



# Lightning Eliminators & Consultants, Inc.

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## LIGHTNING PROTECTION REQUIREMENTS FOR BROADCASTERS & OTHER TOWER USERS

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### Background

Lightning activity presents one of the greatest hazards to broadcasters and other tower users. However, because lightning-related failures are not always identified as such, the system design engineers often overlook this hazard. Actually, there are at least two factors that tend to lull the designer or customer into a false sense of security:

(1) Lightning activity can be random in nature. Several years can pass without any strikes to or near the facility, even when the estimates predict several strikes per average year. For example, the Denver area should experience 4 to 8 lightning flashes per square kilometer per year to grade level. The average lightning flash contains 4 discreet lightning strikes, although this number may be as high as 30. Therefore, if Denver experiences 6 flashes per square kilometer per year, then it experiences 24 strikes per square kilometer (or 62 strikes per square mile) per year to grade level on average. Elevated structures such as towers and buildings will increase this amount, as you can see in Table A.

	Flash Density	Flashes/yr to 100ft <u>Tower</u>	Flashes/yr to 250ft <u>Tower</u>	Flashes/yr to 500ft <u>Tower</u>
<u>Location</u>	<u>strikes/sq km/yr</u>			
Washington, DC	2-4	0.5-0.1	0.35-0.7	1.4-2.9
Denver	4-8	0.1-0.2	0.7-1.4	2.9-5.7
Tampa	8-16	0.2-0.4	1.4-2.8	5.7-11.5

Table A: Expected Lightning Flashes to Towers in Various Locations

(2) The secondary effects of lightning are not always attributed to lightning activity and may be attributed to random or incipient failures. Dealing with the direct strike alone will not influence these failures and, in some instances, can increase the risk of losses due to the secondary effects of lightning. These indirect or secondary effects of lightning include the following and may cause equipment degradation or failure: (1) earth current transients, (2) atmospheric transients and (3) electromagnetic pulses (EMP).

## **Dealing with the Lightning Hazard**

The peak current in a lightning strike can vary from 2,000 to over 400,000 amps. Therefore, in specifying a particular protection plan, the designer must also accept some risk level, either knowingly or inadvertently. A tower site must be protected against (1) direct strikes to the tower or antennas, (2) induced electrical surges and transients on the incoming electrical service and (3) induced electrical surges and transients on the communications lines.

## **Protection Against Direct Strikes to Towers and Antennas**

Direct strikes to broadcasting equipment and towers are a common problem and must be addressed by the system design engineer. There are two broad categories of direct strike protection equipment that can be installed on towers. (1) **Strike avoidance systems** prevent lightning strikes from terminating on the protected structure, and (2) **strike collector systems** are deployed as a preferred terminus for lightning strikes. Strike collection equipment, or conventional lightning protection systems (CLPS), are connected to a down conductor in an attempt to control the collected lightning current down the tower and into the grounding system.

Use of a CLPS is not recommended for “protecting” electronic equipment; it is both dangerous and ineffective. It is dangerous because, in order for it to function correctly, it must be deployed in close proximity to the equipment being protected. The CLPS is ineffective because it encourages the formation of secondary effects within and near the protected equipment. These units may collect the strike, but they will not prevent damage.

Use of a strike **avoidance** system eliminates all potential losses when properly applied to a given site. The Dissipation Array<sup>®</sup> System (DAS<sup>®</sup>) is a strike avoidance system that works by developing an electrostatic shield above the protected site. That shield is a dense layer of space charge (corona) that retards the formation of upward, collective streamers. CLPS’s, on the other hand, are designed to create strong upward streamers which can collect strikes and lead to the formation of strong secondary effects.

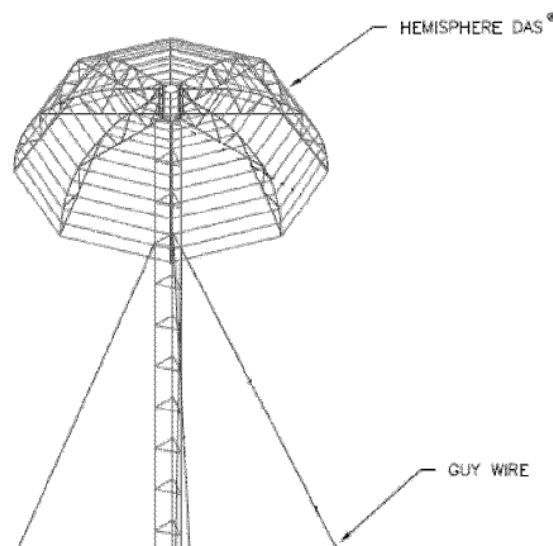


Figure 1: DAS<sup>®</sup> Hemisphere on Tower

**Protection against Surges on the Electrical, Telephone and Datacomm Services**

The incoming electrical service is a primary source of lightning-related surges and transients because of their exposure to lightning. These activities produce various forms of voltage anomalies on the electrical service that are coupled directly to any electronics operating on that line, **unless** they have a proper form of surge protection that can suppress the incoming surges and transients. High quality surge protector devices (SPD's) will also improve the reliability of the protected equipment and extend their useful life.

