LIGHTNING DAMAGE

There are four basic types of damage caused by lightning: physical damage, secondary effect damage, electromagnetic pulse (EMP) 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.

The core temperature of a lightning channel is approximately 50,000˚ Fahrenheit, or about five times the surface temperature of the sun. That means that the temperature increases from the ambient temperature, which may be 80˚ or 90˚ F, to a temperature approaching 50,000˚ F over a very short rise time. It is this heat that causes the sap in a tree struck by lightning to turn into steam and expand, splitting the tree. Concrete never quite dries out. There is always latent moisture in concrete. When a concrete structure is struck, that moisture turns to steam, expanding and damaging the concrete structure.

When the air surrounding the lightning channel is heated that rapidly, it expands violently, compressing into a shock wave. That is why lightning rods have a minimum length – to lift this shock wave off the roof of the protected structure. When the shock wave slows and becomes subsonic, we hear it as thunder.

Secondary effect of lightning can cause arcing and induced currents. During a strike, the point on the surface of the earth that is struck is relatively vacated of ground charge. The area surrounding the point remains highly charged, creating a potential gradient across the site. The surrounding area releases its charge toward the point of the strike. If this inrush of charge crosses a gap, it can arc. If this arc takes place in a flammable material, it can cause a fire or explosion. If it takes place within a bearing, such as in a pump in a treatment plant, it can scar the bearing causing premature wear and failure. If the arcing takes place on a circuit board, it can damage the board.

Electromagnetic pulse (EMP) is similar to that of a high-altitude nuclear blast. The on-off-on-off action of the lightning discharge causes the electromagnetic field surrounding the strike to expand and collapse with the series of discharges. This electromagnetic field motion can induce current flow in wires and other conductors. We have seen ignitions in petroleum production and disposal facilities over half a mile from a strike.

Older vacuum tube-type equipment operated on relatively high internal voltages, so a vacuum tube was more resistant to transients than a microprocessor. When a vacuum tube operating on a few hundred volts experienced a one hundred volt surge, it was no big deal. However, when a microprocessor operating on only a few volts sees a hundred volt transient, it is a big deal. The current induced by EMP can easily damage a microprocessor. In fact, we have had reports of damage caused by a nearby strike when the microprocessor was still in its shipping packaging.

Ground reference potential change damage is like a snapshot in time of secondary effect. When lightning strikes, the potential at the point of the strike is changed. Another point at some distance from the strike will be at a much different potential. This difference in potential over distance can cause current flow in conductors.

Assume that the AC power enters a structure and is grounded at that location. Field data transmitters located at different locations will be at different potentials. Both feed into the control system. The AC power service establishes the potential of the motherboard, and the field data transmitters feed into the data boards. If lightning strikes closer to one than the other, there will be a difference in potential between the two. This difference in potential will produce current flow, possibly damaging the system.

Controlling Lightning Damage: A Three Pronged Approach

So, unfortunately lightning has many different ways to damage and disrupt your operation.

Based upon experience, Lightning Master® has developed an integrated approach to optimizing an environment to resisting lightning damage. This approach may be tailored to and type of facility or operation in any location.

The Lightning Master® approach consists of:

Bonding and Grounding

Transient Voltage Surge Suppression

Structural Lightning Protection