SECURITY OF AIRPORT OBJECTS AND AIRPORT ACTIVIETIS AGAINS LIGHTNING STRIKE

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This thesis is concerned about the protection of airport construction and airport operations before the lightning strike. I draw my attention to the issue of a thunderstorm, a description of their creation, division by storm, and concomitant structure of storms. The second chapter was devoted to self streak as concomitant storm. In this chapter, I spent one hand, describes the origin of lightning, their classification, concomitant, types and effects. The third chapter is devoted to the protection of LPS from the action of lightning protection system according to STN individual methods and structures. In the last chapter, I draw your attention to the protection of airport ingredients before lightning strike, the systems and methods, as well as the description of the economic impact of airports off.

K e y w o r d s: Storms, types of storms, concomitants storms, electrical shock, protecting against electrical discharges, LSS Lightning detection systems,

1 INTRODUCTION

Cloud-to-ground lightning strokes present a clear and immediate danger for ground personnel involved in outdoor ramp operations, such as aircraft fueling, baggage handling, food service, tug operations, and guiding and directing aircraft to their assigned gates. When this danger presents, airport ramp operations are suspended until the threat has passed. Airport staff engaged in outdoor activities are also subject to the impact of lightning strikes. Decisions about ground personnel and ramp operations are made by the airports and airlines, not by the Federal Aviation Administration (FAA). Individual airlines, companies providing airport workers, and airport management often have very different procedures and standards for identifying and responding to potential lightning hazards.

2 GENERAL INFORMATION

The impact of lightning events in the vicinity of, and on, airport operating areas has long been recognized as both a safety and an operational issue by airport and airline operators. Both have frequently invested in lightning detection and warning systems that serve to assess when ramp and outdoor activities should be halted and then resumed without compromising worker safety. The technology to support such decision making is offered by a number of commercial vendors, but appears to be effective given the limited reports of lightninginduced injuries and deaths in the airport setting. These systems combine the acquisition of lightning strike data from such sources as the National Lightning Detection Network (NLDN) with on-site electric field mills and other weather data inputs to produce visual and aural alarms with respect to the impending arrival of thunderstorms and lightning strikes. Airport and airline staff then broadcast the need for clearing of the ramp and other outdoor airport operational areas by their personnel. The return to work announcement is also facilitated by this equipment.

Although the number of aircraft ramp injuries and deaths attributed to lightning events is thought to be low, there has been no effort to collect such data into a systematic database. This is because there is no requirement to report such incidents to federal or state agencies, and most of the known data is derived from anecdotal reports and informal studies by individuals having an interest in the subject. While it is recognized that ramp closures affect the flow of aircraft operations and cause passenger delays that can ripple through the national air transportation system, neither government agencies nor airport and aircraft operators have compiled closure statistics that are available for public information.

The use of lightning detection and warning systems at airports is also dependent on the meteorological characteristics of the location and the geographical distribution of lightning strikes (cloud-to-ground) Most lightning strikes occur in the eastern and central regions of the country. Consequently, the decision to install lightning detection and warning systems is dependent to a large extent on the potential for such events and their impact on airport and airline operations. Airports located along the west coast of the for example, frequently question the cost of installing, operating, and maintaining lightning detection systems.

2.1. Liability of the system

Another factor limiting the usefulness and standardization of lightning detection and warning systems is liability. Some airport operators share information that they obtain concerning lightning and other adverse weather phenomena with airlines and other tenants, while others have expressly avoided this level of cooperation. Those that disseminate information do so in one of several ways. Airports may allow tenants to subscribe to a data feed generated by their lightning detection and warning systems. Those tenants then employ their individual criteria for ramp closure and re-opening. Other airports broadcast a visual display—for example, flashing lights that are visible from all areas of the airline ramp—to warn personnel of a lightning threat. Again, the response from these workers is governed by their specific work rules and procedures. Alternatively, airports may also opt not to divulge weather data out of concern that they may overlook a tenant and be held liable in the event of injury or loss of life. Individual airlines and airport tenants that have invested resources in their own weather monitoring technologies, including lightning detection and warning systems, use the data collected for their own decision making. In practice, the dominant airline at the airport where the threat of lightning events warrants the implementation of such systems typically sets the lead that other airlines may choose to follow. Ramp workers monitor the actions of their colleagues at other airlines, and they typically vacate and return to the ramp in unison.

This practice can extend to airport employee decisions to stop and resume outdoor work activities. There can be instances when such “follow the leader” tactics are not observed, such as when relatively large distances separate airline ramp operations areas, and one airline continues to operate while others have suspended ramp activity, creating a situation that can be confusing to passengers of those airlines.

2.2 Lightning behaviour

The earth’s atmosphere is an integral part of a natural electrical system in which the earth and its atmosphere can be thought of as a spherical capacitor, with the earth as the lower conducting surface and the atmosphere as a slightly conductive medium topped by a highly electrical region in the upper atmosphere, where unfiltered solar radiation effectively ionizes atmospheric molecules and atoms into a highly conductive region called the ionosphere. The ionosphere (sometimes also termed the electrosphere) is positively charged, while the earth’s surface has a net negative charge. This charge imbalance creates an atmospheric electric field (roughly 100 V/m near the earth’s surface) and a corresponding air-earth electrical current directed downward from the ionosphere to the ground, where the direction of the current is defined as the direction that a hypothetical positive charge would flow.

