Lesson 11: Lightning Protection

Lightning strikes the earth 100 times per second every day. In the United States, more than 125 people are killed by lightning each year, not including fatalities from fires related to lightning. Lightning damage also affects electrical systems. In areas where lightning occurs frequently, a properly installed lightning protection system is necessary.

Why Lightning Strikes

Lightning is the visible discharge of static electricity. This discharge can occur within a cloud, between clouds, or between the earth and a cloud. Basically, lightning is a large electric spark caused when current jumps a gap in the air.

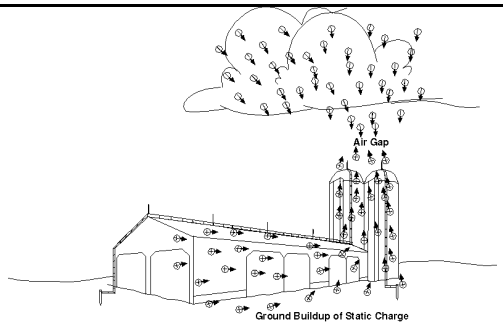
Strikes occur when hot and cold air masses meet, causing atoms to lose electrons. Once freed, negatively charged electrons gather at the A lightning protection system provides a path for lightning to the ground that is an alternative to traveling through a building or equipment. It prevents damage to structures and keeps people and livestock from being injured. It does not directly attract lightning or prevent a lightning strike. Proper planning is essential in developing a lightning protection system that will efficiently protect people and property.

Before installing lightning protection, the need for such protection should be assessed. The cloud base. Positive ions converge at high locations on the earth's surface, such as hilltops, silos, buildings, and trees, as illustrated in Figure 11.1. The ions and electrons are attracted to each other, creating a stepped leader, which is an unseen conduit through which negative charges move from the cloud to the earth. From the earth, ion streamers called leaders travel upward. If the two puncture the air gap insulator and converge, a channel is created for electrical energy to move between the earth and the cloud as the charges rapidly equalize themselves.

The average lightning bolt lasts from 1/1000 to 1/10 of a second and can produce temperatures up to 50,000 degrees Fahrenheit. It can create 1 million volts of electricity. Therefore, lightning protection is necessary for protection from fires and electrical surges.

The Need for Lightning Protection

National Fire Protection Association has published a risk assessment guide in their Lightning Protection Code, while insurance companies may also provide assistance in assessing the risk of damage from lightning. Factors considered include the frequency of lightning, the type of structure and its construction, the location of the structure, the topography of the surrounding area, and the contents of the structure.



When the force is great enough to puncture the air gap, the charge follows the path of least resistance to the ground.

In addition to these factors, a few other considerations exist for agricultural operations. Tall structures such as silos should be grounded not only to protect them but because they can provide a cone of protection with a diameter that is two times the height of the object. This cone can protect other structures that fall within it. Also, like buildings, electric fences should be grounded.

