RISK CONTROL AND CLAIM ADVOCACY PRACTICE

# TECHNICAL ADVISORY BULLETIN

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## LIGHTNING – FIRE IN THE SKY

**Most of us view lightning through the image of an 18th century U.S. legend: Ben Franklin flying his kite in a storm, a brass key dangling at the end to attract the electricity. Or perhaps, those of us with more modern perspectives recall some exciting movie special effects.**

For some people and some operations, lightning is far from nostalgic and not computer generated, but frightening and a real threat to people and property. A U.S. Department of Commerce report has estimated that random lightning strikes cause an estimated $5-6 billon a year in property damages. Lightning has also caused many injuries and deaths. The U.S. National Weather Service has reported that over the last 30 years, an average of more than 50 people are killed and hundreds permanently injured by lightning strikes every year. (U.S. Dept. of Commerce – NOAA, NWS 2012) Globally, thousands of thunderstorms each year cause lightning strikes to earth resulting in fires plus additional electrical and mechanical damage.

While some areas may be more prone to lightning storms, lightning strikes can occur anywhere, have at some time happened throughout most of the world and can damage any structure or equipment located above ground and which is connected to the earth directly or through connection to an object that is (e.g., roof top equipment on buildings).

A number of groups (National Weather Service, various insurance underwriters, etc.) provide maps and charts that show recorded lightning frequencies. These show historical trends and occurrences and can help in evaluating lightning potential in a specific area. Lightning is born in the clouds during certain atmospheric conditions that generate electrical charges sometimes referred to as "down streamers." These down streamers are attracted to ground objects that produce an attractive point known as an "up streamer."

Lightning will occur if these two are connected and the charge will find the path to the ground or grounded structure. The lightning can be attracted by any ground "up streamer" condition at any height, not just to the very tallest structure in an area.

To put the magnitude of the lightning force in perspective, the physical characteristics include levels sometimes in excess of a half million volts, current levels of 200-400 kA, induced temperatures up to 5,000 degrees F, and speeds approaching one-third the speed of light. The speed at which this lightning energy can travel through a structure will generally outpace any emergency shunts on electrical equipment if is not channeled directly to ground by a lightning protection system.

This force can cause physical damages, such as arcing of electrical equipment, electrically ignited fires of combustible materials and explosive failure of building members. It can also cause physical and/or electrical damage, or operational failure to any electronic communications or information technology (IT) equipment systems. A computer controlled manufacturing or business operation could be shut down or operations disrupted via this loss of a critical part or all of a control system. This may include important communication systems, such as ordering, processing, financial trading and e-mail or other operations.

**Example:** A recent lightning strike to a large NY hospital caused the shutdown of a number of medical systems as well as both internal, hospital-wide and outside phone system communications. Luckily, the strike occurred on a Friday evening. This lessened the impact on hospital medical operations, since most important medical treatment areas (operating rooms, etc.) had shut down for the weekend.

Aside from electronics, lightning can impact a key area of the physical plant building structure. Both inside and outside storage systems for gas and liquids can also be affected (tanks, etc.).

Lightning has also been attracted to the inside of buildings with skylights or domes. Lightning connects to an inside metal structure through the roof opening. In buildings with roof openings, a review of such interior exposures as highly sensitive electronics or easily ignited products (flammable materials etc.) should be done. Specially designed lightning protection grates (cages) can be used to limit the potential for a lightning strike.

Interior exposure is also a concern if any rooftop-mounted equipment is connected to the inside of the building, especially if this equipment supplies some building environmental requirement critical to the building's operation, such as air conditioning or air quality.

Resources to help you evaluate the potential and severity of lightning strikes include the **National Fire Protection Association (NFPA) 780 –"Standard for Installation of Lightning Protection Systems."** The standard contains guidance which can help evaluate lightning potentials using building occupancy, construction and physicals information. Lightning equipment industry trade groups also supply information and training on this topic. These trade groups include the **National Lightning Protection Institute (LPI)** and the **National Lightning Safety Institute (NLSI)**

All lightning protection system components should also be approved or listed by a national testing and listing laboratory, such as Underwriters Laboratories (UL). One such listing standard is UL-96 – "Requirements for Lightning Protection Systems."

