NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

ELECTRICAL INSTALLATION OF A FOUR STOREY BUILDING

Graduation Project
EE400

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Abstract

In this day of technological age electrical installations are becoming more and more complex and elaborated. Systems that once were considered to be used only in industrial field, now they are commonly used in domestic environments also. Programmable heaters, washing machines, dishwashers, combi boilers are examples in this instance. In the last couple of decades the electricity usage in domestic buildings almost quadrupled or five folded. This project is one of the necessities of the modern age. Out of these necessities the method and rules of electrical installations also developed because of the dangers that the usage of electricity brought along with it. Therefore these rules and regulations are enforced mainly around the protection of the human beings and the equipment that use electricity. This projects, takes a four storey building as the basis of the discussion and designs the electrical installation that is required for the comfort of the occupants. In the design of the installation, the electrical cables and their protection device have been analyzed and after the analysis the proper sizes and types are selected. Considerable weight has been given onto the bonding of the metal parts, cases, pipes in the building and the method of earthing of the unprotected equipment. In the project cable sizes, voltage drop, positioning of the fittings and luminance calculations takes a large part in the consideration of the installation.

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Chapter 2

Introduction

In this project we shall look into the electrical installation requirements, safety aspects of an installation, method of installation, selection of the materials that are required in an installation and the points that should be observed in an installation. In highlighting these points we shall introduce the installation of a four storey domestic building analyzing how the cables, the switchgear, the fittings are selected and how the load of individual circuits have been calculated and the method of installation. In this building there are four floors a common area and a perimeter that accommodates the preliminary water tanks, each holding two tons of water. Each floor will have two quarters. All water tanks will have water pump to pump the water to the break tanks, which are situated at the roof of the building. The electrical installation generally will be identical, but the cable sizing and positioning of the power outlets; the length, the size and the type of the cables may differ necessitating individual calculation of the current carrying capacity in several cases, which will be discussed in detail at the related chapter.

In selecting the material that will be used in the installation care has been taken that they are in conformity with the local regulations issued by the Chamber of Electrical Engineers. In order to reduce the cost of the installation without compromising in quality many suppliers has been consulted.

Further the project will show how the loads will be calculated, the best possible path, the switchgear and the protection devices of the installation so that they will give the optimum working conditions within the building. The possible voltage drop, short circuit conditions are also considered.

In line with the requirement of the positioning of the meters by the Electricity Authority, the meters of the quarters and the common area meter are considered to be placed at the entrance of the building so that the operatives of this establishment can have access to this area without any obstruction.

Chapter 1 covers the introduction of the project. In includes general information about the equipment, protection devices, insulation of cables, the nature of the cables, fittings, small power outlets, circuits, etc., and the method of installation.

Chapter 2 looks into the types of the cables, their current carrying capacity, insulation material, and their usage in general nature. The chapter also incorporated the effects of the environmental condition on the cables and highlights the correction factors in this respect. Tables of current carrying capacity and for calculation of voltage drop of the cables are also included.

Chapter 3 describes the design and the nature of the installation of the four storey building and the fittings that are considered in this installation, which forms the core of the project. All the cable calculations, voltage drop considerations, water pumps and other ancillary equipment are considered in this chapter.

Chapter 4 covers the electrical installation drawings of the building. In this section each quarter in the floor has been shown separately. A separate drawing for the common areas, earthing pit, electrical meters' layout, all distribution boards for each quarter has been shown separately.

The project is concluded by highlighting the importance in selection of the fittings and the calculation of the cable sizes and the illumination criteria in the installation.

Chapter 1

1.1 Overview

This chapter covers the common methods adopted in usage of fitting lightning circuits, circuit breakers and the fuses and all of the safety matters. Including their characteristic and shows how to handle the light circuits and sockets and cables. It also shows the methods of bonding as a safety precaution.

Further , the circuit breakers fuses, earthing procedures, insulation, appliance classification, electrical, circuits, power distribution procedure, domestic installation consumer cents, cables sockets, RCDs, ring and radial type sockets their wiring methods, connection methods of the sockets switches and light. are discussed broad nature.

1.2 Circuit breakers

since we are going to assume that we are going to use our power in a full load power so we will need a circuit breakers.

The circuit breaker is an absolutely essential device in the modern world, and one of the most important safety mechanisms in our home. Whenever electrical wiring in a building has too much current flowing through it, these simple machines limits the current y cutting the power until somebody can fix the problem if some thing happened . Without circuit breakers (or the alternative,household electricity would be impractical because of the potential for fires and other mayhem resulting from simple wiring problems and equipment failures.

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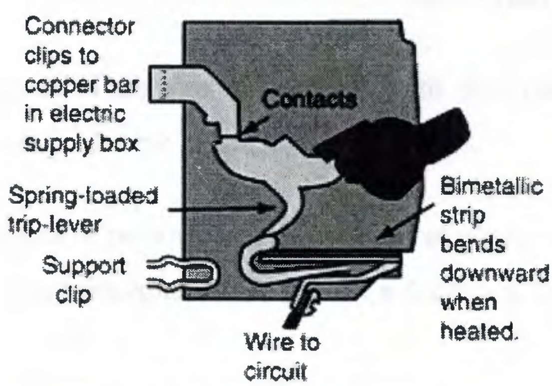


This is a simplified mechanism. the standard breaker has several springs and levers.

1.3 Fuses

The main job of the fuse is to protect the wiring. Fuses should be sized and located to protect the wire they are connected to. So if there is a high current appeared suddenly draws enough current to blow the fuse. The fuse will be there to protect the wire, which would be much easier to replace than the device.

And as we know that the heat heat build-up in the wire depends on the resistance and the amount of current flowing through the wire. Fuses are really just a special type of wire in a self-contained connector. Most fuses today have two blade connectors and a plastic housing that contains the conductor so when a high current or if the heat went high this connection will be destroyed so it will not again so the circuit will be opened in I twill protect the device.

1.4 Safety

1.4.1 Earthing (ground wire)

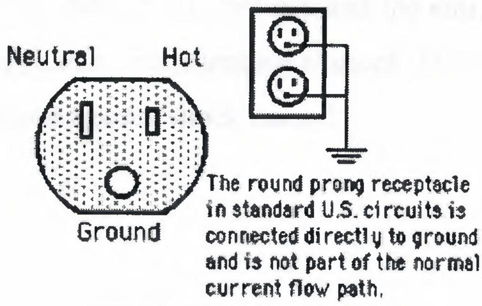
it is one of the basic safety uses and miniature circuit breakers cannot provide protection against earth faults to protect against the risk of electric shock except by indirect contact when combined with earthing and bonding. This can be achieved only by the use of earth fault circuit breakers known as Residual Current Devices (RCDs).

Earth fault is the condition of electric current flowing to earth under fault conditions:

a. direct contact i.e. contact of persons or animals with live parts e.g. conductors and terminals, which may result in electric shock, or

b. indirect contact i.e. contact of persons or animals with exposed conductive parts, such as the metal casing of a washing machine, made live by a fault, e.g. in the wiring of the plug, which may result in electric shock.

The term "ground" refers to a connection to the earth, which acts as a reservoir of charge. A ground wire provides a conducting path to the earth which is independent of the normal current-carrying path in an electrical appliance. Attached to the case of an appliance, it holds the voltage of the case at ground potential (usually taken as the zero of voltage). This protects against electric shock. The ground wire and a fuse or breaker are the standard safety devices used with standard electric circuits.

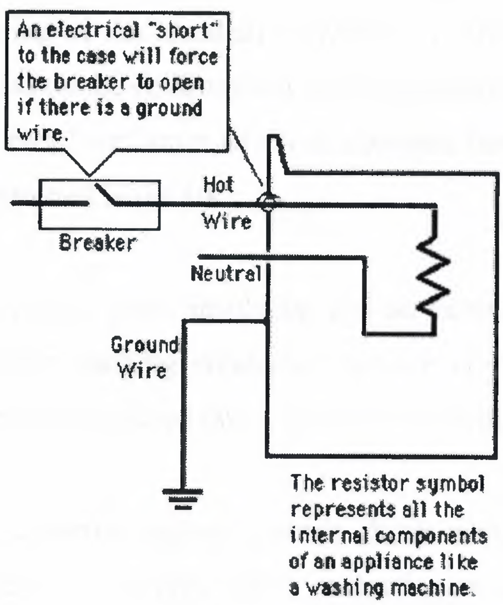


The appliance will operate normally without the ground wire because it is not a part of the conducting path which supplies electricity to the appliance. In fact, if the ground wire is broken or removed, you will normally not be able to tell the difference. But if high voltage has gotten in contact with the case, there may be a shock hazard. In the absence of the ground wire, shock hazard conditions will often not cause the breaker to trip unless the circuit has a ground fault interrupter in it. Part of the role of the ground wire is to force the breaker to trip by supplying a path to ground if a "hot" wire comes in contact with the metal case of the appliance.

The ground wire appears when a Three electrical connections are made to a standard appliance like a clothes washing machine. The "hot" wire carries an effective voltage of 120 volts to the appliance and the neutral serves as a return path. The third wire is the electrical ground which is just connected to the metal case of the appliance.

If the hot wire shorts to the case of the appliance, the 120 volt supply will be applied to the very low resistance path through the ground wire to the earth. This will cause an extremely high current to flow and will cause the breaker or fuse to interrupt the circuit.

One problem with this arrangement is that if the ground wire is broken or disconnected, it will not be detectable from the operation of the appliance since the ground wire is not a part of the circuit for electric current flow. In that case, if the hot wire shorts to the case and the neutral wire does not, then the breaker may not trip and the entire 120 volts will be applied to the metal case of the appliance, representing a shock hazard. The ground wire of an appliance is the main protection against shock hazard.



1.4.2 Insulation

Protection from electric shock is provided by isolation and/or insulation. Live parts must be separated from users and those likely to come into contact with the appliance and covered with non-conducting material to reduce the risk of electric shock.

Basic: insulation applied to live parts to provide basic protection against electric shock.

Supplementary: independent insulation applied in addition to basic insulation to ensure protection against electric shock in the event of a failure of the basic insulation.

Double: comprises both basic and supplementary insulation.

Reinforced: a single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation.

1.4.3 Appliance classification

Appliances are classified according to their protection against electric shock and against moisture:

Class 1 : appliances are those in which protection against electric shock relies upon basic insulation without provision for accessible conductive parts, if any, to the protective conductor in the fixed wiring of the installation, reliance in the event of a failure of the basic insulation being placed on the environment. Such appliances have either an enclosure of insulating material or a metal enclosure which is separated from live parts by insulation. This construction is not permitted in the UK.

Class 2: appliances have at least basic insulation and an earthing terminal. Their power supply cords do not have an earthing conductor and are connected to a plug without earthing contact which cannot be inserted into a socket-outlet with earthing contact.

Class 3: appliances have protection against electric shock which does not rely on basic insulation only but includes an additional safety precaution in that accessible conductive parts are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

Class4: appliances do not rely on basic insulation only but have double or reinforced insulation without provision being made for protective earthing or reliance upon installation conditions.

Class5: appliances rely on supply at safety extra-low voltage [SELV] for protection against electric shock i.e. 24 V maximum.

Appliances are further classified with regard to their protection against moisture:

- ordinary,
- drip-proof,
- splash-proof, and
- watertight.

1.4.4 Electric Circuits

An electricity circuit can be compared to a domestic water system. The pump provides pressure to drive the water round the pipework at a given rate and against any restrictions such as a valve or tap.

In an electrical system, the voltage is the pressure forcing the electrical current in a closed conductor against a resistance such as a piece of equipment e.g. a light bulb.

Water flows down with gravity and electricity similarly tries to reach earth. Like water, electrical current follows the path of least resistance. Copper conductors have a low resistance and for this reason are widely used.

Ideally, current should flow through the cable conductor to provide energy to the electrical appliance. To prevent it flowing to earth by other paths the conductors must be insulated with rubber or PVC.

All exposed metal parts of the installation must be earthed so that in the event of a fault any current will flow immediately to earth rendering the system safe from electric shock.

Voltage is measured in Volts, resistance in Ohms and current in Amperes.

Ohm's Law:

Voltage = Current x Resistance

V (volts) = I (amperes) x R (ohms)

Electrical power is measured in Watts:

Power = Voltage x Current

W (watts) = V (volts) x I (amperes)

It is important to have the correct fuse in a plug. Most homes have 13A sockets for 3-pin plugs. The correct fuse rating can be found by dividing the wattage (volts x amps) of the appliance by the domestic voltage 230V.

A 1000 watt fire would require a fuse of 1000/230 = 4.35 amps.

As fuses are only available in 3, 5 and 13 Amp ratings, the correct fuse in this case would be 5 Amps.

Power rating	Fuse rating
Appliances up to 720 watts	3 Amp
from 720 to 1200 watts	5 Amp
from 1200 to 3000 watts	13 Amp

From 1 February 1995 all new appliances have had to be supplied with fitted plugs which must contain the correct fuse for that appliance. Pressure for this change in the law followed evidence of widespread failure of consumers to wire plugs correctly and safely putting themselves and others at risk of electrocution. If occasionally a new plug is required to be fitted it will come with its own wiring instructions so there is no need to spend valuable effort on training consumers how to do something it has been shown to be outside the scope of their competence and completely unnecessary and virtually unique to the UK.

1.4.5 Electrical distribution

A supply transformer provides a single phase and neutral domestic 230 volt supply to a number of dwellings. When there is no fault condition, current flows from the live side of the supply, through the electrical equipment in the dwelling and back through the neutral conductor to the transformer: a closed loop.

All the accessible metal parts of electrical equipment in the house are connected to earth via earthing conductors, circuit protective conductors, for safety reasons. Other exposed metalwork such as gas and water pipes are connected to the consumer's main earth terminal. This in turn is connected back to the transformer.

In the event of an earth fault on the installation, another closed loop is formed completing the circuit via an earth path. This earth fault loop must be kept to a minimum resistance to allow sufficient current to flow under fault conditions to operate the protective fuse or circuit breaker and thus isolate the electrical supply from the circuit in which the fault has occurred. Protection is thus achieved against the risk of electric shock or fire caused by deterioration of the cable conductors and localised heat generation.

1.4.6 Domestic installation

The Electricity Supply Company cable terminates in a sealed fuse cut-out unit from which the supply is taken via a watt-hour meter to the consumer unit. These units should be mounted within the dwelling where there is ease of access for emergency switching or fuse repair or circuit isolation using the protective devices. The consumer unit should not be sited in enclosures built into outside walls which are intended only to house the cut-out and meter.

1.4.6.1 Consumer unit

The purpose of the consumer unit is to divide the electrical supply into different circuits and to protect the dwelling and occupants from the dangers of electric shock and fire by isolating the supply from the circuit in which a fault has developed.

By touching metal or other conducting material which is "live" a person may receive an electric shock, the degree of danger depending on a number of factors the main one being the voltage across the body. An electric shock is experienced when current passes through the body to earth.

When designing, installing and maintaining a safe electrical installation, the scale of the problem with which one has to contend can be illustrated using a typical domestic installation. A 230 volt supply provides circuits ranging from 6 amps for lighting to 40 amps for a cooker or electric shower unit.

Voltages in excess of 50 Volts are sufficient to produce currents in the human body which can prove fatal. Currents in excess of 50 milliamps (50 thousandths of 1 amp) and, depending on the duration of the shock even much lower currents, can kill.

Time is another crucial factor. The higher the current, the shorter the time needed to caused damage or injury.

Fires due to electrical faults can be caused by:

- continuous overloading of the conductors causing the insulation to break down and expose the hot conductor which can ignite surrounding flammable material, or
- short-circuit which results from two current carrying conductors making contact with each other when large currents can cause thermal and mechanical damage to the conductors themselves.

An important function of the consumer unit is to protect against these conditions.

Various units are available which afford different levels of protection. The simplest contains an isolating switch and a number of rewireable fuses. Slightly more sophisticated ones have cartridge fuses. Both types are still widely used although they present a number of problems:

- easily abused such as the use of silver paper, hairclips and nails in place of the correct size of fuse wire thus removing any protection provided;
- difficult to identify blown fuse;
- inconvenience in re-wiring fuses leading to abuse;
- replacement cartridge fuses to BS 1362 are not widely available.

The miniature circuit breaker (MCB) is the modern replacement for fuses and is increasingly being used. It is an automatic switch which operates under fault conditions giving a high degree of protection against overload or short-circuit faults. They have considerable advantages over fuses being easy to operate and less open to abuse and misuse.

Consumer units are available in a variety of formats, one of the more sophisticated being - an isolator, a number of MCBs, an RCCB followed by more MCBs, a second RCCB followed by a number of MCBs providing non-RCCB protection for security circuits and providing two groups of protected circuits.

1.4.6.2 Cables size

The correct size of cable to carry different current levels is important. Too thin a cable can overheat and create a fire hazard. The following provides a list of the minimum cross-section of cable appropriate for the relevant current:

Amps	Minimum cable size (mm2)
5	1.0
10	1.0
15	1.5
20	2.5
30	2.5*
45	6.0

* ring circuit only, otherwise 4mm2

In addition to switches, ceiling roses and lampholders, shaver units may also be wired into lighting circuits.

Wall mounted switches should have large rockers for ease of operation and incorporate a labyrinth design to prevent knife blades and other objects touching live parts and obscure the arcing flash when operated.

Ceiling mounted switches are used in bathrooms removing the actual switch out of the reach of persons using the bath or shower. Lampholders must be of good quality and meet the standard as they have to withstand very high temperatures.

Shaver sockets are provided as separate units or as part of the lighting fitting. Those fitted in bathrooms must have an isolating transformer which meets BS 3535 to provide shock risk protection to the shaver user.

1.4.6.3 Socket outlets

It is important to have sufficient sockets to reduce overloading using adapters creating a fire risk. The Electrical Industry Liaison Committee have recommended the following number of twin sockets in each room:

Location	Number of sockets
Kitchen	4
Living room	6
Dining room	3
Double bedroom	4
Single bedroom	3
Single bed-sitting room	4
Landing/stairs	1
Hall	1
Garage	2
Store/workroom	1

Any socket outlet 'which may reasonably be expected' to supply equipment for use outdoors e.g. drill, sander, lawn mower, hedge trimmer must be RCD protected according to the IEE Wiring Regulations.

The shutter safety mechanism used in socket outlets requires the insertion of the earth pin of a 3-pin plug to operate it before access can be gained to enable the other pins to make contact with the supply. Plugs are also required to have these two pins sleeved in accordance with BS 1363 thus reducing the risk to young children who try to insert objects into the sockets.

A socket outlet, other than an approved shaver socket, must not be fitted into a bathroom or shower room.

It is safer not to have a dual cooker control unit with a socket outlet for use with appliances such as an electric kettle or toaster. The cable can easily fall onto the hot hob and be damaged. It may also cause the cooker to become live in such a situation creating a potentially lethal condition.

An immersion heater must be wired on its own separate circuit with a 20A double pole switch which isolates both live and neutral conductors. The cable, as in similar installations where excessive heat may be generated, must be heat resistant.

An electric shower must have an isolating switch which is usually a cord operating a 40Amp double pole switch.

Under the Building Regulations all new premises must now have a smoke detection unit on each floor. They should not be fitted on an RCD-protected circuit. The same applies to alarms and security lighting.

1.5 protection from shock

Protection from electric shock is provided by isolation and/or insulation. Live parts must be separated from the user of the appliance and covered with non-conducting material to reduce the risk of electric shock.

The consumer unit contains fuses or miniature circuit breakers (MCB) which identify a fault on a circuit and operate and isolate the electrical supply before further damage can occur to the conductors and their insulating material. This damage can result from overloading or short-circuit faults.

1.5.1 Residual Current Devices (RCDs)

This term covers a number of protective devices:

Residual Current Circuit Breaker (RCCB) – these are to be found in consumer units protecting all or a number of circuits.

Residual Current Breaker with Overcurrent protection (RCBO) - a combined RCD and MCB (miniature circuit breaker) providing overload, short-circuit and earth fault protection in one unit.

Socket-outlets with combined RCD (SRCD) - provides RCD protection at one socket outlet only.

Portable RCD (PRCD) - an integral part of a plug providing protection to the appliance being used only.

It is not recommended to use RCD protection in circuits supplying security and emergency systems e.g. burglar alarms, fire alarms, security lighting. RCDs have developed a reputation for "nuisance" tripping. Causes have been put down to radio frequency suppression devices, electronic timers and leakage to earth due to dampness when cooker hot plates warm up. This problem has been considerably reduced by improvements in design.

RCDs are provided with various levels of sensitiveness:

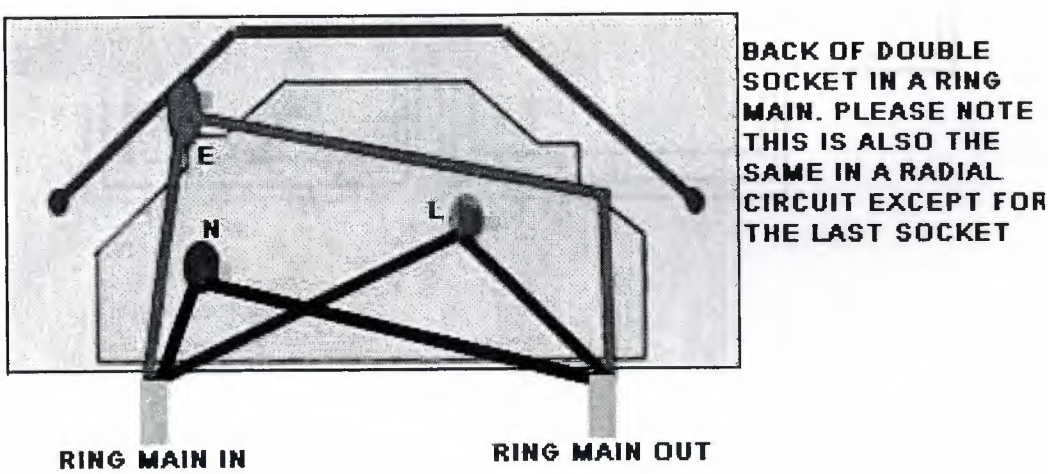
10mA	for specialist uses e.g. laboratories or where children may need to be protected.
30mA	ideal for domestic situations and is the most commonly used. It is a requirement of the Wiring Regulations that all socket outlets 'which might reasonably be expected' to supply equipment to be used outside the dwelling (the equipotential zone).
100mA	for protection against indirect contact situations. Less likelihood of nuisance tripping and therefore could be used to protect a freezer circuit.
300mA	for fire risk protection.

