

Six Components that Will Protect Your Building Enclosure and the Electronic Infrastructure from Lightning Damage

By Michael Chusid, RA, FCSI, and the Lightning Protection Institute

Figure 1. Over 20,000 times a year, fire departments respond to fires caused by lightning.

Nearly 22,600 times in a typical year, fire departments in the United States respond to building fires caused by lightning.¹ While this is a significant number of incidents, fire is *not* the most common type of damage caused by lightning. Instead, the most frequent type of damage caused by lightning is disruption of the electronic infrastructure in buildings (Fig. 1 and 2). Specifically, lightning poses a risk to the electrical and electronic systems that enable us to perform our everyday and critical tasks.

Lightning is an atmospheric discharge that releases tens of thousands of amperes and millions of volts of electricity. When it strikes a building, lightning can surge through every element in the building as the energy seeks a path to ground. If even a portion of that energy passes through an electronic device, it can melt or shatter the fine wires, integrated circuits, and delicate components that control almost all modern machines, appliances, and systems.

We know lightning damage to electronic devices occurs frequently. Over 30 million lightning strikes reach the earth each year in the United States, causing billions of dollars of damage.² In addition to direct strikes on a building,

lightning can enter a building after traveling for miles over electric power lines, other utilities, or conductive appurtenances such as metal fences. Lightning can strike a tree and then side-flash (arc) into a nearby building. It can even travel underground to find a grounding point inside your building.

Immediately, we think of the monetary damage to repair the structure. Beyond the structural damage, we need to consider the impact of not being able to perform business operations or other essential functions inside of these buildings. What will happen if a business owner cannot swipe a credit card? What will happen if the assembly line is shut down? What will happen if a lightning strike hits a fire station or police department—can personnel answer emergency calls or dispatch first responders?

A lightning protection system can often be a wise investment. The capital cost of installing a system is a relatively minor factor in the overall cost of construction or renovation, and it can be far less than the cost of the lightning-related damage and downtime. Fire alarms and sprinkler systems are installed to mitigate risks; a lightning protection system offers similar protections for property and life and should be given the same consideration.

Moreover, when a lightning protection system is properly maintained, it can last the life of a building. And when a structure is demolished, the metallurgical value of copper, bronze, and aluminum used for lightning protection components is partially, if not fully, recoverable.

Without proper assessment of the building and the function of that building, a lightning strike can cause structural damage as well as internal damage to the electrical system that powers essential equipment. Fortunately, the installation of a lightning protection system can mitigate damage to elements of the building enclosure as well as to the electronic infrastructure and contents inside.

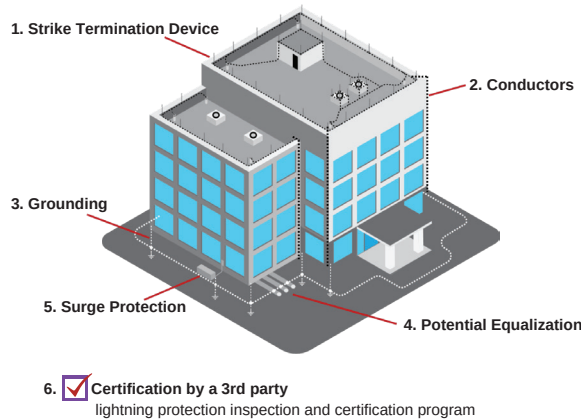
FUNDAMENTALS OF A LIGHTNING PROTECTION SYSTEM

A lightning protection system (Fig. 3) provides multiple paths for lightning to pass safely through a building—between the sky and ground—without damaging the building's structure or electrical infrastructure, sparking fires, or causing injuries to building occupants. Highly conductive copper and aluminum materials used in certified lightning protection systems provide a low-resistance path, which safely grounds the lightning's dangerous and destructive electricity.



Figure 2. Beyond structural damage, lightning can harm the electronic infrastructure that we rely on to perform our essential daily tasks, such as this phone bank used by customer service to emergency call centers.

Figure 3. Fundamental components of a lightning protection system: (1) strike termination devices; (2) conductors; (3) grounding; (4) potential equalization; (5) surge protective devices; and (6) certification.



Systems should meet national safety standards and include six fundamental components shown in Fig. 3:

1. **Strike termination devices:** Air terminals, (informally known as lightning rods) on high points of a building intercept lightning before it reaches the building.
2. **Conductors:** Heavy-duty metal cables interconnect the parts of a lightning protection system.
3. **Bonding:** Conductors are also used to create equal electrical potential throughout a building to prevent lightning from creating dangerous electrical arcing.
4. **Grounding electrodes:** Most buildings can be grounded with 10-ft-long (3-m), copper-clad steel rods driven into the earth at multiple points around a building.
5. **Surge-protective devices:** Special surge-protective devices must be installed wherever power or signal wires enter a building. The surge protectors built into appliances and power strips do *not* protect against powerful lightning surges.
6. **Certification:** All systems should be inspected and certified.



