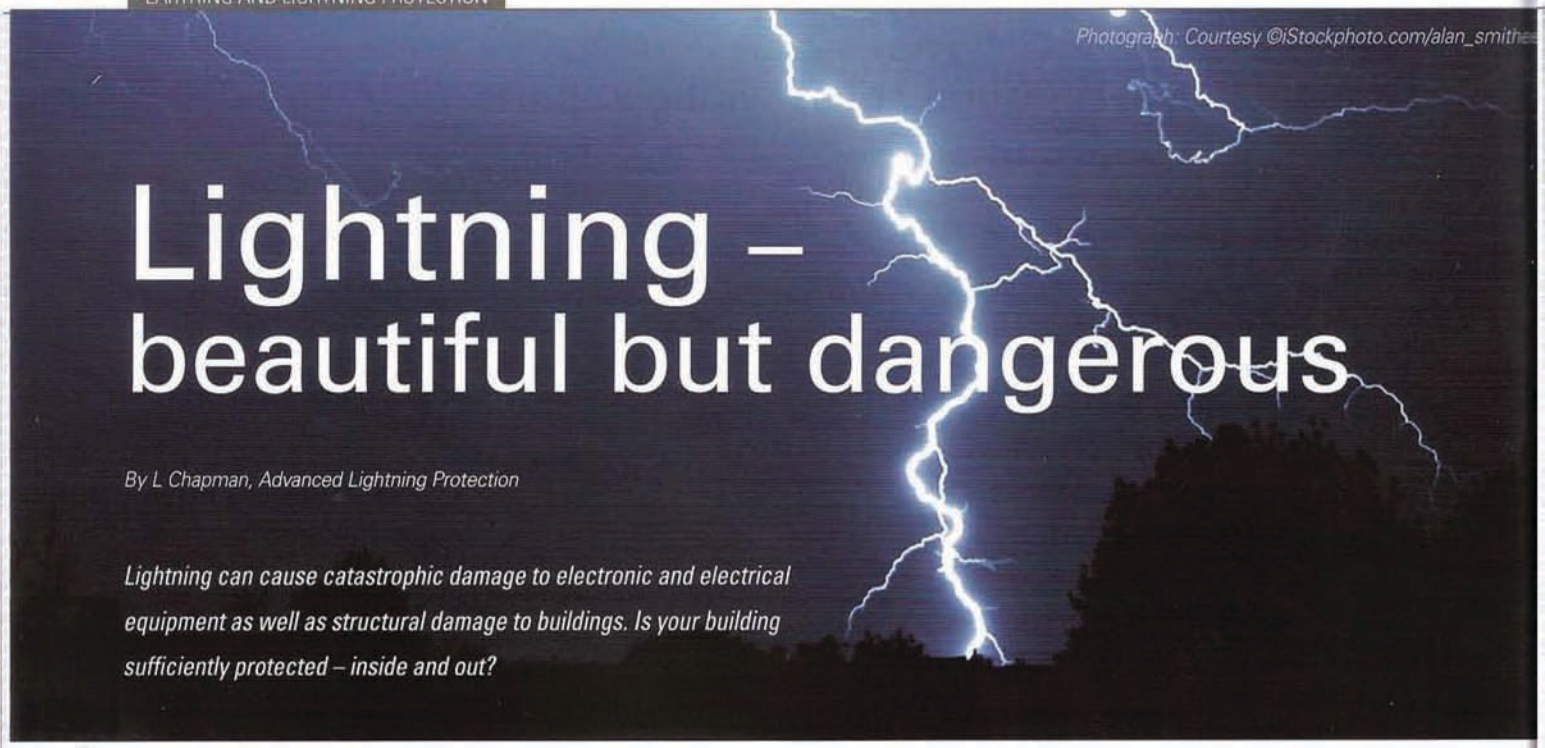

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Lightning – beautiful but dangerous

By L Chapman, Advanced Lightning Protection

Lightning can cause catastrophic damage to electronic and electrical equipment as well as structural damage to buildings. Is your building sufficiently protected – inside and out?

