NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

LIGHTNING ROD

Graduation Project
EE-400

Student: Adnan Diab (991055)

Supervisor: Asst. Prof. Kadri Bürüncük

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

In this thesis, first Lightning is studied. Lightning is defined. and history of lightning is reviewed . facts about lightning is given in detail and when lightning occurs are discussed in this chapter. Then lightning safety rules are listed and finally how lightning kills the peopel are discussed in detail.

Main topic of this thesis is the lightning rod and it discussed in chapter three. In the introduction part historical developments and founder of the lightning rod is studied. Then definition is given and principles of lightning rod are listed. Types of lightning rod (Franklin Bar, Faraday Cage, and Radioactivity Holding End) are listed and studed in detail. All the components are given and installation procedures are explained. Cost for typical systems are given and how a lightning protection system works is explained.

Finally with the help of these informations the situation in Near East University is investigated and suggested installations are given with the required cost.

Chapter 1
INTRODUCTION

1.1 Introduction

Lighting rod is the most important device that human has invented since many centuries because of the need of this device to protect the human, animals, buildings, computer networks and electrical systems, etc from the lightning effects which can damage a lot of things and cause a lot of losses for the whole world.For a long time a lot of scientists have worked hard to provide a way to avoid the huge damage and the dangers of lightning. Therefore, to find the way they started studying the Nature of Lighting and during that time they had a lot of questions about this phenomenon.Where it comes from? How can they protect things from it and more and more... until Benjamin Franklin came and he answered many of these questions from his observations. When he suspected that lightning was an electrical current in nature, and he wanted to see if he was right, one way to test his idea would be to see if the lightning would pass though metal. He decided to use a metal key and looked around for a way to get the key up near the lightning. He used a child toy; a kite to prove that lightning is really a stream of electrified air, known today as Plasm. This famous stormy kite flight in June of 1752 led him to develop many of the term that we still use today when we talk about electricity battery, conductor, condenser, charge, discharge, plus, minus, electric shock. Ben understood that lightning was very powerful, and also he knew that it was dangerous, that's why he also figured out to protect people, buildings and ships from it.The Lightning Rod since the days of Benjamin Franklin there has been confusion surrounding the utility of Lightning Rods. The major question is that how they protect us, and what kind of rods work best?Franklin initially believed that his rod effectively - Beld. The charge outs of the clouds itself and thus prevented lightning from ever occurring. In this he was in error. Though lightning rods especially pointed ones, do produce the current from their tips, some thing called Corona Current. When they are enveloped in an enhanced electric field, they are hardly capable of draining the charge from such a natural monster as a thundercloud. Instead the purpose of Lightning Rod is to give the lighting strike a good ground target. If the rod is properly attached to the earth, grounded a lightning strike will travel through the rod and down to the ground safely.

The real debate about lightning rods these days concerns the shape of the tip due to geometrical enhancement of the electric field around the lightning rods tip - a blunt tip - may be better than a sharper tip. After knowing the nature of lightning the scientists went step forward to produce more developed protection devices such as - early streamer emission (ESE). Lightning protection systems are a relatively new approach to the Perennial problem of lightning damage. And these systems may hold promise for a more effective protection against lightning, However, the scientific and technical basis for this improved performance is far from certain and the efficiency of these technologies remain open to question.The ESE devices considered here are lighting attractors and in this sense, their purpose is the same as that of conventional lightning rods.ESE device, however differ from Conventional Lightning Rods in that they are equipped in some fashion to increase the efficiency of the lightning attraction and there by to extend the effective range of protection over and above that of Conventional Lightning Rods.

1.2 History of Lightning Rod

Original protection can ultimately be traced back to Benjamin Franklin in 1752.

As impressive as Franklin's accomplishments were as public servant, it was his contribution to the comfort and safety of our daily life. Which can consider even more remarkable from his early experimentations with electricity came a revolutionary invention, lightning rod.

For well over 200 years now, this product has continued to advance by using more modern material and techniques.

However, the essential design and function of the lightning rod is the same as it was back when Franklin first invented it. Its sole purpose is to divert the potentially life threatening blast of approximately 50 million volts of electrical current as it is released in the form of lightning bolt upon a standing structure.

Ben also developed another device to help him understand electricity, called lightning bells, the bells would jingle when lightning was in the air, and following are two descriptions. In September 1752, erected and iron rod to draw the lightning down into my house in order to make some experiments on it, with two bells to give notice when rod should be electrified. A contrivance was obvious to every electrician.

In 1760 when Franklin completed his experiments, installations start to be used commonly named Franklin bar. Even the interest to this topic made Franklin's bar to be used on ladies hats or on umbrella as in pallestive way. And after another protection system in 1884 is called Faraday's Cage. In a conductive cage of Faraday, intensity that takes electricity is zero. Belgian physician Melsen was inspired by Faraday.

Protection with radioactivity holding ends in 1914, when Madam Curie discovered the radium, many researchers were interested in the topic and tried to do various different applications and during this time more of protection system have been developed lately. Early Emission Streamer (ESE) lightning protection system are likely new approach to the perennial problem of lightning damage and these systems may hold promise for a more effective protection against lightning.

In his experiment, he theorised that clouds are electrically charged; from which it follows that lightning must also be electrical. The experiment involved Franklin standing on an electrical stand, holding an iron rod with one hand to obtain an electrical discharge between the other hand and the ground. If the clouds were electrically charged then sparks would jump between the iron rod and a grounded wire, in this case, held by an insulating wax candle.

Thomas Francois Dalibard of France successfully performed this experiment in May 1752 when sparks were observed to jump from the iron rod during a thunderstorm. G. W. Richmann, a Swedish physicist working in Russia during July 1753, proved that thunderclouds contain electrical charge, and was killed when lightning struck him.

Before Franklin accomplished his original experiment, he thought of a better way to prove his hypothesis through the use of a kite. The kite took the place of the iron rod, since it could reach a greater elevation and could be flown anywhere. During a Pennsylvania thunderstorm in 1752 the most famous kite in history flew with sparks jumping from a key tied to the bottom of damp kite string to an insulating silk ribbon tied to the knuckles of Franklin's hand. Franklin's grounded body provided a conducting path for the electrical currents responding to the strong electric field build up in the storm clouds.

