When Lightning Strikes

How to know if your next project needs protection

By Keith Lane,
Lane Coburn & Associates, LLC.

Lightning protection can be a critical part of any building's infrastructure, providing protection to people and property. When assessing a particular client's degree of risk on a given project, it's important to realize that certain lightning protection risk analyses are more complicated than others. Before making a recommendation, you must determine if lightning protection is even required in the first place. To do so, an understanding of the basics is in order.

The purpose of a lightning protection system for a commercial building is to provide a path for the lightning strike to pass through without damaging non-conductive parts of the building. A lightning protection system is a method of controlling a lightning strike via a low-resistance path for the strike to flow. These systems do not prevent a lightning strike from occurring. The main components of a lightning protection system are air terminals, down conductors, and ground rods.

There are two main methods of providing a lightning protection risk analysis based on the 1997 edition of NFPA 780 or the 2000 edition of NFPA 780. (*Note:* Although the 2004 version of NFPA 780 is available, the calculation methods in this version are the same as in the 2000 version of the standard.) The 1997 edition requires you to look at lightning frequency levels and the number of lightning storm days in the construction area. The 2000 edition of NFPA 780 requires you to base your design on a Lightning Strike Frequency value (Nd), which is essentially the yearly strike frequency based on the average flash density, the collective area, and an environmental coefficient, and a Tolerable Lightning Frequency value (Nc), which is a measure of the damage threat to the structure.

When developing a preliminary lightning protection analysis, it's best to present clients with both versions. As a lightning protection system is always optional, providing both studies allows the client to determine risk, insurance levels, UL certification requirements, and internal standards compliance based on the most comprehensive information available.

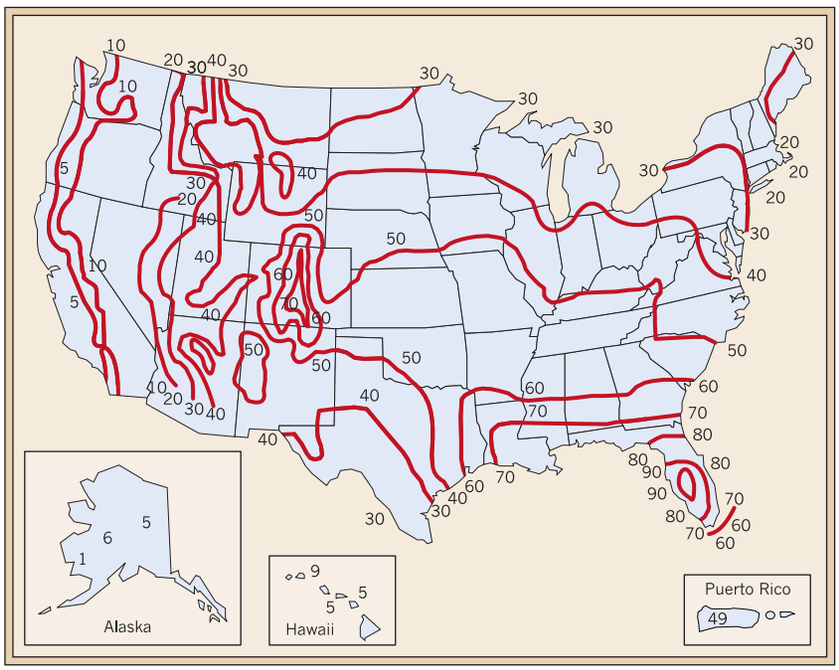

Fig. 1. Isokeraunic map shows mean annual number of days with thunderstorms in the U.S.

A dual approach. The 1997 version of NFPA 780 requires you to calculate the risk of lightning damage on six different criteria.

Type of structure: Select one type of construction from a list of 15 different construction types, which vary from residential, office, and factory structures to public utility buildings, municipal buildings, libraries, and museums.

Type of construction: Select the construction type of both the framework and the roof of the building.

Relative exposure: Identify the location as an urban or suburban area based on the size of the covering area. Additionally, a selection can be made in the "other structures" category if the first two categories do not apply.

Topography: Select either flat land, hillside, hill top, or mountain top location.

Occupancy: Select the occupancy type from a list of 12 possible selections.

Lightning frequency: A map of the United States is shown in **Fig. 1**, illustrating the incident number of thunderstorm days in various areas (i.e., days in which thunderstorms are observed). Select the area of the country and the associated days of thunderstorms per year for your given project.

The 2000 edition of NFPA 780 bases a lightning threat on a number of criterion, including:

1. Height, length, and width of the structure.
2. Approximate location of the building within the country.
3. Environmental coefficient.
4. Building and roof structural material.
5. Structural content coefficient.
6. Occupancy coefficient.
7. Lightning consequence coefficient.

As the electrical designer on the project, you must work hand in hand with the structural engineer and/or project architect to understand all areas of the structure being built. This will allow you to properly evaluate the lightning threat from the design criteria noted above.

The approximate location of the structure within the United States is an important factor in determining the risk analysis for a building. The 2000 edition of NFPA 780 includes a map of the United States illustrated with colors representing the average lightning flash density in flashes per kilometer squared per year. You simply choose the flash density for the specific area in the country the project is located. It also provides a process to calculate the Nd and Nc values.

If the Lightning Strike Frequency value is larger than the Tolerable Lightning Frequency value (i.e., Nd > Nc), then it is recommended that a lightning protection system be integrated into the project. If Nd turns out to be significantly higher than Nc, the actual threat would be greater than if the value of Nd was only a little bit larger than Nc.

