LIGHTNING AND PUBLIC SAFETY COMMUNICATIONS

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1.0 Overview. Lightning is like a monkey with a hand grenade. Protection in an absolute sense is impossible because of the arbitrary, capricious, random, stochastic and unpredictable nature of lightning behavior. However, defenses to mitigate the hazard can be achieved through a deployment of a *Lightning Protection System* (LPS). The LPS details are based upon science and engineering Codes and Standards. The matrix of four cohesive defenses is described here in general terms for application to telecommunications facilities.

2.0 Air Terminals. Lightning usually terminates on grounded objects sticking up in the air. Grass, rocks, fences, trees, cars, people, buildings, radio towers – whatever is a preferred destination. Franklin's invention in 1752 diverted lightning from rods in the air via conductors to rods in the ground, protecting buildings from fire. This LPS component is based upon *Path of Least Impedance* principles. Of course, should lightning strike across the street from a public safety center and couple into its sensitive electronics via underground wiring/water pipes/buried conduits/etc. then an air terminal sub-system has not performed and has no value.

3.0 Bonding. Without proper bonding, all other elements of the LPS are useless. Bonding of all metallic conductors in a facility assures everything is at equal potential. When lightning strikes, all electrical equipment voltages will rise and fall at the same potentials. This protects against unequal voltages in separate sensitive signal and data systems. Bonding should connect all conductors to the same "Mother Earth." A partial listing includes: antenna towers, shields on incoming coaxial cables, cable trays, cabinets and racks, computer room signal reference grids, telephone room equipment, conduits carrying various AC power and low voltage DC current conductors, AC power bus bars, etc. etc. If you doubt bonding is important, check out the requirements of the *National Electrical Code* NEC 250.90 through 250.104 for more details.

A recent inspection revealed a bare copper ground wire in contact with an interior electrical conduit. Result: a visible arcing mark caused by lightning's "flashover" with resulting destruction of nearby low voltage equipment. Solution: Either bond the two adjacent grounds together, or (better) use only insulated, not bare, wire for interior bonding.

4.0 Grounding. Low resistance grounding provides an efficient destination for the Lightning Beast. If site soils are composed of sand or rock they are Resistive, not Conductive. If surrounding soils are clays or dirt with moisture present, they likely are conductive. "Good Grounds" are achieved by volumetric efficiencies. We recommend buried bare 4/0 copper wire – the so called counterpoise ring electrode or ring ground. Welding together all ground references adjacent to buildings should include security fences, tower legs, and all other adjacent metallic objects. NEC 250 describes the perimeter ring concept as well as other grounding designs such as rods, plates, water pipes (beware plastic pipes underground), metal frame of buildings, and concrete-encased electrodes. Grounding designs should be based upon localized conditions and the amount of available real estate at your location. Good grounding largely is a function of volumetric efficiencies. NEC 250.56 suggests a target earth resistivity number of 25 ohms for a single ground rod electrode. Lower is better. Yet some times 50+ ohms will be OK.

Another recent inspection, using an *AEMC 3730 Ground Resistance Tester,* showed grounding measurements of 450 ohms at a power pole ground wire drop. Result: lightning bypassed this high resistance ground and instead went into the building via the overhead phase lines. Solution: Re-work power pole grounds to achieve 25 ohms target resistance.

5.0 Surge Suppression. Surge suppression devices (SPDs aka TVSS) all function either by absorbing the transient as heat or diverting the transient to ground (or some combination thereof). They should be installed at main panel entries and at critical branch or secondary panels and at plug-in outlets where low voltage transformers convert AC power to DC current and voltage. SPDs also should be installed at signal and data line building entry points for critical electronic equipment Included here are Cat. 5/6, coaxial lines, twin lead and other copper wire circuits. Telephone punch blocks should be SPD-protected. Beware the junk SPDs which proliferate the marketplace. Beware counterfeit or false UL and IEEE labeling. Beware of the *"it sounds to good to be true"* marketing hype employed by some vendors. Consider Panel SPDs which have capabilities to remotely signal their operational performance. SPDs rank right behind Bonding in the hierarchy of important steps to mitigate the lightning hazard.

Surge suppression is a complex subject. Where and how to install SPDs? What SPD internal technologies are important? Which SPD codes and standards are important and which are vendor-influenced? We like *Motorola R-56*. How do UPS-protected circuits compare with surge protection? What about fibre optic conductor vulnerabilities?

6.0 Conclusion. For some guidance or for an audit of your comms operations, seek a professional authority, not a vendor, for an impartial review. If you are feeling Lucky you can play the odds that lightning surges never will compromise your uptime. Just wait and let Mother Nature do her assessment for you. But beware of that monkey with a hand grenade.