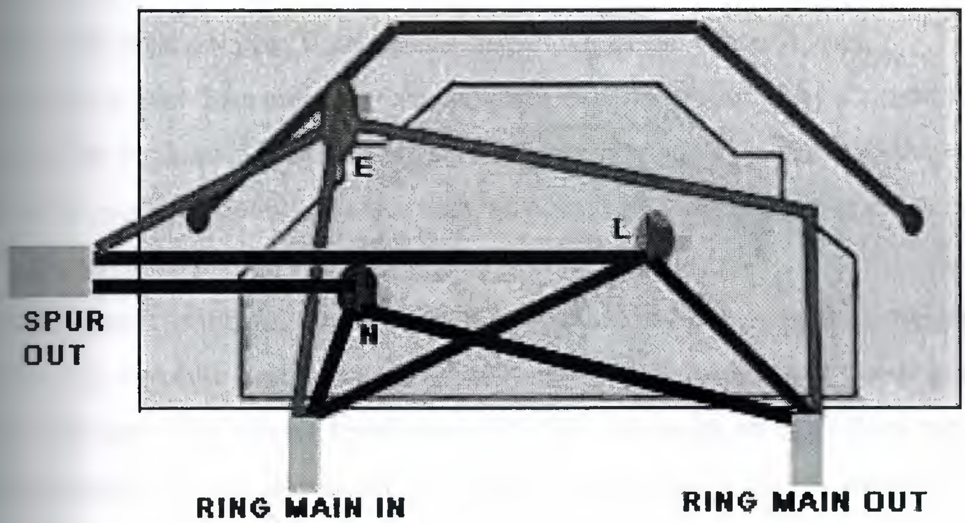
Inadvertently cutting through electric mower cables has resulted in many avoidable deaths. Every precaution however should be taken to ensure the safe use of equipment rather than relying on the RCD for protection against shock. RCDs themselves are not 100% reliable and, in rare instances, may malfunction and fail to cut off the current in a critical situation.

It is proposed in the review mentioned above that RCDs be installed on a number of circuits such as the downstairs ring, circuits to sheds and garages, pond pump and other outdoor circuits where the risk of electrocution is greatest. RoSPA welcomes this proposal.

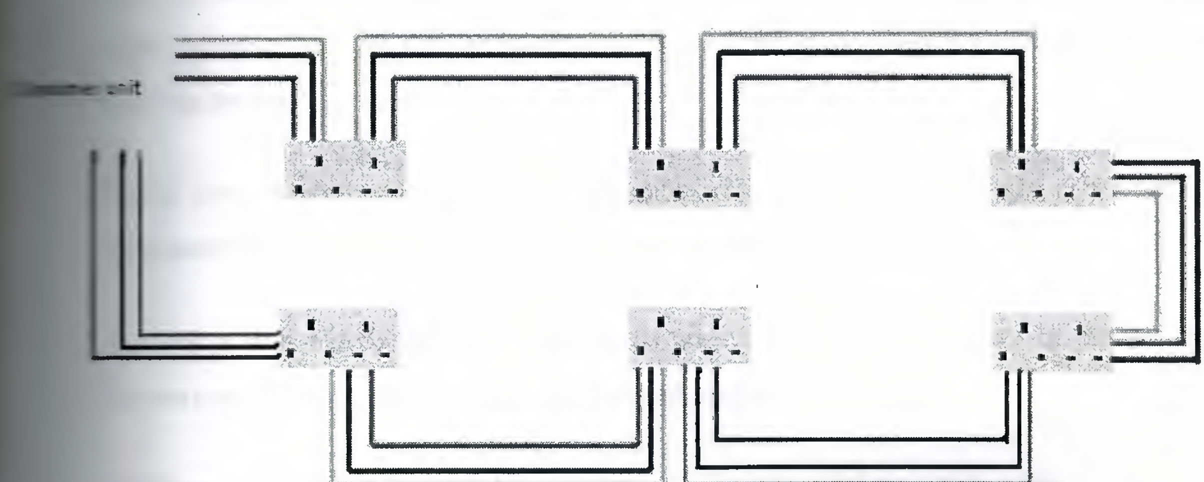
1.5.2. Tthe ring and redial type circuits

The sockets and how they are planed in ring type or redial ciruic
The ring circuit is a circuit which appear in the series way each component behind the other
A spur can be connected to an existing socket, on either a ring main or a redial circuit, providing that socket does not already have a spur. That is only one spur per socket is allowed and the number of spurs must not exceed the number of sockets. If this is necessary in any part of the home the only way we can do this is by adding another ring main or by extending one of the ring mains we have.
The spur must be connected to the last socket using the same cable as used in the main circuit. We can see how to wire a spur to an existing socket from the images above. The first image shows how the back of our double socket should look and the second is the wiring for a spur. A general rule for a ring main is that if you only have two cables in the back of an existing socket then it is ok to spur...However, if you have a radial circuit with two cables coming in and out, this may be the last socket on that circuit and already has a spur.





A spur can be added to any part of the circuit providing the rules above are followed. If there is not an existing socket near enough, you can connect into the cable by means of a junction box for your new spur.



The wiring for a junction box can be seen here. Junction boxes come rated for different uses by the amps they are allowed to carry. A 30amp junction box should be used on a ring or radial circuit feeding sockets only. The junction box must be fixed solidly to a suitable surface and must not just "float around suspended by the cables it joins

The cables to and from any spurs you connect must be protected by a conduit of some kind; be it on the surface or buried in the wall. If you bury cables in the wall they must only run vertically, not horizontally. Cables may be placed in floor or ceiling voids but not amidst, or wrapped in, insulation where they may become too hot.

A radial circuit is a mains power circuit found in some homes to feed sockets and lighting points. It is simply a length of appropriately rated cable feeding one power point then going on to the next. The circuit terminates with the last point on it. It does not return to the consumer unit or fuse box as does the more popular circuit, the ring main.

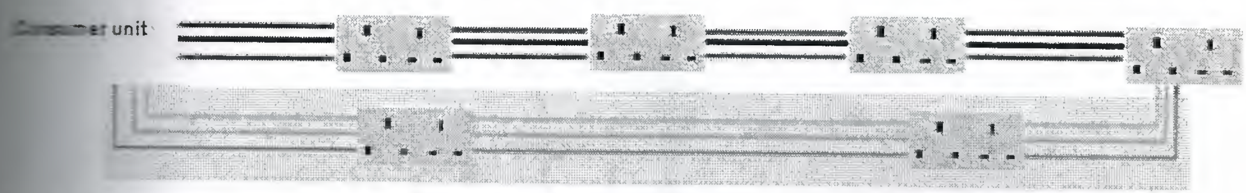
There is no limit to the number of sockets used on a radial circuit and, just like a ring main, spurs, or extra sockets, can be added. The number of spurs must not exceed the number of existing sockets.

Radial circuits are generally used in larger buildings where, to return the cable back to the consumer unit can effectively double the cost of the installation.

As with a ring main, units and appliances which draw large amounts of current such as showers and electric cookers nust be installed on their own circuit.

Additional wiring can be added to a radial circuit to turn it into a ring main.

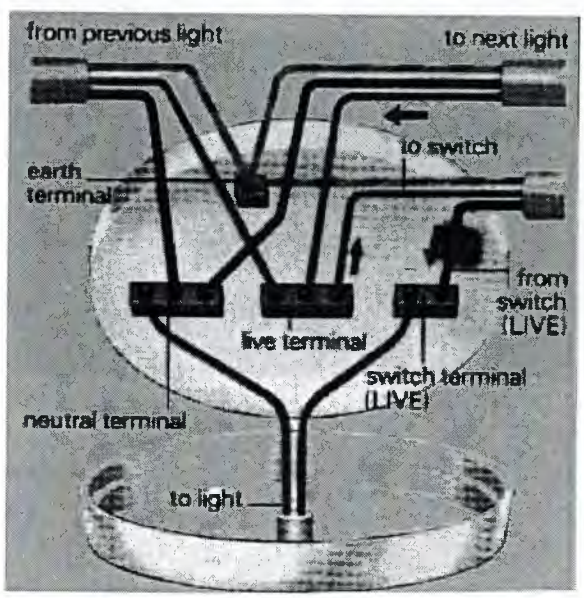
Radial circuit made into a ring main. Additions are in shaded area.



We can add sockets to this circuit but we have be very carefully for ring mains and radial circuits since we are limited in the length of cable we are allowed to use in both circuits and long spurs could make we exceed the limit. If this is the case you are asking the circuit to use much more energy than the circuit is designed for. More energy = more heat and cables can catch fire., you could be breaking the law and your house insurance may not be valid.

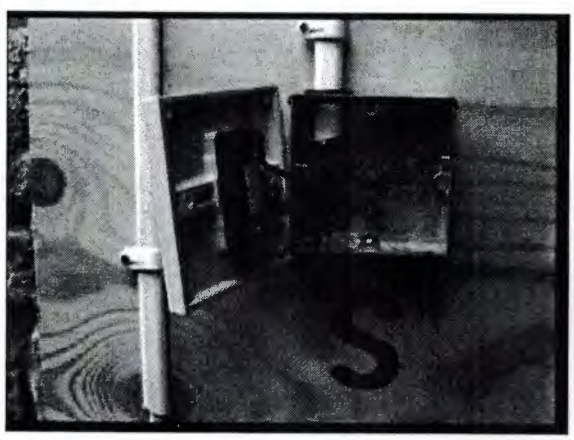
1.6 Lightning circuits and sockets :

The most common mistake made when changing a ceiling light, is connecting black to black and red to red. This is not always the case: The cable that comes from the switch to the light has a black and a red wire, both of these are live wires. The black wire should have a piece of red sleeve or tape around it to indicate this. Before disconnecting an existing light make careful note of how the existing connections are made.



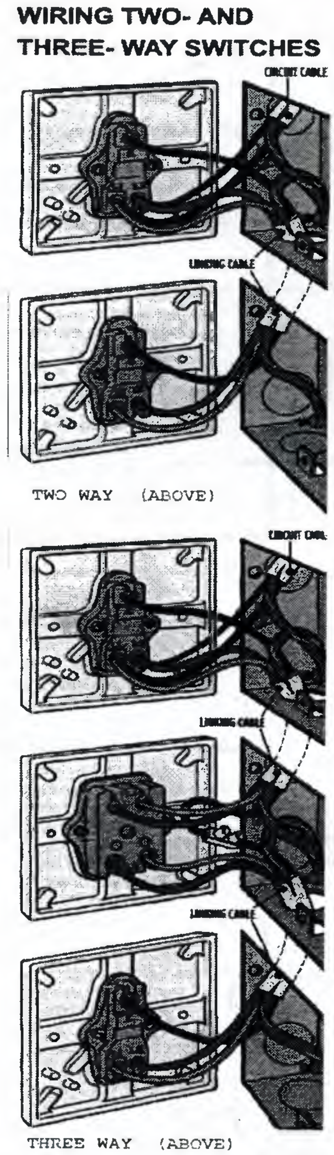
switch simply interrupts the live feed to the light and enables you to turn the light on and off by disconnecting the live flow.

The switch in the ceiling are as shown



A new ceiling light can be added by introducing a new cable into one of the existing ceiling lights, sharing a live and neutral and earth connection with those wires already in the rose. The other ends of the cables are then connected into a new ceiling rose, live, neutral and earth. The switch wires are added as shown in the ceiling rose diagram above and connected to the switch also as shown. The light fitting is then connected also as shown. All connections must be made before the final connection to the live circuit, which must be turned off while connection is made.

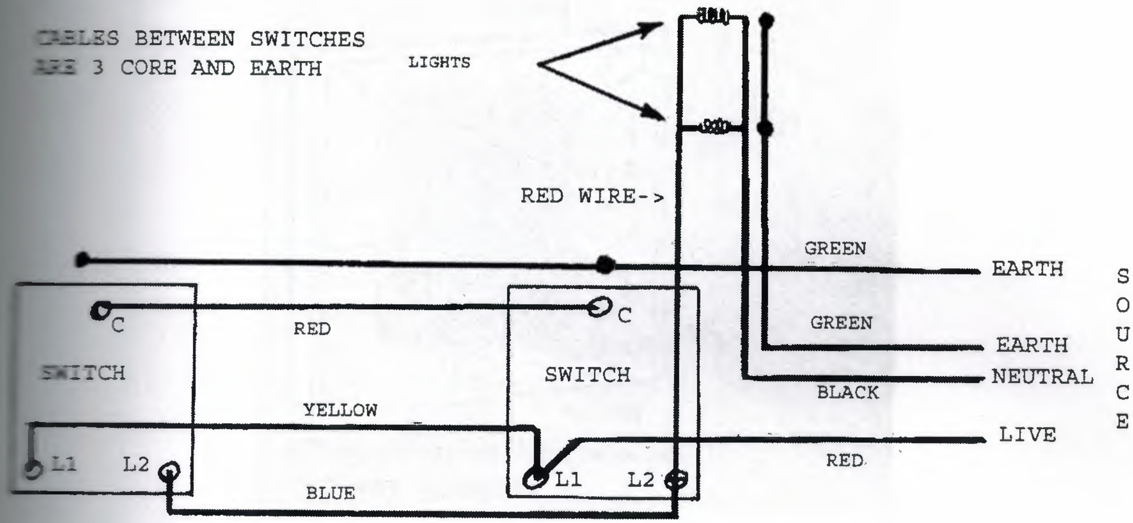
For two or three way light we have to connect it like it is shown below we take the circuit cable to the lightning circuit the live n neutral to the switch n we take from them (from their spur) wires to the other lightning circuit number one n for the other switch for the second switch and there will be a wire between the two switches for three way lightning circuit we give a live for the first and and from their spur we take to the second and from the second we take to the third one in fact there is a wire connecting the first with the third to complete the circuit as it is shown next and sure we r not forgetting the ear thing.

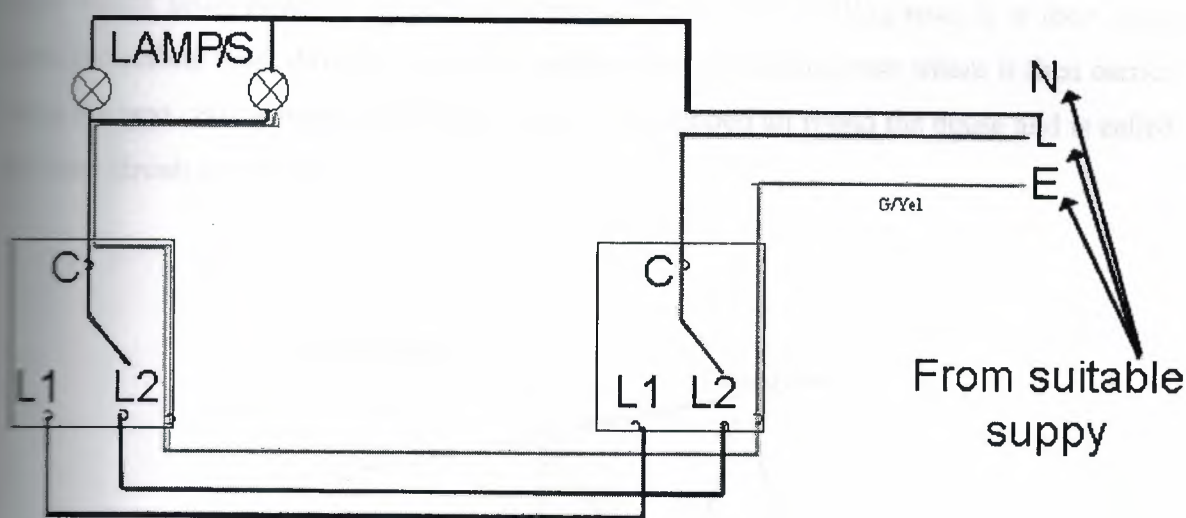


The circuit cable is the only one that goes to the lights despite all the tricky wiring in between. All of the lighting complications are largely between the switches with the end result being a live and a neutral outlet for the two wires from your light fitting to connect to.

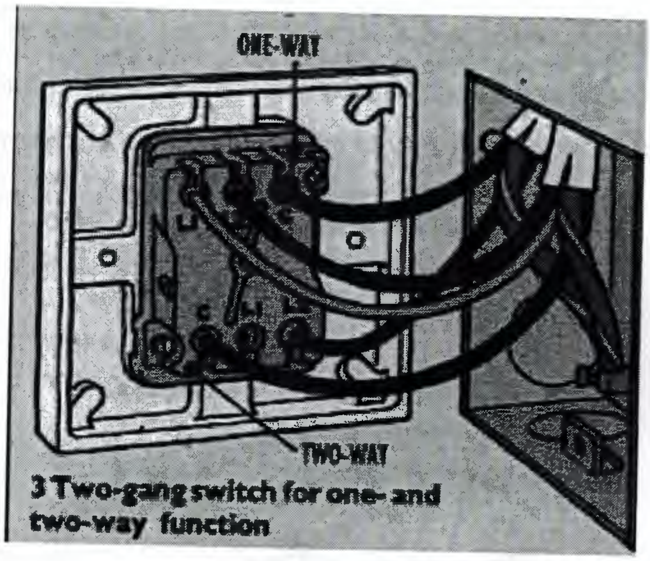
Two way lightning:

The basic wirng diagram for the two way lightning :



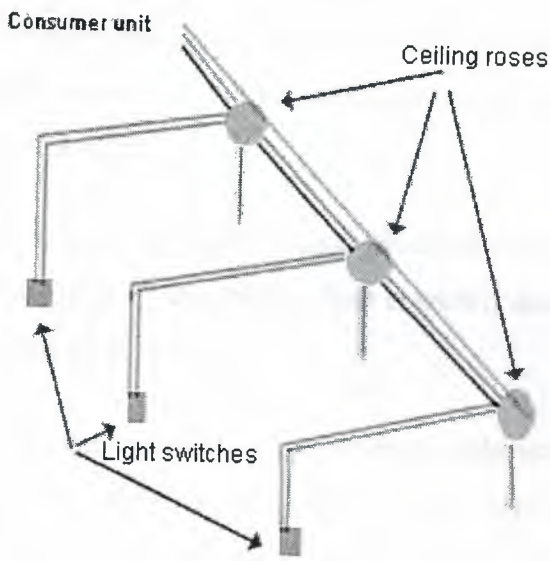


and the two gang switch is is two single switches wired onto one face plate. Each switch may be wired differently, one may be working as a one way switch while the other can be wired as a two way. The diagram below shows how this can be done. Both switches can also be used as one way.

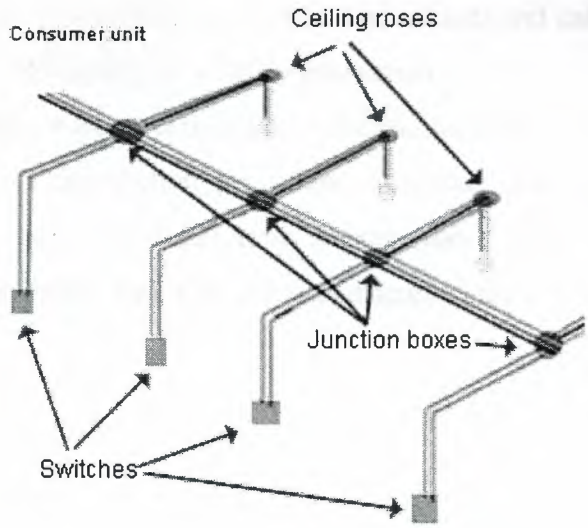


3 Two-gang switch for one- and two-way function

Now for the lightning circuits we have two popular ways to connect them the first one show below takes power from the consumer unit to the first ceiling rose. It is then taken from the ceiling rose, through the switch and back to the ceiling rose where it then carries on to the next ceiling rose. This carries on until it is looped all round the house and is called the loop circuit or system.



The second system in popular use is the junction box circuit or system. Power is taken from the consumer unit to the first junction box. The live is interrupted by the switch wiring and the circuit is carried on to the next junction box. A cable is run from the junction box to the light, usually via a ceiling rose.



Usually 1mm sq. cable will be used for lighting. A lighting circuit can serve up to 12 x 100W bulbs. Using 1mm cable is allowed for up to 95meters of circuit length. This does not include the switches which should be wired in switch wire which contains 2 red cores. If you have longer lengths to cover, 1.5mm squared cable can be used and the maximum length allowed using this is 110m.

To avoid the house being in total darkness if a fuse should blow or trip, lighting circuits are split into upstairs and downstairs. If a cartridge fuse is used it should be rated at 5amps, if an MCB is used it should be rated at 6amps.

And we have to check the ring mains and radial circuit ruls since we are stoked to the length of the cables we are allowed to use in both circuits to deny the volage drop and short circuits because if we used longer there will be more energy passing which will cause the drop or the short circuit.

1.7 Summery

In this chapter we have seen the common methods adopted in usage of fitting lightning circuits, circuit breakers and the fuses and all of the safety matters. Including their characteristic and how to handle the light circuits and sockets and cables was shown too. It also shown the methods of bonding as a safety precaution.

Further , the circuit breakers fuses, earthing procedures, insulation, appliance classification, electrical, circuits, power distribution procedure, domestic installation consumer cents, cables sockets, RCDs, ring and radial type sockets their wiring methods, connection methods of the sockets switches and light. are was discussed too.

Chapter 2

2.1 Overview

In this chapter we will see the cables and the way it is planed for installation in fennel nature and their types and sizes, their insulation and how the voltage drop is calculated, and their coarse and how is the current types will be carried in them and how we have to consider the heating while the current is passing thru and the voltage drop and we will see the cables support and protect and how they bend and how they will be placed in the conduits.

The dissection of the chapter will be contented around, cable size, their colures and sizes , encapsulation method of wiring, types of cable insulation, voltage drop, consideration, cores section areas, their current carrying capacity, certain loss due to the type of encapsulation effect of ambient temperature on the cable examples of calculation methods, protection factors and various tables showing the current carrying capacity voltage drop and growing effect of the conductors, considerable attention also has been given to the methods of supports of the cables, bending and protection that is suffising under the floors.

Some procedures that are common for the electrical installation but are not used in this project are also discussed for reference purports.

2.2 Cable sizes colors and core

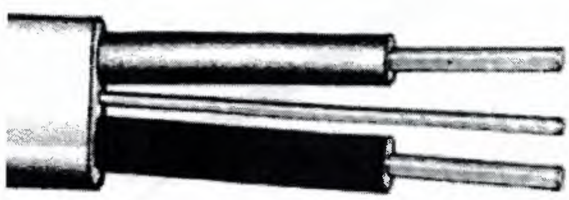
Incorporates the calculation of the cables. Because of different load requirements the size, the type and the length of the cables differ according to their application. Therefore certain calculations and research are necessary. This chapter covers all the necessary work to highlight these characteristics. The Characteristics of the fittings are also indicated in this chapter.

It is vital to remember that values for cables and flexes can change in domestic situations. A cable in an insulated loft space will get hotter, much more quickly, than a cable looped through garage rafters.

