NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

ELECTRICAL INSTALLATION AND ILLUMINAI\lıON
PROJECT OF HOSPITAL

Graduation Project

EE400

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ABSTRACT

Nowadays illumination engineering is getting important. Because of satisfying the consumer requirements, electrical installation should be well designed and applied with a Professional knowledge.

My Project is about the electrical installation of a hotel and this project needs well knowledge about electrical installation and also researching the present system. This project consists the irıstallation of lighting circuits, the installation of sockets, illumination with spots, fan and motor for central heating. system, fire system, television, data and telephone systems. For all of these, there are .some regulations that has to be applied.

INTRODUCTION

With the discovery of fire, the earliest form of artificial lighting used to illuminate an area were campfires or torches. An old adage says, "It is better to light a candle than to curse the darkness". I think we better do both.

Lighting fixtures come in a wide variety of styles for various functions. The most important functions are as a holder for the light source, to provide directed light and to avoid visual glare. Some are very plain and functional; while sôrrıe are pieces of art in themselves. Nearly any material can be used, $o long aS if can. tolerate the excess heat and is in keeping with safety codes

The electrical installation design has many gories based on different conditions and bases.

The chapters are illustrated in term of systems categories in eight chapters as following:

- Beginning chapter is about general information
- Second chapter is illumination
- Third chapter is about insulators
- Fourth chapter is about UPS
- Fifth chapter is CCTV
- Sixth chapter is using lighting
- Seventh chapter is about cables and wiring system
- Eight chapter is about protection of illumination
- And the last chapter is about earthing

CHAPTER1

GENERALS

1.1. The History of Illumination.

Electricity was first used in mining for pumping. In the iron and steel industry, by 1917, electric furnaces of both.the arc and induction type were 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.thefprrıi/ôfôtıemotor-unit per line of shafting. Each motor was started once a day and{c;C>~firiı:ı.ed•to run throughout the whole working day in one direction at a constant sp~eçlty$\.11thevarious machines driven from the shafting were started, stopped, reversed ~p}~~ged in direction and speed·by mechanical means. The development of integrah~l~.qğiq;d.rives, with provisions for starting, stopping and speed changes, led to the extensiv~µs~.qf.the motor in small kilowatt ranges to drive·an associated single machine; e.g.>afat~~:..'(~:rie of the pioneers in the use of motors was the fırın of Bruce Peebles, Edinburgh.. 'rheföm 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.

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 externally 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 been regarded as a time when industrialists awakened to the potential of the new form of power.

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 installatiön, In addition it was guarantied that all the components offered.for sale were technically suited to each other, were of adequate quality and were<offe:ted at an economic price. The first electric winder ever built in Britain was supplieddn1905 to a Lanark oil concern, Railway electrification started as long ago as 1883;b.ut)itwas not until long'afterthe turn of this century that any major developmenttookpla.be;

Many n~es _of the early electric pioneers survive today. Julius Sax</be~a~fö make electric bells in 1855, and later supplied the telephone with which Queçm..:Y:ictoria spoke between Osborne, in the Isle of Wight, and Southampton in 1878. Heifofüıded one of the earliest purely electric manufacturing firms, which exists today: arid still makes bells and signaling equipment.

Specializing in lighting, Falk Statesman & Co. Ltd began by marketing imprc,veddesigns of oil lamps, then gas fittings, and ultimately electric lighting fittings.

Cable makers W. T. Glover & Co. were pioneers in the wire field. Glover was originally a designer oftextile machinery, but by 1868 he w:as also making braided steel wires forthe then fashionable crinolines. From this type of wire"it was a natural step to the pr'Oductionof 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 Ofthe exhibition.

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

.'fhe 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 of a 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. 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. Wooclçasing was a very ear'ly.•invention. It was introduced to separate conductors, this>sepa.ration being considered a necessary safeguard against the two wires touching and so icausing fire. Choosing a cable at the 'tum of the century was quite a task. From one catalogue alone, one could choose from fifty-eight sizes of wire, with no less than foili.1:¢@11 <iiffetent grades of rubber insulation. The grades were described by such terms as Hğht,..high, medium, or best insulation. Nowadays there are two grades of insulation:iμp(to>600V and 600N/1,0_00 V. And the sizes of cables have been reduced to a more pra.ctica.ble seventeen.

Thus a No.90 cable in their catalogue was a cable of which 90 yards>had a resistance of 0.1 ohm. The Standard Wire Gauge also generally knew Cable sizes.

During the 1890s the practice of using paper as an insulating material for cables was well established. One of the earliest makers was the company, which later became a member of the present-_dayBICC Group. The 'idea of using 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 necess~ because the paper insulation when dry tends to absorb moisture.

In 1911, the famous 'Henley Wiring System' came on the market. It comprised flat-twin cables with a lead-alloy sheath. Special junction 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 ö:rlthe 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.

r The main competitor to rubber as an insulating material appeared in the late 1930s. 'Ffıi~material was PVC (polyvinyl chloride), a synthetic material that came from GermanyYThe material, though inferior to rubber so far as elas~ic properties were concerned/icÔuld withstand the effects of both oil and sunlight..During. the Second World War PVC, used both as wire insulation and the protectivetsheath, became well established.

As experience increased with the use of TRS cables, it was made the basis of modified wiring systetns, The first of these was the Calendar farm:..w.iriıg system introduced in 1937. This was tough rubber sheathed cable with asemi..eınbedded braiding treı:ı.ted with a green-colored compound.

Perhaps one of the most interesting systems of wiring to come into existence was the MICS (mineral-insulated copper-sheathed cable), which used compressed••ınagnesium oxide as the insulation, and had a copper sheath .and copper conduc:tors. The cable was. first developed in 1897 and was first produced in France. It has been.made in Britain since 1937, first by Pyrotenax Ltd, and later by other firms. Mineral insulation has also been used with conductors and sheathing of aluminum.

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 electricalproperties, has been produced on a 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, aluminum was looked to for a sheath of, in particular, light weight. Many experiments were carried out before a reliable system of aluminum-sheathed cable· could be. put on the market.

One of the 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;igqtthe idea of close-joint conduit by spending a sleepless night in a hotel bedrbôirı. 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.

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 of a PVC tube, which can be bent cold, compared with earlier material, which required the use ofheat 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 usedforthis purpose.

Non-ferrous conduits were also a feature of the wiring scene. Heavy-gauge co~per tubes were used for the wiring of the Rayland's Library in Manchester in 1886. Aluminum 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.

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 of tracks to another. The 'switch', so far as the electric circuit was concerned, 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 of branch switches in circuit wiring. The term 'branch' meant a tee off from a main cable to feed small current-using items. The earliest switchea were of the 'turn' type, in which the contacts were wiped together in a rotary motionto make the circuit. The first switches were really crude efforts: made of wood and with no positive ON or OFF position. Indeed, it was usual practice to make an inefficient contact to produce an arc to 'dim' the lights! Needless to say, this misuse of the 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 'turn' switch eventually gave way to the 'Tumbler' switchin popularity. It came into regular use about 1890. Where the name 'tumbler' originated is not clear; theri{are many sources, including the similarity of the switch actiôıltô the antics of Tumbler Pigeons. Many accessory names, which are household wôrdst8tlie elebtricfüı.ns of today, appeared at the tum of the century: Verity's, McGeoch, Tutike'.t;>anô'€rabtree. Further developments to produce the semi-recessed, the flush, the·abôıily, andthe 'silent' switch proceeded apace. The switches of today are indeed orlông a.:ô.d worthy pedigrees.

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 lamploads 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. 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 k[illegible] cans of the time. Like much 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 bayoriet-cap type of lamp-holder. The early type was soon improved to the lamp holders we know today.

Many sockets were individually fused, a practice, which was later meet the exteaded to the provision of a fuse in the plug.

These fuses were, however, only a small piece of wire between two terminals and caused such a lot of trouble that in 1911 the Institution of Electrical Engineers banned their use. One firm, 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. 'rhis was really the first attempt to 'polarize', orto differentiate between live, earth and neutraLpins.

One 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 aridplugs.

Early fuses consisted of lead wires; le!id 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. Once 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 Bill & Co., Sanders & Co., and the MEM Co., whose 'Kantark' fuses are so well known today. hı 1928 this Company introduced the 'splitter', which affected a useful econcsny in many of the smaller installations.

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 of the old electrical personalities, Compton, Swan, Edison, Kelvin and many others, is well worth notin?; for it is from their brain-children that the present-day electrical contracting industry has evolved to become one of the most important sections of activity in electrical engineering. For those who are interested in details of the evolution and development of elec~ic wiring systems and accessories, good reading can be found in the book by J. Mellanby: The History of Electric Wiring (MacDonald, London).

It was not until the 1930s that the distribution of electricityirı buildings by means of bus bars came into fashion, though the system had been.used as far back as about 1880, particularly for street mains. In 1935 the English Eleötı:föCo. introduced a bus bar trunking system designed to meet the needs of the 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 prödtı.ced and put onto the market by Marryat & Place, GEC, and Ottermill.

1.2. The history of Wiring Installation

The history of the development of non-legal and statutory rules and regulations for the wiring of buildings is no less interesting than that of wiring systems and accessories. When electrical energy received a utilization impetus :fromthe 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 of the 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.

Three months after the issue of the Phoenix Rules for wiring in 1882, the Society of Telegraph Engineers and Electricians (now the Institution of Electrical Engineers) issued the first edition of Rules 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 basis of laying down a set of principles rathetJthan, .as Heaphy did, drawing up a guide or 'Code of Practice'. A second edition ofthe.iSociety's Rules was issued in 1888. The third edition was issued in 1897 and eıtitled<General Rules recommended for Wiring for the Supply of Electrical Energy.