It is important to note that the 1997 version of NFPA 780 uses the criteria of days in which lightning strikes are observed, and the 2000 version looks at the actual yearly strike frequency based on the average flash density, the collective area, and an environmental coefficient.

If you want to comply with NFPA 780 for insurance purposes and a UL-certified or Master Labeled certified lightning protection system is desired, you need to determine which version of NFPA 780 will be followed by the UL inspector and authority having jurisdiction (AHJ). The 2004 version of NFPA 780 has been published, but the calculation methods are the same as the 2000 version.

For more specific direction on

conducting lightning protection analysis, let's examine the following two scenarios for more guidance.

Ask the experts. The examples below illustrate situations where additional analysis is required to determine if all parts of adjoining structures required lightning protection.

Example No. 1

Q. What happens in a situation where you have two buildings — a hospital and a parking structure, for instance — that are adjoined and separated by a firewall and the NFPA-based lightning protection analysis indicates lightning protection is required in the hospital but not the parking structure?

A. If the risk analysis indicates that lightning protection is required and a lightning protection system is installed in the hospital building, you may also want to consider installation of the lightning protection system on the parking structure. Why? UL will only certify a building if all portions of that building are protected from a lightning strike. This will also prevent the hospital building from receiving UL Master Label certification. However, if there is a firewall separating the two structures, UL can issue a "Letter of Findings," which will state (after an on-site inspection) the installed system at the hospital building meets all code requirements, but because it is attached to an unprotected structure it cannot receive the Master Label designation.

The purpose of a lightning protection system for a commercial building is to provide a path for the lightning strike to pass through without damaging non-conductive parts.

Example No. 2

Q. What about a sky bridge that connects two protected buildings? Will it need protection?

A. Let's take a situation where you have a 30-foot to 50-foot sky bridge between a hospital building and a medical office building. Additionally, the top of the sky bridge is located 40 feet above grade. The hospital and medical office building are both eight stories tall. NFPA 780 defines the "rolling ball" theory to determine if the sky bridges are in the "zone of protection" from the other buildings (**Fig. 2**). Based on this analysis, the sky bridge probably does not need to be protected. However, this risk assessment should be used as a guide only. The final determination of the requirement for a lightning protection system should be made by the owner.

Making the call. The option to install a lightning protection system is a critical decision for the purposes of life safety, protection of property, insurance costs, and installation expense, and should be performed based on the NFPA 780 "Risk Analysis" guidelines. Armed with the right tools and an understanding of NFPA 780, the electrical engineer can provide a critical evaluation of the potential risks. This evaluation can help the building owner make the right decision for his project.

For complex and critical projects, the potential cost of downtime can be very expensive and can even have life safety ramifications. For these types of projects, it's in your — and your client's — best interest to employ the services of a lightning protection institute (LPI)-certified designer/inspector to perform or validate your lightning protection analysis. An LPI-certified designer/inspector has the training and the expertise to provide appropriate recommendation for even the most complex projects. **EC&M**

Lane is a registered professional engineer, licensed electrical administrator, RCDD/NTS specialist, TPM, LC, LEED A.P.
Lane CoBurn and Associates, LLC.

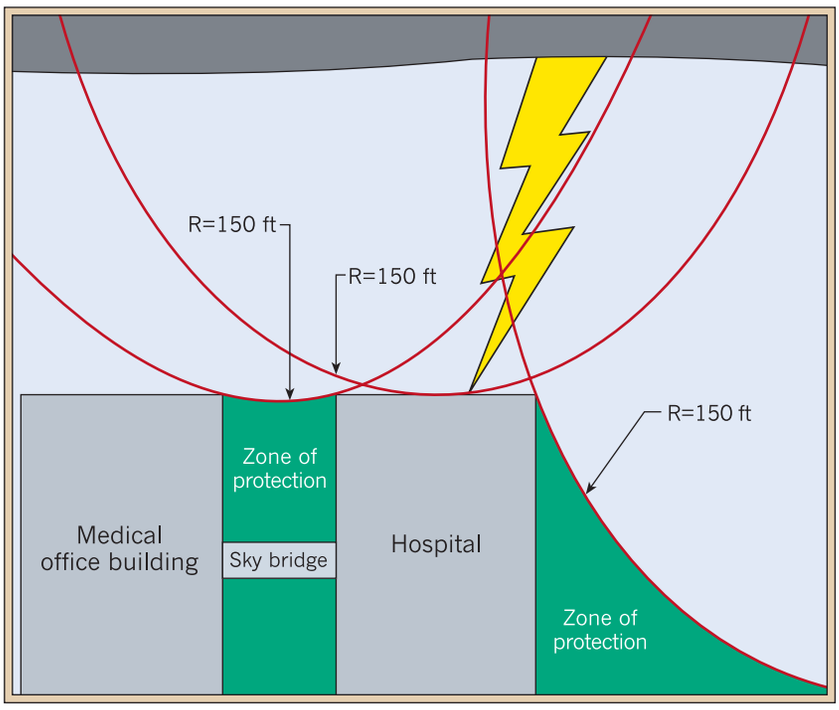

Fig. 2. The drawing above illustrates the hospital and medical office building joined by a sky bridge. The sky bridge enters both buildings on the third floor of an eight-story building. This diagram describes the 150-foot rolling ball theory. If you roll a ball that has a radius of 150 feet over the two buildings, you can define the "zone of protection" that the two buildings will provide over the sky bridge. Based on this analysis, lightning protection would not be required for the sky bridge joining the two buildings.