and property protection and the standard includes much advice and comment with is very useful in informing the building owner or system specifier of the background to the requirements.

Codes of Practice for Different Types of Fire Protection Systems

The parts of BS7273 are codes of practice for different types of fire protection systems. Generally this is considered separately to fire alarm systems but there may be occasions where a tradeoff can be made between the two systems, or where the two systems interact and must be interfaced.

Standards Relatedto Design and Performance of Items of Equipment that Make up a Fire Detection and Alarm System

The EN54 suite of standards relates to the design and performance of items of equipment that make up fire detection and alarm system. Each part relates to a different piece of equipment, for example part 3 relates to alarm devices, part 11 to call points, part 4 to power supplies etc.

Fire Detection Zones

Fire detection zones are essentially a convenient way of dividing up a building to assist in quickly locating the position of a fire. BS 5839-1 has some specific recommendations with respect to detection zones.

Wiring of the fire detection and alarm system will be done using the concealed wiring and the surface wiring methods described in the power line wiring section of this document.

3.10.19 CCTV System inside a Building

Installation of cable network for CCTV System inside a Building shall be done following the guidelines given for cable work for television antennas/cable television system earlier in this document.

For wiring of the power lines required for the Installation of CCTV system inside a building will be done using the concealed wiring and the surface wiring methods described in the power line wiring section of this document.

3.10.20 Design and Installation of Access Control System

Wiring of the Installation of access control systems will be done using the concealed wiring and the surface wiring methods described in the power line wiring section of this document.

3.10.21 Installation of Electronic Security Systems

Wiring of the installation of electronic security systems will be done using the concealed wiring and the surface wiring methods described in the power line wiring section of this document.

3.10.22 Qualification of the Contractor of Electrical and Electronic Engineering Works in a Building

A Contractor who will be working with the electrical and electronic engineering works in a building must have appropriate ABC license from the electrical licensing board of government of Bangladesh.

The contractor must have sufficient number of well trained and experienced technicians to execute the job. For big volume of work, the contractor must have at least one Electrical Engineer assigned for the job.

Appendix I

SAFETY REQUIREMENTS FOR ELECTRICAL WIRING WORKS IN RESIDENTIAL BUILDINGS

1.1 Safety Requirements

Safety requirements for electrical wiring works have to be followed to eliminate any accidents which can result in physical damage or loss of life or property. Failure to meet the safety regulations may result in workers, consumers or the public being inflicted with electrical shocks.

In addition to this, safety steps will also encourage workers or electricity consumers who are disciplined and who always give importance to safety.

1.2 Safety Steps

Safety requirements have to be followed whenever electrical works are undertaken in a residential building.

i. **Personal Safety**

a. Use suitable personal protection equipment as needed such as safety shoes, gloves, safety helmet, etc. when at the work place.
b. Use safety clothing suitable for the work to be undertaken.
c. Do not wear jewellery or decorative items such as rings, watches, chains, etc. while carrying out electrical works.

ii. **Safety at the Work Place**

a. Acquire knowledge about the dangers of electrical works that is to be undertaken and how to deal with those dangers.
b. Always adhere to the safety regulations which have been set for the work place.
c. Ensure that the electricity supply is switched off before carrying out the works.
d. Acquire the needed knowledge and practice a cautious and calm attitude while working, ensure cleanliness in and around the workplace, do not smoke and always coordinate work with fellow workers.
e. While working at elevated places, the worker should always use suitable equipment such as wooden or aluminium ladders, iron scaffoldings or platforms, safety belts or other equipment needed to ensure that the work can be undertaken safely.
f. Use electrical equipment which is operational and safe to be used and ensure that the supply for it is being supplied through a residual current device (RCD) with a sensitivity of 30 mA.
g. Ensure that exposed temporary supply electrical cables have mechanical protection.

h. If inflammable or corrosive material is present, necessary safety steps have to be undertaken as required by the relevant safety regulations.

1.3 Dangers of Electrical Shocks

Electrical Shock

Electrical shocks can occur due to direct or indirect contact.

Direct Contact:

Direct contact occurs when the worker or consumer receives an electrical shock on touching directly a live conductor or cable.

Indirect Contact:

Here the electric shock occurs due to contact with a part which is connected to the electrical installation and not to a direct contact with a live cable or conductor, possibly due to damages in the appliance or insulation, resulting in leakages of current.

Why Electric Shocks Occur

Unsafe Work Method or Action

Undertaking Electrical Work Without Disconnecting the Supply

Maintenance or circuit testing work done without disconnecting the supply will have a high possibility of electrical shocks occurring.

Not Following Safe Work Procedures

To eliminate the occurrence of electrical shocks, each worker has to always follow safe work procedures which are set by regulations and standards.

Defects in the Electrical System

Leakage Current

Leakage currents or earth leakage currents can result in the metallic frames becoming live and energised. This can give rise to the danger of electrical shock to the worker, consumer or the public if they hold or come into contact with the metallic frame.

Exposed Conductor or Disconnected Cable

Exposed conductors or cables which are broken and are alive (energised) can result in electrical shock when touched. The supply source must be immediately isolated or switched off and a report must be made to the responsible entity.

1.4 First Aid and Basic Pulmonary Resuscitation

First Aid

First aid is the initial assistance given to a person who has met with an accident, is sick or is injured to prevent the condition of the victim from becoming more serious while awaiting the arrival of the para medics (ambulance) or before being brought to the hospital.

Pulmonary Resuscitation

Pulmonary resuscitation has to be undertaken to assist the victim who has breathing difficulties as a result of being drowned, receiving an electrical shock, etc.. Pulmonary resuscitation has to be carried out in accordance to the correct method as stated in the first aid manuals issued by accredited first aid bodies.

First Aid Box

A first aid box has to be provided by the building owner, construction site supervisor or brought personally by the worker under the supervision of the responsible person.

1.5 Training Programme

The management shall conduct periodic training programmes for the workers with regards to work safety on aspects including the following: -

i. Dangers of electrical work being undertaken and how to control those dangers;
ii. The safety regulations set for the work place; and
iii. First aid procedures.

1.6 Fire Prevention

Fire Extinguisher

A suitable, functioning fire extinguisher to control fires has to be made available at the work place at all times.

APPENDIX II

Model forms for inspection of electrical installations

A. Model schedule for items requiring inspection for initial verification of an electrical installation.

All items inspected in order to confirm compliance with the relevant clauses in the IEC 60364 series. The list of items is not exhaustive.

ELECTRICAL INTAKE EQUIPMENT

- ☐ Service cable
- ☐ Service cut-out / fuse
- ☐ Meter tails – Distributor
- ☐ Meter tails – consumer
- ☐ Metering equipment
- ☐ Isolator

PARALLEL OR SWITCHED ALTERNATIVE SOURCES OF SUPPLY

- ☐ Dedicated earthing arrangement independent to that of the public supply
- ☐ Presence of adequate arrangements where generator to operate in parallel with the public supply system
- ☐ Correct connection of generator in parallel
- ☐ Compatibility of characteristics of means of generation
- ☐ Means to provide automatic disconnection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values
- ☐ Means to prevent connection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values
- ☐ Means to isolate generator from the public supply system

AUTOMATIC DISCONNECTION OF SUPPLY

- ☐ Main earthing / bonding arrangements

Presence and adequacy of

- ☐ Distributor's earthing arrangement or installation earth electrode arrangement
- ☐ Earthing conductor and connections
- ☐ Main protective bonding conductors and connections
- ☐ Earthing / bonding labels at all appropriate locations

Accessibility of

- ☐ Earthing conductor connections
- ☐ All protective bonding connections
- ☐ FELV – requirements satisfied

OTHER METHODS OF PROTECTION

(Where any of the methods listed below are employed details should be provided on separate pages)

BASIC AND FAULT PROTECTION where used, confirmation that the requirements aresatisfied:

- ☐ SELV
- ☐ PELV
- ☐ Double insulation
- ☐ Reinforced insulation

BASIC PROTECTION:

- ☐ Insulation of live parts
- ☐ Barriers or enclosures
- ☐ Obstacles
- ☐ Placing out of reach

FAULT PROTECTION:

- ☐ Non-conducting location – earth-free local equipotential bonding
- ☐ Electrical separation

ADDITIONAL PROTECTION:

- ☐ RCDs not exceeding 30 mA as specified
- ☐ Supplementary bonding

SPECIFIC INSPECTION EXAMPLES as appropriate to the installation

DISTRIBUTION EQUIPMENT

- ☐ Adequacy of working space / accessibility to equipment Security of fixing
- ☐ Insulation of live parts not damaged during erection Adequacy / security of barriers
- ☐ Suitability of enclosures for IP and fire ratings
- ☐ Enclosures not damaged during installation
- ☐ Presence and effectiveness of obstacles
- ☐ Placing out of reach
- ☐ Presence of main switch(es), linked where required
- ☐ Operation of main switch(es) (functional check)
- ☐ Manual operation of circuit-breakers and RCDs to prove functionality
- ☐ Confirmation that integral test button / switch causes RCD(s) to trip when operated (functional check)
- ☐ RCD(s) provided for fault protection, where specified
- ☐ RCD(s) provided for additional protection, where specified
- ☐ Confirmation over-voltage protection (SPDs) provided where specified
- ☐ Confirmation of indication that SPD is functional
- ☐ Presence of RCD quarterly test notice at or near the origin
- ☐ Presence of diagrams, charts or schedules at or near each distribution board, where required
- ☐ Presence of non-standard (mixed) cable colour warning notice at or near the appropriate distribution board, where required

Presence of alternative supply warning notice at or near

- ☐ The origin
- ☐ The meter position, if remote form origin
- ☐ The distribution board to which the alternative/additional sources are connected All points of isolation of ALL sources of supply
- ☐ Presence of next inspection recommendation label Presence of other required labeling
- ☐ Selection of protective device(s) and base(s); correct type and rating Single-pole protective devices in line conductor only
- ☐ Protection against mechanical damage where cables enter equipment
- ☐ Protection against electromagnetic effects where cables enter ferromagnetic enclosures
- ☐ Confirmation that all conductor connections, including connections to busbars are correctly located in terminals and are tight and secure

CIRCUITS

- ☐ Identification of conductors
- ☐ Cables correctly supported throughout
- ☐ Examination of cables for signs of mechanical damage during installation
- ☐ Examination of insulation of live parts, not damaged during erection
- ☐ Non-sheathed cables protected by enclosure in conduit, ducting or trunking Suitability of containment systems (including flexible conduit)
- ☐ Correct temperature rating of cable insulation
- ☐ Cables correctly terminated in enclosures
- ☐ Adequacy of cables for current-carrying capacity with regard for the type and nature of installation
- ☐ Adequacy of protective devices: type and fault current rating for fault protection
- ☐ Presence and adequacy of circuit protective conductors
- ☐ Coordination between conductors and overload protective devices
- ☐ Wiring systems and cable installation methods / practices with regard to the type and nature of installation and external influences
- ☐ Cables concealed under floors, above ceilings, in walls adequately protected against damage by contact with fixings
- ☐ Provision of additional protection by RCD s having residual rated operating current ($I_{\Delta n}$) not exceeding 30mA
- ☐ For circuits used to supply mobile equipment not exceeding 32 A rating for use outdoors in all cases
- ☐ For all socket-outlets of rating 20 A or less provided for use by ordinary persons unless exempt
- ☐ For cables concealed in walls at a depth of less than 50 mm
- ☐ Provision of fire barriers, sealing arrangements so as to minimize the spread of fire
- ☐ Band II cables segregated / separated from Band I cables Cables segregated / separated from non-electrical services
- ☐ Termination of cables at enclosures
- ☐ Connections under no undue strain
- ☐ No basic insulation of a conductor visible outside enclosure Connections of live conductors adequately enclosed
- ☐ Adequately connected at point of entry to enclosure (glands, bushes etc.) Suitability of circuit accessories for external influences
- ☐ Circuit accessories not damaged during erection
- ☐ Single-pole devices for switching in line conductor only

- ☐ Adequacy of connections, including CPCs, within accessories and fixed and stationary equipment
- ☐ Presence, operation and correct location of appropriate devices for isolation and switching

ISOLATION AND SWITCHING

Isolators

- ☐ Presence and location of appropriate devices
- ☐ Capable of being secured in the OFF position
- ☐ Correct operation verified (functional check)
- ☐ The installation, circuit or part thereof that will be isolated is clearly identified by location and / or durable marking
- ☐ Warning label posted in situations where live parts cannot be isolated by the operation of a single device

Switching off for mechanical maintenance

- ☐ Presence of appropriate devices
- ☐ Acceptable location – state if local or remote from equipment in question
- ☐ Capable of being secured in the OFF position
- ☐ Correct operation verified (functional check)
- ☐ The circuit or part thereof that will be disconnected clearly identified by location and / or durable marking
- ☐ Emergency switching / stopping
- ☐ Presence and location of appropriate devices
- ☐ Readily accessible for operation where danger might occur Correct operation verified (functional check)
- ☐ The installation, circuit or part thereof that will be disconnected clearly identified by location and / or durable marking
- ☐ Functional switching
- ☐ Presence and location of appropriate devices
- ☐ Correct operation verified (functional check)

CURRENT–USING EQUIPMENT (PERMANENTLY CONNECTED)

- ☐ Suitability of equipment in terms of IP and fire ratings
- ☐ Enclosure not damaged / deteriorated during installation so as to impair safety
- ☐ Suitability for the environment and external influences
- ☐ Security of fixing
- ☐ Cable entry holes in ceilings above luminaires, sized or sealed so as to restrict the spread of fire
- ☐ Provision of under-voltage protection, where specified
- ☐ Provision of overload protection, where specified
- ☐ Recessed luminaires (downlighters)
- ☐ Correct type of lamps fitted
- ☐ Installed to minimize build-up of heat by use of "fire rated" fittings, insulation displacement box or similar

SPECIAL INSTALLATIONS OR LOCATIONS

If any special installations or locations are present, list the particular inspections applied.

