NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

ELECTRICAL AND ELECTRONIC INSTALLATION PROJECT OF HOSPITAL

Graduation Project
EE- 400

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ABSTRACT

In life nearly all equipments requires electrical energy for their operation. perefqrn~-· in order to satisfy this requirements electrical installation should be well desl,sne· nd. appli~d with. professionally knowledge. This emphasizes the importanc~\<i:t} he electncal engıneers.
Our project is about electrical installation of a hospital, and this project needs'\.vell\~'.~:;;;;;;;-.:: knowledge about electrical installation and also researching the present systems.
This project consists the installation of lighting circuits, the installation of sockets, fan coils, some special stationary equipments, and distribution boards. For all of these, there are some regulations that have to be applied.
All projects are drawn in AutoCAD 2000.

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INTRODUCTION

Drawing electrical installation projects is one of the most important aspects of electrical engineering. All of the drawings should be based on the principles of the IEE standards and British standards and also has to include the regulations. Before starting the drawing all of the details has to be considered and applied very carefully. The first chapter introduces with some brief information about the historical development of electricity, changes in the life, industrial attacks and historical review of wiring installations.

Chapter two presents the insulators, which are used, in all types of installations including high voltage transmission.

Chapter three presents the generation transmission distribution from the power station step by step until it reaches to the costumer use.

Chapter four gives information about the protection. Why we use protection, what are the protection methods, faults that may occur, risks, corrosion and leakages.

Chapter five is concemed on the most important aspect of electrical installation, which is the earthing process. It gives information about the earthing terms, systems, important points, electric shock and testing the earthing system.

Chapter six is devoted to the types of cables, and how to identify cables.

Chapter seven presents the symbols that are used in electrical installation drawing, also one that we applied in our project.

Chapter nine presents the types of intake positions that can be applied to the buildings,

Chapter ten gives information about the domestic installations principles, applications, regulations and main important points of.domestic installation.

Chapter eleven gives information about some special installations that is applied to the buildings such like sound, TV, telephone, ete.

Chapter twelve presents illumination techniques that are applied to the buildings. Kinds of lamps, practical aspects of lighting, faults, temperature, control, maintenance, and effects of light on humarı life.

The conclusion presents important results obtained by the author and the important points that have to be considered in engineering life.

CHAPTER1:GENERALS

1.1 Historical Review of Installation **Work**

As one might expect to find in the early beginnings of any industry, the application, and the methods of application, of electricity for lighting, heating, and motive power was primitive in the extreme. Large-scale application of electrical energy was slow to develop. The first wide use of it was for lighting in houses, shops, and offices. By the 1870s, electric lighting had advanced from being a curiosity to something with a definite practical future. Arc lamps were the first form of lighting, particularly for the illumination of main streets. When the incandescent-filament lamp appeared on the scene electric lighting took on such a prominence that it severely threatened the use of gas for this purpose. But it was not until cheap and reliable metal-filament lamps were produced that electric lighting found a place in every home in the land. Even then, because of the low power of these early filament lamps, shop windows continued for some time to be lighted extemally by arc lamps suspended from the fronts of buildings. The earliest application of electrical energy as an agent for motive power in industry is still electricity's greatest contribution to industrial expansion. The year 1900 has bean regarded as a time when industrialists awakened to the potential of the new form of power.

Electricity was first used in mining for pumping. Inthe iron and steel industry, by 1917, electric fumaces ofboth the arc and induction typewere producing over 100,000 tons of ingot and castings. The first all-welded ship was constructed in 1920; and the other ship building processes were operated by electric motor power for punching, shearing, drilling machines and woodworking machinery.

The first electric motor drives in light industries were in the form of one motor-unit per line of shafting. Each motor was started once a day and continued to run throughout the whole working day in one direction at a constant speed. All the various machines driven from the shafting were started, stopped, reversed or changed in direction and speed by mechanical means. The development of integral electric drives, with provisions for starting, stopping and speed changes, led to the extensive use of the motor in small kilowatt ranges to drive an associated single machine, e.g. a lathe. üne of the pioneers in the use of motors was the firm of Bruce Peebles, Edinburgh. The firm supplied, in the 1890s, a number of weatherproof, totally enclosed motors for quarries in Dumfries shire, believed to be among the first of their type in Britain. The first electric winder ever built in Britain was supplied in 1905 to a Lanark oil concem. Railway electrification started as long ago as 1883, but it was not until long after the turn ofthis century that any major development took place.

Electrical installations in the early days were quite primitive and often dangerous. It is on record that in 1881, the installation in Hatfield House was carried out by an aristocratic amateur. That the installation was dangerous did not perturb visitors to the house who' ... when the naked wires on the gallery ceiling broke into :flame ... nonchalantly threw up cushions to put out the fire and then went on with their conversation' ...

Many names of the early electric pioneers survive today. Julius Sax began to make electric bells in 1855, and later supplied the telephone with which Queen Victoria spoke between Osbome, in the Isle of Wight, and Southampton in 1878. He founded one of the earliest purely electric manufacturing firms, which exists today and still makes bells and signaling equipment.

The General Electric Company had its origins in the 1880s, as a Company, which was able to supply every single item, which went to form a complete electrical installation. in addition it was guarantied that ali the components offered for sale were technically suited to each other, were of adequate quality and were offered at an economic price.

Specializing in lighting, Faik Statesman & Co. Ltd began by marketing improved designs of oil lamps, then gas fittings, and ultimately electric lighting fittings.

Cable makers W. T. Glover & Co. were pioneers inthe wire field. Glover was originally a designer oftextile machinery, but by 1868 he was also making braided steel wires for the then fashionable crinolines. From this type of wire it was a natural step to the production of insulated conductors for electrical purposes. At the Crystal Palace Exhibition in 1885 he showed a great range of cables; he was also responsible for the wiring of the exhibition.

The well-known J. & P. firm (Johnson & Phillips) began with making telegraphic equipment, extended to generators and arc lamps, and then to power supply.

The coverings for the insulation of wires in the early days included textiles and gutta-percha. Progress in insulation provisions for cables was made when vulcanized rubber was introduced, and it is still used today.

Siemens Brothers made the first application ofa lead sheath to rubber-insulated cables. The manner in which we name cables was also a product of Siemens, whose early system was to give a cable a certain length related to a standard resistance of 0.1 ohm. Thus a No.90 cable in their catalogue was a cable ofwhich 90 yards hada resistance of 0.1 ohm. The Standard Wire Gauge also generally knew Cable sizes,

For many years ordinary VRI cables made up about 95 per cent of all installations. They were used first in wood casing, and then in conduit. Wood casing was a very early invention. it was introduced to separate conductors, this separation being considered a necessary safeguard against the two wires touching and so causing fire. Choosing a cable at the turn ofthe century was quite a task. From one catalogue alone, one could choose from fifty-eight sizes ofwire, with no less than fourteen different grades of rubber insulation. The grades were described by such terms as light, high, medium, or best insulation. Nowadays there are two grades ofinsulation: up to 600 V and 600 V/1,000 V. And the sizes of cables have been reduced to a more practicable seventeen. During the 1890s the practice of using paper as an insulating material for cables was well established. üne ofthe earliest makers was the company, which later became a member ofthe present-day BICC Group. The ideaofusing paper as an insulation material came from America to Britain where it formed part of the first wiring system for domestic premises. This was twin lead-sheathed cable. Bases for switches and other accessories associated with the system were of cast solder, to which the cable sheathing was wiped, and then all joints sealed with a compound. The compound was necessary because the paper insulation when dry tends to absorbmoisture.

In 191 1, the famous 'Henley Wiring System' came on the market. it comprised flat-twin cables with a lead-alloy sheath. Specialjunction boxes, if properly fixed, automatically affected good electrical continuity. The insulation was rubber. it became very popular. Indeed, it proved so easy to install that a lot of unqualified people appeared on the contracting scene as 'electricians'. When it received the approval of the IEE Rules, it became an established wiring system and is still in use today.

The main competitor to rubber as an insulating material appeared in the late 1930s. This material was PVC (polyvinyl chloride), a synthetic material that came from Germany. The material, though inferior to rubber so far as elastic properties were concerned, could withstand the effects ofboth oil and sunlight. During the Second World War PVC, used both as wire insulation and the protective sheath, became well established.

As experience increased with the use of TRS cables, it was made the hasis of modified wiring systems. The first of these was the Calendar farm-wiring system introduced in 1937. This was tough rubber sheathed cable with a semi-embedded braiding treated with a green-colored compound. This system combined the properties of ordinary TRS and HSOS (house-service overhead system) cables.

So far as conductor material was concerned, copper was the most widely used. But aluminum was also applied as a conductor material. Aluminum, which has excellent electrical properties, has been produced ona large commercial scale since about 1890. Overhead lines of aluminum were first installed in 1898. Rubber-insulated aluminum cables of 3/0.036 inch and 3/0.045 inch were made to the order of the British Aluminum Company and used in the early years of this century for the wiring of the staff quarters at Kinlochleven in Argyllshire. Despite the fact that lead and lead-alloy proved to be of great value in the sheathing of cables, aluminium was looked to for a sheath of, in particular, light weight. Many experiments were carried out before a reliable system of aluminium-sheathed cable could be put on the market.

Perhaps one of the most interesting systems of wiring to come into existence was the MICS (mineral-insulated copper-sheathed cable), which used compressed magnesium oxide as the insulation, and had a copper sheath and copper conductors. The cable was first developed in 1897 and was first produced in France. It has been made in Britain since 193 7, first by Pyrotenax Ltd, and later by other firms. Mineral insulation has also been used with conductors and sheathing of aluminium.

üne ofthe first suggestions for steel used for conduit was made in 1883. it was then called 'small iron tubes'. However, the first conduits were of itemized paper. Steel for conduits did not appear on the wiring scene until about 1895. The revolution in conduit wiring dates from 1897, and is associated with the name 'Simplex' which is common enough today. It is said that the inventor, L. M. Waterhouse, got the idea of close-joint conduit by spending a sleepless night in a hotel bedroom staring at the bottom rail of his iron bedstead. in 1898 he began the production of light gauge close-joint conduits. A year later the screwed-conduit system was introduced.

Non-ferrous conduits were also a feature ofthe wiring scene. Heavy-gauge copper tubes were used for the wiring ofthe Rayland's Library in Manchester in 1886. Aluminium conduit, though suggested during the 1920s, did not appear on the market until steel became a valuable material for munitions during the Second World War.

Insulated conduits also were used for many applications in installation work, and are still used to meet some particular installation conditions. The 'Gilflex' system, for instance, makes use ofa PVC tube, which can be bent cold, compared with earlier material, which required the use of heat for bending.

Accessories for use with wiring systems were the subjects of many experiments; many interesting designs came onto the market for the electrician to use in his work. When lighting became popular, there arose a need for the individual control of each lamp from its own control point. The 'branch switch' was used for this purpose. The term 'switch' came over to this country from America, from railway terms which indicated a railway 'point', where a train could be 'switched' from one set oftracks to another. The 'switch', so far as the electric circuit was concemed, thus came to mean a device, which could switch an electric current from one circuit to another.

It was Thomas Edison who, in addition to pioneering the incandescent lamp, gave much thought to the provision ofbranch switches in circuit wiring. The term 'branch' meant a tee off from a main cable to feed small current-using items. The earliest switches were ofthe 'turn' type, in which the contacts were wiped together in a rotary motion to make the circuit. The first switches were really crude efforts: made of wood and with no positive ON or OFF position. lndeed, it was usual practice to make an inefficient contact to produce an arc to 'dim' the lights! Needless to say, this misuse ofthe early switches, in conjunction with their wooden construction, led to many fires. But new materials were brought forward for switch construction such as slate, marble, and, later, porcelain. Movements were also made more positive with definite ON and OFF positions. The 'tum' switch eventually gave way to the 'Tumbler' switch in popularity. It came into regular use about 1890. Where the name 'tumbler' originated is not clear; there are many sources, including the similarity of the switch action to the antics of Tumbler Pigeons. Many accessory names, which are household words to the electricians oftoday, appeared at the tum ofthe century: Verity's, McGeoch, Tucker, and Crabtree. Further developments to produce the semi-recessed, the flush, the ac only, and the 'silent' switch proceeded apace. The switches of today are indeed of long and worthy pedigrees.

It was one thing to produce a lamp operated from electricity. it was quite another thing to devise a way in which the lamp could be held securely while current was flowing in its circuit. The first lamps were fitted with wire tails for joining to terminal screws. It was Thomas Edison who introduced, in 1880, the screw cap, which still bears his name. it is said he got the idea from the stoppers fitted to kerosene cans of the time. Like many another really good idea, it superseded all its competitive lamp holders and its use extended through America and Europe. in Britain, however, it was not popular. The Edison & Swan Co. about 1886 introduced the bayonet-cap type of lamp-holder, The early.type was soon improved to the lamp holders we know today.

Ceiling roses, too, have an interesting history; some of the first types incorporated fuses. The first rose for direct attachment to conduit came out in the early 1900s, introduced by Dorman & Smith Ltd.

Lord Kelvin, a pioneer of electric wiring systems and wiring accessories brought out the first patent for a plug-and-socket. The accessory was used mainly for lamp loads at first, and so carried very small currents. However, domestic appliances were beginning to appear on the market, which meant that sockets had to carry heavier currents. Two popular items were irons and curling-tong heaters. Crompton designed shuttered sockets in 1893. The modem shuttered type of socket appeared as a prototype in 1905, introduced by 'Diamond H'. Many sockets were individually fused, a practice, which was later meet the extended to the provision ofa fuse in the plug.

These fuses were, however, only a small piece of wire between two terminals and caused such a lot oftrouble that in 1911 the Institution ofElectrical Engineers banned their use. üne fırın, which came into existence with the socket-and-plug, was M.K. Electric Ltd. The initials were for 'Multi-Contact' and associated with a type of socket outlet, which eventually became the standard design for this accessory. It was Scholes, under the name of 'Wylex', who introduced a revolutionary design of plug-and-socket: a hollow circular earth pin and rectangular current-carrying pins. This was really the first attempt to 'polarize', or to differentiate between live, earth and neutral pins.

üne of the earliest accessories to have a cartridge fuse incorporated in it was the plug produced by Dorman & Smith Ltd. The fuse actually formed one of the pins, and could be screwed in or out when replacement was necessary. It is a rather long cry from those pioneering days to the present system of standard socket-outlets and plugs.

