EEE 414: Electrical Services Design

Course Schedule:

Time: 11am-1:30pm, Wednesday, Venue - VLSI Lab

Course Teacher:

Yeasir Arafat

Associate Professor

EEE, BUET

EEE 414: Electrical Services Design

Lectures based on

BNBC 2020 (Vol. 3, Part VIII, Ch. 1): Electrical and Electronic Engineering Services for Buildings

Lecture1:	Module1:	INTRODUCTION
Lecture2:	Module2:	LIGHTING AND ILLUMINATION
	Module3:	DESIGN/DRAWING OF ELECTRICAL INSTALLATIONS
Lecture3:	Module4:	Distribution Wiring in a Building
	Module5:	Power Supplies in a Building
Lecture4:	Module6:	Earthing System Design
	Module7:	Lightning Protection System Design
	Module8:	Data/Telecom, FDAS, Security System Design
	Module9:	Compliance Issues of a Building

Distribution Wiring in a Building

M4: Distribution Wiring in a Building, Outline

- Known and Unknown Loads
- Distribution Board, wiring for domestic, office & commercial buildings with large open floor areas.
- Color Codes of Cables Following IEC Standards.
- Electrical Layout and Installation Drawings.
- Electrical Wiring in the Interior of Buildings.
- Methods of Point Wiring and Circuit Wiring.
- Feeder Wiring between DBs.
- Conduits, Channels, Cables and Accessories.

M4: Distribution Wiring in a Building, Outline

- Conduits through the Building Expansion Joints
- Types of Electrical Wiring for exterior purposes
- Various DBs: BDB, SDB, DB, FDB and MDB
- Enclosure Sizes for MCB's and Fuses
- Bulk Distributions: Vertical services shafts for riser, L.T. riser main cables, L.T. BBT, and L.T. Busducts
- L. T. Main Incoming Cable and Service Connection
- Design for Electrical Wiring
- Temporary Wiring: Connection for a Construction Site, and an Outdoor Concert

Known and Unknown Loads

1.3.4.1 General

General illumination is a **known load**, whether derived from **detailed lighting layout**, or developed from **watts/ sq.m²** calculation. Similarly fans are also **known** loads. Besides these two types, there may be some other known loads.

Number, rating, 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.

1.3.4.1 General

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, maintenance, inspection & 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.

1.3.4.2 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 the outgoing 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) 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.

1.3.4.2 Distribution Board

(b) FDBs are located in each of the floors of a multi-storied 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.

1.3.4.2 Distribution Board

(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 gen-set** through **changeover** switch. These may be separate DBs placed by the corresponding normal supply DBs.

Each of these distribution boards must have busbars for Line, neutral and earthing for a single phase box. A 3-phase distribution board must have busbars for **Line 1, Line 2, 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.

1.3.4.3 *Wiring

(a) Separate branch circuits for separate control

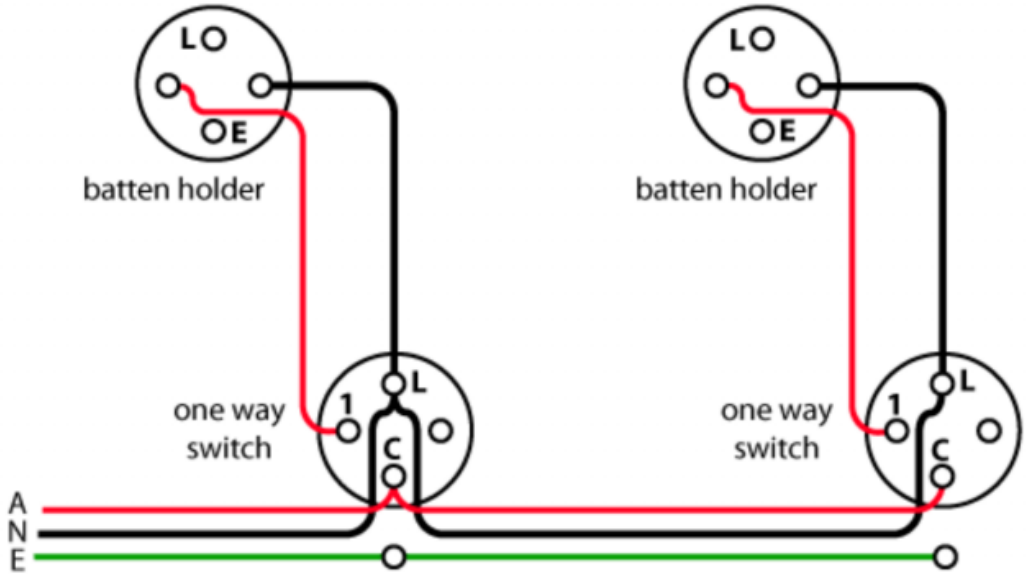
A branch circuit should be independently working and should not be affected due to the failure of another branch circuit. Number of final circuits (also termed as sub-circuits or circuits) required and the points supplied by any final circuits shall comply with -

(i) the requirement of over-current protection,

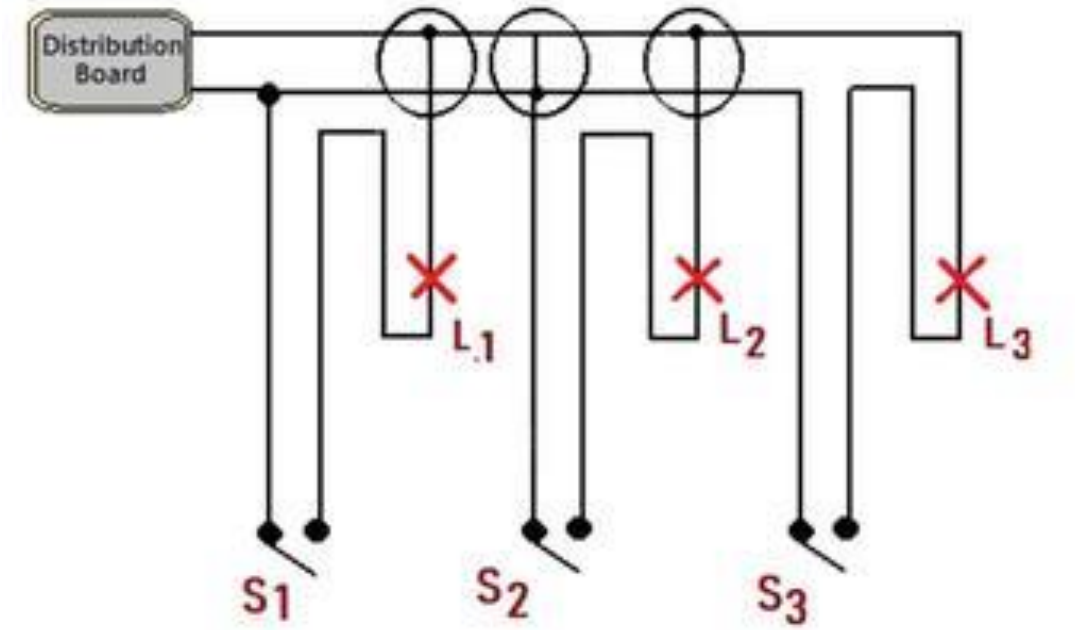
(ii) the requirement for isolation and switching, and

(iii) the selection of cables and conductors.

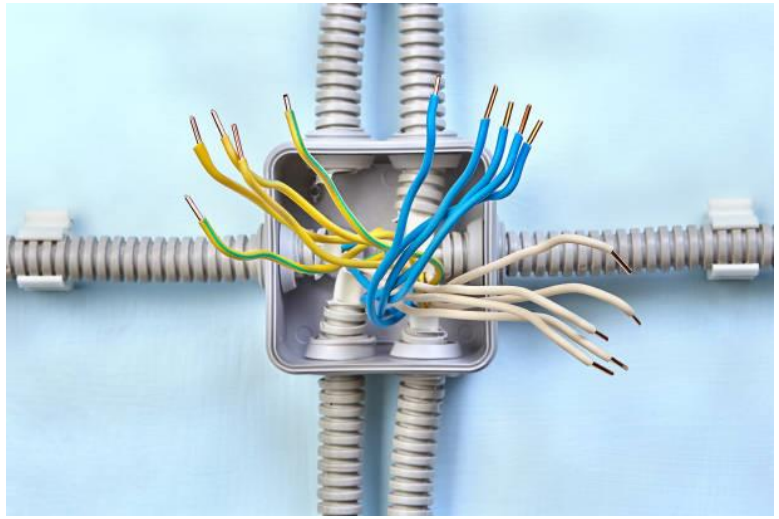
All final circuits shall be wired using **loop wiring system**; no **joint box** shall be used. Sufficient number of 18 SWG sheet steel made (painted with two coats of grey enamel paint) **pull boxes**, with ebonite/perspex sheet cover plate, must be given on the walls near the ceiling. If brick walls are not available, pull boxes must be given in the ceiling.

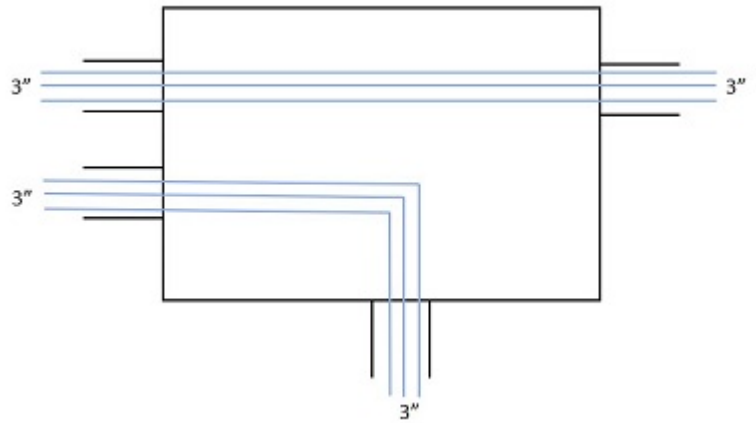


Loop-in System



Joint Box wiring system





Bottom: Left to right - Junction, Joint, Pull boxes

1.3.4.3 Circuit Wiring

(b) For domestic and office buildings

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

(c) Office and commercial buildings with large open floor areas

Under unavoidable circumstances, in case of difficulties in forming 5 A 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 DBs then shall be not less than **2.5 mm^2**. However, use of 5 A light/fan circuits is still emphasized.

