Lightning Storms

Application Note - AN-5

It is the stuff of office legend - Monday morning, after a big thunderstorm has rolled through the area, and many of the computers and electronic devices in the building have shut down, or worse, are damaged. *"We took a direct hit"* says the facility manager, as the company scrambles to recover.

While this scenario does happen occasionally, it's fairly rare. Lightning storms can damage or disrupt sensitive equipment. However, much of this damage is caused by indirect or induced impulses, as opposed to a direct strike.

The Thundercloud
A thundercloud is a huge statically charged body. Like the human body, which can pick up static charge on a carpet on a dry winter's day, the thundercloud picks up an electric charge as it is formed and travels. The human body can pick up sufficient charge to cause a spark that is fractions of an inch - the thundercloud builds up a potential many hundreds of times greater.

When the electric potential of a thundercloud gets high enough, a discharge can occur. Sometimes this occurs within the cloud, other times from one cloud to another. Finally, a discharge can occur from the cloud to the ground.

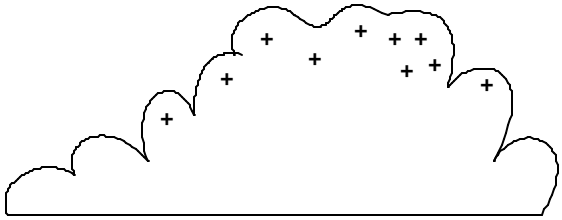
A Direct Lightning Strike
During a direct lightning strike, three factors are critical to prevent building damage or fire:

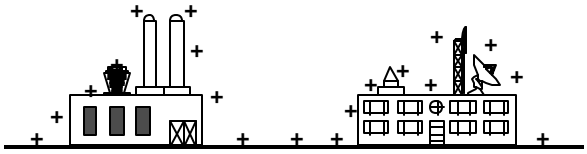
1. Control the "point of strike" using lightning rods or aerials
2. Provide a low impedance path (conductor) from the aerial to earth or ground
3. Provide a low impedance path (ground rods or electrodes) from the building ground system to earth

Severe building damage and lightning induced fires are usually the result of one or more of these items being missing or substandard. Fortunately, a direct lightning strike to a particular facility (especially small residential facilities) is rare.

Secondary Effects
A direct lightning strike to a particular facility or location is rare. However, there are a number of ways that lightning can induce transient currents and voltages into power and data lines. There are three primary ways that the lightning "stroke" can cause secondary transients: Earth Currents, Atmospheric Transients, and Electromagnetic Pulse.

Earth Current Transients
As a thundercloud travels across the sky, it carries with it an electrical charge. Much like a magnet, it "attracts" the opposite charges on the ground below it. These charges gather on buildings, hills, trees, anything in direct contact with the earth.

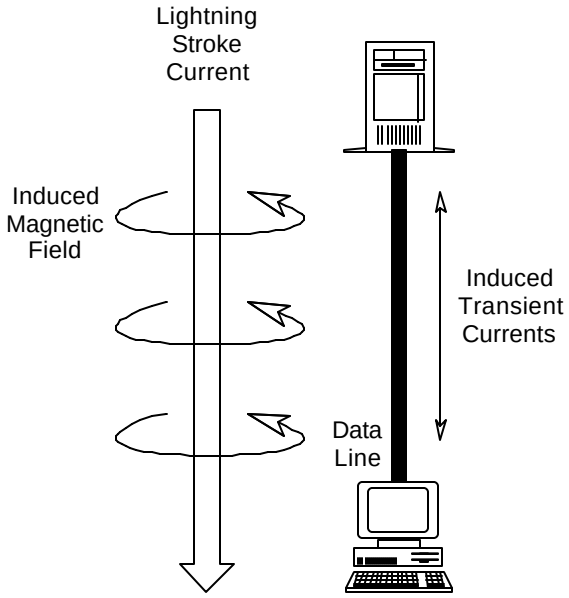




If the cloud travels over without a lightning discharge, the charge on the earth below builds and dissipates slowly without incident. If however, the cloud discharges (to another cloud or to the ground), the built-up charges below the cloud dissipates quickly. This dissipation becomes an induced "mini-stroke" that appears as a transient currents on the ground, and on electrical systems. Since the disharge is very fast (~20 usecs) the di/dt will generate transient voltages across the inductance of wires and the earth.

Atmospheric Transients
Any item suspended in the air between the ground and a thundercloud will take on a charge with relation to earth. When a lightning stroke does occur, this charge will search for a path back to earth. On long conductors (such as comunications lines or utility power lines) this can induce large voltage transients.

Electromagentic Pulse
When a lightning strike does occur, a large electrical current flows. This pulse of rapidly changing current causes a magnetic field, which can in turn induce currents on communications and power cables.



These secondary effects are nowhere near as powerful as the direct lightning stroke. However, each of these has sufficient energy to damage or disrupt sensitive electronic components. And unlike the relatively rare occurrance of a direct lightning strike, secondary transients are very common, occurring whenever a thundercloud discharges nearby.

Lightning Protection

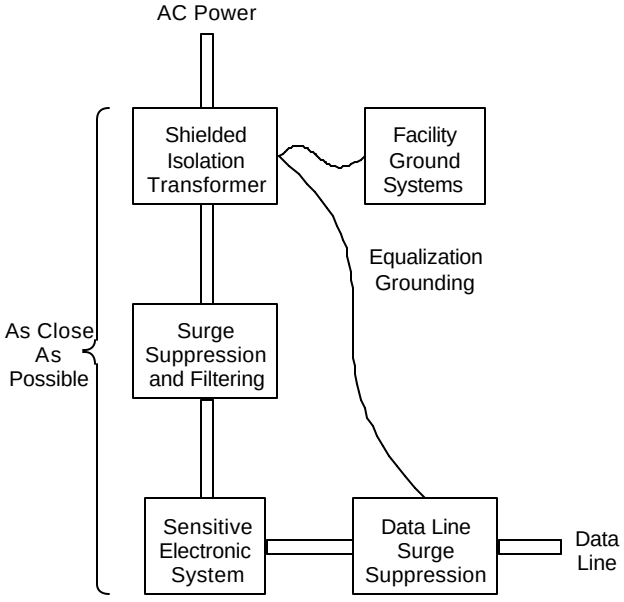
Protecting buldings, electrical distribution systems, and communications systems from direct and indirect lightning transients is a specialty in iteslf, outside the scope of this applications note.

However, protecting sensitive devices within a facility can be equallty critical to minimizing system damage and disruption. Utility protectors and NEC type grounding alone is insufficient protection.

Lightning induced impulses can occur on any electrical conductors: power circuits, data circuits, grounds, etc. As a result, all of these paths must be protected from impulses to provide adequate protection from lightning induced impulses. Unfortunately, most "surge suppressors" concentrate on impulses induced on the power circuits, and ignore the grounding and data aspects.

Effective protection from lightning induced transients includes the following:

- Shielded Isolation transformer, effectively grounded and bonded to local earth, and located as close to the sensitive load as possible
- AC Surge Suppression and Filtering
- Data Line Surge Suppression (networks, video, telecom, miscellaneous I/O, serial and parallel ports to remote equipment) or electrical isolation
- Equipotential Grounding of the AC power and all data line grounds



System Design for Protection from Lightning Induced Transients

