Lightning Protection System—

Ultimate Line of Defense

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Lightning, one of nature's most destructive forces, continues to wreak havoc on lives and property especially in today's electronic environment. On average, a lightning strike contains approximately 50 million volts carrying 18,000–20,000 amperes of current, but strikes with up to 300 million volts and 200,000 amps are not that uncommon.

To protect against this destructive phenomena, a properly designed and UL-listed lightning protection system is required. The National Fire Protection Association (NFPA) 780 *Standard for the Installation of Lightning Protection Systems* defines a lightning protection system as "a complete system of strike termination devices, conductors, grounding electrodes, interconnecting conductors, surge suppression devices and other connectors or fittings [that] are required to complete the system."

How does this system work? Picture a hockey goalie protecting his net. He has four basic tools—gloves, mask, stick, and pads—that help him prevent the puck from entering the net. Just like a goalie, there are four main parts that comprise a lightning protection system.

PART 1—INTERCEPT THE LIGHTNING STRIKE

Like a goalie guarding his net, a strike termination device, commonly known as an "air terminal" or "lightning rod," intercepts the lightning strike and prevents it from hitting the structure. These devices neither attract nor repel lightning.

Air terminals are manufactured primarily from copper, tinned copper, or aluminum. Their size is determined by the structure's height and placement location. Buildings not exceeding 75 feet in height are protected by Class I materials. Structures or portions of structures over 75 feet tall are protected by Class II materials.

PART 2—PROVIDE A PATH TO GROUND

The next part of the system consists of down conductors and various bonding components.

The primary objective is to provide multiple parallel paths for the lightning currents to follow. The second objective is to bond metallic bodies to the lightning protection system, creating potential equalization that prevents unwanted side flashes from occurring.

Class I or Class II lightning protection main conductors, or structural metal with a thickness of 3/16-inch or greater, can be used as down conductors. In fact, in structural metal framed construction, metal is the preferred down conductor since it provides a lower impedance path to ground as does a main lightning conductor. Lightning conductors are manufactured from copper, tinned copper, or aluminum just like the air terminals, and fall into either Class I or Class II categories.

Generally speaking, Class II materials are heavier and larger than Class I materials because they have to travel a longer distance down the structure to ground. It is important to

remember that the use of aluminum materials (conductors, fittings, and components) should not be installed on or in contact with copper surfaces, or be exposed to runoff from copper surface as this would set up a galvanic couple resulting in material failure due to corrosion.

Aluminum materials should not be installed in locations that are subject to excess moisture, imbedded into concrete, or come into direct contact with the earth since alkali, moisture, and soil rapidly disintegrate aluminum. Copper conductors, fittings, and components must not be installed on aluminum surfaces since this also forms a galvanic couple which leads to deterioration of the aluminum components. When transitioning from aluminum to copper, bimetallic fittings must be used.

Another key aspect of Part 2 is to remove the possibility for side flashes. Side flashes are dangerous electrical sparks that are caused by differences of potential. Metal bodies inside or outside the structure that contribute to lightning hazards because they are grounded (or because they help provide a path to ground) must be bonded to the lightning protection system to meet the goal of potential equalization. There are formulas available to help the design engineer determine what metal bodies need to be bonded and where.

PART 3—SAFELY DISPERSE LIGHTNING CURRENTS INTO THE EARTH

Via a properly designed grounding electrode system, lightning currents are safely dissipated into the earth and away from the structure, similar to a goalie using his stick to deflect the opponent's puck from entering the net.

Lightning protection devices include (left to right, starting in the back) lightning conductor on reels, in aluminum and copper; copper air terminal with universal copper base; decorative finial (air terminal); aluminum air terminal with universal aluminum base; one-bolt parallel connector; copper adhesive cable holder; and bonding plate. Courtesy of Harger Lightning & Grounding

There are various types of grounding electrodes such as ground rods, ground plates, ground loop conductors, radials, and concrete encased electrodes. Grounding electrodes are installed for the purpose of providing electrical contact with the earth which allows the lightning currents to dissipate harmlessly into it.

Loop conductors encircle the structure interconnecting the ground electrodes. Ground rod electrodes are made from copper-clad steel, solid copper, or stainless steel. The diameter must not be less than one-half inch with a total length of at least eight feet. Ground rods must extend vertically to a depth of at least ten feet into the earth with soil compacted against both the conductor and the ground rod.

PART 4—SURGE PROTECTION

These devices are installed on the electrical and telecommunications service entrances to prevent unwanted electrical currents from entering the structure via the power and communication lines. In addition to structural damage caused by a strike, lightning energy can cause serious physical and financial damage to electronics inside the structure.

Installed at all power service entrances, surge protection devices must also be installed at all points where an electrical or electronic system conductor leaves one structure to supply another structure, if cable or conductors are longer than 100 feet. Although not required by lightning protection standards, consideration should be given to providing surge protection at the branch panels and at the point of use as well. This practice provides the ultimate in equipment protection for sensitive electronics.

Winning Combination

Upon completion of the installation, it is recommended that UL conduct an inspection to ensure that the system is in compliance with a nationally recognized standard such as NFPA 780 or UL 96A. If the system is in compliance, UL will issue a Master Label Certificate—the "Stanley Cup" of lightning protection.

A properly designed and installed lightning protection system is the ultimate line of defense, much like an all-star goalie that even Wayne Gretzky couldn't score against.

Mr. Harger is an industry expert with more than 20 years of experience in lightning protection, grounding, and bonding. He is a member of the NEMA 8CC section, and chairs the BICSI Grounding & Bonding Committee, which created NECA/BICSI 607-2011. He also chairs the Engineering Subcommittee TIA TR-42.16, which is responsible for rewriting ANSI-J-STD-607-B.