The electromagnetic force couples into any inductive loop that may be in the vicinity of the strike. If no protection devices are present that provide a path for the lightning energy to bypass the electronic equipment, damage could occur. The most common mistake made in lightning and surge protection is to believe that if a building has external protection or a mast, the equipment inside the building is safe. This is not true. Installing a mast or external lightning protection on a building will not be sufficient to prevent damage to equipment inside the building as the electromagnetic effects and induction will still cause damage to equipment within the building. In fact, if you install external lightning protection or a lightning mast, you will actually require Class I type lightning current arresters suitable to use for transition between lightning protection Zone (LPZ) 0A and LPZ 1. The external lightning protection is there only to offer protection to the building itself (structural protection) and therefore does not protect the equipment within the building.

Before any lightning protection system is considered a Lightning Risk Management analysis should be conducted in accordance with SANS 62305-2:2007 [1]. This will determine whether lightning protection is required and what level of lightning protection (level of risk efficiency) must be used in the design to limit the risk of damage accordingly. A risk analysis of a lightning strike to business premises is rarely performed in South Africa. The truth of the matter is that, to a business, the damage that a lightning strike is able to inflict could be devastating in a multitude of unforeseen ways. The good news is that it is largely preventable. The importance of conducting a simple risk analysis and an investigation into methods for preventing damage to the assets is vital to a business.

The risk of a lightning strike to the business premises must be quantified. Valuable equipment which could be damaged in the event of a lightning strike or surge must be identified. The consequences to the business, in terms of cost and downtime, must be estimated. Once this data is analysed, a strategy to limit these consequences must be developed and implemented. A future reassessment must be scheduled, to ensure that the strategy is in line with the growth of the company and maintenance is not neglected.

It is possible to quantify the likelihood of being the victim of lightning damage. Lightning damage may occur either as a result of a direct lightning strike to the building, or as a result of the induced effects of a lightning strike some distance away. Lightning which strikes kilometres away may cause damaging electrical surges which travel long distances on power and telecommunications lines.

Initially the lightning ground-flash density of the area must be identified. Lightning ground flash density is a number which represents the average number of direct lightning strikes to a square kilometre of the area in one year. The lightning ground-flash density for Johannesburg is approximately 7,5 strikes per square km per year while Durban is approximately 4,4 strikes per square km per year and Cape Town approximately 0,3 strikes per square km per year, indicating a significantly lower risk in Durban and Cape Town. The guidelines set out in [2] and [1] and the geography of the area must be investigated to determine what percentage of those strikes to the area are likely to terminate on the building and what percentage are likely to cause induced surges which may damage equipment connected to power or telecommunications cables.

Measuring the risk allows an educated financial decision about the lightning protection measures which need to be employed in the business. Once the lightning risk has been determined, the costs must be calculated should lightning damage occur. These costs may be split into two types, direct and indirect costs:

Direct costs are incurred when lightning damages equipment, buildings and causes lost productivity. Common equipment losses in the business environment include computers and equipment such as faxes, scanners and printers, modems, network equipment, alarm systems, electric fence energisers, CCTV cameras and equipment, electric gate motors and intercom systems, telephones and PABX systems, repairs to damaged wiring and building structures, as well as lost productivity resulting in lost income.

Indirect costs represent losses to the business in ways which are not so easy to put a figure to, such as downtime of the phone and PABX system, computer systems and networks, lost data and breach of security. Companies that utilise machines and equipment where spares and repair expertise are not easily assessable should be especially wary. Lightning strikes sometimes claim human victims although only occasional when compared to the frequent damage of sensitive electronics.