As with most formulas in the building distribution there are regulations defining specific boundaries for the use of all materials. Factors such as resistance and voltage drop may need to be assessed and taken into consideration when working out cable runs. Electricity is dangerous and each year an average of 10 people die and 756 are seriously injured in accidents involving unsafe fixed electrical installations and appliances in the home.

(Figures courtesy of BBC).

The term cable, amongst other things, means "*an encased group of insulated wires*". A cable is a fairly inflexible (although of course they can be bent) set of wires used to supply the electricity to certain points in the home. The meter box is supplied through a cable, sockets are supplied by cables and the lights are fed through cables. A cable can carry many wires depending on the job it needs to do. Most domestic cables carry a black wire which is usually for the neutral current, a red wire for a live current and a bare wire to take residual current to earth. This cable is called 2 core & earth. From. Now for domestic use, the cable wire colours are specified to those of the flex colours.



2 core & earth, 1.5mm cable

The bare wire, when the cable is used, should be marked by a green and yellow earth sleeve.

Another cable used a lot in domestic lighting is called 3 core & Earth. The extra core wire is in a yellow insulating sheath and is used as an extra conductor to carry power between 2 or more switches operating lights.

Special lighting switch cable can be used. This is called "Twin red core" and is used as switch cable for the lights. Often this is replaced, by electricians, who use an ordinary 2 core & earth cable as a switch cable and place a little red tape around the black wire in the cable..

Twin red core

A Flex (abbreviation of flexible) is a flexible cable used to carry electricity from a power point to an appliance. Most appliances are portable and in a lot of cases need to move quite a lot (irons, toasters etc) so the cable supplying them, should it twist or bend, needs to become straight again with the minimum of effort.

Appliance flex

Different cables and flexes are used for different jobs because they are thicker and can carry more current and have more, or less resistance. Resistance can be seen as electrical friction and the wires in the cable or flex will absorb some of the energy in the current, allowing a little less to reach the target than was sent.

High energy users such as electric showers and immersion heaters are supplied by thicker wires than are radios as the current that the appliance needs is considerably greater.

We will mention again that installation of cables depends on the position they are to be in, the temperature of the area or void, the length of the run, the grouping of the points they serve and the type of device (Fuse, RCD etc) by which they are protected. The first table below id for cables which are installed by method 4 " enclosed in an insulated wall" The second table is for cables installed by method 1, "clipped direct". As it is shown there is quite a difference in rating so we have to be absolutely sure that we are doing the right thing.

applying circuits etc should be used as in the following table.

Table 1 = Method 4 Encased in insulated wall

Cable size	Rating in Amps
1mm	11
1.5mm	14
2.5mm	18.5
4.00mm	25
6.00mm	32
10.00mm	43

Table 2 = Method 1 Clipped Direct

Cable size	Rating in Amps
1mm	15
1.5mm	19.5
2.5mm	27
4mm	36
6mm	46
10mm	63

2.3 Wiring

This part is concerned with the selection of wiring cables for use in an electrical installation. It also deals with the methods of supporting such cables, ways in which they can be enclosed to provide additional protection, and how the conductors are identified. All such cables must conform in all respects with the approðpriate BritishStandard.

2.3.1 - Cable insulation materials

Rubber

For many years wiring cables were insulated with vulcanised natural rubber (VIR). Much cable of this type is still in service, although it is many years since it was last manufactured. Since the insulation is organic, it is subject to the normal ageing process, becoming hard and brittle. In this condition it will continue to give satisfactory service unless it is disturbed, when the rubber cracks and loses its insulating properties. It is advisable that wiring of this type which is still in service should be replaced by a more modern cable. Synthetic rubber compounds are used widely for insulation and sheathing of cables for flexible and for heavy duty applications. Many variations are possible, with conductor temperature ratings from 60°C to 180°C, as well as resistance to oil, ozone and ultra-violet radiation depending on the formulation.

Paper

Dry paper is an excellent insulator but loses its insulating properties if it becomes wet. Dry paper is hygroscopic, that is, it absorbs moisture from the air. It must be sealed to ensure that there is no contact with the air. Because of this, paper insulated cables are sheathed with impervious materials, lead being the most common. PILC (paper insulated lead covered) is traditionally used for heavy power work. The paper insulation is impregnated with oil or non-draining compound to improve its long-term performance. Cables of this kind need special jointing methods to ensure that the insulation remains sealed. This difficulty, as well as the weight of the cable, has led to the widespread use of p.v.c. and XLPE (thermosetting) insulated cables in place of paper insulated types.

P.V.C.

Polyvinyl chloride (p.v.c.) is now the most usual low voltage cable insulation. It is clean to handle and is reasonably resistant to oils and other chemicals. When p.v.c. burns, it emits dense smoke and corrosive hydrogen chloride gas. The physical characteristics of the material change with temperature: when cold it becomes hard and difficult to strip, and so BS 7671 specifies that it should not be worked at temperatures below 5°C. However a special p.v.c. is available which remains flexible at temperatures down to -20°C.

At high temperatures the material becomes soft so that conductors which are pressing on the insulation (eg at bends) will 'migrate' through it, sometimes moving to the edge of the insulation. Because of this property the temperature of general purpose P.V.C. must not be allowed to exceed 70°C, although versions which will operate safely at temperatures up to 85°C are also available. If p.v.c. is exposed to sunlight it may be degraded by ultra-violet radiation. If it is in contact with absorbent materials, the plasticiser may be 'leached out' making the p.v.c. hard and brittle.

LSF (Low smoke and fume)

Materials which have reduced smoke and corrosive gas emissions in fire compared with p.v.c. have been available for some years. They are normally used as sheathing compounds over XLPE or LSF insulation, and can give considerable safety advantages in situations where numbers of people may have to be evacuated in the event of fire.

Thermosetting (XLPE)

Cross-linked polyethylene (XLPE) is a thermosetting compound which has better electrical properties than p.v.c. and is therefore used for medium- and high-voltage applications. It has more resistance to deformation at higher temperatures than p.v.c., which it is gradually replacing. It is also replacing PILC in some applications. Thermosetting insulation may be used safely with conductor temperatures up to 90°C thus increasing the useful current rating, especially when ambient temperature is high. A LSF (low smoke and fume) type of thermosetting cable is available.

Mineral

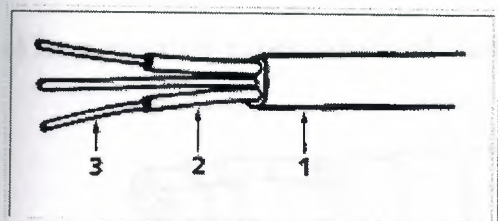
Provided that it is kept dry, a mineral insulation such as magnesium oxide is an excellent insulator. Since it is hygroscopic (it absorbs moisture from the air) this insulation is kept sealed within a copper sheath. The resulting cable is totally fireproof and will operate at temperatures of up to 250°C. It is also entirely inorganic and thus non-ageing. These cables have small diameters compared with alternatives, great mechanical strength, are waterproof, resistant to radiation and electromagnetic pulses, are pliable and corrosion resistant. In cases where the copper sheath may corrode, the cable is used with an overall LSF covering, which reduces the temperature at which the cable may be allowed to operate.

Since it is necessary to prevent the ingress of moisture, special seals are used to terminate cables. Special mineral-insulated cables with twisted cores to reduce the effect of electromagnetic interference are available.

2.3.2 -Non-flexible low voltage cables

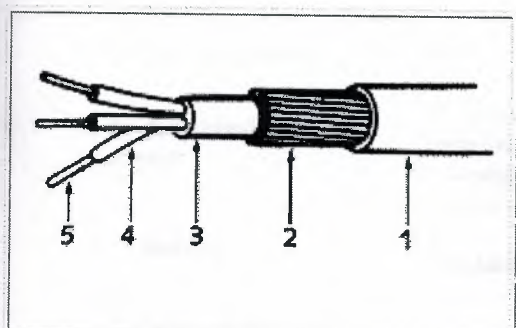
Types of cable currently satisfying the Regulations are shown in {Fig 4.1}.

a) Non-armoured pvc-insulated cables - Fig 2.1a



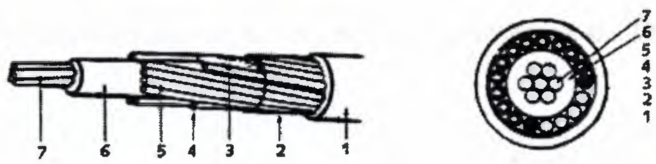
1 - pvc sheath
2 - PVC insulation
3 - copper conductor: solid. stranded or flexible

b) Armoured PVC-insulated cables - Fig 2.1b



1 - PVC sheath
2 - armour-galvanised steel wire
3 - PVC bedding
4 - PVC insulation
5 - copper conductor

c) Split-concentric PVC insulated cables - Fig 2.1c

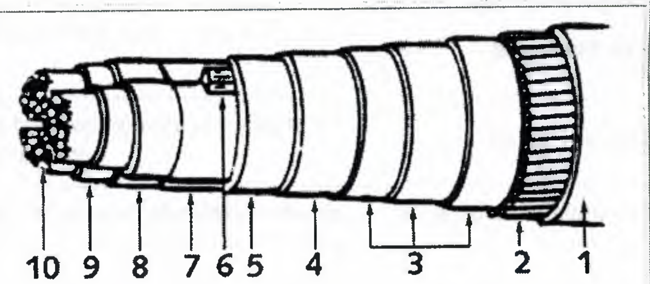


1 - PVC oversheath	5 - earth continuity conductor: ---- bare copper wires
2 - Melinex binder	6 - PVC phase insulation
3 - PVC strings	7 - copper conductors
4 - neutral conductor: ---- black PVC-covered wires	

d) Rubber-insulated (elastomeric) cables - Fig 2.1d

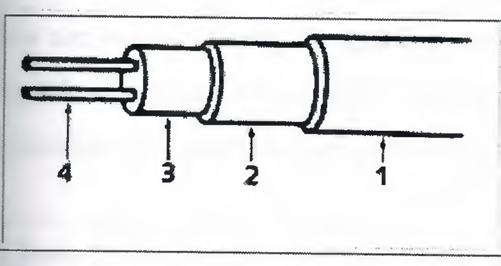
1 - textile braided and ---- compounded
2 - 85°C rubber insulation
3 - tinned copper conductor

e) Impregnated-paper insulated lead sheathed cables - Fig 2.1e



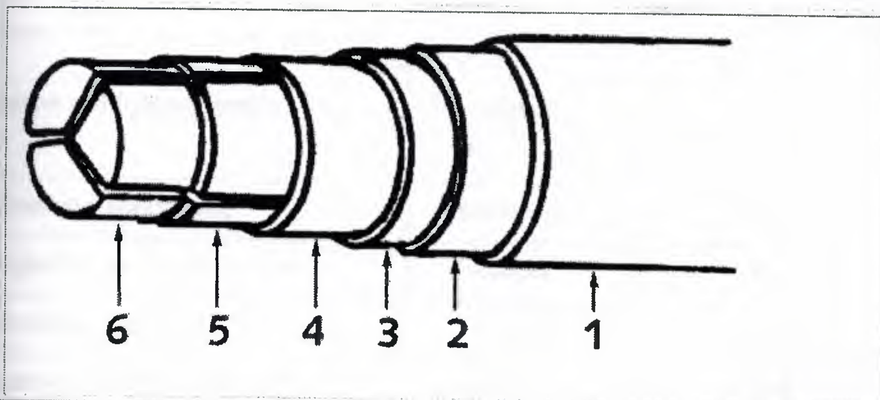
1 - PVC oversheath	6 - filler
2 - galvanised steel wire armour	7 - screen of metal tape intercalated ---- with paper tape
3 - bedding	8 - impregnated paper insulation
4 - sheath: lead or lead alloy	9 - Carbon paper screen
5 - copper woven fabric tape	10 - shaped stranded conductor

f) Armoured cables with thermosetting insulation - Fig 2.1f



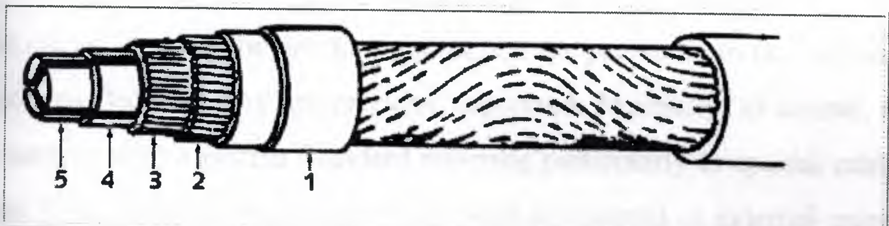
1 - LSF oversheath	
2 - copper sheath	
3 - magnesium oxide insulation	
4 - copper conductors	

g) Consac cables - Fig 2.1h



1 - extruded PVC or polythene oversheath	4 - paper belt insulation
2 - thin layer of bitumen containing a ---- corrosion inhibitor	5 - paper core insulation
3 - extruded smooth aluminium sheath	6 - solid aluminium conductors

h) Waveconal cables - Fig .1i



1 - extruded PVC oversheath
2 - aluminium wires
3 - rubber anti-corrosion bedding
4 - XLPE core insulation
5 - solid aluminium conductors

[Table 52B] gives the maximum conductor operating temperature for the various types of cables. For general purpose p.v.c this is 70°C. Cables with thermosetting insulation can be operated with conductor temperatures up to 90°C **but** since the accessories to which they are connected may be unable to tolerate such high temperatures, operation at 70°C is much more usual. Other values of interest to the electrician are shown in [Table 2.7]. Minimum cross-sectional areas for cables are shown in [Table 2.1].

Table 2.1 - Minimum permitted cross-sectional areas for cables
(from Table 52C of BS 7671: 1992)

type of circuit	*conductor material*	*cross sectional area (mm^2)*
power and lighting circuits	copper	1.0
(insulated conductors)	aluminium	16.0
signalling and control circuits	copper	0.5
flexibles, more than 7 core	copper	0.1
bare conductors and busbars	copper	10.0
-	aluminium	16.0
bare conductors for signalling and control	copper	4.0

2.3.3 - Cables for overhead lines

Any of the cables listed in the previous subsection are permitted to be used as overhead conductors provided that they are properly supported. Normally, of course, the cables used will comply with a British Standard referring particularly to special cables for use as overhead lines. Such cables include those with an internal or external catenary wire, which is usually of steel and is intended to support the weight of the cable over the span concerned.

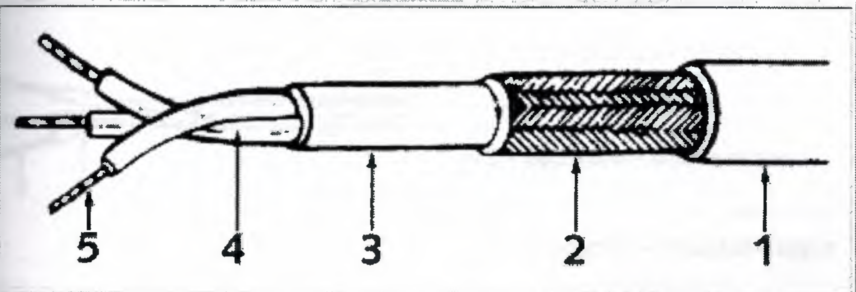
Since overhead cables are to be installed outdoors, they must be chosen and installed so as to offset the problems of corrosion. Since such cables will usually be in tension, their supports must not damage the cable or its insulation. More information on corrosion is given in {2.2.5}

2.2.4 - Flexible low voltage cables and cords

By definition flexible cables have conductors of cross-sectional area 4 mm² or greater, whilst flexible cords are sized at 4 mm² or smaller. Quite clearly, the electrician is nearly always concerned with flexible cords rather than flexible cables.

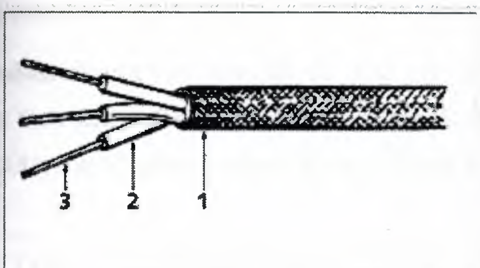
{Figure 2.2} shows some of the many types of flexible cords which are available.

a) Braided circular - Fig 2.2a



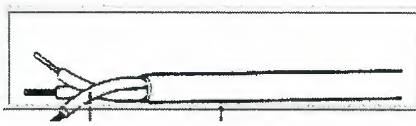
1 - oversheath - PVC	4 - insulation - pvc coloured
2 - braid - plain copper wire	5 - Conductors - plain Copper
3 - inner sheath - pvc	

b) Unkinkable - Fig 2.2b



1 - rubber layer collectively textile braided semi-embedded
2 - insulation (Cores) 60°C rubber
3 -conductors - tinned copper

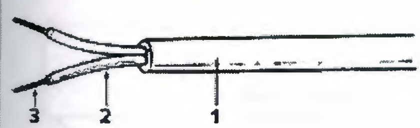
c) Circular sheathed - Fig 2.2c



1 - sheath - rubber or pvc

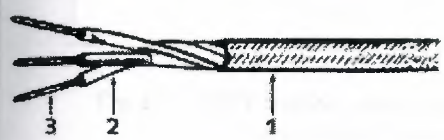
	2 - insulation 60°C rubber or pvc
	3 - conductors - tinned copper

d) Flat twin sheathed - Fig 2.2d



1 - sheath - PVC
2 - insulation - pvc
3 - conductors - plain copper

e) Braided circular insulated with glass fibre - Fig 2.2e



1 - glass braided overall
2 - insulation - silicon rubber
3 - conductors - stranded Copper

f) Single core p.v.c. - insulated non-sheathed - Fig 2.2f

1 - insulation - pvc
2 - conductors - plain copper

Flexible cables should not normally be used for fixed wiring, but if they are, they must be visible throughout their length. The maximum mass which can be supported by each flexible cord is listed in (Table 4H3A), part of which is shown here as (Table 2.2).

Table 2.2 - Maximum mass supported by twin flexible cord

Cross-sectional area (mm^2)	Maximum mass to be supported (kg)
0.5	2
0.75	3
1.0	5
1.25	5
1.5	5

The temperature at the cord entry to luminaires is often very high, especially where filament lamps are used. It is important that the cable or flexible cord used for final entry is of a suitable heat resisting type, such as 150°C rubber- insulated and braided. (Fig 2.3) shows a short length of such cord used to make the final connection to a luminaire.

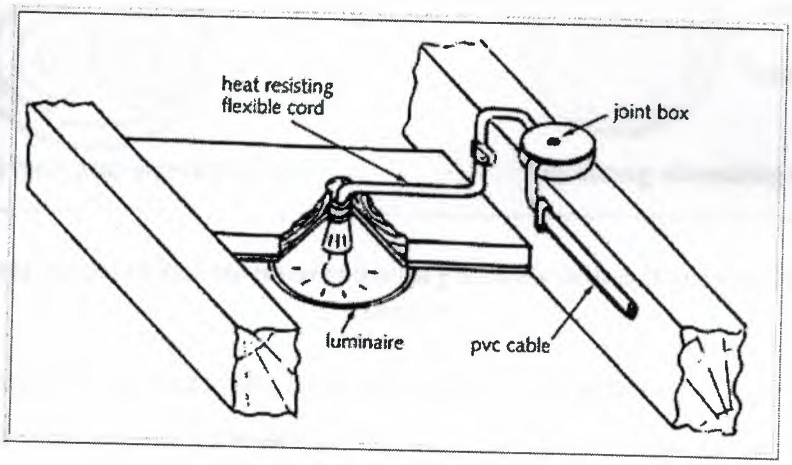


Fig 2.3 - 150°C rubber-insulated and braided flexible cord used for the final connection to a luminaire

2.3.5 Cables carrying alternating currents

Alternating current flowing in a conductor sets up an alternating magnetic field which is much stronger if the conductor is surrounded by an iron-rich material, for example if it is steel wire armoured or if it is installed in a steel conduit. The currents in a twin cable, or in two single core cables feeding a single load, will be the same. They will exert opposite magnetic effects which will almost cancel, so that virtually no magnetic flux is produced if they are both enclosed in the same conduit or armouring. The same is true of three-phase balanced or unbalanced circuits provided that all three (or four, where there is a neutral) cores are within the same steel armouring or steel conduit.

An alternating flux in an iron core results in iron losses, which result in power loss appearing as heat in the metal enclosure. It should be remembered that not only will the heat produced by losses raise the temperature of the conductor, but that the energy involved will be paid for by the installation user through his electricity meter. Thus, it is important that all conductors of a circuit are contained within the same cable, or are in the same conduit if they are single-core types (see {Fig 2.4}).

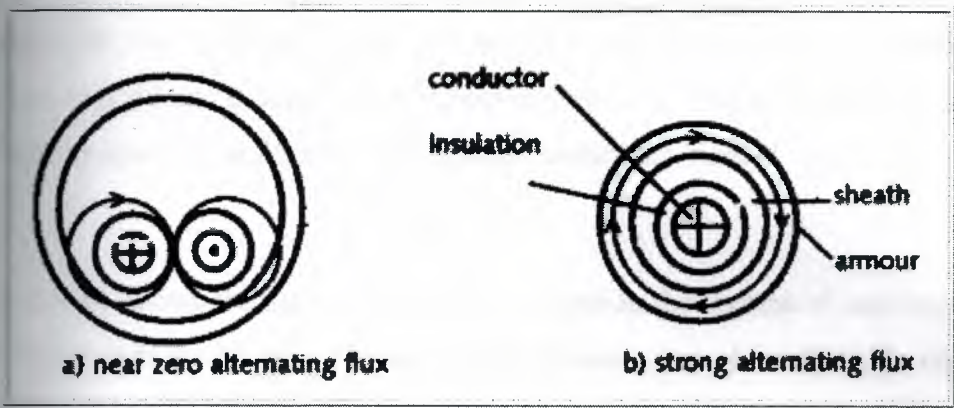


Fig 2.4 Iron losses in the steel surrounding a cable when it carries alternating current

a) twin conductors of the same single-phase circuit - no losses

b) single cone conductor- high losses

A similar problem will occur when single-core conductors enter an enclosure through separate holes in a steel end plate {Fig 2.5}.