(d) For industrial/factory buildings having large open floor areas

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

1.3.4.3 Circuit Wiring

(e) Factory buildings/warehouses with too large open floor areas

For industrial/factory buildings/warehouses having **large** open floor areas, efforts should be given to use circuits not exceeding **10 A**. The corresponding circuit cable* in the BDB/SDB/DB then shall be not less than **2.5 mm²**. 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 cable# in the BDB/SDB/DB then shall be not less than **4 mm²**.

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.

1.3.4.3 Circuit Wiring

(f) Separate branch circuits from Miniature Circuit Breaker (MCB)

Separate branch circuits shall be provided from miniature circuit breaker (MCB) of a BDB*/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 BDB*/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.

(g) 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.

1.3.4.3 Circuit Wiring

(h) Branch circuit must have spare capacity (at least 20% increase)

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.

(i) Spare circuit must be allowed in DB for each 5 circuits in use.

At least 1 spare circuit must be allowed in the distribution board for each 5 circuits in use. Additional space for CBs along with the provision for connecting a pair of outgoing cables shall be kept.

(j) Each final circuit shall be connected to a separate way in a DB

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.

1.3.4.3 Circuit Wiring

(k) 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**.

(l) 4 mm^2 & 6 mm^2 wiring cable for a 15 A socket outlet branch

The minimum size of wiring cable used for a 15 A 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 15 A branch circuit shall be 6 mm^2 (7/0.044).

1.3.4.3 Circuit Wiring

(m) 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**. [If below 1%, length may be longer than 30 m]

(n) 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**.

1.3.4.3 Circuit Wiring

(o) 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 IEC cable colour code standards**, **Table 8.1.21 and Figure 8.1.1**. The current IEC colour code is recommended to be followed in Bangladesh. This coding **must** be indicated in the **design drawing** and **should** also be mentioned in the **specification**.

Table 8.1.21: New introduced Colour Codes of Cables Following IEC Standards

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

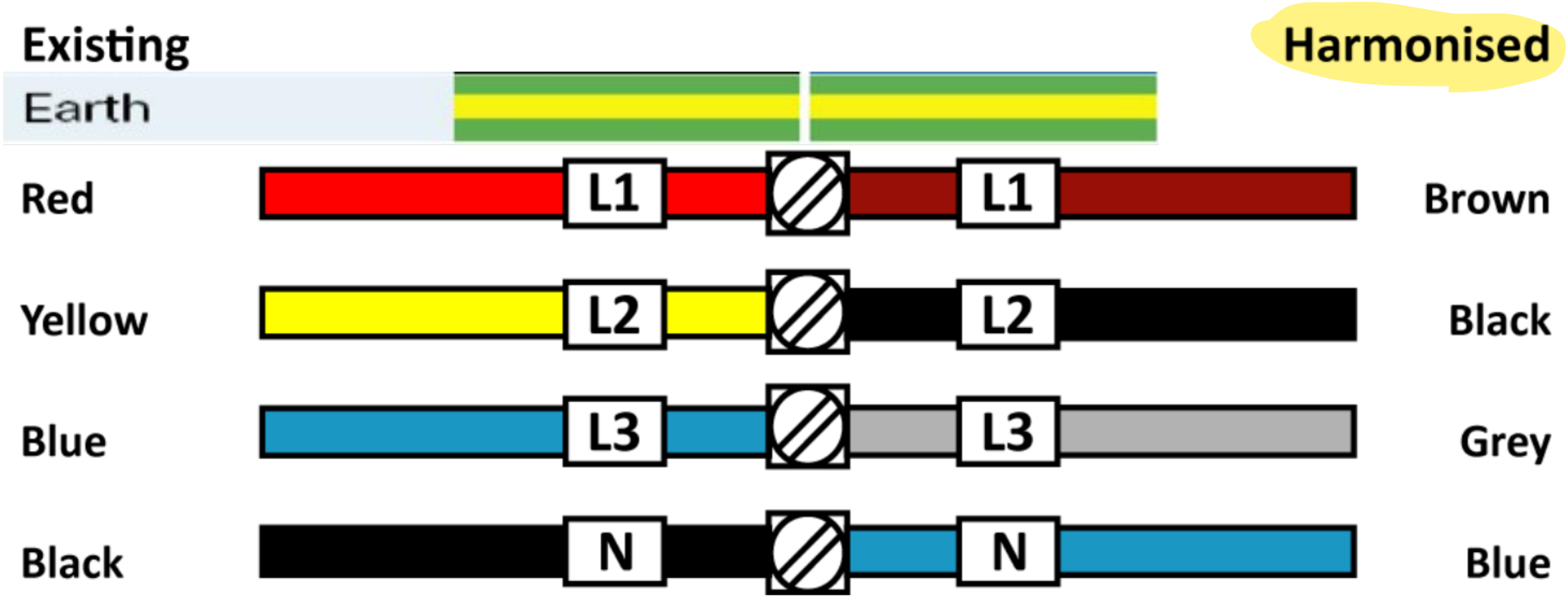


Figure 8.1.1 Existing and harmonised colour code by IEC recommended for use in Bangladesh.

As presented in BNBC 2020.

Cabling code and standard based on IEC 60445 and BS 7671

1.3.4.3 Circuit Wiring

(p) Balancing of circuits in three phase DBs.

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.

Electrical Layout and Installation Drawings

1.3.5 Electrical Layouts and Drawings

An electrical layout drawing shall be prepared after proper locations of all outlets for lamps, fans, fixed and transportable appliances, motors etc. have been selected. 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.

1.3.5.1 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.

1.3.5 Electrical Layouts and Drawings

1.3.5.2 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 centres**. 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**.

1.3.5 Electrical Layouts and Drawings

1.3.5.3 Balancing of circuits in 3-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**.

1.3.5.4 Single phase socket outlets receiving connection from two different phases

1-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**.

1.3.5 Electrical Layouts and Drawings

1.3.5.5 Layout drawings for industrial premises

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

1.3.5.6 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 Diagram* (SLD) indicating the cable sizes of each interconnection and the sizes of the ECCs.

1.3.5 Electrical Layouts and Drawings

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.

1.3.5.7 Preparation of electrical distribution and wiring design drawing by an experienced Engineer

Electrical Distribution and Wiring Design drawing of building must be prepared by **an eligible Engineer** as mentioned in **Table 2.3.4 Chapter 3 Part 2**.

Electrical Wiring in the Interior of Buildings

1.3.6 Electrical Wiring in the Interior of Buildings

1.3.6.1 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 cupper 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 cupper 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.

1.3.6 Electrical Wiring in the Interior of Buildings

(a) 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.

1.3.6 Electrical Wiring in the Interior of Buildings

(b) 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.

(c) 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.**

1.3.6 Electrical Wiring in the Interior of Buildings

(d) Surface wiring: Round core flexible cable with 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.

1.3.6 Electrical Wiring in the Interior of Buildings

1.3.6.2 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.

1.3.6 Electrical Wiring in the Interior of Buildings

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.

1.3.6 Electrical Wiring in the Interior of Buildings

1.3.6.3 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.

1.3.6 Electrical Wiring in the Interior of Buildings

1.3.6.4 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.

1.3.6.5 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.

1.3.6 Electrical Wiring in the Interior of Buildings

1.3.6.6 Restriction on the use of plastic/PVC insulated flexible chords/cables

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

1.3.6.7 Cable joints/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.

Methods of Point Wiring and Circuit Wiring

1.3.7 Methods of Point Wiring and Circuit Wiring

1.3.7.1 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**. 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**. Common neutral shall not be used under any circumstances.

1.3.7 Methods of Point Wiring and Circuit Wiring

1.3.7.2 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 earthing busbar 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.

1.3.7 Methods of Point Wiring and Circuit Wiring

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.

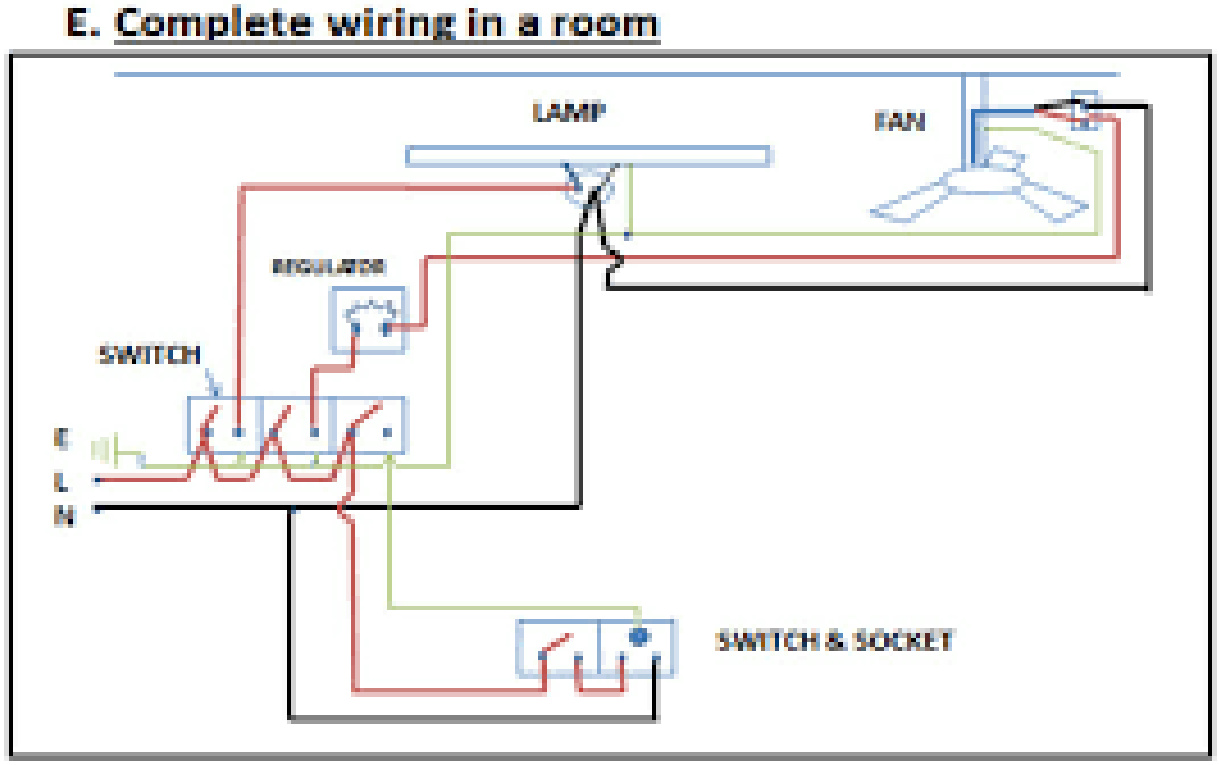
1.3.7 Methods of Point Wiring and Circuit Wiring

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 %**.