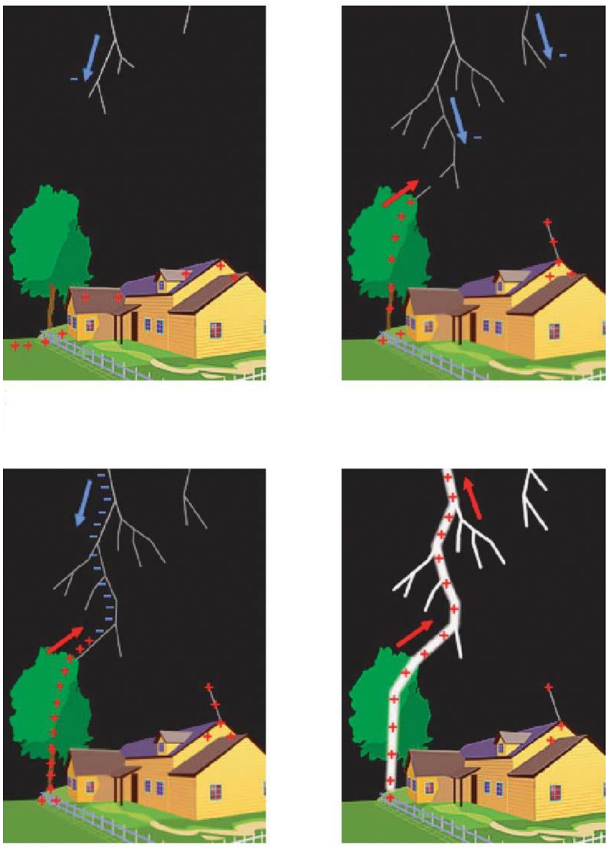
Without a mechanism to recharge the ionosphere, the airearth current would quickly discharge this global capacitor. While historically there have been suggestions that charged particles from the solar wind might help maintain the positive charge in the ionosphere, most atmospheric scientists now accept that the global population of thunderstorms transfer electrical charges back to the ionosphere in a thunderstorm driven global circuit (see Figure 1). At any one time there may be as many as 2,000 thunderstorms occurring around the globe, generating a total of perhaps 40 lightning flashes every second.

The presence of the atmospheric electric field may contribute to the earliest phases of cloud electrification. Even though relatively weak, the field can induce a degree of charge separation in water drops and ice particles, helping them capture ions and other charged particles that are components of the fair weather current and giving them a net charge.

While small and mid-sized convective clouds may become electrified, they seldom produce natural lightning. Lightning requires a tremendous amount of charge separation before a discharge, and this generally happens only in the large convective storms we call thunderstorms. While there are still many unknown factors in the initiation of a lightning strike, years of studies have made it clear that the process involves collisions between super-cooled water and ice (including graupel and small hail) in the presence of strong updrafts and downdrafts. Most often, cloud tops have to cool to at least −20 °C before lightning begins, with the critical charge separation processes occurring in the portion of the clouds with temperatures between −5 °C and −20 °C (24 °F to −5 °F). Particle collisions, combined with size sorting and strong updrafts and downdrafts, separate the positive and negative charges. The descending particles tend to collect negative charges, and the ascending particles are predominately positively charged. The idealized result of these interactions is a simple cloud dipole, with positive charges grouped at the top and negative charges grouped in the middle and lower areas of the cloud, in the −5 °C to −20 °C zone. On the picture is an idealized small thunderstorm with charges separated into a simple electrical dipole.

Figure 1 Typical distribution centers electric charge in the cloud

Even in this simple model of a thunderstorm, lightning strikes are quite complex. Figure 2 shows the development of a typical negative cloud-to-ground lightning strike. Both negative and positive flashes can occur, but negative flashes are more common. Negative flashes bring negative charge to the ground, while positive flashes bring positive charge to the ground. In negative flashes, the descending current from the cloud moves downward in a series of short jumps, called a “stepped leader.” The individual steps in this process branch out in different directions, looking for the path of least resistance toward the ground. As a leader gets close to the ground, a corresponding streamer of positive charge moves up from the surface to meet the descending negative current. When these two currents connect they provide a highly conductive channel for charge transfer between the cloud and the ground. The initial descending negative charge is followed by an even stronger "return stroke" of positive charge from the ground, which seems to move up the channel and into the cloud. The actual charge transfer is, however, done by free electrons so the return stroke is really just a progressive draining of negative charge downward, with the upper limit of the drained path moving upward as electrons flow to the ground. Multiple strokes of dart leaders and return strokes can follow, producing flickering strobe-like flashes of light (see Figure 3). The entire multiple discharge sequence of a lightning strike is normally called a *flash* and is typically made up of two to four separate *strokes*. In some cases, as many as 15 or more strokes have been observed. The subsequent strokes generally follow the established conducting channel, but the final strike point on the earth's surface can jump around from strike to strike, with separations of up to several hundred meters or more. These cloud-to-ground flashes are normally called *CG* lightning, or simply ground lightning.