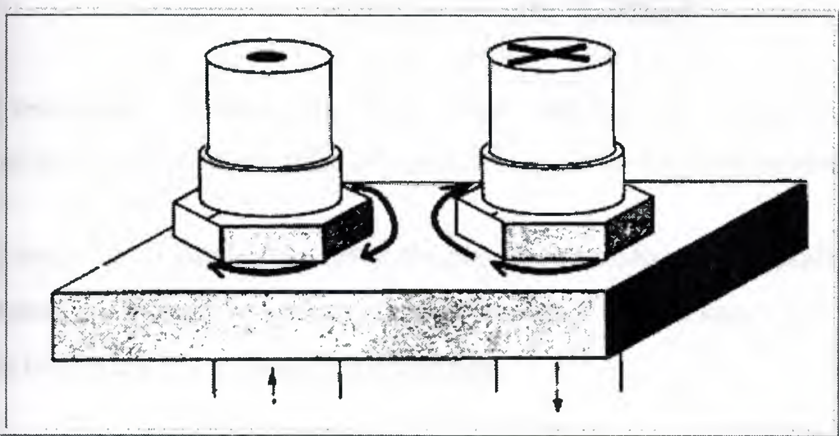


Fig 2.5 Iron losses when single-core cables enter a steel enclosure through separate holes

For this reason, single-core armoured cables should not be used. If the single core cable has a metal sheath which is non-magnetic, less magnetic flux will be produced. However, there will still be induced e.m.f. in the sheath, which can give rise to a circulating current and sheath heating.

If mineral insulated cables are used, or if multi-core cables are used, with all conductors of a particular circuit being in the same cable, no problems will result. The copper sheath is non-magnetic, so the level of magnetic flux will be less than for a steel armoured cable; there will still be enough flux, particularly around a high current cable, to produce a significant induced e.m.f. However, multi-core mineral insulated cables are only made in sizes up to 25 mm² and if larger cables are needed they must be single core.

{Figure 2.6(a)} shows the path of circulating currents in the sheaths of such single core cables if both ends are bonded. {Figure 2.6(b)} shows a way of breaking the circuit for circulating currents.

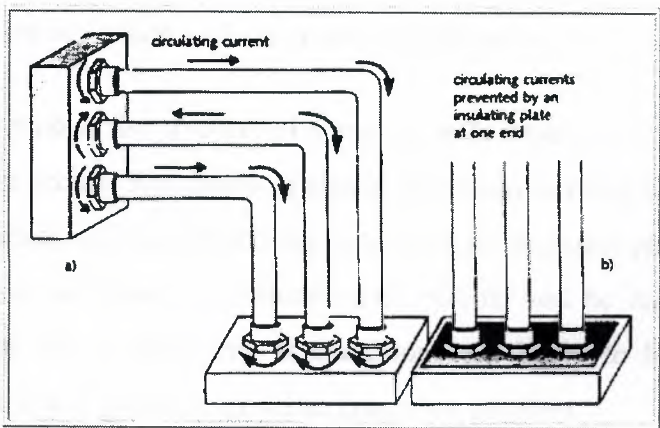


Fig 2.6 Circulating currents in the metal sheaths of single core cables (a) bonded at both ends (b) circulating currents prevented by single point bonding

[523-05-01] calls for all single core cable sheaths to be bonded at both ends unless they have conductors of 70 mm² or greater. In that case they can be single point bonded if they have an insulating outer sheath, provided that:

i) e.m.f. values no greater than 25 V to earth are involved, and
ii) the circulating current causes no corrosion, and
iii) there is no danger under fault conditions.

The last requirement is necessary because fault currents will be many times greater than normal load currents. This will result in correspondingly larger values of alternating magnetic flux and of induced e.m.f.

The metal sheaths and armour of cables, metal conduit and conduit fittings, metal trunking and ducting, as well as the fixings of all these items, are likely to suffer corrosion in damp situations due to chemical or electrolytic attack by certain

materials, unless special precautions are taken. The offending materials include:

1. -unpainted lime, cement and plaster,

2. -floors and dados including magnesium chloride,

3. -acidic woods, such as oak,

4. -plaster undercoats containing corrosive salts,

5. -dissimilar metals which will set up electrolytic action.

In all cases the solution to the problem of corrosion is to separate the materials between which the corrosion occurs. For chemical attack, this means having suitable coatings on the item to be installed, such as galvanising or an enamel or plastic coating. Bare copper sheathed cable, such as mineral insulated types, should not be laid in contact with galvanised material like a cable tray if conditions are likely to be damp. A p.v.c. covering on the cable will prevent a possible corrosion problem.

To prevent electrolytic corrosion, which is particularly common with aluminium-sheathed cables or conduit, a careful choice of the fixings with which the aluminium comes into contact is important, especially in damp situations. Suitable materials are aluminium, alloys of aluminium which are corrosion resistant, zinc alloys complying with BS 1004, porcelain, plastics, or galvanised or sheradised iron or steel

2.4 Cable types

When choosing a cable one of the most important factors is the temperature attained by its insulation (see {2.1.1}); if the temperature is allowed to exceed the upper design value, premature failure is likely. In addition, corrosion of the sheaths or enclosures may result. For example, bare conductors such as busbars may be operated at much higher temperatures than most insulated conductors.

However, when an insulated conductor is connected to such a high temperature system, its own insulation may be affected by heat transmitted from the busbar, usually by conduction and by radiation. To ensure that the insulation is not damaged:

either the operating temperature of the busbar must not exceed the safe temperature for the insulation,

or the conductor insulation must be removed for a suitable distance from the connection with the busbar and replaced with beat resistant insulation (see {Fig 2.7}).

It is common sense that the cable chosen should be suitable for its purpose and for the surroundings in which it will operate. It should not be handled and installed in unsuitable temperatures. P.V.C. becomes hard and brittle at low temperatures, and if a cable insulated with it is installed at temperatures below 5°C it may well become damaged.

[522] includes a series of Regulations which are intended to ensure that suitable cables are chosen to prevent damage from temperature levels, moisture, dust and dirt, pollution, vibration, mechanical stress, plant growths, animals, sunlight or the kind of building in which they are installed. As already mentioned in {3.5.2}, cables must not produce, spread, or sustain fire.

[527-01] contains six regulations which are intended to reduce the risk of the spread of fire and are concerned with choosing cables with a low likelihood of flame propagation (see BS 4066, BS 476, BS EN 50085 and BS EN 50086). A run of bunched cables is a special fire risk and cables in such a situation should comply with the standards stated above.

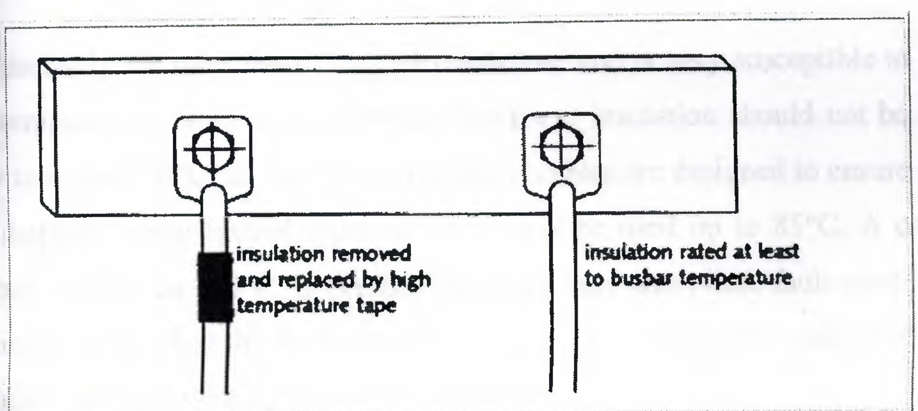


Fig 2.7 Insulation of a cable connected to hot busbar

BS 6387 covers cables which must be able to continue to operate in a fire. These special cables are intended to be used when it is required to maintain circuit integrity for longer than is possible with normal cables. Such cables are categorised with three letters. The first indicates the resistance to fire alone (A,B,C and S) and the second letter is a W and indicates that the cable will survive for a time at 650°C when also subject to water (which may be used to tackle the fire). The third letter (X, Y or Z) indicates the resistance to fire with mechanical shock. For full details of these special cables see the BS.

2.4.1 - Current carrying capacity of conductors

All cables have electrical resistance, so there must be an energy loss when they carry current. This loss appears as heat and the temperature of the cable rises. As it does so, the heat it loses to its surroundings by conduction, convection and radiation also increases. The rate of heat loss is a function of the difference in temperature between the conductor and the surroundings, so as the conductor temperature rises, so does its rate of heat loss.

A cable carrying a steady current, which produces a fixed heating effect, will get hotter until it reaches the balance temperature where heat input is equal to heat loss {Fig 2.8}. The final temperature achieved by the cable will thus depend on the current carried, how easily heat is dissipated from the cable and the temperature of the cable surroundings.

PVC. is probably the most usual form of insulation, and is very susceptible to damage by high temperatures. It is very important that p.v.c. insulation should not be allowed normally to exceed 70°C, so the current ratings of cables are designed to ensure that this will not happen. Some special types of p.v.c. may be used up to 85°C. A conductor temperature as high as 160°C is permissible under very short time fault conditions, on the assumption that when the the fault is cleared the p.v.c. insulation will dissipate the heat without itself reaching a dangerous temperature.

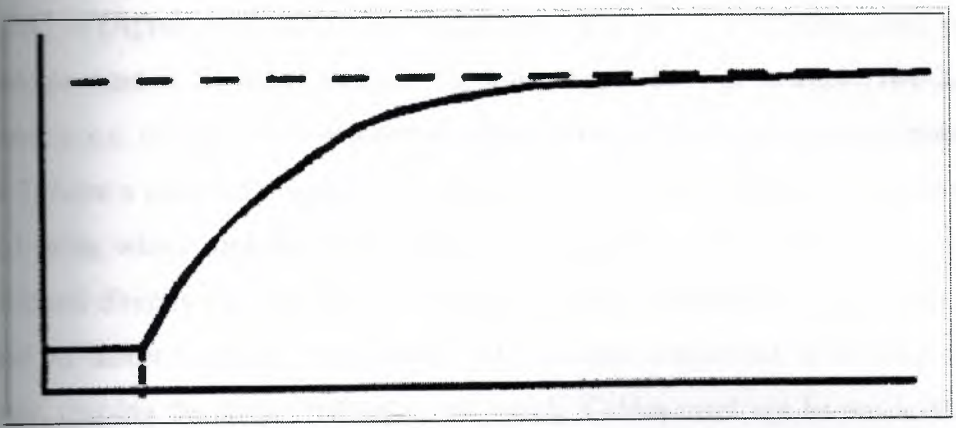


Fig 2.8 Heat balance graph for a cable

A different set of cable ratings will become necessary if the ability of a cable to shed its heat changes. Thus, [Appendix 4] has different Tables and columns for different types of cables, with differing conditions of installation, degrees of grouping and so on. For example, mineral insulation does not deteriorate, even at very high temperatures. The insulation is also an excellent heat conductor, so the rating of such a cable depends on how hot its sheath can become rather than the temperature of its insulation.

For example, if a mineral insulated cable has an overall sheath of LSF or p.v.c., the copper sheath temperature must not exceed 70°C, whilst if the copper sheath is bare and cannot be touched and is not in contact with materials which are combustible its temperature can be allowed to reach 150°C. Thus, a $1mm^2$ light duty twin mineral insulated cable has a current rating of 18.5 A when it has an LSF or p.v.c. sheath, or 22 A if bare and not exposed to touch. It should be noticed that the cable volt drop will be higher if more current is carried [Appendix 4] includes a large number of Tables relating to the current rating of cables installed in various ways.

2.4.2 - Methods of cable installation

We have seen that the rating of a cable depends on its ability to lose the heat produced in it by the current it carries and this depends to some extent on the way the cable is installed. A cable clipped to a surface will more easily be able to dissipate heat than a similar cable which is installed with others in a conduit,

[Table 2A] of [Appendix 4] lists twenty standard methods of installation, each of them taken into account in the rating tables of the same Appendix. For example, two 2.5 mm² single core p.v.c. insulated non-armoured cables drawn into a steel conduit (installation method 3) have a current rating of 24 A {Table 2.6}. A 2.5 mm² twin p.v.c. insulated and sheathed cable, which contains exactly the same conductors, has a current rating of 27 A when clipped directly to anon-metallic surface. Cables sheathed in p.v.c. must not be subjected to direct sunlight, because the ultra-violet component will leach out the plasticiser, causing the sheath to harden and crack. Cables must not be run in the same enclosure (e.g. trunking, pipe or ducting) as non-electrical services such as water, gas, air, etc. unless it has been established that the electrical system can suffer no harm as a result. If electrical and other services have metal sheaths and are touching, they must be bonded. Cables must not be run in positions where they may suffer or cause damage or interference with other systems. They should not, for example, be run alongside hot pipes or share a space with a hearing induction loop.

Special precautions may need to be taken where cables or equipment are subject to ionising radiation. Where a wiring system penetrates a load bearing part of a building construction it must he ensured that the penetration will not adversely affect the integrity of the construction.

The build-up of dust on cables can act as thermal insulation. In some circumstances the dust may be flammable or even explosive. Design cable runs to minimise dust accumulation: run cables on vertically mounted cable ladders rather than horizontal cable trays. When cables are run together, each sets up a magnetic field with a strength depending on the current carried. This field surrounds other cables, so that there is the situation of current-carrying conductors situated in a magnetic field. This will result in a force on the conductor, which is usually negligible under normal conditions but which can become very high indeed when heavy currents flow under fault conditions. All cables and conductors must be properly fixed or supported to prevent damage to them under these conditions.

2.4.3 - Ambient temperature correction factors

The transfer of heat, whether by conduction, convection or radiation, depends on temperature difference - heat flows from hot to cold at a rate which depends on the temperature difference between them. Thus, a cable installed near the roof of a boiler house where the surrounding (ambient) temperature is very high will not dissipate heat as readily as one clipped to the wall of a cold wine cellar.

[Appendix 4] includes two tables giving correction factors to take account of the ability of a cable to shed heat due to the ambient temperature. The Regulations use the symbol Ca to represent this correction factor. The tables assume that the ambient temperature is 30°C and give a factor by which current rating is multiplied for other ambient temperatures.

For example, if a cable has a rating of 24 A and an ambient temperature correction factor of 0.77, the new current rating becomes 24 x 0.77 or 18.5 A. Different values are given depending on whether the circuit in question is protected by a semi-enclosed (rewirable) fuse or some other method of protection. The most useful of the correction factors are given in {Table 2.3}.

In {Table 2.3}, '70°C m.i.' gives data for mineral insulated cables with sheaths covered in p.v.c. or LSF or open to touch, and '105°C m.i.' for mineral insulated cables with bare sheaths which cannot be touched and are not in contact with combustible material. The cable which is p.v.c. sheathed or can be touched must run cooler than if it is bare and not in contact with combustible material, and so has lower correction factors.

Mineral insulated cables must have insulating sleeves in terminations with the same temperature rating as the seals used.

Where a cable is subjected to sunlight, it will not be able to lose heat so easily as one which is shaded. This is taken into account by adding 200°C to the ambient temperature for a cable which is unshaded.

Table 2.3 Correction factors to current rating for ambient temperature ------------ (Ca) (from [Tables 4C1 and 4C2] of BS 7671: 1992)

Ambient temperature	Type of insulation			
(°C)	70°C p.v.c	85°C rubber	70°C m.i	105°C m.i
25	1.03 (1.03)	1.02 (1.02)	1.03 (1.03)	1.02 (1.02)
30	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)

35	0.94 (0.97)	0.95 (0.97)	0.93 (0.96)	0.96 (0.98)
40	0.87 (0.94)	0.90 (0.95)	0.85 (0.93)	0.92 (0.96)
45	0.79 (0.91)	0.85 (0.93)	0.77 (0.89)	0.88 (0.93)
50	0.71 (0.97)	0.80 (0.91)	0.67 (0.86)	0.84 (0.91)
55	0.61 (0.84)	0.74 (0.88)	0.57 (0.79)	0.80 (0.89)
Figures in brackets apply to semi-enclosed fuses used for overload protection				

2.6.4 - Cable grouping correction factors

If a number of cables is installed together and each is carrying current, they will all warm up. Those which are on the outside of the group will be able to transmit heat outwards, but will be restricted in losing heat inwards towards other warm cables. Cables 'buried' in others near the centre of the group may find it impossible to shed heat at all, and will rise further in temperature {Fig 2.9}.

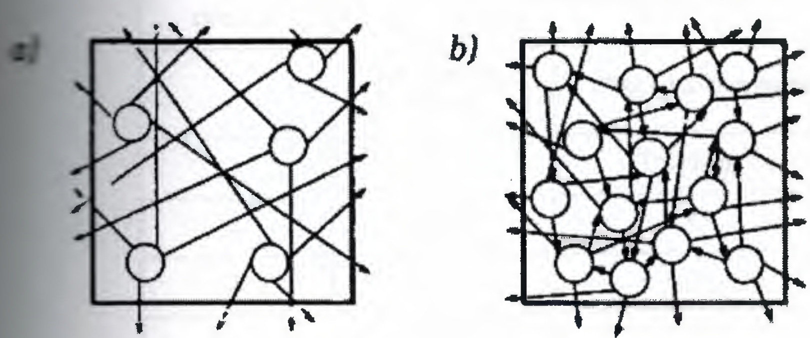


Fig 2.9 The need for the grouping correction factor Cg
a) widely spaced cables dissipate heat easily
b) A closely packed cable cannot easily dissipate heat and so its temperature rises

Because of this, cables installed in groups with others (for example, if enclosed in a conduit or trunking) are allowed to carry less current than similar cables clipped to, or lying on, a solid surface which can dissipate heat more easily. If surface mounted cables are touching the reduction in the current rating is, as would be expected, greater than if they are separated. {Figure 2.9} illustrates the difficulty of dissipating heat in a group of cables.For example, if a certain cable has a basic current rating of 24 A and is installed in a trunking with six other circuits (note carefully, this is circuits and not cables), Cg has a value of 0.57 and the cable current rating becomes 24 x 0.57 or 13.7 A. The symbol Cg is used to represent the factor used for derating cables to allow for grouping. {Table 2.4} shows some of the more useful values of Cg.

The grouping factors are based on the assumption that all cables in a group are carrying rated current. If a cable is expected to carry no more than 30% of its grouped rated current, it can be ignored when calculating the group rating factor. For example, if there are four circuits in a group but one will be carrying less than 30% of its grouped rating, the group may be calculated on the basis of having only three circuits.

The grouping factor may also be applied to the determination of current ratings for cables

Table 2.4 - Correction factors for groups of cables

Number of circuits	Correction factor Cg		
-	Enclosed or clipped	Clipped to non-metallic surface	
-	-	Touching	Spaced*
2	0.80	0.85	0.94
3	0.70	0.79	0.90
4	0.65	0.75	0.90
5	0.60	0.73	0.90
6	0.57	0.72	0.90
7	0.54	0.72	0.90
8	0.52	0.71	0.90
9	0.50	0.70	0.90
10	0.48	----------	0.90

* 'Spaced' means a gap between cables at least equal to cable diameter.

2.4.5 Thermal insulation correction factors

The use of thermal insulation in buildings, in the forms of cavity wall filling, roof space blanketing, and so on. is now standard. Since the purpose of such materials is to limit the transfer of heat, they will clearly affect the ability of a cable to dissipate the heat build up within it when in contact with them,

The cable rating tables of [Appendix 4] allow for the reduced heat loss for a cable which is enclosed in an insulating wall and is assumed to be in contact with the insulation on one side. In all other cases, the cable should be fixed in a position where it is unlikely to be completely covered by the insulation. Where this is not possible and a cable is buried in thermal insulation for 0.5 m (500 mm) or more, a rating factor (the symbol for the thermal insulation factor is Ci) of 0.5 is applied, which means that the current rating is halved.

Table 2.5 - Derating factors (CI) for cables up to 10mm² in cross-sectional ------------ area buried in thermal insulation.

Length in insulation (mm)	Derating factor (CI)
50	0.89
100	0.81
200	0.68
400	0.55
500 or more	0.50

If a cable is totally surrounded by thermal insulation for only a short length (for example, where a cable passes through an insulated wall), the heating effect on the insulation will not be so great because heat will be conducted from the short high-temperature length through the cable conductor. Clearly, the longer the length of cable enclosed in the insulation the greater will be the derating effect. {Table 2.5} shows the derating factors for lengths in insulation of up to 400 mm and applies to cables having cross-sectional area up to 10 mm².

Commonly-used cavity wall fillings, such as polystyrene sheets or granules, will have an adverse effect on p.v.c. sheathing, leeching out some of the plasticiser so that the p.v.c. becomes brittle. In such cases, an inert barrier must be provided to separate the cable from the thermal insulation. PVC cable in contact with bitumen may have some of its plasticiser removed: whilst this is unlikely to damage the cable, the bitumen will become fluid and may run.

2.4.6 When a number of correction factors applies

In some cases all the correction factors will need to be applied because there are parts of the cable which are subject to all of them. For example, if a mineral insulated cable with p.v.c. sheath protected by a circuit breaker and with a tabulated rated current of 34 A is run within the insulated ceiling of a boiler house with an ambient temperature of 45°C and forms part of a group of four circuits, derating will be applied as follows:

Actual current rating (Iz)
= tabulated current (It) x ambient temperature factor(Ca) x group factor (Cg) x thermal insulation factor (Ci)
= 34 x 0.77 x 0.65 x 0.5A = **8.5A**

In this case, the current rating is only one quarter of its tabulated value due to the application of correction factors. A reduction of this sort will only occur when all the correction factors apply at the same time. There are many cases where this is not so. If, for example, the cable above were clipped to the ceiling of the boiler house and not buried in thermal insulation, the thermal insulation factor would not apply.

Then, Iz = It x Ca x Cg = 34 x 0.77 x 0.65 A = **17.0 A**

The method is to calculate the overall factor for each set of cable conditions and then to use the lowest only. For example, if an the way to the boiler house the cable is buried in thermal insulation in the wall of a space where the temperature is only 20°C and runs on its own, not grouped with other circuits, only the carrection factor for thermal insulation would apply. However, since the cable is then grouped with others, and is subject to a high ambient temperature, the factors are:

Ci = 0.5
Ca x Cg = 0.77 x 0.65 = 0.5

The two factors are the same, so either fbut not both) can be applied. Had they been different, the smaller would have been used.

2.4.7 Protection by semi-enclosed (rewirable) fuses

If the circuit concerned is protected by a semi-enclosed (rewirable) fuse the cable size will need to be larger to allow for the fact that such fuses are not so certain in operation as are cartridge fuses or circuit breakers. The fuse rating must never be greater than 0.725 times the current carrying capacity of the lowest-rated conductor protected.

In effect, this is the same as applying a correction factor of 0.725 to all circuits protected by semi-enclosed (rewirable) fuses. The ambient temperature correction factors of {Table 2.3} are larger than those for other protective devices to take this into account.