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.



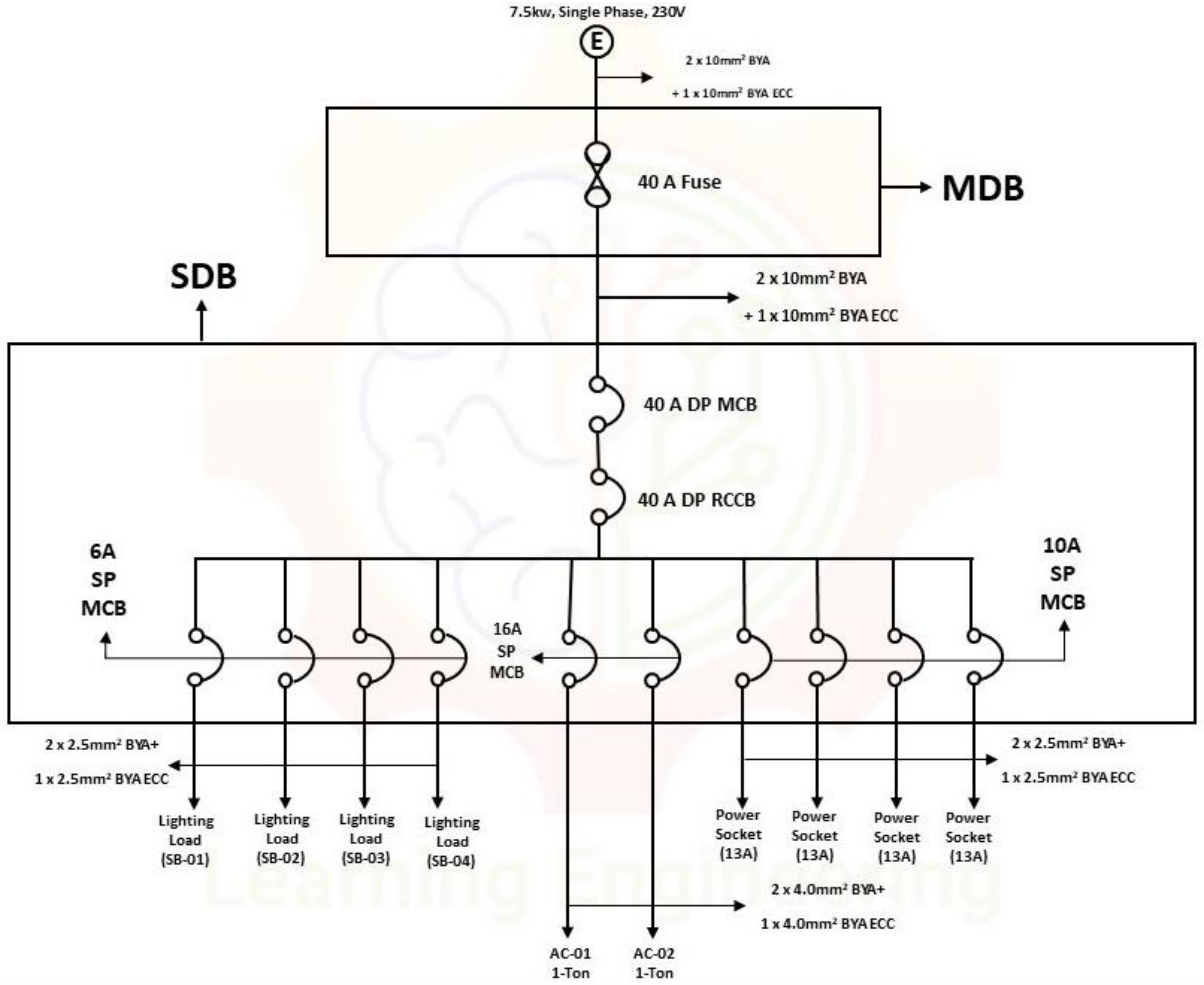


Fig: Point Wiring (L) and Circuit Wiring (R)

Feeder Wiring between DBs

1.3.8 Feeder Wiring between DBs

Wiring between BDB-SDB, SDB-DB, DB-FDB, FDB-MDB needs special attention and the rules are similar to Circuit Wiring. ECC must be present for each of the feed connections*. Appropriate cable sockets/lugs must be used for terminating the L1, L2, L3, N and E connections on the busbars of both the boards. The sizes of the cables must be chosen to match with the rating of the CB/fuse ratings as mentioned above.

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

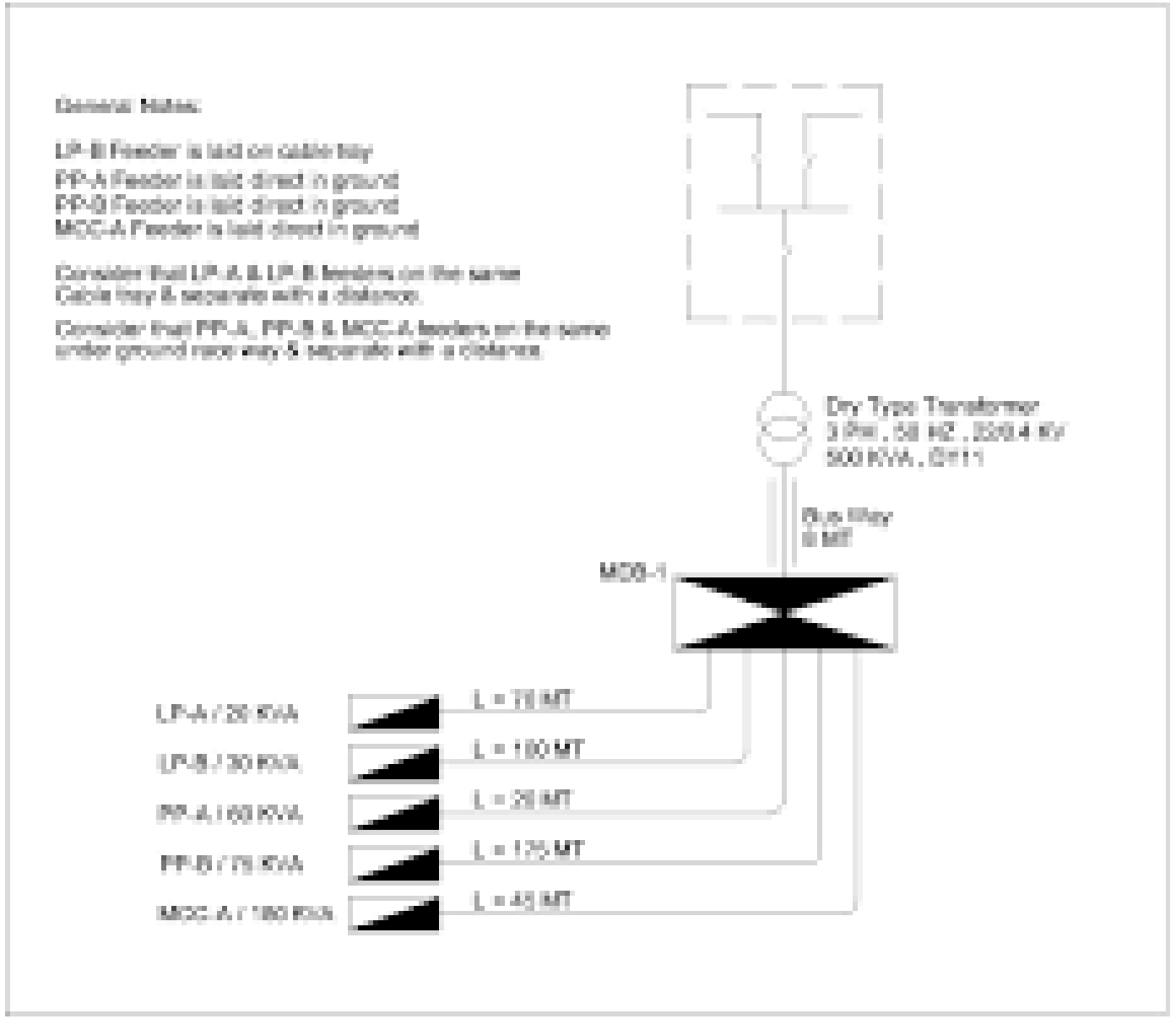


Fig: Feeder Wiring between DBs

Conduits, Channels, Cables, Conductors and related Accessories

1.3.9 Conduits, Channels, Cables & Accessories

1.3.9.1 Conduits and conduit fittings

For the two types of commonly used conduits, PVC and Metal, fittings should be as follows*:

(a) PVC conduits

(i) PVC conduits & 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.

1.3.9 Conduits, Channels, Cables & Accessories

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

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

(b) 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 short# 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.

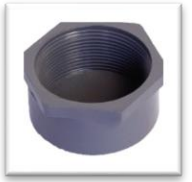
1.3.9 Conduits, Channels, Cables & Accessories

(c) 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.

(d) 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.



PVC (a) conduits (b) channels (c) flexible conduits, (d) steel conduits

1.3.9: ...Accessories (e) 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.

1.3.9 Conduits, Channels, Cables & Accessories

(h) 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 earthing busbar 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.

