Lightning Protection Systems

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Statement

Lightning is a major cause of building fires, even though highly effective protection against this threat has long been available. In the 1700s Benjamin Franklin proposed a method of protecting structures from the effects of lightning. His method was based on observations that suggested (a) lightning preferentially strikes elevated objects and (b) lightning currents can be carried to and dissipated in earth by a suitable network of conductors and grounding electrodes. Various approaches aimed at providing protection against lightning, similar to Franklin's method of elevated rods and down-conductors, have been tried over the past 250 years; the more successful designs have been described and published as standards for guidance and protection of the public. In 1904, The National Fire Protection Association of Quincy, MA, established the American standard for installation of lightning protection systems. Now known as NFPA 780, The Standard for the Installation of Lightning Protection Systems (available for purchase through http://www.nfpa.org/Codes/index.asp) is revised periodically by an NFPA technical committee to incorporate new knowledge about the physics of lightning and advances in technology.

It is well established that properly installed and maintained conventional structural lightning protection systems (LPS) based on Franklin's methods significantly decrease lightning damage. However, the installation of such a system in conformance with NFPA 780 is not a simple matter. Proper procedures must be followed for the protection to be effective. Non-experts need guidance as provided by an appropriate standard which, in the United States, is contained in NFPA 780. Most architects and builders do not have the expertise to evaluate competing LPS designs. In this area (and many others), they depend on accepted standards to provide the guidance needed to properly design and install LPSs, confident that the standard has been appropriately reviewed and approved.

To understand how an object becomes "struck" by lightning, a short summary of the relevant physics is warranted. Lightning strikes usually begin within thunderclouds from which a "leader" descends toward the earth. As the leader approaches within 100 meters or so of the ground, its electric field becomes sufficiently enhanced by objects on the ground, so that upward propagating streamers are emitted by these objects. One or more of these upward streamers may develop into an upward-propagating leader that connects with the downward-moving leader, creating a conductive path to ground. This allows the leader charge to drain to the earth, "striking" the object that launched the successful streamer and subjecting it to the full current of a "return stroke."

To provide effective protection for structures, a lightning protection system must therefore include the following:

- A sufficient number of rods must extend above the upper portions of the structure to be protected and their tips must be so exposed that one of them becomes the locally-preferred strike receptor upon the close approach of a leader, descending from a thundercloud,
- The connections between the strike receptor and the earth, namely the "main conductors" and the "down conductor system," must be able to carry the rapidly-varying lightning current without significant heating and without dislodging,
- The impedance to the flow of current in the down conductor must be sufficiently low that "side flashes" to objects in the vicinity do not occur as a result of high voltages developed by the passage of the current,
- The connections from the down conductors to the earth must allow the lightning current to flow into the ground without the development of large electrical potential differences on the earth's surface and without creating hazards to personnel or structures nearby,
- All nearby metal components of the structure must be electrically bonded to its down-conductor system to minimize the probability of "side flashes.

Given this complexity in designing effective lightning protection systems, standards that specify the requirements which must be met to ensure the adequacy of each lightning protection installation are essential and are required by most industrialized nations. The American standard represents nearly 250 years of practical experience and about 100 years of consensus among specialists in the physics of lightning, of manufacturers of lightning protection equipment, and of lightning protection installers. The members of the AMS Committee on Atmospheric Electricity have reviewed the modern practices of lightning protection and have concluded that NFPA 780 is a useful standard with a sound scientific basis. The Society recognizes the need for a lightning protection standard and supports the current American edition specifying the installation of lightning protection systems. Additional background material can be found in Background for the *AMS Statement on Lightning Protection Systems* by C.B. Moore.

Headquarters: 45 Beacon Street, Boston, MA 02108-3693
Email: amsinfo@ametsoc.org
Phone: 617-227-2425; Fax: 617-742-8718