WHITE PAPER

LIGHTNING PROTECTION CODE CHANGES UPDATES

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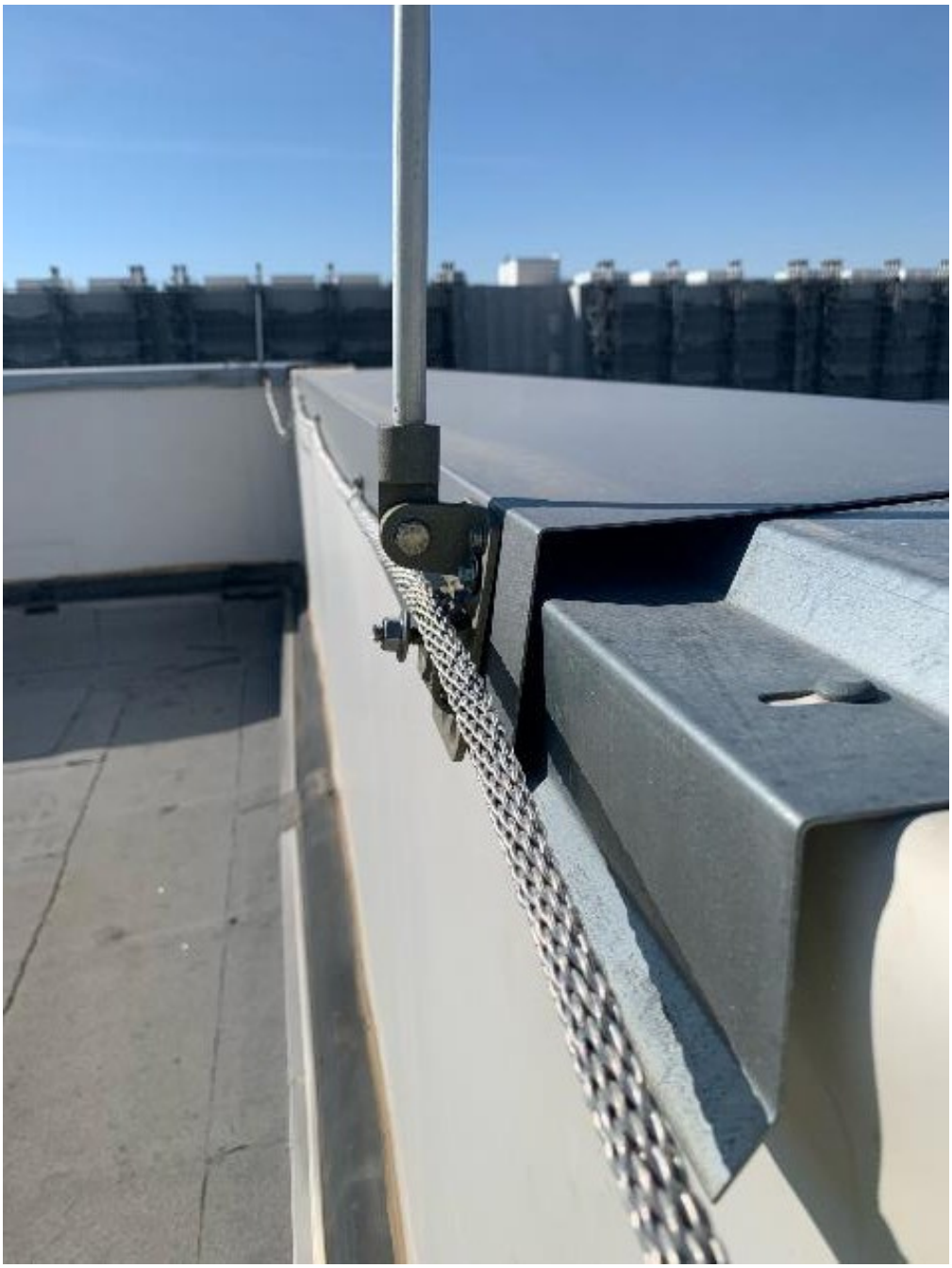
by: SPRI and the Lightning Protection Institute



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LPI LIGHTNING PROTECTION INSTITUTE

SPRI SINGLE PLY ROOFING INDUSTRY

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Section 1: Introduction

Lightning poses a significant threat to property, and with potentially significant damages. According to the Insurance Information Institute (iii), during the first half of 2023, convective storms caused $38 Billion in insured losses. Beyond physical building damage, lightning poses a threat to electrical and electronic components in a building, to its overall security, and to data collected and stored on site. In fact, the Lightning Protection Institute (LPI) estimates that $1.7 trillion in data was lost in one year alone.