The Phoenix Rules were, however, the better set and Wetı.ftbrôuğh.(many editions before revision was thought necessary. That these Rules contribµte~/t~<ar~etter standard of wiring, and introduced a high factor of safety in the electricakwiring and equipment of buildings, was indicated by a report in 1892, which shôweditfıeihigh 'incidence of electrical fires in the USA and the comparative freedom' froın fires of elebtrical origin in Britain.

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 concerned with the electrical equipment of buildings. 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 bad work is now being carried out by electric light contractors . . .. As the carrying out of bad work is attended by fires and other risks, besides injuring the Trade, they respectfully ask you to.. Uphold a higher standard of work'.

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 if an 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.

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.

CHAPTER2

ILLUMINATION

2.1. Illumination

In determining the value of illumination, not only the candle-power of the units, but the amount of reflected light must be considered for the given location of the lamps. Following is a formula based on the coefficient of reflection of the walls of the room, which serves for preliminary calculations: c. p. 1

$I = 1 - k\, d_2$

I = Illumination in foot-candles.

c.p. = Candle-power of the unit.

k = Coefficient of reflection of the walls.

d = distance from the unit in feet.

Where several units of the same candle-power are used this formula becomes:

1 1 1 1

I = c. p. (d 2+ d 21+ d22 +...) 1-k or, c. p = 1

(1 1 1 1 d2 d21 d22 + ----------) 1-k where d, d1, d2, equal the distances from the point considered *to* the various light sources. If the lamps are of different candle-power the illumination may be determined by combining the illumination from each source as calculated separately; An example of calculation is given under "Arrangement of Lamps." The above method is not strictly accurate because it does not take account of the angle at which the light from each one of the sources strikes the assumed plane of illumination, If the rays of light is perpendicular to the plane, the formula I = c. p. gives cord2 rect values. If a is the angle which the ray. of light makes *with* a line drawn from the light source perpendicular to the assumed plane, then the formula I = c. p. X cosine a/ d_2. Therefore, by multiplying the candle-power value of each light source in the

directtion of the illuminated point by the cosine of each angle a, a more accurate result will be obtained

It is readily seen that the effect of reflected light from. the ceilings is of more importance than that from the floor of a room. The value of k, in the above formula, will vary from 60% to 10%, but for rooms with a fairly light finish 50% may be taken as a good average value

2.2. Calculation of Illumination

The formulates symbols:

Φ_{dir} = the flow of the direct light

Φ_s = the flow coming to working table.

Φ_{end} = the light flow coming by reflexion

E_s = the avarage level of light of working table

S = m^2 of working table

Φ_o = the sum of light flow (lumen)

The calculation of illumination by the light flow method. The calculation of internal illumination by efficiency method. This method is mostly used in internal illumination installations. As it is known the Φ light that cames to plane has the components Φ_{dir} and Φ_{end} (Φ_{dir} shows the flow of the direct light, Φ_s shows the flow coming to working table, Φ_{end} shows the light flow coming by reflexion)

$$\Phi_s = \Phi_{dir} + \Phi_{end} \quad (2.1)$$

Φ_{dir} can be calculated easily but Φ_{end} is difficult to calculate. So that efficiency method is used in internal illumination installations. Now in order to understand this method let's think about an ideal room that it's walls and ceiling reflects the light totally, (δ=%100) and absorbs the light completely.(a. = %100) and no object absorbing the light in it. The Φ_o comes out of the light sources falls on the plane Sand it is absorbed their whatever the dimensions of the room, number of the lambs, settlement of the lambs, illumination system. The average illumination degree of the plane for an ideal room is

$$E_o = \Phi_o / S \quad (2.2)$$

E_0 shows the avarage level of light of working table, Φ_0 represents the total light flow from lambs in lumen and S represents the area of the plane in m^2. In reality some of the light flow is absorbed by walls, ceiling, and illumination devices. So that the average illumination degree of the plane is:

$$E_0 = \Phi_0 \eta / S = \Phi_0 / S \qquad (2.3)$$

η factor is called the efficiency *of* illumination and it is a number less then 1.

$\eta = \Phi_a / \Phi_s$ $\quad \Phi_a$ represents flow of light to plane and

Φ_s represents total fl.ow of light that is given by light sourc~s.

Efficiency of device illumination (η) is multiplication of **the efficiency of devices and efficiency of the room.**

$\eta = \Phi ayg / \Phi_0$ $\quad \eta$ ayg represents the efficiency of device

$\eta = \Phi s / \Phi_{ayg}$ $\quad \eta$ oda represents the efficiency of room

$$\eta = \eta\, ayg - \eta\, oda \qquad (2.6).$$

Efficiency of device is related with the illumination device. Efficiency of the room is related with geometric dimensions of room, reflection factors and colours of walls and ceiling, light distribution curves of illumination devices, height of them to plane and their places. Table 2.1 shows belowed in same situations th.at are used mostly.

Table 2.1: Illumination System

Illuminiation system	Direct illiniiniation (nayg=%70)		Semi-direct illiminiation (nayg=%80)		Mixed illiminiation (nayg=%80)		Semi indirect illiminiation (nayg=%80)		Indirect illiminiation (nayg=%70)	
	n(%)		n(%).		n(%)		n(%)		n(%)	
Room index (a/h)	A	B	A	B	A	B	A	B	A	
0,5	13	9	9	5	12	7	11	6	9	
0,7	19	13	13	7	16	10	15	8	12	
1,0	25	19	17	10	21	13	19	12	15	
	35	30	24	15	27	17	25		20	
	40	36	29	19	32	21	29	19	23	
2,5	44	40	33	23	35	24	32	22		
3,0	47	43	36	26	38	26	35	24	28	8
4,0	51	47	41	30	43	30	39	28	32	0
5,0	54	50	45	:34	46	33	42	30	34	2
	57	53	51	39	51	37	46	34	36	4
10,0	59	55	57	40	55	40	S1	37	38	6

In this Table;

a; lenght of one side of a square room

h; height of light sources to the plane in direct and semi-direct illumination system. . Height of ceiling to the plane in direct; mixed and semi-direct illumination system.A; Situation where is ceiling is white (pr= %75) and walls are quite white (po =%50)

B;>Situation where is ceiling is quite white (pr = %50) and wall are dark (ρD=%30)

If the room is a rectangle (a,b), efficiency is;

$$\eta = \eta_a + 1/3 (\eta_a - \eta_b) \qquad (2.7)$$

While preparing the table 10.1 , only two efficiency about illumination devices (η ayg =%70 and η ayg = %80) is taken.

If another illumination device that has the efficiency η' ayg is used.(η' is an aygıt different from %70, %80 efficensy level) , the efficiency that is fouiıff~~~table is multiplied with a factor of η' ayg / η aygAfter finding the efficiency η , liglıtflow that goes to plane (Φ_o) is found with the help of flow of light by illuminatiollsoutces(<Ds), Then the average illumination level is

$$E_o = \Phi_s / S \qquad (2.8)$$

If the average illumination level of plane is given and total light flow that light sources give (<P0) is looked for;

$$\Phi_o = E_o S / h \qquad (2.9)$$

In below the dimensions of living room are given and number of armatures are found by performing necessary calculation.

Table 2.2: Illumination Units

NAME	SYMBOL!	UNIT	EXPLANATION
Light flow		Lumen(Im)	It is the amount of the total light source gives in all directions. İn other words it is the port of the electrical energy converted into the light energy. That isgiven to light source.
Light intensity	I	candela (cd)	It is the amount of light flow in any direction. (the light flow may be constant but the light indensity may be different in various directions)
Illiminiation intensity	E	lux (lux)	It is the total light flow th.at 66iii~S to 1 m^2 area
flashing	L	cd/cm^2	It is th elight indensity that comes from light sources or unit surfaces that the light sources lighten.

Table 2.3: Illuminiation Equations

EQUATION	SYMBOL	EXPLANATION
n= (l)T/(l)L	N	Number of light bulbs
	(l)T	Total light flow necessary (lın)
	(l)L	Light flow given by a light bulb.
		Room index (according to dimensions)
		Length(m)
		width(m)
		Height of the light source to the working sueface (m)
		Height of the light source to the floor(m)
		Height of the working surfaces to the flôr(nı)
(l)T= E.A.d/ ll	E	Necessary illiminiations level (lux) choseufrom the table
	A	Surface area that will be lighted(m2)
	D	Pallution installmentfactors 1,25 - 1,75
	H	Efficensy factors of the installment it is chosen from the table according to wall, ceiling, fl.or reflexion factors, tipe of armature chosen, room index

Table 2.4: Typical flows of some lamps

TYPE OFLA.MP	POWER OF LAMP (W)	AVERAGE FLOWS (Im)
GLW (G	60	
	100	
FLUORESCANT	18/20	1100
	36/40	2850
	65/80	5600
PL (economic)	9	400
	11	600
	15	900
	20	1200
	23	1500
2D COMPACTFLOURESAN	16	1050
	28	2050
	38	3050
MERCURY (MBF)	50	1800
	125	6300
	400	12250
	1000	38000
MERCURY (MBIF)	250	17000
	1000	81000
H.PRESSURİZED SODİUM (SON PLUS)	100	10000
	400	54000
H.PRESSURİZED SODİUM (SON DELUXE)	150	12250
	400	38000
TUNGTEN HALOJEN	300	5950
	500	11000
	750	16500
	1000	22000
	1500	33000