Early fuses consisted of lead wires; lead being used because of its low melting point. Generally, devices which contained fuses were called 'cutouts', a term still used today for the item in the sequence of supply-control equipment entering a building. ünce the idea caught on of providing protection for a circuit in the form of fuses, brains went to work to design fuses and fuse gear. Control gear first appeared encased in wood. But ironclad versions made their due appearance, particularly for industrial use during the nineties. They were usually called 'motor switches', and had their blades and contacts mounted on a slate panel. Among the first companies in the switchgear field were Bili & ce., Sanders & Co., and the MEM Co., whose 'Kantark' fuses are so well known today. in 1928 this Company introduced the 'splitter', which affected a useful economy in many of the smaller installations.

It was not until the 1930s that the distribution of electricity in buildings by means of bus hars came into fashion, though the system had been used as far back as about 1880, particularly for street mains. In 1935 the English Electric Co. introduced abus bar trunking system designed to meet the needs ofthe motorcar industry. It provided the overhead distribution of electricity into which system individual machines could be tapped wherever required; this idea caught on and designs were produced and put onto the market by Marryat & Place, GEC, and Ottermill.

The story of electric wiring, its systems, and accessories tells an important aspect in the history of industrial development and in the history of social progress. The inventiveness ofthe old electrical personalities, Compton, Swan, Edison, Kelvin and many others, is well worth noting; for it is from their brain-children that the present-day electrical contracting industry has evolved to become one ofthe most important sections of activity in electrical engineering. For those who are interested in details ofthe evolution and development of electric wiring systems and accessories, good reading can be found in the book by J. Mellanby: The History of Electric Wiring (MacDonald, London).

1.2 Historical Review of Wiring Installation

The history of the development of non-legal and statutory rules and regulations for the wiring ofbuildings is no less interesting than that ofwiring systems and accessories. When electrical energy received a utilization impetus from the invention of the incandescent lamp, many set themselves up as electricians or electrical wiremen. Others were gas plumbers who indulged in the installation of electrics as a matter of normal course. This was all very well: the contracting industry had to get started in some way, however ragged. But with so many amateurs troubles were bound to multiply. And they did. It was not long before arc lamps, sparking commutators; and badly insulated conductors contributed to fires. it was the insurance companies, which gave their attention to the fire risk inherent in the electrical installations ofthe 1880s. Foremost among these was the Phoenix Assurance Co., whose engineer, Mr, Heaphy, was told to investigate the situation and draw up a report on his findings.

The result was the Phoenix Rules of 1882. These Rules were produced just a few months after those of the American Board of Fire Underwriters who are credited with the issue of the first wiring rules in the world.

The Phoenix Rules were, however, the better set and went through many editions before revision was thought necessary. That these Rules contributed to a better standard of wiring, and introduced a high factor of safety in the electrical wiring and equipment of buildings, was indicated by a report in 1892, which showed the high incidence of electrical fires in the USA and the comparative freedom from fires of electrical origin in Britain.

Three months after the issue of the Phoenix Rules for wiring in 1882, the Society of Telegraph Engineers and Electricians (now the Institution ofElectrical Engineers) issued the first edition ofRules and Regulations for the Prevention of Fire Risks arising from Electric lighting. These rules were drawn up by a committee of eighteen men, which included some of the famous names of the day: Lord Kelvin, Siemens, and Crompton. The Rules, however, were subjected to some criticism. Compared with the Phoenix Rules they left much to be desired. But the .Society was working on the hasis of laying down a set of principles rather than, as Heaphy did, drawing up a guide or 'Code of Practice'. A second edition ofthe Society's Rules was issued in 1888. The third edition was issued in 1897 and entitled General Rules recommended for Wiring for the Supply ofElectrical Energy.

The Rules have since been revised at fairly regular intervals as new developments and the results of experience can be written in for the considered attention of all those concemed with the electrical equipment ofbuildings. Basically the regulations were intended to act as a guide for electricians and others to provide a degree of safety in the use of electricity by inexperienced persons such as householders. The regulations were, and still are, not legal; that is, the law of the land cannot enforce them. Despite this apparent loophole, the regulations are accepted as a guide to the practice of installation work, which will ensure, at the very least, a minimum standard of work. The Institution of Electrical Engineers (IEE) was not alone in the insistence of good standards in electrical installation work. in 1905, the Electrical Trades Union, through the London District Committee, in a letter to the Phoenix Assurance Co., said ' ... they view with alarm the large extent to which had work is now being carried out by electric light contractors .... As the carrying out of had work is attended by fires and other risks, besides injuring the Trade, they respectfully ask you to.. Uphold a higher standard of work'.

The legislation embodied in the Factory and Workshop Acts of 1901 and 1907 had a considerable influence on wiring practice. In the latter Act it was recognized for the first time that the generation, distribution and use of electricity in industrial premises could be dangerous. To control electricity in factories and other premises a draft set of Regulations was later to be incorporated into statutory requirements.

While the IEE and the statutory regulations were making their positions stronger, the British Standards Institution brought out, and is still issuing, Codes of Practice to provide what are regarded as guides to good practice. The position of the Statutory Regulations in this country is that they form the primary requirements, which must by law be satisfied. The IEE Regulations and Codes of Practice indicate supplementary requirements. However, it is accepted that ifan installation is carried out in accordance with the IEE Wiring Regulations, then it generally fulfils the requirements of the Electricity Supply Regulations. This means that a supply authority can insist upon all electrical work to be carried out to the standard of the IEE Regulations, but cannot insist on a standard which is in excess of the IEE requirements.

CHAPTER2: INSULATORS

An insulator is defined as a material, which offers an extremely high resistance to the passage of an electric current. Were it not for this property of some materials we would not be able to apply electrical energy to so many uses today. Some materials are better insulators than others. The resistivity of all insulating materials decreases with an increase in temperature. Because of this, a limit in the rise in temperature is imposed in the applications of insulating materials, otherwise the insulation would break down to cause a short circuit or leakage current to earth. The materials used for insulation purposes in electrical work are extremely varied and are ofa most diverse nature. Because no single insulating material can be used extensively, different materials are combined to give the required properties of mechanical strength, adaptability, and reliability. Solids, liquids, and gases are to be found used as insulation.

Insulating materials arc grouped into classes:

Class A - Cotton, silk, paper, and similar organic materials; impregnated or immersed in oil.

Class B - Mica, asbestos, and similar inorganic materials, generally found in a built-up form combined with cement binding cement. Also polyester enamel covering and glass-cloth and micanite.

Class C - Mica, porcelain glass quartz: and similar materials.

Class E - Polyvinyl acetal resin. Class H - Silicon-glass.

The following are some brief descriptions of some of the insulating materials more commonly found in electrical work.

2.1.1. Rubber

Used mainly for cable insulation. Cannot be used for high temperatures as it hardens. Generally used with sulphur (vulcanized rubber) and china clay. Has high insulation-resistance value.

2.1.2. Polyvinyl chloride (PVC)

This is a plastics material, which will tend to flow when used in high temperatures. Has a lower insulation-resistance value than rubber. Used for cable insulation and sheathing against mechanical damage.

2.1.3. Paper

Must be used in an impregnated form (resin or oil). Used for cable insulation. Impregnated with paraffin wax, paper is used for making capacitors. Different types are available: Kraft, cotton, tissue, and pressboard.

2.1.4. Glass

Used for insulators (overhead lines). In glass fiber form it is used for cable insulation where high temperatures are present, or where areas are designated 'hazardous'. Requires a suitable impregnation (with silicone vamish) to fill the spaces between the glass fibers.

2.1.5. Mica

This material is used between the segments of commutators of de machines, and under slip rings of ac machines. Used where high temperatures are involved such as the heating elements of electric irons. It is a mineral, which is present in most granite-rock formations; generally produced in sheet and block form. Micanite is the name given to the large sheets built up from small mica splitting and can be found backed with paper, cotton fabric, silk or glass-cloth or varnishes. Forms include tubes and washers.

2.1.6. Ceramics

Used for overhead-line insulators and switchgear and transformer bushings as lead-ins for cables and conductors. Also found as switch-bases, and insulating beads for high-temperature insulation applications.

2.1.7. Bakelite

A very common synthetic material found in many aspects of electrical work (e.g. lamp holders, junction boxes), and used as a construction material for enclosing switches to be used with insulated wiring systems.

2.1.8. Insulating oil

This is a mineral oil used in transformers, and inoil-filled circuit breakers where the arc drawn out when the contacts separate, is quenched by the oil. It is used to impregnate wood, paper, and pressboard. This oil breaks down when moisture is present.

2.1.9. Epoxide resin

This material is used extensively for 'potting' or encapsulating electronic items. In larger castings it is found as insulating bushings for switchgear and transformers.

2.1.10. Textiles

This group of insulating materials includes both natural (silk, cotton, and jute) and synthetic (nylon, Terylene). They are often found in tape form, for winding-wire coil insulation.

2.1.11. Gases

Air is the most important gas used for insulating purposes. Under certain conditions (humidity and dampness) it will break: down. Nitrogen and hydrogen are used in electrical transformers and machines as both insulates and coolants.

2.L12. Liquids

Mineral oil is the most common insulant in liquid form. Others include carbon tetrachloride, silicone fluids and varnishes. Semi-liquid materials include waxes, bitumens and some synthetic resins. Carbon tetrachloride is found as an arc-quencher in high-voltage cartridge type fuses on overhead lines. Silicone fluids are used in transformers and as dashpot damping liquids. Varnishes are used for thin insulation covering for winding wires in electromagnets. Waxes are generally used for impregnating capacitors and fibres where the operating temperatures are not high. Bitumens are used for filling cable-boxes; some are used in a paint form. Resins of a synthetic nature form the hasis of the materials known as 'plastics' (polyethylene, polyvinyl chloride, melamine and polystyrene). Natura! resins are used in varnishes, and as bonding media for mica and paper sheets hot-pressed to make boards.

CHAPTER 3: GENERATION AND TRANSMISSION

The generation of electric is to convert the mechanical energy into the electrical energy. Mechanical energy means that motors which mak:es the turbine turn.
Electrical energy must be at definite value. And also frequency must be 50Hz or at other countries 60Hz. The voltage which is generated (the output of the generator) is 11 KV. After the station the lines which transfer the generated voltage to the costumers at expected value. These can be done in some rules. If the voltage transfers as it is generated up to costumers. There will be voltage drop and looses. So voltage is stepped up. When the voltage is stepped up, current will decrease. That is why the voltage is increased. This is done as it is depending on ohm's law. Actually these mean low current. Used cables will become thin. This will be economic and it will be easy to install transmission lines. If we cannot do this, we will have to use thicker cable.

To transfer the generated voltage these steps will be done. Generated voltage (1 lKV) is applied to the step-up transformer to have 66KV. This voltage is carried up to a sub-station. in this sub-station the voltage will be stepped-down again to 1 lKV. At the end the voltage stepped-down to 415V that is used by costuıners. As a result the value of the voltage has tobe at definite value. These;

a-) line to line-415V

b-) line to neutral - 240V

c-) line to earth - 240V

d-) earth to neutral - 0V

CHAPTER 4: PROTECTION

The meaning of the word protection, as used in electrical industry, is not different to that in every day used. People protect them selves against personal or financial loss by means of insurance and from injury or discomfort by the use of the correct protective clothing the further protect there property by the installation of security measure such as locks and for alarm systems.

In the same way electrical system need to be protected against mechanical damage the effect of the environment, and electrical over current to be installed in such a fashion that's person and or dive stock are protected from the dangerous that such an electrical installation may create.

4.1. REASONS FOR PROTECTIONS

4.2. Meehanical Damage

Mechanical damage is the term used to describe the physical harın sustains by various parts of electrical sets. Generally by impact hitting cable whit a hammer by obrasing. Cables sheath being rubbed against wall comer or by collision (e.g. sharp object falling to cut a cable prevent damage of cable sheath conduits, ducts tranking and casing)

4.3. Fire Risk:

Electrical fire cawed by;

a-) A fault defect all missing in the firing

b-) Faults or defects in appliances

c-) Mal-operation or abuse the electrical circuit (e.g. overloading)

4.4. Corrosion: Wherever metal is used there is often the attendant problem of corrosion and it' s prevented. There is two necessary corrosion for corrosion.

a-) The prevention of contact between two dissimilar metals ex copper & aluminium.

b-) Prohibition of soldering fluxes which remains acidic or corrosive at the compilation ofa soldering operation ex cable joint together.

c-)The protection metal sheaths of cables and metal conductions fittings where they come into contact with lime, cement or plaster and certain hard woods ex: corrosion of the metal boxes.

d-)Protection of cables wiring systems and equipment's against the corrosive action of water, oil or dumbness if not they are suitable designed to with these conditions.

4.5. Over current

Over current, excess current the result of either and overload or a short circuit. The overloading occurs when an extra load is taken from the supply. This load being connected in parallel with the existing load in a circuit decreases. The overload resistance of the circuit and current increases which causes heating the cables and deteriorate the cable insulation. And the short-circuit. Short circuit is a direct contact between live conductors

a-)Neautral condactor. (Fuse)

b-)Earthed metal work (Operators)

Protectors of overcurrent

a-)Fuses

b-)Circuit Breakers

I. Fuse

A device for opening a circuit by means of a conductor designed to melt when an excesive current flows along it .

There are three types of fuses.

a-)Rewireable

b:.)Cartridge

c-)HBC (High Breaking Copacity)

a-)Rewireable Fuse:

A rewıreable fuse consists ofa fuse, holder, a fuse element and a fuse carrier. The holder and carrier are being made porselain or bak.elite. These fuses have designed with color codes, which are marked on the fuse holder as follows;

Table.I Fuse current rating and color codes

Current Rating	Color Codes
5A	White
15A	Blue
20A	Yellow
30A	Red
45A	Green
60A	Purple

But, this type of fuse has disadvantages.Putting wrong fuse element can be damaged and spark so fire risk, can open circuit at starting-current surges.

Note: Today's they have not used anymore.

b-)Cartridge Fuse

A cartridge fuse consists ofa porcelain tube with metal and caps to which the element is attached. The tube is filled silica. They have the advantage ever the rewirable fuse of not deteriorating, of accuracy in breaking at rated values and of not arcing when interrupting faults. They are however, expensive to replace.

c-)High -Breaking Capaeity (HBC)

It is a sophisticated variation of the cartridge fuse and is normally found protecting motor circuits and industrial installations. Porcelain body filled with silica with a silver element and lug type and caps. It is very fast acting and can discriminate between a starting surge and an overload.