**The preferred method of connection between any aerials, equipment and connection cables is a non-mechanical splint, such as a heat weld. This helps limit potential line resistance points and prevents possible loss of a mechanical connection due to vibration or movement.**

A system can additionally be provided with a "UL-Master Label," which includes an approved system design and UL-listed components, installed and certified by a listed lightning system installing company. The Master Label certificate system needs to be reinspected and re-certified every five (5) years. And whenever the system components are changed or damaged in some way (i.e... lightning strike, advise weather, etc).

The local building codes may have other requirements that should also be reviewed. A number of recognized third-party companies install, test and certify the performance of any existing lightning systems and system components according to these industry standards.

As lightning is a natural phenomenon created in the simultaneous occurrence of a number of conditions, a lightning strike cannot be prevented by a protection system. However, a well designed protection system can mitigate or reduce the damages and effects of lightning. The actual system parameters and design are developed for each particular installation by taking certain factors into consideration.

Some of the main, visible and design components are shown below in figure LP-1.

1. Each lightning protection system is designed based on a review of the particular building or structure's physical geometry as well the occupancy it protects.

2. Most ordinary buildings of conventional construction are further classified according to height.

3. Buildings less than 75 feet high are considered Class (I) structures, and buildings over 75 feet are rated as Class (II).

4. This classification (I or II) will affect the overall size, electrical capacity and placement of the lightning protection system components.

5. Components used in lightning systems are listed for use in a particular system Class (I or II).

6. The most visual component is the antenna-type rods, a.k.a. air aerials or lightning rods.

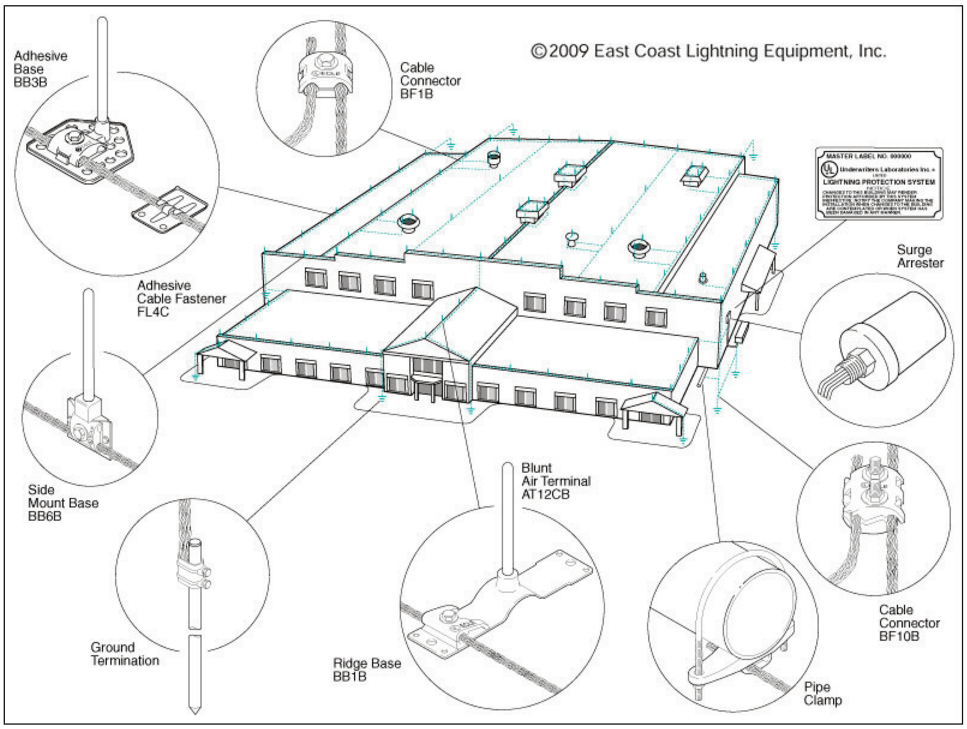
7. To provide proper protection, survivability and structural support, these air terminals have height, spacing and attachment design requirements.