Table 2.5: Light Sources

Light power	Rated luminous flux
15	120-135
25	215-240
40	340-480
60	620-805
75	855-960
100	1250-1380
150	2100-2280
200	2950-3220

Table 2.6: Hanger Height

Ceiling Height	Area Wideness	Cord Height
	2.0	Ceiling
2.0	4.0	Ceiling
	8.0 and upper	Ceiling
	2.5	Ceiling(0.15)
2.5	5.0	Ceiling (0.15)
	10.0 and upper	Ceiling (0.15)
	3.0	0.4 (0.5)
3.0	6.0	0.25 (0.4)
	12.0 and upper	Ceiling (0.3)

Table 2.7: Bright Voice

Stair, Corridor, Shower and WC $10m^2$	20
Class, Library and Teacher room $40m^2$	80, 80 100, 100 120
Physical and Chemistry Lab. $100m^2$	120

CHAPTER3

INSULATORS

3.1. Insulator

An electrical insulator is a material whose internal electric charges do not flow freely, and which therefore does not conduct an electric current, under the influence of an electric field. A perfect insulator does not exist; but some materials such as glass, paper and Teflon, which have high resistivity, are very good electrical insulators. A much larger class of materials, even though they may have lower bulk resistivity, are still good enough to insulate electrical wiring and cables. Examples include rubber-like polymers and most plastics. Such materials can serve as practical and safe insulators for low to moderate voltages.

Insulators are used in electrical equipment to support and separate electfical côtıdlictors without allowing current through themselves. An insulating material used in bulk to wrap electrical cables or other equipment is called insulation. The term insulator is also used more specifically to refer to insulating supports used to attach electric power distribution or transmission lines to utility poles and transmission towers.

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

The following are some brief descriptions of some of the insulating materials more co.ınmonlyfound in electrical work.

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

3.2. 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.

It :must be used in an impregnated forrnIresin 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.

Itis used for insulators (overhead lines). In glass fiber form .it *is* used for cable insulati.6ıi where high temperatures are present, or where· areas are designated hazardous', Requires a suitable impregnation.(with silicone vamishj.to fill thespaces betweenıthe glass fibers.

This material is used between the segments of commutators ofdeffıachiries,arı.d under slip rings of ac machines. Used where high temperatures are involy~q./şµ.cJ:ıl~ı:1:11.e heatingielemeq.tsofelectric irons. It is a mineral, which is present in mqst(ğrarıit~ı-9çk formanons; generally produced in sheet and block form. Micanite is th() ııa.iı:ıe\giyerıtö the lar·ğe sheets built up from small mica splitting and can be foundba.c.kedwithpaper, cotto,nfabric, silk or glass-cloth or varnishes. Forms include tubes andwashers.

It is 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.

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.

3.3. Insulating oil

This is a mineral oil used in transformers and in oil-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.

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

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

Mineral oil is the most common insulator in liquid form. Others include carbon tetrachloride, silicone fluids and varnishes. Semi-liquid materials include waxes, bitumeas and some synthetic resins. Carbon tetrachloride is found as an arc-quencher in high-vÔltage cartridge type fuses on overhead lines. Silicone fluids are used in transforıners and as dashpot damping liquids. Varnishes are used for thin insulstion 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 basis of the materials known as 'plastics' (polyethylene, polyvinyl chloride, melamine and polystyrene). Natural resins are used in varnishes, and as bonding media for mica and paper sheets hot-pressed to make boards.

CHAPTER4

UPS

4.1. What is UPS?

An uninterruptible power supply, also uninterruptible power source, UPS or battery flywheel backup is an electrical apparatus that provides emergency power to a load when the input power source, typically mains power, fails. A UPS differs from an auxiliary or emergency power system.or standby generator in that it will provide near-instantaneous protection from input power interruptions, by supplying energy stored in batteries .or a flywheel. The on-battery runtime of most uninterruptible power sources is relatively short (only a few minutes) but sufficient to start a standby power source or properly shut down the protected equipment.

A UPS is typically used to protect computers, data centers, telecommunication equipment or other electrical equipment where an unexpected power disruption could cause injuries, fatalities, serious business disruption or data loss. UPS units range in size from units designed to protect a single computer without a video monitor (around 200 VA rating) to large units powering entire data centers or buildings. The '0?~1e'sJ!~r~~st UPS, the 46~megawatt, Battery Electric Storage System (BESS), in Fairbanks., .AK, powers the entire city and nearby rural communities during outages.

4.2. Different types of UPS

Ther"tds much confusion in the marketplace about the different types of UPS systems and their characteristics. Each of these UPS types is defined, practical applications of each are discussed, and advantages and disadvantages are listed. With this information, an educated decision can be made as to the appropriate UPS topology for a given need.

The varied types of UPSs and their attributes often cause confusion in the data center industry, For example, it is widely believed that there are only two types of UPS systems, namely standby UPS and online UPS. These two commonly used terms do not correctly describe many of the UPS systems available.

Many misunderstandings about UPS systems are cleared up when the different types of UPS topologies are properly identified. Common design approaches are reviewed here, including brief explanations about how each topology works. This will help you to properly identify and compare systems.

UPS types

A variety of design approaches are used to implement UPS systems, each with distinct performance characteristics. The most common design approaches are as follows:

* Standby
* Line Interactive
* Standby on-line hybrid
* Standby-Ferro
* Double Conversion On-Line
* Delta Conversion On-Line

4.3 Extended Unfnterruptible Power Supply Benefits

Larger uninterruptiblepower supplies can work in parallel to improve systenı resilien.ce, MTBF (mean time between failure) and availability.

For a network-sized uninterruptible power supply, the installation of an external UPS maintenance bypass enables routine or emergency maintenance to be carried out (without supply disruption) during normal working-hours.

Extended runtime (the time a load is running on back-up power) can be acquired using a combination of extra battery packs and an external standby power source, such as a diesel generator or fuel cell.

4.4 The transformer-based UPS system

While many UPS are transform.erless, organizations reliant on larger datacenter and voice networks, industrial processes, security or hospital applications, often require transformer-based uninterruptible power supply. This gives- greater robustness, albeit with slightly lower efficiency and greater heat and noise generation.

As to the role each type of uninterruptible power supply plays in power protection implementations, choice is down to load category, load size and the level of resilience required and the need for redundancy. UPS systems are grouped by manufacturers like Riello UPS into specific applications such as: IT, network, industrial, enterprise and rackmount.

4.5 ICT Environments

IT typically covers smaller applications (300VA - 3kVA); information and communications technology (ICT) typically, including home PCs, sına.il office/home office and data and voice networks.

UPS for this type of application include off-line, line interactive and on-line designs up to 3kVA. On-line uninterruptible power supplies in this range are transformerless so as to achieve a small footprint, minimal weight and low noise and heat output. They are usually located in computer rooms, next to protected equipment. However, their reduced size means fewer output sockets, so in highly populated environments a greater number may be required, which will have an impact on capital and operating costs.

4.6 Applications

Network applications are typically 3kVA to SOkVA. Corporate data and voice networks such as those run by ISPs (internet service providers) and telecommunication companies fall into this category.

Uninterruptible power supply for this type of application are transformerless, which, again, minimizes size and weight. They act as a centralized power source and are hardwired at both input and output due to the high levels of power required. The UPS may also require connection to a three-phase incomer. The loads themselves are more likely to require three-phase and dedicated power distribution switchgear.

Rackmount applications start from around 700VA all the way up to 30kVA. Rack cabinets have become a common installation format for multiple server projects to reduce space and cable runs in computer rooms. Manufacturers of uninterruptible power supplies have responded by creating rackınount UPS formats from standard product ranges. UPS can be installed in racks that are strong enough to take their weight. A typical rack cabinet has a loading of 150-300kg. In this instance, the UPS often sits next to battery packs (part of the power protection installation) and protected loads. Sometimes UPS and batteries will have their own, dedicated rack.

4.7 Industrial and Enterprise

Industrial or enterprise applications, upwards of 10kVA, are usually for enterprise-wide data and voice networks, industrial processes, security (emergency lighting, fire and security systems) and large hospital applications. They are transformer-based and will have either a 6-pulse or 12-pulse rectifier fitted as standard. The transformer provides robustness but with slightly lower efficiency and higher heat and noise generation.

CHAPTERS

CLOSED ÇffiCUIT TELEVISION CAMERA (CCTV) SYSTEM

5.1 History of Closed-circuit Television

The first CCTV system was installed by Siemens AG at Test Stand VII in Peenemünde, Germany in 1942, for observing the launch of V-2 rockets. The noted German engineer Walter Bruch was responsible for the technological design and installation of the system.

In the U.S. the first commercial closed-circuit television system became available in 1949, called Vericon. Very little is known about Vericon except it wa~ advertised as not requiring a government permit.

CCTV recording systems are still often used at modem launch sites to recotdthe.flight of the rockets, in order to find the possible causes of malfunctions,C6l.[7J.iw11ile/larger rockets are often fitted with CCTV allowing pictures of stage se_pı:t:ratiôııvtoybe transmitted back to earth by radio link.

The history of CCTV in the United States varies from that of the United Kingdom. One of its first appearances was in 1973 in Times Square in New York Çity. The NYPD installed it in order to deter crime that was occurring in the area however crime rates did not appear to drop much due to the cameras.·Nevertheless, during the 1980s video surveillance began to spread across the country specifically targeting public areas.£1°1 It was seen as a cheaper way to deter crime compared to increasing the size of the police departments, Some businesses as well, especially those that were prone to theft, began to use video surveillance.