H. Circuit-breakers

The circuit breakers can be regarded as a switch, which can be opened automatically by means ofa 'tripping' device. It is, however, more than this

Whereas a switch is capable ofmaking and breaking a current not greatly in excess of its rated normal current, the circuit-breaker can make and break a circuit, particularly in abnormal conditions such as the occasion ofa short-circuit in an installation. It thus disconnects automatically a faulty circuit.

A circuit breaker is selected fora particular duty, taking into consideration the following. (a) the normal current it willhave to carry and (b) the amount ofcurrent which the supply will feed into the circuit fault, which current the circuit-breaker will have to interrupt without damage to itself.

The circuit breaker generally has a mechanism which, when in the closed position, holds the contacts together. The contacts are separated when the release mechanism of the circuit breaker is operated by hand or automatically by magnetic means. The circuit breaker with magnetic 'tripping' (the term used to indicate the opening ofthe device) employs a solenoid, which is an air-cooled coil. In the hollow ofthe coil is located an iron cylinder attached to a trip mechanism consisting ofa series ofpivoted links. When the circuit breaker is closed, the main current passes through the solenoid. When the circuit rises above a certain value (due to an overload ora fault), the cylinder moves within the solenoid to cause the attached linkage to collapse and, in tum, separate the circuit-breaker contacts.

Circuit breakers are used in many installations in place offuses because ofa number of definite advantages. First, in the event of an overload or fault all poles of the circuit are positively disconnected. The devices are also capable of remote control by push buttons, by under-voltage release coils, or by earth-leakage trip coils. The over-current setting of the circuit breakers can be adjusted to suit the load conditions of the circuit to be controlled. Time-lag devices can also be introduced so that the time tak.en for tripping can be delayed because, in some instances, a fault can clear itself, and so avoid the need for a circuit breaker to disconnect not only the faulty circuit, but also other healthy circuits, which may be associated with it. The time-lag facility is also useful in motor circuits, to allow the circuit-breaker to stay closed while the motor tak.es the high initial starting current during the run-up to attain its normal speed. .After they have tripped, circuit breakers can be closed immediately without loss of time. Circuit-breaker contacts separate either in air or in insulating oil.

In certain circumstances, circuit breakers must be used with 'back-up' protection, which involves the provision ofHBC (high breaking capacity) fuses in the main circuit-breaker circuit. In this instance, an extremely heavy over current, such as is caused by a short circuit, is handled by the fuses, to leave the circuit breaker to deal with the over currents caused by overloads

In increasing use for modem electrical installations is the miniature circuit-breaker (MCB). It is used as an altemative to the fuse, and has certain advantages: it can be reset or reclosed easily; it gives a clöse degree of small over current protection (the tripping factor is 1.1); it will trip on a small sustained over current, but not on a harmless transient over current such asa switching surge. For all applications the MCB tends to give much better overall protection against both fire and shock risks than can be obtained with the use of normal HBC or rewirable fuses. Miniature circuit breakers are available in distribution-board units for final circuit protection.

üne main disadvantage ofthe MCB is the initial cost, although it has the long-term advantage. There is also tendency for the tripping mechanism to stickor become sluggish in operation after long periods of inaction It is recommended that the MCB be tripped at frequent intervals to 'ease the springs' and so ensure that it performs its prescribed duty with no damage either to itself or to the circuit it protects.

Values of fuses;

6A, lOA, 16A, 32A, 45A, 60A,, 100A.

4.6. Earth Leakages:

Protection for Earth Leakages:
Using ELCB, which stands for Earth Leakage Circuit Breaker, does this type of protection. There are two types of earth leakage circuit breaker.

I. Current Operated ELCB (C/0 ELCB)
Current flowing through the live conductor and back through the neutral conductor and there will be opposite magnetic area in the iron ring, so that the trip coils does not operate If a live to earth fault or a neutral to earth fault happens the incoming and returning current will not be same and magnetic field will circulate in the iron ring to operate the trip coil. This type of operators is used in today.
The following are some ofthe points, which the inspecting electrician should look for:
1) Flexible cables not secure at plugs.
2) Frayed cables.
3) Cables without mechanical protection.
4) Use ofunearthed metalwork.
5) Circuits over-fused.
6) Poor or broken earth connections, and especially sign of corrosion.
7) Unguarded elements of the radiant fires.
8) Unauthorized additions to final circuits resulting in overloaded circuit cables.
9) Unprotected or unearthed socket-outlets.
10) Appliances with earthing requirements being supplied from two-pin BC adaptors.
11) Bell-wire used to carry mains voltages.
12) Use of portable heating appliances in bathrooms.
13) Broken connectors, such as plugs.
14) Signs of heating at socket-outlet contacts.

The following are the requirements for electrical safety:
1) Ensuring that all conductors are sufficient in csa for the design load current of circuits.
2) All equipment, wiring systems, and accessories must be appropriate to the working conditions.

3) All circuits are protected against over current using devices, which have ratings appropriate to the current-carrying capacity of the conductors

4) All exposed conductive pans are connected together by means of CPCs.

5) All extraneous conductive parts are bonded together by means of main bonding conductors and supplementary bonding conductors are taken to the installation main earth terminal.

6) All control and over current protective devices are installed in the phase conductor.

7) All electrical equipment has the means for their control and isolation.

8) All joints and connections must be mechanically secure and electrically continuous and be accessible at all times.

9) No additions to existing installations should be made unless the existing conductors are sufficient in size to carry the extra loading.

10) All electrical conductors have to be installed with adequate protection against physical damage and be suitably insulated for the circuit voltage at which they are to operate.

11) In situations where a fault current to earth is not sufficient to operate an over current device, an RCD must be installed.

12) All electrical equipment intended for use outside equipotent zone must be fed from socket-outlets incorporating an RCD.

13) The detailed inspection and testing of installation before they are connected to a mains supply, and at regular intervals there after.

CHAPTER 5: EARTHING

An efficient earthing arrangement is an essential part of every electrical installation and system to guard against the effects of leakage currents, short-circuits, static charges and lightning discharges. The basic reason for earthing is to prevent or minimize the risk of shock to human beings and livestock, and to reduce the risk of fire hazard. The earthing arrangement provides a low-resistance discharge patlı for currents, which would otherwise prove injurious or fatal to any person touching the metalwork associated with the faulty circuit. The prevention of electric shock risk in installations is a matter, which has been given close attention in these past few years, particularly since the rapid increase in the use of electricity for an ever-widening range of applications.

5.1. EARTHING TERMS

5.1.1 Earthı

A connection to the general mass of earth by means of an earth electrode.

5.1.2 Earth Electrode:

A metal plate, rod or other conductor band or driven in to the ground and used for earthing metal work.

5.1.3 Earthing Lead:

The final conductor by means of which the connection to the earth electrode is made.

5.1.4 Earth Continuity Conductor (ECC):

The conductor including any lam connecting to the earth or each other those part of an installation which are required to be earthed. The ECC may be in whole or part the metal conduit or the metal sheath of cables or the special continuity conductor ofa cable or flexible cord incorporating such a conductor.

5.2 Earthing Systems:

In our electricity system, which is same to UK electricity, is an earthed system, which means that star or neutral point of the secondary side of distribution transformer is connected to the general mass of earth.
In this way, the star point is maintained at or about. OV. Unfortunately, this also means that persons or livestock in contact with a live part and earth is at risk of electric shock.

Lightning protection

Lightning discharges can generate large amounts of heat and release considerable mechanical forces, both due to the large currents involved. The recommendations for the protection of structures against lightning are contained in BS Code of Practice 6651 (Protection of Structures Against Lightning). The object of such a protective system is to lead away the very high transient values of voltage and current into the earth where they are safely dissipated. Thus a protective system, to be effective, should be solid and permanent. Two main factors are considered in determining whether a structure should be given protection against lightning discharges:

1. Whether it is located in an area where lightning is prevalent and whether, because of its height and/or its exposed position, it is most likely to be struck.
2. Whether it is one to which damage is likely to be serious by virtue of its use, contents, importance, or interest (e.g. explosives factory, church monument, railway station, spire, radio mast, wire fence, ete.).

It is explained in BS Code of Practice 6651 that the 'zone of protection' ofa single vertical conductor fixed to a structure is considered to be a cone with an apex at the highest point of the conductor and a base of radius equal to the height. This means that a conductor 30 meters high will protect that part ofthe structure which comes within a cone extending to 60 meters in diameter at ground level Care is therefore necessary in ensuring that the whole ofa structure or building falls within the protective zone; if it does not, two down conductors must be run to provide two protective zones within which the whole structure is contained. All metallic objects and projections, such as metallic vent pipes and guttering, should be bonded to form part of the air-termination network. All down conductors should be cross-bonded,

use of multiple electrodes is common. Rule 5 of the Phoenix Fire Office Rules states:

Earth connections and number. The earth connection should be made either by means of a copper plate buried in damp earth, or by means ofthe tubular earth system, or by connection to the water mains (not nowadays recommended). The number of connections should be in proportion to the ground area of the building, and there are few structures where less than two are necessary ... Church spires, high towers, factory chimneys having two down conductors should have two earths which may be interconnected.

All the component parts ofa lightning-protective system should be either castings of leaded gunmetal, copper, naval brass or wrought phosphor bronze, or sheet copper or phosphor bronze. Steel, suitably protected from corrosion, may be used in special cases where tensile or compressive strength is needed.

Air terminations constitute that part of dice system, which distributes discharges into, or collects discharges from, the atmosphere. Roof conductors are generally of sofi annealed copper strip and interconnect the various air terminations. Down conductors, between earth and the air terminations, are also of soft-annealed copper strip. Test points are joints in down conductors, bonds, earth leads, which allow resistance tests to be made. The earth terminations are those parts of the system designed to collect discharges from, or distribute charges into, the general mass of earth. Down conductors are secured to the face ofthe structure by 'holdfasts' made from gunmetal The 'building-in' type is used for new structures; a caulking type is used for existing structures.

With a lightning protection system, the resistance to earth need not be less than 10 ohms. But in the case of important buildings, seven ohms is the maximum resistance. Because the effectiveness ofa lightning conductor is dependent on its connection.with moist earth, a poor earth connection may render the whole system useless The 'Hedges' patent tubular earth provides a permanent and efficient earth connection, which is inexpensive, simple in construction and easy to install. These earths, when driven firmly into the soil, do not lose their efficiency by changes in the soil due to drainage; they have a constant resistance by reason of their being kept in contact with moist soil by watering arrangements provided at ground level. In addition, tubular or rod earths are easier to install than plate earths, because the latter require excavation.

Lightning conductors should have as few joints as possible. If these are necessary, other than at the testing-clamp or the earth-electrode damping points, flat tape should be tinned, soldered, and riveted; rod should be screw-jointed,

All lightning protective systems should he examined and tested by a competent engineer after completion, alteration, and extension. A routine inspection and test should be made once a year and any defects remedied. In the case ofa structure containing explosives or other inflammable materials, the inspection and test should be made every six months. The tests should include the resistance to earth and earth continuity. The methods of testing are similar to those described in the IEE Regulations, though tests for earth-resistance of earth electrodes require definite distances to be observed.

Anti-static earthing

'Static', which is a shortened term for 'static electric discharge' has been the subject of increasing concem in recent years partly due to the increasing use of highly insulating materials (various plastics and textile fibres).

Earthing practice

1. Direct Earthing

The term 'direct earthing' means connection to an earth electrode, of some recognized type, and reliance on the effectiveness of over current protective devices for protection against shock and fire hazards in the event of an earth fault. If direct earthing protects non-current-carrying metalwork, under fault conditions a potential difference will exist between the metalwork and the general mass of earth to which the earth electrode is connected. This potential will persist until the protective device comes into operation. The value ofthis potential difference depends on the line voltage, the substation or supply transformer earth resistance, the line resistance, the fault resistance, and finally, the earth resistance at the installation. Direct earth connections are made with electrodes in the soil at the consumer' s premises. A further method of effecting connection to earth is that which makes use of the metallic sheaths of underground cables. But such sheaths are more generally used to provide a direct metallic connection for the retum of earth-fault current to the neutral of the supply system rather than as a means of direct connection to earth.

earth electrode, the means by which a connection with the general mass of earth is made, can take a number of forms, and can appear either as a single connection or as a network of multiple electrodes. Each type of electrode has its own advantages and disadvantages.

design of an earth electrode system takes into consideration its resistance to ensure that this is of such a value that sufficient current will pass to earth to operate the protective system. It must also be designed to accommodate thermally the maximum fault current during the time it tak.es for the protective device to clear the fault. in designing for a specific ohmic resistance, the resistivity of the soil is perhaps the most important factor, although it is a variable one.

The current rating or fault-current capacity of earth electrodes must be adequate for the 'fault-current/time-delay' characteristic ofthe system under the worst possible conditions. Undue heating of the electrode, which would dry out the adjacent soil and increase the earth resistance, must be avoided. Calculated short-time ratings for earth electrodes of various types are available from electrode manufacturers. These ratings are based on the short-time current rating of the associated protective devices and a maximum temperature, which will not cause damage to the earth connections or to the equipment with which they may be in contact.

In general soils have a negative temperature coefficient of resistance. Sustained current loadings result in an initial decrease in electrode resistance and a consequent rise in the earth-fault current fora given applied voltage. However, as the moisture in the soil is driven away from the soil/electrode interface, the resistance rises rapidly and will ultimately approach infinity if the temperature rise is sufficient. This occurs in the region of 100°C and results in the complete failure ofthe electrode.

The current density ofthe electrode is found by:

$$\text{Current density} = \frac{I}{A} = \frac{92 \times 10^3}{\sqrt{t}}$$

where I = short-circuit fault current; A = area (in cm^2); t = time in seconds (duration of the fault current).

The formula assumes a temperature rise of 120°c, over an ambient temperature of25°C, and the use ofhigh-conductivity copper. The formula does not allow for any dissipation of heat into the ground or into the air.

