WHY INSTALL LIGHTNING MASTER PROTECTION ON AN INDUSTRIAL PROCESS CONTROL PLANT

The National Fire Protection Association NFPA 780, *Standard for the Installation of Lightning Protection Systems*, is the US lightning protection standard. According to that standard, certain types of structures are considered to be self-protecting, that is, they do not require a lightning protection system. The reason behind this exemption is that the primary purpose of a lightning protection system is to keep a structure from burning down. That is why lightning protection is contained in a National FIRE Protection Association document.

A lightning protection system consists of three major components: a strike termination device (qualifying structural member, lightning rod, air terminal, etc.), the conductor system, and the grounding system. The strike termination device must be capable of sustaining a direct lightning strike. By accepting the strike, it prevents physical damage that the structure could otherwise sustain from the heat, current flow and physical impact of a strike. The conductor system conveys the lightning energy from the strike termination device around the structure over multiple, downward-coursing paths to the grounding system. The grounding system allows the lightning energy to equalize and dissipate into earth ground. Lightning protection was originally developed by Ben Franklin to prevent wood houses and barns from burning down, so a lightning protection system for wood structures as covered by NFPA 780 makes perfect sense.

However, in a process control plant process vessels are contained within and supported by steel frames. The top of the steel frame is more than adequate to sustain direct lightning attachment and provide a zone of protection covering the process vessel. A zone of protection is the space adjacent to a lightning protection system that is substantially immune to direct lightning attachment. The zone of protection is determined by the geometry of the structure, and may be defined by strike termination device placement, the

angle method, or the rolling sphere method. This principle presumes that lightning will attach to the steel frame and not to the process vessel. The structural steel of the frame provides multiple downward-coursing paths to ground. The plant grounding system at the base of the structure is more than adequate to equalize and dissipate the lightning energy into earth. Therefore, no lightning protection system is required for fire protection, as the structure itself provides all of the necessary components of the lightning protection system.

This is all fine except that fire is not the major problem in a plant. Even an unprotected plant is highly unlikely to burn down from a lightning strike. In addition to the ability to start a fire, a lightning strike also has the ability to cause other types of damage to plant equipment. Any direct or nearby lightning strike also creates secondary effect, ground reference step potential, and electromagnetic pulse (EMP) effect. Secondary effect is the in-rush of surrounding ground charge towards the point of the strike. Ground reference step potential is a function of distance from the strike producing current flow through conductors. EMP is a pulse radiating outward from the current flow in both the lightning channel and the conductor system. Any of these effects can induce current flow in plant wiring and structural components more than capable of causing damage and disruptions up to and including plant emergency shut-down (ESD). Indeed, we have seen EMP from a lightning strike half a mile away induce sufficient energy into components to trigger arcing and ignition.

Since the plant is considered to be self-protecting, there is no point in or advantage to installing conventional lightning rods. There is, however, an alternative: Lightning Master Ultra-Sharp Point™ air terminals. These air terminals are Underwriters Laboratories UL Listed. In keeping with industry trends to use blunt-tipped air terminals for personnel safety, the tip of the elevation conductor is blunt, with a plurality of small-radius electrodes (wires) inserted into it. These electrodes act to dissipate ground charge into the atmosphere. As such, they accomplish two ends. First, they act as static wicks to reduce overall static charge accumulation on the structures. In fact, when Lightning Master obtained its patent on this technology, our patent application referenced static wicks on aircraft. Second, as lightning air terminals (lightning rods), they delay streamer formation by dissipating part of the lightning-completing ground charge into the atmosphere around the structure.

The small wire electrodes greatly enhance dissipation of ground charge to the atmosphere by virtue of their small radius (sharpness). Lightning attachment is determined by streamer formation. Whichever object on the surface of the earth emits the best streamer, wins. These small radius points break down into corona under a much lower potential (voltage) than a rounded or even pointed Franklin lightning rod, making it more difficult for a sufficient amount of ground charge to accumulate to form a streamer. As the air terminal breaks down into corona sooner, it dissipates the charge over a longer period of time.