B. Model inspection schedule of items requiring inspection for an existing electrical installation

A visual inspection should firstly be made of the external condition of all electrical equipment which is not concealed.

Further detailed inspection, including partial dismantling of equipment as required, should be carried out as agreed with the person ordering the work.

The list of items is not exhaustive.

ELECTRICAL INTAKE EQUIPMENT

- ☐ Service cable
- ☐ Service cut-out / fuse
- ☐ Meter tails – Distributor
- ☐ Meter tails – Consumer
- ☐ Metering equipment
- ☐ Isolator

Where inadequacies in distributor's equipment are encountered, it is recommended that the person ordering the report informs the appropriate authority.

PRESENCE OF ADEQUATE ARRANGEMENTS FOR PARALLEL OR SWITCHED ALTERNATIVE SOURCES

AUTOMATIC DISCONNECTION OF SUPPLY

- ☐ Main earthing / bonding arrangements
- ☐ Presence of distributor's earthing arrangement or presence of installation earth electrode arrangement
- ☐ Presence and adequacy of earthing conductor
- ☐ Main protective earthing conductor connections
- ☐ Accessibility of earthing conductor connections
- ☐ Presence and adequacy of main protective bonding conductors
- ☐ Main protective bonding conductor connections
- ☐ Accessibility of all protective bonding connections
- ☐ Provision of earthing / bonding labels at all appropriate locations FELV

OTHER METHODS OF PROTECTION

(Where any of the methods listed below are employed, details should be provided on separate sheets)

BASIC AND FAULT PROTECTION:

- ☐ SELV
- ☐ PELV
- ☐ Double insulation
- ☐ Reinforced insulation

BASIC PROTECTION:

- ☐ Insulation of live parts

- ☐ Barriers or enclosures
- ☐ Obstacles
- ☐ Placing out of reach

FAULT PROTECTION:

- ☐ Non-conducting location – earth-free local equipotential bonding
- ☐ Electrical separation

ADDITIONAL PROTECTION:

- ☐ RCDs 30 mA or less as specified
- ☐ Supplementary bonding

SPECIFIC INSPECTION EXAMPLES

DISTRIBUTION EQUIPMENT

- ☐ Adequacy of working space / accessibility to equipment
- ☐ Security of fixing
- ☐ Condition of insulation of live parts
- ☐ Adequacy / security of barriers
- ☐ Condition of enclosure(s) in terms of IP and fire ratings
- ☐ Enclosure not damaged / deteriorated so as to impair safety
- ☐ Presence and effectiveness of obstacles
- ☐ Placing out of reach
- ☐ Presence of main switch(es), linked where required
- ☐ Operation of main switch(es) (functional check)
- ☐ Manual operation of circuit-breakers and RCDs to prove disconnection
- ☐ Confirmation that integral test button / switch causes RCD(s) to trip when operated (functional check)
- ☐ RCD(s) provided for fault protection
- ☐ RCD(s) provided for additional protection, where required
- ☐ Confirmation of indication that over-voltage protection (SPDs) is functional, where installed
- ☐ Presence of RCD quarterly test notice at or near equipment, where required
- ☐ Presence of diagrams, charts or schedules at or near equipment, where required
- ☐ Presence of non-standard (mixed) cable colour warning notice at or near equipment, where required
- ☐ Presence of alternative supply warning notice at or near equipment, where required Presence of next inspection recommendation label
- ☐ Presence of other required labelling (please specify)
- ☐ Examination of protective device(s) and base(s); correct type and rating (no signs of unacceptable thermal damage, arcing or overheating)
- ☐ Single-pole protective devices in line conductor only
- ☐ Protection against mechanical damage where cables enter equipment
- ☐ Protection against electromagnetic effects where cables enter ferromagnetic enclosures
- ☐ Confirmation that all conductor connections, including connections to busbars are correctly located in terminals and are tight and secure

CIRCUITS

- ☐ Identification of conductors
- ☐ Cables correctly supported throughout Condition of cables
- ☐ Condition of insulation of live parts
- ☐ Non-sheathed cables protected by enclosure in conduit, ducting or trunking Suitability of containment systems for continued use (including flexible conduit) Cables correctly terminated in enclosures
- ☐ Examination of cables for signs of unacceptable thermal or mechanical damage / deterioration

- ☐ Adequacy of cables for current-carrying capacity with regard for the type and nature of installation
- ☐ Adequacy of protective devices: type and rated current for fault protection Presence and adequacy of circuit protective conductors
- ☐ Coordination between conductors and overload protective devices
- ☐ Wiring systems and cable installation methods / practices with regard to the type and nature of installation and external influences
- ☐ Where exposed to direct sunlight, cable of a suitable type
- ☐ Cables concealed under floors, above ceilings, in walls adequately protected against damage by contact with fixings
- ☐ Provision of additional protection by RCDs having residual rated operating current (IΔn) not exceeding 30 mA
- ☐ For circuits used to supply mobile equipment not exceeding 32 A rating for use outdoors in all cases
- ☐ For all socket-outlets of rating 20 A or less provided for use by ordinary persons unless exempt
- ☐ For cables concealed in walls at a depth of less than 50 mm
- ☐ Provision of fire barriers, sealing arrangements and protection against thermal effects Band II cables segregated / separated from Band I cables
- ☐ Cables segregated / separated from non-electrical services Condition of circuit accessories
- ☐ Termination of cables at enclosures – identify / record numbers and locations of items inspected
- ☐ Connections under no undue strain
- ☐ No basic insulation of a conductor visible outside enclosure Connections of live conductors adequately enclosed
- ☐ Adequately connected at point of entry to enclosure (glands, bushes etc.) Suitability of circuit accessories for external influences
- ☐ Condition of accessories including socket-outlets, switches and joint boxes Single-pole devices for switching in line conductor only
- ☐ Adequacy of connections, including CPCs, within accessories and fixed and stationary equipment
- ☐ Presence, operation and correct location of appropriate devices for isolation and switching General condition of wiring systems
- ☐ Temperature rating of cable insulation

ISOLATION AND SWITCHING

Isolators

- ☐ Presence and condition of appropriate devices
- ☐ Acceptable location – state if local or remote from equipment in question Capable of being secured in the OFF position
- ☐ Correct operation verified
- ☐ Clearly identified by position and /or durable marking
- ☐ Warning label posted in situations where live parts cannot be isolated by the operation of a single device
- ☐ Switching off for mechanical maintenance
- ☐ Presence and condition of appropriate devices
- ☐ Acceptable location – state if local or remote from equipment in question Capable of being secured in the OFF position
- ☐ Correct operation verified
- ☐ Clearly identified by position and /or durable marking

Emergency switching / stopping

- ☐ Presence and condition of appropriate devices
- ☐ Readily accessible for operation where danger might occur Correct operation verified
- ☐ Clearly identified by position and /or durable marking

- ☐ Functional switching
- ☐ Presence and condition of appropriate devices Correct operation verified

CURRENT–USING EQUIPMENT (PERMANENTLY CONNECTED)

- ☐ Condition of equipment in terms of IP and fire ratings
- ☐ Enclosure not damaged / deteriorated so as to impair safety Suitability for the environment and external influences
- ☐ Security of fixing
- ☐ Cable entry holes in ceiling above luminaries, sized or sealed so as to restrict the spread of fire
- ☐ Condition and provision of under-voltage protection, where required Condition and provision of over-load protection, where required

Recessed luminaries (down lighters)

- ☐ Correct type of lamps fitted
- ☐ Installed to minimize build-up of heat by use of "fire rated" fittings, insulation displacement box or similar
- ☐ No signs of overheating to surrounding building fabric No signs of overheating to conductors / terminations

SPECIFICATIONS OF CABLES

GENERAL SPECIFICATION: The specification for the parts of this contract mentioned below cover design, manufacture, assembly and testing at the manufacturer's factory as well as the supply, delivery, installation, testing and commissioning of the cable at site.

CLIMATIC CONDITIONS: The climate is tropical and has marked Monsoon character with seasonal changes from humid, warm, rainy season, summers to cool and dry winters. Maximum temperature occurs during the period from April to May reaching approximately 43^0C (110^0 F) with a relative air humidity of 60% to 70%. The annual mean temperature is approximately 29^0C (84^0 F). During the rainy monsoon month from June to September, the average relative air humidity is 80% and reaches extreme values up to saturation point during longer periods. The annual rainfall, most of which occurs from June to September is 2000mm to 2500mm

OPERATING CONDITIONS: The cable will be connected to the 11KV or 415 volts 3-phase or 220 volt single phase, 50 Hz Bus of Power Development Board / REB / DPDC / DESCO/NESCO BANGLADESH and other power distribution companies.

STANDARDS: All equipment and materials must be in conformity with the most recent relevant BANGLADESH laws, standard rules and regulation. Particular attention is to be paid to the Bangladesh Electricity Act, 2018 and Electricity Rules, 2020 . All equipment and materials to be supplied which required any form of approval by the BANGLADESH Government or a Local Authority like PDB / DPDC / DESCO or REB must satisfactorily pass all inspection and tests procedures imposed by them. Otherwise, all the equipment and materials must be in conformity with the most recent international rules, regulation, standards and recommendation: IEC.

STANDARD DATA: The following standard values for high and low voltage are standard in BANGLADESH. Distribution bus High Voltage : 11kV, Maximum system High Voltage : 12kV, Distribution bus Low Voltage : 415/240 V .The standard power frequency in BANGLADESH will be: 50Hz

DESIGN & CONSTRUCTION REQUIREMENTS: All Cables are to be in accordance with the latest recognized rules of workmanship and modern engineering practice and must be suitable in every respect for continuous operation at maximum output under the climatic conditions as specified above

MATERIAL REQUIREMENTS: Conducting materials for cables must be of 99.99% pure annealed stranded copper, aluminium and insulation of thermoplastic materials based on PVC or XLPE for HT and LT Cables shall be complying with relevant IEC / VDE / BS / BDS standards.

OPERATING TESTS: Current load measurement shall be made on equipment and on all power and lighting feeders. The current reading shall be taken in each phase wire and in each neutral wire while the circuit or equipment is operating under actual load conditions.

Clip-on ammeters may be used to take current readings. All light fittings shall be tested electrically and mechanically to check whether they comply with the standard specifications. Fluorescent light fittings shall be tested so that when functioning no flickering or choke singing is felt.

MARKING AND CODE: The Cables shall be marked and coded in accordance with BDS, BS, IEC, VDE or equivalent standards.

INSULATION CO - ORDINATION: The insulation of thermoplastic materials based on PVC or XLPE for HT and LT Cables shall be complying with relevant IEC/VDE/BS/BDS/ ASTM standards.

The insulation test voltage for Cables is as follows:

Rated voltage of the cables, KV	Single Phase test voltage, KV	Thr.ee phase test voltage, KV	Direct test voltage, KV
0.6	4	4	12
3.5	11	11	33
5.8	17	17	51

TECHNICAL REQUIREMENTS: The Cable specified in the following items shall withstand the impulse levels and test voltages specified by the recommendations of IEC, as stipulated before. They must be capable of carrying the short time current for three seconds and must withstand the short circuit (Peak value) current. The cable must be designed accordingly in order to withstand the mechanical short circuit stresses. They must contain all technical particulars which are mentioned in the Schedule of Technical Data. The Owner reserves the right to have routine tests carried out on each type of equipment at the manufacturer's factory in the presence of his representative. The single bars shall be marked by the colors as per IEC, VDE or BS standard.

HT CABLE

HT XLPE Cables Construction

CONDUCTOR: The Conductor is Plain annealed stranded and compacted round Copper in accordance with BDS IEC-60228. Compacting of conductor improves its current carrying capacity, reduces losses and reduces overall cable diameter.

CONDUCTOR SCREEN: An extruded tight fitting layer of Semi-conducting is provided over the copper conductor as the provisions of BDS IEC-60502-2 & BDS 1521 (part-1 & 2)

INSULATION: The insulation of Cross-linked polyethylene (XLPE) to be applied by extrusion as per IEC-60502-2.