2.4.8 Cable rating calculation

The Regulations indicate the following symbols for use when selecting cables:

Iz	is the current carrying capacity of the cable in the situation where it is installed
It	is the tabulated current for a single circuit at an ambient temperature of 30°C
Ib	is the design current, the actual current to be carried by the cable
In	is the rating of the protecting fuse or circuit breaker
I2	is the operating current for the fuse or circuit breaker (the current at which the fuse blows or the circuit breaker opens)
Ca	is the correction factor for ambient temperature
Cg	is the correction factor for grouping
Ci	is the correction factor for thermal insulation.

The correction factor for protection by a semi-enclosed (rewirable) fuse is not given a symbol but has a fixed value of 0.725.

Under all circumstances, the cable current carrying capacity must be equal to or greater than the circuit design current and the rating of the fuse or circuit breaker must be at least as big as the circuit design current. These requirements are common sense, because otherwise the cable would be overloaded or the fuse would blow when the load is switched an.

To ensure correct protection from overload, it is important that the protective device operating current (I2) is not bigger than 1.45 times the current carrying capacity of the cable (Iz). Additionally, the rating of the fuse or circuit breaker (In) must not be greater than the the cable current carrying capacity (Iz) It is important to appreciate that the operating current of a protective device is always larger than its rated value. In the case of a back-up fuse, which is not intended to provide overload protection, neither of these requirements applies.

To select a cable for a particular application, take the following steps: (note that to save time it may be better first to ensure that the expected cable for the required length of circuit will] not result in the maximum permitted volt drop being exceeded {2.3.11}).

1. -Calculate the expected (design) current in the circuit (Ib)

2. -Choose the type and rating of protective device (fuse or circuit breaker) to be used (In)

3. -Divide the protective device rated current by the ambient temperature correction factor (Ca) if ambient temperature differs from 30°C

4. - Further divide by the grouping correction factor (Cg)

5. -Divide again by the thermal insulation correction factor (CI)

6. -Divide by the semi-enclosed fuse factor of 0.725 where applicable

7. -The result is the rated current of the cable required, which must be chosen from the appropriate tables {2.6 to 2.9}.

Observe that one should divide by the correction factors, whilst in the previous subsection we were multiplying them. The difference is that here we start with the design current of the circuit and adjust it to take account of factors which will derate the cable. Thus, the current carrying capacity of the cable will be equal to or greater than the design current. In {2.3.7} we were calculating by how much the current carrying capacity was reduced due to application of correction factors.

{Tables 2.6 to 2.9} give current ratings and volt drops for some of the more commonly used cables and sizes. The Tables assume that the conductors and the insulation are operating at their maximum rated temperatures. They are extracted from the Regulations Tables shown in square brackets e.g. [4D1A]

The examples below will illustrate the calculations, but do not take account of volt drop requirements (see {2.3.11}).

Example

An immersion heater rated at 240 V, 3 kW is to be installed using twin with protective conductor p.v.c. insulated and sheathed cable. The circuit will be fed from a 15 A miniature circuit breaker type 2, and will be run for much of its 14 m length in a roof space which is thermally insulated with glass fibre. The roof space temperature is expected to rise to 50°C in summer, and where it leaves the consumer unit and passes through a 50 mm insulation-filled cavity, the cable will be bunched with seven others. Calculate the cross-sectional area of the required cable.

First calculate the design current Ib

Ib= P/u=3000a/240=12.5a

The ambient temperature correction factor is found from {Table 4.3} to be 0.71. The group correction factor is found from {Table 4.4} as 0.52. (The circuit in question is bunched with seven others, making eight in all).

The thermal insulation correction factor is already taken into account in the current rating table (4D2A ref. method 4] and need not be further considered. This is because we can assume that the cable in the roof space is in contact with the glass fibre but not enclosed by it. What we must consider is the point where the bunched cables pass through the insulated cavity. From {Table 4.5} we have a factor of 0.89.The correction factors must now be considered to see if more than one of them applies to the same part of the cable. The only place where this happens is in the insulated cavity behind the consumer unit. Factors of 0.52 (Cg) and 0.89 (CI) apply. The combined value of these (0.463), which is lower than the ambient temperature correction factor of 0.71, and will thus be the figure to be applied. Hence the required current rating is calculated:-

Table 2.7 - Current ratings and volt drops for sheathed multi-core p.v.c.-insulated cables

Cross sectional area	In conduit in thermal insulation	In conduit in thermal insulation	In conduit on wall	In conduit on wall	Clipped direct	Clipped direct	Volt drop	Volt drop
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(mV/A/m)	(mV/A/m)
-	2 core	3 or 4 core	2 core	3 or 4 core	2 core	3 or 4 core	2 core	3 or 4 core
1.0	11.0	10.0	13.0	11.5	15.0	13.5	44.0	38.0
1.5	14.0	13.0	16.5	15.0	19.5	17.5	29.0	25.0
2.5	18.5	17.5	23.0	20.0	27.0	24.0	18.0	15.0
4.0	25.0	23.0	30.0	27.0	36.0	32.0	11.0	9.5
6.0	32.0	29.0	38.0	34.0	46.0	41.0	7.3	6.4
10.0	43.0	39.0	52.0	46.0	63.0	57.0	4.4	3.8
16.0	57.0	52.0	69.0	62.0	85.0	76.0	2.8	2.4

Table 2.6 - Current ratings and volt drops for unsheathed single core p.v.c. insulated cables

Cross sectional area	In conduit in thermal insulation	In conduit in thermal insulation	In conduit on wall	In conduit on wall	Clipped direct	Clipped direct	Volt drop	Volt drop
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(mV/A/m)	(mV/A/m)
-	2 cables	3 or 4 cables	2 cables	3 or 4 cables	2 cables	3 or 4 cables	2 cables	3 or 4 cables
1.0	11.0	10.5	13.5	12.0	15.5	14.0	44.0	38.0
1.5	14.5	13.5	17.5	15.5	20.0	18.0	29.0	25.0
2.5	19.5	18.0	24.0	21.0	27.0	25.0	18..0	15.0
4.0	26.0	24.0	32.0	28.0	37.0	33.0	11.0	9.5

$$I_z = \frac{in}{C_g \times C_i} = \frac{15\ A}{0.52 \times 0.89} = 32.4\ A$$

From {Table 2.7}, 6 mm² p.v.c. twin with protective conductor has a current rating of 32 A. This is not quite large enough, so 10 mm²with a current rating of 43 A is indicated. Not only would this add considerably to the costs, but would also result in difficulties due to terminating such a large cable in the accessories.

A more sensible option would be to look for a method of reducing the required cable size. For example, if the eight cables left the consumer unit in two bunches of four, this would result in a grouping factor of 0.65 (from {Table 2.4}). Before applying this, we must check that the combined grouping and thermal insulation factors (0.65 x 0.89 = 0.58) are still less than the ambient temperature factor of 0.71, which is the case.

Table 2.8 - Current ratings of mineral insulated cables clipped direct

Cross-sectional area	Volt	p.v.c. sheath 2 x single or twin	p.v.c. Sheath 3 core	p.v.c. Sheath 3 x single or twin	Bare sheath 2 x single	Bare sheath 3 x single
(mm^2)		(A)	(A)	(A)	(A)	(A)
1.0	500v	18.5	16.5	16.5	22.0	21.0
1.5	500v	24.0	21.0	21.0	28.0	27.0
2.5	500v	31.0	28.0	28.0	38.0	36.0
4.0	500v	42.0	37.0	37.0	51.0	47.0
1.0	750v	20.0	17.5	17.5	24.0	24.0
1.5	750v	25.0	22.0	22.0	31.0	30.0
2.5	750v	34.0	30.0	30.0	42.0	41.0
4.0	750v	45.0	40.0	40.0	55.0	53.0
6.0	750v	57.0	51.0	51.0	70.0	67.0
10.0	750v	78.0	69.0	69.0	96.0	91.0
16.0	750v	104.0	92.0	92.0	127.0	119.0

Note that in (Tables 2.8 and 2.9) 'P.V.C. Sheath means bare and exposed to touch or having an over-all covering of p.v.c. or LSF and 'Bare' means bare and neither exposed to touch nor in contact with combustible materials.

Table 2.9 - Volt drops for mineral insulated cables

Cross-sectional area	Single-phase p.v.c. Sheath	Single-phase bare	Three-phase p.v.c. Sheath	Three-phase bare

(mm²)	(mV/A/m)	(mV/A/m)	(mV/A/m)	(mV/A/m)
1.0	42.0	47.0	36.0	40.0
1.5	28.0	31.0	24.0	27.0
2.5	17.0	19.0	14.0	16.0
4.0	10.0	12.0	9.1	10.0
6.0	7.0	7.8	6.0	6.8
10.0	4.2	4.7	3.6	4.1
16.0	2.6	3.0	2.3	2.6

This leads to a cable current rating of $\frac{15}{0.65 \times 0.89}$ A = 25.9 A

This is well below the rating for **6 mm²** of 32 A, so a cable of this size could be selected.

2.4.9 Special formulas for grouping factor calculation

In some cases the conductor sizes where cables are grouped and determined by the methods shown in {2.3.9} can be reduced by applying some rather complex formulas given in [Appendix 4].

Whilst it is true that in many cases the use of these formulas will show the installer that it is safe for him to use a smaller cable than he would have needed by simple application of correction factors, this is by no means always the case. There are many cases where their application will make no difference at all. Since this book is for the electrician, rather than for the designer, the rather complicated mathematics will be omitted.

2.4.10 Cable volt drop

All cables have resistance, and when current flows in them this results in a volt drop. Hence, the voltage at the load is lower than the supply voltage by the amount of this volt drop.

The volt drop may be calculated using the basic Ohm's law formula	
U = I x R	
where	U is the cable volt drop (V

	I is the circuit current (A), and
	R is the circuit resistance □(Ohms)

Unfortunately, this simple formula is seldom of use in this case, because the cable resistance under load conditions is not easy to calculate.

[525-01-03] indicates that the voltage at any load must never fall so low as to impair the safe working of that load, or fall below the level indicated by the relevant British Standard where one applies.

[525-01-02] indicates that these requirements will he met if the voltage drop does not exceed 4% of the declared supply voltage. If the supply is single-phase at the usual level of 240 V, this means a maximum volt drop of 4% of 240 V which is 9.6 V, giving (in simple terms) a load voltage as low as 230.4 V. For a 415 V three-phase system, allowable volt drop will be 16.6 V with a line load voltage as low as 398.4 V.

It should be borne in mind that European Agreement RD 472 S2 allows the declared supply voltage of 230 V to vary by +10% or -6%. Assuming that the supply voltage of 240 V is 6% low, and allowing a 4% volt drop, this gives permissible load voltages of 216.6 V for a single-phase supply, or 374.5 V (line) for a 415 V three-phase supply.

To calculate the volt drop for a particular cable we use {Tables 2.6, 2.7 and 2.9}. Each current rating table has an associated volt drop column or table. For example, multicore sheathed non-armoured P.V.C. insulated cables are covered by {Table24.7} for current ratings, and volt drops. The exception in the Regulations to this layout is for mineral insulated cables where there are separate volt drop tables for single- and three-phase operation, which are combined here as {Table 2.9}.

Each cable rating in the Tables of [Appendix 4] has a corresponding volt drop figure in millivolts per ampere per metre of run (mV/A/m). Strictly this should be mV/(A m), but here we shall follow the pattern adopted by BS 7671: 1992. To calculate the cable volt drop:

1.-take the value from the volt drop table (mV/A/m)

2. - multiply by the actual current in the cable (NOT the current rating)

3.-multiply by the length of run in metres

4.divide the result by one thousand (to convert millivolts to volts).

For example, if a 4 mm² p.v.c. sheathed circuit feeds a 6 kW shower and has a length of run of 16 m, we can find the volt drop thus:

From {Table 2.7}, the volt drop figure for 4 mm² two-core cable is 11 mV/A/m.

Cable current is calculated from $I = \frac{P}{U} = \frac{6000}{240} A = 25 A$

Volt drop is then $\frac{11 \times 25 \times 16 V}{1000} = 4.4 V$

Since the permissible volt drop is 4% of 240 V, which is 9.6 V, the cable in question meets volt drop requirements.

For small cables, the self inductance is such that the inductive reactance, is small compared with the resistance. Only with cables of cross-sectional area 25 mm² and greater need reactance be considered. Since cables as large as this are seldom used on work which has not been designed by a qualified engineer, the subject of reactive volt drop component will not be further considered here.

If the actual current carried by the cable (the design current) is less than the rated value, the cable will not become as warm as the calculations used to produce the volt drop tables have assumed, The Regulations include (in [Appendix 4]) a very complicated formula to be applied to cables of cross-sectional area 16 mm² and less which may show that the actual volt drop is less than that obtained from the tables. This possibility is again seldom of interest to the electrician, and is not considered here.

2.4.11 - Harmonic currents and neutral conductors

A perfectly balanced three-phase system (one with all three phase loads identical in all respects) has no neutral current and thus has no need of a neutral conductor. This is often so with motors, which are fed through three core cables in most cases.

Many three-phase loads are made up of single-phase loads, each connected between one line and neutral. It is not likely in such cases that the loads will be identical, so the neutral will carry the out-of-balance current of the system. The greater the degree of imbalance, the larger the neutral current.

Some three-phase four-core cables have a neutral of reduced cross-section on the assumption that there will be some degree of balance. Such a cable must not he used unless the installer is certain that severe out-of-balance conditions will never occur. Similar action must be taken with a three-phase circuit wired in single-core cables. A reduced neutral conductor may only be used where out-of-balance currents will be very small compared to the line currents.

A problem is likely to occur in systems which generate significant third harmonic currents. Devices such as discharge lamp ballasts and transformers on low load distort the current waveform. Thus, currents at three times normal frequency (third harmonics) are produced, which do not cancel at the star point of a three-phase system as do normal frequency currents, but add up, so that the neutral carries very heavy third harmonic currents. For this reason, it is important not to reduce the cross-sectional area of a neutral used to feed discharge lamps (including fluorescent lamps).

In some cases the neutral current may be considerably larger than the phase currents. Where the load concerned is fed through a multi-core cable, it may be prudent to use five-core (or even six-core) cables, so that two (or three) conductors may be used in parallel for the neutral.

In some cases it may be necessary to insert overload protection in a neutral conductor. Such protection must be arranged to open all phase conductors on operation, but not the neutral. This clearly indicates the use of a special circuit breaker.

It is very important that the neutral of each circuit is kept quite separate from those of other circuits. Good practice suggests that the separate circuit neutrals should be connected in the same order at the neutral block as the corresponding phase conductors at the fuses or circuit breakers.

2.4.12 - Low smoke-emitting cables

Normal p.v.c. insulation emits dense smoke and corrosive gases when burning. If cables are to be run in areas of public access, such as schools, supermarkets, hospitals, etc, the designer should consider the use of special cables such as those with thermo-setting or elastomeric insulation which do not cause such problems in the event of fire. This action is most likely to be necessary in areas expected to be crowded, along fire escape routes, and where equipment is likely to suffer damage due to corrosive fumes.

2.4.13 - The effects of animals, insects and plants

Cables may be subject to damage by animals and plants as well as from their environment. Rodents in particular seem to have a particular taste for some types of cable sheathing and can gnaw through sheath and insulation to expose the conductors. Cables impregnated with repellent chemicals are not often effective and may also fall foul of the Health and Safety Regulations. Rodents build nests, often of flammable materials, leading to a fire hazard. Care should be taken to avoid cable installation along possible vermin runs, but where this cannot be avoided, steel conduit may be the answer.

Mechanical damage to wiring systems by larger animals such as cattle and horses can often be prevented by careful siting of cable runs and outlets. Attention must also be given to the fact that waste products from animals may be corrosive. Access by insects is difficult to prevent, but vent holes can be sealed with breathers. Damage by plants is a possible hazard, the effect of tree roots on small lighting columns being an obvious problem area.

2.5 Cable supports and protection

Overall cable diameter (mm)	p.v.c. sheathed		Mineral insulated	
	Horizontal (mm)	Vertical (mm)	Horizontal (mm)	Vertical (mm)
up to 9	250	400	600	800
10 to 15	300	400	900	1200
16 to 20	350	450	1500	2000
21 to 40	400	550	2000	3000

Where cable runs are neither vertical nor horizontal, the spacing depends on the angle as shown in {Fig 2.11}.

Where a cable is flat in cross-section as in the case of a p.v.c. insulated and sheathed type, the overall diameter is taken as the major axis.

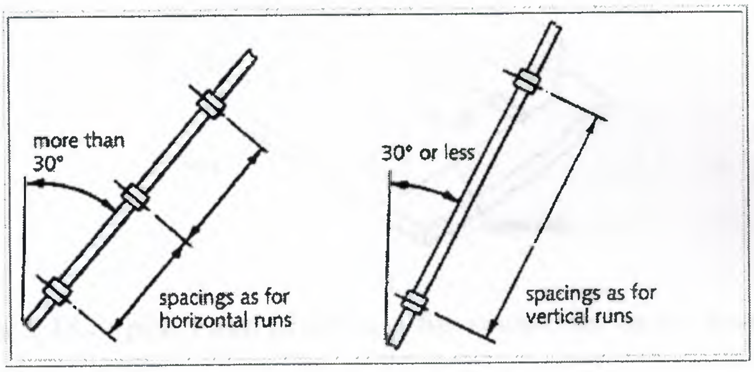
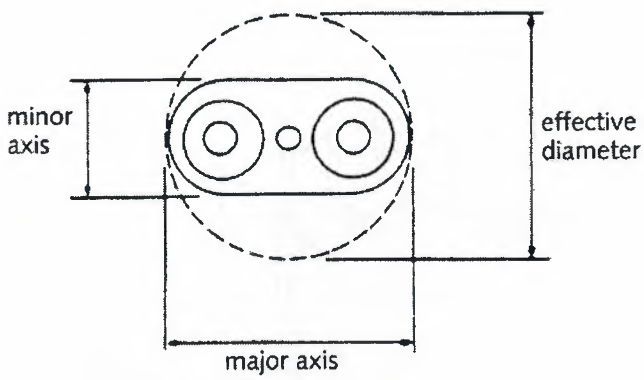


Fig 2.11 Spacing of support clips on angled runs



The Regulations are concerned to protect hidden cables from damage. Thus, where cables are run beneath boarded floors, they must pass through holes drilled in the joists which are at least 50 mm below the top surface of the joist. This is to prevent accidental damage due to nails being driven into the joists. The hole diameters must not exceed one quarter of the depth of the joist and they must be drilled at the joist centre (the neutral axis). Hole centres must be at least three diameters apart, and the holes must only be drilled in a zone which extends 25% to 40% of the beam length from both ends.

An alternative is to protect the cable in steel conduit. It is not practicable to thread rigid conduit through holes in the joists, so the steel conduit may be laid in slots cut in the upper or lower edges as shown in {Fig 2.13}. The depth of the slot must be no greater than one eighth of the joist depth and notches must be in a zone extending from 10% to 25% of the beam length from both ends.

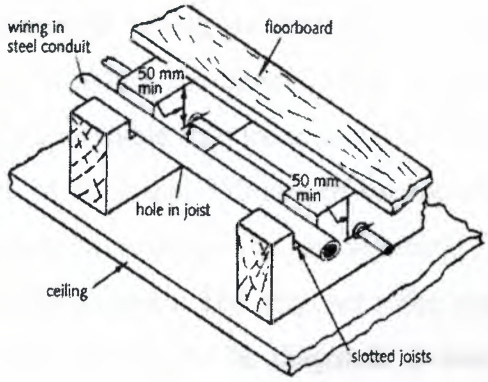
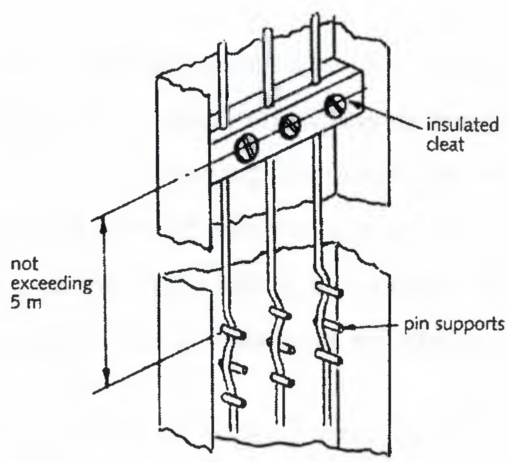
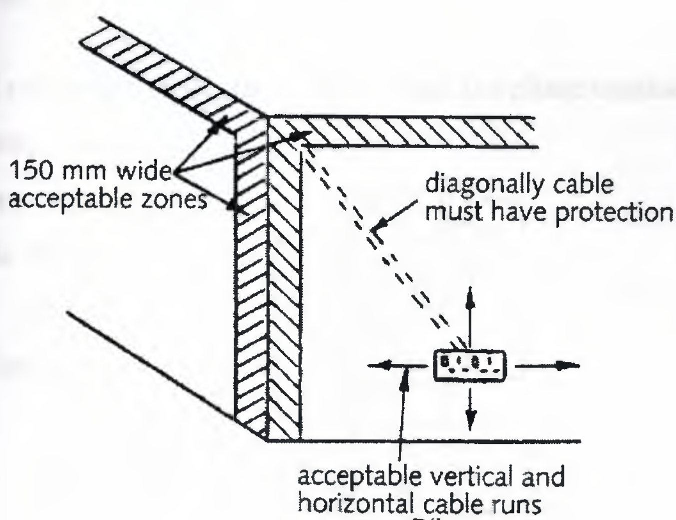


Fig 2.12 Support and protection for cables run under floors



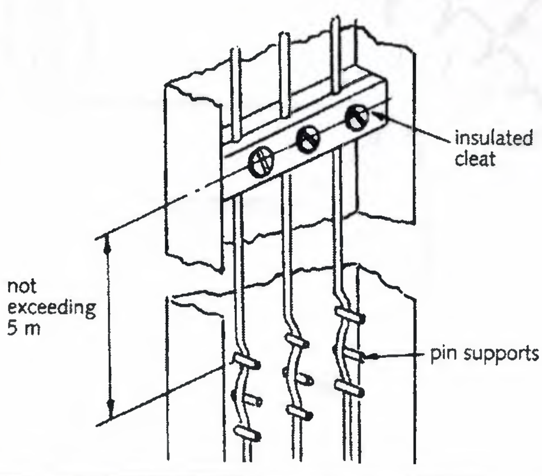


Where cable runs are concealed behind plaster they must he installed in 'acceptable zones' which are intended to reduce the danger to the cables and to people who drill holes or knock nails into walls. Cable runs must only follow paths which are horizontal or vertical from an outlet, or be within 150 mm of the top (but not the bottom) of the wall, or within 150 mm of the angle formed by two adjoining {Fig 2.14} Acceptable installation zones for concealed cables. The diagonal cable must be enclosed in earthed metal walls. Where a cable run has to be diagonal, it must be protected by being enclosed in steel conduit, or must be a cable with an earthed metal sheath (such as mineral insulated cable), or an insulated concentric cable. In this latter case, the phase conductor will be surrounded by the neutral, so that if a nail or a screw penetrates the cable it will be impossible for it to become live. The internal partition walls of some modern buildings are very thin, and where cables complying with the requirements above are within 50 mm of the surface on the other side, they will require protection.