In addition to showing that thunderstorms contain electricity, by measuring the sign of the charge delivered through the kite apparatus, Franklin was able to infer that while the clouds were overhead, the lower part of the thunderstorm was generally negatively charged.

Little significant progress was made in understanding the properties of lightning until the late 19th century when photography and spectroscopic tools *became available for lightning research.*

Lightning current measurements were made in Germany by Pockels (1897-1900) who analysed the magnetic field induced by lightning currents to estimate the current values. Many experimenters used time-resolved photography during the late 19th century to identify individual lightning strokes that make up a lightning discharge to the ground.

Lightning research in modern times dates from the work of C.T.R. Wilson who was the first to use electric field measurements to estimate the structure of thunderstorm charges involved in lightning discharges. Wilson, who won the Nobel Prize for the invention of the Cloud Chamber, made major contributions to the present understanding of lightning.

Research continued at a steady pace until the late 1960's when lightning research became particularly active. This increased interest was motivated both by the danger of lightning to aerospace vehicles and solid state electronics used in computers and other devices as well as by the improved measurement and observational capabilities which were made possible by advancing technology.

2.3 Definition of Lightning

The way in which lightning beings within a cloud is still a difficult process to explain and subject continual debate in the scientific literature. How ever one can say by definition that lightning is generated in thunder storms as thunder and lightning are both products of the electrical discharge a positive charge is concentrated in the ice phase at the top of the thunder storm cloud, often resulting in an alignment of the ice crystals that can be observed with remote sensing equipment. The base of the cloud contains the negative charge.

In addition there is evidence which suggests that there are also a few coulombs of positive charge at the cloud base. The negative charge is concentrated in a temperature band between -10 - 25 C as the cloud grows and becomes deeper the separation of these charges increase, strengthening the electrical activity. But although electric fields in thunderstorms are large, they are not great enough to cause electrical break down in laboratory conditions, so other mechanism must play a part.

The convective activity (up ward and down ward motions) which deepens the cloud can also contribute to increased charging through collisions between ice crystal and small hail (groupel) in the presence of super cooled water drop lets which exist in aliguid state below zero Centigrade. A number of studies have considered the importance of super cooled water to lightning generation and high flash rates.

In the absence of ice, and in a shallow cloud, the electric field growth is slow, charges on cloud particles are low and lightning is produced only rarely. For the interested reader a more comprehensive review of the processes involved in lightning is presented in as scientific statement produced by Royal meteorological society and the summary here is largely is view of this statement.

2.4 Lightning forms:

It may be occur as cloud to cloud (CTC), cloud to air (CTA) or cloud to ground (CTG), with (CTA) and (CTA) typically occurring up to 90 minutes prior to the CTG activity. The high electrical currents in lightning strokes ((typically 20000 A)) heat the air sufficiently to cause rapid expansion. The channel can be heated to as high as 30 000 oC in a matter of seconds. The resulting shock wave is heard as a thunder and the flash is seen as a result of the effect of the electrical discharge on the gases through which this current travels.

In the CTG lightning the channel travels towards the surface generally, as a weak negative leader, attracted by positively charged objects on the ground. A positive leader from the ground can often be seen travelling up to meet downward strokes. When the channels is complete the return stroke occurs.

Lightning mainly brings negative charge to the earth's surface, although some discharges can occur from the tops of the cloud anvil that over hangs the main part of the cloud, bringing positive charge to the ground.

The balance between the negative charge brought to the ground and positive charge in the atmosphere leads to voltage difference of around 300 KV in the earth-conducting layer.

((bonded some 70Km from the surface)).

While the current within a strike is high the average current per thunderstorm is low, and therefore not a possible candidate for efficient energy generation, as the move imaginative environment list may have thought.

In fair weather there is a leakage of current from the earth back into the air that keeps the current flows equilibrium.

2.5 Facts about Lightning

- Packs between 35,000 to 40,000 amperes of current.
- Can generate temperature as high as 50,000 degree celsius.
- Falls somewhere on the earth every second.
- Travels as far as 40 miles.
- Kills nearly 100 people each year in the U.S. and injures hundreds of others.
- Can, and does strike the same place twice.
- Causes billions of dollars in property damage each year, many times resulting in fire and total

property loss.

2.6 When lightning occurs?

Lightning occurs when the difference between the positive and negative charges - the electrical potential - becomes great enough to overcome the resistance of the insulating air and to force a conductive path for current to flow between the two charges. Electrical potential in these cases can be as much as 100 million volts.

Lightning strokes proceed from,

- Cloud to cloud,
- Cloud to ground,
- Or where high structure are involved, from ground to cloud.

2.7 Lightning Safety rules

In the event of an approaching storm seek shelter immediately. If you're unable to find shelter in a building or residence that is equipped with a lightning protection system.

The following safety guidelines are suggested.

1- I doors;

- Stand clear from windows, doors and electrical appliances.
- Don't attempt to unplug T.V.'s, Stereos, computers, etc. During a storm.
- Do not use the telephone except for emergencies.

2- out doors:

- Look for a shelter equipped with a lightning protection system, like those found at the golf courses, public parks and pools.
- Never use a tree as shelter.
- Avoid areas that are higher than the surrounding landspace.
- Keep away from metal objects including bikes, golfcards, fencing, machinery, etc.
- Avoid standing near tall objects.
- Immediately get out and away from pools.
- Lakes and other bodies of water.
- If you're in a crowd - spread out.

- If you feel a tingling sensation, or your hair stands on end, lightning may be about to strike! Immediately crouch down and cover your ears. Do not lie down or place your hands on the ground.
- If you're with a group of people spread out; the chance of "attracting" a lot as a group increase.
  - For anybody near or in a body of water during a storm, the rule of thumb is to get as far away from the water as possible. A lone water skier or swimmer becomes an inviting target. Lightning seeks the path of least resistance and water and metal preferred conductors.
  - The winning strategy when playing is: If you hear thunder it is important for people to understand the severity of lightning strikes. Lightning offers no second chance, for children especially, coaches and parents must raise their awareness on the importance of taking shelter as a storm approaches.
  - If you hear thunder or see flashes of lightning in the distance- it's to call it a game.