INSULATION SCREEN: An extruded tight fitting layer of Semi-conducting is provided over the XLPE insulation as the provisions of BDS IEC-60502-2 & BDS 1521 (part-1 & 2).

METALLIC SCREEN: A metallic screen of copper is provided over insulation screen as per the provisions of IEC-60502-2 & BDS 1521 (part-1 & 2)

INNER COVERING: Inner covering of extruded or taped PVC is provided wherever applicable as per IEC-60502-2.

ARMOUR: Armouring by Round wires or Flat wires or Double tapes. The material of armour for Single core is aluminum whereas, for multi-core cables it is Galvanized Sheet. Counter helix of Galvanized sheet tape is provided on request for round steel wire & Flat wire armoured cables. The armour is applied over the inner covering as per IEC-60502-2.
OVER SHEATH: Over sheath is of extruded PVC as per IEC-60502-2. Special properties for sheath can be provided on specific request, such as FRLS, anti-termite & anti-rodent, resistance to ultraviolet radiation etc.

3 Core Round / Flat Wire HT XLPE Cables

Type: 2xSEYRGY/2xSEYFGY

Applicable Specification: IEC-60502-2 BDS & BDS 1521 (part-1 & 2).

Voltage grade 6/10(12) KV.

Construction: Stranded copper conductor, extruded semi conducting conductor screen, XLPE insulation, extruded semi conducting insulation screen, metallic screen of copper, cores laid up with PVC fillers. Extruded PVC Inner covering, Galvanized steel Round/Flat wire armour with counter helix binder tape, PVC over sheathed.

Dimension & Mechanical Data

Nominal conductor cross section	Nominal thickness of insulation	Steel armour wire Dia.	Nominal Over Sheath thickness	Approx. Cable Dia.meter	Approx. weight of cable
mm^2	mm	mm	mm	mm	kg / km
3 x 50	3.4	2.5	2.5	52.5	5820
3 x 70	3.4	2.5	2.5	56.5	6900
3 x 95	3.4	2.5	2.8	61	8150
3 x 120	3.4	2.5	2.9	64.3	9100
3 x 150	3.4	2.5	3	68	10350
3 x 185	3.4	2.5	3.2	72.1	11950
3 x 240	3.4	3.15	3.3	78	15050
3 x 300	3.4	3.15	3.5	86	17700

Electrical Data

Nominal Conductor cross-section	Max. Conductor DC resistance @ 20°C	Current Rating @ 20°C in ground	Current Rating @ 20°C in air	Capacitance	Inductance
mm^2	Ohm / Km	Amps	Amps	Micro F/ Km	mH / Km
3 x 50	0.387	181	205	0.321	0.343
3 x 70	0.268	220	253	0.371	0.325

3 x 95	0.193	263	307	0.417	0.309
3 x 120	0.153	298	352	0.459	0.297
3 x 150	0.124	332	397	0.494	0.289
3 x 185	0.0991	374	453	0.543	0.280
3 x 240	0.0754	431	529	0.583	0.273
3 x 300	0.0601	482	599	0.602	0.267

L.T. CABLE : Single / Multi-core low voltage cables shall be PVC / XLPE insulated, PVC sheathed armoured / non-armoured direct burial type, termite proof, made and tested according to relevant IEC / VDE / BS / BDS for this type of installation rated voltage being 600 / 1000V. LT cable shall be used for domestic wiring, control and power wiring.

BYA Cable

Description: Plain annealed Stranded Copper conductor of 99.99% purity or Aluminium Conductor, PVC insulated single core cable.

Application: Suitable for use in surface mounted or cosseted PVC conduits or trunking. Also suitable for field protected installation in and appliances up to 1000 V A.C or up to 750 V to earth D.C.

Reference Standards: BDS IEC-60502-1, VDE-0250, BDS-900 and BS: 6004

BYM Cable

Description: Plain annealed Stranded Copper conductor of 99.99% purity purity or Aluminium, PVC insulated, PVC outer sheathed single core cable .

Application : Suitable for use in fixed installations in dry or damp premises clipped direct to a surface or on a cable tray unclosed and also for use in non-metallic conduit (PVC) to be used in appliances up to 1000 V A.C or up to 750 V to earth D.C.

Reference Standards : BDS IEC-60502-1, VDE-0250, BDS-900 and BS: 6004

BYFYE Cable

Description: Plain annealed Stranded Copper conductor of 99.99% purity or Aluminium , PVC insulated, two core flat cable with earth continuity conductor and PVC sheathed.

Application: Suitable for use in fixed installation in dry or damp premises and for installation in walls, on boards and in channels or embedded in plaster. Not to be used in thr.ee phase 400 V circuits.

Reference Standards: BDS IEC-60502-1, VDE-0250, BDS-900 and BS: 6004

NYY Cables

Description: Plain annealed Stranded Copper conductor of 99.99% purity or Aluminium, PVC insulated, PVC outer sheathed.

Application : Suitable for use in indoors, outdoors, underground and in water for continuous permissible service voltage of 720/1200 Volts.

Reference Standards: BDS IEC-60502-1, VDE-0271, BDS-900 and BS: 600

CURRENT CARRYING CAPACITY OF COPPER (IN AMPERE) OF DIFFERENT TYPES CABLES

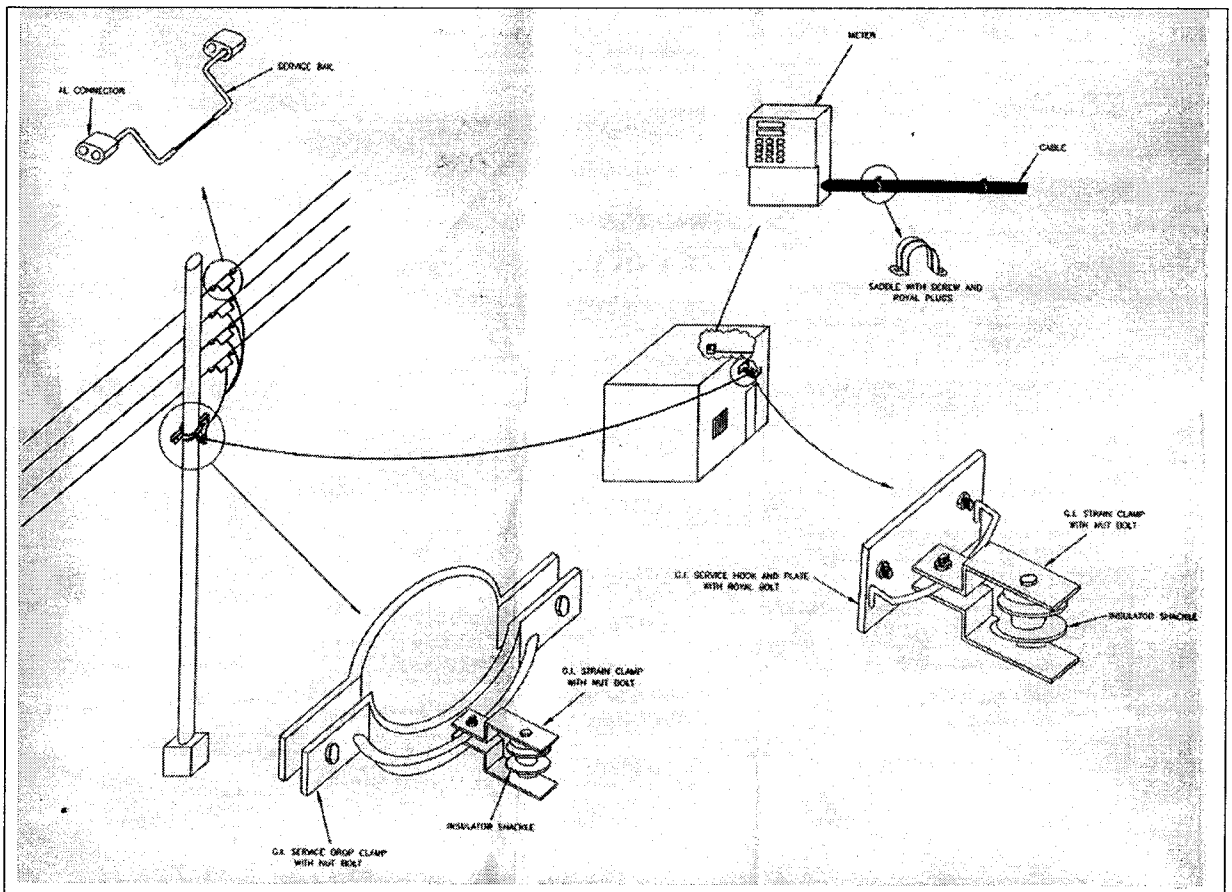
CROSS SECTION	NO./DIA OF WIRE	BYA		BYM						BYFYE		NYY						NYFGbY		NYSEYFGbY		XLPE	
		1-CORE		1-CORE		2-CORE		¾-CORE		2-CORE		1-CORE		2-CORE		¾-CORE		¾-CORE		3-CORE		3-CORE	
mm2	mm	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	U/G	A	U/G	A	U/G	A
1.0 RE	1/1.13	13	16	13	16	1	15	11	12	13	15	-	-	-	-	-	-						
1.5 RE	1/1.38	16	20	16	20	16	18	15	16	16	18	27	22	25	19	22	16						
2.5 RE	1/1.78	22	28	22	28	22	26	20	22	22	26	36	30	34	27	30	23						
4 RM	7/0.85	30	37	30	37	30	33	27	30	30	33	47	39	44	35	38	32						
6 RM	71.04	38	47	43	47	37	43	33	27	37	37	59	50	55	45	45	48						
10 RM	7/1.35	52	63	52	63	50	60	46	51			78	69	74	62	64	56						
16 RM	7/1.70	70	85	70	85	66	80	58	67			100	94	97	84	83	75	83	75	79	79	100	105
25RM/SM	7/2.14	91	110	91	110	75	88	66	77			130	125	125	110	110	98	110	98	100	100	120	140
35RM/SM	7/20/2.03	112	136	112	136	92	108	81	90			155	160	150	140	130	120	130	120	120	120	150	170
50RM/SM	19/20/1.83	136	164									185	195			155	150	155	150	140	145	180	200
70RM/SM	19/20/2.10	173	207									225	245			190	190	190	190	170	170	225	255
95RM/SM	19/20/2.52	216	253									270	300			225	230	225	230	200	220	260	305
120RM/SM	37/39/2.03	244	291									310	350			260	270	260	270	230	250	300	350
150RM/SM	37/39/2.27	-	333									350	405			295	305	295	305	260	290	330	400
185RM/SM	37/39/2.52	-	381									390	460			330	350	330	350	290	325	370	455
240RM/SM	61/39/2.24	-	452									450	555			385	410	385	410	200	220	430	530
300RM/SM	61/39/2.39	-	526									515	640			425	470	425	470			470	600
400RM/SM	61/2.89	-	639									585	770			480	530					525	675
500RM/SM	61/3.23	-	752									680	900			525	600						
630RM/SM	127/2.52	-	855									800	1030			590	690						

Note: C – Concealed; S – Surface; U/G – Under Ground; A – Ambient.

