Lightning Protection Systems

Question: Our church has old lightning rods. How can I tell if they are still in working condition? Do I need them today?—Father Kevin O'Brien, St. James Roman Catholic Church, New York, New York

Answer: Lightning has long been a threat to buildings. Today, it is estimated that more than 30% of all fires in religious properties are the direct result of lightning.

Lightning is a rapid exchange of electrical charges between a cloud and the ground. Objects, especially tall ones, which are considered a vertical extension of the earth's surface, are particularly vulnerable to this force. Lightning is classified in four categories: negative descending, positive descending, negative ascending, and positive ascending. Ninety per cent of all lightning is of the negative ascending type. The force of a single bolt of lightning can contain as much as 100 million volts of energy or the equivalent voltage of ten major power companies. Temperatures have been found to be as high as 30,000°C.

Dense, gray column-shaped clouds known as cumulonimbus are the source of lightning. As they grow, positively charged electrical substances known as ions elevate towards the frigid upper layers of the cloud while their negative counterparts tend to gather at the lower levels. As the charged cloud moves closer to its eventual point of impact, an electrical tension is created in the air by the attractive, opposite charges in the ground and the clouds. Lightning seeks the path of least resistance to the ground; elevated points such as church steeples are constantly at risk.

Lightning protection systems have been around for centuries. The purpose of most systems is to conduct and control the lightning current away from the building by providing a direct and easy low-resistance electrical path to the ground. The path is insulated from contact with the building to prevent fire or other damage. The most commonly used system on spires is the Franklin lightning conductor developed by Benjamin Franklin. A Franklin conductor protects a cone-shaped area in which the radius of the base is equal to the height. For example, if the height from the ground to the top of the conductor is equal to 50 feet, then the area protected by the conductor extends 50 feet in all directions from the point on the ground that the conductor is above. All building elements contained within the volume of this cone are protected.

Case Study: *Trinity Episcopal Church in Limerock, Connecticut, built in 1873, stood in a rural setting amidst tall trees. One autumn evening seven years ago, the Church was struck by lightning which damaged the slate roof and main beams, sent a shower of splinters into the sanctuary, destroyed a water pump, and affected electrical equipment. Fortunately, no fire occurred and repairs were covered by insurance. However, the frightened parish members immediately borrowed money to install a lightning protection*

Courtesy of the United Lightning Protection Association

Whether from antique or modern designs, the effectiveness of lightning rods remains the same.

Starting at the highest point of the building, the basic components of a Franklin lightning conductor system include a solid or tubular lightning rod or air terminal, which is mounted on an insulated base and designed to intercept a direct stroke. The rod or terminal is connected to the conductors, which are typically insulated copper or aluminum cables, but can also be solid or tubular strips, bars or rods. The conductors serve as downleads to at least two ground connections, of which there are several types, each of which provides ample contact with the earth (Figure 1).

Lightning protection systems should be inspected periodically to insure that they will properly function when needed. A system in poor condition, in fact, can actually attract lightning. The Lightning Protection Institute (lpi) is a not-for-profit organization that researches and disseminates information on lightning and lightning protection, advises looking at critical check points at least every five years.

Since standards for the industry have only existed since the 1950s, it is especially important for older systems that materials be in sound physical condition. Outdated materials should be replaced. System components should be properly situated and the route to the ground be intact. Air terminals should not be bent, cracked, broken or otherwise damaged.

All cable connections and holders for the conductors should be tight and secure. The cable should be taut, have no bends with an angle less than 90° and have no loose ends. The conductor should be properly bonded to other metal bodies on the roof, including those installed after the system to prevent lightning "side flash" or arcing between metals. The condition of the grounding at the base is especially important due to its need to receive over a million volts of energy and dissipate it into the ground. Lpi recommends grounding at least one foot below grade. In addition, a ground resistance check should be performed by a qualified engineer or lightning system installer using an "ohms" resistance meter (Ohms are a unit of electrical resistance).

Every newly-installed system should meet contemporary standards of lpi or the Underwriters Laboratory. Some insurance companies will allow rebates on premiums for such certified systems.

Besides the Franklin protection system, another type of system available is the ionizing lightning conductor (ilc) or "Preventor." This is classified as a preventive system. It sits on the highest point of the building. The ilc utilizes the principle that lightning will readily travel along a stream of ions to reach the ground. By using an ilc in a tension-filled atmosphere, the ions discharged by the ilc unit bond with the charges and thus reduce the amount of electrical tension present. However, it is only a temporary lowering of the tension and it is not always sufficient to prevent a discharge of lightning. The ions in the ilc are produced by such radioactive materials as radium and americum.