LIGHTNING PROTECTION SYSTEM

Research Prepared

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Historical Introduction About Lightning Arrester:

Benjamin Franklin was born on January 17, 1706 in Boston, Massachusetts. His accomplishments as a scientist was about several things one of them was lightning arrester, In 1752, Benjamin Franklin conducted his famous kite flying experiments and proved that lightning is electricity. During the 1700s lightning was a major cause of fires. Many buildings caught on fire when struck by lightning and kept burning because they were built mainly of wood. Benjamin Franklin wanted his experiment to be practical, so he developed the lightning rod. A tall rod is attached to the outside wall of the house. One end of the rod points up into the sky; the other end is connected to a cable, which stretches down the side of the house to the ground. The end of the cable is then buried at least ten feet underground. The rod attracts the lightning and sends the charge into the ground, which helps to decrease the amount of fires.

Annual Effect of Lightning:

a. An average of 1000000 of thunder bolts (Meteorage source).
b. The cost of the damages caused by Lightning numbers in milliards of euros.
c. Between 8 and 15 dead persons (Lightning Protection Association source).
d. 20 000 animals killed by Lightning.
e. 20 000 sinister due to Lightning (15 000 fires).
f. 50 000 electrical counters destroyed.
g. 250 bell-towers destroyed.
h. 13% of the incidents on the computer material are due to Lightning.

What is a Lightning Arrester?

According to most definitions,

* A lightning arrester is a device used on power Systems above 1000 v to protect other equipment From lightning and switching surge.

* A lightning arrester is a device that protects electrical power systems from damages caused by lightning. A typical lightning arrester has both a ground terminal and a high voltage terminal. When a powerful electric surge travels from the power system to the lightning arrester, the high voltage current is sent directly to the insulation or to the ground to avoid damaging the system.

The devastating effects of lightning

Luminous effects:

The ionization of the air produced by the lightning current provokes numerous luminous particles, or "photons".

It can create an image on the observer’s retina which may leave him dazzled for several seconds before regaining his sight.

Acoustic effects:

The current of lightning is at the origin of enormous electro dynamic forces, which result in a strong rise, in the pressure of the air (2 to 3 atmospheres) in the outfall channel. The shock wave created or "thunder" can be heard at many kilo meters from the impact point, like rumbling or crackling sounds, according to spectral distribution and position of the observer.

Effect due to electrical arcs:

The receptivity of the soil and earthing systems provoke a sudden rise in the potential of the installation, when a lightning current passes through it. Differences in potential can appear on various metal parts connected incorrectly to the earthing system creating excitation, electrical arcs and destruction of electrical or electronic equipment.

Electrodynamics effects:

Close to the path of lightning current, appears a strong magnetic field creating voltages and induction current on all conducting elements situated in its sudden action field. The mechanical forces induced can provoke deformation, twisting, and destruction.

Electrocution effects:

As the path of the lightning current can provoke death, the dispersion of lightning current in heterogeneous soils can create potential differences dangerous to all live animals and people (pace voltage). These can provoke burns or heart attacks and respiratory problems.

Thermal effects:

Thermal effects or "Joule effect" can create at the impact point the melting of the materials and even their destruction by explosion when it presents a high humidity rate or causes fires to start.

Electrochemical effects:

These effects are caused by the chemical decomposition of the materials by electrolytic reactions. Although very negligible and without effect compared to stray currents in the soil, it appears mainly at the earthing systems level.

The Storm Cloud …..

Possibly reaching several kilometers height and depth, Lightning is produced by cumulo-nimbus storm clouds.

A separation of charges in the cloud is caused by atmospheric turbulences and big differences of temperature (up to – 60 °C at 10 km altitude): the upper part of the cloud is made up of positively charged ice crystals and the base contains negatively charged water droplets.

The base of the cloud influences locally the charge of the ground at the surface, attracting an equivalent quantity of electrical charges of opposed signs.

