Prevent Lightning Strikes with Charge Transfer Systems

Nov 1, 2001 12:00 PM, By Donald W. Zipse, Zipse Electrical Engineering Inc., Wilmington Del.

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For 200 years, lightning rods have been used as a means of collecting and controlling the awesome and destructive power of lightning. But is it wise to allow thousands of amperes to flow near sensitive electronic equipment, especially when charge transfer systems (CTSs) are available and can prevent strikes in protected areas? With businesses around the world installing 500 such systems per year, it's a concept worth investigating.

The history of the CTS begins in 1930, when a southern California oil-field worker patented the original concept. In 1971, Roy B. Carpenter Jr. came across the patent while working for the United States Air Force. Carpenter was a chief engineer for the first space shuttle design team. After leaving the USAF, he expanded the patent into the dissipation array system® (DAS®).

It wasn't until the early 1990s that the theory behind DASs advanced and developed into the CTSs available today. Let's take a look at the science behind this technology.

The Underlying Theory

Proof of lightning rods' effectiveness lies mainly in empirical and anecdotal evidence. CTS technology, however, is based on existing electrical and physical formulas and mathematical basics. Here's how it works:

A lightning storm cell contains an electrical charge. In the United States, the majority of storm cells have a negative charge contained in the bottom of the clouds. Raindrops carry the negative charged ions to the ground, which causes a buildup of electrical charge on the earth's surface.

Acting like a shadow of the cloud above, the positive electrical charge (at ground potential) follows the charged cloud because opposite charges attract each other (see **Fig. 1**). The lightning leader also contains an electrical charge as it approaches the earth.

Imagine taking the frame of a large umbrella, wrapping barbed wire around the top of it, and connecting the barbed wire to the earth. This is what a charge transfer system resembles.

When a storm cloud is overhead, it creates an electrical field between the cloud and the earth. The potential can be as high as 30,000V. When placed in this electrical field, every sharp point connected to earth will emit charged ions into the air above. These ions form a charged cloud (see **Fig. 2**, on page 26). The charged cloud reduces the potential in the immediate area.

With the potential reduced, charged leaders may be diverted away from the site. However, when there are two opposite electrical charges, there will be a force between them drawing them closer together. As the two charges draw closer together, the force

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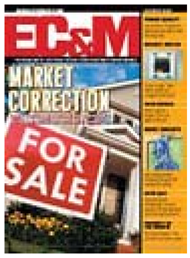

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distance between them.

As the leader progresses downward through the sky, it loses its charge and must draw more charge from the bottom of the cloud. The temporary loss of charge causes the leader to pause in its downward motion, until more charge can flow down it.

This explains why the leader starts out from the cloud in short jumps. The force is weak because the distance is great. As the leader (with its charge on the tip) draws closer to the charge on the earth, the amount of force increases, and the leader makes larger and larger jumps in distance.

When the charged downward leader meets the charged space cloud, the leader is neutralized (see **Fig. 3**). When this happens, there is no electrical path for the earth's charges to flow back to the cloud. If the cloud lacks an adequate amount of electrical ion charge to completely neutralize the downward leader, additional charge flows immediately into the neutralization area and completes the neutralization. Measurements have verified this additional flow of instantaneous charge.

Since the overhead storm cell attracts the charge flowing on the earth, the charge is contained on the earth's surface. Therefore, the ground rods are only 40 in. deep. There are a multitude of ground rods to collect the available charge on the earth. A CTS's earthing rods are connected together (single-point grounding) to the ionizers with a low-impedance conductor.

Present Status

In June 2000, the standards council of the National Fire Protection Association (NFPA) declined to publish a revision for Standard 780 — the “Standard for the Installation of Lightning Protection Systems.” Prior to this decision, a committee reviewed 377 public comments on the issue. Committee members concluded that lightning rods lack scientific and technical merits. They also reported that field tests do not validate lightning rod systems.

At the October 2000 meeting, the standards council issued a decision (D#00-30) postponing any action on Standard 780 until the October 2001 meeting. The last round of public comments requested by the council were due June 15, 2001. At the time this article went to press, the outcome of the pending appeal for Standard 780 was unknown.

Meanwhile, CTSs are receiving deserved attention overseas. Two Russian universities, the Moscow Institute of Physics and Technology and the Krzhizhanovsy Power Engineering Institute are doing extensive research on CTSs, along with the Japanese. Two of Japan's largest electrical companies, Hitachi and NEC, are deeply involved in the support, research, and sales of these systems. Several Southeast Asian countries, including Indonesia, Singapore, and Malaysia, are using CTSs. The largest user outside the United States is Venezuela.

Unfortunately, the United States has been disinclined to embrace CTS technology. Work is underway to change this situation. The American Petroleum Institute (www.api.org) has included a reference to the CTS in its latest RP 500 standard.

I have sponsored Project 1576 for the Institute of Electrical and Electronics Engineers (IEEE). The purpose of the project, titled “Standard for Lightning Protection System Using the Charge Transfer System for Industrial and Commercial Installations,” is to develop a new IEEE standard.

Some IEEE members are vehemently opposed to the concept. But relying on obsolete information or refusing to consider a viable technology won't benefit the industry. In 1989, I wrote an article purporting that dissipation array systems were ineffective and based on an insufficient theory. Since then, I've admitted my conclusions were incorrect based on additional information developed after 1991 and presently available to the public. I encourage others to do the same.

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