ESE Air Terminal Systems

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Abstract – Unfortunately, a number of project specifiers have been lured into specifying an early streamer emitter (ESE) air terminal system over a conventional lightning protection system for protection of structures or other valuable assets. The intent of this paper is to explain the science behind this technology, a brief history of design and use, short-comings exposed through the years, and finally discuss the installation of a universally recognized lightning protection system.

Basis of Design - An early streamer emitter (ESE) is an air terminal that is equipped with a device or formed in such a manner that allegedly creates an upward propagating streamer faster than a standard air terminal or other building elements. This streamer connects with a downward propagation leader of a lightning stroke, thereby completing the circuit and carrying the current to ground. The design and layout of an ESE air terminal system is based on the Collection Volume Method (CVM) which commonly requires only a single ESE air terminal for protection of an entire structure.

History - The basis for the ionizing method of lightning protection was theorized in a paper submitted to the Academy of Science in Paris by J.B Szillard in March of 1914. It was theorized that by increasing the amount of ionization that occurred around the air terminal, the efficacy of the air terminal would increase. Early ESE air terminals were filled with Radium-226 or Americium-241. The intention was to generate massive amounts of ionized air without the presence of storm conditions. It is estimated that Hélita (French manufacturer) manufactured more than 230,000 of these radioactive air terminals between 1936 and 1986. Other manufactures including Duval-Messien and Indelec manufactured unknown quantities of radioactive air terminals. In the 1980's, environmental and occupational hazard concerns forced governments around the world to ban the installation of radioactive air terminals. Removal of these air terminals is highly expensive as remediation must be performed by highly skilled decontamination and decommissioning contractors. In the post-radioactive era of ESE air terminals, manufacturers now base the design of their ESE air terminals on the theory that certain designs or shapes of air terminal tips can generate the substantial upward leaders required to "reach out and grab" the lightning stroke before other conductive, grounded objects.

Collection Volume Method – The Collection Volume Method (CVM) was developed in the late 1970's as an attempt to replace the industry standard Electrogeometric Model (EGM). Both of these models allow designers to mathematically calculate and accurately locate strike termination devices on or around a structure. The CVM was not originally designed as the basis for ESE air terminal systems, rather it attempted to address incorrectly perceived shortcomings of the EGM. In recent times an alarming number of ESE air terminal manufactures have begun using the CVM as a way to justify and advertise their claims of protective radii while simultaneously attempting to provide mathematical and theoretical justification for their claims. These manufactures realized they could apply their ESE air terminal's exaggerated field intensification factors to create massive collection volumes. These massive collection volumes typically require a single ESE air terminal for protection of an entire structure. In a very basic form, the CVM calculates that the upper sections on the sides of tall structures are considered inherently immune to direct lightning strikes. Unfortunately, this is easily disproven by the substantial photographic and eyewitness testimony in regards to lightning striking the sides of tall structures or striking a structure protected based on the CVM.

Failures of ESE – Presently, no laboratory can fully replicate all of the intricate variables involved in generating a lightning stroke. Historically, laboratory studies have been performed on specific aspects of a lightning strike. Noack, et al. testing concluded that ESE air terminal systems do not have the ability to generate the substantial upward leaders when compared to other (including conventional) air terminal systems. In fact, out of 420 electrical discharges across four air terminals, the conventional (franklin) air terminal was the preferred attachment point for almost 50% of the electrical discharges.

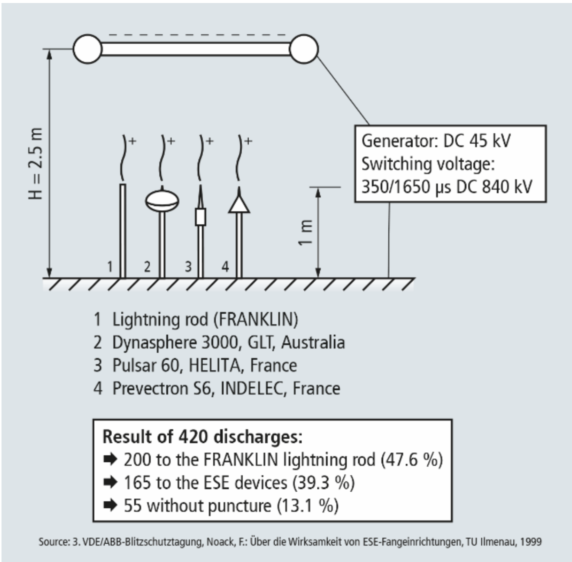

Figure 1- Disruptive discharge measurements in the laboratory to compare the frequency of lightning strikes; Test according to NFC-102 of the University of Manchester. Image courtesy of DEHN.