Under fault conditions, the earth electrode is raised to a potential with respect to the earth surrounding it. This can be calculated from the prospective fault current and the earth resistance of the electrode. It results in the existence of voltages in soil around the electrode, which may harın telephone and pilot cables (whose cores are substantially at earth potential) owing to the voltage to which the sheaths of such cables are raised. The voltage gradient at the surface of the ground may also constitute a danger to life, especially where cattle and livestock are concemed. In rural areas, for instance, it is not uncommon for the earth-path resistance to be such that faults are not cleared within a short peri od of time and animals which congregate near the areas in which current carrying electrodes are installed are liable to receive fatal shocks. The same trouble occurs on farms where earth electrodes are sometimes used for individual appliances. The maximum voltage gradient over a span of 2 meters to a 25 mm diameter pipe electrode is reduced from 85 per cent of the total electrode potential when the top of the electrode is at ground level to 20 per cent and 5 per cent when the electrode is buried at 30 cm and 100 cm respectively. Thus, in areas where livestock are allowed to roam it is recommended that electrodes be buried with their tops well below the surface of the soil.

Corrosion of electrodes due to oxidation and direct chemical attack is sometimes a problem to be considered. Bare copper acquires a protective oxide film under normal atmospheric conditions which does not result in any progressive wasting away of the metal. It does, however, tend to increase the resistance ofjoints at contact surfaces. It is thus important to ensure that all contact surfaces in copper work, such as at test links, be carefully prepared so that good electrical connections are made. Test links should be bolted up tightly. Electrodes should not be installed in ground, which is contaminated by corrosive chemicals. If copper conductors must be run in an atmosphere containing hydrogen sulphide, or laid in ground liable to contamination by corrosive chemicals, they should be protected by a covering of PVC adhesive tape or a wrapping of some other suitable material, up to the point of connection with the earth electrode.

Electrolytic corrosion will occur in addition to the other forms of attack if dissimilar metals are in contact and exposed to the action of moisture. Bolts and rivets used for making connections in copper work should be of either brass or copper. Annulated copper should not be run in direct contact with ferrous metals. Contact between bare copper and the lead sheath or armouring of cables should be avoided, especially underground. If it is impossible to avoid the connection of dissimilar metals, these should be protected by painting with a moisture-resisting bituminous paint or compound, or by wrapping with PVC tape, to exclude all moisture.

The following are the types of electrodes used to make contact with the general mass of earth:

a) Plates. These are generally made from copper, zinc, steel, or cast iron, and may be

To maintain the potential of any part ofa system at a definite value with respect to earth.

I. To allow current to flow to earth in the event ofa fault so that, the protective gears will operate to isolate the faulty circuit.

II. To make sure that in the event ofa fault, apparatus "Normally death (OV)" cannot reach a dangerous potential whit respect to earth.

5.4. Electric Shock:

This is the passage of current through the body of.such magnitude as to have significant harmful effects these value of currents are;

lmA-2mA	Barely perceptible, no harmful effects
5mA-10mA	Throw off, painful sensation
10mA-15mA	Muscular contraction, cannotlet go
20mA-30mA	Impaired breathing
50m.A and above	Ventricular fibrillation and earth.

There are two ways in which we can be at risk.

a-) Touching live parts of equipment for systems. .That is intended to be live. This is called direct contact.

b-) Touching conductive parts which are not meant to be live, but which have become live due to a fault. This is called indirect contact.

5.5. Earth testing

IEE Regulations requires that tests he made on every installation to ensure that the earthing arrangement provided for that installation is effective and offers the users of the installation a satisfactory degree of protection against earth-leakage currents. The following are the individual tests prescribed by the Regulations.

I. Circuit-protectlve conductors

Regulation 713-02-01 requires that every circuit-protective conductor (CPC) be tested to verify that it is electrically sound and correctly connected. The IEE Regulations Guidance Notes on inspection and testing give details on the recognized means used to test the CPC. For each final circuit, the CPC forms part of the earth-loop impedance patlı, its purpose being to connect all exposed conductive parts in the circuit to the main earth terminal. The CPC can take a number of forms. If metallic conduit or trunking is used, the usual figure for ohmic resistance of one-meter length is 5 milliohms/m. Generally if the total earth-loop impedance (Zs) fora particular final circuit is within the maximum Z_s limits, the CPC is then regarded as being satisfactory. However, some testing specifications for large installations do require a separate test of each CPC to be carried out. The following descriptions of such tests refer to a.c. installations.

il. Redueed a.e. test.

in certain circumstances, the testing equipment in the a.c. test described above is not always available and it is often necessary to use hand-testers, which deliver a low value of test current at the frequency ofthe mains supply. After allowing for the resistance of the test lead, a value for impedance of 0.5 ohm maximum should be obtained where the CPC, or part of it, is made from steel conduit. If the CPC is in whole or in part made of copper, copper-alloy, or aluminium, the maximum value is one ohm.

IH. Direct current.

Where it is not convenient to use a.c. for the test, D.C. may be used instead. Before the D.C. is applied, an inspection must be made to ensure that no inductor is incorporated in the-length ofthe CPC. Subject to the requirements ofthe total earth-loop impedance, the maximum values for impedance for the CPC should be 0.5 ohm (if of steel) or one ohm (if of copper, copper-alloy or aluminium).

The resistance of an earth-continuity conductor, which contains imperfect joints, varies with the test current. it is therefore recommended that a D.C. resistance test for quality is made, first at low current, secondly with high current, and finally with low current. The low-current tests should be made with an instrument delivering not more than 200 mA into one ohm; the high-current test should be made at 10 A or such higher current as is practicable. The open-circuit voltage of the test set should be less than 30 V. Any substantial variations in the readings (say 25 per cent) will indicate faulty joints in the conductor; these should be rectified. If the values obtained are within the variation limit, no further test of the CPC is necessary.

IV. Residual current devices

IEE Regulation 713-12-01 requires that where an RCD provides protection against indirect contact, the unit must have its effectiveness tested by the simulation ofa fault condition. This test is independent ofthe unit's own test facility. The consumer who is advised to ensure that the RCD trips when a test current, provided by an internal resistor, is applied to the trip-coil of the unit designs the latter for use. Thus, on pressing the 'Test' button the unit should trip immediately. If it does not it may indicate that a fault exists and the unit should not be used with its associated socket-outlet, particularly if the outlet is to be used for outdoor equipment.

The RCD has a normal tripping current of 30 mA and an operating time not exceeding 40 ms at a test current of 150 mA.

RCD testers are commercially available, which allow a range of tripping currents to be applied to the unit, from 10 mA upwards. In general the lower the tripping current the longer will be the time of disconnection.

It should be noted that a double pole RCD is required for caravans and caravan sites and for agricultural and horticultural installations where socket-outlets are designed for equipment to be used other than 'that essential to the welfare of livestock'.

V. Earth-electrode resistance area

The general mass of earth is used in electrical work to maintain the potential of any part ofa system at a definite value with respect to earth (usually taken as zero volts). It also allows a current to flow in the event ofa fault to earth, so that protective gear will operate to isolate the faulty circuit. üne particular aspect of the earth electrode resistance area is that its resistance is by no means constant. It varies with the amount of moisture in the soil and is therefore subject to seasonal and other changes. As the general mass of earth forms part of the earth-fault loop patlı, it is essential at times to know its actual value of resistance, and particularly of that area within the vicinity of the earth electrode. The effective resistance area of an earth electrode extends for some distance around the actual electrode; but the surface voltage dies away very rapidly as the distance from the electrode increases . The basic method of measuring the earth-electrode resistance is to pass current into the soil via the electrode and to measure the voltage needed to produce this current. The type of soil largely determines its resistivity. The ability of the soil to conduct currents is essentially electrolytic in nature, and is therefore affected by moisture in the soil and by the chemical composition and concentration of salts dissolved in the contained water. Grain size and distribution, and closeness of packing are also contributory factors, since these control the manner in which moisture is held in the soil. Many ofthese factors vary locally. The following table shows some typical values of soil resistivity.

Table 2.soi 1-resistivity values

Type of soil	Approximate value in ohm-cm
Marshy ground	200 to 350
Loam and clay	400 to 15,000
Chalk	6000 to 40,000
Sand	9000 to 800,000
Peat	5000 to 50,000
Sandy gravel	5000 to 50,000
Rock	100,000 upwards

When the site of an earth electrode is to be considered, the following types of soil are recommended, in order of preference:

1. Wet marshy ground, which is not too well drained.
2. Clay, loamy soil, arable land, clayey soil, andclayey soil mixed with small quantities of sand.
3. Clay and loam mixed with varying proportions of sand, gravel, and stones.
4. Damp and wet sand, peat.

Dry sand, gravel, chalk, limestone, whinstone, granite, and any very stony ground should be avoided, as should all locations where virgin rock is very close to the surface. Chemical treatment of the soil is sometimes used to improve its conductivity Common salt is very suitable for this purpose. Calcium chloride, sodium carbonate, and other substances are also beneficial, but before any chemical treatment is applied it should be verified that no corrosive actions would be set up, particularly on the earth electrode. Either a hand-operated tester or a mains-energized double-wound transformer can be used, the latter requiring an ammeter and a high-resistance voltmeter. The former method gives a direct reading in ohms on the instrument scale; the latter method requires a calculation in the form:

Voltage

Resistance = -----

Current

The procedure is the same in each case. An auxiliary electrode is driven into the ground ata distance of about 30 meters away from the electrode under test (the consumer's electrode). A third electrode is driven midway between them. To ensure that the resistance area of the first two electrodes do not overlap, the third electrode is moved 6 meters farther from, and nearer to, the electrode under test. The three tests should give similar results, the average value being tak.enas the mean resistance of the earth electrode.

üne disadvantage of using the simple method of earth electrode resistance measurement is that the effects of emfs (owing to electrolytic action in the soil) have to be tak.eninto account when testing. Also, there is the possibility of stray earth currents being leakages from local distribution systems. Because of this it is usual to use a commercial instrument, the Megger earth tester being a typical example.

VI. Earth-fault loop impedance

Regulation 113-11-01 stipulates that where earth-leakage relies on the operation of over current devices, an earth-loop impedance test should be carried out to prove the effectiveness of the installation's earthing arrangement. Although the supply authority makes its own earth-loop impedance tests, the electrical contractor is still required to carry out his own tests. The tests carried out by a supply authority will not absolve the contractor from his legal responsibilities for the safe and effective operation of protection equipment which he may install as part ofa wiring installation. This applies both to new installations and extensions to existing installations. Earth-loop impedance tests must be carried out on all extension work of major importance to ensure that the earth-continuity patlı right back to the consumer's earthing terminal is effective and will enable the protective equipment to operate under fault conditions.

VII. Phase-earth loop test.

This test closely simulates the condition which would arise should an earth- fault occurs. The instruments used for the test create an artificial fault to earth between the 'me and earth conductors, and the fault current, which is limited by a resistor or some other means, is allowed to flow for a very short period. During this time, there is a voltage drop across the limiting device, the magnitude of which depends on the value of the earth loop. The voltage drop is used to operate an instrument movement, with an associated scale calibrated in ohms. The contribution of the consumer's earthing conductor should be not more than one ohm. This is to ensure that the voltage drop across any two Points on the conductor is kept to a low value and, under fault conditions there will be no danger to any person touching it at the time of the test.

The testers, which are commercially available, include both digital readouts and analoguescales, and incorporate indications ofthe circuit condition (correct polarity and a proven earth connection). The readings are in ohms and represent the earth-loop impedance (Z_8). ünce a reading is obtained, reference must be made to lEE Regulations Tables 41B1 to 41D, which give the maximum values of $Z;$ which refer to: (a) the type of over current device used to protect the circuit and (b) the rating of the device. Reference should also be made to any previous test reading to see whether any increase in $Z;$ has occurred in the meantime. Any increase may indicate a deteriorating condition in the CPC or earthing lead and should be investigated immediately. The values of $Z;$ indicated in the Tables are maximum values, which must not be exceeded ifthe relevant circuits are to be disconnected within the disconnection times stated.

Before a test is made, the instrument should be 'proved' by using a calibration unit, which will ensure that it reads correctly during the test. It is also recommended that the serial number and type or model used for the test should be recorded, so that future tests made by the same tester will produce readings, which are correlated.

CHAPTER 6: CABLES

6.1. Types of Cables:

1.Single core cable

2.Two-core cable

3.Three-core cable

4.Composite cable

5.Power cable

6. Wiring cable

7.0verhead cable

8.Equipment cable

9.Applience Wiring cable

10.Twin Twisted cable

11. Three-Core Twisted

12.Twin Circular cable

13. Three Core

14.Coaxial cable

IS.Tel. cable

The range of types of cables used in electrical work is very wide: from heavy lead-sheathed and armored paper-insulated cables to the domestic flexible cable used to connect a hair-drier to the supply. Lead, tough-rubber, PVC and other types of sheathed cables used for domestic and industrial wiring are generally placed under the heading of power cables. There are, however, other insulated copper conductors (they are sometimes aluminum), which, though by definitions are termed cables, are sometimes not regarded as such. Into this category fall for these rubber and PVC insulated conductors drawn into some form of conduit or trucking for domestic and factory wiring, and similar conductors employed for the wiring of electrical equipment. In addition, there are the various types of insulated flexible conductors including those used for portable appliances and pendant fittings.

The main group of cables is 'flexible cables', so termed to indicate that they consist of or more cores, each containing a group of wires, the diameters of the wires and the construction of the cable being such that they afford flexibility.

Single-core,

These are natural or tinned copper wires. The insulating materials include butyl -rubber, silicon-rubber, and the more familiar PVC.

The synthetic rubbers are provided with braiding and are self-colored. The IEE Regulations recognize these insulating materials for twin-and multi-core flexible cables rather than for use as single conductors in conduit or trunking wiring systems. But that are available from the cable manufacturers for specific insulation requirements. Sizes vary from 1 to 36 mm squared (PVC) and 50 mm squared (synthetic rubbers).

Two-core.

Two-core or 'twin' cables are flat or circular. The insulation and sheathing materials are those used for single-core cables. The circular cables require cotton filler threads to gain the circular shape. Flat cables have their two cores laid side by side.

Three-core,

These cables are the same in all respects to single-and two-core cables except, of course, they carry three cores.

Composite cables.

Composite cables are those, which, in an addition to carrying the currency-carrying circuit conductors, also contain a circuit-protective conductor.

To summarize, the following group of cable types and applications are to be found in electrical work, and the electrician, at one time or.another during his career, may be asked to install them.

Wiring cables.

Switchboard wiring; domestic at workshop flexible cables and cords. Mainly copper conductors.

Power cables.

Heavy cables, generally lead sheathed and armored; control cables for electrical equipment. Both copper and aluminum conductors.

