

LIGHTNING RISKS AND PROTECTION

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Lightning is an electrical and natural hazard

AT-A-GLANCE

Each year lightning strikes the Earth 20 million times.

A properly designed and installed lightning protection system will protect property against lightning damages.

There is specific protection against direct and indirect lightning.

INTRODUCTION

Cloud-to-ground lightning bolts are a common phenomenon – about 100 strike Earth’s surface every single second – yet their power is extraordinary. Each bolt can contain up to one billion volts of electricity. A bolt of lightning can travel at speeds of 60,000 m/s (200,000 ft/s). Lightning is extremely hot and a flash can heat the surrounding air to temperatures five times hotter than the sun’s surface, reaching temperatures around 30,000°C (54,000°F), carrying an electric current of 40 kiloamperes (kA), and transferring a charge of five coulombs and 500 MJ. The energy from one lightning flash could light a 100-watt light bulb for more than three months.

Lightning is a massive electrostatic discharge between cloud and ground, other clouds, or within a cloud. It occurs in all thunderstorms. Each year lightning strikes the Earth 20 million times, about 2,000 people are killed, many fires are started and other important property damage is generated through electrical surge.

Lightning strokes (Global frequency of lightning strokes per km ² and year)	0.2 - 1	10 - 20
	1 - 4	20 - 40
	4 - 10	40 - 80



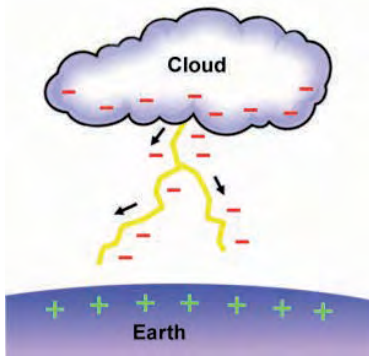
Munich RE map of global frequency of lightning strokes per km² and year

LIGHTNING DEVELOPMENT

Rising and descending air within a thunderstorm separates positive and negative charges. Lightning results from the buildup and discharge of electrical energy between these positively and negatively charged areas.

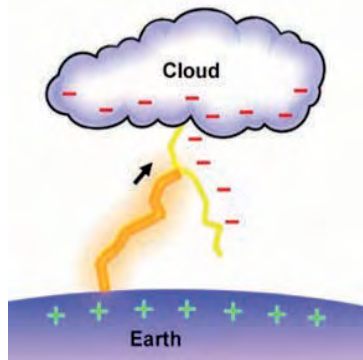
LIGHTNING DEVELOPS IN TWO STEPS

1. A cloud-to-ground lightning strike begins as an invisible channel of electrically charged air moving from the cloud toward the ground called the step leader.



The formation of the step leader

2. When one channel nears an object on the ground, a powerful surge of electricity from the ground moves upward to the clouds and produces the visible lightning strike, called return stroke.



The formation of the return stroke

TYPES OF LIGHTNING PROTECTION

Damage from lightning is either due to direct lightning impact (thermal and/or mechanical effects) or indirect effects (electromagnetically induced) of lightning impacts.

A properly designed and installed lightning protection system will protect property against such direct and/or indirect lightning damages, based on a lightning risk assessment to be carried out by a qualified company. Once installed, lightning protection systems should be visually inspected at least annually and a complete, in-depth inspection should be completed every 1 to 5 years according to the criticality of the protected buildings/ equipment and environmental conditions.

PROTECTION AGAINST DIRECT LIGHTNING IMPACTS

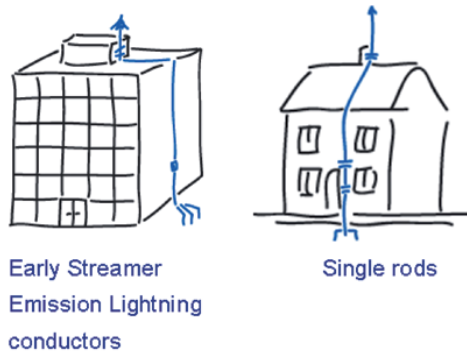
Such a system is designed to carry lightning currents to ground without damage to the protected structure. Therefore, it needs to provide a sufficiently low impedance path for the lightning to travel around or through the building to the ground. This ground impedance needs to be measured according to international standards and bonding of the ground potentials of the lightning protection device and of the equipment/building to be protected needs to be assured.