If you plan to be outdoors, check the latest weather forecast and keep a weather eye on the sky. At signs of an impending storm-towering thunderheads, darkening skies, lightning, increasing wind-tune in your NOAA Weather Radio, AM-FM radio, or television for the latest weather information.

When a thunderstorm threatens, get inside a home, a large building, or an all-metal (not convertible) automobile. Do not use the telephone except for emergencies.

If you are caught outside, do not stand underneath a tall isolated tree or a telephone pole. Avoid projecting above the surrounding landscape. For example, don't stand on a hilltop. In a forest, seek shelter in a low area under a thick growth of small trees. In open areas, go to a low place, such as a ravine or valley.

Get off or away from open water tractors and other metal farming equipment or small metal vehicles, such as motorcycles, bicycles, golf carts, etc. Put down golf clubs and take off golf shoes. Stay away from wire fences, clotheslines, metal pipes, and rails. If you are in a group in the open, spread out, keeping people several yards apart.

Remember lightning may strike some miles from the parent cloud. Precautions should be taken even though the thunderstorm is not directly overhead. If you are caught in a level field or prairie far from shelter and if you feel your hair stand on end, lightning may be about to strike you. Drop to your knees and bend forward, putting your hands on your knees. Do not lie flat on the ground.

2.8 HOW LIGHTNING KILLS

Lightning, which consists of electrical current flowing at a rate that has been measured in thousands of amperes and at millions of volts, can cause fatal injuries in five different ways.

2.8.1 DIRECT STRIKES

Injuries are caused, when an individual is hit directly by the lightning discharge. Usually these injuries, especially if they occur to the head, are fatal.

2.8.2 SIDE FLASHES

Injury may occur if an individual affords a better ground or is at a different ground potential than the nearby object that has just been struck. A side flash or "spark" will actually jump from a tree or other target, to then strike the nearby victim.

2.8.3 CONDUCTING CURRENTS

Injuries caused by conducted currents range from painful zaps to the eardrum while talking on the telephone during a storm, to being electrocuted while touching trees, poles, fencing or other electrically conductive items.

2.8.4 STREAMER CURRENTS

Injuries are sustained when low level ground currents shoot upward from people or other nearby targets during a lightning strike. Usually flowing at approximately 1,000 amperes, such streamers will then join the main current column. Streamer currents usually cause headaches and a feeling of sickness and dizziness, but they could be fatal to a victim who is in poor health.

2.8.5 STEP VOLTAGE

Step voltage consists of ground currents flowing outward from an object that has been struck. The magnitude of step voltage depends on several factors, such as the amount of the current flow, the victim's proximity to the strike, and the conductivity of the soil. In rocky or gravelly soils, (which are poor conductors of electrical current) ground currents may extend over a large area. In areas that have more conductive clay or loam soils, ground currents are dissipated more rapidly.

2.9 Lightning Triggering Summary of 1997

The following tables are the summary of the thunderstorm activities at Langmuir Laboratory during the summer of 1997-98. The times are approximately given Greenwich Mean Time.

Date	Time	Triggers/attempts	What was hit?	Data available
July 4	4:3Opm-5:3Opm	0/1	-	No
July8	1:lSpm-2:3Opm	1/7	Coal	No
July 8	4:OOpm-5:OOpm	3 / 4	Glass beads Puflballs coal	No
July 9	3:45pm-4:3Opm	2/5	#5 mixture Puftballs	No
July16	11:lSpm-1:OOpm	3/6	Beeswax rock gypsum sand	No
July17	12:lSpml:4Opm	0/1	-	No
July 17	3:OOpm-4:OOpm	1/2	Cane sugar	No
July 20	5:3Opm-6:45pm	1/4	Concrete	No
August 5	2:45pm-5:OOpm	6/13	Glass pebbles blunt rod (twice) cane sugar beet sugar glass pebbles	
August 10	3:45pm-4:25pm	1/ 4	Glass pebbles blunt rod	Yes
August 14	2:OOpm-2:2Opm	0/0	-	Yes
August 14	4:30pm-5:00pm	0 /1	-	Yes

Table 2.1: Thunderstorm Activity at Langmuir Lab in 1997

Date	Time	Triggers/Attempts	Lightning Rod struck	Remarks
July 6	1900Z-2100Z	0/1 (2022Z	-	2.40" of rain, pea-sized hail
July 9	0030Z-0130Z	0/0	-	Storm pass over Sawmill Canyon
July 17	0200Z-0400	0/0	-	70-80mph winds!
	1800Z-2030Z	0/1 (1953Z)	-	1 failed launch, pea-sized hail
July21	1730Z-1900Z	0/0	-	Pea-sized hail
July 26	2250Z-OOOOZ	0/0	-	Pea-sized hail
July27	2300Z-O1OOZ	0/0	-	
August4	2015Z-2130Z NW	0/0	-	Pea-sized hail, 10 km to

Table 2.2: Summary of the thunderstorm activity at Langmuir Laboratory during the summer of]998

Chapter3

LIGHTNING ROD

3.1 Introduction

3.1.1 Introduction:

Lighting rod is the most important device that human has invented since many centuries. Because of the need of this device to protect the human, animals, buildings, computer networks and electrical systems, etc. From the lightning effects which can damage a lot of things and cause a lot of losses for the whole world.

Since long time ago a lot of scientists have worked hard to provide a way to avoid the huge damage and the dangers of lightning. Therefore, to find the way they started studying the Nature of Lighting and during that time they had a lot of questions about this phenomenon.

Where it comes from? How can they protect things from it and more and more... until Benjamin Franklin came and he answered many of these questions from his observations. When he suspected that lightning was an electncal current in nature, and he wanted to see if he was right, one way to test his idea would be to see if the lightning would pass though metal. He decided to use a metal key and looked around for a way to get the key up near the lightning. He used a child toy; a kite to prove that lightning is really a stream of electrified air., known today as Plasm.

This famous stormy kite flight in June of *1752* led him to develop many of the term that we still use today when we talk about electricity battery, conductor, condenser, charge, discharge, plus, minus, electric shock. Ben understood that lightning was very powerful, and also he knew that it was dangerous, that's why he also figured out to protect people, buildings and ships from it.