According to National Geographic, a single bolt of lightning can produce anywhere from 100 million to 1 billion volts and contains billions of watts of power. In addition, the energy from lightning heats the air briefly to around 50,000 degrees Fahrenheit according to the National Oceanic and Atmospheric Association.

Across the U.S., many commercial building owners are opting to have a lightning protection system (LPS) installed to help prevent structural damage or loss due to a lightning strike.

"Lightning damage is a reliably preventable issue," said Bret Peifer, president of Mr. Lightning of Colorado Springs, Colorado, independent designers, and installers of lightning protection systems for commercial and residential properties, and LPI board member who participated in the code review process and hearings. "A properly designed, installed, inspected, and certified lightning protection and grounding system can virtually mitigate this risk to policyholders and the public.

Section 2: Lightning Protection Systems and Components

The National Fire Protection Association has developed an ANSI standard -- NFPA 780 -- for lightning protection systems in North America, which have five fundamental components, including:

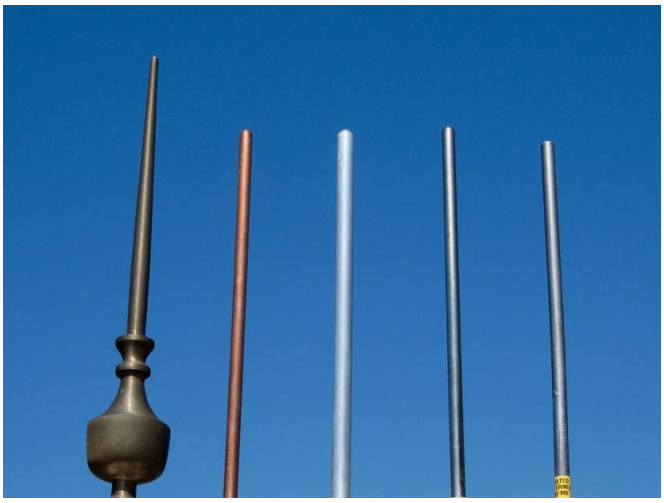

Photo Courtesy of East Coast Lightning Equipment, Inc.

1. Air Terminals or Strike Termination Devices. Commonly referred to as lightning rods, strike termination devices are installed on high points of a structure to intercept lightning before it hits the building, or a building component, and leads the electrical charge to the ground. These devices can be solid, pointed, or blunt tipped, and are typically made of aluminum alloy or copper.

Photo Courtesy of East Coast Lightning Equipment, Inc.

2. Cable Conductors. Heavy-duty metal cables called cable conductors are used to connect the air terminals on the roof to provide a path for the lightning current to follow to the below-grade grounding electrode system. Such cables are often braided, but can be solid, and are typically made of aluminum or copper.

Photo Courtesy of SPRI, Inc.

3. Bonding Connections. Bonding connections are used to connect the LPS to other internally grounded metallic systems on the roof, such as air conditioning units, vent stacks, and other components. The purpose of bonding is to create a path for lightning current and helps to prevent lightning from side-flashing or arching to another metallic systems in the building.
4. Grounding Electrodes. Electrodes are typically 10-foot-long copper-clad steel rods, connected to the cable conductors and driven into the ground at multiple points around the building.
5. Surge-Protection Devices. Wherever power or signal wires enter a building, surge protection devices specifically configured for lightning are installed. These are necessary to stop the intrusion of lightning from utility lines and equalize differences between grounded systems during lightning events.