When it is highly charged, the cloud tries to dispel this charge in "exploding": it discharges with charge exchanges either with the ground (lightning), either with other clouds or clouds zones (lightning flashes intra or inter-clouds). Millions of electric charges are then dissipated giving rise to currents, possibly reaching 500 000 A and several millions of volts.

It is important to note that currents of 30 mA under voltages of only 50 V can be dangerous for people, even mortal for values higher than 1 A!

How does lightning arrester divert the lightning?

Diverting lightning and electrical surges by using MOV…….

The surge arrester does not absorb all of the high voltage that passes through it. It simply diverts it to the ground or clamps it to minimize the voltage that passes through it. The secret to the arresters success in diverting lightning or high electrical surge is the MOV {Metal Oxide Varistor}. MOV is a semiconductor that is highly sensitive to voltage. At normal voltages, the MOV works as an insulator and does not allow current to pass through, but at high voltage the MOV acts as a conductor. It works as a switch that is open when there is a standard AC voltage and a switch that is closed when lightning or high voltage is present.

ON What Lightning Arrester Depend on?

The evaluation of lightning risk takes in to account the lightning risk and the following factors:

a. Environment of the building.

b. Type of construction.

c. Structure content.

d. Structure occupancy.

e. Consequence of lightning strike, Service continuity.

How to Determined the protection level for arrester before installation :

(According to the France standards NF C 17-100 and NF C 17-102)

Standard NF C 17-100 and NF C 17-102 described the method for calculating the lightning risk and the choice of protection level for an outdoor lightning protection system.

The evaluation of the lightning risk is summarized below:

$Nd = Ng.Ae.C1.10^{-6}$

Where:

Nd = expected lightning frequency

Ng = lightning flash density (Local flash density of the region)

Ae = equivalent collection area of the structure considered

C1 = environment coefficient

$Ae = L \times W + 6H \times (L+W) + 9\pi H^2$

Where :

L= Maximum length of the building

W= Maximum width of the building

H= Maximum height of the building

C1= Environment coefficient (structure to be protected)

Surrounded by structures or trees of the some height or higher	0.25
Surrounded by smaller structures	0.5
Isolated, no other structure within a distance equal to 3 times the height	1
Isolated on top of hill	2

$Nc = 5.5 \times 10^{-3} / (C2.C3.C4.C5)$

Where:

Nc = accepted lightning frequency

C2 = Structure coefficient

	Roof		
Structure	Metallic	Common	Flammable
Metallic	0.5	1	2
Common	1	1	2.5
Flammable	2	2.5	3

C3 = Structure contents

No value and non flammable	0.5
Standard value or normally flammable	1
High value particularly flammable	2
Exceptional value, irreplaceable or highly flammable explosive	3

C4 = Structure occupancy

Unoccupied	1
Normally occupied	5
Difficult occupied	10

C5 = lightning consequences

Service continuity not required	1
Service continuity required without consequences on the environment	5
Consequences on the environment	10

Conclusion : With efficiency E= 1 – (Nc / Nd) IF Nd ≤ Nc protection is optional

IF Nd > Nc Its protection level is found as to calculating efficiency value

		Level of protection	
Structure	Efficiency	NF C 17-100	NF C 17-102
Metallic	E > 0.98	1+AM	1+AM
Common	0.95< E ≤ 0.98	1	1
Flammable	0.90< E ≤ 0.95	2	2
	0.80< E ≤ 0.90	3	2
	0 < E ≤ 0.80	4	3

Lightning protection system

Until recent years, people thought that the installation of a lightning conductor provided a building sufficient protection against lightning. This partial protection is now supplemented a set of compatible devices designed to :- protect against direct strikes, avoid dangerous differences of potential between neighbors point of the building, prevent induction effects on switch gear and electrical conductors and suppress over voltages conveyed on network lines.

Standard NF C 17-100

The standard sets out, to extent of knowledge and techniques, the arrangement required for obtain adequate protection and provides information about the means required to set up this protection. It deals with:

Franklin rods.

Protection by meshed cage.

Protection by tight strands.