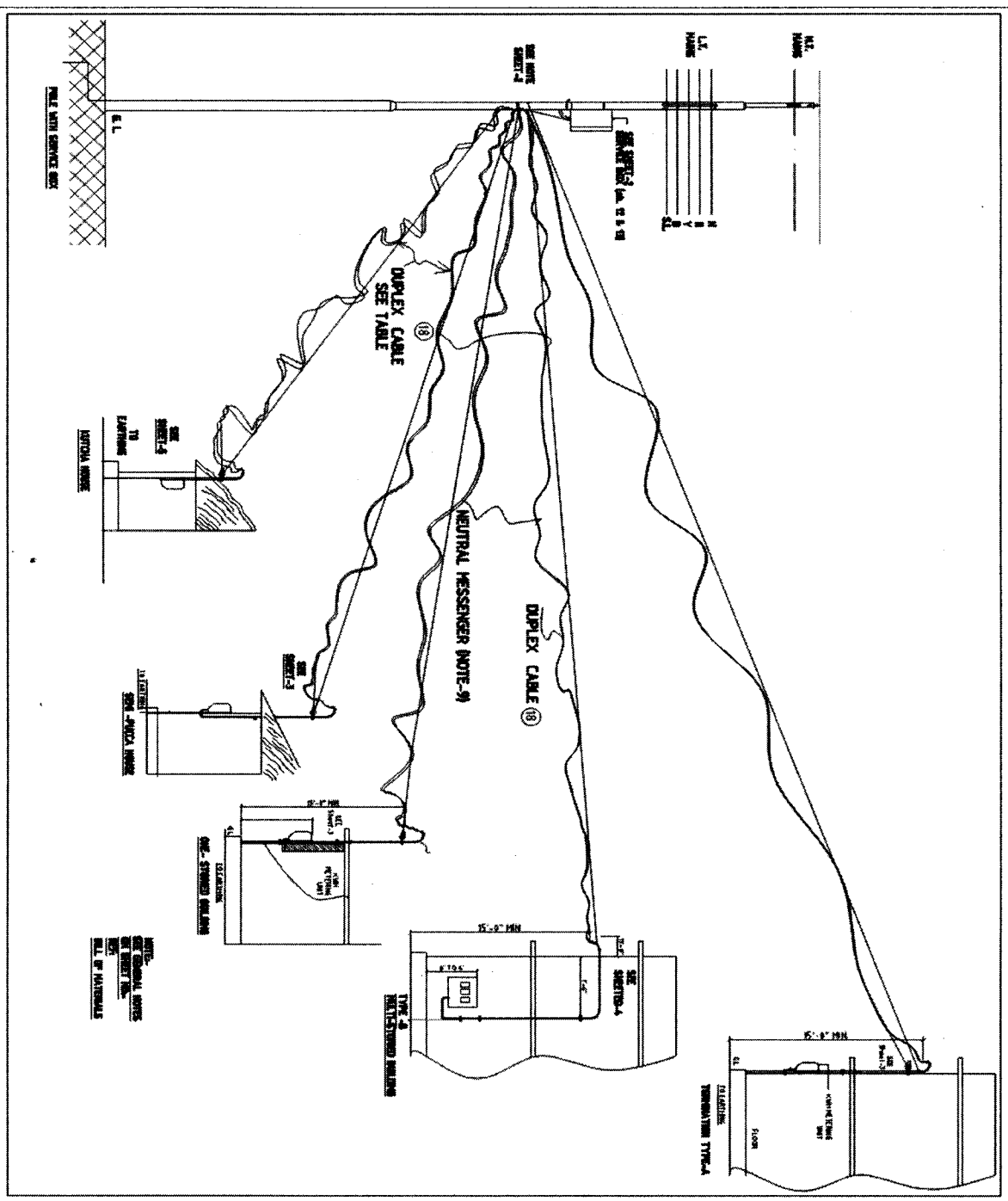
APPENDIX IV

List of Service Connection Materials

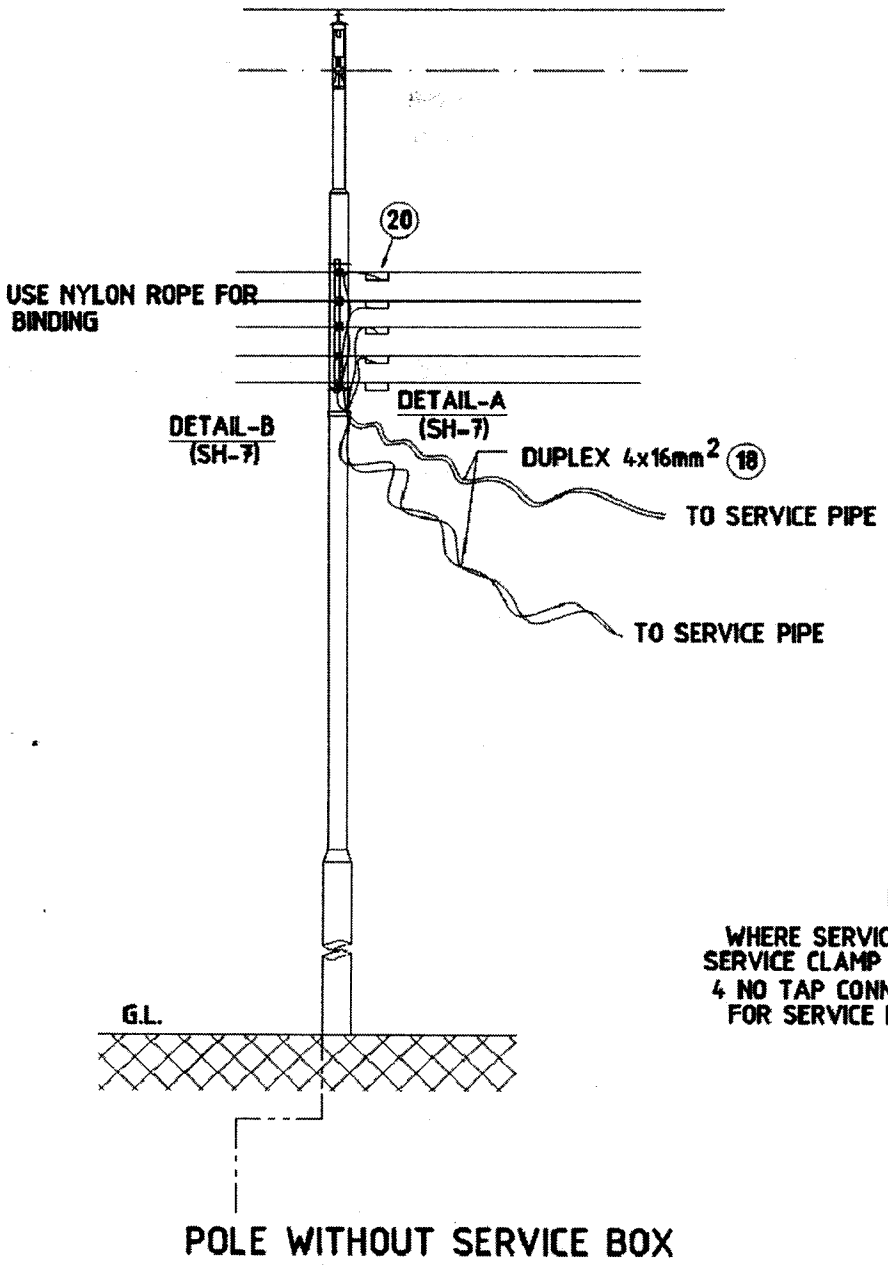
Sl. No.	Description of Items	Remarks
All Service connection materials and hardware for Service Drop are listed below:		
01	Junction Box for single phase connection	
02	Junction Box for three phase connection	
03	Service Bale	
04	Service Cable	
	a) PVC Copper Cable (4rm, 6rm, 10rm & 16rm)	
	b) Concentric Copper Cable (6rm, single Core)	
	c) Concentric Copper Cable (16rm, single Core)	
05	H-Type/ Compression Type/ CrimPpitConnector	
06	Piercing connectors (25 mm& 12mm)	
07	Service Drop Clamp	
08	Strain Clamp	
09	Service Hook with Flat Plate	
10	Wage Clamp	
11	Shackle Insulators	
12	G. I wire 16 SWG Dia=0.0625" (1.587mm)	
13	Cable Tie 100 mm	
14	Cable Tie 150 mm	
15	Wall clip, for fixing round cable, ¾"	
16	Wall clip, for fixing round cable, 1 ½"	



TITLE: GENERAL ARRANGEMENT OF SERVICE CONNECTION – PPM.	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	



TITLE: GENERAL ARRANGEMENT OF SERVICE CONNECTION – 1P (CONVETIONAL)	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

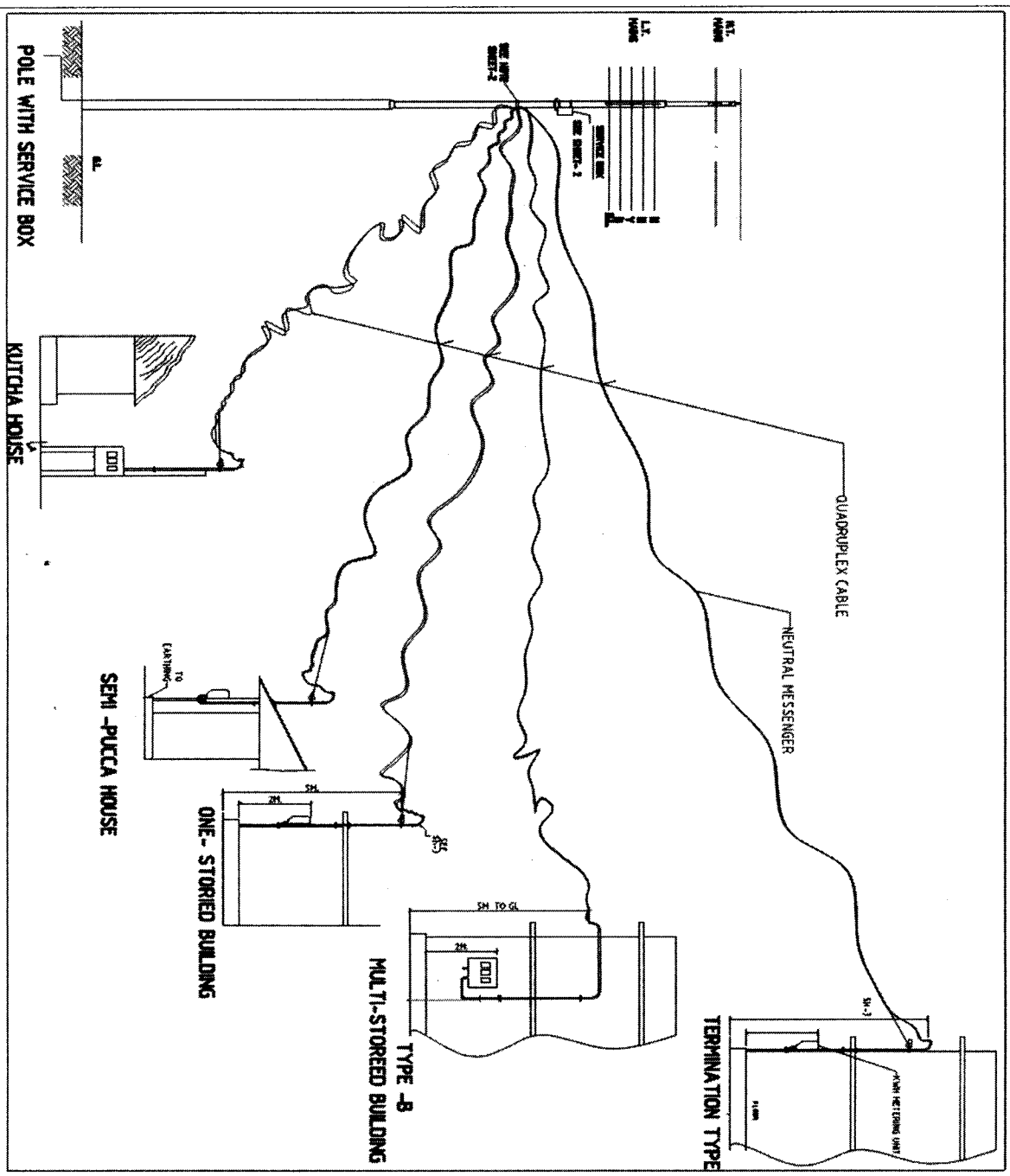


NOTE:

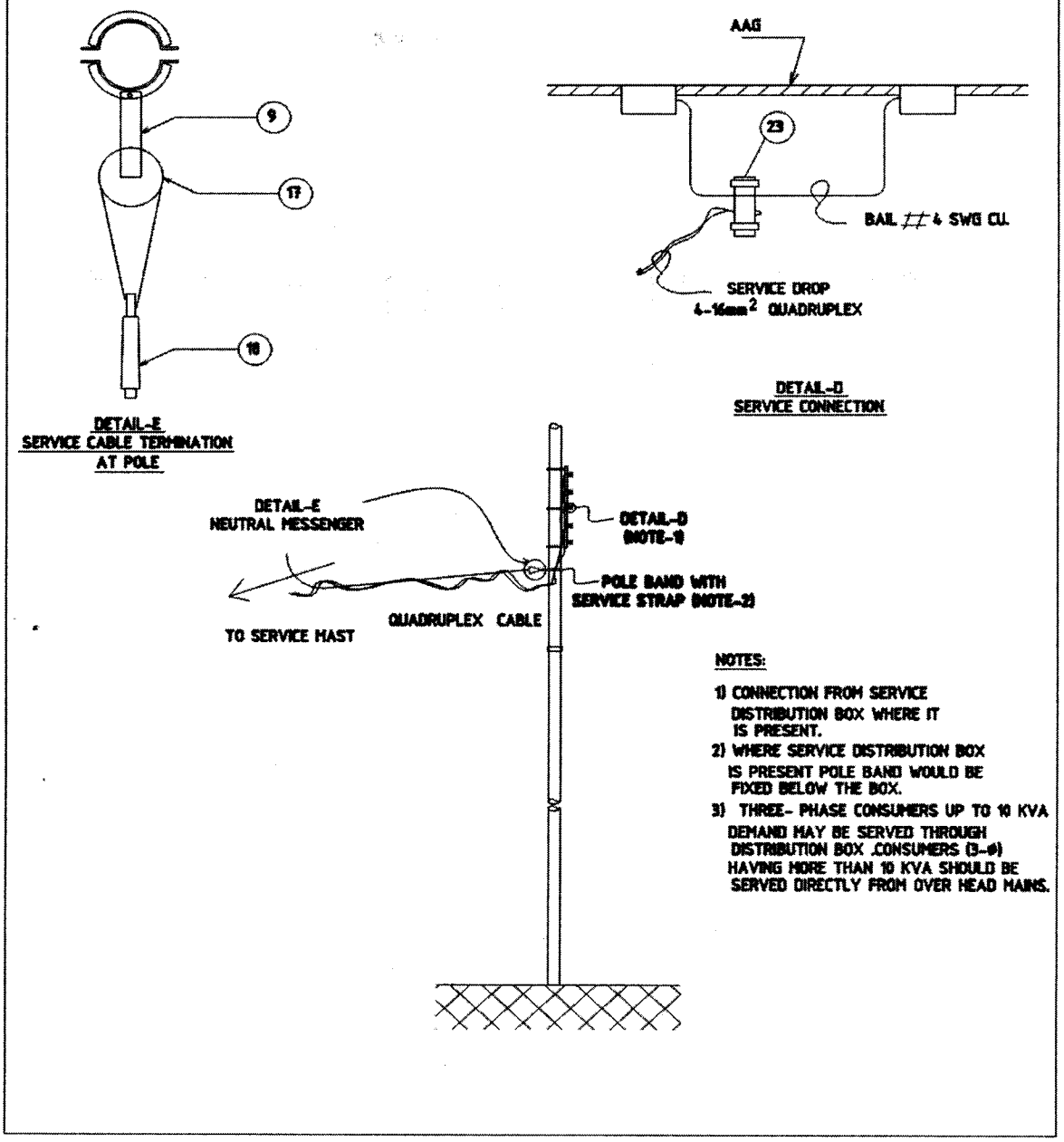
WHERE SERVICE BOX IS PRESENT, SERVICE CLAMP IS FIXED BELOW BOX 4 NO TAP CONNECTOR IS REQUIRED FOR SERVICE DROP. SEE SHEET-1