Since the days of Benjamin Franklin there has been confusion surrounding the utility of Lightning Rods. The major question is that how they protect us, and what kind of rods work best?

Franklin initially believed that his rod effectively - Beld. The charge out of the clouds itself and thus prevented lightning from ever occurring. In this he was in error. Though lightning rods especially pointed ones, do produce the current from their tips,

some thing called Corona Current. When they are enveloped in an enhanced electric field, they are hardly capable of draining the charge from such a natural monster as a thundercloud. Instead the purpose of Lightning Rod is to give the lighting strike a good ground target. If the rod is properly attached to the earth, grounded a lightning strike will travel through the rod and down to the ground safely.

The real debate about lightning rods these days concerns the shape of the tip due to geometrical enhancement of the electric field around the lightning rods tip - abut tip

- may be better than a sharper tip. After knowing the nature of lightning the scientists went step forward to produce more developed protection devices such as - early streamer emission (ESE). Lightning protection systems are a relatively new approach to the Perennial problem of lightning damage. And these systems may hold promise for a more effective protection against lightning, However, the scientific and technical basis for this improved performance is far from certain and the efficiency of these technologies remain open to question.

The ESE devices considered here are lighting attractors and in this sense, their purpose is the same as that of conventional lightning rods.

ESE device, however differ from Conventional Lightning Rods in that they are equipped in some fashion to increase the efficiency of the lightning attraction and there by to extend the effective range of protection over and above that of Conventional Lightning Rods.

3.1.2 Who Found Lightning Rod:

BENJAMIN FRANKLIN (1706-1790)

The Franklin Stove

Benjamin Franklin was probably the most significant "founding father" of the United States of America who never served as its President. But he was much more than a statesman: he was a man of letters, a publisher, a philosopher, a scientist, and the first major American inventor.

Franklin was born in Boston in 1706. At age 12, he was apprenticed to his older brother James, a printer; but Franklin resented being ordered about, and so five years later he virtually ran away from home. He moved to Philadelphia, then London, then back to Philadelphia, where he established his own printing office (1728). Like his

Contemporary inventor Benjamin Banneker, Franklin used his polymathic knowledge to publish an almanac ("Poor Richard: An Almanack " - 1732-58).

In 1748, Franklin retired from printing, in order to devote himself fully to various aspects of biology and physics that had captivated him for some time. His most famous experiment, of course, was flying a kite with a key attached to its string, proving that lightning carries an electrical charge (1752). Franklin had by then already invented the lightning rod, which he primarily intended for use atop ships, not houses.

Afier he reached 40 years old, Franklin needed to wear glasses for reading as well as for everyday nearsightedness. In order to save himself the trouble of constantly switching between them, he cut the lenses in half horizontally, and joined the tops of his everyday lenses to the bottoms of his reading glasses, thereby inventing the world's first bifocal glasses.

Franklin also conceived the mid-room furnace, the "Franklin Stove." In those days rooms could only be heated with a fire in a fireplace, which by definition was set into a wall. Franklin knew that, since heat radiates from a fire in all directions, a fireplace was inefficient. So he built a cast-iron furnace that could be placed in the middle of a room. The heat it generated spread out in all directions, and was also absorbed by the furnace's iron walls, so that the stove provided warmth even afier the fire went out.

However, Franklin's design was flawed, in that his furnace vented the smoke from its base: because the furnace lacked a chimney to "draw" fresh air up through the central chamber, the fire would soon go out. It took David R. Rittenhouse, another hero of early Philadelphia, to improve Franklin's design by adding an L-shaped exhaust pipe that drew air through the furnace and vented its smoke up and along the ceiling, then into an intramural chimney and out of the house.

Franklin's other inventions include an odometer and first known medical catheter. In addition, he first conceived a number of institutions, including the American Philosophical Society (1728), first American Fire Department (1736), and what became the University of Pennsylvania (1742). He was Philadelphia's first Postmaster General (1736), and of course played a major role in the formation of the United States of America. One of the last roles he played before his death at age 84 in 1790 was President of the Pennsylvania Society for Promoting the Abolition of Slavery.

Benjamin Franklin was a true philosopher in the earliest sense of the word:
interested in all aspects of the natural world, including mankind's place in it, he learned through his own experimentation and his conversation with those who shared his interests; and he showed little interest in patenting or profiting from the things he invented and discovered. Scientifically speaking, he may be the best role model that 21st-century American inventors could find.

3.2 History of Lightning Rod

Original protection can ultimately be traced back to Benjamin Franklin in 1752. As impressive as Franklin's accomplishments were as public servant, it was his contribution to the comfort and safety of our daily life. Which can consider even more remarkable from his early experimentations with electricity came a revolutionary invention, lightning rod.

For well over 200 years now, this product has continued to advance by using more modern material and techniques.

However, the essential design and function of the lightning rod is the same as it was back when Franklin first invented it. Its sole purpose is to divert the potentially life threatening blast of approximately 50 million volts of electrical current as it is released in the form of lightning bolt upon a standing structure. Ben also developed another device to help him understand electricity, called lightning bells, the bells would jingle when lightning was in the air, and following are two descriptions. In September 1752, erected and iron rod to draw the lightning down into my house in order to make some experiments on it, with two bells to give notice when rod should be electrified, A contrivance obvious to every electrician.

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Protection with radioactivity holding ends in 19~4, when Madam Curie discovered the radium, many researchers were interested in the topic and tried to do various different applications and during this time more of protection system have been developed lately Early Emission Streamer (ESE) lightning protection system are likely new approach to the perennial problem of lightning damage and these systems may hold promise for a more effective protection against lightning.

3. 3 Definition of Lightning Rod

A lightning rod is only one part of the entire lightning protection system. Quite it is a conductive metal Rod, which is start glacially, installed on the structure design to safety the powerful electric blast of lightning Rod bolt.

So lightning protection system is designed to control force of electrical 'ge on a specific path harmlessly. Disputing the current in to the ground and zing the change fire or explosion with nonconductive parts of house the system attracts nor repels a lightning strike, but provides a safe path on which the flow.