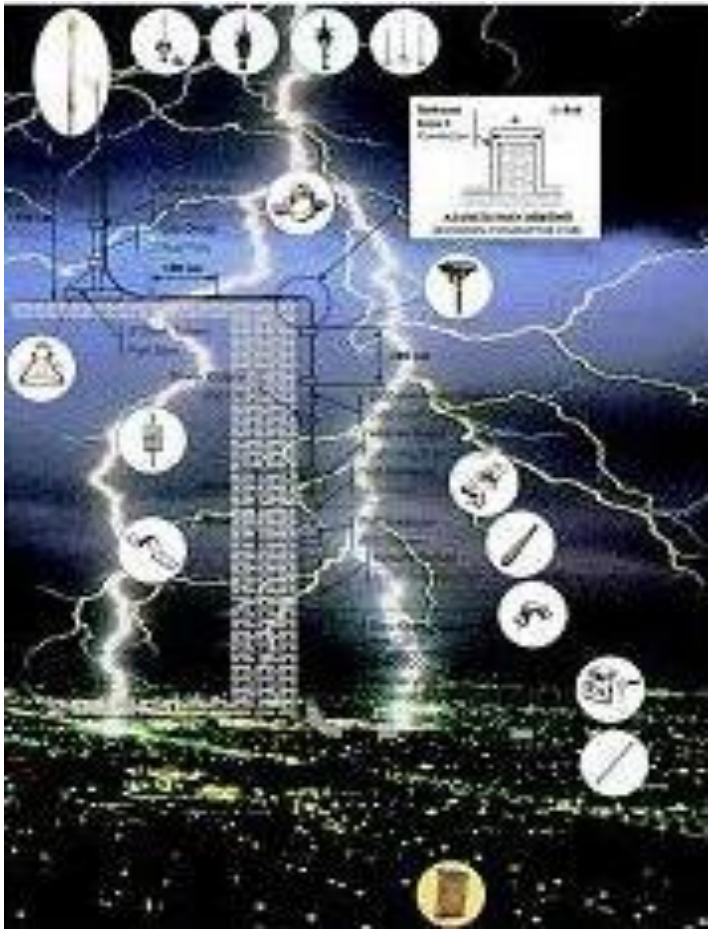
Standard NF C 17-102

This standard concerns systems using early streamer emission devices.

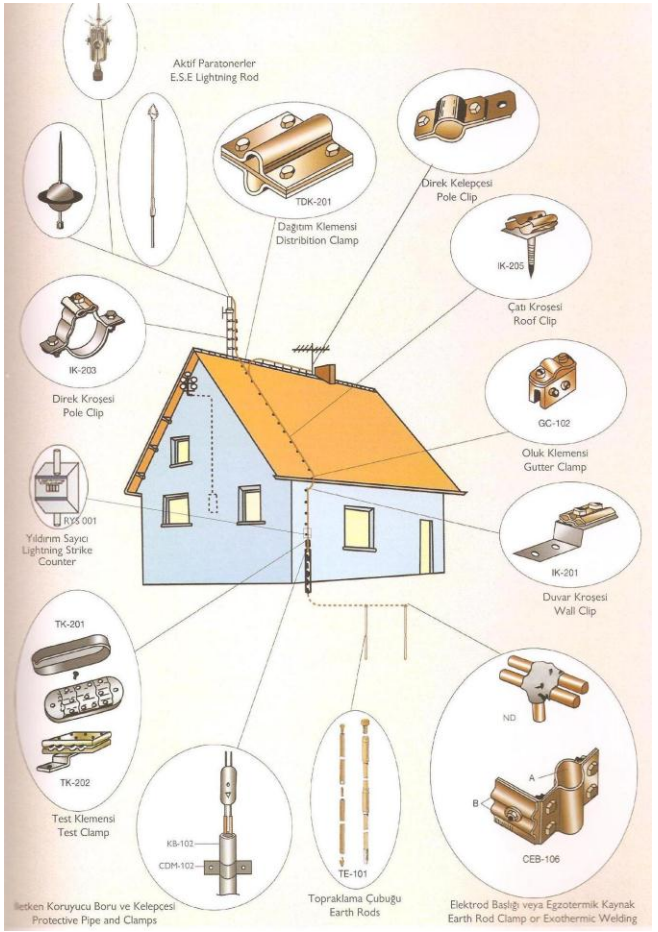
Note :

The figures below are explains how to install lightning arrester on different building with different type of arrester.