According to the LPI, it is also critically important that lightning protection systems always be installed, inspected, and certified by a professional trained in installing these systems. Additionally, the installed system should meet the standards outlined in either NFPA 780 Standard for the Installation of Lightning Protection Systems, or UL 96A Installation Requirements for Lightning Protection Systems.

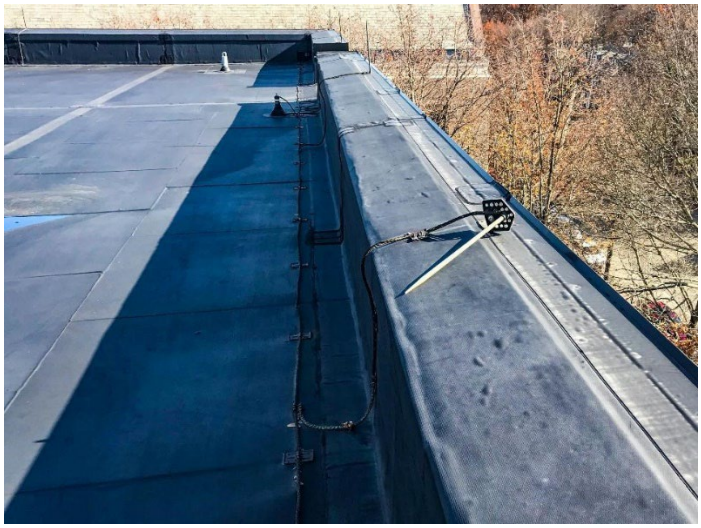

Photo Courtesy of SPRI, Inc.

Section 3: Updated Code Language

The International Building Code (IBC) is updated in multiple phases, based on annual review cycles. In 2021, the Group A Cycle included updates to Chapter 27, which covers 'electrical' issues, including lightning protection systems. During this cycle specific language referencing the industry's two standards commonly used by lightning protection system installers -- NFPA 780 and UL 96A -- was first added to Chapter 27 of the building code. The update requires compliance with either NFPA 780 or UL 96A when lightning protection equipment is installed but does not mandate that lightning protection equipment be installed on commercial buildings.

However, neither the updated language, nor the referenced standards, address how lightning protection systems should be specifically secured to existing roofing components. The addition of this language to the 2024 IBC, led SPRI, Inc., the trade association representing the manufacturers of single-ply roofing systems and the related component materials, to take steps to clarify how LPS components should be secured to edge metal and other tested roofing components. The specific wording added to Section 2703 for the 2024 IBC, under Lightning Protection Systems, reads as follows:

Photo Courtesy of SPRI, Inc.

Section 2703 Lightning Protection Systems

2703.1 General. Where provided, lightning protection systems shall comply with Sections 2703.2 through 2703.3.

2703.2 Installation. Lightning protection systems shall be installed in accordance with NFPA 780 or UL 96A. UL 96A shall not be utilized for buildings used for the production, handling, or storage of ammunition, explosives, flammable liquids, flammable gases, or other explosive ingredients, including dust.

2703.2.1 Surge protection. Where lightning protection systems are installed, surge protective devices shall also be installed in accordance with NFPA 70 and either NFPA 780 or UL 96A, as applicable.

2703.3 Interconnection of systems. All lightning protection systems on a building or structure shall be interconnected in accordance with NFPA 780 or UL 96A, as applicable.

The 118-page NFPA 780 standard, which dates to 1904, has been continuously updated and revised since it was established. According to NFPA, the stated purpose for the standard is to 'provide for the safeguarding of persons and property from hazards arising from exposure to lightning.'

The standard defines and details the components of a lightning protection system, including the material composition, diameter, and cross section area of air terminals, as well as the main conductor cables and bonding conductors. Furthermore, it specifies the height of air terminals, material requirements for air terminals, cables, brackets as well as fasteners. Lastly, the standard provides details for air terminal placement, which varies based on the roof slope and/or design, building height, cable placement, and ground rod installation.

UL has been testing and certifying lightning protection equipment since 1908 and examines lightning protection system components and completed installations for compliance with its standards. The UL 96A standard provides minimum requirements for installation of air terminals, cable conductors, connectors, fittings, and fasteners used in quality lightning protection systems.