Mining cables,

In this field cables are used for trailing cables to supply equipment; shot-firing cables;

roadway lighting; lift -shaft wiring; signaling, telephone and control cables. Adequate protection and fireproofing are features of cables for this application field.

Ship-wiring cables.

These cables are generally lead-sheathed and armored, and mineral-insulated, metal-sheathed. Cables must comply with Lloyd's Rules and Regulations, and with Admiralty requirements.

Overhead cables,

Bare, lightly-insulated and insulated conductors of.copper, copper-cadmium and aluminum generally. Sometimes with steel core for added strength. For overhead distribution cables are PVC and in most cases comply with British Telecom requirements.

Communication cables.

This group includes television down-leads and radio-relay cables; radio frequency cables; telephone cables.

Welding cables.

These are flexible cables and heavy cords with either copper or aluminum conductors.

Electric-slgn cables,

PVC-and rubber-insulated cables for high-voltage discharge lamps able to withstand the high voltages.

Equipment wires.

Special wires for use with instruments, often insulated with special materials such as silicon, rubber and irradiated polythene.

Appliance-wiring cables,

This group includes high-temperature cables for electric radiators, cookers, and so on. Insulation used includes nylon, asbestos, and varnished cambric.

Heating cables.

Cables for floor-warming, road-heating, soil-warming, ceiling-heating, and simil applications.

Flexible cords.

A flexible cord is defined as a flexible cable in which the csa of each conductor does not exceed 4 mm squared. The most common types of flexible cords are used in domestic and light industrial work. The diameter of each strand or wire varies from 0.21 to 0.31 mm. Flexible cord come in many sizes and types; for convenience they are groups as follows:

I. Twin-twisted: These consist of one single insulated stranded conductors twisted together to form a core-cable. Insulation used is vulcanized rubber and PVC. Color identification in red and black is often provided. The rubber is protected by a braiding of cotton, glazed-cotton, and rayon-barding and artificial silk. The PVC-insulated conductors are not provided with additional protection.

II. Three-core (twisted): Generally as two -twisted cords but with a third conductor colored green, for eating lighting fittings.

III. Three-core (circular): Generally as twin-core circular except that the third conductor is colored green and yellow for earthing purposes.

IV. Four-care (circular): Generally as twin- core circular. Colors are brown and blue.

V. Parallel twin: These are two stranded conductors laid together in parallel and insulated to forma uniform cable with rubber or PVC.

VI. Twin-eere (flat): This consists of two stranded conductors insulated with rubber, colored red and black. Lay side-by-side and braided with artificial silk.

VII. High-temperature lighting, flexible cord: With the increasing use of filament lamps which produce very high temperatures, the temperature at the terminals ofa lamp holder can reach 71 centigrade or more. in most instances the usual flexible insulators (rubber and PVC) are quite unsuitable and special flexible cords for lighting are now available. Conductors are generally of nickel-plated copper wires, each conductor being provided with two lapping of glass fiber. The braiding is also varnished with silicone. Cords are made in the twisted form (two-and three-core).

VIII. Flexible cables: These cables are made with stranded conductors, the diameters being 0.3, 0.4, 0.5, and 0.6 mm. They are generally used for trailing cables and similar applications where heavy currents up to 630 A are to be carried, for instance, to welding plant.

IX. Coaxiel cables (antenna cable):

Antenna cables is a special cable which is used to.transfer high frequancy. This cable is a type of flexible cables. We use this cale for TV. We are using this type of cable between television sockets and from television to antenna.

X. Telephone cables:

Telephone cable is special cable. We use telephone circuit in the buildings and also for intercom circuits. This cables are very slim. Telephone cables are not same as electric cables. There are a lot of size the telephone cables. Telephone cables are 0.5mm and everytime one cable is extra near this cables.

Table 3. Telephone cables sizes

lx2+0.5 mm"
2x2+0.5 mm"
3x2+0.5 mm"
4x2+0.5 mm"
6x2+0.5 mm"
10x2+0.5 mm"
15x2+0.5 mm"
20x2+0.5 mm"

6.2 Conductor Identification:

The wiring regulations require that all conductors have to be identified by some meaning to indicate their functions i.e. phase conductors ofa 3 phase system are colored by red, yellow, blue with neutral colored by black, protective conductors are identified by green or yellow/green. In British Standard;

Red Phase

Black Neutral

Green Earth

We have some methods to identify the conductors.

1.Colouring ofthe conductor insulation

2.Printed numbers on the conductor

3.Colorued adhesive cases at the termination ofthe conductor

4.Colored see levels types at the termination of the conductors

5.Numbered paint for bare conductors

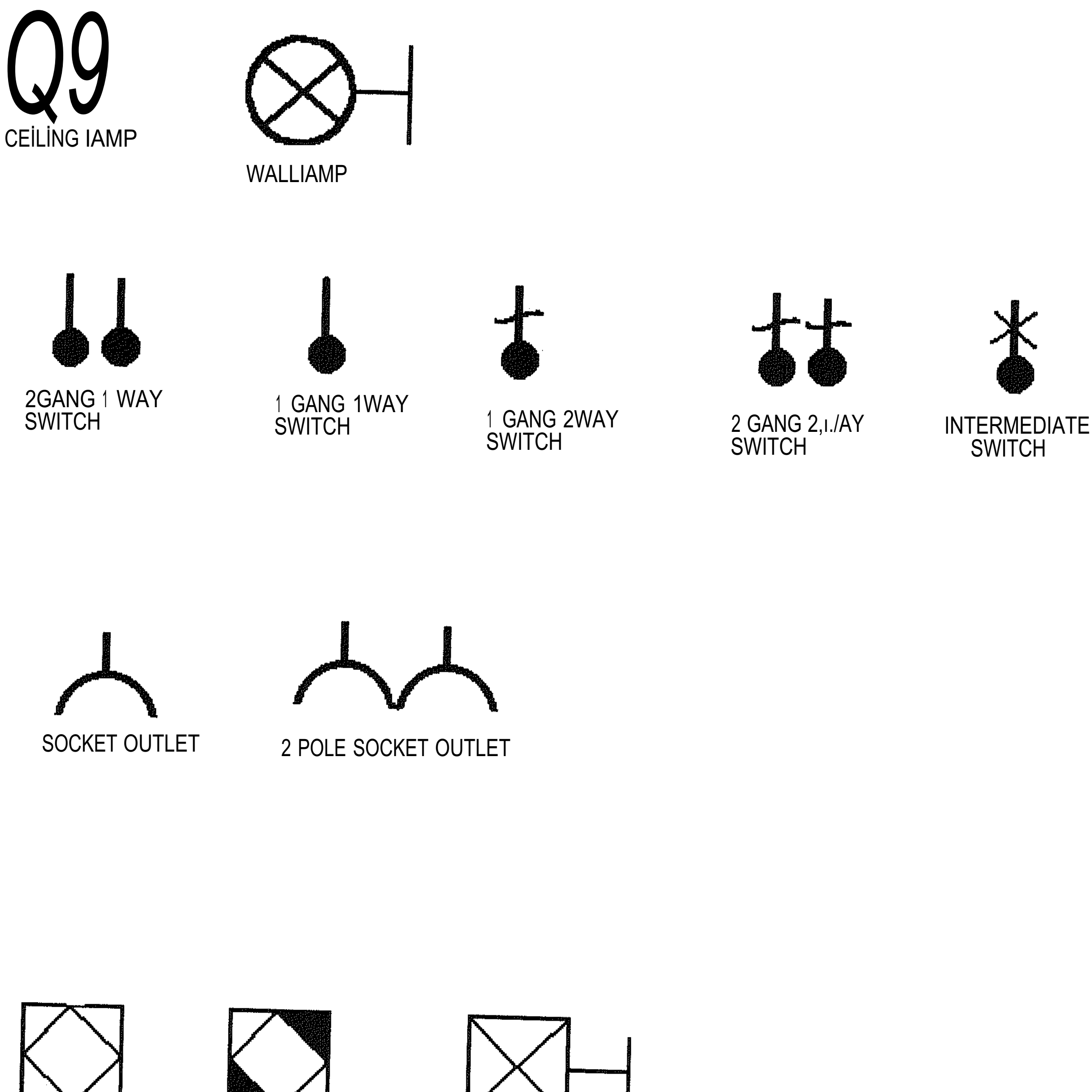
6.Colored discs fixed to the termination of conductors' e.g. ona distribution board.

Table 4. Standard thickness of cables

Cable size
0.75 mm"
1 mm.2
1.5 mm"
2.5 mrrr'
4mm.2
6 mm"
lOmm.2
16 ınnı2
25mm.2
35mm2
50mm2
70mm.2
90mm2
120 mm"
150 mrrr'
185 mnr'
240mm2
300 mm"
400 mm"
500 mnr'
630mm2

CHAPTER 7. SYMBOLS

Here are some symbols that we are using in installation



CHAPTER 8. PLASTIC PIPES

In past, iron pipes were used but in today' s the plastic pipes is used. They can bended however you want. Their life is long and also they do not effect from corrosion. You can work easily with them. They are produced at standard sizes and length, which is 3 meters.

Table 4. Plastic pipes thickness and length

Inch	MM	Length (M)
5/8	16mm	3
3/4	20mm	3
1	25mm	3
1 1/4	32mm	3
1 1/2	38mm	3
2	50mm	3

CHAPTER 9. TYPES of INTAKE POSITION

There are two types of intake position;

1.Over-Head Transmission Lines

2.Underground Transmission Lines

9.1. Over-Head Transmission Lines

The metal is put (~) on to building, which is near to the transmission lines. We connect the lines, which are coming from pillar, to the "T Point", and, the lines will be gotten into the box of the metering units.

9.2. Under-ground Intake:

Lines are taken from pillar but here under-ground cable is used. When the cable put under-ground, it will be done in some rules. These rules are;

1. Earth will be dogged (depth nearly 100 cm)
2. Sand will be separated in channel
3. Plastic pipes will be put into channel
4. Again sand is separated onto pipes
5. And these are covered by cement
6. Cable will be passed through the pipes to the box of metering units.

After these the lines are connected to the HRC (High Rupturing Fuses) fuses. And then, Cutout, metering unit, operator, and distribution board.

CHAPTER 10. DOMESTIC INSTALLATIONS

10.1 General Rules for Domestic Installation

There are two types of installation

I. Surface Installation
H. Under plaster installation

Installation system at costumers place

OPERATOR •• DISTRIBUTION BOARD •• FUSES •• LINES (CABLES)

in both types of installation, same main principle is accepted these are;

1. Lines from metering unit will be applied to the operator (V/0, C/0) or if operator is in distribution board, we put 2-pole isolator into box of metering unit and earth continuity conductor will come from another place, not with line and neutral conductor. If the operator is outside of the operator line neutral earth will be connected

together to 2-pole isolator, which is in distribution board. These maybe 3 phase or 1 phase operator or isolator.

2. In distribution board for each type of circuit different cable sizes and fuses or miniature circuit breakers are used.

10.2. POWER CIRCUITS

1. Soekets

There are two types of sockets.

I. Radial Socket Circuit

II. Ring Socket Circuit

a-) Radial Socket Circuit:

We have some standards.

1-) In a kitchen area two sockets can be put in radial socket circuit with 2.5 mm^2 conductor and 15 amps. fuse.

2-) In an area, which is not in kitchen and less, than 30 m^2' 6 sockets can be put in radial circuit with 2.5 mm^2 conductors and 15 Anıp. fuse.

3-) If the area is greater than 30 m^2, 6 sockets can be put in a radial socket cet. With 4 mm^2 conductor and 20 Anıp. fused.

Figure 1. Radial socket circuit

i0--0---0---{] Socket

DB

b-) Ring Socket Circuit:

Ring means, you will start from one point and after you went to each point, you will come
back to fist point.

1-) Any number of socket can be put in a ring socket circuit if the area less than 100 m^2' if area is greater than 100 m^2 in any building. You have to another ring socket circuits.

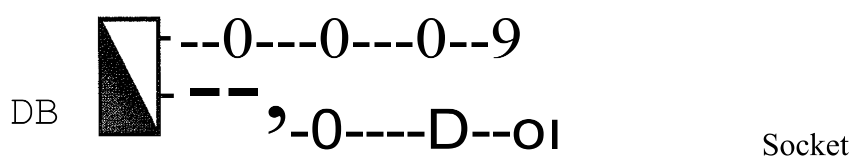
2-) From any sockets in a ring sockets circuits you can put spur from each sockets.

3-) Only one stationary appliance can be put in a ring socket circuit either include in the ring or taken asa spur. (Washing machine, dish washer, bathroom heater or heater, and waterpump)

NOTE: If these are connected to the ring socket circuit as a spur or with any heater switch. The heater switch has to be fused.

For other power circuits cable sizes and value of fuse.

Figure 2. Ring socket circuit



Flgure 3. Ring socket circuit with spur sockets

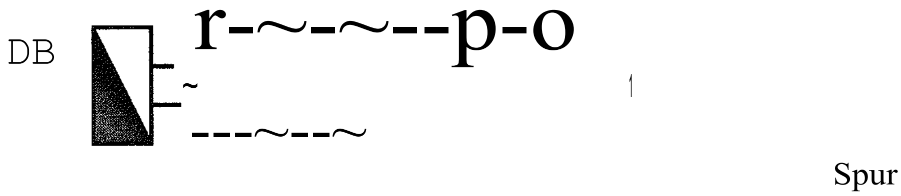


Table 5. Circuits cable thickness and fuses			
Circuit	L+N	Earth	Fuses
Cooker Control	₆ mm"	2.5 mm"	30A
Heater	2.5mm.t	1 mm"	15 A
Dish Washer	2.5mm.t	1 mm"	15 A
Washing machine	2.5mm.t	1 mm"	15 A
Jacuzzi	2.5mm.t	1 mm"	5A
Instant Heater	4mm.t	2.5mm.t	30A
Air Conditioner	2.5-4mm.t	1-2.5 mm"	15-30 A

10.3. LIGHTING CIRCUITS

in lighting circuits generally, 1 mm2 cable is used with 5 A fuse because the authority says that in a lamb circuit you will put 10 lamp (100 W), this will be 1 kW=I=lkW/240=4.16 A. 5 A limit must not be passed that's why we use the fife Amp. lfwe want to put more thanlO lamps in a circuit we have to change the cable size to 1.5 mm.2 with a 10 A fuse.

10.4. TYPES of DOMESTIC INSTALLATION

There are two types of installation; Surface Installation and under plaster installation.