Figure 3a. Strike termination devices



Figure 3b. Conductors



Figure 3d. Potential equalization



Figure 3c: Grounding electrodes

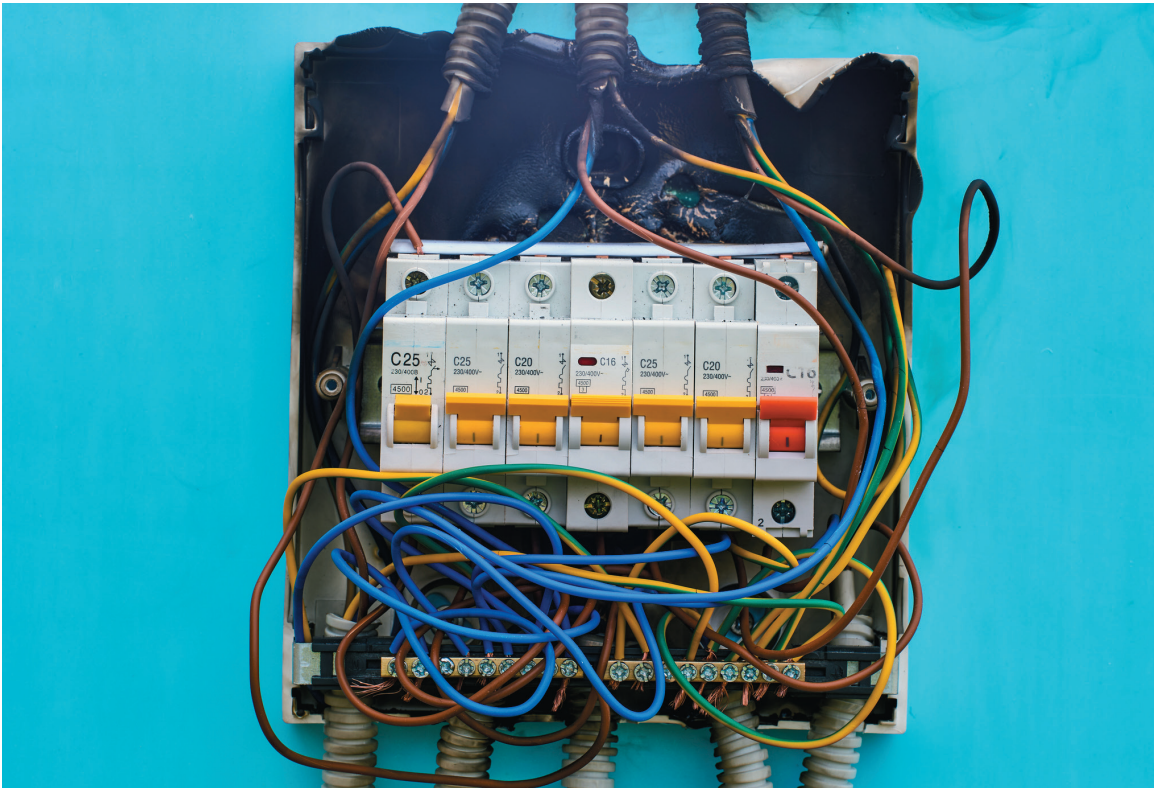


Figure 3e. Surge protective devices



**3rd Party Inspection
& Certification**

Figure 3f: Certification.



UNDERSTANDING THE RISK OF ELECTRONIC INFRASTRUCTURE DAMAGE

The electronic infrastructure of many buildings reaches into almost every aspect of a building's operations, including the sensors, controls, and actuators that enable communication, information processing, environmental control, safety and security, access control, power, and process equipment. Lightning is unlikely to damage all these systems in a single strike. However, damage to even a single critical piece of the infrastruc-

Figure 4. Damage to even a single critical piece of the infrastructure can be enough to shut down a building or bring operations to a halt.

"I can't afford to lose vital equipment when someone's on the operating table."

—Hospital facility manager

ture can be enough to shut down a building or bring operations to a halt until the problem is located, diagnosed, and repaired (**Fig. 4** and **5**).

No one knows how often lightning damages electronic devices. There are several reasons for this gap in our knowledge. First, there is no central database for recording incidents. In addition, most individual incidents of damage to electronic equipment are not covered by insurance companies and, therefore, are not reported.

Furthermore, many incidents of lightning damage are misattributed to other causes such as product defects or ordinary end of service life. Damage to a component in a microprocessor can be difficult to see and requires painstaking effort to locate. Moreover, device failure is not always discovered while a thunderstorm still rages. For example, when a failure is first noticed on a Tuesday after a device fails to turn on, who thinks to associate the failure with a thunderstorm the previous Thursday night that occurred when no one was in the building?



Figure 5. Protecting the electronic infrastructure of critical buildings, like hospitals, is vital to the health of individuals and our community.



Figure 6. Lightning protection system on the Seminole Hard Rock Hotel and Casino in Florida (close-up shown at right). Credits: Bonded Lightning Protection Systems, Inc./Florida; to see more on this project, visit lightning.org/most-innovative-design-award.