During the 1990s digital multiplexing, which allowed for several cameras at once to record, and introduced time lapse and motion only recording, increased the use of CCTV across the country and increased the savings of time an money. From the mid 1990s on, police departments across the country installed-an increasing number of cameras in various public spaces including housing projects, schools and public parks departments. Following the September 11 attacks, the use of video surveillance has become a common occurrence in the country to deter future terrorist attacks.

In September 1968, Olean, New York was the first city in the United States to install video cameras along its main business street in an effort to fight crime.

CCTV later became very common in banks and stores to discourage theft, by recording evidence of criminal activity. Their use further popularised the concept. The first place to use CCTV in the United Kingdom was King's Lynn, Norfolk.

In recent decades, especially with general crime fears growing in the 1990s and 2000s, public space use of surveillance cameras has taken off, especially in some countries such as the United Kingdom.

5.2 Closed-circuit television

Closed-circuit television (CCTV) is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though it may employ point to point (P2P), point to multipoint, or mesh wireless links. Though almost all video cameras fit this definition, the term is most often applied to those used for surveillance in areas that may need monitoring such as banks, casinos, airports, military installations, and convenience stores. Videotelephony is seldom called "CCTV" but the use of video in distance education, where it is an important tool, is often so called.

In industrial plants, CCTV equipment may be used to observe parts of a process from a central control room, for example when the environment is not suitable for humans. CCTV systems may operate continuously or only as required to monitor a particular event. more advanced form of CCTV, utilizing digital video recorders (DVRs), provides recording for possibly many years, with a variety of quality and performance options and extra features (such as motion-detection and email alerts). More recently, decentralized IP-based CCTV cameras, some equipped with megapixel sensors, support recording directly to network-attached storage devices, or internal flash for completely stand-alone operation. Surveillance of the public using CCTV is particularly common in many areas around the world including the United Kingdom, where there are reportedly more cameras per person than in any other country in the world. There and elsewhere, its increasing use has triggered a debate about security versus privacy.

5.3 The Influences of CCTV

The characteristics of a system that determine whether it is likely to have a chance of success can be grouped under five headings:

- System objectives
- Management of the project
- Density, camera coverage and positioning of cameras
- Technical characteristics of the CCTV system
- Control room operation

This chapter discusses how the characteristics of the CCTV projects being assessed influenced their capacity to meet their objectives. It can be seen that, whilst some projects were set up so that they met certain objectives some of the time, none achieved all of them.

5.4 Density, Camera Coverage and Positioning

Three factors potentially impacting on the effectiveness of the systems were the density (number of cameras per unit area), the camera coverage (the amount of area that the cameras can see) and the positioning of cameras. Clearly all three are related. The density varied widely from scheme to scheme. Eight to 12 camera systems covered areas, which varied in geographical size from one or two streets to an entire estate, or even several estates. Similarly, the number of cameras installed in town or city centers ranged from nine to 51. One of the main implications of using more cameras is that they cost more to purchase and install. Partnerships bid for varying numbers of cameras from a small system of eight cameras up to the largest, consisting of more than 600. These systems were installed in areas of varying sizes. Whilst capital cost was not the greatest concern for projects bidding for Home Office funding, it is clear that they wanted bids to appear 'sensible' so as to maximize the chances of success and no written home guidance was provided as to what was a sensible level. One partnership felt confident enough to bid for funds to install 154 cameras in a residential area with approximately

3,100 properties. In contrast, a 14-camera system was installed to cover two residential areas and a main road, and one of these residential areas contained only five cameras covering approximately 1,700 properties.

The statistical analysis showed a complex relationship between camera density and reduction of crime in the target area Whilst it is generaly true that the greater the number of cameras, the greater the reduction in crime, it posble to install too many cameras in a small area so that the effect of some is reduced virtually to nil, This occurred in Areas C and D of South cap Estate , and Borough. The above can arise because the level of overlap between cameras becomes too great to be useful.

It is of far more significance that the cameras have the largest possible camera coverage, which is. bro~gh.t about through careful system design. Camera coverage was shown to be important for deterring offenders. Obviously, if the camera can see them then they can see the camera and where it is pointing. There was evidence from the present study to suggest that offenders were aware of the cameras' focus which supports the findings of earlier studies From control room studies it could be seen th.at known individuals tried to hide behind street furniture to avoid the cameras' gaze; in focus groups both members of the public and offenders stated that offenders were aware of. the cameras.

CHAPTER6

LIGHTING

6.1.Light sources

- Characteristics of Light Sources
- Incandescent Lamps
- Fluorescent Lamps
- High-Intensity Discharge Lamps

Commercial, industrial, and retail facilities use several different light sources. Each lamp type has particular advantages; selecting the appropriate source depends on installation requirements, life-cycle cost, color qualities, dimming capability, and the effect wanted. Three types of lamps are commonly used:

- incandescent
- fluorescent
- high intensity discharge
- mercury vapor
- metal halide
- high pressure sodium
- low pressure sodium

Before describing each of these lamp types, the following sections describe characteristics that are common to all of them.

6.1.1.Characteristics of Light Sources

Electric light sources have three characteristics: efficiency, color temperature, and color rendering index (CRI). Exhibit 4 summarizes these characteristics.

6.1.2.Efficiency

Some lamp types are more efficient in converting energy into visible light than others. The efficacy of a lamp refers to the number of lumens leaving the lamp compared to the number of watts required by the lamp (and ballast). It is expressed in lumens per watt. Sources with higher efficacy require less electrical energy to light a space.

6.1.3. Color Temperature

Another characteristic of a light source is the color temperature. This is a measurement of "warmth" or "coolness" provided by the lamp. People usually prefer a warmer source in lower illuminance areas, such as dining areas and living rooms, and a cooler source in higher illuminance areas, such as grocery stores.

Color temperature refers to the color of a blackbody radiator at a given absolute temperature, expressed in Kelvins. A blackbody radiator changes color as its temperature increases first to red, then to orange, yellow, and finally bluish white at the highest temperature. A "warm" color light source actually has a lower color temperature. For example, a cool-white fluorescent lamp appears bluish in color with a color temperature of around 4100 K. A warmer fluorescent lamp appears more yellowish with a color temperature around 3000 K. Refer to Exhibit 5 fol' color temperatures of various light sources.

6.1.4. Color Rendering Index

The CRI is a relative scale (ranging from 0 ~ 100). indicating how perceived colors match actual colors. It measures. the degree that perceived colors of objects, illuminated by a given light source, conform to the colors of those same objects when they are lighted by a reference standard light source. The higher the color rendering index, the less color shift or distortion occurs.

The CRI number does not indicate which colors will shift or by how much; it is rather an indication of the average shift of eight standard colors. Two different light sources may have identical CRI values, but colors may appear quite different under these two sources.

Lighting Glossary

Term	Definition
Accent Lighting	Directional lighting to emphasize a particular object or to draw attention to a part of the field of view.
Absorption	The dissipation of light within a surface or medium.
Accommodation	The process by which the eye changes focus from one distance to another.
Adaptation	The process by which the visual system becomes accustomed to more or less light than it was exposed to during an immediately preceding period. It results in a change in the sensitivity of the eye to light.
Alternating Current (AC)	Flow of electricity which cycles or alternates direction many times per second. The number of cycles per second is referred to as frequency. Most common frequency used in this country is 60 Hertz (cycles per second).
Ambient Lighting	Background or fill light in a space.
Amperes (amps or A)	The unit of measurement of electric current
Back Lighting	The illumination provided for scenery in off-stage areas visible to the audience.
Baffle	An opaque or translucent element that serves to shield a light source from direct view at certain angles, or serves to absorb unwanted light.
Ballast	An auxiliary device consisting of induction windings wound around a metal core and sometimes includes a capacitor for power correction. It is used with fluorescent and HID lamps to provide the necessary starting voltage and to limit the current during operation.
"Batwing" Distribution	Candlepower and distribution which serves to reduce glare and veiling reflections by having its maximum output in the 30° to 60° zone.

Candela — The unit of measurement of luminous intensity of a light source in a given direction.

Candlepower — Luminous intensity expressed in candelas.

Candlepower Distribution Curve — A curve, generally polar, representing the variation of luminous intensity of a lamp or luminaire in a plane through the light center.,

Cavity Ratio — A number indicating cavity proportions calculated from length, width and height.

Class "P" Ballast — Contains a thermal protective device which deactivates the ballast when the case reaches a certain critical temperature. The device resets automatically when the case temperature drops to a lower temperature.

Coefficient of Utilization (CU) — The ratio of the luminous flux (lumens) :from a luminary calculated as received on the work-plane to the luminous flux emitted by the luminaries lamps alone.

Cold Cathode Lamp — An electric-discharge lamp whose mode of operation is that of a flow discharge.

Colorimetry — The measurement of color.

Color Rendering Index (CRI) — Measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source of comparable color temperature.

Color Temperature — The absolute temperature of a blackbody radiator having a chromaticity equal to that of the light source.

Cone Reflector — Parabolic reflector that directs light downward thereby eliminating brightness at high angles.

Contrast — The difference in brightness (luminance) of an object and its background.

Cool Beam Lamps — Incandescent PAR lamps that use a special coating (dichroic interference filter) on the reflectorized potion of the bulb to allow heat to pass out the back while reflecting only visible energy to the task, thereby providing a "cool beam" of light.

Cove Lighting — Lighting comprising sources sheilded by a ledge or horizontal recess, and distributing light over the ceiling and upper wall.