1.3.9.2 Cables and Conductors

(a) Cables

Conductors of a PVC insulated cable, thin or thick, shall be **copper**. Cable containing Aluminum conductors may be used for thick cable of size **more than 35 mm²** but copper is always preferred.

Recommended sizes (in **mm²**) 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

1.3.9.2 Cables and Conductors

(b) 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**.

(c) Flexible cables/flexible cords

The **minimum cross-sectional area** of conductors of flexible cables/cords shall be **0.5 mm²** for **copper** conductors. Flexible cable or cords shall **not be used as fixed wiring** unless contained in an enclosure affording mechanical protection. They may be used for 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.

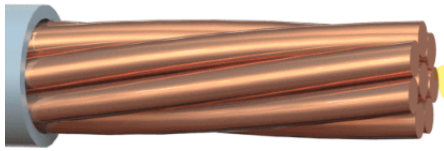
1.3.9.2 Cables and Conductors

(d) Treatment of cable ends/cable terminations

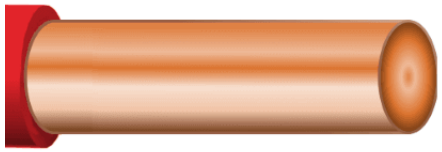
Stranded conductors must be provided with cable sockets /cable lugs of appropriate size fitted using appropriate **hand press tool or hand crimp tool or hydraulic press tool** depending on the size of the cable. This is necessary for termination of the cable ends on bus-bars.

(e) Jointing of cables in wiring

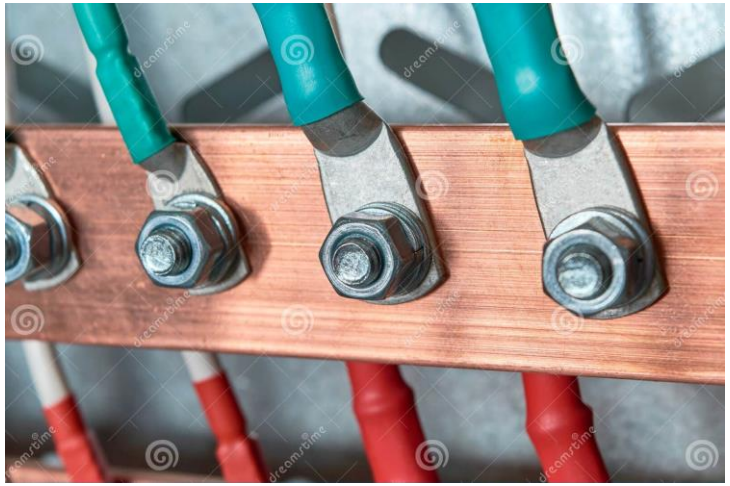
Cable **joints** for the PVC insulated cables used in circuit wiring (thin cables) are to be made through porcelain/ PVC connectors with PIB tape wound around the connector before placing the cable inside the box joint/ junction* box.



Stranded



Solid



1.3.10 Conduits through the 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.

Types of Electrical Wiring for Exterior Lighting and other exterior purposes

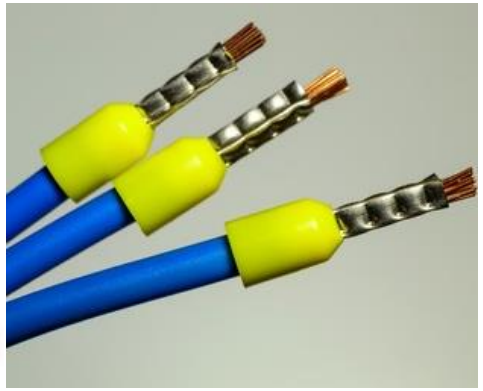
1.3.11 Types of Wiring for Exterior Purposes

1.3.11.1 Electrical wiring for garden lighting

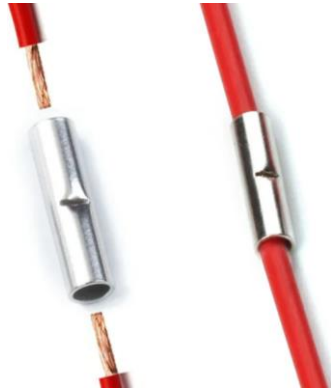
For garden lighting PVC insulated PVC sheathed (NYY)* underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. 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.

Metal Sleeve

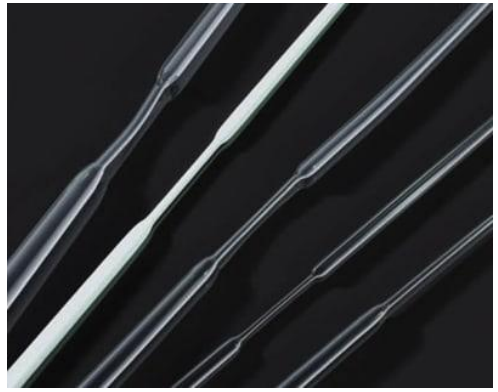
Electric Cable Ferrules



Ferruled end of Cables



Metal sleeve cable joint



Heat Shrink on top

1.3.11 Types of Wiring for Exterior Purposes

1.3.11.2 Electrical wiring for street lighting

For street lighting PVC insulated PVC sheathed underground (**NYY**) cables shall be used, as described for garden lighting*.

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**.

1.3.11 Types of Wiring for Exterior Purposes

1.3.11.3 Electrical wiring for boundary light

For boundary lighting PVC insulated PVC sheathed underground (NYY)* 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 (BYA) conduits may be used.

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

1.3.12 Various DBs: BDB, SDB, DB, FDB & MDB

1.3.12.1 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.

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

Table 8.1.22 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.

Table 8.1.22: 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

1.3.12 Various DBs: BDB, SDB, DB, FDB & MDB

1.3.12.3 Location

A 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.

1.3.12.4 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.

1.3.12 Various DBs: BDB, SDB, DB, FDB & MDB

(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.

Large Distributions: Electrical Services Shafts, Bus Ducts, L.T. Riser Cables and BBT, L. T. Main Incoming Cable and Service Connection

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

1.3.13.1 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 m²** 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 (BBT)

(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.

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

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/BBT/*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 nonelectrical 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.

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

1.3.13.2 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^2** in 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 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.

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

(d) For more than 9 storied building, BBT preferably **sandwiched copper BBT** should be used for safety reasons.

(e) PVC insulated PVC Sheathed underground (#) cables must be used as Riser Main Cables. These cables shall be placed 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/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*.

(g) Each riser cable must have appropriate CB or fuse at the source busbar (board) and also at the tap off point.

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

1.3.13.3 LT Busbar Trunking

For **high rise** buildings, LT (0.4kV, TP&N) **BBT** system* 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 **neat distribution** system. Most part of the BBT shall be installed vertically. The **horizontal** portion of the **BBT** shall usually connect the **vertical** portion with the Substation **LT panel**. (Also in each floor)

(a) Busbar trunking are specially useful to minimize space and to minimize risks of spreading fire (during accidents) which may happen with bundles of insulated cables.

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

The conductors supported by insulators inside the BBT shall be **copper of solid rectangular cross-section**. The copper bars are insulated. A BBT system shall be laid with minimum number of bends for distribution system. Typical rating of feeder BBT for 3-phase-3-wire or 3-phase-4-wire system shall range from **200 A to 3000 A** although lower amperes are not impossible.

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

(c) BBT shall be placed in a **dry place** and must not be installed in a place which is even slightly exposed to weather/moisture/ spray or sprinkle of water.

1.3.13 Electrical Services Shafts, Bus Ducts, L.T. Riser Cables, BBT, L. T. Incoming and Service Connection

1.3.13.4 LT Busducts*

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 CBs of appropriate rating is needed. In most cases, these busducts 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.

L T Main Incoming Cable and Service Connection

1.3.14 L T Main Incoming Cable and Service Connection

(a) **Overhead** service connection to a building shall be achieved with PVC insulated Cables with GI support wire (similar to catenary) or catenary wire (mainly for single phase consumers). 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 PVC insulated PVC sheathed **water proof** cables 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*

1.3.14 L T Main Incoming Cable and Service Connection

(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 as per description provided earlier*.

(f) The power and telecommunication or antenna cables must be laid separately (but same duct), 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.

1.3.14 L T Main Incoming Cable and Service Connection

(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.

(i) 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.

Design for Electrical Wiring

1.3.15 Design for Electrical Wiring

Design of Electrical wiring must be done following the provisions provided in this Chapter. Detailed design drawings must be prepared by **eligible Engineer** for complete execution of the electrical works mentioned in **this document** and any other **new items** arising because of the evolution of new technologies in the near future.

Typically, there must be **Conduit Layout Drawing**(s) indicating the conduit layouts, the locations of the switch boards, locations of the sockets, locations of all DBs, and location of the Main incoming cable.

A **Distribution Diagram** of all the DBs indicating the **amperage** of the incoming CBs, interlinking cable sizes and the ECCs must be presented.

Detailed **Circuit Diagrams** of the circuits and DBs must be presented.

Detailed drawings of earthing, inspection pits and any other complicated parts must be presented. The **contractor** shall prepare as built drawings after completing a project.

1.3.15 Design for Electrical Wiring

1.3.15.1 Design for electrical wiring in bedrooms/drawing rooms

The location of a switch board **must** be near the entrance door of a bedroom like any other room. The location of the wall mounted light fittings must be chosen based on the possible locations of furniture which is also needed in other rooms. Sufficient number of 3-pin 13 A switched shuttered flat pin sockets must be provided in a bed room. Same principles are applicable for a **Living room**.

Design must be made in such a way that sufficient clearance (space) is left inside the concealed conduits (i) for the ease of pulling the cables and also for adding few **more** cables in case of necessity during future modification.

Generally, single core PVC insulated stranded electrolytic annealed copper cables (*) shall be used in concealed wiring technique or in the other methods.