For the theory of ESE to be valid, the test results should be flipped with the ESE air terminals being the preferred attachment point. With a lack of ability in terms of full scale experiments, we must also rely on the substantial field data available. For example, the Marriott Hotel on Marco Island in Florida was protected by an ESE air terminal system. On August 23, 2010, lightning struck the roofing surface, sending clay roof tiles plummeting to earth. No one was injured in this incident but it reinforces the evidence that ESE air terminals are not able to generate the substantial leaders required to intercept the lightning strike.

Preventable Tragedy –The routine failures of ESE air terminal systems have traditionally been limited to structural damage. On September 10, 2011, a 21 year old lifeguard was struck and subsequently killed by a lightning strike while he was performing his duties of evacuating patrons from the Key West Rapids attraction at Adventure Island in Tampa, Florida. Experts within the lightning protection community began their own investigation and found that the Key West Rapids attraction was located between (2), pole mounted ESE air terminals. The entry and exit point of the attraction were located well within the advertised protection radius of the ESE air terminals. While building elements damaged by lightning can be repaired or replaced, the loss of a life cannot.

Legal Issues – Several times over the last three decades, manufacturers of ESE air terminal systems have repeatedly and unsuccessfully tried to propose then force their way into many different national and international standards. In 1996, the three largest US based manufacturers of ESE air terminals initiated a lawsuit containing allegations of conspiracy, false advertising and product defamation. A lengthy court battle ensued and in 2003, the Federal District Court of Arizona dismissed their lawsuit based on the fact that the ESE air terminal manufacturers presented no admissible evidence to support their claims. In closing remarks, "claims that ESE products provide a measurable zone of protection and protect against lightning strikes in open spaces are not supported by tests sufficiently reliable to support those claims and are 'literally false' under the Lanham Act." Their legal troubles continued into 2005, when the Federal District Court of Arizona, under the Lanham Act ruled they had committed false advertising as their claims are not sufficiently reliable to establish that ESE air terminals provide enhanced zones of protection within a specific, measurable radius or protect against lightning strikes in open spaces.

Conventional System – A conventional (also known as an integral, Franklin, or faraday) lightning protection system, as defined by NFPA 780 is "a complete system of strike termination devices, conductors (which could include conductive structural members), grounding electrodes, interconnecting conductors, surge protective devices, and other connectors and fittings required to complete the system." While no current method can prevent a lightning strike, a complete system will provide multiple attachment points for the lightning stroke. The complete system will then carry the stroke current safely to ground.

Changes in Building Practices – When NFPA first adopted *Specifications for Protection of Buildings against Lightning* in 1904, the structures being protected were incredibly basic. These structures typically housed livestock, stored animal feed, or were single family residential housing; with many lacking electrical services. Over the years, structures have become more complex. It is now common for structures to include sensitive electronics, photovoltaic array panels, communication services, or advanced building materials and complicated designs. In order to address the ever changing building practices, NFPA 780, *Standard for the Installation of Lightning Protection Systems* is comprised of a technical committees which include government agencies, research laboratories, end users, installers/maintainers, manufactures and inspection agencies who consistently and routinely update the standard as our understanding of lightning protection has changed and in relation to new building practices.

International Standards – Around the world many other recognized standards exist. Arguably, BS EN/IEC 62305, *Standard for Lightning Protection* is considered one of the leading international standards for the installation of lightning protection systems. While several differences exist between NFPA 780 and BS EN/IEC 62305, they are both in agreement about the inefficiencies and hazards of ESE air terminal systems and do not allow them.

Closing - Currently no lightning protection system is 100% effective in preventing structural damage to a structure. The system's effectiveness substantially decreases when an ESE air terminal system is employed. Their design and flawed application of lightning theory have caused a great deal of concern within the lightning protection community, including several lawsuits, and injuries; with some resulting in death. By specifying a lightning protection system compliant to the current edition of NFPA 780, *Standard for the Installation of Lightning Protection Systems* the project specifier and building owner can be confident that the system installed is the most widely accepted and scientifically researched method to protect structures and other valuable assets from damage caused by lightning.

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