There are cases where cables are enclosed in long vertical runs of trunking or conduit. The weight of the cable run, which effectively is hanging onto the top support, can easily cause damage by compressing the insulation where it is pulled against the support. In trunking there must be effective supports no more than 5 m apart, examples of which are shown in Fig 2.15, whilst for conduit the run must be provided with adaptable boxes at similar intervals which can accommodate the necessary supports.

The top of a vertical conduit or trunking run must have a rounded support to reduce compression of insulation. The diameters required will be the same as those for cable bends given in

.insulated concentric cable. In this latter case, the phase conductor will be surrounded by the neutral, so that if a nail or a screw penetrates the cable it will be impossible for it to become live. The possible zones are shown in (Fig 2.14). The internal partition walls of some modern buildings are very thin,



and where cables complying with the requirements above are within 50 mm of the surface on the other side, they will require protection.

Fig 2.15 Support for vertical cables in trunking

The top of a vertical conduit or trunking run must have a rounded support to reduce compression of insulation. The diameters required will be the same as those for cable bends given in {2.4.2}.

2.5.1 - Cable bends

If an insulated cable is bent too sharply, the insulation and sheath on the inside of the bend will be compressed, whilst that on the outside will be stretched, This can result in damage to the cable as shown in {Fig 2.16}.

The bending factor must be used to assess the minimum acceptable bending radius, values for common cables being given in {Table 2.11}.

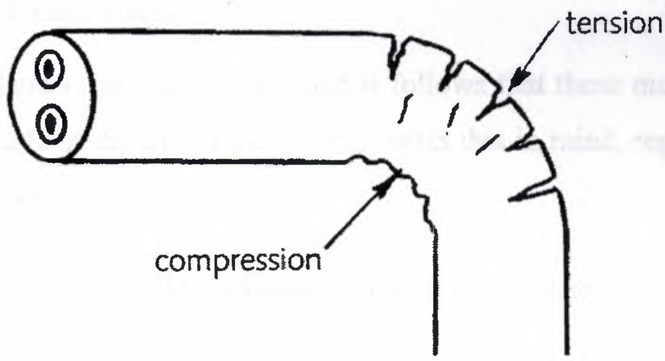


Fig 2.16 Damage to cable insulation due to bending

Type of insulation	*Overall diameter*	*Bending factor*
p.v.c.	Up to 10mm	3 (2)
p.v.c.	10mm to 25mm	4 (3)
p.v.c.	Over 25mm	6
mineral	any	6 *
The figures in brackets apply to unsheathed single-core stranded p.v.c. cables when installed in conduit, trunking or ducting.		
* Mineral insulated cables may be bent at a minimum radius of three cable diameter provided that they will only be bent once. This is because the copper sheath will 'work harden' when bent and is likely to crack if straightened and bent again.		

Table 2.11 Bending factors for common cables

The figures in brackets apply to unsheathed single-core stranded p.v.c. cables when installed in conduit, trunking or ducting.

* Mineral insulated cables may be bent at a minimum radius of three cable diameter provided that they will only be bent once. This is because the copper sheath will 'work harden' when bent and is likely to crack if straightened and bent again.

The factor shown in the table is that by which the overall cable diameter {Fig 4.12} must be multiplied to give the minimum inside radius of the bend. For example, 2.5 mm^2 twin with protective conductor sheathed cable has a cross-section 9.7 mm x 5.4 mm. Since the Table shows a factor of 3 for this size, the minimum inside radius of any bend must be 3 x 9.7 = 29.1 mm.

2.5.2 - Joints and terminations

The normal installation has many joints, and it follows that these must all remain safe and effective throughout the life of the system. With this in mind, regulations on joints include the following:

1. -All joints must be durable, adequate for their purpose, and mechanically strong.

2. -They must be constructed to take account of the conductor material and insulation, as well as temperature: eg, a soldered joint must not be used where the temperature may cause the solder to melt or to weaken. Very large expansion forces are not uncommon in terminal boxes situated at the end of straight runs of large cables when subjected to overload or to fault currents.

3. - All joints and connections must be made in an enclosure complying with the appropriate British Standard.

4. - Where sheathed cables are used, the sheath must be continuous into the joint enclosure {Figure 2.17}.

5.-All joints must be accessible for inspection and testing unless they are buried in compound or encapsulated, are between the cold tail and element of a heater such as a pipe tracer or underfloor heating system, or are made by soldering, welding, brazing or compression

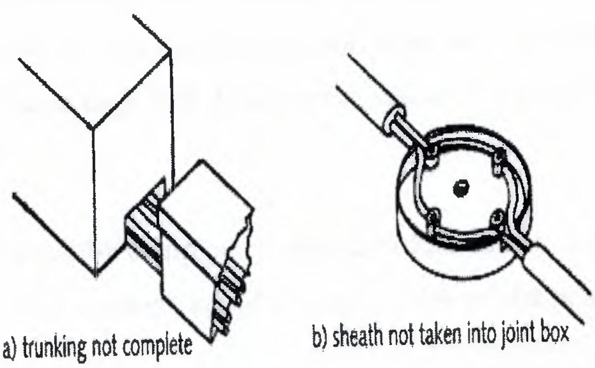


Fig 2.17 Failure to enclosenon-sheathed cables

2.6 conduits

2.6.1 - Plastic and metal conduits

A system of conduits into which unsheathed cables can be drawn has long been a standard method for electrical installations. The Regulations applying to conduit systems may be summarised as follows:

1. - All conduits and fittings must comply with the relevant British Standards.

2. -Plastic conduits must not be used where the ambient temperature or the temperature of the enclosed cables will exceed 60°C. Cables with thermo-setting insulation are permitted to run very hot, and must be suitably down-rated when installed in plastic conduit. To prevent the spread of fire, plastic conduits (and plastic trunking) must comply with ignitability characteristic 'P' of ES 476 Part 5.

3. -Conduit systems must be designed and erected so as to exclude moisture, dust and dirt. This means that they must be completely closed, with box lids fitted. To ensure that condensed moisture does not accumulate, small drainage holes must be provided at the lowest parts of the system.

4. - Proper precautions must be taken against the effects of corrosion (see {4.2.5}), as well as against the effects of flora (plant growths) and fauna (animals). Protection from rusting of steel conduit involves the use of galvanised (zinc coated) tubing, and against electrolytic corrosion the prevention of contact between dissimilar metals eg steel and aluminium. Any additional protective conductor must be run inside the conduit or its reactance is likely to be so high that it becomes useless if intended to reduce fault loop impedance.

5. - A conduit system must be completely erected before cables are drawn in. It must be free of burrs or other defects which could damage cables whilst being inserted.

6. - The bends in the system must be such that the cables drawn in will comply with the minimum bending radius requirements

7. - The conduit must be installed so that fire cannot spread through it, or through holes cut in floors or walls to allow it to pass. This subject of fire spread will be considered in greater detail in {2.5.2}

- Allowance must be made, in the form of expansion loops, for the thermal expansion of long runs of metal or plastic conduit. Remember that plastic expands and contracts more than steel.

- Use flexible joints when crossing building expansion joints

Table 2.12 - Maximum spacing of supports for conduits				
Conduit diameter	*Rigid metal (m)*		*Rigid insulating (m)*	
(mm)	*Horizontal*	*Vertical*	*Horizontal*	*Vertical*
Up to 16	0.75	1.0	0.75	1.0
16 to 25	1.75	2.0	1.5	1.75
25 to 40	2.0	2.25	1.75	2.0
Over 40	2.25	2.5	2.0	2.0

2.6.2 - Ducting and trunking

Metal and plastic trunkings are very widely used in electrical installations. They must be manufactured to comply with the relevant British Standards, and must be installed so as to ensure that they will not be damaged by water or by corrosion (see {4.2.5}).

Table 2.13 Support spacings for trunking				
Typical trunking size	*Metal*		*Insulating*	
(mm)	*Horizontal*	*Vertical*	*Horizontal*	*Vertical*
Up to 25 x 25	0.75	1.0	0.5	0.5
Up to 50 x 25	1.25	1.5	0.5	0.5
Up to 50 x 50	1.75	2.0	1.25	1.25
Up to 100 x 50	3.0	3.0	1.75	2.0

If it is considered necessary to provide an additional protective conductor in parallel with steel trunking, it must be run inside the trunking or the presence of steel between the live and protective cables will often result in the reactance of the protective cable being so high that it will have little effect on fault loop impedance. Trunking must be supported as indicated in {Table 4.13}. The table does not apply to special lighting trunking which is provided with strengthened couplers. Where crossing a building expansion joint a suitable flexible joint should be included.

Where trunking or conduit passes through walls or floors the hole cut must be made good after the first fix on the construction site to give the partition the same degree of fire protection it had before the hole was cut. Since it is possible for fire to spread through the interior of the trunking or conduit, fire barriers must be inserted as shown in {Fig 4.18}. An exception is conduit or trunking with a cross-sectional area of less than 710 mm^2, so that conduits up to 32 mm in diameter and trunking up to 25 mm x 25 mm need not be provided with fire barriers. During installation, temporary fire barriers must be provided so that the integrity of the fire prevention system is always maintained.

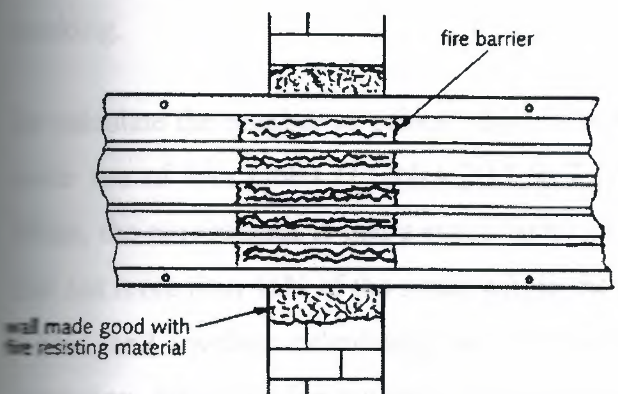


Fig 2.18 Provision of fire barriers in ducts and trunking

Since trunking will not be solidly packed with cables (see {4.5.3}) there will be room for air movement. A very long vertical trunking run may thus become extremely hot at the top as air heated by the cables rises; this must be prevented by barriers as shown in {Fig 4.19}. In many cases the trunking will pass through floors as it rises, and the fire stop barriers needed will also act as barriers to rising hot air.

Lighting trunking is being used to a greater extent than previously In many cases, it includes copper conducting bars so that luminaires can be plugged in at any point, especially useful for display lighting.

The considerably improved life, efficiency and colour rendering properties of extra-low voltage tungsten halogen lamps has led to their increasing use, often fed by lighting trunking. It is important here to remember that whilst the voltage of a 12 V lamp is only one twentieth of normal mains potential, the current for the same power inputs will be twenty times greater. Thus, a trunking feeding six 50 W 12 V lamps will need to he rated at 25 A.

2.6.3 - Cable capacity of conduits and trunking

Not oflly must it be possible to draw cables into completed conduit and trunking systems, but neither the cables nor their enclosures must be damaged in the process. If too many cables are packed into the space available, there will be a greater increase in temperature during operation than if they were given more space. It is important to appreciate that grouping factors (see {4.3.5}) still apply to cables enclosed in conduit or trunking.

To calculate the number of cables which may be drawn into a conduit or trunkmg, we make use of four tables ({Tables 2.14 to 2.17}). For situations not covered by these tables, the requirement is that a space factor of 45% must not be exceeded. This means that not more than 45% of the space within the conduit or trunkmg must be occupied by cables, and involves calculating the cross-sectional area of each cable, including its insulation, for which the outside diameter must be known. The cable factors for cables with thermosetting insulation are higher than those for pvc insulation when the cables are installed in trunking, but the two are the same when drawn into conduit (see {Table 2.14})

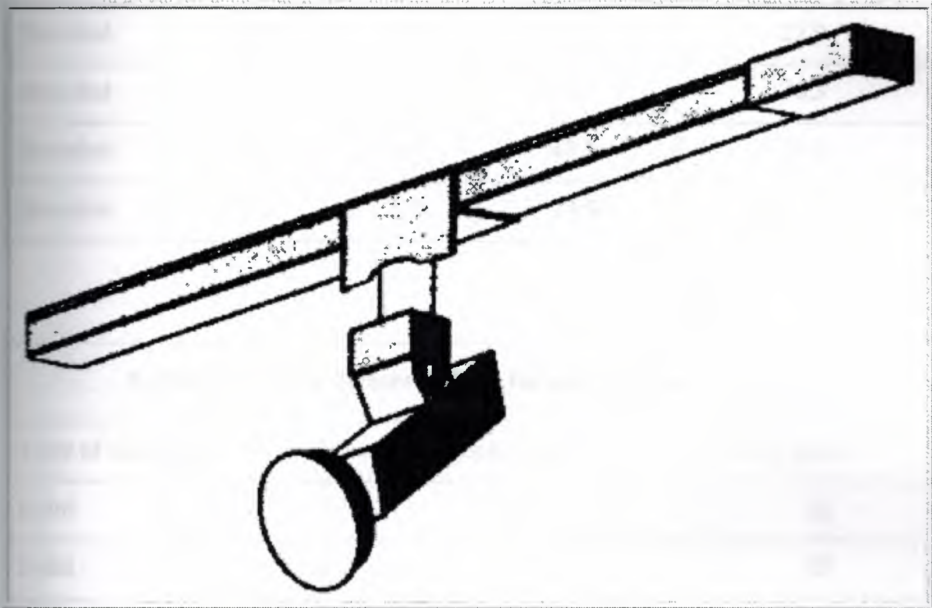


Fig 2.20 Low voltage luminaire on lighting trunking

The figures in {Table 2.14} may be high when applied to some types of plastic trunking due to the large size of the internal lid fixing clips.

To use the ({Tables 2.14 to 2.17}). the cable factors for all the conductors must be added. The conduit or trunking selected must have a factor (otherwise called 'term') at least as large as this number,

Example

The following single-core p.v.c. insulated cables are to be run in a conduit 6 m long with a double set: 8 x 1,4 x 2.5 and 2 x 6 mm². Choose a suitable size.

Table 2.14 - Cable factors (terms) for conduit and trunking

Type of conductor	Conductor c.s.a. (mm²)	Factor for conduit	Factor for trunking pvc insulation	Factor for trunking thermosetting insulation
Solid	1.0	16	3.6	3.8
Solid	1.5	22	8.0	8.6
Stranded	1.5	22	8.6	9.1
Solid	2.5	30	11.9	11.9
Stranded	2.5	30	12.6	13.9
Stranded	4.0	43	16.6	18.1

Stranded	6.0	58	21.2	22.9
Stranded	10.0	105	35.3	36.3
Stranded	16.0	145	47.8	50.3
Stranded	25.0	217	73.9	75.4

Table2.15 - Cable factors (terms) for straight runs up to 3m.		
Type of conductor	Conductor c.s.a. (mm^2)	Cable factor
Solid	1.0	22
Solid	1.5	27
Solid	2.5	39
Stranded	1.5	31
Stranded	2.5	43
Stranded	4.0	58
Stranded	6.0	88
Stranded	10.0	146

Table 2.16 - Conduit factors (terms)								
	Length of run between boxes (m)							
	1	2	3	4	5	6	8	10
Conduit, straight	-							
16mm	290	290	290	171	171	167	158	150
20mm	460	460	460	286	278	270	256	244
25mm	800	800	800	514	500	487	463	442
32mm	1400	1400	1400	900	878	857	818	783
Conduit, one bend	-							
16mm	188	177	167	158	150	143	130	120
20mm	303	286	270	256	244	233	213	196
25mm	543	514	487	463	442	422	388	258

32mm	947	900	857	818	783	750	692	643
Conduit, two bends	-							
16mm	177	158	143	130	120	111	97	86
20mm	286	256	233	213	196	182	159	141
25mm	514	463	422	388	358	333	292	260
32mm	900	818	750	692	643	600	529	474
For 38mm conduit use the 32mm factor x 1.4. For 50mm conduit use the 32mm factor x 2.6. For 63mm conduit use the 32mm factor x 4.2.								

Table 2.17 Trunking factors (terms)

Dimensions of trunking (mm x mm)	*Factor*
37.5 x 50	767
50 x 50	1037
25 x 75	738
37.5 x 75	1146
50 x 75	1555
75 x 75	2371
25 x 100	993
37.5 x 100	1542
50 x 100	2091
75 x 100	3189
100 x 100	4252

Consulting {Table 2.14} gives the following cable factors:

16 for 1 mm^2, 30 for 2.5 mm^2 and 58 for 6 mm^2

Total cable factor is then $(8 \times 16) + (4 \times 30) + (2 \times 58)$

$= 128 + 120 + 116 = 364$

The term "bend" means a right angle bend or a double set.

{Table 2.16} gives a conduit factor for 20 mm conduit 6 m long with a double as 233, which is less than 364 and thus too small. The next size has a conduit factor of 422 which will be acceptable since it is larger than 364.

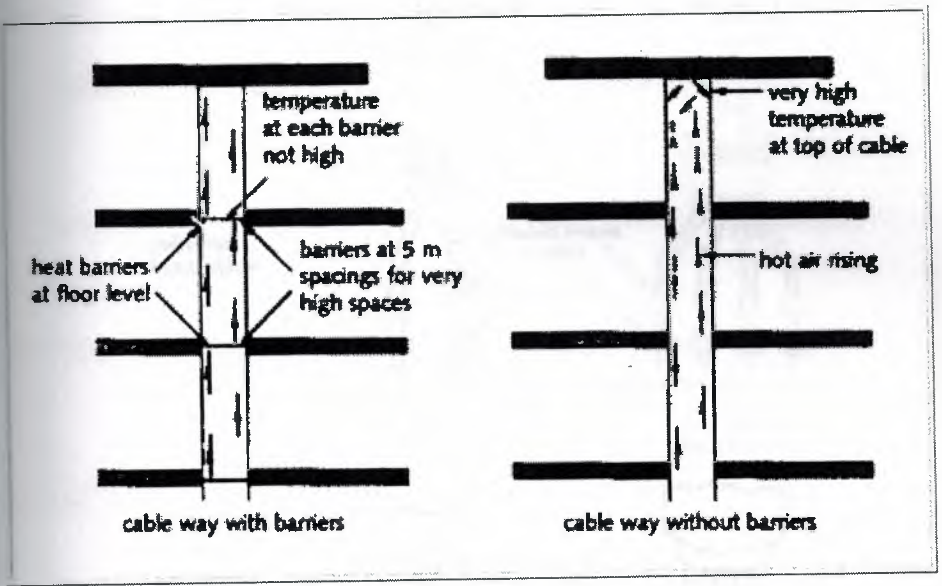


Fig 2.19 Heat barriers provided in vertical cable ways

2.7. conductors

The 'electrical' colour to distinguish conduits from pipelines of other services is orange (BS 1710). Oversheaths for mineral insulated cables are often the same colour, which is also used to identify trunking and switchgear enclosures.

2.7.1 - Identification of fixed wiring conductors

Colour is used to identify the conductors of a wiring system where it is possible to colour the insulation. Where it is not, numbers are used. The requirements for identification of fixed wiring are shown in {Fig 2.21}. There is as yet no requirement to use brown and blue to identify the phase and neutral conductors of fixed wiring, although this applies to flexible cords and cables (see {2.6.3}. The colour green on its own is prohibited, although green and yellow stripes identify the protective conductor. The functional earth conductor for telecommunication circuits is identified by the colour cream.

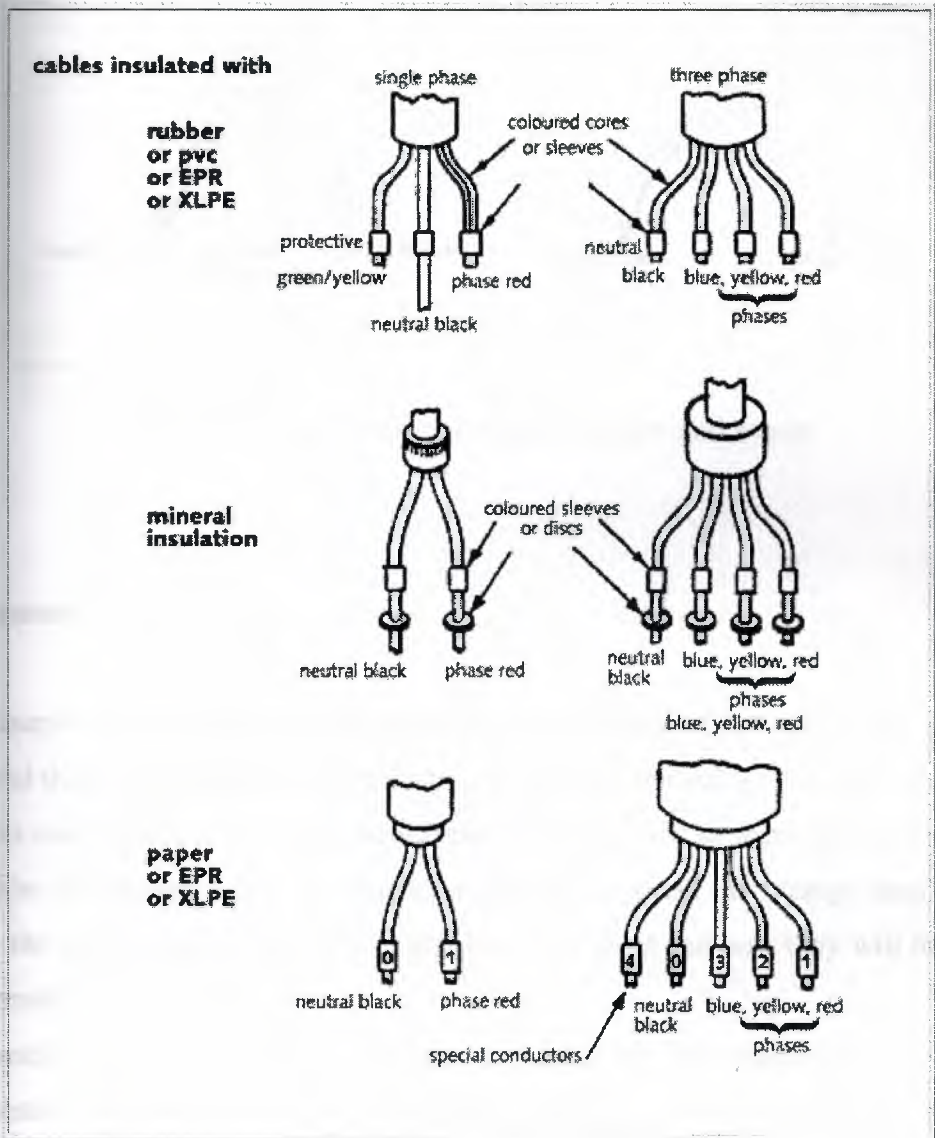


Fig 2.21 Identification of fixed wiring

Some cables comply with HD 324:1977 and have blue insulation on the neutral conductor. This colour does not comply with BS 7671 and if such cables are used, they must be correctly identified at their terminations by the use of black cable markers or black tape.