Cutoff Luminaires — Outdoor luminaires that restrict all light output to below 85° from vertical.

Digital Addressable Lighting Interface (DALI) — An open communications protocol used by multiple control and ballast manufacturers for digital control.

Dimming Ballast — Special fluorescent lamp ballast, which when used with a dimmer control, permits varying light output.

Direct Current (DC) — Flow of electricity continuously in one direction from positive to negative.

Direct Lighting — Lighting involving luminaires that distribute 90 to 100% of emmited light in the general direction of the surface to be illuminated. The term usually refers to light emitted in a downward direction.

Direct Glare — Glare resulting from high luminances or insufficiently shielded light sources in the field of view. It usually is associated with bright areas, such as luminaires, ceilings and windows which are outside the visual tasks or region being viewed.

Discharge Lamp — A lamp in which light (or radiant energy near the visible spectrum) is produced by the passage of an electric current through a vapor or a gas.

Discomfort Glare — Glare producing discomfort. It does not necessarily interfere with visual performance or visibility.

Emergency Lighting — Lighting system designed to provide minimum illumination required for safety, during power failures.

Efficacy — See Lamp Efficacy.

Efficiency — See Luminaire Efficiency.

Equivalent Sphere Illumination (ESI) — The level of sphere illumination which would produce task visibility equivalent to that produced by a specific lighting environment.

"ER" (Elliptical Reflector) Lamp whose reflector focuses the light about 2" ahead of the bulb, reducing light loss when used in deep baffle downlights.

Extended Life **Lamps** Incandescent lamps that have an average rated life of 2500 or more hours and reduced light output compared to standard general service lamps of the same wattage.

Fill Light Illumination added to reduce shadows or contrast range.

Floodlighting A system designed for lighting a scene or object to a luminance greater than its surroundings. It may be for utility, advertising or decorative purposes.

Fluorescent Lamp A low-pressure mercury electric-discharge lamp in which a phosphor coating transforms some of the ultraviolet energy generated by the discharge into light.

Footcandle (fc) The unit of illuminance when the foot is taken as:t:he unit. of length. It isthe illuminance on a surface one square foot in area on which there is a uniformly distributed flux of one lumen.

Foot Lambert (fl) A unit of luminance of perfectly diffusing suttace!eınittifiğ or reflecting light at the rate of one lumen per square foot.

Footlights A set of striplights at the front edge of the stage plateforın.iused to soften face shadows cast by overhead Iuminaires and to a.dd general toning lighting from below.

General Lighting See Ambient Lighting.

General Service **Lamps** "A" or "PS" incandescent lamps.

Glare The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance and visibility.

Group Relamping Relamping of a group of luminaires at one -time=or .reduce. relamping labor costs.

High Intensity **Discharge** (HID) A discharge lamp in which the light producing arc is stabilized by wall temperature, and the arc tube has a bulb wall loading in

Lamp excess of three watts per square centimeter. HID lamps include groups of lamps known as mercury, metal halide, and high pressure sodium.

High Output Fluorescent Lamp Operates at 800 or more milliamperes for higher light output than standard fluorescent lamp (430MA}.

High Pressure Sodium (HPS) Lamp High intensity discharge (HID) lamp in which light is produced by radiation from sodium vapor. Includes clear and diffuse-coated lamps.

Incandescence The self-emission of radiant energy in the visible spectrum. due to the thermal excitation of atoms or molecules.

Incandescent Lamp A lamp in which light is produced by a filament heated to incandescence by an electric current.

Instant Start Fluorescent Lamp A fluorescent lamp designed for starting by a high voltage without preheating of the electrodes.

Inverse Square Law The law stating..that the illuminance at a pgin\g~}."~~~~ff varies directly with the intensity of a point so~rc~,.:,~~/İn]ft~~ly as the square of the distance between the sourcean.dtlıepoint.1£ the surface at the point is normal to the direction of the incident light, the law is expressed by fc=cp/d2..

Kelvin Unit of measurement for color temperature. The>K.elvffı.iscale starts from absolute zero, which is -273° Celsius.

Kilowatt-Hour (KWH) Unit of electrical power consumed over a period of time. KWH = watts/1000 x hours used.

Lamp An artificial source of light (also portable luminaire equipped with a cord and plug).

Lamp Efficacy The ratio of lumens produced by a lamp to the watts consumed. Expressed as lumens per watt (LPW).

Lamp Lumen Depreciation (LLD) Multiplier factor in illumination calculations for reduction in the light output of a lamp over a period of time.

Light Radiant energy that is capable of exciting the retina and producing a visual sensation. The visible portiorı- of the electromagnetic spectrum extends from about 380 to 770 nm.

Lens — Used in luminaires.to redirect light into useful zones.

Local Lighting — Lighting designed to provide illuminance over a relatively small area or confined space without providing any significant general surrounding lighting.

Louver — A series of baffles used to shield a source from view at certain angles or to absorb unwanted light. The baffles usually are arranged in a geometric pattern.

Long Life Lamps — See Extended Life Lamps.

Low Pressure Sodium Lamp — A discharge lamp in which light is produced by radiation of sodium vapor at low pressure producing. a single wavelength of visible energy, i.e. yellow.

Low Voltage Lamps — Incandescent lamps that operate at 6 to 12 volts.

Lumen — The unit of luminous flux. It is the luminous fl.me. e:rnitt6cFwitliin a unit solid angle (one steradian) by a pöfut>sôurcehaving a uniform luminous intensity of one candela.

Luminaire — A complete lighting unit consisting of a lamp otla.hips fôgetb.et with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply.

Luminaire Direct Depreciation (LDD) — The multiplier to be used in illuminance provided by clean, new luminaires to the reduced illuminance that they will provide due to direct collection on the luminaires at the time at which it is anticipated that cleaning procedures will be instituted.

Luminaire Efficiency — The ratio of luminous flux (lumens) emitted by a luminaire to that emitted by the lamp or lamps used.

Luminance — The amount of light reflected or transmitted by an object.

Lux — The metric unit of illuminance. One Iuxis one luneiiper square meter (lm/m2).

Maintenance Factor (MF) — A factor used in calculating illuminance after a given period of time and under given conditions. It takes into account temperature and voltage variations, dirt accumulation on luminaire and room surfaces, lamp depreciation, maintenance procedures and atmosphere conditions.

Mercury Lamp A high intensity discharge (HID) lamp in which the major portion of the light is produced by radiation from mercury. Includes, clear, phosphor-coated and self-ballasted lamps.

Metal Halide Lamp A high intensity discharge (HID) lamp in which the major portion of the light is produced by radiation of metal halid~s.and their products of dissociation-possible in combinatipıı..'\yith metallic vapors such as mercury. Includes clear and phosphor coated lamps.

Nadir Vertically downward directly below the luminaire or lamp; designated as 0°.

Overall Length (OAL) Maximum overall length of a light fixture.

"PAR" Lamps Parabolic aluminized reflector lamps which offer excellent beam control, come in a variety of beanı p~ttFrııs from very narrow spot to wide flood and can be used.putdo°:rs unprotected because they are made of "hard" glass that can withstand adverse weather.

Parabolic Louvers A grid of baffles which redirect light dowııWard< arid provide very low luminaire brightness.

Photometry The measurement of light quantities.

Point Method Lighting Calculation A lighting design procedure for predetermining the illuminance at various locations in lighting installations, by use of luminaire photometric data.

Polarization The process by which the transverse vibrations of light waves are oriented in a specific plane. Polarization may be obtained by using either transmitting or reflecting media.

Power Factor Ratio of: Watts (volts x amperes) Power factor in lighting is primarily applicable to ballasts. Since ygıt~.. f1-11~••"Y~~.~ ıu-e usually fixed, amperes (or current) will go ~ga~. p9'\yefifactor goes down. This necessitates the use of larger wire sizes to carry the increased amount of current needed· with -Lowe Power Factor (L.P.F) ballasts. The addition of a capacitor to an L.P.F.

ballast converts it to a H.P .F. ballast.

Preheat Fluorescent **Lamp** — A fluorescent lamp designed for operation in a circuit requiring a manual or automatic starting switch to preheat the electrode in order to start the arc.

"R" Lamps — Reflectorized lamps available in spot (clear face) and flood (frosted face).

Rapid Start **Fluo**rescent Lamp — A fluorescent- lamp designed for operation with a ballast that provides a low-voltage winding for preheating the electrodes and initiating the arc without a starting switch or the application of high voltage.

Raw Footcandles — See Footcandles.

Reflection — Light bouncing off a surface. In specular reflection the light strikes and leaves a surface at the same angle. Diffuse reflected light leaves a surface in all directions.

Reflectance — Sometimes called reflectance factor. The ratio ofre:fl~cted light to incident light (light falling on a surface). Reflectance is generally expressed in percent.

Reflected Glare — Glare resulting from specular "reflections of high luminances in polished or glossy surfaces in the field of view. It usually is associated with reflections from within a visual task or areas in close proximity' to the region being viewed.

Reflector — A device used to redirect the light flow from a source by bouncing it off the surface.

Refraction — The process by which the direction of a ray of light changes as it passes obliquely from one medium to another in which its speed is different.

Room Cavity Ration (RCR) — A number indicating room cavity proportions calculated from length, width and height.

Rough Service **Lamps** — Incandescent lamps designed with extra fila11J.enfsii._ppôrt~ to withstand bumps, shocks and vibrations with some loss in lumen output.

Self-ballasted Mercury Lamps Any mercury lamp of which the current-limiting device is an integral part.