3.4 The Principle of Lightning Protection

The most basic and in the protection of life and property against lightnjng, is to provide a means where a lightning discharge ca n enter or leave the Earth without resulting in be offered where the damage or loss. Impedance paths offered by building materials such as wood, brick, tile, stone or concrete.

When lightning follows the higher impedance path, mechanical forces generated during the passage of the discharge may cause damage. Most metal, being good electrical conductors, are virtually unaffected by either heat or the mechanical forces, if they are of sufficient size to carry the current that can be expected. The metal path must he continuous from the ground terminal to the air terminal.

Care should be exercised in the selection of metal conductors for an extended period. A non-ferrous metal such as copper or aluminium will provide, in most atmospheres, a lasting conductor free of the effects of rust or corrution. The parts of structures most likely to be struck by lightning are the that project above the surroundings parts such as chimneys, ventilators, flag polls, towers, water tanks, deck railings, shafi houses, sky lights, and paraphats.

he edge of the roof is the part of the structure most likely to struck on flat-roof buildings.

3.5 Types of lightning rod:

3.5.1 Franklin Bar

In 1760 when Franklin completed his experiments, installation started to be used commonly, named Franklin bar. Even the interest to this topic, made Franklin's bar to be used on ladies hats or on umbrellas in palletise way.

The primary years when Franklin Bar was applied, it was expected that the affect the radius is equal to double the height of the bar and base is circle and this cone is protecting its volume. (The physician Charles and Gray Lussac) this value is changed today to; equal to its won height radius, with cone volume. Because of its limited activity, it is considered for very special structures in practice like minaret, tower etc. But in all methods the basic principal is, atmospheric pressure is palletised with such kind of system.

3.5.2 Faraday Cage

In a conductive cage of Faraday, intensity that takes electric is 0 (zero). Belgian physician Melsen, inspired by Faraday's such study and in 1884, palletised small sharp ends and tried to surround it with Faraday's cage. This study is the only application until today. But to have the use of this cage, it is seen that it is used gradually with more wide openings, more distances and bad transmission quality wires. It is unnecessary to insist that such type of Faraday obtain protection. Unfortunately, now a days buildings like explosive material depots and hydrocarbon depots, which are "protected" with such type of Faraday's Cages.

Schaffer's, explains the second reason of the bad operation of Faraday Cage which used lightning rod: Generally it is forgotten that the cage has to surround the whole building and the horizontal surface, which touches the ground. And the closing on this face of cage is trusted to the conductivity of the ground. This conductivity is insufficient in many conditions. As a typical example Mont Blanc observatory can be shown which is covered with copper panel and equipped with holding ends. Observatory, in spite of all these precautions, exposed to may lightning strokes, which even caused death accidents. Mont Blanc observatory is built on a thick layer, which cannot be under estimate, and this layer has good duty for insulation. This cage only includes the roof and walls; therefore it is not surprising that it cannot obtain whole protection. Because its highly cost and difficulty, this method is reduced to more simplified level which can just obtain a relatively protection.

3.5.3 Radioactivity Holding Ends

Protection with radioactivity holding ends in 1914, when Madam Curie discovered the radium, many researchers were interested in the topic and tried to do various different applications. The most interesting one of those is Radioactivity Holding Ends, which is certified by the Hungarian Physicist Szilard.

In this system the ionisation effect of radiation material obtains the holding discharge at near by ends very early and obtains low electric fields to become real. This advantage, R. Conductor (lightning rod) gives opportunity to protect wide fields.

The amount of radioactive material, which is used at R. Conductors change in a ratio with the size of field, which is protected, but this change is limited. Instead of very high increment of radioactive material, in protection diameter because of some limitations at nature it is determined that there is 0 increment. At the production it is planed that, the protection diameter of protection should be maximum 200 m.

At first, the radioactive holding ends, isotopes were used which had wide energy spectrum like Radium. At these isotopes the 0: small pieces which ahs more ionic effect, it forms the working principle of radioactive holding ends. In time, Cripton-85 that is loaded electronically, cc pieces sources are also used. In recent years specially produced radioactive sources are produced which only makes cc publications. Am-241 is such kind of source, which has no effect on human health (comparing to Ra-226). The radioactive holding ends, which are imported to our country, Ra-226 element spreads other rays at various energies other than cc pieces. These rays don't contribute to the operation of conductor. But for the living beings in the environment, carries small risk. The Am-24 1, which is, used now on radioactive holding ends only spreads cc pieces, beside this they have Gamma rays whose energy is very small (around 50 Kev). Pieces are mass, which are equal to helium nucleus owning 2 positive loads. The pieces, which are spreaded by Am-24 1, moves in the air by making ionisation with 5MeV energy. cc Pieces spend their energy to create ion clouds, and the effects of the electric field which is between the sharp ends, creates second ions and depending on this, current channels

as well which groves like a snowball. A study which is conducted at A.E.K (this study is presented as notification at an International forum) published a report at the electric field intensity of Franklin bar (rod) where there is no current, it is determined that there is a current which is going through radioactive material equipped rod. And this is a very important result, which shows the superiority of radioactive holding end. In the last radioactive holding end model a basic physics rule is used and this obtained the production and direction of ion productivity.

Basically if we look to this event more simple. Radioactive holding end is not different than the Franklin rod. Instead of a very high rod, to create it with loaded pieces does not change the installation of equipment than the Franklin Rod installation. Therefore, the calculations are done in the same way in projects.

3.6 Components of Lightning Rod

1) Air Terminals: In conspicuous cylinder rod installed on the roof at regular intervals as defined by industry standards.

2) Conductors: Aluminium or Copper cables that inter connect the air terminals and the other system components. Both copper and aluminium are used for the installation of lightning rod systems. There is little argument that coppers is the material of choice because it is a better conductor of electricity.

If aluminium is used in an installation, the cable has to be larger than the copper cable to conduct the same amount of current.

When ever possible, we specify the use of copper in the protection system because its is a better material and its physically stronger. The copper cable is smaller and thus less conspicuous and blends in better with most architectures, such as against brick walls and dark roofs there are times when it is preferable to use aluminium, since aluminium and copper are of dissimilar metals, they tend to corrode each other. We would specify aluminium in the following exceptions.