POLE WITHOUT SERVICE BOX

TITLE: GENERAL ARRANGEMENT OF SERVICE CONNECTION – 1P (CONVETIONAL)	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	



TITLE: GENERAL ARRANGEMENT OF SERVICE CONNECTION – 3P (CONVETIONAL)	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	



TITLE: GENERAL ARRANGEMENT OF SERVICE CONNECTION – 3P (CONVETIONAL)	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

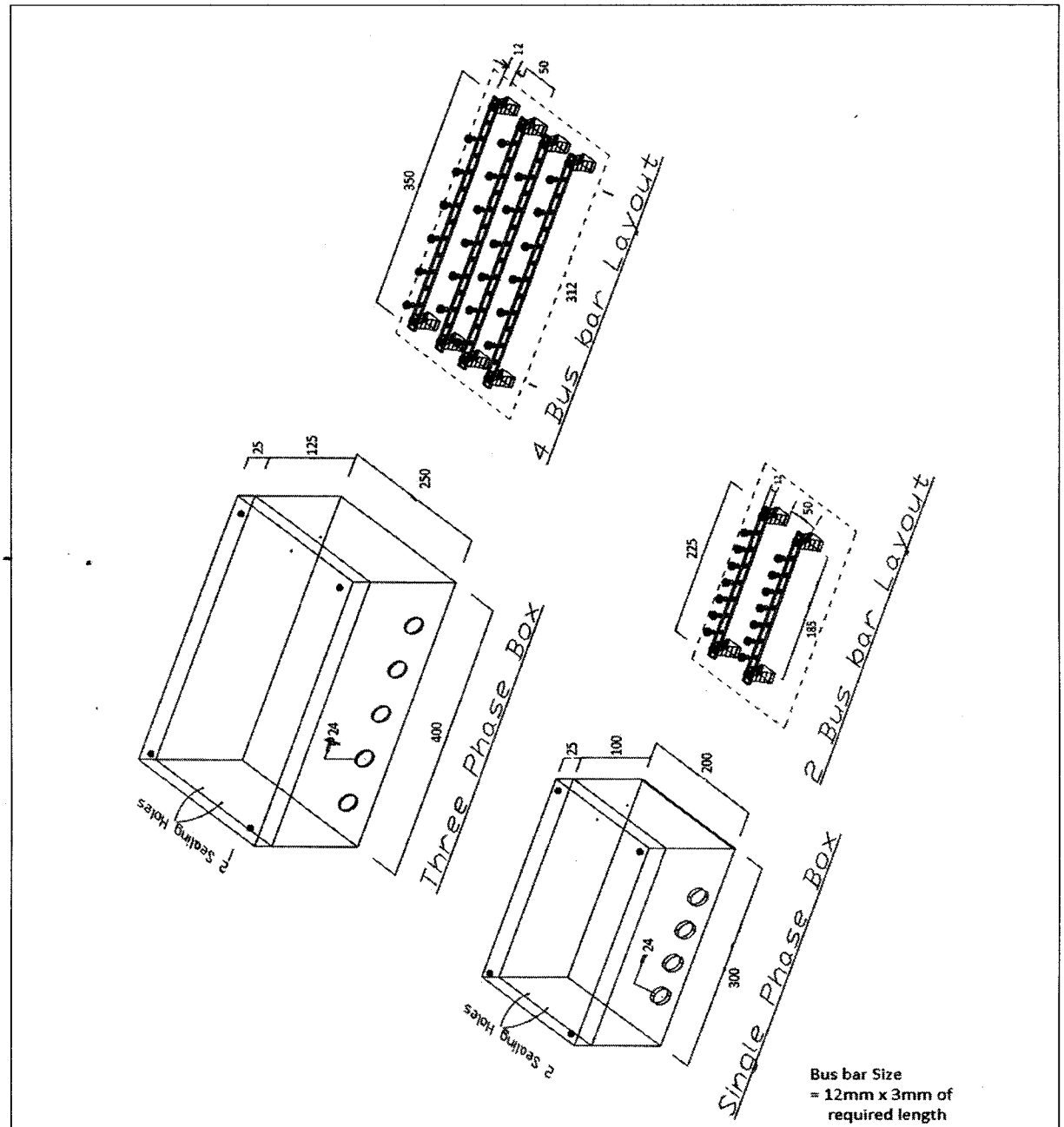
1. **Specifications of Junction Box (Single phase connection)**

Sl. No.	Description	Required specifications
1	Applicable Standard	BS, IEC, VDE or equivalent international standard
2	Installation	Outdoor and Pole Mounted.
3	Connection	Single phase, Two wire, Whole current, Solidly grounded neutral side connected
4	Material	ABS Resin/Mild & high Tensile Steel
5	Galvanization	Hot Dip as per ASTM A90/ BS EN ISO 1461:1999
6	Thickness of Material	20 SGW
7	Dimension	As per Drawing
8	Voltage Rating	440 Volt
9	Current Rating	80 A
10	No. of Input Terminal	
	a) Phase	1
	b) Neutral	1
	c) Earthing	1
11	No. of Output Terminal	
	a) Phase	4
	b) Neutral	4

2. **Specifications of Junction Box (Three phase connection)**

Sl. No.	Description	Required specifications
1	Applicable Standard	BS, IEC, VDE or equivalent international standard
2	Installation	Outdoor and Pole Mounted.
3	Connection	Three phase, Four wire, Whole current, Solidly grounded neutral side connected
4	Material	ABS Resin/Mild & high Tensile Steel
5	Galvanization	Hot Dip as per ASTM A90/ BS EN ISO 1461:1999
6	Thickness of Material	20 SGW

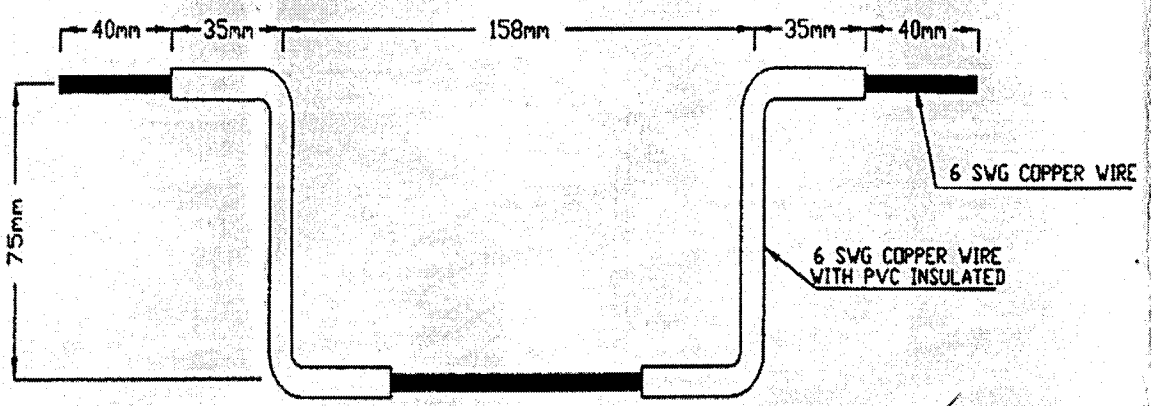
7	Dimension	As per Drawing
8	Voltage Rating	750 Volt
9	Current Rating	120 A
10	No. of Input Terminal	
	a) Phase	3
	b) Neutral	1
	c) Earthing	1
11	No. of Output Terminal	
	a) Phase	5
	b) Neutral	5



TITLE: JUNCTION BOX	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	PM-02
	APPROVED:	
	DATE :	

3. Specifications of Service Bail (Compatible for taking off Service drops from LT Lines.)

Sl. No.	Description	Required specifications
1	Applicable Standard	BS, IEC, VDE or equivalent international standard
2	Installation	Overhear lines (Service drop connection)
3	Type	PVC Insulated
4	Thickness of Insulation	1 (one) mm
5	Material	Copper & PVC
6	Strand	Single
7	Size of Bail	6 SWG Copper
8	Shape	U-shaped
9	Length of Copper Wire	458 mm
10	Min. continuous current rating at 35°C rise over 40°C ambient temperature (75°C)	125 Amps (min)
11	Dimension	As per drawing



Technical Specification

TYPE	: PVC INSULATED
THICKNESS OF INSULATION	: 1 mm
SIZE OF BAIL	: 6 SWG COPPER
SHAPE	: U SHAPED
LENGHT OF COPPER WIRE	: 458 mm

SERVICE BAIL

TITLE: SERVICE BAIL	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

4. a(i) Specifications of PVC Copper Cable (4rm)

Sl. No.	Description	Unit	Purchaser's Requirement
1	Name of the Item		1CX4 sq. mm PVC Insulated and PVC Sheathed Cables
2	Standard		Performance Design and Testing shall be in accordance to the BS, IEC, BDS or equivalent International standards.
3	Cable Size	mm^2	1CX4
4	Material		PVC Insulated and PVC Sheathed plain annealed copper.
5	Numbers & Diameter of wires	mm	7/0.85
6	Maximum resistance at 20 deg. C	Ω/KM	4.61
7	Nominal thickness of insulation	mm	1.0
8	Nominal thickness of sheath	mm	1.8
9	Colour of sheath		Black
10	Continuous permissible service voltage	V	600/1000
11	Current rating at 35 deg. C ambient temperature in U/G	Amps	47
12	Current rating at 35 deg. C ambient in air	Amps	39
13	Drum wound length	M	500
14	Treated Wooden Drum Standard		AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

4. a(ii) Specifications of PVC Copper Cable (6rm)

Sl. No.	Description	Unit	Purchaser's Requirement
1	Name of the Item		1CX6 sq. mm PVC Insulated and PVC Sheathed Cables
2	Standard		Performance Design and Testing shall be in accordance to the BS, IEC, BDS or equivalent International standards.
3	Cable Size	mm^2	1CX6

4	Material		PVC Insulated and PVC Sheathed plain annealed copper.
5	Numbers & Diameter of wires	mm	7/1.04
6	Maximum resistance at 20 deg. C	Ω/KM	3.08
7	Nominal thickness of insulation	mm	1.0
8	Nominal thickness of sheath	mm	1.8
9	Colour of sheath		Black
10	Continuous permissible service voltage	V	600/1000
11	Current rating at 35 deg. C ambient temperature in U/G	Amps	59
12	Current rating at 35 deg. C ambient in air	Amps	50
13	Drum wound length	M	500
14	Treated Wooden Drum Standard		AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

4. a(iii) Specifications of PVC Copper Cable (10rm)

Sl. No.	Description	Unit	Purchaser's Requirement
1	Name of the Item		1CX10 sq. mm PVC Insulated and PVC Sheathed Cables
2	Standard		Performance Design and Testing shall be in accordance to the BS, IEC, BDS or equivalent International standards.
3	Cable Size	mm^2	1CX10
4	Material		PVC Insulated and PVC Sheathed plain annealed copper.
5	Numbers & Diameter of wires	mm	7/1.35
6	Maximum resistance at 20 deg. C	Ω/KM	1.83
7	Nominal thickness of insulation	mm	1.0
8	Nominal thickness of sheath	mm	1.8
9	Colour of sheath		Black
10	Continuous permissible service voltage	V	600/1000

11	Current rating at 35 deg. C ambient temperature in U/G	Amps	78
12	Current rating at 35 deg. C ambient in air	Amps	69
13	Drum wound length	M	500
14	Treated Wooden Drum Standard		AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

4. a(iv) Specifications of PVC Copper Cable (16rm)

Sl. No.	Description	Unit	Purchaser's Requirement
1	Name of the Item		1CX16 sq. mm PVC Insulated and PVC Sheathed Cables
2	Standard		Performance Design and Testing shall be in accordance to the BS, IEC, BDS or equivalent International standards.
3	Cable Size	mm^2	1CX16
4	Material		PVC Insulated and PVC Sheathed plain annealed copper.
5	Numbers & Diameter of wires	mm	7/1.70
6	Maximum resistance at 20 deg. C	Ω/KM	1.15
7	Nominal thickness of insulation	mm	1.0
8	Nominal thickness of sheath	mm	1.8
9	Colour of sheath		Black
10	Continuous permissible service voltage	V	600/1000
11	Current rating at 35 deg. C ambient temperature in U/G	Amps	100
12	Current rating at 35 deg. C ambient in air	Amps	94
13	Drum wound length	M	500
14	Treated Wooden Drum Standard		AWPA C_1 – 82, C_2 –83, C_{16} –82, P_5 –83.