8. These air terminal requirements are related to the aerial height above the structure.

9. Aerials more than 10 inches high are generally spaced every 20 feet and those over 24 inches are spaced every 25 feet.

10. Aerials are connected to a conductive wire cable system that runs directly to ground via the shortest path.

Figure LP - 1




11. The connective cables should be connected to ground level rods that extend approximately 10 feet into the ground.

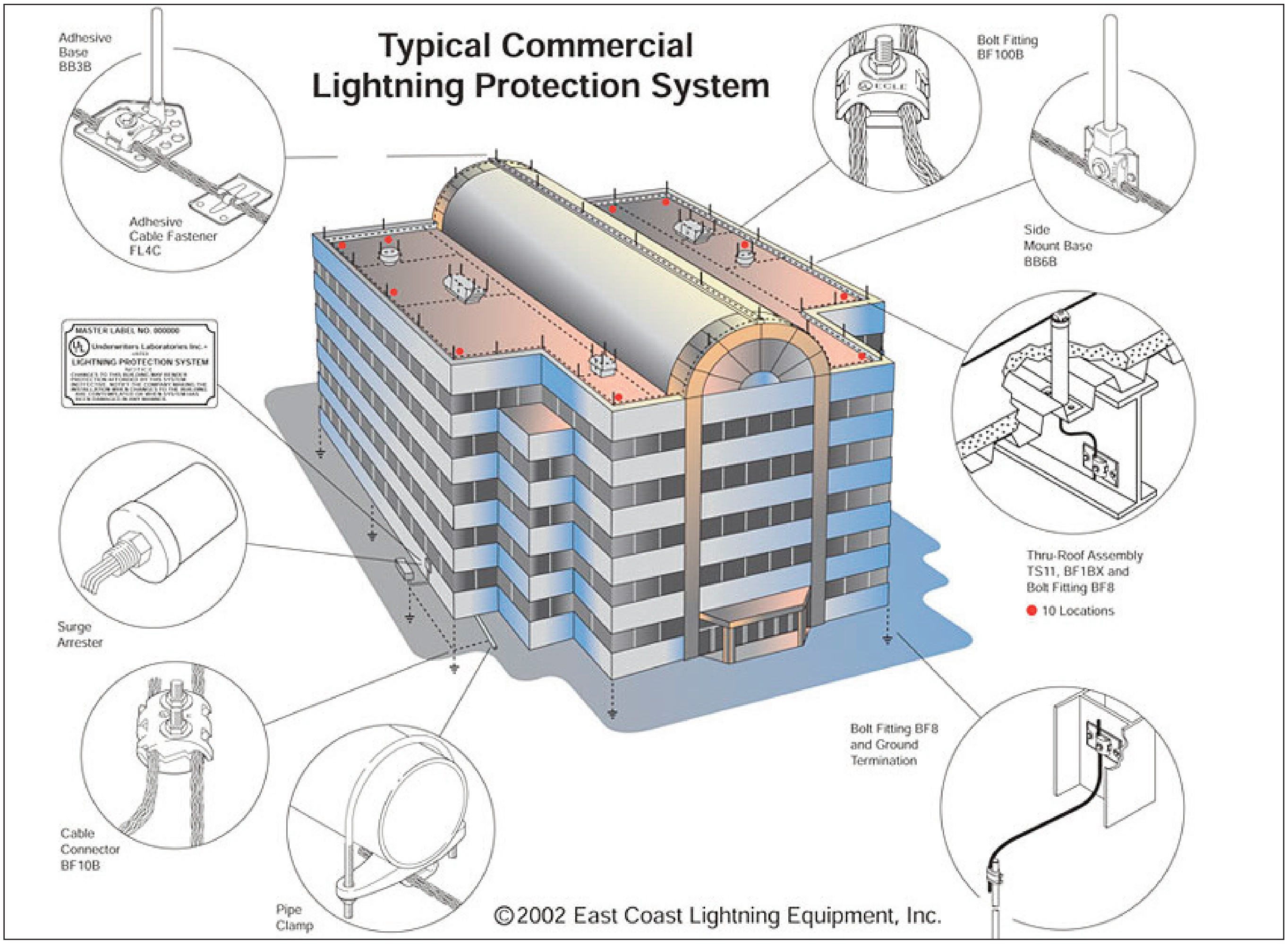
12. These grounding rods should be located away from any ground-level electrical equipment as well as any above- or below-ground storage tanks.

