Can Lightning Really be Prevented with Point Dissipation?

by Ron Nott

The summer storm season is nearly upon us. Stations are checking their grounding and surge suppression systems, and wondering what else can be done. Can "point dissipation" provide an extra margin of safety from lightning? Ron Nott discusses the topic.

After more than three decades of experience with this technology, what have we learned? Some users claim great success. Others disagree. Who is right?

THE STORAGE AND DISCHARGE OF ELECTRICITY

More than two and a half centuries ago, the Leyden jar was invented. If you search its history, you will find that in most illustrations and photos, a round knob is affixed to the top terminal. Why the round knob?

This construction comes from the work of early experimenters who charged the Leyden jar with static electricity, which was high voltage and low current. The underlying principle is the same as when you shuffle across a carpet and touch a doorknob. The voltage can be as high as 35,000 Volts, but only a few microamperes of current are created – or you would be dead.

Experimenters of the eighteenth century learned that if a sharp, pointed wire were placed as the top terminal of a Leyden jar, the charge would rapidly dissipate into the air. But if a round knob were placed on the jar or the wire, the charge would be retained for much longer. Understanding the reason why this works will lead us to a better understanding of how to protect equipment from lightning.

Sharp or Pointy Objects?

Early experimenters found that the larger the diameter of a sphere, the greater would be the voltage before corona began to occur. They found that a radius of one centimeter of the sphere would increase the corona threshold to somewhere between 35 and 55 kV. This was found to be a linear function so that a sphere of 10 cm radius (20 cm diameter) would begin corona discharge between 350 and 550 kV. When Tesla created artificial lightning more than a century ago, he simply built a sphere large enough to initiate corona at 5 million Volts.

Ben Franklin observed that a silent current flowed into the air above a sharp wire which led to his lightning rod. Seemed like a great idea, but why did it not work? It did work, but had limited capacity.

A single sharp point has a maximum current value that can flow from it. But when many points are placed in parallel with the *correct geometry*, the capacity is increased enormously.


Multiple points can dissipate larger charges.

DEALING WITH LIGHTNING

As a thunderstorm approaches, the electric field between earth and cloud begins to increase. *This* is the time to begin to discharge this field. If the voltage can somehow be held to a value below that which is necessary to initiate a lightning strike, there will not be a strike.

A single lightning rod placed atop a tall structure will begin to discharge the field, but once its current capacity is exceeded, it may initiate an upward streamer that can cause a strike. If the goal is to *prevent* a strike and/or equipment damage at a location, the lightning rod may be the wrong approach.

You can find information on the Internet stating that a dissipation system will not work, the writers often assuming that the field contains too much energy. However, a properly designed system does not wait for the field energy to reach this large value – it begins to dissipate the field *before* the buildup can reach the value necessary to initiate a strike.

ENERGY POTENTIAL

We measure the energy contained in a lightning strike in Coulombs. Estimates from most lightning strikes range from 1 to about 50 Coulombs, but in the most extreme cases may reach 300 Coulombs. Typical is probably 5 to 10 Coulombs.

What is a Coulomb? It is a *quantity* of electrical charge consisting of a current flow of one Ampere past a point for one second. Since electric current consists of electron flow, the number of electrons in one Coulomb is approximately 6.25 x 10 to the 14th power. This is a very big number, but it is a *finite number.*

As an example, suppose we have a 120 Watt light bulb which, when connected to a 120 Volt AC power source would have a flow of one Ampere through it. This means that in one second, one Coulomb of electrons would flow through it. In 30 seconds, 30 Coulombs would flow through it.

DAMAGE POINT

If a lightning strike of 30 Coulombs occurs, why does it do so much damage? Simply because it occurs in such a short time period.

A typical strike happens in only 20 to 50 microseconds. If the same energy discharge could be spread out over even a few minutes, there would be no damage. This is how and why multiple point dissipation works, by discharging the same energy into the air over a longer time frame than lightning does.


The Eagle's Nest from Nott Ltd. Intended for tall towers, the points are bent, on site, to make shipping and installation easier.

You can find information on the Internet stating that the energy in a lightning strike can light a 100 Watt bulb for a long period of time, but this assumes millions of Volts at one Ampere, which is just not the case.

The reason why is that a Coulomb is a finite number of electrons and multiplying 10 million Volts times one Ampere does not result in 10 million Watts.

DISCHARGE POINTS

An important point to remember is that as the electric field builds prior to a storm, it builds not just on the top of a tower, but from the ground up.

This means that while the top of a tall structure should be protected, the sides also need protection as side strikes may occur including those on guy wires. A Rule of Thumb is that dissipaters should project from the sides of the structure about every 200 feet to adequately discharge the structure.

ANECDOTAL EVIDENCE

While some may discount the value of anecdotes, many are of great value at times. Here is one.

About 20 years ago, a dissipation system was installed on a tall TV transmission tower (more than 1,000 tall). After one thunderstorm season, the chief engineer called with a complaint. He said that the system had eliminated lightning damage to his site, but then asked if it possibly could have helped his competitor stations as well because their lightning damage had also been eliminated.

It turned out that several tall towers were located in an east-west row and his was the farthest west. The prevailing winds at that site during storms are from the west. I explained that the dissipater points generate plasma and, as a result, an ion cloud was carried downwind and apparently protected the towers to the east.


Different adaptations of multiple point dissipaters.

The engineer was not pleased to hear this (one must assume there were hard feelings between the stations) and asked what he could do. I told him the only solution that would protect him and remove protection from his neighbors would be for him to move his tower downwind from the others – and this, of course, was not acceptable. The competitors were happy, though.

DEALING WITH AM ANTENNA GUY WIRES

You may have been near an AM transmitter site when lightning struck some distance away. If so, you heard crackling, like popcorn popping. This is because each segment of guy wire between insulators takes on a charge like a capacitor floating in air. A lightning strike nearby causes them to discharge across the insulators which causes the crackling sound.

Many years ago when guy wires were terminated with Crosby clips instead of modern preforms, an old tower erector told me that when he put together segmented guys for an AM station, he would use 10 or 12 excess guy wires at each insulator. Then before they were hoisted up, he would flare the excess lengths outward so that they could dissipate the charge into the air. It worked very well. No popcorn sounds were heard.

Down in the tropics of southern Mexico, another AM station had a terrible time with this problem. We fabricated some 42 small dissipaters that were attached to the guys adjacent to the insulators. This solved the problem completely.

However, please note that you cannot get American tower climbers to trolley down the guys to install dissipaters on them; OSHA would likely frown on such activity. Nevertheless, several more Mexican stations have used this same solution with success.

SAFE RELEASE OF ENERGY

So after all this rambling, it can be seen that the science is there to greatly decrease damage from lightning. The reason that lightning does damage is not because it has massive energy, but that the energy is released in such a short period of time.

How energy is released is the key. We all use gasoline in our vehicles and prolong the release over a relatively long period. But a gallon of gasoline evaporated in a container that also has the proper quantity of air can result in a rapid, powerful, and damaging explosion.

Without doubt, there are those who will always believe that nothing can be done to prevent lightning damage. But those with open minds, willing to pursue the facts of how charge transfer by point dissipation works will realize that, with proper design and application, it can decrease damage from 95 to 99 percent.

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