2.7.2 -Colours for flexible cables and cords

Unlike the cores of fixed cables, which may be identified by sleeves or tapes where they are connected, flexibles must be identified throughout their length. The colour requirements are shown in {Fig 2.22}.

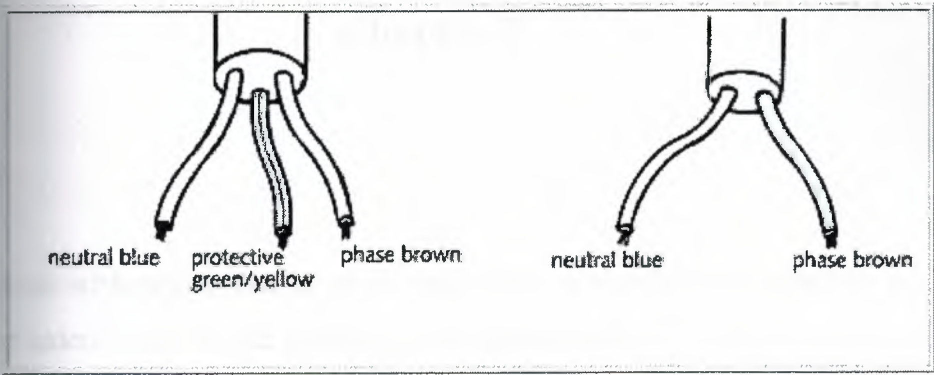


Fig 2.22 Care colours for flexible cables and cords

2.8 Summary

In this chapter we have seen the cables and the way it is planed for installation in fennel nature and their types and sizes, their insulation and how the voltage drop is calculated . And their coarse and how is the current types will be carried in them and how we have to consider the heating while the current is passing thru and the voltage drop and we will see the cables support and protect and how they bend and how they will be placed in the conduits.

Our dissection in this chapter was contented around, cable size, their colures and cores, encapsulation method of wiring, types of cable insulation, voltage drop, consideration, cores section areas, their current carrying capacity, certain loss due to the type of encapsulation effect of ambient temperature on the cable examples of calculation methods, protection factors and various tables showing the current carrying capacity voltage drop and growing effect of the conductors, considerable attention also was given to the methods of supports of the cables, bending and protection that is suffusing under the floors.

Some procedures that are common for the electrical installation but are not used in this project are also discussed for reference purports.

Chapter 3

3.1 Overview

This chapter deals with project that has been defined as an example incorporates the electrical and luminance calculations of the building. Each quarter has been taken individually in the calculation of their cables, power references of the appliances the small power defaults the other quarters. in the calculation the voltage drop also considered for all cables .
In the drawing the 4 story building have 2 similar quarters together with their electrical installations , the small power defaults heater ,washing machine, power distribution boards are also shown. In the text all the points are included for the calculation purposes.

3.2 Ground floor

3.2.1 first Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and two heaters will be separately planed because of the saving a voltage drop

3.2.1.1 power main rings

since we have two main rings we will calculate them separately

3.2.1.1.1 main ring one

cable length is 18.63 m and we have 8 single sockets and 1 doubled we will consider .5 m for every one as a default from the floor to it

9x.5=4.5m

4.5+18.64=23.13 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

23.13x.O15x13=4.51O35 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2,5% =6 v

and our voltage drop for this ring is 4.51O35 v so it is acceptable

1.2 main ring two

cable length is 22.38 m and we have 4 single sockets and 3 doubled we will consider .5 m for every one as a default from the floor to it

7x.5=3.5 m

so total length is 22.38 + 3.5 =25.88 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

25.88x.015x13=5.0466 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

so our voltage drop for this ring is 4.51035 v so it is acceptable

1.2 power to light circuit

here we r going to calculate the voltage drop too and we have two power lightning circuits in radial type.

1.2.1 light circuit one

here we r going to calculate the voltage drop too

cable length is 9.87 and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 14 .87 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

14.87x.018x13=3.47958 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.47958 v so it is acceptable

1.2.2 light circuit two

cable length is 9.79 and we have 8 switches and we will consider for them 1.25 m default so total length = 19.79 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

19.79x.018x13=4.63086 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 4.63086 v so it is acceptable

3.2.1.3 power to heater circuit

we have two heaters so we will consider each alone since every one have a separate line in radial circuit.

3.2.1.3.1 heater circuit one

cable length is 2.35 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the ground floor we will consider 12 m till the roof and 3 m till the water tank

total length =18.6 m

and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

18.6x.OO6x28= 3.1248 v

and as it is known from the regulation till 2.5 % voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.1248 v so it is acceptable

3.2.1.3.2 heater circuit two

cable length is 6.35 we have 1 switches and we will consider for them 1.25 m default and since her we are on the ground floor we will consider 12 m till the roof and 3 m till the water tank

total length =22.6 m

and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

22.6x.006x28=3.7968 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240x2.5 % =6 v

and our voltage drop for this circuit is 3.7968 v so it is acceptable

2.2.1.4 cooker circuit

the cooker circuit is a radial type with cable length is 4 m we have 1 switches and we will consider for them 1.25 m default

so total length will be 5.25

and since we are going to use a 6 mille miter square cable it s voltage drop is .OO6 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

5.25x.OO6x28=.882 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is .882 v so it is acceptable

2.2.1.5 water motor

this is a radial type with cable length is .4 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the ground floor we will consider it 8 m

total length = 9.65 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

9.65x.O18x22=3.8214 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.8214 v so it is acceptable

3.2.1.6 washing machine

washing machine circuit is a radial type with cable length is 4.16 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .

total length = 5.41 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

5.41x.OO9x22=1.07118v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.907118 v so it is acceptable

3.2.2 second Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and one heaters will be

3.2.2.1 main rings

since we have two main rings we will calculate them separately

3.2.2.1.1 main ring one

cable length is 22.33 m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it so 8x.5=4 m

total length=4+22.23=26.33 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

26.33x.O15x13=5.13435 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 5.13435 v so it is acceptable

3.2.1.2 main ring two

cable length is 23.95m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it

8x.5=4 m

23.95 + 4 =27.95 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

27.95x.015x13=4.67O25v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 4.67O25v so it is acceptable

3.2.2 power to light circuit

here we r going to calculate the voltage drop too and we have two power lightning circuits since they are in radial circuit.

3.2.2.1 light circuit one

cable length is 12.8O and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 17.8O m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

17.8Ox.O18x13=4.1654 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 4.1654 v so it is acceptable

3.2.2.2 light circuit two

cable length is 3.7 and we have 4 switches and we will consider for them 1.25 m default

4x1.25=5 so total length = 8.7

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

8.7x.018x13=2.0358 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 2.0358 v it is acceptable

3.2.2.3 Power to heater circuit

the heater circuit will be a radial type with cable length is 3.53 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the ground floor we will consider 12 m till the roof and 3 m till the water tank

total length =19.78

and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

19.78x.OO6x28= 3.323O4 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.323O4 v so it is acceptable

3.2.2.4 cooker circuit

the cooker circuit will be a radial type with cable length is 4 m we have 1 switches and we will consider for them 1.25 m default

so total length will be 5.25 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

5.25x.OO9x22=1.0395 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v
and our voltage drop for this circuit is 1.0395 v so it is acceptable

3.2.2.5 water motor

it will be a radial circuit type with cable length is .2 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the ground floor we will consider it 19.8 m
total length = 21.25 m
and since we are going to use a 1.5 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be
cable length x voltage drop x full current will be carried by it
21.25 x.O18x13=4.725
and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable
240 x 6% =6 v
and our voltage drop for this circuit is 4..725v so it is acceptable
and as we mentioned before the other two quarters are similar to the two before.

3.2.2.6Washing machine circuit

the washing machine circuit is a radial type with cable length is 3.53 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .
total length = 4.78 m
and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be
cable length x voltage drop x full current will be carried by it
4.78x.OO9x22=.094644
and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable
240 x 2.5% =6 v
and our voltage drop for this circuit is .94644 v so it is acceptable

3.3 second floor

3.3.1 first Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and two heaters will be separately planed because of the safety a voltage drop

power main rings

since we have two main rings we will calculate them separately

1 main ring one

cable length is 18.63 m and we have 8 single sockets and 1 doubled we will consider .5 m for every one as a default from the floor to it

9x.5=4.5m

4.5+18.64=23.13 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

23.13x.015x13=4.51035 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 4.51035 v so it is acceptable

1.2 main ring two

cable length is 22.38 m and we have 4 single sockets and 3 doubled we will consider .5 m for every one as a default from the floor to it

7x.5=3.5 m

22.38 + 3.5 =25.88 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

25.88x.015x13=5.0466 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 4.51O35 v so it is acceptable

3.3.1.2 power to light circuit

and we are going to calculate the voltage drop too and we have two power lightning circuits in this type.

3.3.1.2.1 light circuit one

and we are going to calculate the voltage drop too for this circuit with cable length is 9.87 and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 14 .87 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

14.87x.O18x13=3.47958 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 6% =6 v

and our voltage drop for this circuit is 3.47958 v so it is acceptable

3.3.1.2.2 light circuit two

cable length is 9.79 and we have 8 switches and we will consider for them 1.25 m default

8x1.25=10 so total length = 19.79 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

19.79x.O18x13=4.63086 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 4.63086 v so it is acceptable

3.3.1.3 power to heater circuit

...two heaters in a radial circuit and we will consider each alone since every one have a ...e line.

...1 heater circuit one

...length is 2.35 and we have 1 switches and we will consider for them 1.25 m default and ...ce we are on the second floor we will consider 9 m till the roof and 3 m till the water ...k.

...length =15.6 m

...since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage ...drop and it carries 28 A so the voltage drop will be

...cable length x voltage drop x full current will be carried by it

...x.006x28= 2.62O8 v

...as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

...x 2.5% =6 v

...our voltage drop for this circuit is 2.1168 v so it is acceptable

...3.2 heater circuit two

...cable length is 6.35 we have 1 switches and we will consider for them 1.25 m default and ...since her we are on the second floor we will consider 9 m till the roof and 3 m till the water ...tank

...total length =19.6 m

...and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage ...drop and it carries 28 A so the voltage drop will be

...cable length x voltage drop x full current will be carried by it

...x.OO6x28=3.2928 v

...and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

...240 x 2.5% =6 v

...and our voltage drop for this circuit is 3.2928 v so it is acceptable

3.3.1.4 cooker circuit

This circuit is a radial type with cable length 4 m we have 1 switches and we will consider for them 1.25 m default

total length will be 5.25 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

5.25x.009x22=1.0395

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.0395 v so it is acceptable

3.3.1.5 water motor

This circuit is a radial circuit with cable length is .4 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the second floor we will consider it 11 m

total length = 12.65 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

12.65x.O18x13=2.9601

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 6% =14.4 v

and our voltage drop for this circuit is 2.9601 v so it is acceptable

3.3.1.6 washing machine circuit

The washing machine circuit is a radial type with cable length is 4.16 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .

total length = 5.41 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

[illegible].009x22=1.07118

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

[illegible] x 2.5% =6 v

and our voltage drop for this circuit is 1.907118 v so it is acceptable

3.3.2 second Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and one heaters will be

3.3.2.1 main rings

since we have two main rings we will calculate them separately

3.3.2.1.1 main ring one

cable length is 22.33 m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it so 8x.5=4 m

total length=4+22.23=26.33 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

26.33x.O15x13=5.13435 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 6% =6 v

and our voltage drop for this ring is 5.13435 v so it is acceptable

3.3.2.1.2 main ring two

cable length is 23.95m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it

8 x .5=4 m

23.95 + 4 =27.95 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

23.95x.O15x13=4.67O25v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 6% =6 v

and our voltage drop for this ring is 4.67O25v so it is acceptable

3.3.2.2 power to light circuit

here we are going to calculate the voltage drop too and we have two power lightning circuits in a radial circuit

3.3.2.2.1 light circuit one

cable length is 12.8O and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 17 .8O m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

17.8Ox.O18x13=2.9601v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 6% =6 v

and our voltage drop for this circuit is 2.9601 v so it is acceptable

3.3.2.2.2 light circuit two

cable length is 3.7 and we have 4 switches and we will consider for them 1.25 m default

4x1.25=5 so total length = 8.7 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

.018x13=2.0358 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

x 6% =6 v

and our voltage drop for this circuit is 2.0358 v so it is acceptable

3. Power to heater circuit

it will be a radial circuit with cable length is 3.53 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the second floor we will consider 9 till the roof and 3 m till the water tank

total length =16.78

and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

16.78x.OO6x28= 2.819O4 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

x 6% =6 v

and our voltage drop for this circuit is 2.819O4 v so it is acceptable

4 cooker circuit

this circuit is a radial circuit with cable length is 4 m we have 1 switches and we will consider for them 1.25 m default

so total length will be 5.25 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

5.25x.OO9x22=1.0395 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 6% =14.4 v

and our voltage drop for this circuit is 1.0395 v so it is acceptable

3.3.2.5 water motor

Cable length is .2 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the second floor we will consider 22.8 m

Total length = 24.25 m

And since we are going to use a 1.5 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

24.25 x.OO9x22=5.6745 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 5.6745 v so it is acceptable

and as we mentioned before the other two quarters are similar to the two before.

3.3.2.6 washing machine circuit

The washing machine circuit is a radial type with cable length is 3.53 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .

Total length = 4.78 m

And since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

4.78x.OO9x22=.94644

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.907118 v so it is acceptable

3.4 third floor

3.4.1 first Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another

...line for the water bump and two heaters will be separately planed because of the ... a voltage drop

...1 power main rings

... we have two main rings we will calculate them separately

...1.1 main ring one

...length is 18.63 m and we have 8 single sockets and 1 doubled we will consider .5 m for ... one as a default from the floor to it

...5=4.5m

...18.64=23.13 v

... since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m ... drop and it carries 17 A so the voltage drop will be

... length x voltage drop x full current will be carried by it

...x.O15x13=4.51O35 v

... as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

...0 x 2.5% =6 v

... our voltage drop for this ring is 4.51O35 v so it is acceptable

...1.1.2 main ring two

... length is 22.38 m and we have 4 single sockets and 3 doubled we will consider .5 m for ... one as a default from the floor to it

...x .5=3.5 m

...38 + 3.5 =25.88 v

... since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m ... drop and it carries 17 A so the voltage drop will be

... length x voltage drop x full current will be carried by it

...88x.O15x13=5.O466 v

... as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

...0 x 2.5% =6 v

... our voltage drop for this ring is 4.51O35 vso it is acceptable

3.4.1.2 power to light circuit

here we r going to calculate the voltage drop too and we have two power lightning circuits in radial type.

3.4.1.2.1light circuit one

here we r going to calculate the voltage drop too

cable length is 9.87 and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 14 .87 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

14.87x.O18x13=3.47958 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.47958 v so it is acceptable

3.4.1.2.2 light circuit two

cable length is 9.79 and we have 8 switches and we will consider for them 1.25 m default

8x1.25=10 so total length = 19.79

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

19.79x.O18x13=4.63086 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

24O x 2.5% =6 v

and our voltage drop for this circuit is 4.63086 v so it is acceptable

3.4.1.3power to heater circuit

we have two heaters in radial type and will consider each alone since every one have a separate line

3.4.1.3.1 heater circuit one

cable length is 2.35 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the third floor we will consider 3 m till the roof and 3 m till the water tank

total length =1O.6

and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

10.6x.OO6x28= 1.78O8 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.78O8 v so it is acceptable

3.4.1.3.2 heater circuit two

cable length is 6.35 we have 1 switches and we will consider for them 1.25 m default and since her we are on the third floor we will consider 3 m till the roof and 3 m till the water tank

total length =13.6 m

and since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

13.6 x.OO6x28=2.2848 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 6% =6 v

and our voltage drop for this circuit is 2.2848 v so it is acceptable

3.4.1.4 cooker circuit

it is a radial circuit with cable length is 4 m we have 1 switches and we will consider for them 1.25 m default

so total length will be 5.25

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

..009x22=1.0395

... it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

... x 2.5% =6 v

... our voltage drop for this circuit is 1.0395 v so it is acceptable

...5 water motor

... radial circuit have cable length is .4 m we have 1 switches and we will consider for them ...25 m default and we have to consider the length till the motor and since we are in the third ... we will consider it 14 m

... length = 15.65 m

... since we are going to use a 4 mille miter square cable it s voltage drop is .O18 v/m ... drop and it carries 13 A so the voltage drop will be

... length x voltage drop x full current will be carried by it

...x.O18x13=3.6621

... as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

...0 x 6% =14.4 v

... our voltage drop for this circuit is 3.6621 v so it is acceptable

...4.1.6 washing machine circuit

... washing machine circuit is a radial type with cable length is 4.16 m we have 1 switches ... we will consider for them 1.25 m default and we have to consider .

... length = 5.41 m

... since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m ...tage drop and it carries 22 A so the voltage drop will be

...able length x voltage drop x full current will be carried by it

5.41x.OO9x22=1.07118

...nd as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

...nd our voltage drop for this circuit is 1.907118 v so it is acceptable

3.4.2 second Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and one heaters will be

3.4.2.1 main rings

since we have two main rings we will calculate them separately

3.4.2.1.1 main ring one

cable length is 22.33 m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it so 8x.5=4 m

total length=4+22.23=26.33 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

26.33x.O15x13=5.13435 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 5.13435 v so it is acceptable

3.4.2.1.2 main ring two

cable length is 23.95m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it

8 x .5=4 m

23.95 + 4 =27.95 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

23.95x.O15x13=4.67O25v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 4.67O25v so it is acceptable

3.4.2.2 power to light circuit

here we r going to calculate the voltage drop too and we have two power lightning circuits in radial type.

3.4.2.2.1 light circuit one

cable length is 12.8O and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 17.8O m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

17.8Ox.O18x13=4.1652 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 4.1652 v so it is acceptable

3.4.2.2.2 light circuit two

cable length is 3.7 and we have 4 switches and we will consider for them 1.25 m default

4+1.25=5 so total length = 8.7 m

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .15 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

8.7x.O15x13=1.695 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

24O x 2.5% =6 v

and our voltage drop for this circuit is 1.695so it is acceptable

3.4.2.3 powr to heater circuit

this is a radial circuit with cable length is 3.53 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the third floor we will consider 3 m till the roof and 3 m till the water tank

total length =1O.78 m

and since we are going to use a 6 mille miter square cable it s voltage drop is .o6 v/m voltage drop and it carries 28 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

10.78x.OO6x28= 1.811O4 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =14.4 v

and our voltage drop for this circuit is 1.811O4 v so it is acceptable

3.4.2.4 cooker circuit

this radial circuit have a cable length is 4 m we have 2 switches and we will consider for them 1.25 m default

so total length will be 5.25

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

5.25x.OO9x22=1.0395

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.0395v so it is acceptable

3.4.2.5 water motor

this radial circuit have cable length is .2 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the third floor we will consider it 12 m

total length = 13.45 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

13.45 x.O18x13=3.1473 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.1473 v so it is acceptable

and as we mentioned before the other two quarters are similar to the two before.

3.4.2.6 washing machine circuit

the washing machine circuit is a radial type with cable length is 3.53 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .

total length = 4.78 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

4.78x.OO9x22=.94644 v

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.907118 v so it is acceptable

3.5 fourth floor

3.5.1 first Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and two heaters will be separately planed because of the safety n voltage drop

3.5.1.1 power main rings

since we have two main rings we will calculate them separately

5.1.1.1 main ring one

cable length is 18.63 m and we have 8 single sockets and 1 doubled we will consider .5 m for every one as a default from the floor to it

9x.5=4.5m

4.5+18.64=23.13 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .15 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

23.13x.O15x13=4.51O35 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 4.51O35 v so it is acceptable

5.1.1.2 main ring two

cable length is 22.38 m and we have 4 single sockets and 3 doubled we will consider .5 m for every one as a default from the floor to it

7x.5=3.5 m

22.38 + 3.5 =25.88 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .15 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

25.88x.O15x13=5.O466 v

and since we are going to use a 2.5 mille miter square cable it s voltage drop is .15 v/m voltage drop and it carries 17 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

23.13x.O15x13=4.51O35 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this ring is 4.51O35 vso it is acceptable

5.5.1.2 power to light circuit

we r going to calculate the voltage drop too and we have two power lightning circuits which is radial type

5.5.1.2.1 light circuit one

we r going to calculate the voltage drop too

cable length is 9.87 and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 14 .87 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

14.87x.O18x13=3.47958 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 3.47958 v so it is acceptable

5.5.1.2.2 light circuit two

cable length is 9.79 and we have 8 switches and we will consider for them 1.25 m default

8x1.25=10 so total length = 19.79

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

19.79x.O18x13=4.63086

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit 4.63086 v so it is acceptable

3.5.1.3powr to heater circuit

We have two heaters in a radial type and we will consider each alone since every one have a separate line.