Most standards require that SPD's for AC power service entrances have protection rating in the 10kA to 20kA range. However, these ratings are too low compared to the available current in a lightning strike. Lightning strike current ranges from an average of 20kA to some strikes of over 400kA. In addition, remote or mountaintop locations will experience transient conditions that are more severe than normal. For these reasons, LEC recommends an SPD with a surge capacity of at least 200kA per phase for AC power service entrance applications. For telecom and data lines, LEC recommends using SPD's with a surge capacity of at least 10kA per wire.

**Grounding Considerations**

Grounding electrode systems (GES) are an important component of the overall lightning protection system. A well-designed GES will:

1. Provide a low resistance, low surge impedance connection to the earth.
2. Provide a common reference for all of the systems on the site, with no significant impedance between those grounding points.
3. Collect the charge induced on the earth by the thundercloud, and conduct it to the DAS<sup>®</sup>.

A well-designed GES can be accomplished by surrounding the protected site with a ring conductor augmented with Chem-Rod<sup>®</sup>s, thus creating a localized low impedance grounding system. The ring conductor will ensure an equipotential ground plane within the ring itself during thunderstorm conditions, while the Chem-Rod<sup>®</sup>s provide an efficient, low impedance connection to earth during all seasons and weather conditions. A Chem-Rod<sup>®</sup> is a chemically activated grounding electrode that will yield a very low resistance and low surge impedance connection to earth.

The DAS<sup>®</sup> on the tower should be electrically bonded to the GES at an additional Chem-Rod<sup>®</sup> location at the base of the tower. The ground connection (or ground window) at the electrical power service entrance should also be electrically bonded to the GES at an additional Chem Rod<sup>®</sup> location. See Figure 2.

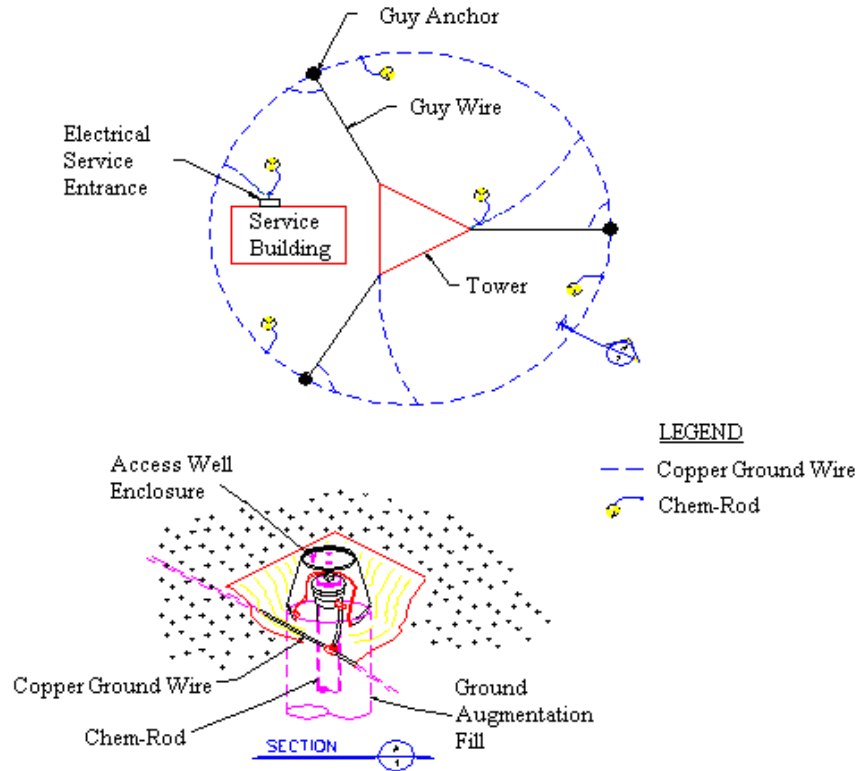


Figure 2: Typical Chem-Rod® Based Grounding System

The LEC Chem-Rod® has been proven to be the best grounding electrode available on the market. This proof was the result of a five-year test conducted during the National Electrical Grounding Research Project, which was a country-wide test managed by the National Fire Protection Association.

A common ground reference must be provided at one point where one ground wire enters the facility service building. A ground bus should be mounted inside the building, to which the external ground wire is bonded, thus creating a “ground window.” In the ideal arrangement, the ground of each unit of electrical/electronic equipment should be connected **directly** to that ground bus.

**Conclusion**

Lightning activity presents one of the greatest hazards to broadcasters and tower users. These hazards can be reduced or eliminated through proper implementation of direct lightning strike prevention equipment and by installing surge protectors on both AC power lines and low voltage datacomm lines. A proper wired and low resistance grounding electrode system is required to ensure proper operation of the protective equipment and also of the interconnected electrical and electronic equipment.