lightning protection systems safeguard structures from one of the most violent forces of nature. While the principles of lightning protection were established more than 250 years ago by Benjamin Franklin, the design and installation of lightning protection systems continue to evolve in response to advances in science and changes in architectural design, construction materials, and building technology. One area of ongoing innovation is lightning protection systems for occupied roofs.

Rooftop terraces and gardens have become some of the most sought-after amenities in urban buildings. Tenants and condominium owners pay a premium for these design features and expect high-quality detailing and construction that does not distract from the views the rooftops provide. Anything installed on an occupied roof must also be robust enough to withstand damage, unintentional or otherwise, from people coming in contact with rooftop equipment.

Lightning protection systems can satisfy these expectations, as demonstrated by several recently constructed buildings in downtown Chicago, Illinois. These case study projects illustrate innovative approaches to integrating lightning protection into roofing, parapets, and railings while still complying with North American standards.

BEST PRACTICES

Lightning protection is a specialized building system that must be integrated with electrical, structural, mechanical, and enclosure design and construction. The following guidelines will help building enclosure consultants to coordinate their work with other building systems:

- **Codes:** A lightning protection system should comply with the latest requirements of the North American consensus standards, including:
  - NFPA 780 – Standard for the Installation of Lightning Protection Systems,
  - LPI 175 – Standard of Practice for the Design–Installation–Inspection of Lightning Protection Systems,
  - UL 96 – Lightning Protection Components,
  - UL 96A – Installation Requirements for Lightning Protection Systems, and

- **Risk Assessment:** Best practice requires building design professionals to conduct a lightning risk assessment to ensure public health, safety, and welfare. NFPA 780 contains a simplified risk assessment methodology that can be completed in as little as 15 minutes using free, online apps such as www.bit.ly/LightningRisk; performing an assessment does not require specialized knowledge or training. Building enclosure consultants can best serve their clients (and limit their own liability) by determining whether this risk assessment has been addressed by the client or other members of the client’s design team and, if necessary, discussing with the client who might be best qualified to do the assessment.

- **System:** Rooftop air terminals, informally called lightning rods, are the most visible element of a lightning protection system, yet they are only one part of a complete system. A system also includes a network of lightning conductors extending down a building to connect to ground electrodes embedded in the earth outside the structure’s foundations, bonding connections to metal objects on and within the structure, and surge protection devices on incoming power and data lines (Figure 1).

Air terminals are not highly visible when viewed from the ground; they can be as small as 3/32-in. diameter, rise as little as 10 in. above surrounding construction, and be set back up to 24 in. from the building perimeter.

Still, some designers would prefer that air terminals not be seen up close by someone on a terrace. For them, a strike termination device can be used instead of a conventional lightning rod. A strike termination device can be any permanent part of a structure made from metal at least 3/16-in. thick (0.064-in. thick for handrails) and made electrically continuous with the lightning protection system. Railings, shade structures, decorative items, and other metal fabrications can be used in lieu of air terminals to meet design requirements.

Air terminals or strike termination devices must be located around a roof perimeter and at high points of a structure as determined by a “rolling sphere” analysis. The electrical charges capable of causing damage by lightning usually strike within a 150-ft. radius and are modeled...
as if a 300-ft.-diameter sphere is rolled across a building’s surface; wherever the sphere touches the building is a location where lightning can attach to the building.

**Design:** Most lightning protection systems can be specified by requiring compliance with North American consensus standards and then delegating the actual design to individuals holding Lightning Protection Institute (LPI) certification, based on rigorous examination, as a Master Installer/Designer or Master Installer. When practical, the lightning protection professional should be consulted early in the design process to help assure the lightning protection system will meet the project’s aesthetic requirements, be affordable, and provide reliable protection.

**Installation and Certification:** Installation should also be entrusted to firms employing LPI-certified professionals. Lightning protection systems are not in the bailiwick of most building code officials, so third-party inspection and certification by the Lightning Protection Institute–Inspection Program (LPI-IP) should be used for quality assurance; LPI-IP is the industry's most comprehensive inspection program. Inspection and certification programs are also available for reroofing of or modifications to existing buildings.

**RENELLE ON THE RIVER**

Renelle on the River, a luxury condominium building at 403 N. Wabash Ave. in Chicago, uses railings as strike termination devices around its rooftop terrace, giving visitors unimpaired views of the Chicago River and the city’s skyline. The top rail of the parapet’s aluminum glazing system contains an extra-thick...
channel sized to meet the metal thickness requirements for strike termination devices. The channel is made electrically continuous with steel balusters concealed inside the parapet’s framing members. The base of the balusters is attached to lightning protection conductor cables that lead to through-structure penetration devices and, from there, into the ground. In occupied roof areas, the connections and conductors are located beneath raised paving panels (Figures 2 and 3).

