Limit Losses
Make Your Facility Lightning Safe
BY KIM LOEHR

Lightning is a force of nature responsible for massive property damage each year. According to Underwriters Laboratories, lightning accounts for more than $1 billion annually in structural damage to buildings in the United States. What’s not reported is the loss of business, downtime and liability when business or commercial tenants are forced to shut down to repair lightning damage.

Facilities that have witnessed lightning’s destructive power understand the need to protect their personnel, structure and contents from lightning. Unlike threats posed by other forces of nature such as tornadoes, hurricanes or floods, lightning’s incredible power can be controlled on a specified path.

How Lightning Enters a Structure
According to the National Weather Service, there are three main ways that lightning enters homes and buildings:
1. A direct strike;
2. Through wires or pipes that extend outside the structure; and
3. From the ground.
Regardless of the method of entrance, once inside the structure, the lightning can travel through the electrical, communication, or data wiring, along with plumbing, gas or process piping systems. Lightning can also travel through structural steel framing and reinforcing rods in concrete walls or flooring.

On the outside of the structure, lightning can travel along the outer shell and may follow conductive metal vents, roof drainage elements and external supports as it seeks a path to ground. The U.S. Fire Administration says two-thirds of lightning fires happen from June through August, with 55 percent of these fires occurring outdoors and 41 percent occurring in structures. Among the structure fires, lightning most often ignited roofs, sidewalls, framing and electrical wires. Packing up to 100 million volts of electricity, a lightning strike to an unprotected structure can be disastrous. The good news again, is that lightning losses can be prevented.

How the System Protects the Structure
Lightning is electricity. When electricity is confined to a properly designed conductive path, damage can be minimized. Destruction results when electricity encounters resistance, similar to the resistance used in arc welding. When electrical current runs through an arc welder, the resistance it encounters when arcing through air, generates the heat necessary to melt steel. The highly conductive copper and aluminum materials used in a lightning protection system provide a low resistance path for lightning to travel without resistance.

When the lightning protection network is in place, a lightning strike is intercepted and directed to ground without impact to a structure or its contents.

Without the presence of the low resistance path provided by a lightning protection system (network), the lightning will light its way through non-conductive building materials like wood, brick, rubber membranes, glass, plastic, etc., on its way to earth ground. The resistance the lightning encounters will produce heat, fires and even explosions.

It is also common for lightning to travel via conductive matter it finds along the way, including plumbing, flashing, structural members and/or wiring for power, communication or data. None of these systems is designed to provide a safe path to ground for lightning. Providing this safe path to ground is the first focus of a lightning protection system design.

Roof and Ground Protection Network
While the concept behind lightning protection is relatively simple, the requirements for proper installation are specific and often complex. The single best way to ensure proper system design and installation is to specify compliance with ANSI safety standards for lightning protection (NFPA 780, UL96 and UL96A).

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Strict compliance with the requirements of these standards for the roof system, grounding and surge protection are essential to proper system performance. A lightning protection system includes the following elements:

- A network of prominent strike termination devices;
- A network of ground terminations;
- A network of conductors or qualified structural steel members interconnecting the strike and ground terminations;
- Interconnections with other metallic grounded building systems; and
- Surge protection devices on all incoming power, data and communication lines.

The first three elements of the system intercept, conduct and dissipate the lightning discharge, while the fourth addresses the secondary effects of a strike by limiting the dangers of the harmful current caused by side flashing.

The last element protects connected equipment and wiring from damaging currents and surges that can travel on utility lines. Specialized techniques are often needed to address field applications for individual structures, such as protected zones on multi-level structures, proper bonding points for interconnection of building grounded systems, and various ground terminals available for site soil conditions. Failure to make proper provision for any of the above five elements can result in inadequate protection.

Safety Standards Govern Installation

Specifications, technical information and installation methods should comply with these three nationally recognized authorities that publish safety standards for lightning protection installation:

- Lightning Protection Institute (LPI); Standard of Practice, LPI-175;
- National Fire Protection Association (NFPA); Standard for the Installation of Lightning Protection Systems, NFPA 780; and
- Underwriters Laboratories (UL); Installation Requirements for Lightning Protection Systems, UL 96A, and UL 96, Standard for Lightning Protection Components.

Of the above, LPI is the only organization founded specifically to study lightning protection. The LPI was established in 1955 to promote lightning protection education, awareness and safety. Membership is comprised of manufacturers, contractors, scientists, architects, engineers and safety directors—all of whom are interested in improving the science of lightning protection and promoting lightning safety. In addition to publishing the LPI-175 Standard of Practice to help ensure the best possible quality in lightning protection materials and installation techniques, the institute offers certification and education programming.

The organization is the leading resource for lightning protection information and system requirements, and houses a database of specialists and contractors on its website at www.lightning.org.

Importance of System Quality Control

Lightning protection technology is a specialty discipline, and expertise is required for system design and installation. An experienced lightning protection specialist who is certified through LPI will take into account the architecture and contents of a structure without compromising industry safety standards for installation.

Installation requirements according to the safety standards are specific and often complex—even for ordinary structures. Requirements for miscellaneous structures, special occupancies, heavy-duty stacks and structures containing flammable vapors, gases or liquids can be stringent with special considerations dictated by NFPA 780.

In addition, the safety standards mandate that metal rooftop equipment, such as ventilators, skylight frames, air conditioning units and railings be incorporated into the lightning protection system. Connections for these objects depend on their construction, location and skin thickness.

A bonding connection might be sufficient to ensure lightning conductivity, or the object may require cable conductors and air terminals, as well as the bonding connection. The experienced and certified lightning protection specialist will know how to interpret the safety standards to meet all requirements with the completed installation.

Maintenance of the lightning protection system in accordance with industry recommendations is another important aspect of quality control. In the event a facility is changed structurally (additions, re-roofing, etc.), or if modifications are made to a commercial system, the lightning protection system must be repaired or updated to ensure continued compliance with installation safety standards. The NFPA Safety Standard provides guidelines for inspection and maintenance procedures that should be established for the lightning protection system and incorporated as part of the overall maintenance program for the facility it protects.
While maintenance is typically uncomplicated and inexpensive, it is an important service to ensure that mechanical damage, modifications to the structure or age, do not degrade a system. System defects or disconnections can pose safety problems that should always be addressed.

Lightning wants to get to ground by the easiest route available and the lightning protection system provides a controlled path. Without the presence of a low-resistance path as provided by a lightning protection system, lightning will travel via any conductive matter it finds along the way, including internal metallic systems.

"Interconnecting all grounded systems at grade level and roof level to equalize potential and keep lightning on a preferred path is the goal of today’s lightning protection systems,” said LPI’s VanSickle. “Facility owners purchase a system knowing that they will not use it every day, but that it will be there to protect them when needed.” FSM

Contributed by Kim Loehr on behalf of the not-for-profit industry organization, the Lightning Protection Institute (LPI).