SHOULD YOUR PLANT RELY ON 250-YEAR-OLD LIGHTNING ROD TECHNOLOGY?

By Del Williams

Today's sensitive process control instrumentation is at heightened risk from lightning strike and its secondary effects such as Electromagnetic Pulses (EMP) which lightning rods can inadvertently make worse. New technologies can provide a comprehensive solution with up to a 100% no-strike warranty.

Though lightning may not affect most companies as tragically as the Sago mining accident that recently cost 12 miners their lives in West Virginia, it can wreak havoc with their industrial facilities and processes. From fire, shutdown, and process/quality control issues to component replacement, data loss, and lost business, the risk of lightning strike disruption to industrial, oil or gas facilities is higher than ever. This is due to increasing instrumentation sensitivity and reliance on antiquated lightning rod technology never intended for 21st century business.

Even thirty years ago, when process control systems were primarily mechanical, pneumatic, and hydraulic with switches connecting relays and motor-driven valves, industrial processes were less sensitive to lightning strikes and their secondary effects. Today, however, instrumentation including PCs, servers, sensors, integrated circuits, and programmable logic controllers (PLCs) are minutely sensitive to lightning's enormous electrical transients and its secondary effects such as Electromagnetic pulse (EMP), which can fry hardware, corrupt data, and disrupt processes.

According to global thunderstorm statistics, there are 45,000 lightning storms every day, 2,000 lightning storms every moment, 100 cloud-to-ground strikes per second, and $1 billion in annual global damage due to lightning strikes. In a single lightning strike, peak voltage can reach up to ten billion volts, peak current up to 510 kA, and temperature up to 50,000 F.

What industrial engineers need to realize is that lightning rods were never intended to protect modern computer equipment or electronic process control systems. When Benjamin Franklin first used one in 1752, lightning rods - also known as "Franklin rods" or air terminals - were intended to prevent fires to wooden structures by attracting and conducting lightning's intense currents and voltages to ground. Hundreds of years later, lightning rods still ATTRACT lightning and conduct it to ground; this, however, may be a poor choice if it's anywhere in the vicinity of today's sensitive electronic, control, telecommunications, or data storage equipment.

The IPG is the only strike collector proven to be effective to at least 100 meters in a competitive environment, and the only one related to the physics of the problem. Compared to a single lightning rod of the same height, the IPG provides a collection zone several times larger.

Yet antiquated lightning and grounding rod technology has been codified into standards such as National Fire Protection Association 780 (NFPA 780) and its international variants. Even though many buildings have implemented NFPA 780, incidents of fire caused by lightning still exist. Some even inappropriately implement lightning rods in the wrong places, such as on oil tanks - which are perhaps the last place to which engineers should ATTRACT lightning.

PREVENTION TRUMPS PROTECTION

While many engineers still maintain budgets for lightning rod protection and equipment damage, they should be aware of new technologies designed to keep up with advances in the industrial, oil, gas and process control industries. For instance, the Dissipation Array System (DAS), a charge transfer technology based product, is being lauded as a comprehensive, preventive solution for modern lightning protection.

DAS essentially prevents strikes by continually lowering the voltage differential between the ground and charged storm clouds to well below lightning potential even in worst-case storms. In the US and abroad, DAS has proven to be the preventative solution for lightning protection, cutting storm-induced voltages down to less than 2% within the protected zones as compared to the unprotected surroundings, thus eliminating the lightning strike risk.

Since it prevents, DAS is possibly the best long-term solution to lightning strike problems. One company, Lightning Eliminators and Consultants, Inc. (LEC), based in Boulder, Colorado, has long been at the forefront of DAS development. In the three decades since LEC introduced DAS into the U.S. marketplace, it has been the only lightning protection system proven to prevent lightning strikes to any protected facility. Over 35 years, the system has accumulated over 33,000 system-years of history with 99.85% no-strike performance.

In applications ranging from communications towers to petrochemical tank farms, electrical power transmission lines to public buildings, thousands of Dissipation Array Systems have been installed in 55 countries worldwide to date. DAS has been used to protect facil-

ities as large as three square kilometers and structures as high as 1,700 ft.

100% STRIKE PREVENTION AT OVER 140+ JAPANESE INSTALLED DAS SITES

Hitachi Industries Co. Ltd., a member of the Hitachi Group, was impressed enough with DAS's performance record to recently purchase a minority stake in LEC. Hitachi researched DAS and even built a scale model of the system dissipating charge, of which a video clip can be viewed at www.lightningeliminators.com.

"Investment in LEC follows ten years of partnering with them on more than 140 installations in Japan," explains Dr. Akihiro Wakabayashi, Doctor of Engineering, and General Manager of Hitachi Industries' Defense Thunder Center. "In that time, DAS and related technologies have proven themselves in research and installations with a lightning strike prevention record of 100%."

ENGINEERED PROTECTION UP TO A 100% NO-STRIKE WARRANTY

From simple lightning protection to lightning prevention with a 100% no-strike warranty, companies such as LEC are at the forefront of maintaining industrial equipment and process uptime in the face of lightning threat. Taking into account factors such as the facility's location, size, shape, geography, and exposure to lightning activity, for instance, LEC can engineer protection for a single component or lightning strike prevention for an entire site.

An engineered solution typically involves: consultation; lightning attraction and collection for protection, or charge dissipation for strike prevention; grounding systems; and transient voltage surge suppression (TVSS).