1.3.15 Design for Electrical Wiring

1.3.15.2 Design for electrical wiring in a kitchen.

The **sensitive item** in a kitchen is placing 3-pin 13 A switched shuttered flat pin sockets on wall of the kitchen side table near the wall. Appropriate distance must be maintained between the kitchen water tap and the socket. The socket for the refrigerator (if any) shall also be a 3-pin 13 A switched shuttered flat pin socket, and may be placed at the same level as the other socket. For the ease of operation a 3-pin 13 A switched shuttered flat pin socket for this purpose may be placed at the bottom level height of a switch board provided this is acceptable in terms of aesthetics.

For kitchens, the light plus fan sub circuits shall not be of more than 5A rating.

1.3.15 Design for Electrical Wiring

1.3.15.3 Switches for toilets and bath rooms

Switches for toilet lights and **toilets** ventilating fans **must be placed outside** the toilets adjacent to the entrance door but must not be placed **inside** the toilet.

The same rule should be followed for **bath rooms**.

Using ceiling mounted **chord switch** at the entrance path of the door of a **toilet** is a good idea for **small toilets** attached to bed rooms.

Ceiling mounted chord switches may be used with a chord suspended from the ceiling near the opening of the door of a **bath room**.

1.3.15 Design for Electrical Wiring

1.3.15.4 Design for electrical wiring in office rooms

The location of a switch board must be near the entrance door of an office room. The location of the light fittings must be chosen based on the possible locations of work table, furniture. Sufficient number of 3-pin 13 A switched shuttered flat pin sockets must be provided in each office room. In this regard special consideration needs to be given on the possible location of computers and other office equipment. Sufficient conduits and cables **must be left** for future modification as often rearrangement of cables needs to be made.

Generally, single core PVC insulated stranded electrolytic annealed copper cables (*) shall be used for wiring by using the concealed wiring technique or the other two methods mentioned in the wiring section.

In case of special requirements, PVC insulated PVC sheathed Stranded Electrolytic Annealed Copper Cables (#) may be used for wiring through conduits or other methods. For Offices the sub circuits shall not be of more than 5 A rating.

Temporary Wiring: Connection for a Construction Site, and an Outdoor Concert

1.3.16 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 busbars **OR** distribution board containing incoming circuit breakers, outgoing circuit breakers plus busbars of appropriate rating must be installed for such connections. Such boards shall not be installed near flammable materials(*).

Such boards shall be installed in a dry place so that rain water or waters coming from a construction zone cannot reach such boards. Flat 3-pin switched shuttered 13 A sockets(*) should be used for distribution.

1.3.17 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. Similar DB as described for construction site can be used (*). Such boards shall not be installed near flammable materials. 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.

Cables of appropriate types (#) and appropriate ratings must be used for such applications. Appropriate type of sockets, preferably flat 3-pin switched shuttered 13 A sockets should be used for distribution.

Power Supplies in a Building

M5: Power Supplies in a Building - Outline

- 11/0.4 kV Electrical Substation
- Transformers
- Standby Power Supplies
- Electrical Distribution System
- Precautions regarding Rotating Machines
- LT Energy Meters, Laying of LT and HT UG Cables
- Main Switch & Switchboards, Mounting of MCG*
- Wooden Main/Sub-Boards with fuse & main switches
- Location of DBs, Over-current & SC Protection
- Fire alarm and emergency lighting circuits

11/0.4 kV Electrical Substation in a Building

1.3.18 11/0.4 kV Electrical Substation in a Building

1.3.18.1 General

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

1.3.18 11/0.4 kV Electrical Substation in a Building

1.3.18.2 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 (specially if the SS is located at basement).

1.3.18 11/0.4 kV Electrical Substation in a Building

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.

1.3.18 11/0.4 kV Electrical Substation in a Building

Location of substation in the basement

Location of substation in the basement floor and on the floors above ground floor level (GFL), preferably be **avoided.** If substation is 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 (NOC) stating the Sub-Station safe by the Fire Service and Civil Defence Department.

1.3.18 11/0.4 kV Electrical Substation in a Building

(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.

1.3.18 11/0.4 kV Electrical Substation in a Building

1.3.18.3 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 Table 8.1.23 for general guidance. **Minimum recommended spacing** between the **transformer periphery** and **walls** should be:

1.3.18 11/0.4 kV Electrical Substation in a Building

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

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

(iii) **1.25 m** for Transformer installed in an **enclosed room**. (wall on 4 sides)

(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.

1.3.18 11/0.4 kV Electrical Substation in a Building

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

The areas given in **Table 8.1.23** 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.

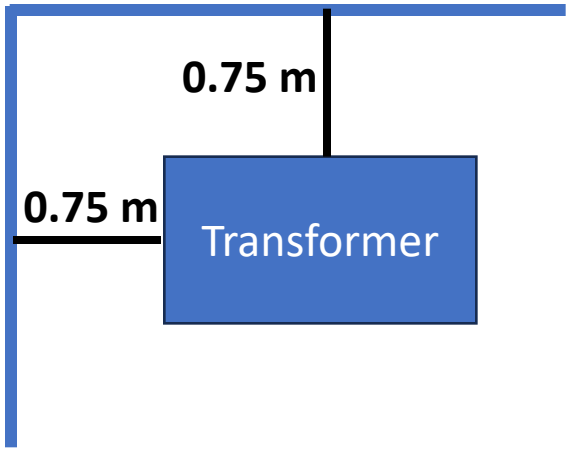
The floor level of the substation should be high. Arrangement shall be made to **prevent storm water entering the transformer** and switch rooms through the soak pits, if floor level of the substation is low.

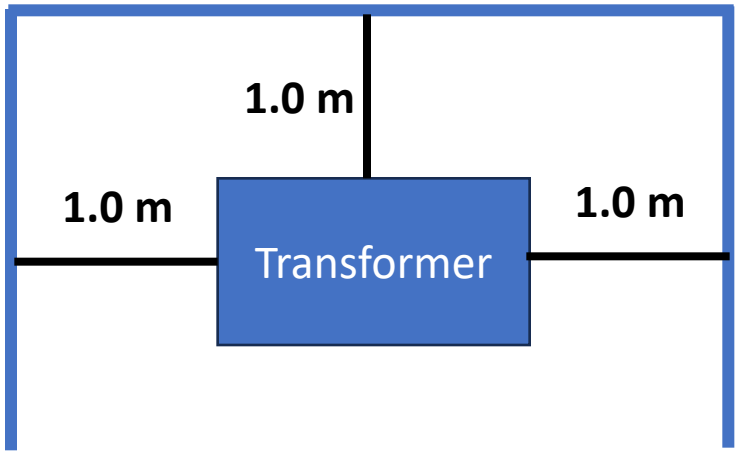
Substation of higher voltage may also be considered to the basement floor having proper and safe building design.

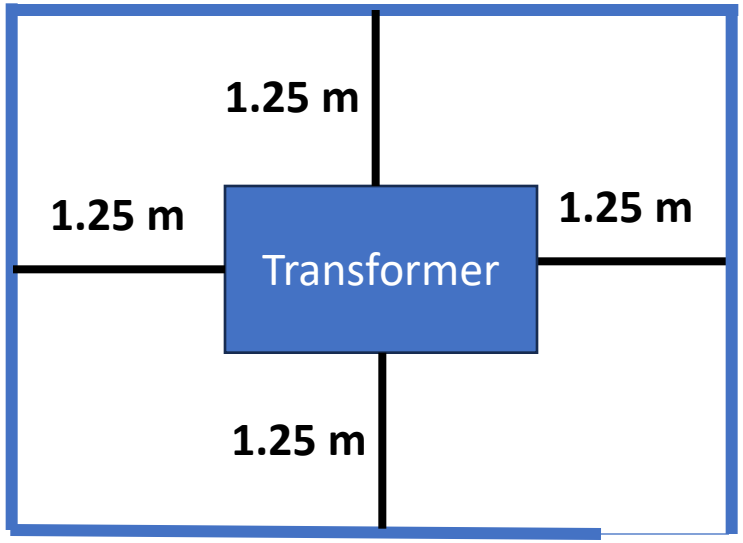
Table 8.1.23: Recommended Area for Transformer and Substation of Different Capacities

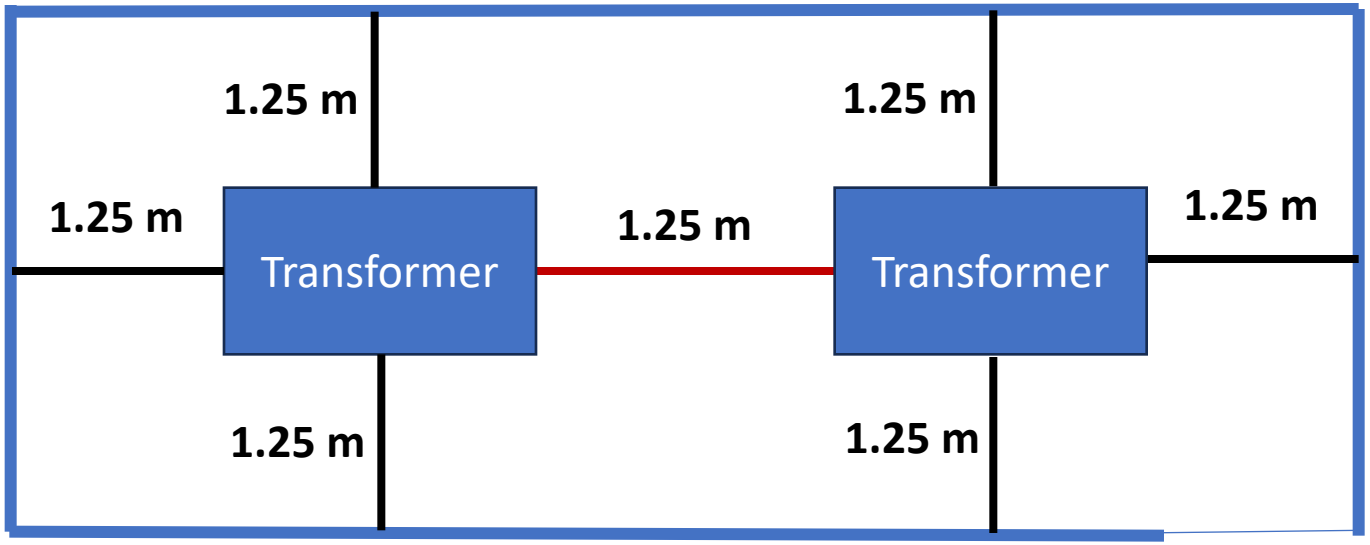
Capacity of Transformer (kVA)	Transformer Area (m^2)	Total Substation Area (with HT, LT Panels & Transformer Room but without Generators), (m^2)
1 × 150	12	45
1 × 250	13	48
2 × 250	26	100
1 × 400	13	48
2 × 400	30	100
3 × 400	40	135
2 × 630	26	100
3 × 630	40	190
2 × 1000	40	180
3 × 1000	45	220

Table 8.1.23 is for **general guidance**, not mandatory. In BNBC 2006, this was the **minimum requirement**.