10.4.1. Under Plaster Installation

Steps do this type of installation as follows;

l. Ceiling installation and stairs.

il. inside of home and stairs.

10.4.1.1. Ceiling Installation;

Plastic pipes and plastic lamb box do this part of installation. Generally, 5/8 plastic pipes are used for cell lighting. While we are doing these also, pipes of stairs installation is fixed. Pipes and lamb boxes are out be cording to the electric installation project.

Following steps to do these,

a-)Ceiling installation and stairs. First the lamp boxes are filled by wet papers. Lamps boxes may fi.ll with concrete there fore we fill the inside of lamp boxes with paper not to have problem.

b-) Lamps boxes will be nailed according to the electrical plan. If there is only single lamp in a room. Lamp boxes will be nailed to the center of room. If there is more than one lamp. You have to follow a special ways. For example, in a corridor generally there are two lamps length of corridor will be divided by there and with will be divided two to point the place of lamp.

c-) You will take out the pipes from the lamp boxes for switches (to under of the roof). We have to be careful. When we put the pipes inside of the coulomb the pipes, which will be under roof, must not be above doors *ot* windows and also, it should not be behind doors.

d-) For each circuit, from the lamb boxes, pipes will be taken out up to the distribution board. This is done as same as position of switches.

e-) Pipes will be put for the heater and for the water tank on the roof to the distribution board. (3/4")

f-) For antenna and telephone lines pipes are fixed to the suitable position (1" or %"). In apartments extra pipes are put in stairs for main lines and for the lighting of stairs. They are put inside of the coulomb

Figure 4. Ceiling installation samples

10.4.1.2. inside of Home and Stairs.

According to the plan, you paint the positions of sockets, switches, ete. with paint (spray paint). Painted places have to be broken. Metal boxes and plastic pipes that are in different sizes, for each type of circuit.

5/8" pipes for lighting, telephone lines, water pump, .and earthing.

3/4" for sockets, antenna, heater circuits.

3/4" or 1" fore cooker control

1 1/.1" or thicker is used for main lines,

When the metal boxes are being put they have to have different heights. These heights are;

in bathroom, dinning rooms, and corridor, sockets/Telephone/Antenna sockets 50cm (between floor to metal box)

Switches 150cm (between floor to metal box)

Special lamps on wall 200cm (between floor to metal box)

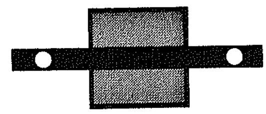


Figure 5. Switch or socket box

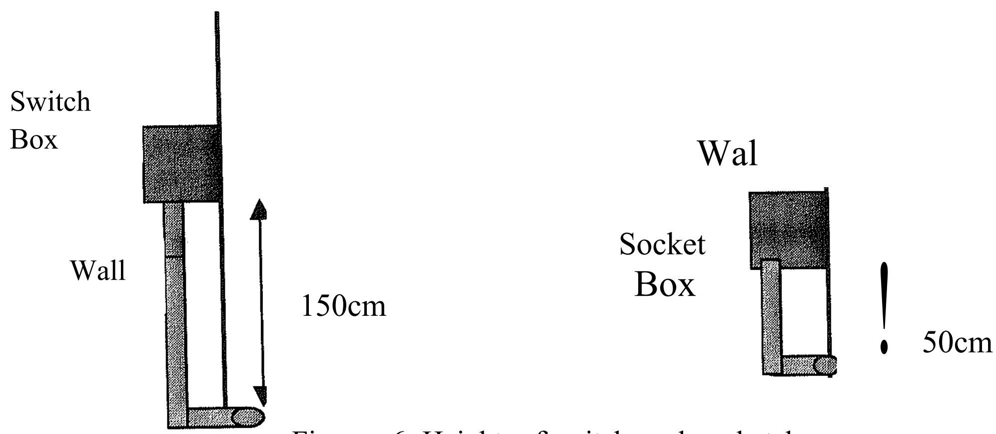


Figure 6. Height of switch and socket boxes

in Kitchen;

Here you have to be careful for position of metal boxes. Because cooker, switches, sockets boxes have to be at the same line and you have to measure careful not to put them on the place of the cupboards and this height is generally 125cm.

in Toilet and Bathrooms;

You must not put the metal box of switches inside of toilets or bathrooms. Because you may have risk of electric shock. Lamps must be waterproof. In these wet places, we have to use waterproof components for protection of life. Height of lamp is nearly at 200cm.

The round of the metal boxes must not be plastered because, metal box will have corrosion problem.

Steps

a-) We paint the places of switches, sockets, ete.

b-) Painted paces have to be broken, up to 65cm for sockets, switches 150cm, if the pipes of switch will come from roof, that pipe will come to 150cm painted line.

c-) Metal box will be fixed at painted places, but they have to be flat and good appearance we tie with wire on at piece of flat wood. This wood is nailed to the wall.

d-) We bend the pipes from anywhere of pipes, where it is needed and put them in boxes from hole on box.

e-) After plasterer to fait and the pipes plasters these boxes which are on floor are also plastered to protect the pipes.

After these have been finished, we will pullthe cable as connecting to the special stainless wire. What types of cables are suitable for each circuit.

In kitchen, toilets and bathrooms metal place labs will be earthed by special elips which is

called earthen elips and also switches, sockets and something like these will be connected and this is called finish.

10.5. Choosing Cable Sizes

The selection of the size of a cable to carry a load current involves the consideration of the rating and type of the protective device, the ambient temperature, and whether other cables are run alongside the cable (grouping). There are many situations in which cables can find themselves being overheated. The more obvious are the conditions set up when over currents are carried due to overloading and when a short-circuit occurs. Others include the increase in temperature when a number of current carrying cables are bunched together, for instance in conduit and trunking, which is a situation in which each cable contributes its heat to that of others and which, because of tile enclosed situation, produces an environment, which can quickly lead to the deterioration of the cable insulation (particularly when PVC is involved) and lead to a possible source of fire. At about 80 °C, PVC becomes very son, so that a conductor can 'migrate' or travel through the insulation and eventually make contact with earthed metalwork. This produces a shock-risk situation, with an increase in the leakage current, which could prove fatal if the installation earthing arrangement is faulty. Eventually, when the insulation breaks down completely, a short-circuit occurs and the circuit is now dependent on the ability of the over-current protection device to operate to disconnect the circuit from its supply. As is probably realized, the time of operation of the protective device is crucial: a semi-enclosed fuse will take longer to operate than would a miniature circuit breaker.In some circumstances, particularly where PVC insulated cables are used, the time taken by a semi-enclosed fuse to operate may be long enough for the cables to bum out and create a fire hazard.

Another problem, which has occurred in recent years, concems the use of thermal insulation in buildings, with cables being installed in conditions where the natura! heat produced by even their normal load currents cannot be dissipated easily. The IEE Regulations recognize the fact that, in these circumstances, the ratings of cables have to be reduced quite considerably. These classifications are used in the tables, which give the current-carrying capacities of cables. The installation conditions include 'enclosed (e.g. in conduit, trunking and ducts); 'open and clipped direct' (e.g. clipped to a wall, to a cable tray, embedded direct in plaster which is notthermally-insulating, and suspended from a catenaries wire); 'defined conditions', which include cables in free air; and cables 'in enclosed trenches'.

From this, it can be seen and appreciated that theselection ofa cable to feed a circuit is now required to be undertaken with a number offactors to be considered carefully. Situations, which were formerly tak.en for, granted must now be investigated so that the cable is installed in the best conditions, which will allow the cable to carry its load current with the safety of the user of the installation in mind.

The IEE Regulations require that the choice ofa cable for a particular circuit must have due regard for a number of factors, and not just the circuit current. These factors include:

a) the ambient temperature in which the cable is installed;

b) the installation condition, e.g. whether grouped or bunched with other current-carrying cables, enclosed or installed open';

c) whether the cable is surrounded by or in contact with thermal insulating material;

d) whether the circuit is protected by semi-enclosed (rewirable) fuses to BS 3036.

The method of choosing the correct size of conductor for a particular load condition, as recommended by the IEE Regulations, is based on the rating of the over current protective device. All factors affecting the cable in its installed condition are applied as divisors to the rating of the device. in general, the size of every bare conductor or cable conductor shall be such that the drop in voltage from the origin of the installation to any point in that installation does not exceed 4% of the nominal voltage when the conductors are carrying the full load current. It should be noted that conductors of large cross-sectional area have different volt drops per ampere per meter for ac circuits than those operating from de supplies. This is because of the reactance inherent in conductors carrying ac.

The following process for working out the correct size of cables is as follows:

1. First find the load current of the circuit (I_B).
2. Determine the correction factor for the ambient temperature, which of course does not include the heat generated in the cable itself, but is more concemed with the maximum temperature of the medium through which the cable runs.
3. Determine the correction factor for grouping.
4. Determine the correction factor if the cable is in contact with or is surrounded by thermal insulation material. Two factors are given: 0.75 if only one side of the cable is in contact with the material (e.g. a cable clipped to the side of a joist) and 0.5 if the cable is completely surrounded by the material.
5. Select the rating of the over current device. If this is offering what used to be called 'close' protection, the correction factor is 1. If, however, protection is by means of a semi-enclosed fuse, the factor is 0.725. The rating of the device must at least equal the load current.
6. Determine the size of the circuit conductor by calculating its current rating.
7. Check that the volt drop does not exceed the maximum permissible allowed.

If I_z represents the current rating of the conductor and in the rating of the protective device, then

$$I_z = \frac{\quad}{C_g \times C_a \times C_i \times C_f} \text{ amperes}$$

where Cg is the factor for grouping;

Ca is the factor for ambient temperature;

C, is the factor for thermal insulation (0.5 if cable is surrounded and 0.75 if the insulation is in contact with only one side of the cable;

Cr is the factor for the over current device. This factor is 1 for all devices except semi-enclosed fuses, when the factor is 0.725.

CHAPTER 11. SPECIAL INSTALATIONS

Though the bulk of electrical installation work carried out in this country does not involve the consideration of special factors in the context of the wiring systems, accessories and the equipment to be used in an installation, there are some types of installation conditions which call for special consideration. These conditions create the need for what are called in this chapter 'special installations', which tend to fall out with the general run of installations and require their special and particular requirements to be satisfied. These special installations are dealt with in the IEE Regulations in a rather general way and the electrician must therefore consult other sources of information as to installation procedures, techniques, and recommended types of equipment. These sources include BS Codes of Practice and manufacturers' instructions, and IEE Regulations.

11.1 Damp Situations

In general terms a 'damp situation' is one in which moisture is either permanently present, or intermittently present to such an extent as to be likely to impair the effectiveness of an installation conforming to the requirements for ordinary situations. These situations create a hazard from electric shock(particularly from surface leakage over otherwise healthy insulation) and the risks, which attend a gradual deterioration of the metalwork ofthe installation as the result of corrcsion.

The IEE Regulations require that every cable installed in a damp situation, and where it is exposed to rain, dripping water, condensed water, and accumulations ofwater, shall be ofa type designed to withstand these conditions. In addition all metal sheaths and armour of cables, metal conduit, ducts or trunking, and elips and their fixings, shall be of corrosion-resisting material. In particular, they should not be placed in contact with other metals with which they are liable to set up electrolytic action. If steel conduit is involved in such damp installations, it must be ofheavy gauge. Conduit threads should be painted over with a bituminous paint immediately after erection Cables, which are armoured and destined for installation in a damp situation, are required to have further protection in the form of an overall PVC sheath.

Even though an installation is not classed as 'damp', there may occasionally arise a situation, which could place it in this category. This is one result of condensation, which, though it might occur intermittently, may well appear in the form ofa considerable quantity of condensate. Condensation exists where there is a difference in temperature, for instance, where equipment is installed inside a room in which the ambient temperature is high, the equipment being controlled by switchgear outside the room in a lower ambient temperature. If the switchgear and the equipment are connected by trunking or conduit, then condensation is likely to occur. It will also occur where a room has a high ambient temperature during the day and where the temperature subsequently falls when the room is unoccupied during the night.

Generally, whenever dampness, whatever its source, is present, galvanized or sherardised metalwork is recommended. In addition, site conditions may be such that fixing accessories and materials may also he required to withstand any corrosive action that might occur. If conduit is used, drip points should be provided so that water can drip away. Long runs of conduit should be slightly offlevel to allow any accumulated condensate to run to a drain point at the lowest level.

The problem of condensation occurs frequently in cold-store installations and around refrigeration plant. Switchgear and other control equipment should be installed outside the cold rooms in a position some reasonable distance away from blasts of cold air and clear of door openings where changes in temperature are likely to occur. Cables of the MICS and lead-sheathed types should be glanded into totally enclosed lighting fittings and run into the cold chambers on wood battens. Cable entries into cold rooms should be sealed with some bituminous material. It is important to recognize that working PVC cables in low temperatures will injure the cables. At temperatures below 0°C, PVC hasa 'cold-shatter' characteristic and may crack if hit sharply. There is also a warning note regarding the use of cables with bituminous-compounded beddings or servings.

11.2 Corroslon

Wherever metal is used there is the attendant problem of corrosion. Two conditions are necessary for corrosion: a susceptible metal and a corrosive environment. Nearly all of the common metals in use today corrode under most natura! conditions; the bulk of all anti-corrosive measures have thus been attempts either to isolate the metal from its environment, or to changing the environment chemically to render it less corrosive'In installation work, the problems of corrosion tend to be more acute in certain types of installation. Chemical works, salt works, cow byres and other ammonia-affected areas, all require special consideration in their design and the work executed to produce the installation. Corrosion, in a normal installation condition, may affect earth connections.