Silver Bowl Lamps Incandescent "A" lamps with a silver finish inside the bowl or portion of the bulb. Used for indirect lighting.

Spacing Ratio Ratio of the distance between luminaire centers to the mounting height above the work-plane for uniform illumination.

Spectral Energy Distribution (SED) Curves A plot of the level of energy at each wavelength of a light source.

Sphere Illumination The illumination on a task from a source providing equal luminance in all directions about that task, such as an illuminated sphere with the task located at the center.

Surface Mounted Luminaire A luminaire that is mounted directly on a ceiling.

Suspended (Pendant) Luminaire A luminaire that is hung from a ceiling by supports.

Task Lighting Lighting directed to a specific surface or area that provides illumination for visual tasks.

Three-Way Lamps Incandescent lamps that have two separately switched filaments permitting a choice of three levels or light such as 30/70/100, 50/100/150 or 100/200/300 watts. They can only be used in a base down position.

Transformer A device to raise or lower electric voltage.

Transmission The passage of light through a material.

Tungsten-Halogen Lamp A gas filled tungsten incandescent lamp containing a certain proportion of halogens.

Veiling Reflections Regular reflections superimposed upon diffuse reflections from an object that partially or totally obscure the details to be seen by reducing the contrast. This is sometimes called reflected glare.

Vibration Service Lamps See Rough Service Lamps.

Visual Comfort Probability (VCP) The rating of a lighting system expressed as a percent of people who, when viewing from the specified location and in a specified direction, will be expected to find it acceptable in terms of discomfort glare.

Visual Edge The line on a isolux chart which has a value equal to 10% of the maximum illumination.

Visual Field The field of view that can be perceived when the head and eyes are kept fixed.

Wall Wash Lighting A smooth even distribution of light over a wall.

Watt (W) The unit for measuring electric power. It defmesthe power or energy consumed by an electrical device.. 'l'lıf.e9st,9foperating an electrical _device is determined by the -wa~~;i~. consumes times the•. hours·or use. It is related to volts\and amps by the following formula: Watts = Volts x Amps.

Zonal Cavity Method Lighting Calculation A lighting design procedure used for predeterıııu~~Atlıe relation between the number and types of lamps orluminairesıthe room characteristics, and the average illuminanc~ on 'the work-plane. It takes into account both direct and reflected flux.

CHAPTER7

CABLES.

7.1. Types of Cables

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.

Type of cables used:

1. Single core cable
2. Two-core cable
3. Three-core cable
4. Composite cable
5. Power cable
6. Wiring cable
7. Overhead cable
8. Equipment cable
9. Appliance Wiring cable
10. Twin Twisted cable
11. Three-Core Twisted

12. Twin Circular cable

13. Three Core

14. Coaxial cable

15. Tel. cable

7.1.1 Single-core

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

The synthetic rubbers are provided with braiding and are self-colored. The IEE Regulations recognize these insulating materials for twin-and multi-core':flexiblecables rather than for use as single conductors in conduit or trunking wiriı ıisvsteıns.But that are available from the cable manufacturers for specific insulatio:fi.~equiteme:rıts. Sizes vary from 1 to 36 mm squared (PVC) and 50 mm squared (synthetic rubbers).

7.1.2 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.

7.1.3 Three-core

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

7.1.4 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, 'andthe electrician, at one time or another during his career, may be asked to install them.

7.1.5 Wiring cables

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

7.1.6 Power cables

Heavy cables, generally lead sheathed and armored; control cables for electrical equipment. Both are 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 andfireproofing are features of cables for this application field.

7.1.7 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.

7.1.8 Overhead cables

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

7.1.9 Communication cables

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

7.1.10 Welding cables

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

7.1.11 Electric-sign cables

PVC-and rubber-insulated cables for high-voltage discharge lamps abletowithstand the high voltages.

7.1.12 Equipment wires

Special wires for use with instruments often insulated with specialnıa'.tefialssuch as silicon, rubber and irradiated polythene.

7.1.13 Appliance-wiring cables

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

7.1.14 Heating cables

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

7.1.15 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 ate 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 PVCMinsulated conductors are not provided with additional protection.

II;Three-core (twisted): Generally as two -twisted cords but with1ithirdcörtd11ctor coloredgreen, 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 form a uniform cable with rubber or PVC.

Vl.Twin-core (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 t¢r.tn.iıals/öfJamp holder can reach 71 centigrade or more. hı 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 instanee, to welding plant.

IX.Coaxiel cables {antenna cable): Antenna cables are a special cable which is used to transfer high frequency. Coaxial cable is a type of flexible cables. We use this cable 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. These cables are very slim. Telephone cables are not same as electric cables -. There are a lot of sizes the telephone cables. Telephone cables are 0.5mm and every time one cable is extra neerthis cahlesi

Table 6.1: Telephone cables sizes

lx2+0.5 mm"
2x2+0.5mm~
3x2+0.5 mm"
4:x2+0.5mnr'
6:x2+0.5mm2
10x2+0.5 mm'
15x2+0.5 mın2
20x2+0.5 mnr'

7.2 Conductor Identification:

The wiring regulations require that all conductors have to be iderıtified by some meaning to indicate their functions i.e. phase conductors of a 3 phase system are colored by red, yellow, blue with neutral colored by black, protective conductors are identified by green or yellow and green.

- In Turkey Standards;

Red	Phase
Black	Neutral
Green	Earth

- There are some methods to identify the conductors:

1. Coloring of the conductor insulation
2. Printed numbers on the conductor
3. Colored adhesive cases at the termination of the 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. on a distribution board.

- Cables sizes: Cables are in different common sizes 0.75 rrıın.2, tn:ıın2, 1.5 mnr', 2.5 mm2, 4 mm2, 6 mm2, 10 mnr', 16 mnr', 25 mm2, 35J:ii:rn.2.f<5ôfü:trı2.;i'7ö mnr', 95 ının2, 120 mm', 150 ının2, 185 mm2, 240 mnr', 300 ri'lilı.2.:n4ôöJ:ii:rn.%/a.11d 500 mm.2.

CHAPTERS

PROTECTION OF ILLUMINATION

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 fürth.er 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 iti such a fashion that's person and or dive stock are protected from the dangerht.is th.af such an electrical installation may create.

8.1.Reasons for protections

8.1.1 Mechanical Damage

Mechanical damage is the term used to describe the physical ha.rm susta.ins by various parts of electrical sets. Generally it happens by impact hitting da.hm wit:11. a hammer, 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 trunking and casing)

8.1.2.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)

8.1.3.Corrosion:

Wherever metal is used there is often the attendant problem of corrosion and it's prevented(There are two necessary preventions for corrosion:

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

b-) Prohibition of soldering fluxes which remains acidic or corrosive at the compilation of a 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 côndītiôus.

8.1.4 Over current

Over current, excess current the result of either and overload or a shorfc:iföuit.)'f.he 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 short-circuit. Short circuit is a direct contact between live conductors

a-) Neautral condactor. (Fuse)

b-) Earthed metal work (Operators)

8.2 Protectors of Over Current

a-) Fuses

b-) Circuit Breakers

8.2.1 Fuse

A devi.e. for opening a circuit by means of a conductor designed to melt when an excessive current flows along it.

There are three types of fuses.

a-) Rewrieable

b-) Cartridge

c-) HBC (High Breaking Capacity)

8.2.1 a Rewireable Fuse:

A rewireable fuse consists of a fuse, holder, a fuse element and a.fuse carrier. The holder and carrier are being made porselain or bakelite. These fusesha.vedesigned'With color codes, which are marked on the fuse holder as follows;

Table 7.1: Fuse current rating and color

Current Rating	Color Codes
SA	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.

8.2.1 b Cartridge Fuse

A cartridge fuse consists of a 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.

8.2.1 c High -Breaking Capacity (HBC)

It is a sophisticated variation of the cartridge fuse and is nomıally 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 disorlmlrıate between a starting surge and an overload.

8.2.2.Circuit-breakers

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

Whereas a switch is capable of making and breaking a current notgreatlyd:ı:ı.excess of its rated normal.current, the circuit-breaker can make and break a circuit, particularly in abnorınal conditions such as the occasion of a short-circuit in an installation. It thus disconnects automatically a faulty circuit.

A circ~t breaker is selected for a particular duty, taking into consideration the following.

(a) The normal .currentit will have to carry

(b) The amount of current 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 of the device) employs a solenoid, which is au air-cooled coil. In the hollow of the coil is located an iron cylinder attached to a trip mechanism consisting of a series of pivoted links. When the circuit breaker is closed, the main current will pass through the solenoid. When the circuit rises above a certain value (due to an overload or a fault), the cylinder moves within the solenoid to cause the attached linkage to collapse and, in turn, separate the circuit-breaker contacts.

Circuit breakers are used in many installations in place of fuses because of a 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 adjustedto suit the load conditions of the circuit to be controlled. Time-lag devices can also be introduced so that the time taken 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 takes 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 of HBC (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 alternative to the fuse, and has certain advantages: it can be reset or reclosed easily; it gives a close 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 as a 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.

One main disadvantage of the MCB is the initial cost, although it has the long-term advantage, There is also tendency for the tripping mechanism to stick or 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.

8.3 Values of fuses;

6A, lOA, 16A, 20A, 25A, 32A, 40A, 50A, 63A.

8.4 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.

8.5 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 th.at 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 of the points, which the inspecting electrician should look for:

1) Flexible cables not secure at plugs.
~) Frayed cables.
3) Cables without mechanical protection.
4) Use of unearthed metalwork.