4. b) Specifications of Concentric Cable (6 rm)

Sl. No.	Name of Item	Required specifications
1	Type	Water Blocked Concentric Cable
2	Standard Reference	IEC-60502-1
3	Rated Voltage	600/1000
4	One Central Core:	
	i) Phase Conductor Area	6
	ii) No. of wires	7
	iii) Nominal Wire Size	1.04
	iv) Nominal Conductor Diameter	3.12
	v) No of Cores	1
	vi) Type	Stranded Circular
	vii) Conductor Material	HD Copper
5	i) Phase Insulation Type	XLPE UV Red
	ii) Nominal Thickness of Insulation	1.00
	iii) Core Identification	Coloured -Red UV
	iv) Nominal Core Diameter	5.12
6	i) Neutral Conductor Area	6
	ii) No. of wires	7
	iii) Nominal Wire Size	1.05
	iv) Type	Concentric
	v) Conductor Material	Annealed Copper
	vi) Identification	PVC/PE. Black, 0.25
7	i) Earth Conductor Area	4.5
	ii) No. of Wires	3
	iii) Nominal Wire Size	1.40
	iv) Type	Concentric

	v) Conductor Material	Annealed Copper
8	Filler/ Separator: (No.-2)	
	i) Material	PVC
	ii) Diameter	1.4
9	Serving/ Over Sheath	
	i) Material	PVC/PE
	ii) Nominal Thickness	1.40
	iii) Overall Diameter	10.80
	iv) Net Mass of Cable	221
10	i) Max. D.C. Resistance of conductor at 20 ^{0}C	3.18
	ii) Current Ratting in Ground	55
11	Binder	2 layer of PVC Tape over laid up cores/ Melinex Tape
12	Packing Length	500 ± 5%
13	Packing Material	Treated Wooden Drum

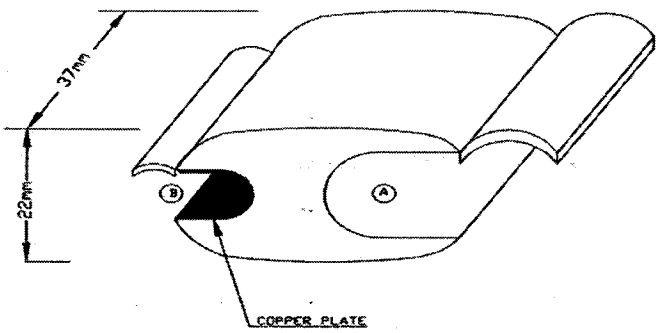
4. c) Specifications of Concentric Cable (16 rm)

Sl. No.	Name of Item	Required specifications
1	Type	Water Blocked Concentric Cable
2	Standard Reference	IEC-60502-1
3	Rated Voltage	600/1000
4	One Central Core:	
	i) Phase Conductor Area	16
	ii) No. of wires	7
	iii) Nominal Wire Size	1.67
	iv) Nominal Conductor Diameter	5.01
	v) No of Cores	1
	vi) Type	Stranded Circular
	vii) Conductor Material	HD Copper
5	i) Phase Insulation Type	XLPE UV Red
	ii) Nominal Thickness of Insulation	1.00
	iii) Core Identification	Coloured -Red UV
	iv) Nominal Core Diameter	7.01
6	i) Neutral Conductor Area	16
	ii) No. of wires	7
	iii) Nominal Wire Size	1.76
	iv) Type	Concentric
	v) Conductor Material	Annealed Copper
	vi) Identification	PVC/PE. Black, 0.25
7	i) Earth Conductor Area	10.5
	ii) No. of Wires	3
	iii) Nominal Wire Size	2.20
	iv) Type	Concentric

Sl. No.	Name of Item	Required specifications
	v) Conductor Material	Annealed Copper
8	Filler/ Separator: (No.-2)	
	i) Material	PVC
	ii) Diameter	1.83
9.	Serving/ Over Sheath	
	i) Material	PVC/PE
	ii) Nominal Thickness	1.60
	iii) Overall Diameter	14.73
	iv) Net Mass of Cable	505
10	i) Max. D.C. Resistance of conductor at 20 ^{0}C	1.19
	ii) Current Ratting in Ground	85
11	Binder	2 layer of PVC Tape over laid up cores/ Melinex Tape
12	Packing Length	500 ± 5%
13	Packing Material	Treated Wooden Drum

5) Specifications ofH-type/Compression type Connector (Compatible for Insulated AAC WASP Conductor)

Sl. No.	Description	Required specifications
1	Applicable Standard	BS, IEC, BDS or equivalent standard
2	Installation	Outdoor and shall be installed for the above-mentioned conductor.
3	Type	H-Type
4	Material	Aluminium
5	Continuous current rating	Shall be mentioned and capable of carrying the continuous current of the specified conductor in Amps.
6	Length	63 mm
7	Dimension	As per Drawing



THE SIZE OF THE H-TYPE SERVICE CRIMPIT (CONNECTORS) ARE AS FOLLOWS:-

NAME	GROVE A	GROVE B	DIMENSION	
	(Sq. mm)	(Sq. mm)	L (mm)	H (mm)
SERVICE CRIMPIT (CONNECTORS)	100	25	37	22

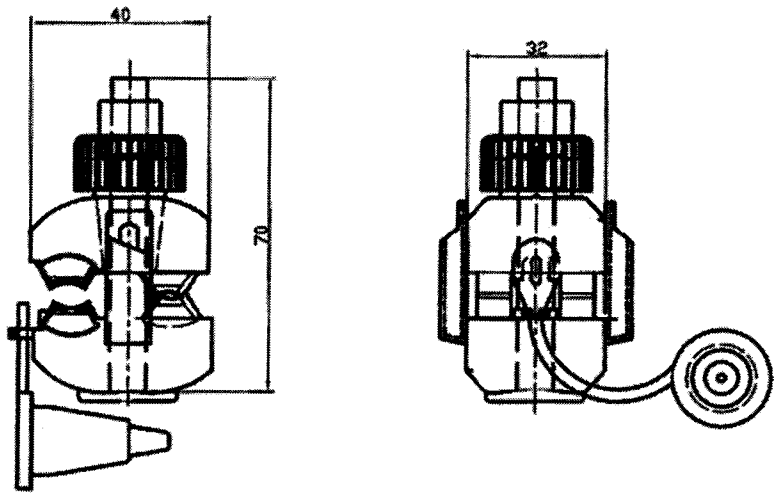
AL CONNECTOR

TITLE: H-TYPE/COMPRESSION TYPE CONNECTOR	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

6.Specifications for Piercing Connector (Insulated)

Sl. No.	Description	Required specifications
	Compatible for House Service Tap-off from 95-120 mm^2 Run Conductor	
1	Applicable Standard	BS, IEC, BDS or equivalent international standard
2	Installation	Outdoor and shall be installed for Al and/or Cu Conductor.
3	Material	Plated hardened copper alloy with PVC Insulation
4	Dimension	Shall be mentioned
5	Current carrying capacity	Shall be mentioned
	Compatible for House Service Tap-off from 35-70 mm^2 Run Conductor	
1	Applicable Standard	BS, IEC, BDS or equivalent international standard
2	Installation	Outdoor and shall be installed for Al and/or Cu Conductor.
3	Material	Plated hardened copper alloy with PVC Insulation
4	Dimension	Shall be mentioned
5	Current carrying capacity	Shall be mentioned

INSULATION PIERCING CONNECTOR



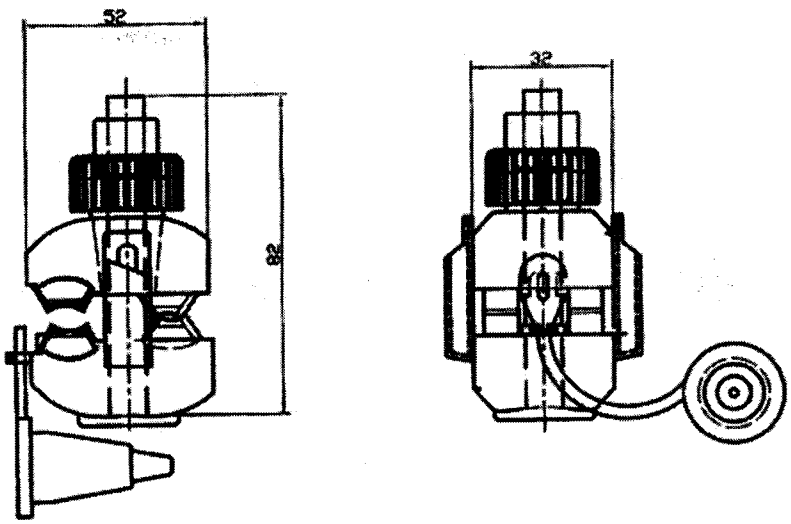
TECHNICAL DATA-
MATERIAL-FIBER REINFORCED THERMOPLASTIC WITH RUBBER INSERT
PIERCING TEETH-COPPER ALLOY.
FASTENERS-STEEL, G.R. 4.6/4.0 TO IS :1367/BS
FINISH-FERROUS PARTS ARE HOT DIP GALVANISED TO IS:1367/BS

CONDUCTOR SIZE-
IPC ABC MAIN 35-70 SQ.MM
TAP 6-25 SQ.MM

DIMENSIONS ARE IN m.m.

TITLE: INSULATED PIERCING CONNECTOR (35-70 sq.mm)	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

INSULATION PIERCING CONNECTOR



TECHNICAL DATA-
MATERIAL-FIBER REINFORCED THERMOPLASTIC WITH RUBBER INSERT
PIERCING TEETH-COPPER ALLOY.
FASTENERS-STEEL. G.R. 4.6/4.0 TO IS :1367 /BS
FINISH-FERROUS PARTS ARE HOT DIP GALVANISED TO IS:1367/BS

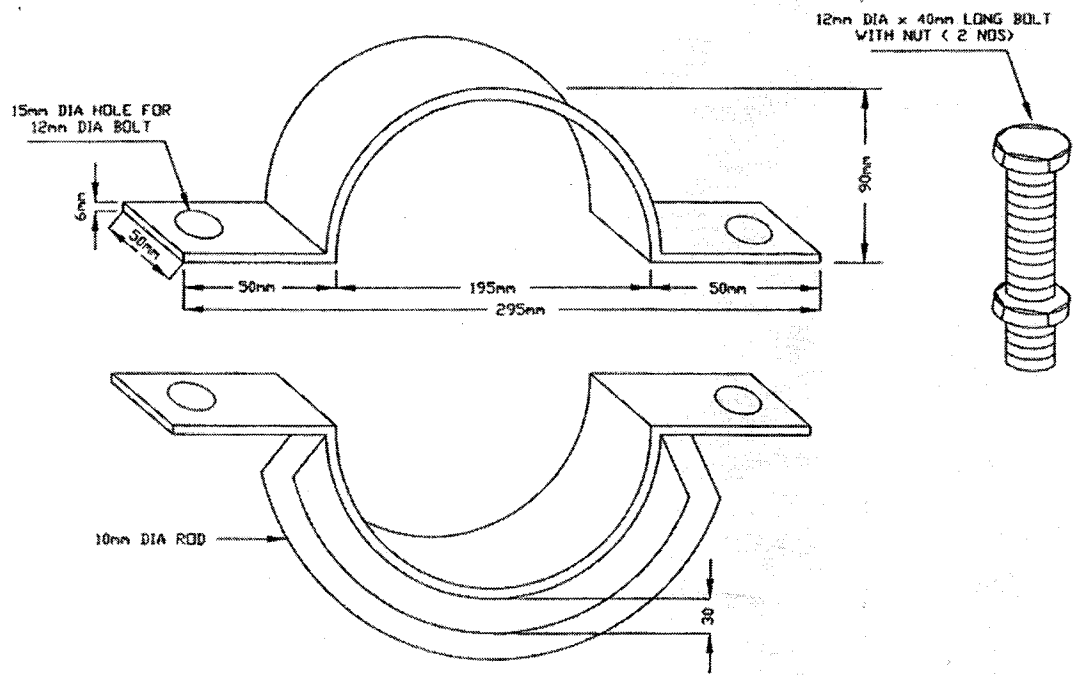
CONDUCTOR SIZE-
IPC ABC MAIN 95-120 SQ.MM
TAP 6-25 SQ.MM

DIMENSIONS ARE IN m.m.