All the 4 arrangements are for 11 kV transformer. The 4th one can be extended along the width also and applicable for other 3 type of rooms.

For higher level of voltage, inter-distance should be 2.5 m.

1.3.18.4 11kV/0.4kV Distribution Transformer for SS

An 11/0.4 kV 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 recently. These are –

(i) Oil Type Natural Cooled transformer (*ONAN)

(ii) Cast Resin Dry Type Natural Cooled (*AN) transformers.

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


Conservator
EXPLOSION VENT
BREATHER
Buchholz Relay
COOLING
TUBES


GVOLTS


GVOLTS

LV terminals

Normal arrangement:
Top, rear
Special version:
Bottom, available on request at extra charge

HV terminals

Variable arrangements, for optimal station design. HV tapping links for adjustment to system conditions, reconnectable in de-energized state*

Temperature monitoring

By PTC or Pt 100 thermistor detectors in the LV winding

Paint finish on steel parts

Thick layer coating, RAL 5009. On request: Two-component varnish (for aggressive environments or high humidity)

Ambient class E2
Climatic category C2

(If the transformer is installed outdoors, degree of protection IP23 must be assured)

Fire class F1

Three-leg core

Made of grain-oriented, low-loss electrolaminations insulated on both sides

Resilient spacers

To insulate core and windings from mechanical vibrations, resulting in low noise emissions

HV winding

Consisting of vacuum-potted single foil-type aluminum coils. See enlarged detail in fig. 5.9-5

LV winding

Made of aluminum strip. Turns firmly glued together by means of insulating sheet wrapper material

Insulation

Mixture of epoxy resin and quartz powder makes the transformer practically maintenance-free, moisture-proof, tropicalized, flame-resistant and self-extinguishing

Clamping frame and truck

Rollers can be swung around for lengthways or sideways travel

* on-load tap changers on request

1.3.18.4 11kV/0.4kV Distribution Transformer for SS

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, Multi-storied 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.

1.3.18.5 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 1st method should be used although there is no restriction in using the 2nd method. However, for big substations the 2nd method is **safer** and at the same time gives a neat solution.

1.3.18.4 11kV/0.4kV Distribution Transformer for SS

1.3.18.6 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.

1.3.18.7 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.

1.3.18.7 Layout of a Substation

(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.

1.3.18.7 Layout of a Substation

(g) The 11/0.4 kV SS 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**.

[(g), (h) above conflict with **1.3.18.2(i), (ii). (iii)** - Location of an electrical substation: special safety measures, consultant's certification and user/owner's undertaking]

Standby Power Supply

1.3.19 Standby Power Supply

1.3.19.1 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**.

1.3.19 Standby Power Supply

1.3.19.2 Capacity of a standby generating set

The capacity of standby generating set shall be chosen on the basis of essential light load, essential air-conditioning load, essential equipment load and essential services load, essential lift (s), one or all water pumps and other loads required as essential load. **Table 8.1.24** shows recommended room area for different sizes of generators as a **general guidance**. Minimum recommended spacing between the generator periphery and walls need to be included:

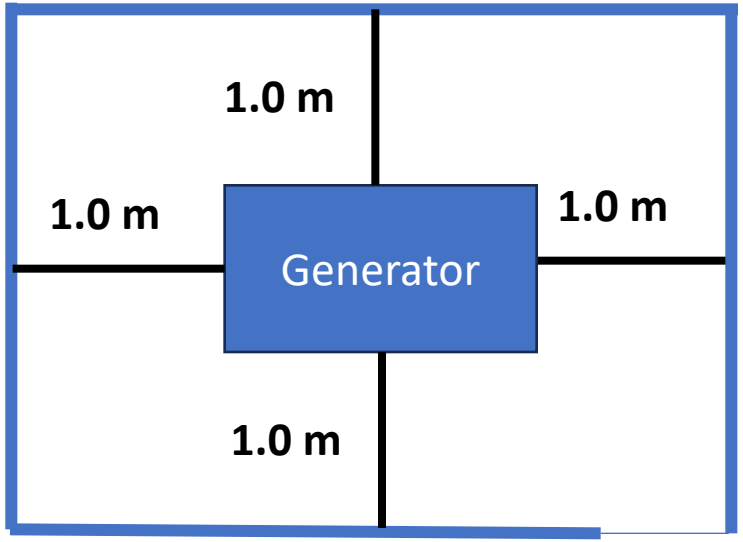
(i) **1.0 m** for generator installed in an **enclosed** room.

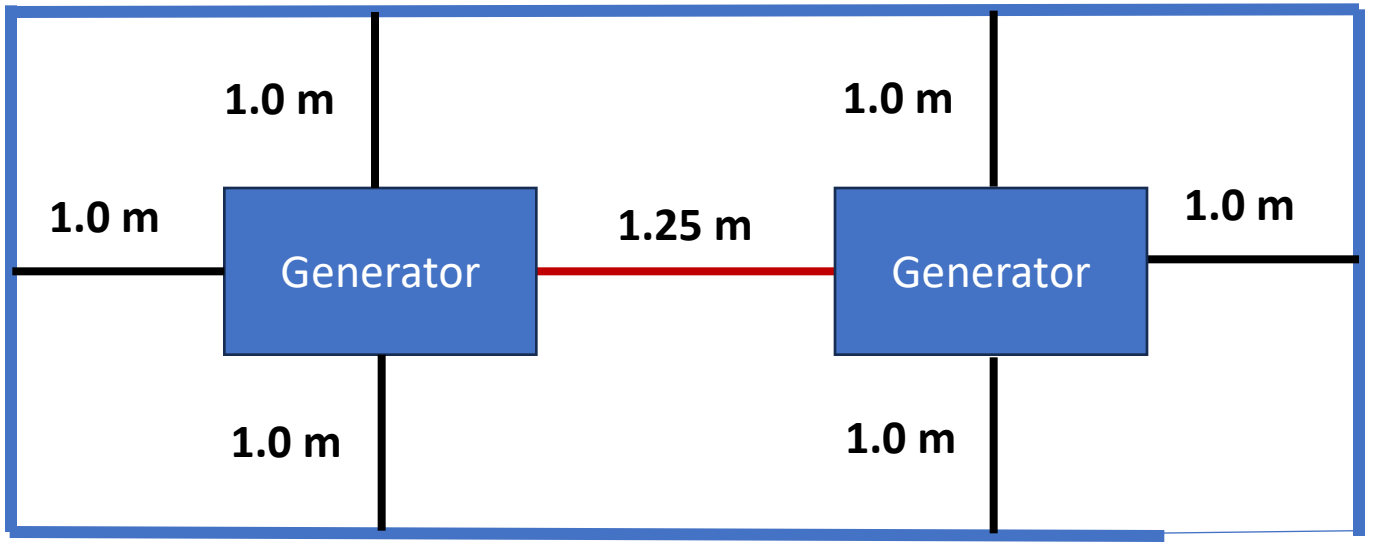
(ii) **1.25 m** distance from one to another generator for multiple generators in the room.

Table 8.1.24: Recommended Area for Standby Generator Room

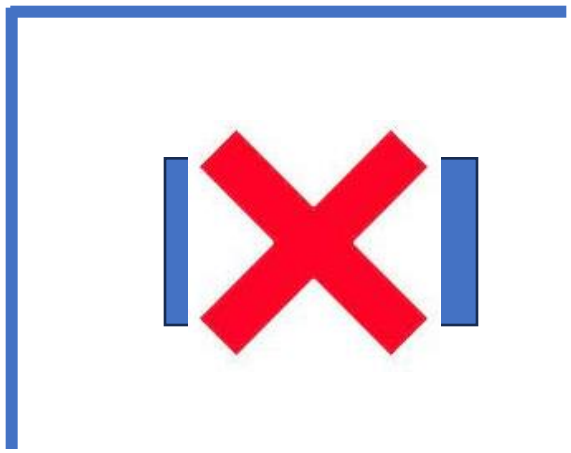
Capacity (kW)	Area (m^2)
1 × 25	20
1 × 48	24
1 × 100	30
1 × 150	36
1 × 300	48
1 × 500	56

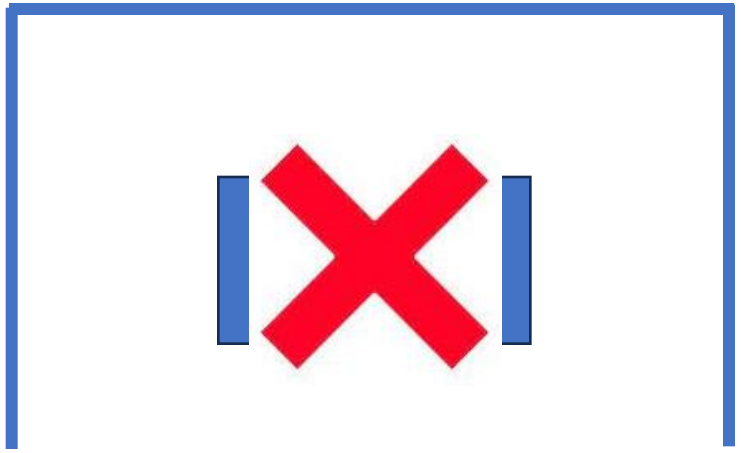
Table 8.1.24 is for **general guidance**, not mandatory. In BNBC 2006, this was the **minimum requirement**.