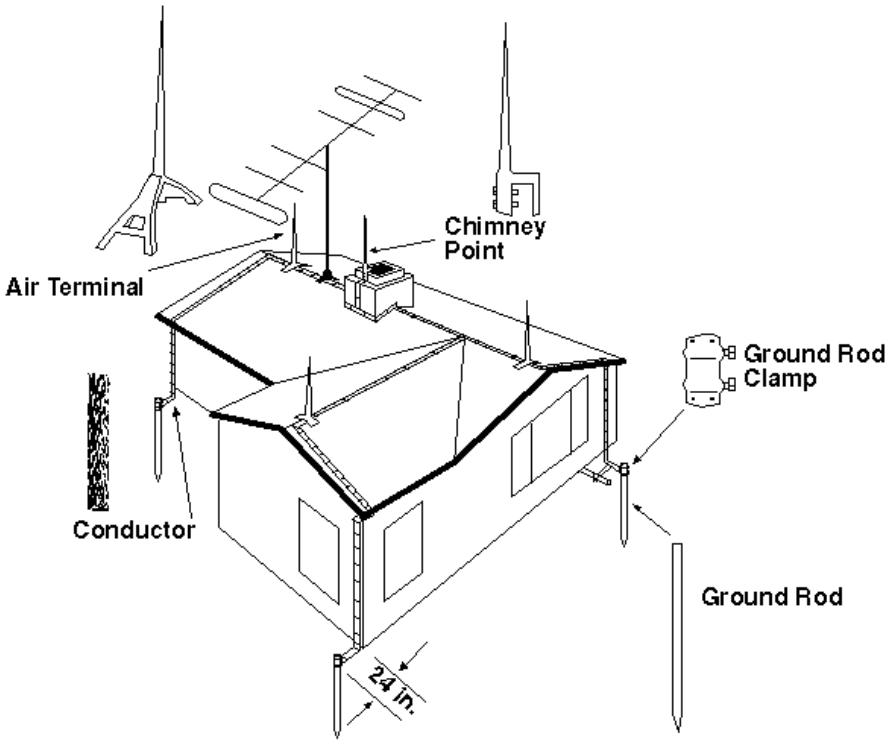
A Good System of Protection

A good lightning protection system has some basic components shown in Figure 11.2. Air terminals, or lightning rods, are the points where lightning strikes. Air terminals need to be installed on high points on structures, such as roof ridges or ventilators. The main conductors are the cables that connect the air terminals to the grounding electrodes, or ground terminations. The ground terminations are copper or copper-clad rods driven into the earth, preferably to a minimum of ten feet in depth. Lightning arresters are used to protect electrical wiring from lightning-induced damage. They are installed at the service entrance. Surge suppressors are used to further protect electrical equipment, such as computers. They are typically small boxes into which electrical equipment is plugged. Arresters and suppressors work by breaking the electrical circuit when an overload is present. These devices handle any residual current that may leak through the main lightning protection system.

Installing the Lightning Protection System

Proper installation is crucial to an efficient lightning protection system. Most insurance companies follow the guidelines described when they inspect the system to see if it is acceptable. A qualified professional should install the lightning protection system to make sure the proper procedures are followed.

Some general design rules apply to all lightning protection systems. These rules affect the number of grounding electrodes and the grounding cables. All buildings with a perimeter of 250 feet or less must have two grounding electrodes, preferably diagonally at opposite corners of the structure. If the perimeter is between 250 and 350 feet, three electrodes are required. At perimeters of 350 to 450 feet, four



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electrodes are necessary. As the perimeter increases, another grounding electrode is added for every 100 feet of perimeter. Also, the grounding conductors should follow a straight horizontal or vertical path to the grounding electrode. The cables need to be free of sharp turns and "U" or "V" pockets, which are sharp kinks or small bends in the cable. Turns in conductors should not exceed 90 degrees, and bends should not have a radius of less than eight inches. Sharper bends can restrict the flow of electricity.

Certain guidelines must be met when installing a lightning protection system. For proper protection, air terminals should be properly sized, spaced, and installed to receive lightning strikes. The down conductors, which are the vertical conductors that are attached to the ground rods, should carry the discharge directly to the ground. Entrance conduits, gutters, drain pipes, pipe vents, metal water pipes, radio and T.V. antennas, metal roofing, fences, and other metal objects should be bonded or connected to the down conductors and ground rods. The main bonding conductors must be at least AWG 6 copper wire or its equivalent. Down conductors should be enclosed in a conduit or metal tubing. The conduit should extend from a point at least five feet above ground level to one foot below the ground's surface to provide protection against physical damage.

Ground rods of adequate size must be located properly throughout the system. Lightning system ground rods must be driven to a minimum depth of 10 feet where soil conditions permit. If grounding electrodes cannot be driven to this depth, other acceptable options are to dig a trench 3 to 4 feet deep by 10 feet long and bury a grounding rod or to bury a grounding plate at least 18 inches deep. Another method of grounding involves connecting down conductors to a metallic water system, as long Lightning or surge arresters are used to remove high voltage charges from the system by breaking the circuit and then diverting the electricity to the ground. These devices act as a safety valve, draining power surges out of the system. They are installed where service wires enter the building at the service entrance panel or prior to the connection of specialized electrical loads, such as submersible water pumps or feed handling equipment, or other equipment away from protected buildings.

as the pipes are a minimum of three feet deep and ten feet long and are in direct contact with the earth. If ground rods used for the electrical or telephone system are within 6 feet of a grounding electrode for the lightning protection system, they must be bonded together to prevent side flashes, or the arcing of electricity between conductors. Side flashes can lead to fires, physical damage, and power surges to other electrical systems.

Protecting Equipment from Lightning

Protecting equipment is another important reason to install lightning protection. Overloads can cause tremendous damage to electrical systems and equipment. The power supply system has built-in lightning protection. A number of devices are also used to protect individual pieces of equipment from lightning.