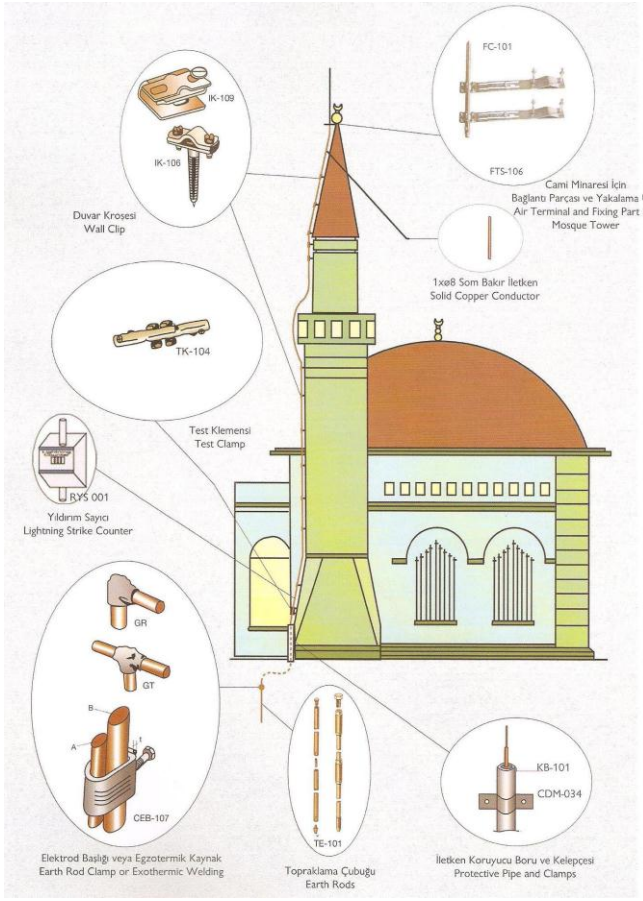
Installation of lightning rod on building