Generator can't be installed in a room with open boundary. All residential, commercial and most of the industrial loads are at 415 V. 11 kV or more voltage is available only in utility grids*.





1.3.19 Standby Power Supply

The generating set should preferably be housed in the substation building or should be placed adjacent to the SS room to enable transfer of electrical load (change over) with negligible voltage drop as well as to avoid transfer of vibration and noise to the main building.

The generator room should have significant amount of ventilation and fitted with a number of ceiling fans. Appropriate type and number of firefighting equipment must be installed inside the generator room. The generator engine exhaust should be appropriately taken out of the building and should preferably be taken out through any other side except South.

1.3.19 Standby Power Supply

The generator **oil tank** should be placed away from the control panel side. In case of gas engine generator extra precaution must be taken **regarding ventilation**, **leakage** to prevent **explosion**. The standby generator room should preferably be located **outside** the building*. In the case of a gas engine driven generator, the generator **must** be located **outside** the building with adequate ventilation and windows. In general, the generator room must have adequate ventilation and fans for continuous cooling.

The generator shall be placed either on the **ground floor** or in the **first basement**. Location of generator in the basement floor **preferably be avoided**.

1.3.19 Standby Power Supply

If generator is to be installed on the basement, **special safety measures** is to be taken by the **user or owner** as per **manufacturer's safety specification**. A **continuous running generator must be located outside the building**. Other rules mentioned above for standby gen are strictly applicable for this case. For both the standby and continuous running generators the generator room and the areas adjacent to cable routes must have adequate fire alarm and fire extinguishing/fighting system appropriate for extinguishing fire due to cable burning and fuel burning. Generators **must** be installed on **shock absorbing mounting bases**.

1.3.19.4 Changeover switch of a Generator

A standby generator, if needed, is to be connected at the supply input point after the energy meter and after the **main incoming switch or the main incoming CB**, but through a changeover switch of appropriate rating. The rating of such a switch shall be at **least 1.25 times the rating of the main incoming CB**. The changeover switch shall be of such a type so that when moved to the mains position, there is no chance that the generator will be connected and vice versa(*). [Interlocked]

The Changeover Switch may be **manual type** with knife switch type switching or may be **automatic type** with magnetic contactors. In both the cases the Changeover Switch shall be properly made so that there is no chance of loose connection or spark.

Installation of an IPS or a UPS

1.3.19.5 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 CB** protection.

1.3.19.5 Installation of an IPS or a UPS

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

1.3.19.6 Installation of Rooftop Solar PV

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. Rooftop solar water heaters on residential/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.

Evacuated Tube Collector V/S Flat Plate Collector

1.3.19.6 Installation of Rooftop Solar PV

The integral parts of a conventional solar PV 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 (DC*)

(e) Cables between battery and battery charge controller (DC*)

(f) Cables between the inverter and the DBS (AC*)

(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 **5 A** 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.

1.3.19.6 Installation of Rooftop Solar PV

Battery maintenance for solar PV: same as IPS/UPS

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**.

1.3.19.6 Installation of Rooftop Solar PV

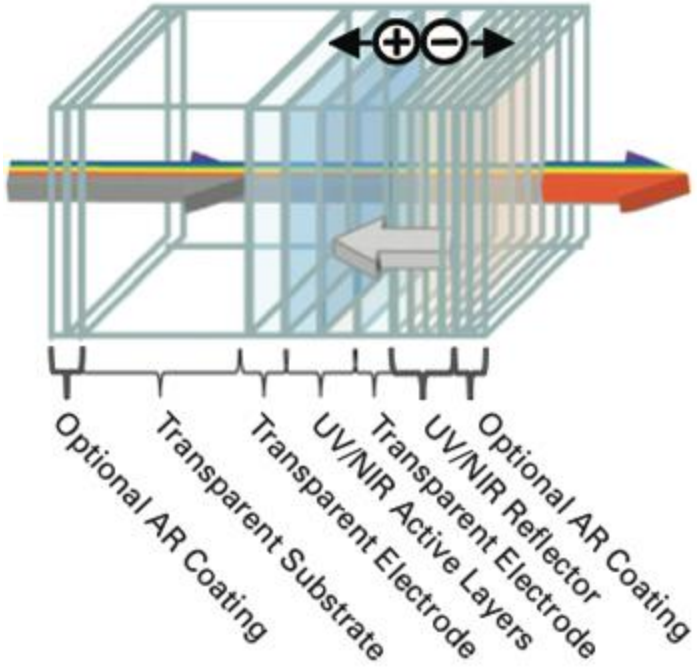
For a commercial/office building, one or two circuits for each office/office area shall come from the DB of the photo-voltaic source at roof top to each flat depending on the requirement. Connection to load in each flat will be done through a changeover switch for each circuit.

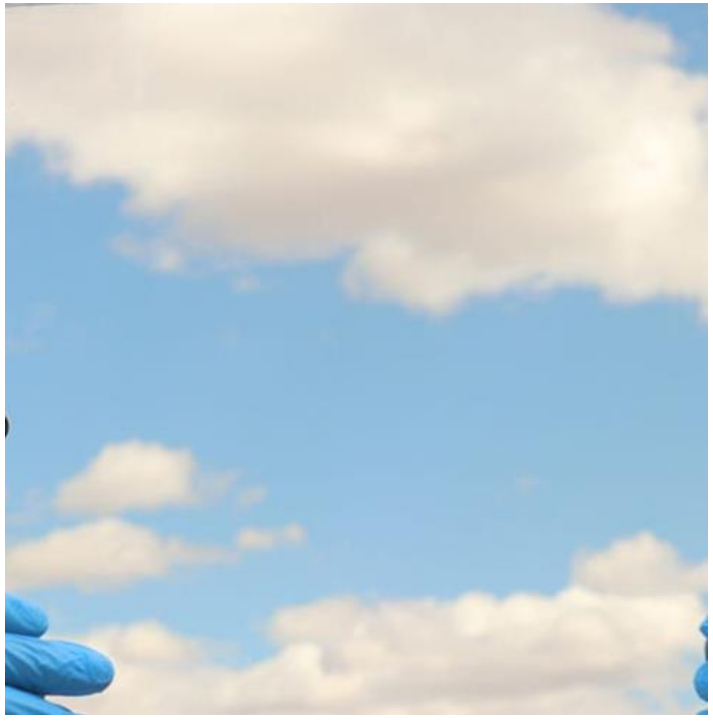
Conduit based riser system must carefully be installed, separately for this system only, during the construction of the building to bring down the cables from the roof top DB room up to each flat/office/office area. Special care must be taken during installation so that rain water can under no circumstances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

1.3.19.7 Installation of Glass Façade PV

1.3.19.7 Installation of a Solar Photovoltaic System on the exterior Glass of a Building having Large Glass Façade

For semi-transparent solar panels mounted on exterior glass of multi-storied building, similar process and precautions mentioned above must be followed.


Optional AR Coating
Transparent Substrate
Transparent Electrode
UV/NIR Active Layers
Transparent Electrode
UV/NIR Reflector
Optional AR Coating



Electrical Distribution System

1.3.20 Power* Distribution System

1.3.20.1 Design, selection and 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.

1.3.20 Power Distribution System

(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) Following features 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.

1.3.20 Power Distribution System

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

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

(e) *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.

1.3.20.2 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 I_{SC} at the point of supply,

(iii) the size and layout of electrical installation,

(iv) the availabilities of substation room, 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.

1.3.20.2 Equipment and Accessories

(ii) In the case of duplicate or RMU* supply, switches with interlocking arrangement shall be provided to prevent simultaneous switching of 2 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:

1.3.20.2 Equipment and Accessories

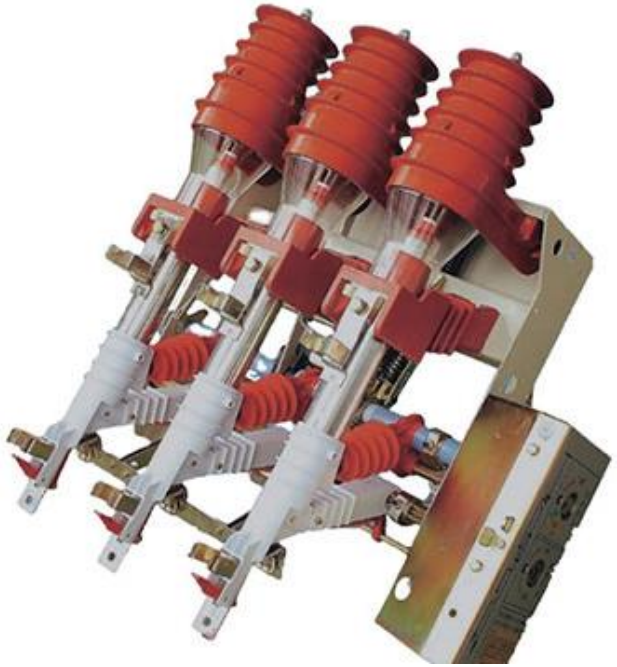
(iii) In certain installations, supplied with electric power from remote transformer substations, it may be necessary to protect main circuit with CBs operated by earth leakage trips, in order to ensure effective earth fault protection.

(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.

1.3.20.2 Equipment and Accessories

(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 **PFI** capacitors at the substation bus, suitable capacitor 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).



(L to R) -> Air LBS, Vacuum LBS, SF6 LBS, Medium Voltage LBS, Low voltage LBS

1.3.21 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 ckt. 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.

1.3.21 Transformers

(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 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.

1.3.22 Precautions Regarding Rotating M/C

(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.

1.3.22 Precautions Regarding Rotating M/C

(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(*).

1.3.23 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.

1.3.24 Laying of LT Underground Cables

PVC-PVC NYY underground cables shall be laid using any of these methods.

(a) 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 2nd method, **900 mm** deep trenches prepared by ground excavation (underground direct burial method) shall be used for placing the cables on top of a **75 mm sand** layer. In this method, 2 layers of brick on top, marking tape and then back filling the trench will have to be done.

(c) In the 3rd 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. 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.

