An Economic Case for Facility Lightning Protection Systems in 2017

Lightning strikes the earth 100 times every second: that's more than 8 million times a day. In the United States, lightning strikes 25 million times each year. Wherever it is not properly controlled or absorbed, it can cause damage to urban, residential, and rural areas. Industrial and business facilities are exposed to operational breakdown, and degradation and destruction of installations and assets. A 2015 IDC survey[3] estimates that in general unplanned downtime costs Fortune 1000 businesses $2.5 billion dollars each year. The same survey puts the average hourly cost of infrastructure failure at $100,000, with critical system outages potentially costing $500,000 per hour. Total impact to businesses increases still further when costs of lightning strikes to all small and medium businesses are added. The total costs from lightning related damage to US industry and property is between $8 billion and $10 billion per year[2].

The Need to Improve Risk Management

In industry, the growing demand for availability of service and operations, as well as downtime costs, make risk management increasingly important. Lightning strikes will be an increasingly large part of the risk to be managed. Changing weather patterns mean lightning strikes are expected to grow by 50% in this century[1], with an annual increase of 150,000 strikes. In parallel, costs attributable to lightning strikes damage are increasing by 20% per year.

These mounting risks affect all areas: lightning is not selective about which buildings or domains it strikes. The types of damage and injury caused are:

- **Injury** to people and fatalities caused by high voltage
- **Fire, explosion, and destruction** of machinery, structures, and vegetation due to lightning current
- **Interruption and failure** of systems due to lightning electromagnetic impulse (LEMP.)

Why Lightning Strikes are Likely to Increase

Lightning flash rate per area (F) is determined by the product of the precipitation rate (P) and the potential electrical energy of that area (CAPE or "convective available potential energy.")

As an equation, F=Constant x P x CAPE

As P and CAPE increase, so does F, i.e. the lightning flash rate. CAPE increases as the atmosphere becomes more unstable and as air becomes more buoyant or able to rise more rapidly into the upper atmosphere, meaning CAPE rises with planetary warming.

Lightning Related Failures Can Be Prevented

Increasing risk distinguishes lightning strikes from other causes of infrastructure failure. On the other hand, lightning related failures are nearly completely preventable. Technologies available today mean that any facility, structure or operation can be protected from loss. Lightning warning systems, grounding, bonding, surge suppression devices, and structural lightning protection meet both lightning detection and damage prevention needs. As an example, a facility lightning protection system helped the Google Belgium data center[4] limit data losses to just 0.000001% after being struck by lightning no less than four times in one storm.

Why is Protection Out of Step with Vulnerability?

Although increasingly exposed to lightning, facilities are not sufficiently protected. A recent Carnegie Mellon Survey[5] concluded that 30% of US business (currently about 5.8 million in total) will suffer lightning related failure or disruption. Yet only 10% of new buildings constructed each year in the US implement a facility protection system against lightning related damage. With this level of unmanaged risk, increasing as lightning strikes become more frequent, why does industry remain so vulnerable even though effective solutions are readily available?

Challenges in Implementing Facility Lightning Protection Systems

Ignorance plays a large part in the discrepancy between levels of lightning related risk and protection. Unaware of the availability and effectiveness of protective technologies, building owners, architects, and engineers continue to accept lightning as an unavoidable risk. As such, their only solution is to seek insurance against business interruptions and damage. However, no insurance can cover all the loss concerned.

Misconceptions are also rife:

- **Expenses** for protection systems are assumed to be high, often for lack of precise figures. This in adversely and wrongfully affects the business case for investing in such protection.
- **Complexity** is inferred from the fact that effective facility protection systems must be properly integrated with the facility, but are often blown out of proportion.
- **Negative visual impact** on architectures and the environment is also considered as an unavoidable drawback, but incorrectly so.

In addition, many national electrical or building codes have so far omitted facility lightning protection systems. With the exception of the State of Florida, the implementation of a facility lightning protection system is at the discretion of the building owner and not a legal requirement.

Cost Considerations and Return on Investment

The average cost of a comprehensive facility lightning protection system (FLPS) for a commercial building is typically in the region of $35,000. In principle, the useful life of such an FLPS will be close to the useful life of the building itself. In reality, the system is likely to be replaced whenever a new roofing system is installed, which is often every 30 years or so. On this basis (renewal every 30 years), a comprehensive FLPS costs about $1,200 per year or $100 per month. Yet it can prevent infrastructure failure costing as much as $100,000 per hour, not to mention its benefits in enhancing the safety of employees, customers, and any other persons on site.

Two further factors can help make facility lightning protection systems more affordable:

- The use of "protection levels" allows expenses to be kept in line with real needs for protection. For instance, the requirements for the protection of a nuclear reactor may be different compared to those for a residential condominium complex, which may in turn be different from an industrial facility. Each installation needs protection, but in accordance with its unique associated risk.
- Different types of FLPS and associated applications allow cost reductions to be factored into implementations, without compromising the level or quality of protection.

