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Lightning Protection based on Early Streamer Emission Technology

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Introduction

Manufacturers of lightning protection air terminals have offered many solutions to mitigate damages arising from lightning; however, there are still adequate deficiencies in the effectiveness of lightning protection systems. Appolonov, V.V. et al., [1] stated that the existing air terminals being used currently were not always in a position to ensure the desired level of efficiency. From their studies, Norfizah, O., and Zafirah, A., [2] determined that conventional air terminals were inefficient in capturing lightning downwards leader.

The research and development on air terminal technologies to control or prevent lightning strokes still continues. Considering the involvement of electronics and automated control in today's lifestyle, the requirement of a reliable lighting protection system remains very essential.

Review of ESE Technology Development

Generally, active lightning protection is categorized into two types. One categorization is by the collection of lightning strokes, used by conventional Franklin rods and several types of Early Steamer Emissions (ESE). An ESE is comprised of a special unit attached near the top of the terminal or special shape that provides the capability to consistently generate streamers. The ESE terminals are theoretically designed to develop an upward propagating streamer faster than the one generated from a conventional air terminal. The efficiency in the propagation of a streamer allows these terminals to intercept a lightning leader much above the point of their installation resulting in a larger radius of protection. The efficiency and reliability of these devices vary depending upon the made by different manufacturer and the type of construction used.

C.B Moore concluded, from his analysis and from the results of the lightning strike competition, that moderately blunt Franklin rods with height-to-tip radius curvature ratios of about 680:1 are more likely to furnish return strokes, and therefore, provide better protection against lightning than either very blunt rods or the traditional, sharp rods [8].

On March 9, 1914, Szillard, J.B, presented a paper to the Academy of Science in Paris with a new idea that became the foundation of the ionization method for lightning protection air terminal innovation. Later, in 1931, Gustav P. Carpart patented the first ionizing lightning air terminal. Gustav's son, Alphonse Capart, in 1953, started to improve the device and commercialized his development [3]. This improved device was equipped with a radioactive ionization generator that could ionize the air molecules in the immediate vicinity of the air

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terminal continuously, with or without the presence of a storm cell.

In the 1980s, the ESE air terminals with electrical triggering devices were introduced to provide more control over ion production at the tip of the terminal at which the electrically-triggered device produces ionization. This ionization production only occurs during a brief period prior to the lightning stroke. The manufacturers of these ESE air terminals claim that the device can improve the probability of initiating an upward streamer within that brief period of ionization to connect with the downward propagating leader of a lightning stroke.

At present there are three methods in producing the electrical triggering for ESE lightning terminals. These methods are based on a nonelectrical passive geometrical design using an auxiliary power apparatus, and with a piezoelectric device [4,7].

The principle of the geometrical-configured ESE is to absorb the ambient electrical energy, which is acquired from the electrical field intensity used to charge a capacitor. This energy is subsequently discharged to the nearby grounded rod. From published literature, we found that the energy absorber can be a set of sensors in a sharp form, or a floating semi-spherical dome [6].

The ESE based on auxiliary power apparatus uses batteries and photo cells to produce a voltage pulse, and a detector that senses the approach of a downward propagating leader. The detector produces an electrical signal proportional to either the electric field or the rate-of-change found in the electric field produced by the approaching leader [6].

The ESE incorporated with the piezoelectric device was patented by Robert Andre, et al [4], and even though this type of terminal is available commercially, there is very little published information about the performance of lightning terminals with these devices.

Conclusion

Research conducted on air terminals showed that conventional air terminals often missed being the points of strike. The analysis of sharp and blunt air terminals revealed that blunt air terminals were more consistent in developing healthy strong streamers capable of successfully attracting downward leaders while the sharp terminals created space charge that often inhibited formation of streamers. The incorporation of streamer-generating geometry or specially designed electronic circuits can provide the required reliability and consistency to generate early streamers.

The ESE Terminals supplied by Energy Control Systems are designed with a unique geometry of strike termination tip and nonelectronic surface capacitors to consistently react to a certain ground field level and always generate strong impulses of streamers. The strength of the

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impulses allows the streamers to be launched to a certain height that increases their capability to intercept the downward leaders. As per NFC 17-102 and UNE 21186, the gain in height not only enables the terminal to intercept the lightning earlier than any other conventional air terminal but is also said to provide a larger protection radii that is calculated as per defined formulas and graphs given in the standard.

References

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