

Lightning Protection

Understanding the Risk

Lightning is a natural phenomenon during thunderstorm weather activity when very large electrical potential (millions of Volts) within clouds and between clouds and the ground develop and an electrical discharge (several hundreds of thousands of Ampere) between the positive and negative regions of the thunderstorm results as the electrical resistance in air breaks down.

A direct lightning strike to an unprotected building will result in the flow of the discharge current through the building in an erratic path to earth causing damage/fire.

Direct lightning strikes to ground or within clouds can cause damage to structures, power lines, electrical systems, tele-communications towers and electronic data processing equipment through resistive, inductive and capacitive coupling.

Resistive coupling is the most common cause of transient overvoltages in conductors, affecting both underground and overhead lines and occur when a lightning strike raises the electric potential of one or more of a group of electrically connected buildings/ structures. As the discharge current attempts to flow through earth electrodes, electrical cables and circuitry of electronic equipment, devastating transient overvoltages can occur destroying equipment.

Inductive coupling is the magnetic field transformer effect between lightning discharges and overhead conductor lines. A lightning discharge is an enormous current flow producing an electromagnetic (EM) field which will induce current flow and transient overvoltages in line conductors within that field. Similarly, lightning discharge current flows through a building/ structure Lightning Protection System (LPS) will produce an EM field in that system, inducing current flow and transient overvoltages in conductor cables/lines located in that field/building.

Capacitive coupling is the charge/voltage accumulation on long lines, isolated from earth at each end, due to capacitance between the line and charged thunder clouds. If the charged line voltage exceeds the breakdown strength of line isolators, damage to these elements occurs.

The problems caused by lightning induced transient overvoltages are discussed in a separate RiskFix document – Transient Overvoltage Protection.



Related Loss Statistics

Accurate data on lightning loss statistics is elusive, however it is suggested and admitted that 30% of all power outages are lightning related.

There is an average of 170 lightning strikes on UK ground between 2004 and 2014. The most active year was 2006 with more than 350 strikes and 2010 the less active with less than 50 strikes.

Controlling the Hazard

Decision criteria governing the rating of lightning risk and its protection is documented in various technical standards risk assessment procedures, based on geographical lightning flash density, the lightning collection area of the structure/building under assessment, the type of structure, degree of isolation/congestion, type of terrain and economic human/environmental consequential loss factors.

If the expected/actual annual frequency of lightning strike to the property/facility (N_d) exceeds the accepted/allowable annual frequency (N_c), then a Lightning Protection System (LPS) is required. The extent to which N_d exceeds N_c governs the level of protection required.

The basic objective of an LPS and protection level is to reduce to below the accepted level the extent of damage from direct lightning strike to a structure or space.

This is accomplished through internal structural equipotential bonding and/or external mast and/or overhead catenary conductor protection. These systems provide balanced grounding of discharge flows, which preferentially follow a path external to the building/space.

Important supplementary features, to minimise lightning currents within the building/ space, include:

- Bonding of all incoming/outgoing conducting services to a single earth reference point.
- Services entering/leaving at a single point, unless these are dual sourced supplies in which case separate entry points are preferred to maintain resilience.
- Interconnected earthing systems of adjacent buildings where services are connected.
- Enclosed, metal conduit/ducting, bonded at both ends, for power/data cables/lines between adjacent interconnected buildings.

Inspection and maintenance of LPS is critical and technical standards make provision for the issue of a Certificate of Compliance for new installations and maintenance inspections. Certification governs fit-for-purpose condition of LPS and considers design integrity, corrosion and building additions/extensions. Testing/certification is recommended annually and required after alterations/repair or lightning strike.

Reference

NFPA 780 – Standard for the Installation of Lightning Protection Systems

NFPA 70 – National Electrical Code

BS7671: 2008 + A3: 2015 – Requirement for Electrical Installation IET Wiring Regulations

BS EN 62305 – Protection Against Lightning

BS EN 61643 – Low Voltage Surge Protective Devices

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