5) Circtiits over-fused.

6) P.por or broken earth connections and especially sign of corrosion.

7) Unguarded elements of the radiant fires.

8) {Unauthorized additions to fuıal 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-wireysed to carry mains voltages.

12,) Use of portable heating appliances in bathrooms.

13,)Broken connectors, such as plugs.

1.4) Signs of heating at socket-outlet contacts.

The following are the requirements for electrical safety:

1) Ensuring that all conductors are sufficient 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 ofnıa.inibonding 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 equipmenthas 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.

lO)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 eaıth 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.

CHAPTER9

EARTIDNG

9.1. Earthing

In electricity supply systems, an earthing system uefines the electrical potential of the conductors relative to. the Earth's conductive surface. The choice of earthing system can affect the safety and electromagnetic compatibility of the power supply, and regulations can vary considerably among countries. Most electrical systems connect one supply conductor to earth .If a fault within an electrical device connects a hot supply conductor to an exposed conductive surface, anyone touching it while electrically connected to the earth will complete a circuit back to the earthed supply conductor and receive an electric shock.

A protective earth, known as an' equipment grounding conductor in the US National Electrical Code;'avoids this hazard by keeping the exposed conductive surfaces of a device at earth potential. To avoid possible voltage drop no current is allowed to flow in this conductor'under·normal circumstances, but fault currents will usually trip or blow the fuse or circuit breaker protecting the circuit. A high impedance line-to-ground fault insufficient to trip the overcurrent protection may still trip a residual current device if one is present.

In contrast, a functional earth connection serves a purpose other than shockprotection, and may normally carry current. Examples of devices that use functional earth connections 'include surge suppressors and electromagnetic interference filters,·certain antennas and measurement instruments. But the most important example of a functional earth is the neutral in an electrical supply system. It is a current-carrying conductor connected to earth, often but not always at only one point to avoid earth currents. The NEC calls it a grounded supply conductor to distinguish it from the equipment grounding conductor.

In most developed countries, 220/230/240V sockets with earthed cohtacts were introduced either just before or soon after WW2, though with considerable national variation in popularity. In the United States and Canada, 120 volt power outlets installed before the mid 1960s generally did not include a ground pin. In the developing world, local wiring practice may not provide a connection to an earthing pin of an outlet.

In the absence of a supply earth, devices needing an earth co;nnection.>öftei:ı used the supply neutral. Some used dedicated ground rods. Many 1 lOV<appliatı.ces have polarized plugs to maintain a distinction between live and neutra, hıitusinğthe supply neutral for equipment earthing can be highly problematical. Live aı:ı.dneutfalfm.iğh.fcl)e accidentally reversed in the outlet or plug, or the neutral-to-earth conneetiğ11Vnıiğht.Iail or be improperly installed. Even normal load currents in the n.eütra.f:\\rrı.igijfi!g~rı~f~t~ hazardous voltage drops. For these reasons, most countries/ ha.ve now mandated dedicated protective earth connections that are now almost universal.

9.2. Earthing Safety

In TN, an insulation fault is very likely to lead to a high short-circuit current that will trigger an overcurrent circuit-breaker or fuse and disconnect the L conductors. With TT systems, the earth fault loop impedance can be too high to do thist or too high to do it quickly, so an RCD (or formerly ELCB) is usually employed. :.{'he provision of a Residual-current device (RCD) or ELCB to ensure safe disconriection makes these installations EEBAD (Earthed Equipotential Bonding and Automa.tic]Disconnection). Earlier TT installations may lack this important safety feature;iallğ wing the CPC (Circuit Protective Conductor) to become energized for extendedip~:riqc:lşunder fault conditions,which is a real danger.

In TN-S and TT systems (and in 1N~C-S beyond the point current device can be used as an additional protection. In the absence fault in the consumer device, the equation IL1+IL2+IL3+IN = 0 disconnect the supply as soon as this sum reaches a threshold An insulation fault between either L or N and PE will trigger probability.

In IT and 1N-C networks, residual current devices are far less likely tQ cleteçt an insulation fault. In a TN-C system, they would also be very vulnerable·to.1.:mwanted triggering from contact between earth conductors of circuits on different R.CDs or with real ground, thus making their use impracticable. Also, RCDs usually isolate the neutral core. Since it is unsafe to do this in a TN-C system, RCDs on TN-C should be wired to only interrupt the live conductor.

In single-ended single-phase systems where the Earth and neutral are combined (TN-C, and the part of TN-C-S systems which uses a combined neutral and earth core), if there is a contact problem in the PEN conductor, then all parts of the earthing system beyond the break will rise to the potential of the L conductor. In an unbalanced multi-phase system, the potential of the earthing system will move towards that of the most loaded live conductor. Such a rise in the potential of the neutral beyond the break is known as a neutral inversion,[1] Therefore, TN-C connections must not go across plug/socket connections or flexible cables, where there is a higher probability of Contact problems than with fixed wiring. There is also a risk if a cable is damaged, which can be mitigated by the use of concentric cable construction and multiple earth electrodes. Due to the (small) risks of the lost neutral raising 'earthed' metal work to a dangerous potential, coupled with the increased shock risk from proximity to good contact with true earth, the use of TN-C-S supplies is banned in the UK for caravan sites and shore supply to boats, and strongly discouraged for use on farms and outdoor building sites, and in such cases it is recommended to make all outdoor wiring TT With RCD and a separate earth electrode.

In IT systems, a single insulation fault is unlikely to cause dangerous currents to flow through a human body in contact with earth, because no low-impedance circuit exists for such a current to flow. However, a first insulation fault can effectively tum an IT system into a TN system, and then a second insulation fault can lead to dangerous body currents. Worse, in a multi-phase system, if one of the live conductors made contact with earth, it would cause the other phase cores to rise to the phase-phase voltage relative to earth rather than the phase-neutral voltage. IT systems also experience larger transient overvoltages than other systems.

In TN-C and TN-C-S systems, any connection between the combined neutral-and-earth core and the body of the earth could end up carrying significant current under normal conditions, and could carry even more under a broken neutral situation. Therefore, main equipotential bonding conductors must be sized with this in mind; use of TN-C-S is inadvisable in situations such as petrol stations, where there is a combination of lots of buried metalwork and explosive gases.

9.3 Electromagnetic Compatibility

In 1N-S and TT systems, the consumer has a low-noise connection to earth, which does not suffer from the voltage that appears on the N conductor as a result of the return currents and the impedance of that conductor. This is of particular importance with some types of telecommunication and measurement equipment.

In TT Systems, each consumer has its own connection to earth, and will not notice any currents that may be caused by other consumers 011 a shared PE line

9.4 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 of a cable or flexible cord incorporating such a conductor.

9.5 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.

9.5.1 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, etc.).

It is explained in BS Code of Practice 6651 that the 'zone of protection' of a 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 of the structure which comes within a cone extending to 60 meters in diameter at ground level. Care is therefore necessary in ensuring that the whole of a 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.

The 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 of the 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 of a 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 soft annealed copper strip and interconnect the various air terminations. Down conductors, between earth and the aırteıminattorıs areialso 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 ma~s of earth. Down conductors are secured to the face of the 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 lO ohms. But in the case of important buildings, seven ohms is the maximum resistance. Because the effectiveness of a 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 cöntıectiô:ri, which: is inexpensive, simple in construction and easy to install. These. eartlısfWlıen. 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 clamping 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.

9.5.2. Anti-static Earthing

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

9.5.3. Earthing Practice

A routine inspection and test should be made once a year and any defects remedied, In the case of a 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.

9.5.3 a. 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 of this potential difference depends on the line voltage, the substation or supply transformer earth resistance, the line resistance, the fault resistance, and fmally, 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 return of earth-fault current to the neutral of the supply system rather than as a means of direct connection to earth.

The 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.

The 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 a.ls() be designed to accommodate thermally the maximum fault Current during the 'time it takes 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 of the 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 manufücfutersiTheseratings are based on the short-time current rating of the associated protective devices and a maximum temperature, which will not cause damage to the earthCônfıectiörısör to the equipment with which they may be in contact.

In general soils have a negative temperature coefficient of i'esistari.ce. Sustained current loadings result in an initial decrease in electrode resistance arid a.Consequentrise in the earth-fault current for a given applied voltage. However, as tb.eın.öisture 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 of the electrode.

The current density of the electrode is found by:

$$\text{Current density} = I / A\sqrt{t} = 92 \times 10^3 \qquad (4.1)$$

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 of 25 °C, and the use of high-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 harm telephone and pilot cables (whose co.resiir~ 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 concerned. 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 period 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 itis 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 sometir 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 of joints 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. Cotı.tactihetweenbare copper and the lead sheath or .amıoring 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 solid or the lattice type. Because of their mass, they tend to be costly. With the steel or cast-iron types care must he taken to ensure that the termination of the earthing lead to the plate is water-proofed to prevent cathodic action taking place at the joint, If this happens, the conductor will eventually become detached from the plate and render the electrode practically useless. Plates are usually installed on edge inJahôleiinthe ground about 2~3 meters deep, which is subsequently refilled with .soil.\Because one plate electrode is-seldom sufficient to obtain a low-resistance earth connection,.the cost of excavation associated with this type of electrode can be oonaiderableefntaddition, due to the plates being installed relatively near the surface of the ground; the resistance value is liable to fluctuate throughout the year due to the seasonal changes in the water content of the soil. To increase the area of contact between the plate .and the surrounding ground, a layer of charcoal can be interposed. Coke, which is sometimes used as an alternative to charcoal, often has a high sulphur content, which can lead to serious corrosion and even complete destruction of the copper. The use of hygroscopic salts such as calcium chloride to keep the soil in a moist condition around the electrode can also lead to corrosion.

b) Rods. In general rod electrodes have many advantages over other types· of electrode in that they are less costly to install. They do not require much space, are convenient to test and do not create large voltage gradients because the earth-fault current is dissipated vertically. Deeply installed electrodes are not subject to seasonalresista:ııcelchan.ges . There are several types of rod electrodes. The solid coppet<födi gives excellefit conductivity and is highly resistant to corrosion. But it tends to be expensiveaμô/beinğ relatively soft, is not ideally suited for driving deep into· heavy soils because it1s,likely to bend if it comes up against a large rock. Rods made from galvanizedCsteeFate inexpensive and remain rigid when being installed. However, the life6:f ğalvanizedsteel in acidic soils is short. Another disadvantage is that the copper ea:rthinğ1ea.d côrıtıection to the rod must be protected to prevent the ingress of moisture. Thecô:ii~ıfotivityôfsteel is much less than that of copper, difficulties may arise, particularlyunde:rlieavyfault current conditions when the temperature of the electrode wilts rise}and\therefore its inherent resistance.