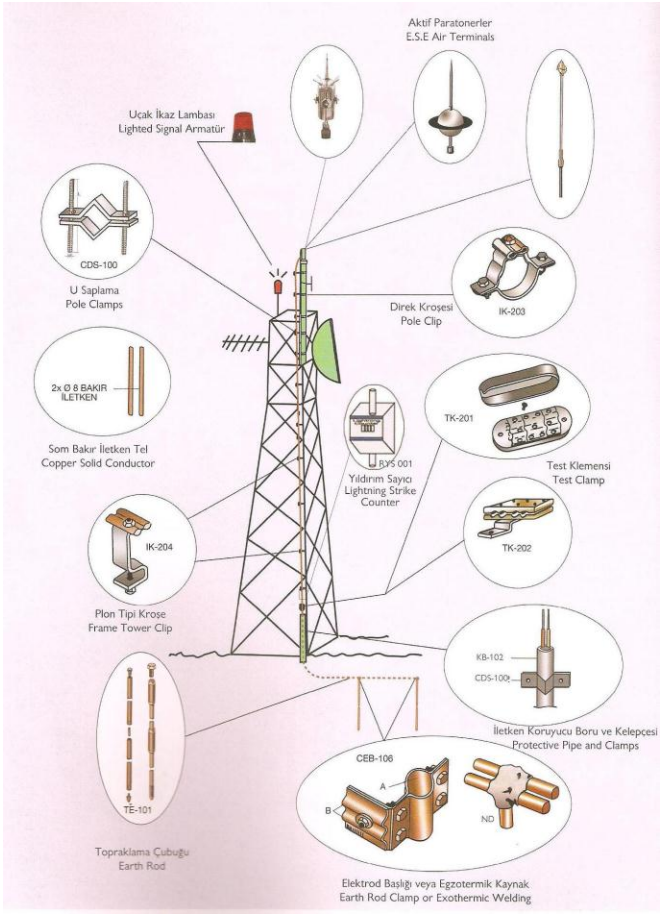
Installation of lightning rod on house



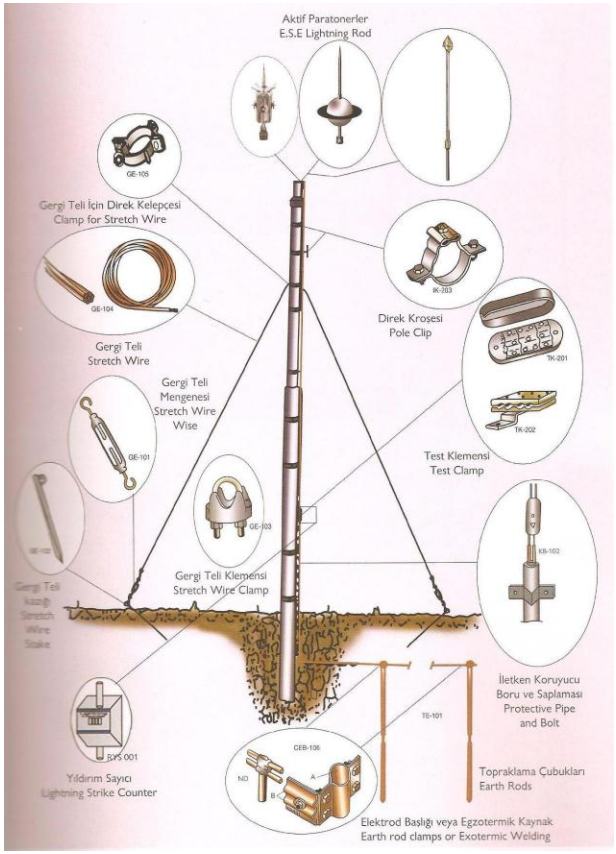
Installation of a air rod on mosque



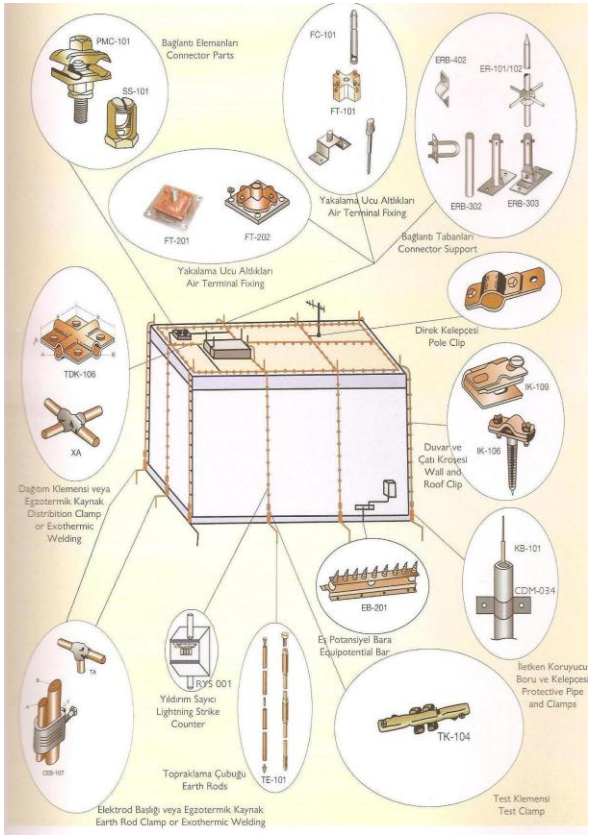
Installation of lightning rod on pylon



Installation of lightning rod on the ground



Detail of mesh method



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