- If your roof were made of bare aluminium or bare galvanised steel.
- If your buildings were very light coloured and the use of dark copper cable would be unattractive.

If the absolute lowest were the only considerations.

- Aluminium and copper never be used where it will come in contact with white wash. calcium or alkali - base paints, as these are most injurious to aluminium.
- Aluminium and copper material should not be used together unless approved time tallic connectors are used.
- Copper grounding equipment is always used with aluminium systems.
-Aluminium should never be placed where liquids or moisture will collect and remain for a long period of time.

3) Ground Terminations: Metal rods driven into the earth to guide the lightning current harmlessly to ground.

4)Surge Arrestors and Suppressors: Devices that are installed in conjunction with a lightning protection system to protect electrical wiring and electronic systems and equipments.

3.7 How to Select the Right Approved Lightning Rod Components for YOUR Home

Study the accompanying drawings and determine your roof type or combinations of types. Measure and make a diagram of your home. Indicate path of Cable and grounding points where the Ground Rods should be installed.

Show the position of your TV antenna and indicate where the mast will be bonded to the main cable run. Show the position of your chimney and where it will be tied in.

From your drawing you can now determine the length of cable needed, and the necessary fittings needed to support the cable and to tie in branches to the main cable run. Crimp Straight Splkers are used to connect the ends of cables to each other. Crimp Tee Splicers connect branches to main cable. These are crimped over the cable with pliers.

Cable must be supported every three feet by Cable Holders, both on the roof and on its downward course.

Using the order form and your drawing, you can now determine the type and amount of material needed.

3.8 COST OF LIGHTNING ROD

The cost of a lightning protection system varies depending on the size of your home, the rooflines, and the soil depth and conditions. In general, though, our experience shows the prices in the following table to be average. Factors that affect the price include the following:

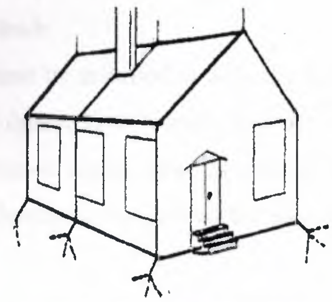
Least expensive	**Most expensive**
Straight roof lines	Complex roof shape
Good working conditions	Bad conditions
Few chimneys	Many chimneys
Few dormers/cupolas	Many dormers, etc.
Gradual slop/low roof	Steep ,high roof
Clay loam/sand ground	Bedrock near surface
Asphalt	Clay tiles, slate, metal, cedar shingles

Types and prices of some Lightning rods are listed in the following table. Table 3.1 Types and prices of some Lightning rods

TYPE	ROOF AREA	DO-IT YOURSELF	FULLY INSTALLED
Smaller home	up to 1500 sq. ft	\$400 - \$900	Price on average
Mid-sized home	1500 - 3000 sq. ft	\$600- \$1,700	is about \$1.00
Larger home	3000 sq. ft and up	\$1,500 & up	per sq. ft

Table 3.1 Types and prices of some Lightning rods

3.9 Typical House Lightning Installation Procedure



Protection of a house by a Faraday cage

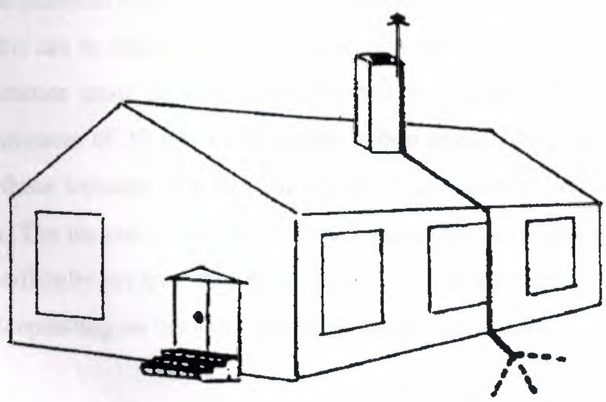
Fig .1

Positioning the lightning rod

Generally speaking, all lightning conductors must be positioned on the highest point of the building or buildings to be protected. Collective antennas can, in certain cases, be used as supporting masts, providing the radioactive head of the lightning conductor extends by at least one metre beyond the highest antenna. Inversely, HELITA extension-mast units can be used as supports for TV aerials, without any staying. (Maximum height: 7,50 metres).

Securing the lightning conductor

All methods of securing depending on the structure of the materials (concrete, wood, metal).



Protection of a house by a radio-active lightning conductor

Fig.2

Lead

The leads must be installed along the most direct route, avoiding all sudden bends and all upward bends (piercing of acroteria, passage through cornices) and making sure that all the outside metal parts situated less than a metre away are electrically connected to the leads.

Furthermore, all lightning conductor leads must be installed outside the buildings to be protected. If this is not possible, a special sheath must be provided for (about 30 x 30 mm), statically ventilated.

The conductor used, for the lead, must be a tinned copper strip measuring 30 x 2 mm (copper ribbon under lead sheath for corrosive atmosphere, 30 x 3 mm aluminium strip when the lead can come into contact with aluminium parts of the building).

Securing the lead

Masonry : clamps or spits.

Roof: staples for slates, tiles or zinc.

Wooden frames on porcelain isolator.

Control Joint

A section strip placed two meters from the ground permits the checking of the ground connection resistance and of the integrity of the lead.

Ground connection

Preferably, each lead should be provided with its own ground connection. If there is a general ground connection at the bottom of an excavation, this can be used as a ground connection for lightning conductors (U.T.E).

In any case, the ohmic resistance must be less than 10 ohms in dry periods. Lightning conductor ground connections are made of a minimum of 20 metres of copper ribbon under a lead sheath, split into three strands buried under the ground. in three trenches dug in a fan shape 50 cm deep approximately, forming a so-called goose-foot, ground connection. The longest strand should be connected to the control joint and the other two to the first by rivet. If there is some difficulty involved in fitting this type of ground connection, the vertical tubes system, either with or without boring (depending on the nature of the ground), can be used.