The power supply system itself serves as protection from lightning. As power comes from the source, it passes through several transformers and other devices that reduce and convert the electricity into forms the consumer can use. This process is referred to as "stepping down." Lightning protection is offered at each level.

Surge suppressors, as discussed previously, are used to protect electronic equipment, particularly computers, from surges or spikes of electrical current. These devices provide a receptacle or a bank of receptacles with a breaker that automatically trips when the electricity spikes. If computer equipment is plugged into telephone lines, the lines also require surge suppressors to prevent damage from lightning. Telephone companies place lightning suppression devices in the lines. Special surge suppressors have connections for telephone lines.

Controllers are another type of device that helps protect electrical equipment from lightning. All motors must have some type of controller, which is normally used for starting and stopping the motors. For small motors of _ hp or less, the overcurrent device at the service entrance panel is sufficient to act as a controller. However, for larger motors, a separate switch with a current capacity at least twice the full load rating of the motor is required. The controller should have

overload devices installed that stop the current to the motor during electrical surges and power overloads. These devices should also have a manual reset so the motor does not restart automatically when normal power is restored.

Grounding Lightning off a Structure

The grounding of the lightning protection system will determine the extent of protection available. Grounding consists of connecting one end of a properly sized copper conductor to the air terminals and the other end to a metal conductor that is in direct and permanent contact with the earth, as shown in Figure 11.3. A ½-inch copper rod, a _-inch copper-clad rod, a ¾-inch galvanized iron pipe, or a metallic water system should be used for grounding. If a ground rod cannot be used due to rock beneath the soil, a When installing the grounding system, the wire is clamped to the grounding electrode using lugs or clamps. A steel strap or solder should not be used to attach wires because these methods are structurally weak and may not provide the contact needed during a lightning strike.

Summary

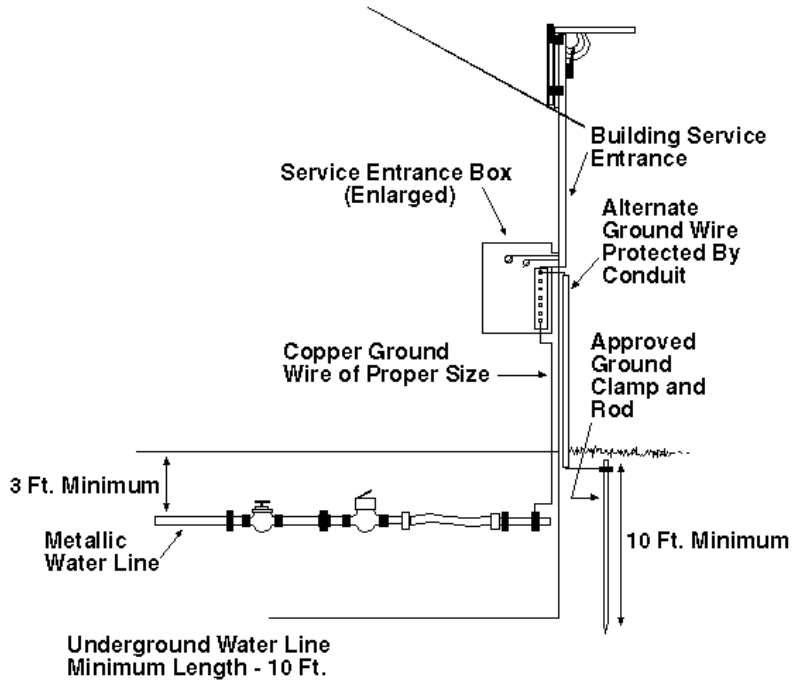
An efficient lightning protection system is necessary to help prevent damage to buildings and equipment and loss of life. The system should consist of properly sized and placed air terminals, down conductors, bonding conductors, and grounding electrodes. It should also include protection for equipment, such as surge suppressors, arresters, and controllers. It is highly recommended that a qualified and certified professional install this system for the home and farm.

metal plate may also be buried underground to serve as a ground. The size of the grounding wire is determined by the size of the wire supplying power to the service entrance panel, as indicated in Table 11.1.

Table 11.1 - Wire Sizes

Service Entrance Wire Size	Copper Ground Wire Size
Up to AWG 2	AWG 8
AWG 1 or 0	AWG 6
AWG 00 or 000	AWG 4
AWG 0000 or larger	AWG 2

Credits



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