1.3.25 Laying of HT Underground Cables

HT underground **armoured** cables shall be laid using 1 of the 3 methods.

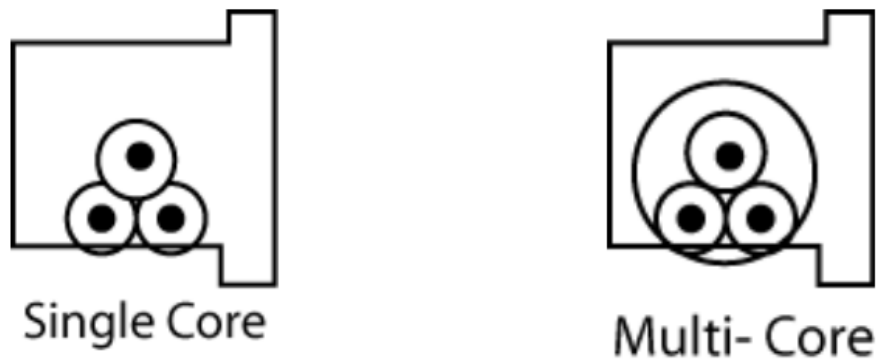
(i) Brick wall prepared 900 mm deep trenches with cover plates shall be used for placing the cables at the bottom of the trench.

(ii) 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 **75 mm** sand layer. In this method, 2 layers of brick on top, marking tape and then back filling the trench will have to be done.

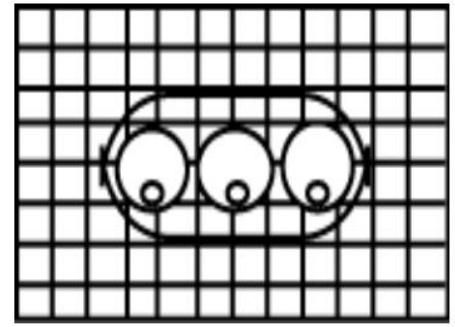
(iii) Pre-laid PVC pipes having sufficient clearance compared to the cable size(s) may be required at places. The PVC pipes must be laid in trenches of the 900 mm depth. Brick wall made underground inspection pits will be required at an interval of at least 10 m for cable pulling and future extensions 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 are specified in **Table 8.1.25**.

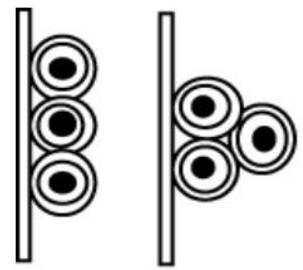
Table 8.1.25: Different ways of Installation of Cables and Conductors in Common Use

Type	Description	Example
A	Cables enclosed in conduit	
B	Cables enclosed in trunking	
C	Cables enclosed in underground conduit, ducts, and cable ducting.	

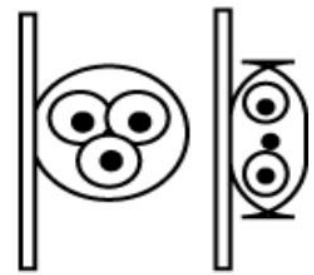
D Two or more single-core cables contained in separate bores of a multi-core conduit and intended to be solidly embedded in concrete or plaster or generally incorporated in the building structure.



E Sheathed cables clipped direct to a nonmetallic surface.



Single-core



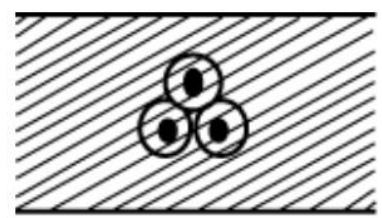
Multi-core

F Sheathed cables on a cable tray.

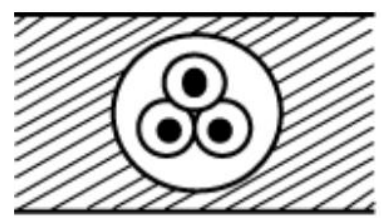
Single-core

Multi-core

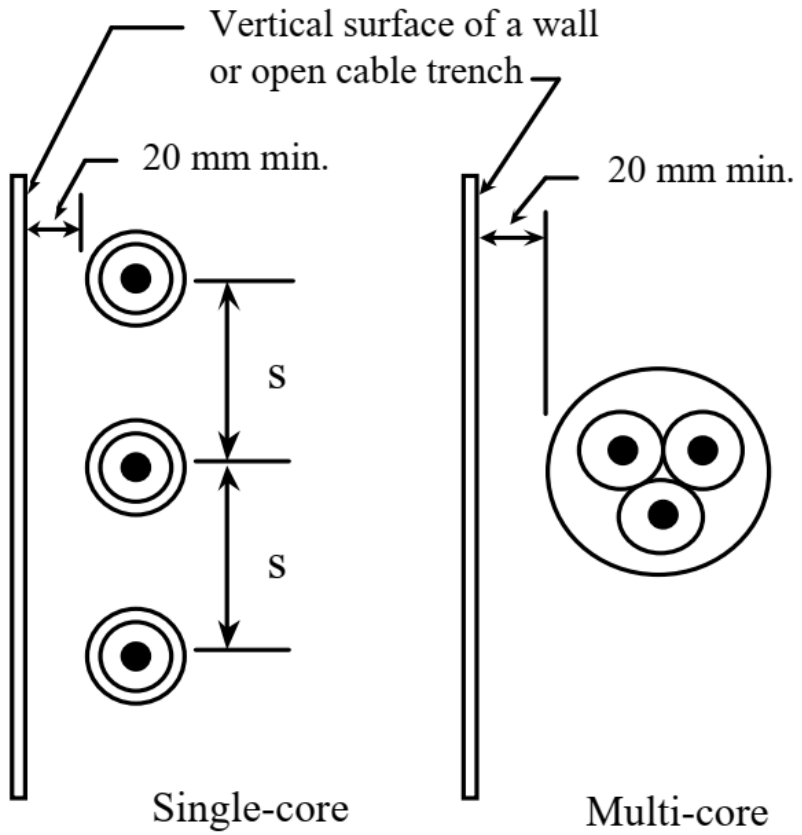
G Sheathed cables embedded direct in plaster.

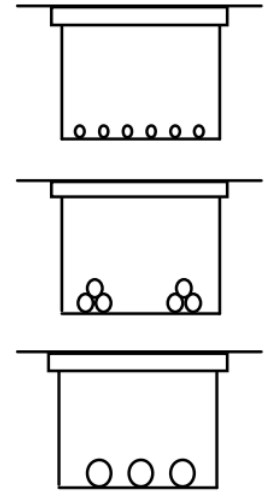
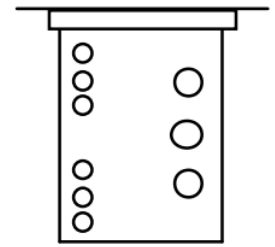


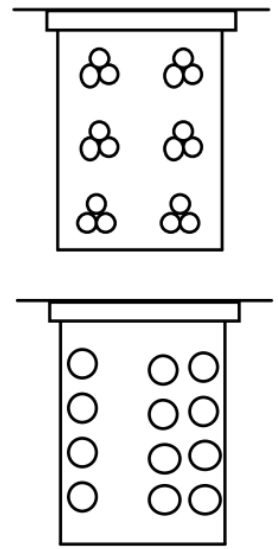
Single-core



Mutli-core

Type	Description	Example
H	Sheathed cables suspended from or incorporating a catenary wire.	
J	Sheathed cables in free air. For cables in which the conductor cross-sectional area does not exceed 185 mm^2, S is equal to twice the overall diameter of the cable. For cables in which the conductor cross-sectional area exceeds 185 m^2, S is about 90 mm. For two cables in horizontal formation on brackets fixed to a wall, S may have any lesser value.	

K	Single and multi-core cables in enclosed trench 450 mm wide by 600 mm deep (minimum dimensions) including 100 mm cover.	Two single-core cables with surfaces separated by a distance equal to one diameter; three single-core cables in trefoil and touching throughout. Multi-core cables or groups of single-core cables separated by a minimum distance of 50 mm.	
L	Single and multi-core cables in enclosed trench 450 mm wide by 600 mm deep (minimum dimensions) including 100 mm cover.	Single-core cables arranged in flat groups of two or three on the vertical trench wall with surfaces separated by a distance equal to one diameter with a minimum separation of 50 mm between groups. Multi-core cables installed singly separated by a minimum* distance of 75 mm. All cables spaced at least 25 mm from the trench wall.	

Type	Description	Example
M	Single and multi-core cables in enclosed trench 600 mm wide by 760 mm deep (minimum dimensions) including 100 mm cover.	Single-core cables arranged in groups of two or three in flat formation with the surfaces separated by a distance equal to one diameter or in trefoil formation with cables touching. Groups separated by a minimum* distance of 50 mm either horizontally or vertically. Multi-core cables installed singly separated by a minimum* distance of 75 mm either horizontally or vertically. All cables spaced at least 25 mm from the trench wall. 

* Larger spacing to be used where practicable.

1.3.26 Main Switch and Switchboards

1.3.26.1 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.

1.3.26.2 Circuit breakers on each live conductor

There shall be circuit breakers (*MCB or MCCB) 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 (#except DP switch/breaker).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1.3.26 Main Switch and Switchboards

1.3.26.3 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.

1.3.26 Main Switch and Switchboards

(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.

1.3.27 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/wooden bush at the entry hole. Earth stud should be proportionate to the size of 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 **1 meter** at the front of the SBs.

1.3.28 Wooden Boards as Main/Sub-Boards

Wooden boards containing fused cutouts and main switches as **Main Board or Sub-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.

1.3.29 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. 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 than 2.0 m** and the bottom of the panel shall be more than **0.45m** above the floor or working platform.

1.3.29 Location of Distribution Boards

(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 2 or more distribution fuse boards feeding LV circuit 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 impossible to open 2 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.

1.3.29 Location of Distribution Boards

(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.

1.3.30 Over-current and Short Circuit Protection

(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.

1.3.30 Over-current and Short Circuit Protection

(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.

1.3.31 Fire Alarm and Emergency Lighting

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.

Q?

Thanks!