Order of the work:

- Installation of the ground connection and fitting of the protection tube.
- Securing of the lead and installation of the control joint.
- Lastly, installation of the lightning conductor and connection to the lead.

MAINTENANCE

- Periodical check of the ground connection resistance value.
- Five years check of the whole installation.

GENERAL DEISGIN RULES:

All buildings have two groundings as widely separated as possible, preferable at diagonally opposite corners if perimeter, distance around, is 250 feet or less.

If building perimeter is between 250 feet and 350, then three groundings are required. If between 350 feet and 450 feet, then four groundings, etc.

Lightning Protection Systems shall be applied to metal covered buildings in like manner as on buildings without metal coverage.

Cables shall be free of sharp turns and "u" and "v" pockets. Cables shall maintain a horizontal or downward course

3.10 How a Lightning Protection System Words

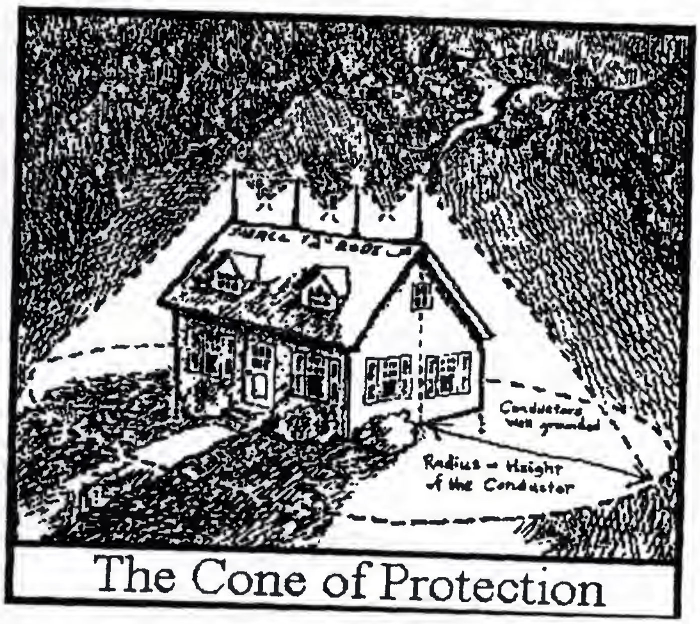


Fig.3

Lightning rods DO NOT attract lightning, but…if lightning is going to hit your house,it will hit the rods.

HOW IT WORKS

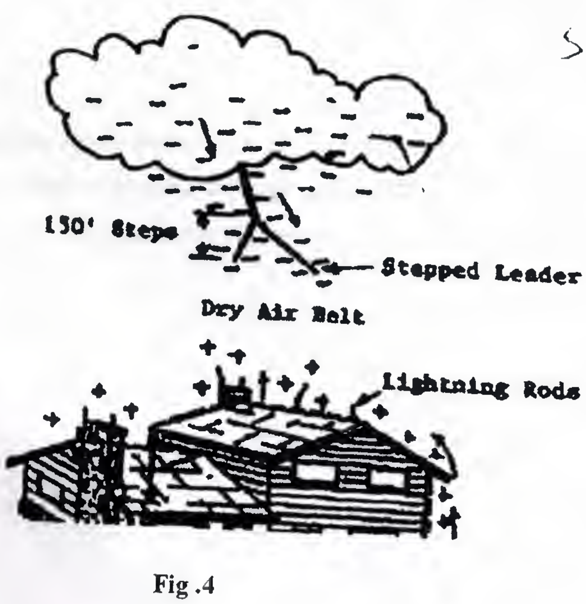


Fig .4

A lightning strike of opposite charges of electrical energy. A negative charge or build-up occurs in the bottom part of the clouds closest to earth and opposite charge of energy occurs directly underneath in the ground. Separating these two opposite charges is the non~conducting dry air belt separating cloud and earth. As the two opposite charges continue to build up and the dry air belt becomes moist, lighting starts down towards earth in 150 foot jagged steps or intervals. The positive ground charge is attracted upward, utilizing the lightning protection system on the building as an outlet.

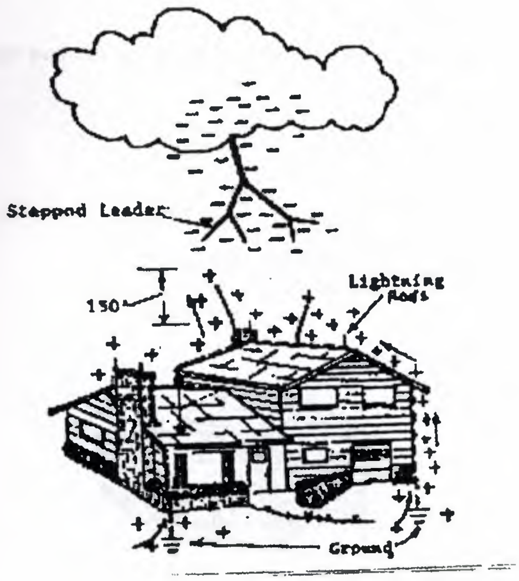


Fig 5

As the negative leader stroke from the cloud continues towards earth, the opposite ground charge travel up through the Lightning rod System and when the negative leader is about 150 feet above the top of the protected building, the positive ground charge starts upwards to meet and neutralise the downward leader stroke.

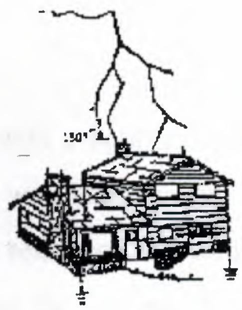


Fig. 6

In the figure ,the opposite charges are neutralized emptying the negative charges from the cloud and dissipating the ground charges .

Fig.7

In the figure,the discharge has been completed and the negative cloud charge and the positive ground charge becomes zero.

If the residence had not been equipped with a lightning protection system, the positive ground charge would have accumulated under or with in the house. The negative cloud charge would not have been neutralised 150 feet above the residence and would have entered the building, causing possible fire, destruction, side flashes within the building or even injury or death.