This will tend to dry out the surrounding soil, increasing its tesistiwty·value and resulting in a. general increase in the earth resistance of the electrode.In fact, in very severe fault conditions, the resistance of the rod may rise so :rapicllyia.nd. to such an extent that protective. equipment may fail to operate.

The bimetallic rod has a steel core and a copper. exterior arıff(ôffers\the best alternative to either the copper or steel rod. The steel core gives the necessary rigidity while the copper exterior offers good conductivity and resistance to.icôrrôsfon.. In the extensible type of steel-cored rod, aııd rods made from bard-drawn copper, steel driving caps are used to avoid splaying the rod end as it is being driven into the soil. The first rod is also provided with a pointed steel tip. The extensible rods are fitted with bronze screwed couplings. Rods should be installed by means of a power driven hammer fitted with a special head. Although rods should be driven vertically into the ground, an angle not exceeding 60° to the vertical is recommended in order to avoid rock or other buried obstruction.

c) Strip. Copper strip is used where the soil is shallow and overlies rock: It should be buried in a trench to a depth of not less than 50 cm and should not be used where there is a possibility of the ground being disturbed (e.g. on farmland). The strip electrode is most effective if buried in ditches under hedgerows where the bacteriological action arising from the decay of vegetation maintains a low soil resistivity.

d) Earths mat, These consist of copper wire buried in trenches up to one meter deep. The mat can be laid out either linearly or in 'star' form and terminated at the down lead from the transformer or other items of equipment to be earthed. The total length of conductor used can often exceed 1.00 meters. The cost of trenching alone can be expensive. Often scrap overhead line conductor was used but because of the increasing amount of aluminum now being used, scrap copper conductor is scarce. The most common areas where this system is still used are where rock is present near the surface of the soil, making deep excavation impracticable. As with plate electrodes, this method of earthing is subject to seasonal changes in resistance. Also, there is the danger of voltage gradients being created by earth faults along the lengths of buried conductor, causing a risk to livestock.

9.6 Important Points of Earthing:

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

I. To allow current to flow to earth in the event of a fault so that, the protective gears will operate to isolate the faulty circuit.
II. To make sure that in the event of a fault, apparatus "Normally death (0V)" cannot reach a dangerous potential whit respect to earth.

9.7. 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;

1mA-2mA	Barely perceptible, no harmful effects
5mA-10mA	Throw off, painful sensation
10mA-15mA	Muscular contraction, cannot let go

20mA-30mA Impaired breathing

50mA 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.

9.8. 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. following are the individual-tests prescribed by the Regulations.

9.8.1. Circuit-protective 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 JEE Regulations Guidance Notes on inspection and testing give advice on the recogni means used to test the CPC. For each final circuit, the CPC forms part of the earth-loop impedance path, 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-metre length is 5 milliohms/m.

Generally if the total earth-loop impedance (Zs) for a particular final circuit is within the maximum Zs 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.

9.8.2. Reduced A.C. 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 of the mains supply.
resistanee of the test lead, a value for impedance of 0.5 ohm uu,ı,,ıı,.uuw.u i).l.lvu,,u
obtained where the CPC, or part of it, is made from steel ....,~.".."..".
or in part made of copper, copper-alloy, or aluminum, the uu,,a.uuUJ.H

9.8.3. Direct current

Where it is not convenient to use a.c. for the test, ne. 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 of the CPC. Subject to the requirements of the total earth-loop impedance, the maxirnum values for impedance for the CPC sliôuld be 0.5 ohm (if of steel) or one ohm (if of copper, cöpper;.allôyor aluminum).

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 cur.tent}'.and finally with low current. The low-current tests should be made with atı instrumen.t/delivering not more than 200 mA into one ohm; the high-current test should be made at<10\0:A or such higher current as is practicable.

The open-circuit voltage of the test set should be less tlian 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.

9.8.4. Residuaf current devices

IEE Regulation 713-12-01 requires that where an RCD piövides<ptotection against indirect contact, the unit must have its effectiveness tested by the simtılation of a fault condition, This test is independent of the 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 foruse.Thus, on pressing the 'Test' button the unit should trip immediately. If it does not.it ınaydndicate that a fault exists and the unit should not be used with its associated socket-wu.tlet,partictı.larly if the outlet is to be used for outdoor equipment.

The RCD has a normal tripping current of 30 mA and an öperatlıg time not exceeding 40 ms at a test current of ~50 mA.

RCD testers are commercially available, which allow a range of tripping currents to be applied to the unit, from 10 ınA 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 beuse.d other than 'that essential to the welfare of livestock'.

9.8.5 Earth-electrode resistance area

The general mass of earth is used in electrical work to maiıifaiıthe potential of any part of a system at a definite value with respect to earth (usually taken as zero volts). It also allows a current to flow In the event of a fault to e~rtlı,'.sc>'tl:ıat protective gear will operate to isolate the faulty circuit. One particular aspectôfthe earth electrode resistance area is.that its resistance is byno means constant. It varie.s~th.theamount of moisture in the soil and is therefore subject to seasonal and otherichanges. As the general mass of earth forms part of the earth-fault loop path, 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 futa 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 of these factors vary locally. The following table shows some typical values of soil resistivity.

Table 4.1: Soil 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, and clayey 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.

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:

$$R=V/I \tag{4.2}$$

The procedure is the same in each case. An auxiliary electrocleisidrivenfoto the ground at a distance of about 30 meters away from the elec'ti:gdf?/uhdertest (the consumer's electrode). A third electrode is driven midway betwey11.iJ:ı.¢ırı.':ÇcJ.ensurethat the resistance area of the first two electrodes does not overlap, Jhç./Jlıircl electrode is moved 6 meters farther from, and nearer to, the electrode undf?rJ~ştli.'.fh.e.threetests should give similar results, the average value being taken as the. n:ı.~~:11,ıı-esistance of the earth electrode.

One disadvantage-of using\the simple method of earth.¢ı@çtj_'()c.lç.resistance measurement is that the effects of e:tnfs(owing to electrolytic ac~io11.jnt!ıe§9il)have to be taken into.account when testing. Also, there is the possibility PMstr~yçarth currents being leakages from local distribution systems. Because of thişpit\iş tısμal.to use a commercial instrument, the Megger earth tester being a typical ex~ırıpJ¢,

9.8.6 Earth-fault loop impedance

Regulation 113-11-01 stipulates that where earth-leakage r~li~sonthe.·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.vvilLtıotabscılvethe con.tractor from his legal responsibilities for the safe and effective operation of protection equipment which he may install as part of a 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 path right back to the consumer's earthing terminal is effective and will enable the protective equipment to operate under fault conditions.

9.8.7 Phase-earth **loop** test

This test closely simulates the condition which would aris¢)shôuld.an.earth-fault occurs. The instruments·used for the test create an artificial faulftôi.eı:ı.rtb. between the 'me and earth conductors, and the fault current, which is limited.ihyar~şi.storör some other means, is allowed to flow for a very short period. During thi.s time, .there is a voltage drop across the limiting device, the magnitude of which depeııds ôrıthe yalue of the earth loop. The voltage drop is used to operate an instrument movement, with an associated s~ale 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 batlı diğitalreadouts and analogue scales, and incorporate indications of the circuit conditiöhi(cdtrect polarity anda proven earth connection). The readings are in ohms and represeııfthe earth-loop impedance (Zs). Once a reading is obtained, reference must be made tô.ilEE:R.egulations Tables 41Bl to 41D, which give the maximum values of Zs whichtefettô:(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 Zs 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 Zs indicated in the Tables are maximum values, which must not be exceeded if the relevant circults 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 rests made by the same tester will produce readings, which are c?rrelate_d.

CONCLUSION

The computer program, Auto-Cad takes an İmportant place in engineering field in of facilities on providing the computer technology to develop. Therefore, we got interior installation, loading schedule, column diagram with preferring Auto-Cad computer program when drawing this project, and also we used Microsoft office program.

We have investigated some other hotel projects for being a-,var~}~f~~~~;;cııtrent projects before we have started to construct this project. This projectsh()wed.rμe.to .get different facilities about business life in this field. And then we determined ıny target for my job in the future. We have applied my theoretical knowledge'tö practical work. In this project, all regulations of Turkey standards have been appli6tlVet)' ctıtefully. As a result, we tried to do our best for constructing the project. We are sure that you will find it good when you examine.it,

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