DAS are structurally engineered to withstand the harshest conditions anywhere on earth, and can be installed in many different specialized configurations, including:

a) Hemisphere Arrays (for towers, and many other applications)

b) Rim Arrays (for floating roof petrochemical storage tanks)

c) Conic Arrays (for conic roof storage tanks and structures)

d) Parapet Arrays (for buildings)

e) Paragon Arrays (for complex buildings, and certain structures)

f) Peak Roof and Flat Roof Arrays (for buildings and structures)

g) U-Bracket Arrays (for buildings and structures with architectural or weight restrictions)

h) Trapezoid Arrays (for special telecommunications towers)

i) Special Arrays:

i. Stack Arrays (for exhaust and chimney stacks)

ii. Radome Arrays (for radar domes and telecommunication dishes)

iii. Helipad Arrays (for helicopter landing pads usually installed on offshore oil platforms)

Extensive laboratory and field testing has shown that the following parameters are critical to the effectiveness, efficiency, and rate of local area ground charge dissipation:

a) "Point Separation": length, shape, tip geometry, and spacing of the points.

b) The number of points required (usually in the thousands) for each struc-

ture or feature, or the total number required for a given area. The protected area can be one square kilometer or larger.

c) The selection/configuration of each Array relative to the height, shape, location and function of the structure or structures to be protected.

d) The actual locations of the Arrays relative to the overall area.

To enhance and broaden the area of DAS strike prevention, LEC also recommends the installation of a variety of sizes, configurations, and clusters of Spline Ball Ionizers (SBIs). Similar to DAS, the SBIs prevent lightning strikes by dissipating the storm-induced charge in the area of concern through point discharge ionization. Since lightning always terminates in areas of high charge, discharging the site substantially reduces the risk of lightning strikes to the site. Those strikes not prevented by the SBI are collected by it, since its default mode is to function as a highly effective lightning rod.

Spline Ball Terminals (SBTs) are another form of the hybrid preventer/collector assembly designed to augment DAS to provide maximum protection from direct lightning strikes. Interchangeable with standard lightning rods or air terminals, these are usable in any NFPA-780 or UL-96A system and are an off the shelf product for Master Label installations.

To prevent mid-span strikes in high-voltage transmission/distribution or for wind turbines, LEC recommends the Ion Plasma Generator (IPG), a high-performance collection device for lightning strike protection. The IPG is more effective at collecting strikes than traditional lightning rods and is used in special applications that are better suited for strike collectors than DAS.

An ultra-low impedance grounding system is also necessary to transfer induced ground charges efficiently, since transient voltages such as lightning are affected by impedance while resistance pertains to DC voltage. An appropriate number, sizing and spacing of Chem-Rods, which use natural mineral chemicals such as salts to improve conductivity up to ten fold over traditional grounding rods, can help achieve a target ground resistance of less than one ohm.

In order to handle secondary effects from nearby strikes, LEC also recommends that all incoming and outgoing conductors (including power, telephone, data, and co-axial wiring) be isolated to protect sensitive equipment. A variety of Transient Voltage Surge Suppression (TVSS) devices including Sandwich Block Surge Suppressers can intercept and ground any anomalies using Chem-Rods.

Dissipation array system mounted to a communications tower.

While 250-year old lightning rod technology may have been adequate before the prevalence of sensitive electronic instrumentation in industrial processes, this is no longer true today. Instead, forward-looking engineers are seeking to maximize production uptime and quality control while minimizing the need for emergency repair and maintenance. By turning to advanced new technologies such as DAS for lightning prevention, they are putting their facilities and industries on a more solid footing to compete into the 21st century and beyond.

At the Myoken Weir Control Office in Nagaoka City, Japan, which had suffered severe lightning damage several times in the past, for instance, Hitachi Industries demonstrated the efficacy of DAS in lowering the ambient electric charge within the site, which had otherwise attracted lightning strikes.

In one storm, Hitachi Industries showed that DAS lowered electrostatic strength to near 0.0 kV/m in a 48-meter radius zone around the building, while electrostatic strength ranged from +32 kV/m to -35kV/m outside the zone. In another storm, Hitachi Industries showed DAS lowered electrostatic strength to near 0.0 kV/m in the protected zone while electrostatic strength ranged from +52 kV/m to -38 kV/m outside the zone.

"DAS rapidly generates or bleeds off ions from a site as needed to adapt to changes in storm cloud electrostatic strength and polarity," explains Wakabayashi. "This neutralizes the electrostatic charge at the site, making it unattractive to lightning, which effectively and reliably prevents damaging strikes."

Lightning maps of DAS-protected sites in Japan provide evidence of its effectiveness in preventing strikes.

During one storm, the Sapporo Brewery Company plant in Hita City, Japan had more than 150-recorded incidents of lightning activity within a 5.0 km radius of the DAS-protected site in an hour. Since the installation of the DAS systems, no incidents of lightning activity have occurred in a 1.0 km radius around the site and just two lightning incidents in a 2.0 km radius.

Similarly, despite more than 170 incidents of lightning activity occurring within an hour in a 3.0 km radius around the 167-meter high Sapporo Ebisu tower in Tokyo, since it was protected by DAS no lightning has struck it and just four lightning incidents were recorded in a 0.5 km radius surrounding the tower.

DAS is currently providing complete lightning protection to an extensive list of customers and facility types, including many Fortune 500 firms such as Federal Express, Turner Broadcasting/CNN, PPG Chemical, Union Camp, ExxonMobil, and ChevronTexaco. To view a Hitachi video clip of a scale model demonstrating spark discharge vs. ionization/corona charge dissipation, visit www.lighningeliminators.com.

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