Section 4: Roofing Industry Concerns & Current Code Language

"In the language updated by the Group A code development cycle in 2021, NFPA 780 and UL 96A are specifically referenced in Chapter 27 of the building code," said Amanda Hickman, president of The Hickman Group, a code consulting firm based in Plantation, Florida, representing SPRI, Inc. "This is the first time that those two industry standards will be specified in the code. And while detailed in many ways, neither NFPA 780 nor UL 96A, address the impact that attaching lightning protection systems to the roof system may have on the tested components of the roof assembly, including the edge metal, roof membrane, and more."

The perimeter of low slope commercial roofs provides a critical protection point for roofing assemblies relative to wind pressures and water infiltration. The edge metal system is not only a critical component of the roof's design, but it also serves as the roof's first line of defense when it comes to severe weather. Estimates from insurance carriers including FM Global (FM) indicate that the roof's perimeter failures account for nearly 59% of roofing system failures in high wind events. Furthermore, fascia, coping, and gutter edge metal components are required by the building code to be tested to resist specific wind loads. As such, there is a concern in the roofing community that when lightning protection systems are installed, it may alter the wind load or system performance of the edge metal system.

Additionally, the roofing assemblies, which include all components from the roof deck up (i.e., deck, air barrier, insulation, membrane as well as the fasteners or adhesive), are often tested and approved for use through FM. While not a code requirement, FM wind ratings are based on tested roofing assemblies. Any changes to the roof assembly components, e.g., insulation type or thickness, deck type or grade, fasteners, etc., can impact the assemblies' performance, have significant implications for the building owner, and nullify the FM rating. Therefore, adding lightning protection to the roofing system may also impact its FM rating.

Concerns from SPRI members about how lightning system are attached, combined with the two guiding installation standards for LPS – NFPA 780 and UL 96A – being added to the code, prompted SPRI to take action to address this situation and the code update.

The first step was for SPRI to establish a task force to seek and build cooperation between the lightning protection industry and the commercial roofing industry. The goal of the task force was to clarify the code language on how lightning protection systems, when used, should be secured to the roof or perimeter edge metal system without negatively impacting the wind rating or system performance.

The task force held initial discussions and meetings with a variety of key stakeholders, including LPI, UL Solutions, the National Electrical Manufacturers Association (NEMA), and NFPA, who were all interested clarifying the code language, which would come in the Group B code development cycle in 2022.

"It was important to the commercial roofing industry that when lightning protection systems are used, they are installed with guidance from the roofing system and/or the edge system manufacturer, to preserve the building envelope in a wind or weather event," said Hickman. "The roof and edge metal systems are required by code to be tested to ensure that they meet certain performance standards, and therefore it is critical that these components maintain their integrity when lightning protection systems are installed."

As part of the Group B Cycle, which followed the initial discussions, proposed new language was developed and sent to all the organizations with which SPRI had been working. The draft language was also submitted in January 2022, as an update to Chapter 15, 'Rooftop Structures,' which had not been updated in the earlier review cycle.

"The wording added to Chapter 27 in the first phase of the code update, was focused on installing lightning protection, but there was nothing about maintaining or protecting the integrity of the roofing system, which is covered in Chapter 15 of the code and a critical consideration in the process," said Hickman.

Proposed IBC updates go through a series of developmental process steps. The first is a Committee Action Hearing. Approval of a proposed change during a Committee Action Hearing is based on a simple majority vote by a technical committee. Further changes are subject to a Public Comment Hearing in front of the International Code Committee's (ICC) governmental membership. In both steps, testimony, arguments, and opposing viewpoints are verbally presented about the proposed changes. However, once the proposed change reaches the Public Comment Hearing step, revisions to the code then require approval by 2/3rds of the ICC's governmental voting members.

The ICC held a Committee Action Hearing on this topic in Rochester, NY in April 2022. Several from the lightning industry attended the hearing and spoke out against the proposed new language, to the surprise of the SPRI representatives at the meeting. In the end, the ICC technical committee disapproved the proposed language in a resounding 13 to 1 vote.