The information obtained is analysed and a simple but effective strategy put into place in order to deal with the threats, such as:

- A reputable and qualified lightning protection specialist must check the earthing system of the premises. The earthing system is vital to both general electrical safety and the correct operation of lightning surge protectors and must be in accordance with the relevant codes of practice.
- Reputable SABS approved surge protection must be installed on all valuable equipment. The cost of installing surge protection will be a fraction of the cost of the equipment that is being protected and should be viewed as a vital form of insurance. Insurance companies are now starting to realise the necessity of lightning protection, and may not be willing to cover claims unless lightning protection has been installed.
- If the risk analysis indicates that the expected number of direct lightning strikes is high due to the geographical location, an external lightning protection system, should be installed. This system comprises a series of interconnected conductors running from the building's roof, down the walls and into an earthing system. This system is designed to dissipate the lightning currents safely to earth on the outside of the building and prevents damage to the structure, dangerous side-flashes and touch-potentials inside the building and minimises the risk of damage to equipment. The external lightning protection is only there to protect the building and to provide a convenient path for the lightning current to be dissipated into the earth. It is the combination of the earthing systems, the structural protection system and the surge protection system that creates the entire lightning protection system.
- All lightning protection installations must be in accordance with SANS 10313:2008 [2].
- A maintenance strategy should be put into place to check that the earthing system and surge protection devices remain in good working order. Earthing systems degrade with time due to corrosion, theft and accidental disconnection and needs to be inspected on a regular basis. Surge protection devices degrade with use and should be maintained and replaced accordingly. Maintenance strategy should include the checking of all surge protection devices after big storms, as well as checking the devices and the earthing system after the summer lightning season and possibly the replacement of all surge protection every one to three years regardless of visible condition. It is recommended that all lighting and surge protection installations are tested annually.

Case study

Client A requested a risk analysis to be conducted on their factory. The following data was collected:

- The lightning flash density in the city where the structure is located was detemined as Ng = 7,0 flashes/km² year .
- The structure's dimension, attributes and environmental influences were determined. This particlar building had a metallic roof with continous reinforced concrete framework and was situated on a hilltop.
- Power lines, overhead and underground services were determined.
- It was noted that there was no Lightning Protection System and Surge Protection had not been installed.
- The types of loss were then ascertained and catorgorised into: 1) Loss of human Life, 2) Loss of essential public services, 3) Loss of cultural heritage, 4) Economic Loss.

To evaluate the need of protection against lightning, according to SANS 62305-2:2007, all the data as described was entered into a risk assessment computer program and the results were calculated at a risk for the structure R1 = 1.22E-05, which is greater than the tolerable risk RT = 1E-05. It was concluded that the structure was not protected against lightning. In order to reduce the risk R1 to the tolerable risk, it was recommended that a Lightning Protection System be installed. We recommended that the client install an External Lightning Protection System, strictly in accordance with the specifications [1, 2, 3, 4].

- An External Lightning Protection System (LPS) Level 4 was installed on the electric fence, weighbridge, and all the buildings, These external lightning protection systems were linked together and then linked to the electrical earth, achieving equipotential bonding in accordance with [1, 2].
- Surge protection was installed on the telephone lines and in the distribution board and was then linked to the External Lightning Protection System.

Once the lightning protection was installed and commissioned, another risk analysis was performed and according to [1], the risk was calculated at risk R1 for the structure: 2.44E-06, which is lower than the tolerable risk RT = 1E-05. It was concluded that according to [1] the structure is protected against lightning.

Take note

- A risk assessment must precede the design of an LPS.
- An LPS reduces the risk.
- The type of LPS must reduce the risk to acceptable levels.

Conclusion

The negative effects of direct and indirect lightning strikes to a business can be devastating, however these effects can be minimised. Performing a risk analysis will enable the business to identify potential issues and risks ahead of time. Although the initial installation may seem costly, in the long term, the resultant protection of electrical and electronic equipment, as well as buildings greatly compensates for the initial cost.

References

[1] SANS 62305 1-4: Protection against lightning. 2007.
[2] SANS 10313: Protection against lightning - physical damage to structures and life hazards. 2008.
[3] SANS 1063: Earthrods, couplers and connections. 2008.
[4] SANS 10199: The design and installation of earth electrodes. 2004.

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