There are three kinds of direct lightning impact protection systems: strike termination devices (also called lightning arresters), Faraday cage and tightened wire (also called overhead wire).

STRIKE TERMINATION DEVICES

The lightning arresters or strike termination devices can be either passive (simple lightning rods) or active (early streamer emission (ESE) systems).

ESE systems provide an increased zone of protection by initiating a controlled step leader before any naturally occur. ESE systems should be able to direct the main lightning stroke to a very small number of lightning arresters on a structure, thus using fewer components than passive systems. But they could become too attractive and dissipate indirect effects to the neighborhood (note that ESE systems are only registered in France and Spain, for example, but not as per NFPA 780).



FARADAY CAGE

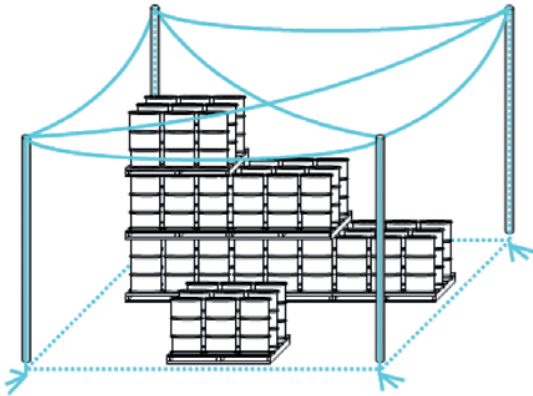
This Franklin-type lightning protection system consists of copper or aluminum lightning protection conductors and lightning rods, which are installed in a criss-cross pattern on the roof of the building to intercept any lightning before it strikes the building.



Single rods and Meshed cage

TIGHTENED WIRE

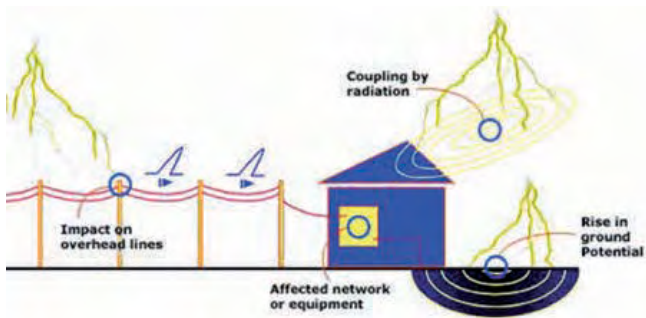
Tightened wire is copper or steel overhead wire tightened over the building/equipment area to be protected.



PROTECTION AGAINST INDIRECT EFFECTS OF LIGHTNING IMPACTS

Surge Protection Devices (SPD) are designed to limit the transitory excess voltage caused by a lightning discharge. It can affect every type of cable for power supply, telecom lines, computer networks, remote control system, TVs and CCTV networks, etc.

Lightning can cause these phenomena either directly through a discharge on high voltage overhead power lines or indirectly by coupling through radiation or rise in ground potential.



ARC RECOMMENDATIONS

According to the site location, design of the building and specifications, a recognized company should perform a risk assessment.

Based on the calculations and conclusions, a technical survey should define the protection measures. It may include direct and indirect protection systems, equipotential bonding, etc.

The installation of the equipment should be performed by a qualified and recognized company. Only listed/approved devices should be installed.

Also, keep in mind that lightning protection systems require maintenance programs to maintain the expected level of operation and safety. Because of that, the survey should also detail the commissioning and maintenance requirements.

REFERENCES

NFPA 780, *Standard for the Installation of Lightning Protection Systems*

NFPA 70, *National Electrical Code*

European standard EN 62305 (-1, -2, -3 and -4)

QUESTIONS OR COMMENTS?

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Tech Talk is a technical document developed by ARC to assist our clients in property loss prevention. ARC has an extensive global network of more than 100 property risk engineers that offers tailor made, customer focused risk engineering solutions.

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