NEMA BUILDING

The NEMA (Chicago) at 1200 S. Indiana Ave. has commanding views of Grant Park. To honor the views, its architects specified railings as strike termination devices around the pool deck. The railings were installed on the inside face of the building’s extra-wide parapet, placing them more than 24 in. from the face of the building. This required air terminals to be installed on the parapet coping to satisfy a rolling sphere analysis (Figures 4 and 5).

In this instance, the visual impact of the air terminals is minor, because the air terminals are outside the glass railing and below the common sight lines for views of the park. Lightning conductor cables connect the air terminals and the bottom of the balusters to through-structure penetration devices that connect with the rest of the lightning protection system. The conductors and through-structure penetration devices are concealed among the foliage in planter beds around the terrace.
THE PARAGON

Instead of trying to minimize the appearance of the lightning protection system at the nearby Paragon building (1326 S. Michigan Ave.), the architect exalts the air terminals, making them a proud part of the tall wind screen.

Aluminum air terminals are bolted to the tops of aluminum stanchions that, in turn, conduct lightning to beneath the elevated concrete roof pavers. There, lightning conductor cables connect the stanchions to through-structure penetration devices that connect to down conductors inside the building (Figures 6, 7, and 8).

Figure 6. Aluminum air terminals are mounted to the top of the windscreen baluster to extend the vertical lines of the building. Photo courtesy of East Coast Lightning Equipment, Inc.

Figure 7. The metal balusters conduct lightning to beneath the deck pavers where they connect to lightning conductor cables leading to through-roof penetration devices. Photo courtesy of East Coast Lightning Equipment, Inc.

Figure 8. The balusters and slender air terminals blend into downtown Chicago’s skyline. ©Solomon Cordwell Buenz / ©Dave Burk
ONE BENNETT PARK

The richly appointed One Bennett Park (451 E. Grand Ave.) utilizes several creative techniques to incorporate rooftop lightning protection components into the building’s architectural features.

Classically shaped, cast-bronze air terminals are used around a terrace located on a two-story-high podium. Viewed from the terrace, the air terminals are partially screened by foliage, and the masonry parapet is drilled so that conductor cables can run, out of sight, into the planters. However, the air terminals are visible from the street and are mounted on limestone pedestals aligned with the building’s fenestration (Figures 9 and 10).

Terraces at upper levels utilize ornate metal railings, wind screens, and pergolas as strike termination devices (Figure 11).

155 N. WACKER

Many tall buildings have building maintenance units (BMUs) or other roof-mounted devices for raising and lowering window-washing and exterior-maintenance crews. As these machines move from one location to another, they can bump into and damage air terminals. The potential for damage can be minimized by installing air terminals on spring adapters that will flex upon impact (Figure 12).

The 155 N. Wacker building also has an extensive “green roof” that

Figure 9. The decorative air terminals are barely noticeable through the planter foliage. Photo courtesy of East Coast Lightning Equipment, Inc.

Figure 10. The ornamental cast-bronze air terminals are stylistically appropriate for the cladding’s classical limestone detailing. Photo courtesy of East Coast Lightning Equipment, Inc.

Figure 11. The metal balcony and frames of the windscreens and pergola are made electrically continuous with the lightning protection system and used as strike termination devices. Credit: Peter Aaron/Otto for Robert A.M. Stern Architects
required lightning protection system conductor cables to be installed beneath the rooftop plantings (Figure 13).

**A FINAL WORD ABOUT SAFETY**

More than a quarter of work-related lightning fatalities occur during roofing and construction activities. While lightning protection systems protect people inside buildings, they do not protect anyone on the roof. Building enclosure consultants should communicate to their clients and instruct their
own personnel working in the field that, as
the National Weather Service advises, “When
thunder roars, go indoors.”

EDITOR’S NOTE
A previous version of this article appeared

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   streamer emission or charge dissipation
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   at bit.ly/nonconventional_systems.
4. Some photos in articles have been
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Jennifer Morgan is
a co-owner of East
Coast Lightning
Equipment. She can
be reached via ecle.
biz.

Jennifer Morgan

Michael Chusid, RA,
FCSI, is an expert in
building products
and can be reached
via www.chusid.
com.

Michael Chusid,
RA FCSI

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