3.5.1.3.1 heater circuit one

Cable length is 2.35 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the fourth floor we will consider 12 m till the roof and 3 m till the water tank

Total length =18.6

And since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

18.6x.OO6x28= 3.1248 v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 3.1248 v so it is acceptable

3.5.1.3.2 heater circuit two

Cable length is 6.35 we have 1 switches and we will consider for them 1.25 m default and since her we are on the fourth floor we will consider 3 m till the roof and 3 m till the water tank

Total length =13.6 m

And since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

13.6 x.OO6x28=2.2848 v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 2.2848 v so it is acceptable

3.5.1.4 cooker circuit

This is a radial circuit with cable length is 4 m we have 1 switches and we will consider for them 1.25 m default

so total length will be 5.25

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

5.25x.OO9x22=1.0395 v

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 1.0395 v so it is acceptable

3.5.1.5 water motor

this radial circuit have cable length is .4 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the fourth floor we will consider it 12 m

total length = 14.65 m

and since we are going to use a 1.5 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be

cable length x voltage drop x full current will be carried by it

14.65x.O18x13=3.4281

and as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 3.4281v so it is acceptable

3.5.1.6. Washing machine circuit

The washing machine circuit is a radial type with **cable** length is 4.16 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .

total length = 5.41 m

and since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be able length x voltage drop x full current will be carried by it

.4x.009x22=1.07118

and as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

and our voltage drop for this circuit is 1.907118 v so it is acceptable

3.5.2 second Quarter

we have in this quarter 2 main rings and 2 power lightning circuits and one separate line for the cooker and another separate line for the washing machine and dish washer and another separate line for the water bump and one heaters will be

3.5.2.1 main rings

Since we have two main rings we will calculate them separately

3.5.2.1.1 main ring one

cable length is 22.33 m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it so 8x.5=4 m

total length=4+22.23=26.33 m

And since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

26.33x.015x13=5.13435 v

And as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x2.5% =6 v

And our voltage drop for this ring is 5.13435 v so it is acceptable

3.5.2.1.2 main ring two

cable length is 23.95m and we have 4 single sockets and 4 doubled we will consider .5 m for every one as a default from the floor to it

8 x .5=4 m

23.95 + 4 =27.95 v

And since we are going to use a 2.5 mille miter square cable it s voltage drop is .015 v/m voltage drop and it carries 17 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

23.95x.O15x13=4.67O25v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this ring is 4.67O25v so it is acceptable

3.5.2.2 power to light circuit

Here we r going to calculate the voltage drop too and we have two power lightning circuits in radial type.

3.5.2.2.1 light circuit one

Cable length is 12.8O and we have 4 switches and we will consider for them 1.25 m default

1.25 x 4 = 5m so total length is 17 .8O m

And since we are going to use a 1.5 mille miter square cable it s voltage drop is 0.018 v/m voltage drop and it carries 13 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

17.8Ox.O18x13=3.978 v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

24O x 2.5% =6 v

And our voltage drop for this circuit is 3.978 v so it is acceptable

3.5.2.2.2 light circuit two

Cable length is 3.7 and we have 4 switches and we will consider for them 1.25 m default

4x1.25=5 so total length = 8.7

And since we are going to use a 1.5 mille miter square cable it s voltage drop is .018 v/m voltage drop and it carries 13 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

8.7x.O18x13=2.0358 v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 2.0358 v so it is acceptable

3.5.2.3. power to Heater circuit

This radial circuit have cable length is 3.53 and we have 1 switches and we will consider for them 1.25 m default and since her we are on the fourth floor we will consider 3 m till the and 3 m till the water tank

Total length =1O.78

And since we are going to use a 6 mille miter square cable it s voltage drop is .006 v/m voltage drop and it carries 28 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

1O.78x.OO6x28= 1.811O4 v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 3.323O4 v so it is acceptable

3.5.2.4 cooker circuit

This radial circuit have cable length is 4 m we have 1 switches and we will consider for them 1.25 m default

So total length will be 5.25

And since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

5.25x.OO9x22=1.0395

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 1.0395v so it is acceptable

3.5.2.5 water motor circuit

Cable length is .2 m we have 1 switches and we will consider for them 1.25 m default and we have to consider the length till the motor and since we are in the fourth floor we will consider 20 m

Total length = 21.45 m

And since we are going to use a 1.5 mille miter square cable it s voltage drop is .O18 v/m voltage drop and it carries 13 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

21.45 x.O18x13=5.0193 v

And as it is known from the regulation till 2.5% voltage drop of the hall voltage is acceptable

240 x 2.5% =16 v

And our voltage drop for this circuit is 5.0193 v so it is acceptable

And as we mentioned before the other two quarters are similar to the two before

3.5.2.6 washing machine circuit

The washing machine circuit is a radial type with cable length is 4.16 m we have 1 switches and we will consider for them 1.25 m default and we have to consider .

Total length = 5.41 m

And since we are going to use a 4 mille miter square cable it s voltage drop is .OO9 v/m voltage drop and it carries 22 A so the voltage drop will be

Cable length x voltage drop x full current will be carried by it

5.41x.OO9x22=1.07118

And as it is known from the regulation till 6% voltage drop of the hall voltage is acceptable

240 x 2.5% =6 v

And our voltage drop for this circuit is 1.907118 v so it is acceptable

3.6 coast calculation

3.6.1 first floor

3.6.1.1 first quarter

We have here 2 bedrooms and 1 kitchen and 2 bathe rooms and living room we will calculate each of them separately

In this quarter we have 10 single sockets and 4 doubled sockets and 11 switches and 4 switches for the water motor and washing machine and heater and 7 globs and 4 florescent lamps with 30w and 6 florescent lamps 70w and home bill and the circuit breakers.

we have total cable length 73.8 m of 2.5 mille meter square with coast .9 ytl per m and 16 m of 4 mille meter square with coast 1.2 ytl per m and 41.2 m of 4 mille meter square with 1.5 ytl per m

73.8x.9=66.32 ytl

16x1.2=19.2 ytl

41.2x1.5=49.44 ytl

So total coast for cables will be 134.96 ytl

For the normal switches they coast 1.5 ytl for each so we will have 16.5 ytl total

For the single Sackets they coast 1.25 ytl for each so we will have 12.25

Fro the doubled sockets they will coast 1.75 ytl for each so we will have 7 ytl total

For the other switches they will coast 2 ytl for each so we will got 8 ytl total

For the florescent lamps with 70w they will coast 4 ytl for each so we will got 24 ytl

For the florescent lamp with 30 w they will coast 3 ytl for each so we will got 12 yti

For the globs they will coast 3.65 ytl so we will got 26.25 ytl

The bill will coast 2.6

The circuit breaker will coast 15 ytl

So the total coast for this quarter will be 393.42

and as we mentioned before the second quarter is similar to this one so we will multi ply it with 2

393.42x2= 786.84 ytl

3.6.1.2 second quarter

we have here 2 bedrooms and 1 kitchen and 1-bathe rooms and living room, we will calculate each of them separately

in this quarter we have 6 single sockets and 6 doubled sockets and 9 switches and 3 switches for the water motor and washing machine and heater and 5 globs and 2 normal bulbs and 10 florescent lamps with 70w and home bill and the circuit breakers.

we have total cable length 8O.78 m of 2.5 mille meter square with coast .9 ytl per m and 27.75 m of 4 mille meter square with coast 1.2 ytl per m and 19.87 m of 4 mille meter square with 1.5 ytl per m [illegible]x9=72.702 ytl

27.75x1.2=33.3 ytl

19.78x1.5=29.805

so total coast for cables will be 135.807 ytl

for the normal switches they coast 1.5 ytl for each so we will have 13.5 ytl total

For the single Sackets they coast 1.25 ytl for each so we will have 7.5

Fro the doubled sockets they will coast 1.75 ytl for each so we will have 10.5 ytl

For the other switches they will coast 2 ytl for each so we will got 6 ytl total

For the florescent lamps they will coast 4 ytl for each so we will got 40 ytl

For the normal bulbs they will coast 1.15 for each so we will got 2.3 ytl

For the globs they will coast 3.65 ytl so we will got 18.25 ytl

The bill will coast 2.6

The circuit breaker will coast 15 ytl

So total coast for this quarter will be 387.264

And as we noticed the fourth quarter is similar to this one so we will multi ply it with 2

387.264x2=774.528ytl

3.6.1.3 coast for the stairs lightning

We have 4 switches for the lights for each floor so the total of them will be

4x4=16 per floor

And we have 19.51 m length of 2.5 mille meter square with coast .9 ytl per m so they will coast 17.559 per ytl floor

And we have 4 bill switches with coast .8 for each so the coast for them will be

3.2 ytl er floor

And we have 3 globs with coast 3.65 ytl for each so they will coast 10.95 ytl

so total coast for the stairs will be 161.636

3.6.1.4 total coast

And as we know the other floors are similar to this one but we will have little different in the length of the heater cable since it will be little shorter so we will consider it the same coast and the difference as a error factor

We have the total coast for the hall building

76.84 x 4)+(774.528 x 4)+ 161.636 =6407.3247 ytl

3.7 luminance calculation

As we know the building have 3 floors and every floor have 4 quarters and the floors are similar and we have 2 quarters in the floor are similar so we will make this calculation for only 2 quarters form the building and the others will be similar .

and since we are calculating for a communistic building we will consider the room index (Ri) equal to 1.Infact the equation to find the Ri is

Room index=Ri= which =lxw/ h(l+w)

Where l is the length of the room

w is the length

h is the height

3.7.1 first quarter

3.7.1.1 first bedroom

Number of lamps required=N=Ri{e x a/ n x f x llf x uf}

Where n is number of lamps in the same point

llf light loss factor which is .85

uf is for the surface and since we will use white walls it will be .48

e is the luminance for the area

f is the flux for the lamp and it is got from the manufacturer maul

so for this room since it is a bed room e=350

f=her will be 300 since we are using 30 w florescent

N=350x(3.8x2.8)/2x3000x.85x.48=1.52124183

So it is enough to have one double florescent lamp.

3.7.1.2 second bedroom

Number of lamps required=N=Ri{e x a/ n x f x llf x uf}

Where n is number of lamps in the same point

llf light loss factor which is .85

uf is for the surface and since we will use white walls it will be .48

e is the luminance for the area

f is the flux for the lamp and it is got from the manufacturer maul

e for this room since it is a bed room e=350

Fher will be 300 since we are using 30 w florescent

N=350x(3.8x2.8)/1x3000x.85x.48=1.52124283

So it is enough to have one double florescent lamp.

3.7.1.3 the kitchen

N=exa/nxfxllfxuf

N=400x(3x3)/2x5800x.48x.85=.760649

Which mean one doubled florescent is more than enough

3.7.1.4 bathrooms

3.7.1.4.1 first bathroom

N=300x(2x2.1)x/1x1500(2+2.1)= 1.960784

so what we chosen and planed is enough

3.7.1.4.2 second bathroom

N=300(1.6x2.8)/1x1500x.48x.85=2.196072

So 2 bulbs is enough as we chosen

3.7.1.5 the living room

here we will consider it like two parts

part a

N=350(3.5x2.8)/1x300x.48x.85=1.4 so it is enough the 1 florescent is ok

Part b

N=350x(3x5.4)/1x300x.48x.85=1.5 so the 1 florescent is enough

3.7.2 second quarter

3.7.2.1 first bedroom

N=350x(2.8x3.8)/1500x1x.48x.85=1.5 so the lightning we chosen is enough

3.7.2.2 second bedroom

N=350x(2.8x3.8)/1500x1x.48x.85=1.5 so the lightning we chosen is enough

3.7.2.3 kitchen

N=400x(2.5x2.2)/1x5800x.48x.85=.929 so the doubled florescent with 70 w is good

3.7.2.4bathroom

N=300(2.6x2)/1x1500x.48x.85=2.5

3.9 chapters summery

This chapter discussed as an example incorporates the electrical and luminance calculations of the building. Each quarter has been was taken individually in the calculation of their cables, power references of the appliances the small power defaults the soon quarters. in the calculation the voltage drop also considered for all cables .

In the drawing the 4 story building had 2 similar quarters together with their electrical installations , the small power defaults heater ,washing machine, power distribution boards was shown. In the text all the points are included for the calculation purposes.

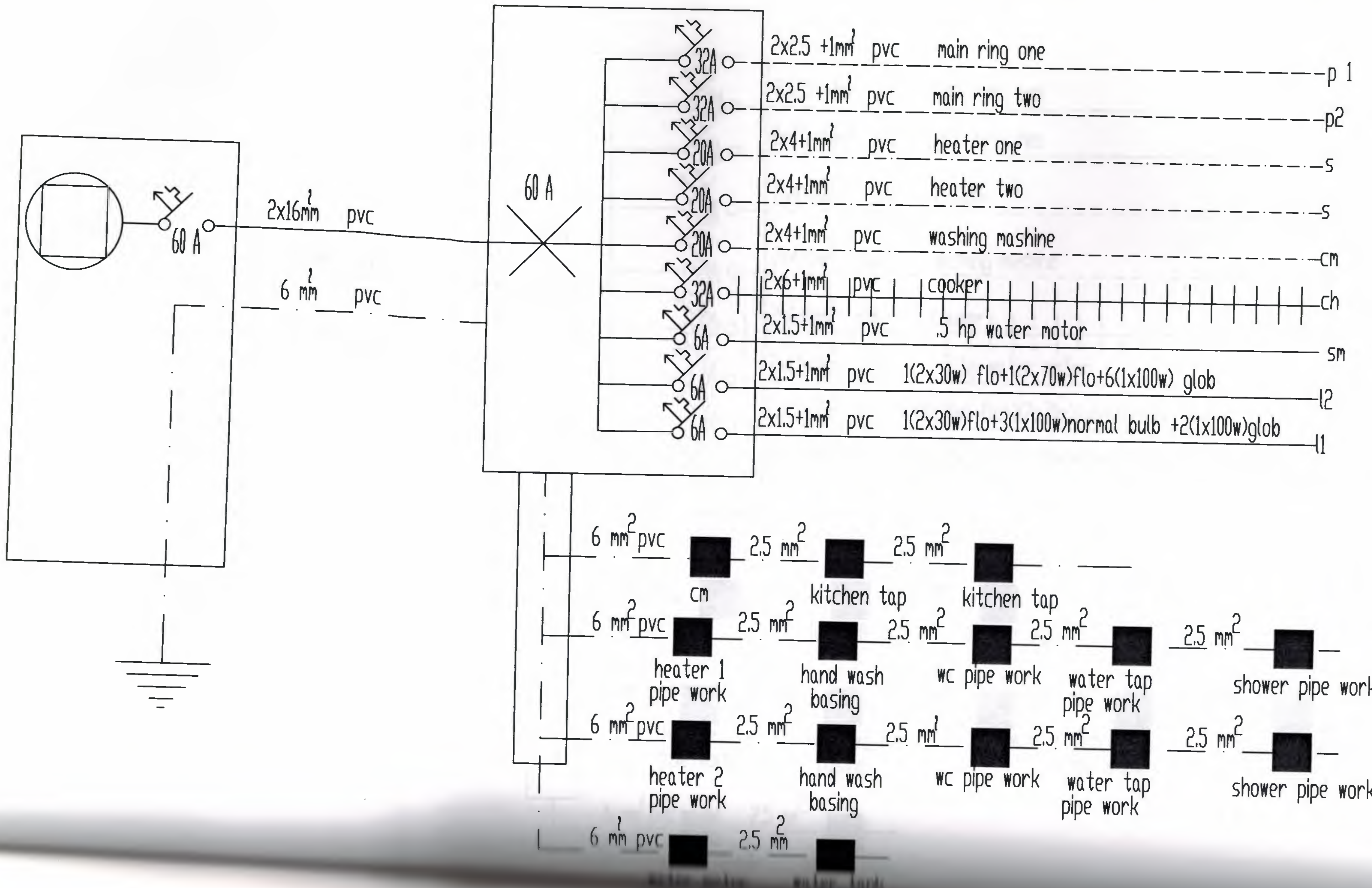
Chapter four

4.1 Overview

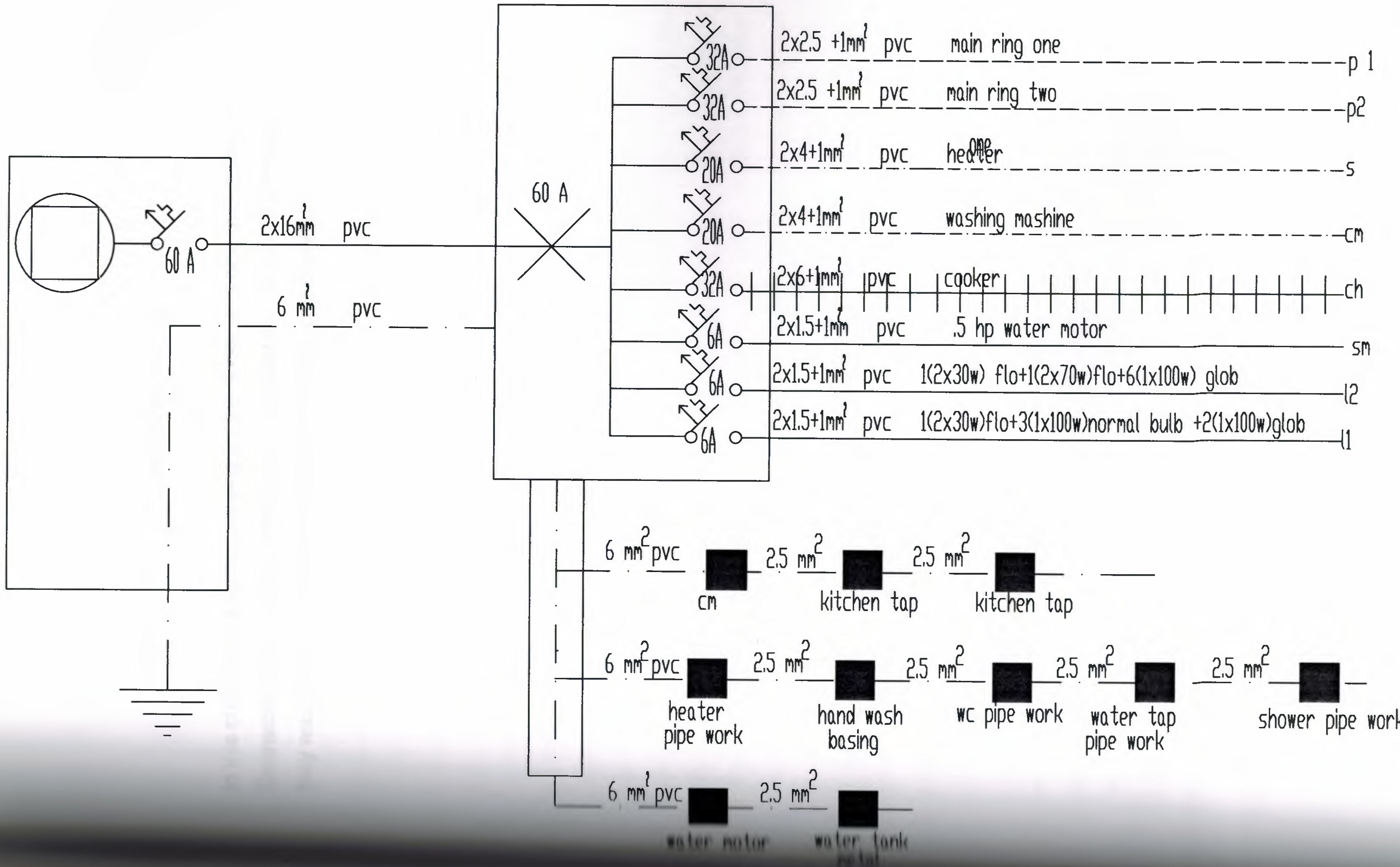
In this chapter we will see the drawing for the floors, and how the cables will be connected and we will see how they the distribution boxes and meters, and how they will be connected for the main cable and main circuit maker.

4.2 drawing of the building

here we are going to see the drawing of the building and shown in it the cables how they will take place and we will see the distribution boxes too and how the will be planed and how the cables will be coming to our devices and sockets.and since we have two similar quarters in the same floor and they are similar to the others in the other floors we are going to show only two distribution boxes and two floors too.



60 A
2x16mm² pvc
6 mm² pvc
60 A
32A
32A
20A
20A
20A
32A
6A
6A
6A
2x2.5 +1mm² pvc main ring one
p 1
2x2.5 +1mm² pvc main ring two
p2
2x4+1mm² pvc heater one
s
2x4+1mm² pvc heater two
s
2x4+1mm² pvc washing mashine
cm
2x6+1mm² pvc cooker
ch
2x1.5+1mm² pvc .5 hp water motor
sm
2x1.5+1mm² pvc 1(2x30w) flo+1(2x70w)flo+6(1x100w) glob
l2
2x1.5+1mm² pvc 1(2x30w)flo+3(1x100w)normal bulb +2(1x100w)glob
l1
6 mm² pvc
2.5 mm²
2.5 mm²
cm
kitchen tap
kitchen tap
6 mm² pvc
2.5 mm²
2.5 mm²
2.5 mm²
2.5 mm²
heater 1 pipe work
hand wash basing
wc pipe work
water tap pipe work
shower pipe work
6 mm² pvc
2.5 mm²
2.5 mm²
2.5 mm²
2.5 mm²
heater 2 pipe work
hand wash basing
wc pipe work
water tap pipe work
shower pipe work
6 mm² pvc
2.5 mm²


60 A
2x16mm pvc
6 mm pvc
60 A
32A
32A
20A
20A
32A
6A
6A
6A
2x2.5 +1mm pvc main ring one
p 1
2x2.5 +1mm pvc main ring two
p2
2x4+1mm pvc heater
s
2x4+1mm pvc washing mashine
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2x6+1mm pvc cooker
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2x1.5+1mm pvc .5 hp water motor
sm
2x1.5+1mm pvc 1(2x30w) flo+1(2x70w)flo+6(1x100w) glob
l2
2x1.5+1mm pvc 1(2x30w)flo+3(1x100w)normal bulb +2(1x100w)glob
l1
6 mm pvc
2.5 mm
2.5 mm
cm
kitchen tap
kitchen tap
6 mm pvc
2.5 mm
2.5 mm
2.5 mm
2.5 mm
heater pipe work
hand wash basing
wc pipe work
water tap pipe work
shower pipe work
6 mm pvc
2.5 mm
water motor
water tank

Chapter summery

In this chapter we saw the drawing for the floors, and how the cables was Connected and we saw how they the distribution boxes and meters, and how they was connected to the main cable and main circuit maker.

Conclusion

The invention of electricity is one of the wonders ever discovered in the world. Since its discovery many products developed around it. The products that manufactured using electricity expand day by day. But all these products and the utensils that are used for domestic purposes require electrical installation to perform their wonders. This project is based evolved around a four storey building using the latest known technique for its electrical installation. During the determination of the size and type of the cables, required calculation has been made in accordance with the IEE wiring regulations. In order to determine the lumens CIBSE guidance has been taken as priority in finding the number of lamps and luminaries. In designing the distribution boards and selection of the positions of the fittings and the symbols the guidance of the booklet issued by the Chamber of Electrical Engineers has taken precedence over the other regulations. Electrical protection of the quarters, are maintained through MCBs and Residual Current Devices. All meters are accommodated at the ground floor near the stairs at the entrance of the building. Instead of using a copper rod of 1.5m length for the earthing a 1 m^2 plate or mesh has been used to provide very good earthing even in dry seasons. The electricity for the common area will be provided by a distribution board placed on a board near the meters. Single phase has been used throughout the building. A separate line has been used for the water pump, simply because it uses inductive load.

In the project I have also considered to discuss the ways of wiring the power circuit and lightning circuits too. In my opinion everyone should adhere the consideration of the importance of the electrical installation and pay attention to the published rules and regulation, code of practices of the authorized bodies for the safety of people in order to minimize the shocks and possible fires.

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