TITLE: INSULATED PIERCING CONNECTOR (95-120 sq.mm)	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

7. Specifications of Service drop clamp with nut bolt

Sl. No.	Description	Required specifications
Service drop clamp		
1	Applicable Standard	BS, IEC, BDS or equivalent standard
2	Installation	Outdoor and shall be installed on the pole
3	Galvanization	Hot Dip as per ASTM A90/ BS EN ISO 1461:1999
4	Material	Mild Steel
5	Nut & Bolt	Galvanized
6	Dimension	As per Drawing



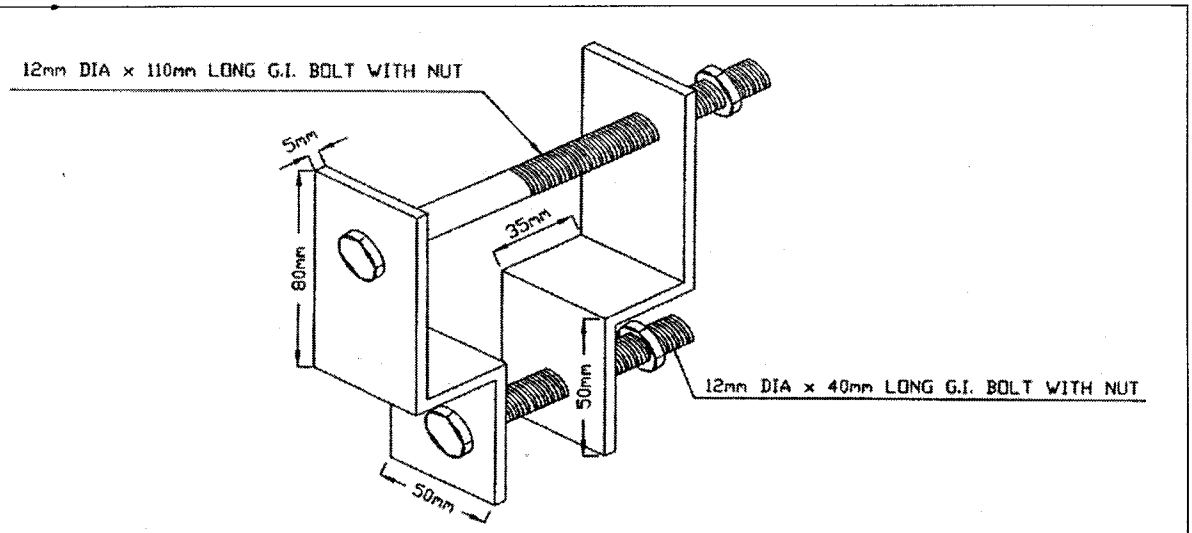
G.I. SERVICE DROP CLAMP WITH NUT BOLT

TITLE: SERVICE DROP CLAMP	DESIGNED :	
	DRAWN :	DRG. NO.

	CHECKED :	
	APPROVED:	
	DATE :	

8.Specifications for Strain Clamp

Sl. No.	Description	Required specifications
1	Applicable Standard	BS, IEC, BDS or equivalent standard
2	Galvanization	Hot Dip as per ASTM A90/ BS EN ISO 1461:1999
3	Material	Mild Steel
4	Nut & Bolt	Galvanized
5	Dimension	As per Drawing

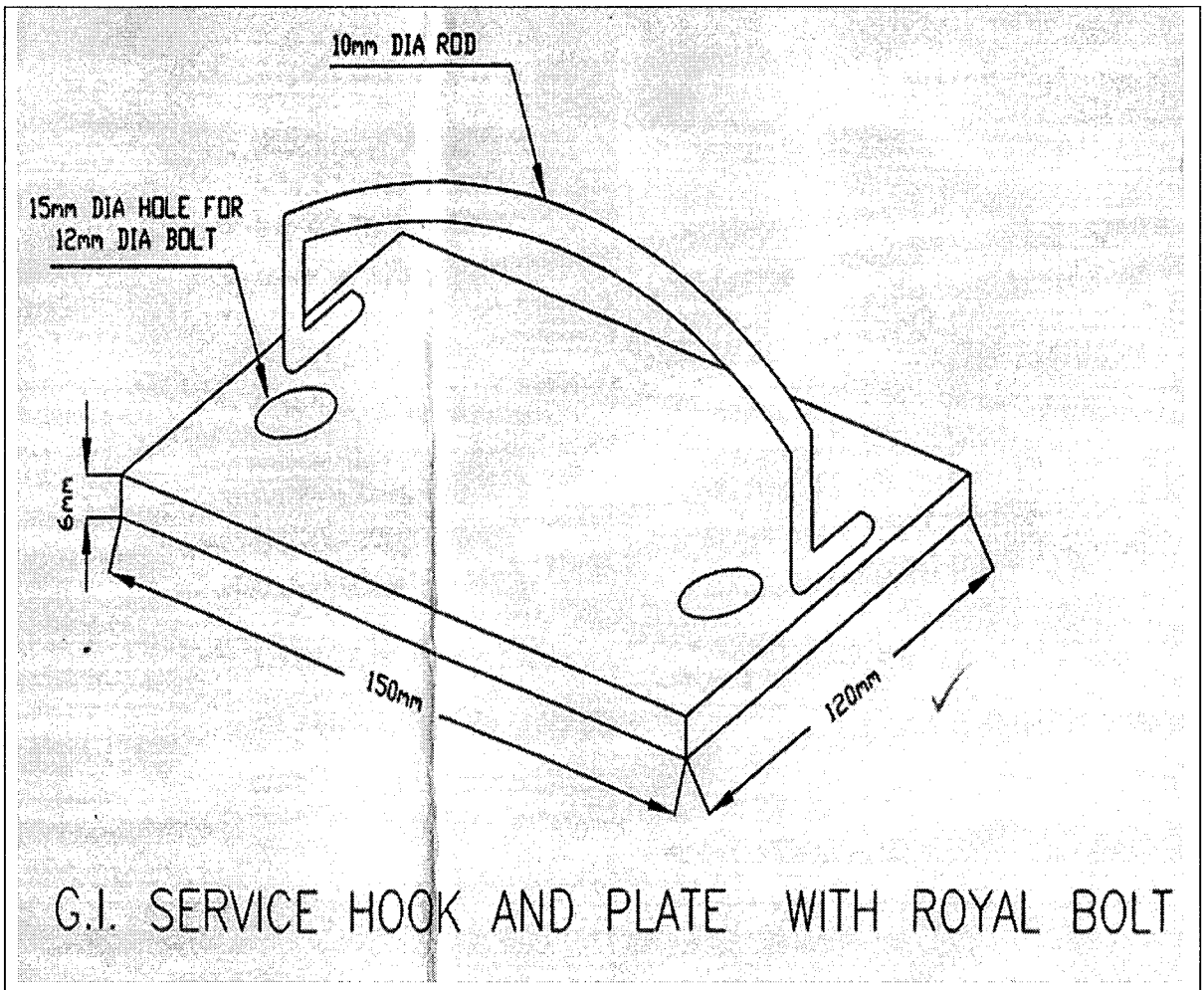


G.I. STRAIN CLAMP

TITLE: STRAIN CLAMP	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

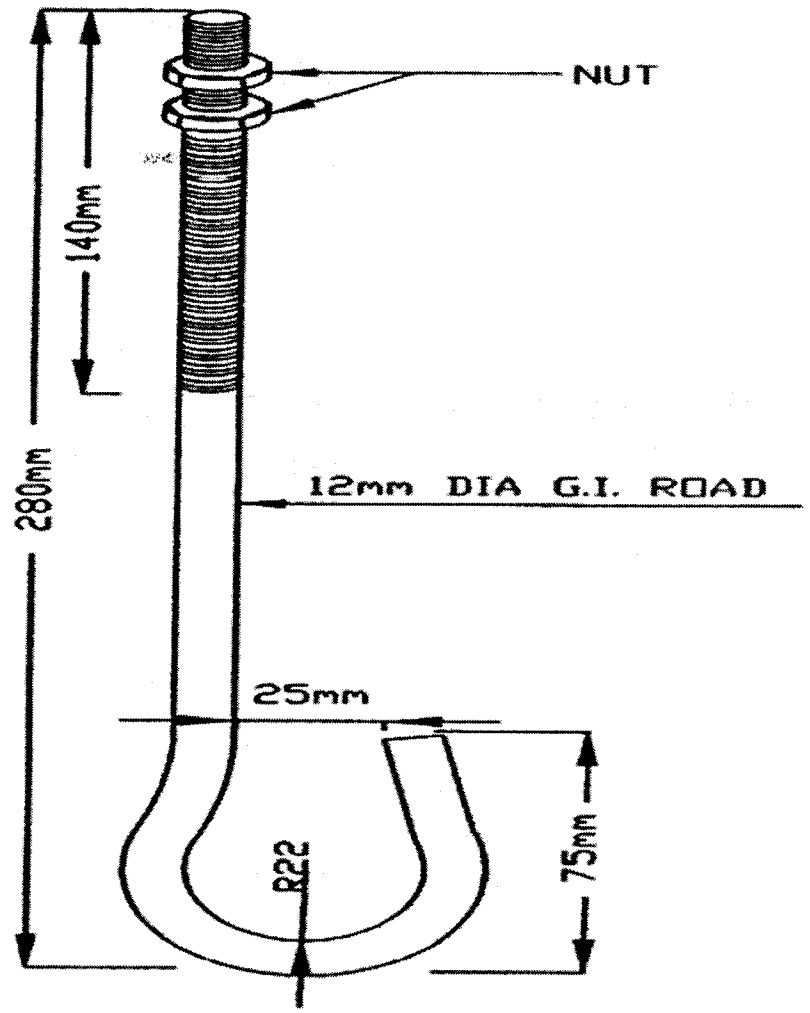
9.Specifications of Service Hook with flat Plate

Sl. No.	Description	Required specifications
Service Plate		
1	Applicable Standard	BS, IEC, BDS or equivalent standard
2	Installation	Outdoor and shall be installed on the pole
3	Galvanization	Hot Dip as per ASTM A90/ BS EN ISO 1461:1999
4	Material	Mild Steel
5	Nut & Bolt	Galvanized
6	Dimension	As per Drawing
Service Hook		
1	Applicable Standard	BS, IEC, BDS or equivalent standard
2	Installation	Outdoor
3	Galvanization	Hot Dip as per ASTM A90/ BS EN ISO 1461:1999
4	Material	Mild Steel
6	Dimension	As per Drawing



G.I. SERVICE HOOK AND PLATE WITH ROYAL BOLT

TITLE: SERVICE PLATE	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

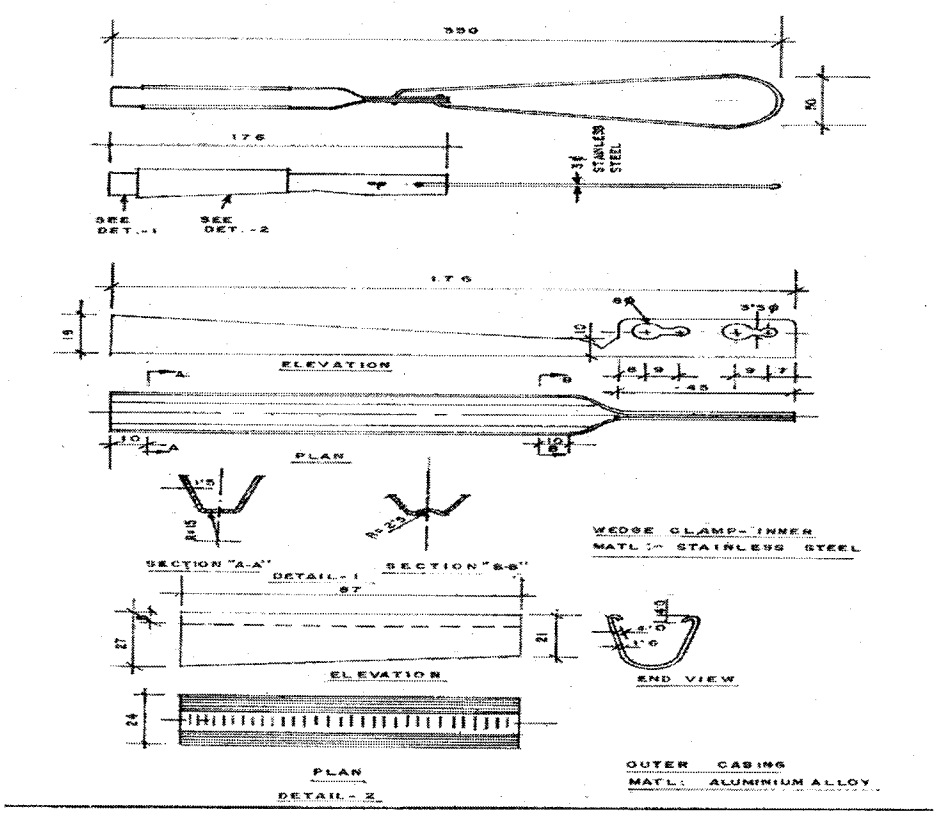


G.I. SERVICE HOOK

TITLE: SERVICE HOOK	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

10. Specifications for Wedge Clamp (Compatible for Service Connection)

Sl. No.	Description	Required specifications
1	Applicable Standard	BS, IEC, BDS or equivalent international standard
2	Installation	Outdoor and shall be installed for service drop cable
3	Conductor Range	4 to 25 mm^2
4	Materials	
	a) Outer Casing	Aluminium Alloy
	b) InnerCasing	Stainless Steel
5	Breaking Load (Minimum)	160 daN
6	Dimension	As per Drawing