Reducing Complexity and Increasing Efficiency

An effective facility lightning protection system must be comprehensive. This is especially true for modern digital facilities that are naturally more prone to outages and damage caused by the extremely high electrical charges produced by lightning. Requirements for grounding, potential equalization, surge suppression devices, and structural lightning protection make an effective FLPS a complex one in many cases, especially for buildings that already exist. On the other hand, the integration of an FLPS into the design of a building before construction allows efficiency to be increased and complexity to be reduced.

Visual Impact and Esthetics

Once a suitable system is installed, it should work reliably and effectively with little external indication of its existence. When an FLPS is taken into consideration at the design stage, it can be incorporated in a way that reduces or eliminates any visual impact. Even in existing buildings, railings and other structural elements or decorative features can be used or slightly altered to become integral parts of the protective system.

Facility Lightning Protection Standards and Building Codes

Every year, more regions in the world incorporate facility lightning protection systems in their building codes. In the US, Florida is a leader in the specification of requirements for such systems. In the US and internationally, there are three predominant standards for the risk assessment, design, and implementation of an FLPS:

- NFPA 780 is the National Fire Protection Association standard for installation of passive systems with simple risk assessment and does not implement protection levels.
- IEC 62305, the International Standard for Protection against Lightning used in Europe and South America among other regions, deals with passive systems; it uses advanced risk assessment and definition of protection levels.
- NF C 17-102 for Europe and much of Asia concerns active systems (Early Streamer Emission Air Terminals or ESEAT) using IEC 62305 for risk assessment and protection levels.

Buildings equipped with an FLPS complying with today's standards are more likely to meet future building code requirements, as well as ensuring effective protection for owners and users against lightning strikes and induced currents.

Savings for US Industry and the US Economy

According to the Commercial Buildings Energy Consumption Survey (CBECS)[6], there were 5.6 million commercial buildings in the United States in 2012, with 87 billion square feet of floor space. These levels represented a 14% increase in the number of buildings and a 21% increase in floor space over the preceding decade.

If the same growth rates apply over the next decade and assuming correlation between rising floor space (21%) and levels of lightning related damage to industry, a current yearly loss of $10 billion could rise to $12.1 billion. Within the same decade, lightning strikes could increase by an extra 6%, causing yearly figures for loss to further rise to $12.82 billion. By properly protecting 50% of new buildings, instead of the current 10%, losses could be prevented (i.e. net savings would be made) up to the amount of $1.56 billion per year (before upward adjustment for inflation.)

By comparison, the comparable increase over a decade in billions of square feet of residential buildings has been about three times that of commercial buildings. If losses sustained due to lightning in the residential sector were then just one-third of those for industry, the same reasoning and the same new level of 50% of buildings protected would mean total savings for commercial and residential structures for the US economy would be up to $3.12 billion per year.

Practical Steps for Improving Protection Against Lightning

The following four-stage process allows building owners, architects and engineers to cost-effectively prevent losses and other risks due to lightning strikes:

1) Comprehensive Risk Assessment. All facilities have risk, but they are not equal. Application of NFPA 780 Appendix L, or IEC 62305 allows risks to be evaluated correctly.
2) Protection-Level Based Design. Understanding the risk of each facility is the key to defining protection levels and containing costs. This can more easily be applied by using IEC 62305 and commercially available applications, such as StrikeRisk IEC/EN 62305-2 Risk Management Software.
3) Comprehensive Design
    a. Prior to construction, as part of overall facility construction design documents.
    b. Complete design prior to implementation on existing facilities.
    c. Designed by qualified design/engineering personnel, notably a Lightning Protection Institute (LPI) Certified Master Designer.
4) Installation by qualified/certified installation personnel. Facility lightning protection is a specialty discipline and must be deployed by qualified, LPI Certified Installers.

Conclusion

US industry and the US economy are connected today via a vast electronic infrastructure, which will continue to grow. Digital assets are extremely vulnerable to damage from lightning and transient currents, and this vulnerability extends to any other asset controlled by or dependent on these digital assets. Meanwhile, lightning strikes, already at 25 million per year in the US, are also growing. As urban sprawl develops, these lightning strikes will have an even bigger impact. Downtime from infrastructure failure now costs $2.5 billion per year. Overall lightning related damage to US industry is estimated to be between $8 billion and $10 billion per year.

Solutions are available to prevent harm done by lightning and transient currents. Current technologies in grounding, potential equalization, surge protective devices, structural lightning protection, and lightning warning systems if deployed and integrated properly can completely mitigate damage. The systems are readily available, very cost effective, and can save US industry and the US economy billions of dollars each year if their use is increased.

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LINKS:

1. Lightning strike increase: https://eos.org/articles/lightning-strikes-predicted-increase-climate-warms

2. http://lightningsafety.com/nlsi_lls/ListofLosses14.pdf

3. 2015 IDC survey: http://info.appdynamics.com/rs/appdynamics/images/DevOps-metrics-Fortune1K.pdf

4. Google Belgium data center: http://time.com/4004192/google-data-lightning-belgium/

5. Carnegie Mellon survey 2006: http://lightningsafety.com/nlsi_lls/ListofLosses14.pdf

6. CBECS figures: https://www.eia.gov/consumption/commercial/reports/2012/buildstock/