STEPS TO IMPLEMENT LIGHTNING PROTECTION SYSTEMS

The process of protecting a building enclosure and building infrastructure from lightning strikes has several steps: risk assessment, specification, design, installation, inspection and certification, and maintenance. **Figures 6** and **7** highlight two innovative lightning protection system designs.

Risk Assessment

Although we have emphasized in the preceding sections the potential risk of lightning damage, it also is true that not every structure needs lightning protection. A systematic approach can





Figure 7. Texas home protected with a lightning protection system. Credit: Bonded Lightning Protection Systems, Ltd./Texas; to learn more about this project, visit lightning.org/most-innovative-design-award-2.

be used to determine whether a building or structure design should specify a lightning protection system.

A critical question to ask early in the risk assessment process is, "How many electronic systems are mission-critical to the enterprise?"

Risk assessment is fundamental to business planning. When selecting a site, for example, you would want to know if it is in a floodplain. Lightning risk at the site deserves the same consideration.

A useful risk assessment tool to determine whether a particular building needs a lightning protection system is the Simplified Lightning Risk Assessment in NFPA 780, *Standard for the Installation of Lightning Protection Systems*.³ It considers several basic building parameters:

- **Frequency of lightning within a building's region:** While some locations have a greater density of lightning strikes, no part of the US is free from risk.
- **Building size and height:** These measurements determine how large a target a building presents to lightning.
- **Relative exposure of a building to surroundings.**
- **Combustibility and electrical conductivity of roof and structural materials:** The more combustible the material is, the more susceptible it will be during a lightning strike to catch fire.
- **Value and combustibility of building contents:** These are ranked on a scale from "low value and noncombustible" to "exception-

al value and irreplaceable cultural items." Because of their vulnerability to surges, structures with computers and electronic equipment are ranked at the higher end of the scale.

- **Occupancy:** Special consideration must be given to buildings that are difficult to evacuate or where there is risk of panic.
- **Consequences of a lightning strike:** Is continuity of operations a concern? Could lightning damage cause dangerous environmental impacts such as release of toxic chemicals?

Risk assessment calculations can be readily performed with the assistance of certified lightning protection professionals. These individuals will also be able to discuss lightning protection costs and strategies.

Specification, Design, Installation, and Inspection

Certified lightning protection professionals can assist you or your architectural and engineering consultants in preparing specifications for projects. A specification will typically address the following key points:

- **Defining the extent of the work:** Does the project involve new construction, remodeling, reroofing, or making an addition to a building with an existing lightning protection system?
- **Delegating design:** The actual layout of a lightning protection system should be provided by a qualified lightning protection professional.
- **Standards:** The design and installation of the lightning protection system should comply with NFPA 780,³ the ANSI-recognized standard for construction. LPI 175,⁴ UL 96,⁵ and UL 96A⁶ are complementary standards that will help ensure the quality of the lightning protection system.
- **Installer credentials:** The specification should require *certified* lightning protection system installers for new roofs, reroofs, and remodels/additions.
- **Inspection:** Lightning protection systems should be inspected to ensure the proper function and adherence to the standards. Building code officials in most jurisdictions do *not* inspect lightning protection systems. Instead, inspections should be completed by an independent third party for reviews.

As this list of specification elements makes clear, highly qualified project team members with lightning protection expertise and certification play critical roles during the installation and inspection steps. Experience alone is not enough when installing or inspecting lightning protection systems. Certification is necessary to understand the full scope of the system and to avoid unnecessary impact to roofing materials and structures. Certified installers should be used for the installation of lightning protection systems as well as for their removal or reinstallation on reroofing projects. Building inspection and certification serve as a further layer of risk management by verifying that the building has been adequately protected.

Maintenance

Finally, it is important to understand that changes to the building may require modifications to the lightning protection system. Even something as simple as mounting a security camera on the roof could require extension of the lightning protection system if the camera

risks above the “zone of protection” created by the lightning protection system.

Similarly, building maintenance staff and service vendors must be cautioned against mishandling lightning protection components when, for example, servicing rooftop mechanical equipment. It is also wise to have a lightning protection professional inspect the building periodically to verify that the system is still in compliance with standards.

CONCLUSION

The impact of a lightning strike can be disastrous to buildings and operations. At best, the resulting damage is an inconvenience that can be remedied with minimal expenditure of dollars or time. At worst, human lives can be affected.

The assessment of a building’s specific needs with regard to lightning protection systems is a best practice for any new building or renovation project. Proper installation and inspection of these systems reduces risks to the building enclosure and the electronic infrastructure. The six fundamental components of a lightning protection system protect the outside and inside of a building, minimizing the potential for lightning-associated business interruption, loss of revenue, and even loss of life. 

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Michael Chusid, RA, FCSI, was an architect and a fellow of the Construction Specifications Institute. Sadly, Chusid passed away in May of 2022, prior to publication of this article. His contributions to the betterment of building design and construction over many years were significant, and he will be greatly missed.

Lightning Protection Institute (LPI) is a national organization that establishes standards and guidelines for the design, installation, and inspection of lightning protection systems. LPI and its members provide guidance and support to ensure best practices for lightning protection systems. For more information, visit www.lightning.org.



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