"We were very surprised by the outcome of that hearing," said Hickman. "We had been working with several people from the lightning industry and believed that everyone was on the same page, perhaps without recognizing the potential negative impact that the new wording would have on their industry. What was immensely clear was that there was a huge gap between what the roofing industry and the lightning protection industry needed to resolve this issue, and that's when the really hard work began."

Section 5: Originally Proposed Language Issues

There were several critical problems with the draft language presented from the lightning protection industry's perspective. Lightning protection must be installed around the outmost perimeter of a structure, according to the UL and NFPA standards, fastened every three-feet, and installed within two-feet of the building's perimeter. This design ensures that the lightning protection system is located on the portions of the structure to which lightning is typically attracted. The updated draft language was in direct conflict with the standards, as noted below:

1. Lightning Rods (strike termination devices) are required to be within two feet of the outside corner. Not allowing the Lightning Protection industry to attach to the coping, would make this impossible. Especially on rooftop objects such as cameras, antennas, or any items that project over the top of the coping and are on the outer edge of the building.

   *NFPA 780 Section 4.7.2.1 states: "As shown in Figure 4.7.2.1, the distance from the strike termination devices to ridge ends on pitched roofs or to edges and outside corners of flat or gently sloping roofs shall not exceed 2 ft." Similar language is provided UL 96A, Section 8.1.5.*2.

2. Lightning Rods are required to be installed around the perimeter at 20-foot intervals. It is not just the corners that this proposal would compromise. Depending on the width of the coping, every lightning rod could be affected.

   NFPA 780 Section 4.7.2.2 states "Strike termination devices shall be placed on ridges or pitched roofs and around the perimeter of flat or gently sloping roofs at intervals not exceeding 20 ft." Similar language is provided UL 96A, Section 8.2.2.1.

3. Lightning Protection conductors are required to be attached every three feet maximum. This creates a problem all to itself. If we, as an industry, fasten to the membrane below the coping, that is a ton of holes in the membrane. If we are forced to use brackets, that is a ton of brackets and it will be problematic to coordinate the exact layout, timing, warranty, etc.

   NFPA 780 Section 4.10 "Conductor Fastener. Conductors shall be fastened to the structure upon which they are placed at intervals not exceeding 3 ft." Similar language is provided UL 96A, Section 9.1.5.

"We were very surprised by the outcome of that hearing," said Hickman. "We had been working with several people from the lightning industry and believed that everyone was on the same page, perhaps without recognizing the potential negative impact that the new wording would have on their industry. What was immensely clear was that there was a huge gap between what the roofing industry and the lightning protection industry needed to resolve this issue, and that's when the really hard work began."

Section 6: Consensus Building

The next step was to develop and submit new language for 'public comment.' During the next several months, SPRI reached out to all the key industry organizations and stakeholders for discussions and meetings about this issue. During that time, they held meetings with representatives from UL Solutions, LPI, the United Lightning Protection Association (ULPA), the Asphalt Roofing Manufacturers Association (ARMA), the National Roofing Contractors Association (NRCA), the National Electrical Manufacturers Association (NEMA), the Roof Coating Manufacturers Association (RCMA), as well as others to build consensus for revising the language from the original proposal.

Eventually, and after several months of meetings and discussions, new language was drafted jointly by SPRI and the lightning protection industry with assistance from UL Solutions, RCMA, NRCA, ARMA, NEMA and others, and submitted for public comment.

ICC Public Comment Hearings were held in Louisville, KY in the Fall of 2022. It was during that meeting that the Public Comment language was approved by 2/3rds of the ICC Governmental Voting Membership and ratified via a subsequent online vote, thereby solidifying the new language which will be published in the 2024 edition. The IBC is due out in the fall of 2023 and will then be ready for adoption by states and jurisdictions across the US and the world.

During the Public Comment Hearing, representatives from National Association of Home Builders (NAHB), the United Lightning Protection Association (ULPA), UL Solutions and others spoke in favor of the modified language, which addressed the earlier concerns of the lightning and home building industries.

Section 7: 2024 Code Language

The new language essentially goes beyond the existing installation standards outlined in UL 96A and in NFPA 780. It clarifies that attaching lightning protection system components to any part of the roofing system or assembly must be completed in accordance with the manufacturer's installation instructions for the roof assembly, roof covering, metal edge systems, or gutter, however it does not impact the placement or spacing of any lightning protection equipment.