The corrosion of metals in contact with soil or water is an electrochemical reaction; that is, the corrosion reaction involves both the chemical change (e.g., from iron to rust) and a flow of electric current. It is this principle, which is used in the dry cell, where the corrosion of the zinc case provides the cell's electrical output. The current flows from the metal into the soil or water (called the electrolyte) at the anode and then from the electrolyte into the metal at the cathode. Corrosion occurs at the point where the current flows from the metal into the electrolyte. Every metal develops its own particular electrode potential when placed in an electrolyte or similar medium. If two different metals are coupled together in the same electrolyte, the difference between their potentials will be sufficient to produce a current of electricity. The metal with the more negative potential will suffer corrosion. It follows that the more compatible the metals are, the less will be the rate of progress of any corrosive action which takes place between them, because the amount of potential difference between them is reduced.
In general there is a 'natural' potential of -0.3 to - 0.6 V between a buried mass of metal and its surrounding soil. This potential is measured by using a very-high-resistance voltmeter and a device called a half-cell, which consists of a copper rod immersed in saturated copper sulphate solution contained in a plastic tube which has a porous plug at the bottom for making contact with the soil as near as possible to the buried mass. Certain areas of the mass surface will act as anodes (where the current leaves the metal) and these will corrode. The areas, which act as cathodes (where the current enters the metal) do not corrode. This sub-division in the areas of the surface of the buried mass is due to the fact that the areas assume the roles of anodes and cathodes depending upon variations in the metal itself, its surface treatment, and the electrolyte.
Reducing the amount of current that flows from it into the surrounding medium or electrolyte can diminish the corrosion of a metal. Painting or otherwise coating the metal will increase the electrical resistance of both anodes and cathodes. But if the coating has flaws or holes in it, then the current concentrates at these points and deep pitting will occur. The corrosion current can also be reduced by lowering the electrical potential difference between the anodes and the cathodes either by controlling the purity of the electrolyte or by adding inhibitors to it.

Because only the anodes corrode, current flowing into them from an introduced external anode so as to cause the whole of the buried structure to become a cathode can prevent corrosion. This is the principle of cathodic protection. The method can be used only where the introduced anode can be accommodated within the electrolyte that surrounds the buried metal, and the soil or water must be present in bulk.

The method is widely employed as a corrosion preventive measure on underground metalwork. Two basic techniques are used to give cathodic protection: (i) the sacrificial anode system; (ii) the impressed current system.

In the first method , a mass of base metal, such as magnesium, is buried in the electrolyte and connected electrically to the structure to be protected. The natural difference in potential between the structure metal, usually steel, and the magnesium causes a current to flow from the magnesium (the new anode) through the electrolyte to the steel, which is the new cathode. The anode gradually corrodes and is thus called a 'sacrificial anode'. In practice a closely controlled magnesium-alloy is used. The main factors which govem the degree of protection, and the current output from the galvanic cell so formed by the protective system, are the surface area, volume and shape of the anodes used, the resistivity of the electrolyte and the surface area of the exposed metal being protected. The sacrificial anode system is common in congested areas since the low potentials generated by the galvanic system virtually eliminate the possibility of corrosion arising on adjacent metal structures on account of stray current. The system also needs no extemal electrical supply and is to a great extent self regulating in output, which latter will vary according to the resistivity ofthe surrounding medium (e.g., in wet or dry weather conditions). The anodes need periodical renewal. in reasonable soil conditions, the life of an anode may be up to 15 years.

The second method of protection, the impressed-current system, uses a conventionally generated direct current from rotating machinery .or via a transformer/rectifier unit. The negative side of the supply is connected to the structure to be protected; the positive side is fed to an 'anode ground-bed' usually formed from high-quality graphite impregnated by resin, wax or linseed oil, silicon iron or serap iron or steel. The buried structure then becomes the cathode. The anode may, but need not, corrode. Silicon-iron and graphite anode ground-beds are semi-inert and have a very long life. Serap iron or serap steel beds go into solution quite rapidly and disintegrate at the rate of about

10 kg/Ampere/year.

The metalwork associated with electrical installations, which may require cathodic protection include supporting lattice structures, armoured cables with rotted servings, metal pipes containing cables, and general structural steelwork.

Another aspect of corrosion may not be too familiar to installation installers. This points are ofa metal, which gives long service without becoming pitted or corroded. If the bell push is to be installed outside, protection against the ingress of moisture must be provided.

Indicators are installed in a central position in the building. in large premises, such as hotels and factories, the indicator board is located in a room in which some person is always in attendance, e.g., kitchen or reception office. The use of lamps is necessary where the sound of bells must be either objectionable or useless, e.g., in hospitals at night or in noisy workshops. Hand-setting indicators should be mounted at a height convenient for access and visibility.

Multiple-call systems are used in very large hotels.where the call points are too many to be indicated conveniently on a single indicatorboard or panel. Pushes are fitted at each call point, but the circuits are grouped to serve a corridor or floor. Each group gives the indication in a central service room. in these systems, arrangements must be made to have attendants on duty in corridors or floors to deal with the calls. Multiple-call systems use indicators, which have to be reset by the attendant.

Time-bell systems are common in schools andfacteries to indicate the beginning or end ofa time or period (e.g., break, class change, ete.). These systems usually have one or two pushes or other switches connected in parallel and a number of bells throughout the building, which are also connected in parallel. The.bells can be controlled from a clock system, to eliminate the human element required with bell pushes.

The burglar-alarm system is also a call system. The switches in this case are sets of contacts mounted at doors and windows. There are two circuit types; open-circuit and closed circuit. The first type requires contacts to close to energies the bell circuit. in the closed circuit type, all contacts are closed. A circulating current energizes a series relay with normally open contacts. When a contact set is opened, this current ceases to flow, de-energizes the relay, and closes the relay contacts to ring an alarm bell. Some alarm systems operate from photoelectric cells, which work when an invisible light beam is broken. The large plate-glass windows ofjewelers' shops often have a series length of very thin wire, which, if broken when the window is smashed in or a hole cut in it, will bring the relay into operation to ring a bell. in certain systems today, no bell rings, but a buzzer and light indication circuit is wired from the protected building and terminated at a nearby police station. Thus the intruder is not wamed, and the police have the opportunity of catching the burglar red-handed.

The open-circuit system is seldom used because it can be interfered with. For instance, a cut in a wire will render the complete system inoperative, whereas such a break in the series circuit ofa circulating-current (closed-circuit) system will immediately set an alarm-bell ringing. Supplies are sometimes from the mains, but in this instance a standby-battery supply is provided in the event ofa power failure. Alarm bells are often installed in a place inaccessible to unauthorized persons, and outside the building. Another type of call alarm system is the watchman's supervisory service. it is designed to provide a recorded indication of the visits of watchmen or guards to different pans of a building in the course of the duty round. The system uses a clock movement of the impulse, synchronous-time controlled a.c. or 8-day clockwork type installed at each contact station throughout the building. Each station has a box with a bell push operated by the insertion ofa special key. Opera tion of the contacts energizes an electromagnetic ally-operated marker which records the time ofthe visit on a paper marked off in hours. In some systems, an alarm is given after a predeterınined time ifthe watchman fails to 'clock in' at any contact station.

Luminous call systems are used instead of helis. These Systems use color lights, which summon staff to fulfill a service duty. They are Iargely used in hospitals and hotels. When the bell push is pressed in any position in the building, a small lamp lights in a duty room to indicate the general area from which the call has come. Altematively, a lamp outside the call room lights and remains so until an attendant extinguishes it by operating a reset push located just outside the room. Some systems incorporate a single-stroke bell. Call and indicating circuitry is also incorporated in lift systems.

11.5. Fire-Alarm Circuits

A fire-alarm is defined as 'an arrangement of call points, detectors, sounders and other equipment for the transmission and indication of alarm and supervisory signals, for the testing of circuits, and where required, for the operation of auxiliary services' Section 37(7) ofthe Factories Act of 1937 states: where in any factory ... more than 20 persons are employed ... effective provision shall be made for giving warning in case of fire, which shall be clearly audible throughout the building.

A fire-alarm system consists ofa number of press-buttons or call-points, which operate bells, sirens, or hooters, generally known as 'sounders'. Manually operated call-points are effective only if there are persons present to give an alarm. But if protection from fire is required when the premises are unoccupied, as at night and during weekends or during holiday periods, then automatic call-points are necessary. On very large operation an auxiliary fire service, such as a sprinkler system. Other examples of such services are the closing of windows and the closing of the covers of tanks, which contain inflammable liquids.

Some means of giving an audible warning of fire is a statutory obligation in certain premises under the Offices, Shops, and Railway Premises Act, 1963. Normally for these premises, an automatic fire alarm system must also be capable of manual operation, but this may not be necessary if the fire risk is low.

in a large installation a visual indicator panel (enunciator board) sited in a position agreed with the local Fire Authority, is normallyincorporated in the system. All circuits to which detectors are fitted are connected to it. Each circuit is connected to a separate enunciator, so that when a detector actuates.ftindicates onthe board the area in which the fire has occurred. The panels are also provided with test facilities, by means of which the circuits can be tested and certain faıltstindicated. With some systems, faults are indicated automatically.

Warning devices included bells, sirens, hooters; ôr whistles; they may be arranged to give either local or general alarms. in either case,the waming should sound continuously once a detector has operated, until the Fire Brigade arrives. An extemal audible waming device is recommended for mounting near to the visual indicating panel. The device should indicate which building is involved, this being particularly necessary for premises, which comprise several'biiildings. in hospitals, department stores and other places where a general internal'alıırn is not thought desirable, an alarm may be given at a manned central point only and waming passed by telephone or light signal to other parts of the premises.

The object of an automatic fire-alarm system is to call the fire brigade. The most effective and reliable means of satisfying this requirement is the provision ofa signal, which is automatically transmitted to the local fire brigade, through a direct-line connection. The line can be continuously monitored so that an immediate alarm is given as soon as a fault develops; regular testing can be arranged.

Some methods use an auto-dialing unit at the protected premises, which connects alarm calls in the form ofa pre-recorded message, either via the public '91 l' emergency call service to the appropriate fire-control room, or direct via the automatic telephone system to a pre-selected telephone number. This method is cheaper than the direct-line method, but is less reliable. it for some reason, connection to the appropriate fire-control point is not achieved at the first attempt, it is possible for an alarm call to be lost. Also, required extension phone. There are two types of private installations: PMBX (private manual branch exchange) and PABX (private automatic branch exchange).

In the PMBX system, each extension phone is wired to the main switchboard and connection is made by sockets calledjacks. There are certain disadvantages associated with this system, which usually requires an additional intemal phone system.

In the PABX system, all incoming calls are terminated at the manual switchboard and are answered by the telephone operator. AII extension to extension calls are set up automatically and direct out dialing on certain extensions is possible. AII extension phones can call the operator who can identify the extension on a lamp-per-line hasis. Direct access to the local Fire Brigade can be incorporated in the system, a special code being allocated for this purpose. A cordless switchboard (PMBX 4) is a more recent development of the PABX system. It has a switchboard with a translucent screen or lamp signaling. It enables -the operator to supervise and connect all calls with full control given by a few levers and keys. When a cali is transferred to an extension it disappears from the switchboard and is then under the full control of the extension; this is a feature not available with the older approvedgystem known as PABX 3.

CHAPTER 12. ILLUMINATION

12.1 Some Kinds ofLamps

Filament lamps

Filament lamps fall into a group of light-producing devices called 'incandescent'. They give light asa result of heating a filament conductor to a very high temperature. In 1860, Sir Joseph Swan produced the first lamp using carbonized paper strip. Later, carbonized filaments made from silk were used. Until 1900, carbon-filament lamps enjoyed an undisputed field of use. Then the metal-filament lamp appeared and by 1910 it had superseded the carbon lamp. The carbon lamps, which are made today, have a limited application: for lamp resistances (battery-charging), and radiant-heat apparatus. The modem carbon lamp has a filament of Swedish filter paper, which is dissolved in zinc chloride solution. The resultant viscous solution is squirted slowly through a fine die into ajar of acidified alcohol. Tough cellulose threads are the result. They are wound on formers, which are packed into a crucible filled with finely powdered

Discharge lamps

The discharge laınp consists ofa glass tube containing a gas. At each end ofthe tube there is an electrode. Ifa sufficiently high voltage is applied across these electrodes a discharge takes place between them. The gas now becomes an electrical conductor and light is produced. The color ofthe light produced by a discharge laınp depends on the gas in the tube: Neon - red; mercury vapor - bluish-white; helium - ivory; sodium vapor -yellow.

There are a number of electric-discharge laınps available today, each ofwhich hasa particular application or advantage over another.

Low-pressure mercury-vapor

This laınp is popularly known as the 'fluorescent' laınp. it consists ofa glass tube filled with mercury vapor at a low pressure. The electrôdes are located at the ends ofthe tube. When the laınp is switched on, an arc-discharge excites a barely-visible radiation, the greater part ofwhich consists ofultra-violet radiaıion, The interior wall ofthe tube is coated with a fluorescent powder, which transfonns the ultra-violet radiation into visible radiation or light. The type oflight, that is the colôr range, is determined by the composition ofthe fluorescent powder. An important aspect ofthe gas-discharge laınp is that the discharge has a 'negative resistance chatacteristic'. This means that when the temperature ofthe gas or vapor rises, its resistance·decreases and will thus tend to draw an ever-increasing current from the supply. Thecurrent is limited to a predetermined value by the insertion in the circuit, in series with the lamp, ofa limiting resistor or choke (inductor).

There are two types offluorescent lamp: the hot-cathode and the cold-cathode.
The hot-cathode lamp is the more common type, familiar in tube lengths of2.5, 1.7, 1.3 m and down to 30 cm. in this type, the electrodes are heated and the voltage of operation is low or medium voltage. To assist starting, the mercury vapor is mixed with a small quantity ofargon gas. The light produced varies from 30 to 35 lm/W. The colors available from the laınp include a near-daylight and a color-corrected Iight for use where colors (ofwool, paints, ete.) must be seen correctly. The practical application of the lamp includes the lighting ofshops, homes, factories, streets, ships, transport +uses and trains), tunnels, coalmines and caravans. The auxiliary equipment associated with the hot-cathode laınp includes.

1. The choke, which supplies a high initial voltage on starting (caused by the interruption of the lamp's inductive circuit), and also limits the current in the lamp when it is operating.

2. The starter.

3. The capacitor, which is fitted to correct or improve the power factor of the circuit by neutralizing the inductive effect of the choke.

There are a number of methods used to start fluorescent lamp circuits.

The methods fall into two general groups." those which use a switch (sometimes called a 'glow' starter) and those, which do not use.a switching arrangement but rely on an autotransformer to produce the high voltage, needed to start the lamps. With the glow-starter, it is important to use the correct type for the size of lamp. Although 'universal' starter switches are available, it must be remembered that they are not in fact suitable for all sizes.

The semi-resonant start circuit has the usual chcıke or inductor replaced by a specially wound transformer and is used for starting fluorescent lamps in cold temperatures. Current flows through the primary coil to one cathode of the lamp and thence through the secondary coil, which is wound in opposition-to.it.A large capacitor is connected between the secondary and the second cathode ofthe lamp. The starting current quickly heats up the cathodes and as the circuit is mainlycapacitive; this current leads the mains voltage. Because the primary and secondary windings are in opposition, the voltage across the lamp is increased and causes the lamp to strike.