13. For each system at least two down conductors spaced at intervals averaging 100 feet around the perimeter of the structure should be provided.

The preferred method of connection between any aerials, equipment and connection cables is a non-mechanical splint, such as a heat weld. This helps limit potential line resistance points and prevents possible loss of a mechanical connection due to vibration or movement.

All air terminals should be interconnected and provided with a two-way path to the ground. Conductors should maintain a downward path to the ground. Bends in the cable should be avoided but, if required, should not be more than 90 degrees. Conductors should have fasteners placed every three feet on each run of exposed cable.

Figure LP – 2




The system cabling lines connecting aerials should run around the perimeter of the building roof and not across it. Rooftop equipment, such as heating and air conditioning units, should be protected. Rooftop openings (skylights, hatched, etc.) should be protected across their entire horizontal surface areas as well as their perimeters.

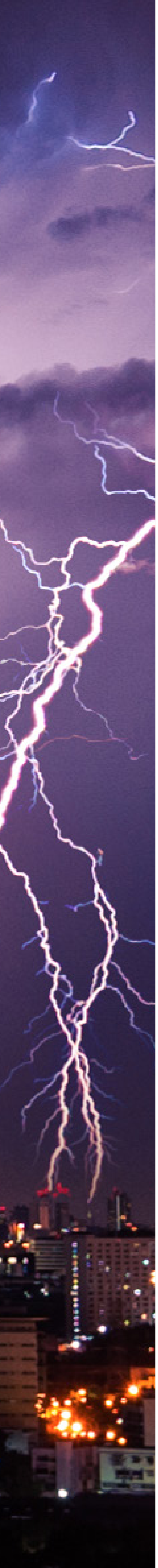
All of these system components are typically made of highly conductive metals, such as copper or aluminum. Copper materials have a lower resistance and thus a higher conductivity, which together will channel lightning surges to the ground more quickly and help reduce potential damage.

Aluminum is approved, but it is generally recommended to not mix these two materials within one building lightning protection system.

The aerials themselves can be designed to different configurations and shapes (pointed or rounded) to provide different attractive lightning potentials.

Lightning protection should also be reviewed for outside equipment, such as storage tanks – especially those containing combustible materials. The location of these tanks or equipment relative to any building and the potential for cross strikes should also be evaluated. Rooftop emergency equipment, such as emergency generators and emergency communication systems, should be reviewed and protected as necessary.

A lightning protection system is located outside and exposed to natural elements and possible mechanical failure. The system needs to be visually inspected and electrically tested each year or following severe weather or damage (i.e., windstorm, mechanical damage). An electrical conductivity test should be done yearly to help identify areas of high resistance, which could cause failure or impair the



performance of a lightning protection system. The Federal Emergency Management Administration (FEMA) has also issued recommendations for additional securement of lighting systems in high wind-prone (i.e., hurricane) areas.

The final design may have some standard components, but each system will also have some unique components that will vary for each lightning system installation.

Additional design and performance features can be found in a recent UL publication "UL Lighting Protection Application Guide."

The attached figure (LP-1 and LP-2) show examples of some typical protection schemes for the types of buildings or equipment depicted.

In summary, like sprinkler systems, fire alarms and other building safety systems, a properly designed lightning protection system should be considered in the design of every building. Both building owner and tenants should review their facilities' exposure potentials and protect their operations as necessary.

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