LightningMaster Corporation

Lightning Damage

There are four basic types of lightning damage: physical damage, secondary effect damage, electromagnetic effect damage, and damage caused by changes in ground reference potential.

Physical damage is caused by current flow and heat. A typical lightning strike in the United States conveys between 25,000 and 45,000 amps, with the higher amperage strikes occurring in the south, where the storms build higher. Lightning is high current flowing over a short period of time.

The core temperature of a lightning channel is approximately 50,000 degrees Fahrenheit, or about five times the surface temperature of the sun. During a strike, the temperature rises from the ambient temperature to a temperature approaching 50,000 degrees over a very short rise time. It is this heat which causes the sap in a tree struck by lightning to turn to steam and expand, splitting the tree. Concrete never quite dries out; there is always latent moisture in concrete. When a concrete structure is struck, the latent moisture turns to steam, expanding and damaging the concrete structure. When the air surrounding the lightning channel is heated this rapidly, it expands in a shock wave. This shock wave can damage a structure. This is why lightning rods have a minimum length – to top lift this shock wave off the roof of the protected structure.

The **secondary effect** of a lightning strike can cause arcing and induced currents. During a lightning strike, the point at which the strike occurs is relatively vacated of ground charge. The area surrounding the point of the strike remains highly charged, causing an almost instantaneous potential gradient across the area. The surrounding area releases its charge to the point at which the strike occurred, causing a flow of current. This current flow can arc across any gaps in its path. If that arc takes place within a flammable material, it can cause a fire or explosion. If the arc takes place within a bearing, such as in a pump in a treatment plant, it can scar the bearing and cause premature wear. If it takes place on a circuit board, it can damage the circuit board.

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The **electromagnetic field effect** is similar to nuclear blast EMP, and can induce currents in nearby wires or other conductors. The on-off-on-off action of a lightning strike causes the electromagnetic field surrounding the strike to expand and collapse with the series of flashes. This electromagnetic field motion can induce electrical currents in nearby conductors, including wires and electrical equipment.

Older vacuum tube equipment is operated on relatively high voltages. Therefore, the vacuum tube was able to absorb a much higher voltage surge without damage. When a vacuum tube which operates on a few hundred volts sees a one hundred volt surge, it is no big deal. When a microprocessor which operates on only a few volts sees a one hundred volt surge, it is a big deal. The current induced by electromagnetic effect can easily be sufficient to cause damage. In fact, microprocessors can be damaged by a nearby strike even if they are not in use or even connected to a power source.

This effect explains why lightning may strike a few hundred feet away from a structure and the telephone system in the structure stops working. Why? Obviously, the lightning energy did not enter the structure. The electromagnetic pulse from the strike induced current into the telephone wiring, both into and within the building, damaging a microprocessor within the system and causing a system failure.

When the **ground reference potential changes** across a site, it can cause current flow through grounding systems. Assume that the AC power service enters a structure at one location and is grounded at that location. The telephone service enters the same structure and is grounded at a different location. Both feed into a computer. The AC power service ground establishes the potential of the motherboard, and the telephone service ground establishes the potential of the modem board. Current divides and takes all paths - the amount of current flowing over any one path is proportionate to the surge impedance of that part vis-à-vis the surge impedance of all paths. If lightning strikes near the structure closer to one service ground than the other, there will be a difference in potential between the two grounds. This difference in potential will produce current flow. Most of the current will flow through the ground under the structure (the lower impedance path). However, some current will flow from one service ground, through the modem and computer, to the other service ground. This current flow can damage the computer.

About Lightning Master Corporation

Established in 1984, Lightning Master® is a global, full service, static solutions, lightning and surge protection manufacturing company. We serve a wide range of customers including oil, gas, chemical and other industrial facilities. Our complete line of products, systems and consulting services are backed by our worldwide customer service. Our track record of success in the Americas, Asia, Africa, Europe and the Middle East has established LMC as a global authority on lightning and static protection.

We wrote the book on Static Solutions and Lightning Protection.