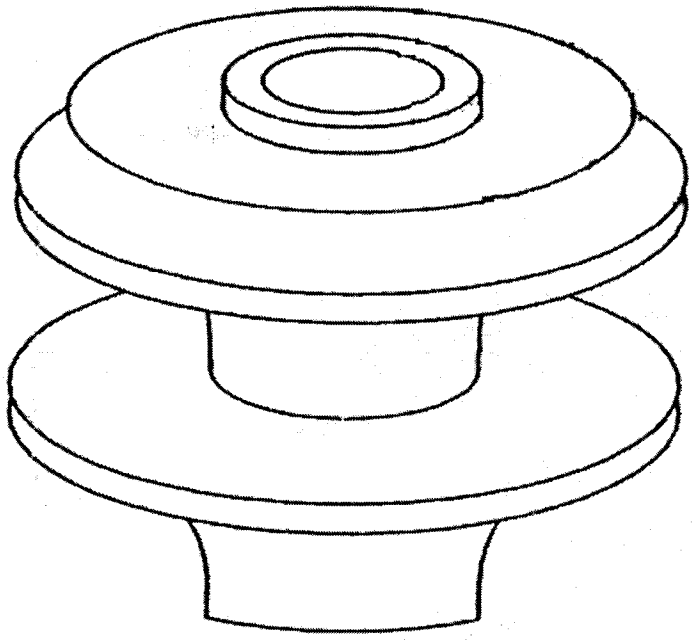


TITLE: WEDGE CLAMP	DESIGNED :	
	DRAWN :	DRG. NO.

	CHECKED :	
	APPROVED:	
	DATE :	

11. Specificationsof Shackle Insulator

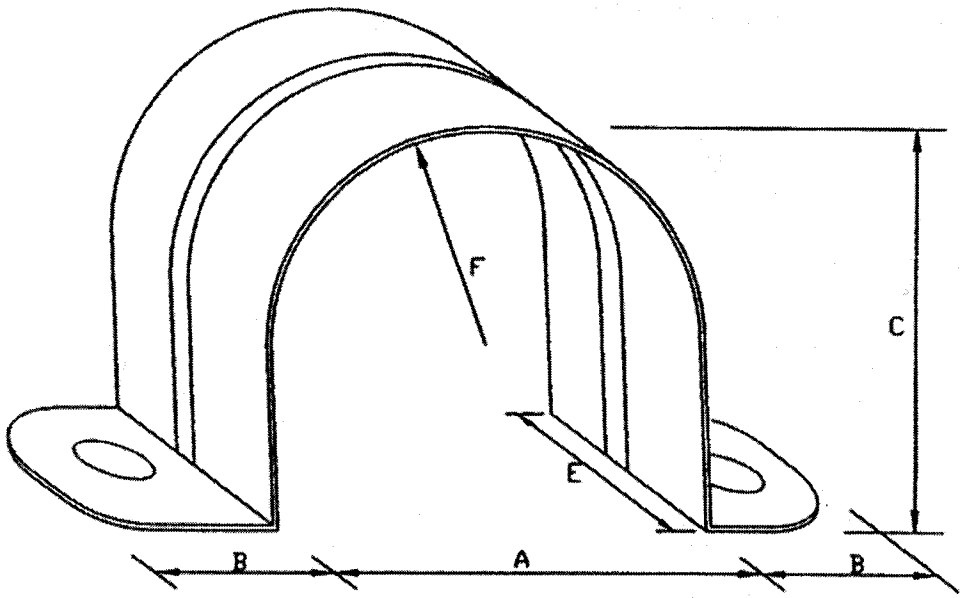
Sl. No.	Description	Required specifications
1	Type	LV Shackle
2	Line Voltage	230/400 V
3	Material	Glazed Porcelain
3	Leakage Distance, min	64 mm
4	Flash over Voltage Power Frequency, Dry Power Frequency, Wet	 25 kV 12 kV
5	Power Frequency Puncture Voltage	70 kV
6	Transverse Strength, min	1140 Kg
7	Height, max	76 mm
8	Dia, max	89 mm
9	Groove Dia.	19 mm
10	Insulator Hole Dia., min	17.5 mm
11	Dimension	As per Drawing



89mm X 76mm

INSULATOR SHACKLE

TITLE: SHACKLE INSULATOR	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

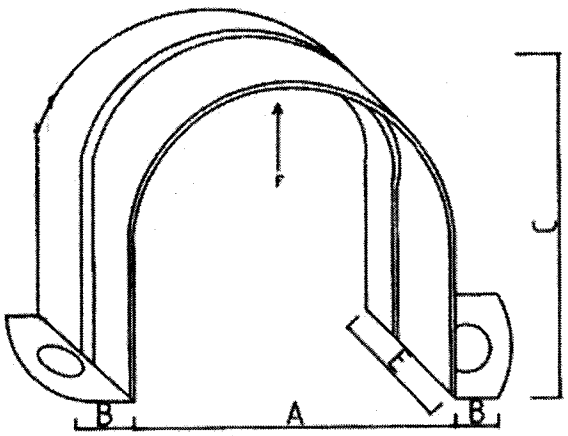


SADDLE SIZE	A (mm)	B (mm)	C (mm)	E (mm)	F (mm)	THICKNESS
1	100	20	90	22	42R	0.5mm
2	50	20	60	22	22R	0.5mm
3	30	12	25	15	10R	0.5mm

SADDLE WITH SCREW AND ROYAL PLUGS

TITLE: SERVICE ITEM	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

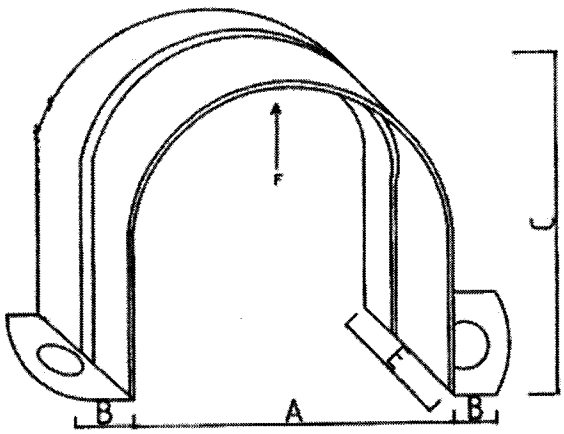
Wall Clip For Fixing Round Cable, 1½"



Wall Clip Size	A	B	C	E	F	THICKNESS
1	40	12	40	15	10R	0.5

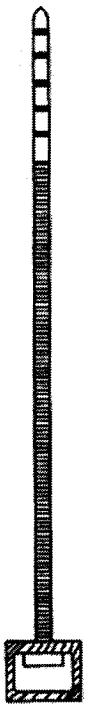
TITLE: SERVICE ITEM – WALL CLIP	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

Wall Clip For Fixing Round Cable,3/4"

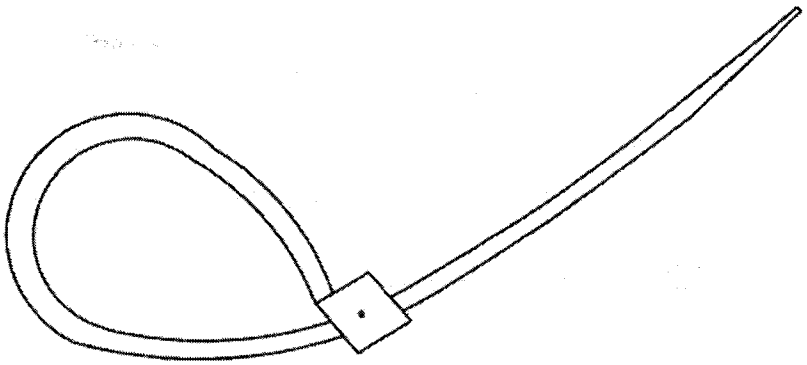


Wall Clip Size	A	B	C	E	F	THICKNESS
1	20	12	20	15	10R	0.5

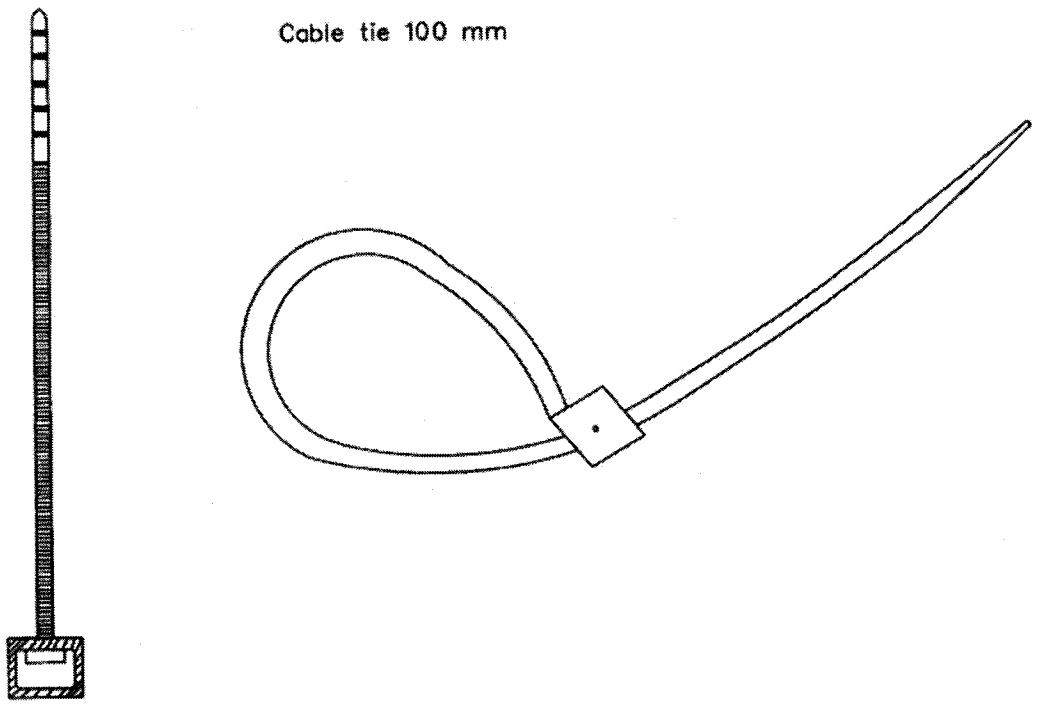
TITLE: SERVICE ITEM – WALL CLIP	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	



Cable tie 150 mm



TITLE: SERVICE ITEM – CABLE TIE	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	



TITLE: SERVICE ITEM – CABLE TIE	DESIGNED :	
	DRAWN :	DRG. NO.
	CHECKED :	
	APPROVED:	
	DATE :	

Abbreviation

- BANGLADESH NATIONAL BUILDING CODE (BNBC)
- SINGLE LINE DIAGRAM (SLD)
- BRANCH DISTRIBUTION BOARD (BDB)
- SUB-DISTRIBUTION BOARD (SDB)
- DISTRIBUTION BOARD (DB)
- FLOOR DISTRIBUTION BOARD (FDB)
- MAIN DISTRIBUTION BOARD (MDB)
- MINIATURE CIRCUIT BREAKERS (MCB)
- FUSES, RESIDUAL CURRENT DEVICES (RCD)
- SINGLE POLE SINGLE THROW (SPST)
- SINGLE POLE DOUBLE THROW (SPDT)
- DOUBLE POLE SINGLE THROW (DPST)
- DOUBLE POLE DOUBLE THROW (DPDT)
- EARTH CONTINUITY CONDUCTOR (ECC)
- FUSE DISTRIBUTION BOARDS (FDB)
- GALVANIZED IRON (GI)
- EARTH CONTINUITY CONDUCTORS (ECC)