The new language stipulates that LPS installations must be completed in accordance with the roofing system or edge metal manufacturer's instructions, or specifications from a qualified design professional. In addition, where LPS components are secured to, or penetrate the roof, they must be properly flashed. The new language, which will be added as new sub-sections in Section 1511 'Rooftop Structures,' reads as follows:

1511.7 Other rooftop structures. *Rooftop structures* not regulated by Sections 1511.2 through 1511.6 shall comply with Sections 1511.7.1 through 1511.7.6, as applicable.

1511.7.6 Lightning Protection Systems. Lightning protection system components shall be installed in accordance with Sections 1511.7.6.1, 1511.7.6.2, and 2703 of this code.

1511.7.6.1 Installation on metal edge systems or gutters. Lightning protection system components attached to ANSI/SPRI/FM 4435/ES-1 or ANSI/SPRI GT-1 tested metal edge systems or gutters shall be installed with compatible brackets, fasteners or adhesives, in accordance with the metal edge systems or gutter manufacturer's installation instructions. Where the metal edge system or gutter manufacturer is unknown, installation shall be as directed by a *registered design professional.*

1511.7.6.2 Installation on roof coverings. Lightning protection system components directly attached to or through the *roof covering* shall be installed in accordance with this chapter and the *roof covering* manufacturer's installation instructions. Flashing shall be installed in accordance with the *roof assembly* manufacturer's installation instructions and Sections 1503.2 and 1507 where the lightning protection system installation results in a penetration through the *roof covering*. When the roof covering manufacturer is unknown, installation shall be as directed by a *registered design professional.*

"This is a significant and important update to the building code," said Hickman. "We worked very hard with both the roofing and lightning protection industries to develop language that everyone could agree on, and we all made compromises and concessions to make this happen. A key part of the revision included language allowing registered design professionals to direct the installation of lightning protection equipment when the roofing or edge system manufacture cannot be identified."

"In the end, working with SPRI, UL and others was critically important for this development. We clearly had different perspectives and business concerns that had to be addressed in the process," said Peifer. "In true consensus building, no one is ever 100% happy with the outcome, and I think that's what happened here. But we worked together to get to wording that everyone can live with."

Protecting the integrity of the building envelope is critical. Lightning installers are not roofing experts, and commercial roofing contractors are not experts in lightning protection installation. For the benefit of the building structure, equipment, occupants, and owner, it is therefore incumbent on the specifier or system manufacturer to clearly document how the roofing and lightning protection systems effectively interface for best performance of both systems.

The IBC is written to benefit building owners, building occupants, and society. Conflicts among the various component providers will always occur and must be addressed and solved by the parties involved. Building consensus is difficult, time consuming, and requires compromise by all entities, for the overall benefit of the building owner and occupants.

Photo Courtesy of Mr. Lightning

The 2024 edition of the IBC has been published and many jurisdictions will begin their adoption of it in 2024. *However, whenever installed, the impact of a lightning protection system on the performance of a roof system should always be considered.* Moving forward, manufacturers of edge metal systems and roofing materials will need to work with the lightning protection industry to provide clear installation instructions for this equipment, in conjunction with the roofing system.

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Section 8: About the authors

SPRI, Inc.

SPRI is a collection of commercial roofing industry experts dedicated to providing an open forum for discussion, education, and innovation. We provide ongoing resources and expertise for contractors, architects, and building owners.

We are the leading authority in single-ply roofing. Our network deals exclusively with thermosets, thermoplastics, and modified bitumens. Here, you'll find easy access to online publications and documents that range from industry standards, generic technical guidelines for design and application to general information about roof maintenance and emergency repairs.

Lightning Protection Institute

The Lightning Protection Institute (LPI) is the national organization that leads the way in establishing the highest standards and guidelines for the design, installation, and inspection of lightning protection systems. Our work includes collaboration with architects, engineers, building enclosure consultants, roofers, general contractors, as well as many other construction and facility management individuals.