Chapter 4

Situation in Near East University

4.1 Introduction

In previous chapters lightning, lightning rod, importance of lightning rod is studied. Especially when the importance of lightning rod comes into account, education buildings have one of the highest priorities for protection of lightning. Because here human life will also be protected as well as the buildings. Which you can always renew the buildings and you can always buy the instruments again but you can never bring the human life back. For this reason this chapter is included in this thesis. The current situation in Near East University and suggested installations for the best protection is discussed in this chapter. Also an approximate cost for suggested installations be calculated.

4.2 Current Situation and Suggested Installations

Current situation:

Inside the Near East University campus only one lightning rod is installed to protect the Radio NEU equipments. This is installed on top of the AKM building: This lightning rod range will also cover the library building.

Suggested Installations:

Lighting Rod and ground system if properly installed are believed to be at least 90 percent effective in preventing damage should alighting strike occur. So it is necessary to avoid Near East building and equipment from lighting damage which will cost a lot of money. So the best way to avoid this losses is to support the university by lighting rod in the highest places. Therefore it is important to put about five lighting rod system as follows. These buildings can be followed from the Near East Map given in Figure 4.1: -

Registration office: This building is located at high area so it needs one lighting rod.

The swimming pool: One lighting rod will cover this building and will cover the dormitory of the girls.

High school building.

Business department: It will cover the architecture and prep school.

Civil engineering department.

For the NEAR EAST UNIVERSITY administration to do as fast as possible to avoid the university disaster which lighting will occur it.

The lighting rod system is easy to installed and the cost of this installed not expensive with compare to the looses of money result from the damage.

The approximate cost of five lighting systems is as follows:

If we consider the area of each building is approximately around 1000 m*m so for each square meter the cost approximately 3.3 dollars fully installed here for each building cost almost about 3300 dollars, the total cost of this five (5) lighting rod nearly 5*3300 = 16,500 dollars.

Finally this small amount of money of money can protect the buildings and student and almost every things in university.

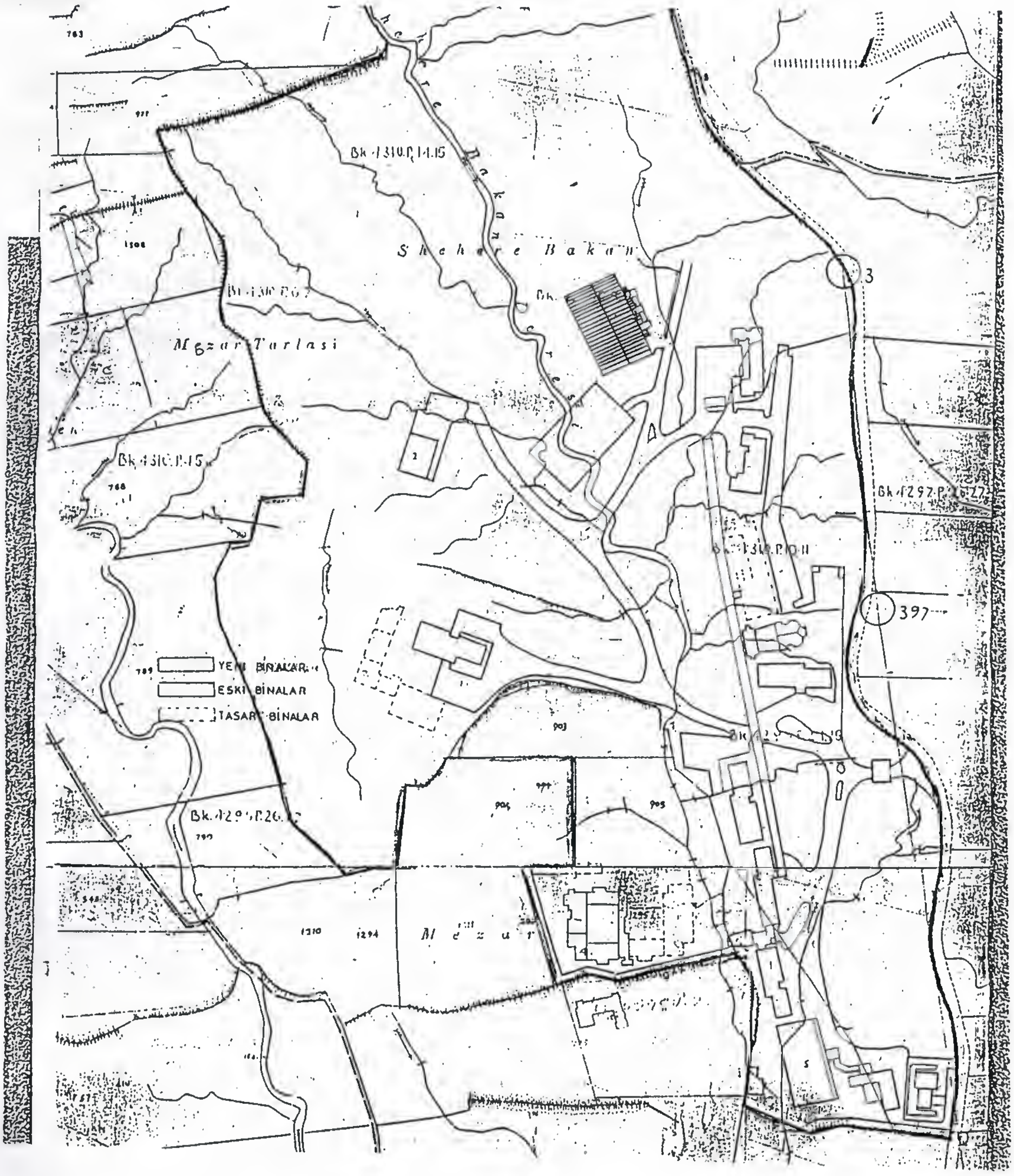


Figure 4.1 Map of Near East University

Chapter 5

Conclusion

This project contains two main parts, first is lighting, definition of lighting, where it come from, how it happen and the nature of lighting.Second is the lighting protection system (Lighting Rods). History of the lighting rod, development, types, components and installation of the lighting rod.In chapter 4 situation in Near East University, suggested installations and approximate cost is studied. Finally I would like to thank my supervisor for his help suggestion and wasting his voluble time for making this project of unfilled one.

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