Imagine the corner of a structure. The charge on the base of the storm cloud pulls the ground charge surrounding the structure up and onto the corner of the structure. As the storm builds in intensity, the difference in potential between the cloud base charge and the corner of the structure builds. When the difference in potential overcomes the dielectric (resistance) of the intervening air, the difference in potential is equalized by a lightning strike. In order for the corner of the structure to emit a streamer, the ground charge must accumulate sufficiently to do so. The ground charge leaking off the small radius points interferes with that accumulation.

In its primary operating mode, the Ultra-Sharp Point™ air terminal dissipates the ground charge that would otherwise form a lightning-completing streamer, reducing the likelihood of direct lightning attachment. If the ground charge rises too quickly or builds too high, the dissipation ability of the air terminal may be exceeded. In that event, the air terminal reverts to its secondary mode of a conventional lightning rod accepting the strike. Since the air terminal is located at the top of the structure as required by both NFPA 780 and UL 96A, and it is already saturated with streamer constituting ground charge, it then emits a streamer, reliably collecting any strike and conveying it to ground over the existing plant structure and grounding system.

Lightning Master air terminals meet the requirements of National Fire Protection Association NFPA 780 and are Underwriters Laboratories Listed to UL 96. They provide a zone of protection exactly the same as any other lightning rod, and are designed and intended to be used as components in a NFPA 780 or UL 96A system. As such, a completed installation is eligible for a UL Master Label or Letter of Findings, the gold standard in lightning protection.

How well do these systems work? Please consider the following. This is an excerpt from a letter from a Project Manager at a large chemical plant in the southeast US. "After the installation was completed, several company personnel were skeptical of the performance of the "fuzzy ball" lightning rods. Perhaps the strongest indication of the effectiveness of your system was when it did not work. In one particular area of our plant, we had a particularly corrosive environment. That caused the stainless steel dissipation electrodes at the tip of the air terminals to corrode away, turning the air terminals into the equivalent of blunt lightning rods. We immediately started experiencing damage to microprocessor equipment in that block of the plant. You worked with us to change the air terminal material to titanium, going so far as to change NFPA 780 to allow its use. When we changed out the air terminals to titanium, the problems stopped."

A large company operates a paper plant located in the salt marshes of northeast Florida. The commercial AC power to the plant runs across the marshes, and suffered numerous lightning strikes causing equipment damage and unacceptable downtime at the plant. The operator installed Lightning Master air terminals on each of the utility poles leading across the marsh. Their incidence of damage and outages dropped so dramatically that they published an article in their company newsletter explaining to its employees the decrease in lightning problems.

An operator of a south Louisiana plant experienced numerous fires atop their hydrogen stacks during electrical storms causing numerous plant shutdowns. One engineer commented that after a storm, the production area "looked like Kuwait" (this was after the first Gulf War). After installing Lightning Master systems on their stacks, they only suffered one or two stack fires in the following two years.

The instrument and electronics engineers at petroleum production sites in the northern US experienced multiple failures of their guided-wave tank level sensors. The sensors were not physically damaged; they were just confused by transients and required a manual reset by a technician. Another division on the company installed Lightning Master lightning and static control systems on their sites as part of a separate project. The I&E engineers noted an immediate and drastic improvement in the reliability of the level sensors. It turned out that static has been causing the problems, and the Lightning

Master system, in addition to its role in lightning protection, also solved the static-related issues.

So, why install lightning protection on a process control plant when it is not required by applicable standards? There is no reason for or advantage to installing Franklin-type lightning protection. However, installing Lightning Master® Air Terminals has a long history of successfully limiting the build-up of static charge on a plant. This discourages the formation of lightning-completing streamers with the resulting secondary and EMP effect damage to plant equipment and disruptions in plant operations. This greatly enhances plant reliability.

For further information, please refer to the Lightning Master white paper, *LIGHTNING MASTER® ULTRA SHARP POINT™ ENHANCEMENT TO FRANKLIN LIGHTNING ROD TECHNOLOGY.*