The glow-start switch consists of two-separated bimetallic contact strips contained in a small glass bulb filled with helium gas. The contacts are connected in series with the lamp electrodes. When the circuit-control switch is closed, the mains voltage appears across the two contacts and results in a small gas discharge. The heat generated by the discharge effects the bimetallic strips, which bend forward to meet each other. When they make contact, current flows through the lamp electrodes to heat them. The gas discharge in the bulb ceases and the strips begin to cool down. When they separate, a high voltage appears between the electrodes and the main gas discharge is started. The voltage, which now appears across the contacts in the bulb, is, during running conditions, insufficient to cause further discharge in the helium gas, and so the contacts remain open while the lamp is buming.

The instant-start or 'quick-start' method of starling fluorescent lamps consists of an autotransformer connected across the tube. Two tapings provide a small current for

Conductors for very high temperatures are now nickel-plated copper, instead of the usual tinned-copper; some conductors are natura! copper and are associated with thermoplastic insulating materials such as polythene and polyvinyl chloride (PVC). The greatest advances have been made with insulating materials. Natura} rubber is now limited to use where the temperatures do not exceed 65°C. Above this limit the rubber becomes hard and the life ofa cord may be as little as a year or so. Inspection of rubber insulation, which has become hard during service, has shown that it may still function as an insulator provided the cable is not fixed.

Polyethylene (polythene) has many electrieal pfoperties. But it is a thermoplastic material and deforms seriously under pressure arıdexcessive heat. At about 110°C there is a sharp melting point when severe flow rtıaytake place with consequential electrical failure. This type of cable is not used inlamp fıfüıığs. PVC has excellent age-resisting properties, but has a low maximum operatingtempera.füre of 70°C. This type is also not used for lamp fittings, unless the ventilation is adequate.

Butyl-rubber insulation is suitable for lamp fittiriğsWhere higher ambient temperatures are prevalent. The maximum permitted operatiriğtempeiature is 85°C. At this temperature, the cable has a long life. At higher temperatures the insulation deteriorates rapidly. Around 130°C it turns to powder. Silicôrie riıbber can be operated continuously at 150°C, and is used for many of the enclosed lartıp fittings installed at the present time. The physical properties of this type of insulation are such that a suitable protection is necessary and a heat-resisting braid is normal for this purpose. Glass braiding with a heat-resisting lacquer is an excellent finish, butmakes an expensive cable. An alternative is terylene braiding, which is considered ideally suitable for many lamp fittings. Another good heat-resistant type of finish is an impregnated glass lapping with an impregnated glass braid. The temperature of operation of this type of cable may be as high as 180°C. For enclosed lamp fittings, where temperatures ofthis order are obtained, this cable is a suitable answer. installations, are chlorosulphonated polyethylene (CPS or 'Hypalon') and PVC

Two sheathing materials, which are used widely in /nitrile rubber (NCR/PVC) generally known as HOFR insulants. These materials are both vulcanisable rubbers and besides having good weathering, solvent, and oil resistance, are flame retardant. They may be compounded so as to be used over an insulated conductor operating at 85°C. Another new product, which appears suitable, particularly for insulation, is ethylene propylene rubber. The age-resistance ofthis material is proving excellent and may well prove to be a common material in the near future.

12.4. The effect of voltage drop

The voltage applied to a lamp is reduced if the actual voltage at the lamp terminals is lower than the rated lamp voltage. Generally, the reduction in light output is more rapid than the reduction of the wattage. it is therefore not economical to run lamps at less than the rated voltage. Another aspect of reduced voltage at the lamp terminals is that financial loss can be experienced in addition to.less light being available. Over-volting a lamp by 5 per cent (e.g. a 230V lamp on 242V)halves its life, as the filament is operated at a higher than normal temperature and vaporizes more rapidly. On the other hand, under-volting a lamp lengthens its life butreduces its light output without a corresponding reduction in the wattage consumed.Electricity, in effect, is being run to waste.

Voltage drop can also occur as a result of the lighting cables being too small for the current carried. This situation may arise when.eld wiringis allowed to supply new lamp fittings, which contain lamps with higher wattage ratings. In fact, in many modem commercial and industrial premises it is oftenfound that with high-wattage lamps being used and long circuit runs, cables larger than theusual 1, 1.5 and 2.5 mm^2 are necessary.

12.5. Faults in discharge lamps

Because of their associated circuitry, containing components such as starters, chokes and capacitors, and transformers, discharge lamps may fail or fault, to show certain symptoms which can be useful in any diagnosis by the electrician sent to investigate the fault. The following is summarized information on different lamp types.

Mercury lamps, üne of the first points to note about these lamps is that they require up to 5 minutes to cool before re-ignition can take place. In factory situations lamps are often extinguished because of voltage 'dips'. If a lamp fails to reignite after cooling, the ballast should be checked for over-heating and continuity. If the lamp is nearing the end of its life it will fail to re-strike and should be replaced. If the lamp delivers a poor light output, the choke should be checked for continuity. In some circuits, parallel chokes are used and their currents should be equal. However, one type of 700W circuit uses dissimilar chokes. Some types of lamp may suffer from 'thermal shock' as the result of cold water, e.g. rain, falling onto the hot glass envelopes. Cracked lamps (perhaps the result of damage in transit) will operate until the intemal pressure falls to atmospheric when the arc tube will fail. Excessive pressure used when screwing lamps in their hol ders also produces faults resulting in eventual lamp failure. If the tight output is unstable, a possible cause could be poor contact in the lamp holder (look for signs or arcing on the cap center contact).

12.6. Maintenanee

Immediately a lighting installation is put into serviceit begins to deteriorate. A film of dust or dirt begins to reduce the transparency or'refleeting power of all the exposed surfaces of lamps, fittings, and the walls and ceiliıg ofa room. This process, if unchecked, may result in the level of illuminatierrfalling very low in a comparatively short time. Only thorough and periodic cleaning of lighting equipment and attention to room decorations can maintain the performanceıöf'the installation at a reasonably high average value. Generally a maintenance factor is applied, The general figure is 0.8. This means that in planning the amount of illuminatiön required for a particular installation, the light-in lumens must be divided by 0.8 to allow fora decrease in light output caused by dust, ete. Very dirty situations may have a maintenance factor of 0.6 applied to them. Maintenance of lighting installations also involves the replacement of lamps, which have either failed or have suffered reductions iı:1.their light output.Labour costs generally determine whether such lamps should be replaced individually as they fail, or by group replacement.

12.7. Light control

Most sources radiate light in all directions, and .are too brilliant to be viewed comfortably. The light must therefore be controlled to direct it where it is required and to soften its brilliance. All substances absorb some of the Iight which strikes or passes through them All substance also reflect some of the light falling on them, or transmit it, or both. Reflection of light may be of three kinds:

a) Specular reflection. When light strikes a mirror-like surface it is reflected at the same angle and in the same plane as it strikes. The type of reflection is much used for the precise control of light, e.g. car headlamps, silvered shop-window reflectors. Accidental specular reflection is generally unwanted, e.g. lighting fittings reflected in glossy table tops. A mirror-like surface can took dark even though a great deal of tight is striking it, and vice versa. Its appearance depends only on what is mirrored in its surface from the particular viewpoint concemed. The streakiness sometimes obtained from specular reflection is avoided by breaking up the reflector surface by ripples, flutes or dimples, by giving it a 'satin' finish, by using a pearl (or otherwise obscured) type of lamp, or by using a moulded or lightly frosted glass cover to the lamp fitting.

b) Diffuse refleetion. This is the reflection obtained from a perfectly matt surface, the distribution of the reflected tight being independent of the direction of the incident light. The distribution of reflected light follows the cosine law, i.e. the intensity in any direction is proportional to the cosine of the angle between that direction and the perpendicular to the surface. A surface having this characteristic appears equally bright whatever the direction of view. White blotting pa.per and whitewash are nearly perfect diffuse reflectors. Diffuse reflection is useless for the precise control of light, but it can be used to reflect light in a general direction.

c) Spread reflection. Depolished metals and satin-finished mirrored surfaces have reflection characteristics between secular and diffuse. Vitreous and synthetic enamels are widely used for the reflecting surfaces of lighting fittings. Vitreous enamel is the more hard-wearing.

12.8. Stroboscopie effects,

When discharge lamps operate on altemating current systems, their light output varies in each cycle and this produces certain effects. These are rarely very troublesome, but it is sometimes necessary to take certain precautions to minimize them. The cyclic variation in the light output is not normally perceptible with Lamps operating on a 50 Hz (cycles per second) supply, since it occurs at twice the frequency ofthe mains. However, it can give rise to stroboscopic effects where the true speed ofrotating machinery or other objects is not immediately apparent and they can appear to be, lowed down or even stationary. The means of overcoming this stroboscopic effect are easy to provide in circuitry, and should be used where there is any possibility that accidents may result from misjudgment of machine speed.

Apart from the stroboscopic effect, this flicker from tubular fluorescent lamps may be a source of optical annoyance. This flicker arises from half-wave rectification in the lamps or from the random movement of hot spots on the lamp electrodes. Flicker is also apparent at the extreme ends of fluorescent lamps and is caused by the fact that a small pan of the discharge emits radiation only during one-half ofa complete cycle. This fluctuation, which occurs at mains frequency, may be overcome by fitting opaque apparent at the extreme ends of fluorescent lamps and is caused by the fact that a small pan of the discharge emits radiation only during one-half of a complete cycle. This fluctuation, which occurs at mains frequency, may be overcome by fitting opaque shields over the lamp ends, or by other methods, which screen the ends of the lamp from direct view.

üne method used to eliminate or minimize strôböscopic effect is the connection of every second lamp in a pair of fluorescents in.series with a capacitor, to change the phase of the second lamp's circuit. The circuit .is usually known as a lead/lag circuit. Another method is to use banks of fluorescent.Iamps.supplied from a three-phase four-wire supply, where each bank of lamps is connected to each phase wire and neutral to give a balanced three-phase lighting load.

CONCLUSION

For an electrical engineer the most important subject is drawing electrical installation projects. Because the engineer is imagining something that is not present and he or she has to think and apply in a very unusual and complex way. We choose a project about electrical installation.

While working in the topic of electrical installation everyone, technicians or engineers should be very careful because small mistakes can cause big damages in application.

in this project all regulation standards of IEE and British standards have been applied very carefully.

This project indicated us nearly all critical points of drawing an electrical installation project ofa complex building like a hospital.

This project also showed us it is not enough to just to be an engineer. Also an engineer has to be a good electrical technician to clarify his mine about some critical points while drawing an electrical project.

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APPENDIXA

ILUMINATION CALCULATIONS OF BASEMENT FLOOR;

Parameters;
a= length of room,
b= width of room,
H= height of room from floor,
h= height of room from working area,
k= area (room) index,
rı = efficiency of room,
A= area of room,
d= dirt factor (from table),
E= necessary illumination level (from table),
01= necessary lampflux (from table),
0T= necessary total flux,

Calculation for surgery rooms 1,2,5,6,7,8,11,12;

a=6,37m,
b=6,31m,
H=4m,

h=4-0,85=3,15m,

k=(a*b)/(h(a+b))

=(6,37*6,31)/(3, 15(6,37+6,3 l))=l,OO

rı= 0,36 (from table), d= 1,25 (from table),

A=a*b

=6,37*6,31=4 lm2

0r-(E* A *d)/ TJ

= (500*41 *1,25)/0,36=71180,

01= 2*5600=11200 lm (for 2*65/80W flo.)

n= 0T/0L

=71180/11200=6 (2*80W flo. Lamp).

Calculation for surgery rooms 3,4,7,8;

a=6,24m,
b=7,62m,
H=4m,

"

h=4-0,85=3,15m,

k=(a*b)/(h(a+b))

=(6,24*7 ,62)/(3,15(6,24+ 7,62))=1,09

11= 0,36 (from table), d= 1,25 (from table),

A=a*b

=6,24*7 ,62=48m2

0r-(E*A.*d)/ 11

= (500*48*1,25)/0,36=83333,

0L= 2*5600==11200 lm (for 2*65/SOW flo.)

n=0T/0L

=83333/11200=8 (2*80W flo. Lamp).

APPENDIXB

1. TOTAL PRICE: 144.822.600.000,00
2. HOSPITAL BASEMENT FLOOR
3. DATE: 04/06/2003

	Price	@	Cost
1. 2x13A Ring sockets	53.800.000,00	278	14.956.400.000,00
2. 1X13A Ring sockets	45.000.000,00	20	900.000.000,00
3. 2X80W Flo.	110.200.000,00	156	17.191.200.000,00
4. 13A Stationary Equipment	73.500.000,00	70	5.145.000.000,00
5. 5X0.50 tel.	5.500.000,00	48	264.000.000,00
6. T.v.	60.300.000,00	48	2.894.400.000,00
7. Emergency	34.200.000,00	48	1.641.600.000,00
8. 1x20W UV Flo.	100.000.000,00	48	4.800.000.000,00
9. Surgery lamp	3.000.000.000,00	12	36.000.000.000,00
10. 8xMCCBCOVER	12.000.000,00	9	108.000.000,00
11. CENTRAL EARTHING	1.800.000.000,00	1	1.800.000.000,00
12. 4x1200AMCCB	7.928.000.000,00	2	15.856.000.000,00
13. 3x630AMCCB	2.550.000.000,00	1	2.550.000.000,00
14. 3x400A MCCB	1.523.000.000,00	3	4.569.000.000,00
15. 3x60A MCCB	283.000.000,00	8	2.264.000.000,00
16. 3x100A MCCB	429.000.000,00	9	3.861.000.000,00
17. 3x6 WAYS 600A MAiN DB.	5.332.000.000,00	1	5.332.000.000,00
18. 3x12 WAYS 400A MAiN DB.	4.358.000.000,00	1	4.358.000.000,00
19. 3x4WAYS DB.	490.000.000,00	1	490.000.000,00
20. 3x6 WAYS DB.	533.000.000,00	2	1.066.000.000,00
21. 3x12 WAYS DB.	649.000.000,00	4	2.596.000.000,00
22. 3x8 WAYS DB.	590.000.000,00	2	1.180.000.000,00
23. 4x1200A CHANGE-OVER	15.000.000.000,00	1	15.000.000.000,00
	TOTAL		144.822.600.000,00