Cloud and ground flashes produce significantly different RF emissions over different time scales, which can be used to distinguish between these two classes of lightning. With their high current and predominately vertically oriented return strokes that generate magnetic fields, CG flashes produce strong signals that can easily be associated with a single position near the point they strike the earth's surface. The strong LF and VLF pulses generally follow the curvature of the earth and can be detected for ranges of 300–600 km (185–375 mi). IC strokes, on the other hand, are identified by their VHF emissions, which are a line of sight transmission that can normally only be detected out to ranges of 200 to 300 km (125 to 185 mi). In summarizing years of lightning research, the National Severe Storm Laboratory has concluded that taller, more complex storms produce more lightning and more CG flashes than do smaller, isolated storms. The first flashes produced by a storm are usually IC flashes, and if detected, they can signal the initiation of a thunderstorm. The ratio of IC flashes to CG flashes is quite variable, but cloud flashes predominate, often by a factor of five or more.

2.3 Lightning detection technologies

Lightning flashes and strokes can be detected in many different ways. Most notably the discharge of thousands of amperes of current in a fraction of a second generates temperatures estimated to be as hot as 30,000 °C, hotter than the surface of the sun, with a brilliant flash of light and an acoustic shock wave we call thunder. At the same time, the surging electrical currents release a wide spectrum of electromagnetic radiation and modify the strength of the local atmospheric electrical field. for a ligthning detection we could use:

- **Acustic detectors** - it is easy to recognize the sound of the lightning, but it is difficult to use it in quantitative sence. Acoustic detectors were tested to locate the lightning, but with limited success.
- **Optical detectors -** The instantaneous flash of light associated with lightning can be difficult to see in the daytime and, until lately, has not often been used for quantitative applications. By using sensitive detectors and narrow bandwidth filters, however, optical lightning detection systems have been developed that can be used in the daytime and which have been incorporated into ground-based sensors in conjunction with magnetic and electrostatic pulse analysis to reduce false alarms.
- **Atmospheric electric field measurements -** Electric field measurements have a long and important history of use by scientists interested in atmospheric electricity and lightning. The most common instrument to measure the atmospheric electric field is the field mill although there are other instruments, including some that are proprietary, that can also be used to monitor the electric field. Nearby lightning discharges will produce sudden changes in the

strength of the local electrical field, and these distinctive changes can be used to detect lightning—although without any direct way of measuring the distance or range to the lightning flash. Nearby charge centers, such as a cloud developing directly overhead, can dominate the local electric field and may limit the detection of distant lightning strikes. Perhaps more important than detecting lightning, electric field mills can also monitor the buildup in the local electrostatic field, which normally precedes a lightning strike. Most currently available lightning detection systems that employ field mills use them to alert users to the electric field buildup and to warn them of a potential lightning event. This application is unique in focusing on anticipating the lightning "threat" rather than on detecting lightning strikes after they occur. The technology, however, has a somewhat uncertain range and detection efficiency, along with a potential for false alarms.

- **Electromagnetic emissions from lightning strokes -** Most lightning detection systems currently available make use of the electromagnetic emissions, predominately RF**,** associated with the electrical discharge Lightning strokes produce RF static (mostly in the MF band) and are familiar to listeners of AM radios. CG strokes generate strong signals in the LF band, which can be detected at ranges of many hundreds of kilometers. IC strokes, on the other hand, predominately generate VHF, line-of-sight emissions. Lightning detectors based on RF electromagnetic emissions range from relatively simple, low-cost, handheld devices to sophisticated sensors and groups of sensors organized into detection networks. Low-end systems, however, are of uncertain sensitivity and are subject to false detections. They are most commonly marketed for hikers, sports activities, and outdoor gatherings. The most basic systems do not try to identify the direction of the lightning, but may try to produce a rough estimate of the lightning distance by measuring the amplitude of the signal. This technology can be enhanced by using more sophisticated receivers that can monitor the signal at multiple frequencies and analyze the time evolution and properties of the signal to minimize false alarms. Analysis of the incoming signal can also be used to distinguish between CG flashes and discharges from an IC stroke.

3 CONCLUSION

From a safety point of view, the existing lightning warning systems for airports seem to be doing a very good job. Because airports and airlines are safety conscious and closely monitor the weather, lightning injuries to ramp and other outdoor workers have been infrequent and fatalities rare. At the same time, however, there appears to be no systematic attempt to collect or maintain lightning-related ramp injury records for the cases that do occur, and the information that is available is mostly in the form of anecdotal stories or in the corporate memory of long-term employees.

With increasing pressure for on-time operations and efficiency, ramp closures resulting from nearby lightning can have a serious impact on local airport operations and reduce the efficiency of the national air transportation system. Although lightning frequently halts ramp operations at many airports, it is difficult to analyze the true scope and magnitude of the problem because neither airlines nor airports routinely record the frequency or duration of ramp closures. The serious impact of lightning on ramp safety and operational efficiency, and the potential impact on the national air transportation system, need to be reflected in better efforts to collect and maintain records.

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