Lightning Protection

Lightning has the potential to cause significant damage to buildings and other assets, whether by direct strike or localised power surges.

This Loss Prevention Standard provides an overview of the main risks, protection methods and standards to consider when installing and maintaining lightning protection systems.

Version: 1.0
Date: 31st May 2025

Lightning Protection

Introduction

Lightning is a phenomenon where electrical energy is released from cloud formations, typically in the form of a visible lightning bolt, strike or flash. A typical discharge can contain up to 1 billion volts of electricity, which when striking property, infrastructure and other valuable assets, can cause significant damage and interruption.

Whilst lightning strikes can cause extensive physical damage and secondary fires, lightning related electrical surges can also cause disproportionate levels of localised damage to sensitive electrical and electronic equipment, leading to systems outage and trading impacts to many organisations.

The frequency and consequences of lightning activity is also expected to worsen as a result of global climate change.

This Loss Prevention Standard outlines the principal areas of concern in relation to lightning events, along with guidance on choosing and maintaining lightning protection systems.

Note: This document relates to lightning events and protection. It is not intended to address liability exposures. The presumption is that all regulatory requirements, Fire Risk Assessments, and compliance with requirements placed by the local authority having jurisdiction which would include licencing, building permissions, regulations, codes, or standards, have or will be met.

Understanding the Risks

Lightning events can lead to several types of property damage or loss, including:

- **Material damage**. Direct lightning strikes can cause significant damage to property and other valuable assets. Property in proximity to buildings, trees etc., that have been struck by lightning can also be damaged by collapse, falling debris etc.
- **Secondary Fire**. Lightning strikes, and the heat generated, can ignite combustible materials in proximity to the lightning strike.
- **Electrical damage**. Lightning can create power surges that can overload electrical equipment and damage more sensitive electronic equipment.
- **Warranty avoidance.** Lightning damage to recently completed construction projects, or property in the course of construction, can potentially void product or building warranties, resulting in contractual disputes.

Some damage, whilst appearing outwardly limited, may be so significant that structures need to be dismantled and rebuilt or replaced. For example, concealed insulation materials on certain buildings can suffer irreversible damage, even whilst the external surfaces appear visibly undamaged.

Managing the Risks

Lightning Protection

A lightning protection system is designed to intercept, conduct and disperse lightning strikes on a property by providing a path of low impedance to earth, along which the discharge can travel to ground. Without this the lightning would follow other paths through the property, including metal, brick, concrete, wood, insulation materials, electrical equipment etc., leading to damage.

To ensure that adequate protection is installed, the design should consider both the direct effects of lightning events, which include physical damage to a property or key assets and the secondary effects, which include fire and damage to electrical and electronic equipment as a result of voltage/current surges produced in wiring and cables resulting from a strike to the property or nearby.

Risk Assessment

Prior to commissioning and installing a lightning protection system, a specific risk assessment should be undertaken to identify the risks or hazards that could lead to damage or loss. In the United Kingdom, **BS EN 62305 - Protection Against Lightning** and globally **IEC 62305 - Protection Against Lightning** identifies four types of loss to be assessed:

- L1: loss of human life (including permanent injury)
- L2: loss of service to the public
- L3: loss of cultural heritage
- L4: loss of economic value (the structure, its contents and loss of activity)

For each of the first three primary risks (L1-L3), a tolerable risk is set. Each primary risk is determined through a series of calculations as defined within the Standard. If the actual risk is less than or equal to the tolerable risk, then no protection systems are needed. If the actual risk is greater than its corresponding tolerable risk, then protection systems must be instigated. It is this iterative process that decides the choice or indeed lightning protection Level or lightning protection system to counter lightning risks.

In assessing the economic value (L4) the benefits of providing protection should be evaluated in order to reduce the loss, i.e., lightning protection is effective if the loss in the presence of protection plus the cost of the measures is assessed to be lower than the total loss without the protection measures installed.

Note: Some properties benefit from construction which provides the function of a lightning protection system without the need for specialist protection. This may not extend to surge protection to electrical and electronic devices. Guidance should be sought from a competent and qualified lightning company or contractor to confirm such arrangements are adequate.

Controlling the Hazard

Installation

To reduce or lessen this damage, a lightning protection system should be designed, installed and tested in accordance with recognised national or local regulations, standards or codes, such as **BS EN 62305** in the United Kingdom, which is derived from International Standard **IEC 62305**.

Any such lightning protection system should be installed by a competent and qualified company or contractor, such as a member of the Association of Technical Lightning and Access Specialists (ATLAS) or an internationally recognised equivalent.

The parts of the property most likely to be struck by lightning are those that project above the surrounding property, including: -

- Flagpoles.
- Chimneys.
- Towers.
- Elevated water tanks.
- Roof structures.
- Steeples.
- Radio, television, mobile phone masts etc.
- Trees.
- Renewable energy installations e.g., Battery Energy Storage Systems (BESS), Solar Photovoltaic (PV) systems etc.

Note: BS EN 62305 is not retrospective and thus existing UK lightning protection systems designed to the previous standard, **BS 6651 - Code of Practice for Protection of Structures Against Lightning**, need not be altered unless the structure has been substantially altered or extended, or a new electrical system has been installed. All newly installed or refurbished electrical mains systems require surge protection for indirect lightning strikes.

In addition to the effects of lightning on the property, surges along electrical and electronic services entering and leaving may also need to be eliminated by way of strategically placed surge arresters.

System Components

The four main components of a lightning protection system comprise:

Air Termination Device Networks

An air termination device, also known as an air terminal, lightning rod, Franklin rod, finial, lightning protection mast or air termination rod, is a pointed tip rod made from conductive material such as copper or aluminium, which is positioned externally on a property as protection from direct lightning strikes. The devices act as the interception point for lightning strikes allowing for it to be collected at a controlled location and dispersed to ground safely.

On high-risk structures such as explosive factories, no part of the roof should be more than 2.5m from an air termination device. This is generally achieved by applying a 5m x 10m mesh to the roof. However, for most structures, a mesh of 10m x 20m is considered sufficient, giving a maximum distance from any part of the roof to the nearest conductor of 5m.

Down Conductors

Down conductors provide paths of low impedance from the air termination devices to the earth terminations. Down conductors may be in either copper or aluminium and when designing a lightning protection system, it is possible to use more than one type, namely flat tape, solid circular or stranded tape. The decision of which type to choose is frequently influenced by historical or aesthetic preferences.

The positioning and distancing of down conductors is often dictated by architectural constraints. There should be one down conductor for every 20m or part thereof of the property perimeter at roof or ground level (whichever is greater). These should be evenly spaced and distances apart of more than 20m avoided if possible. If the building is above 20m in height or of an abnormal risk, this distance should be reduced to 10m. They should be routed as directly as possible from the air termination device network to the earth termination network to avoid risks of side flashing. Re-entrant loops are also to be avoided. The length of conductor forming the loop should not exceed eight times the width of its open side.

Earth Termination Networks

Properly made earth terminations; comprising conductors; earth rods; clamps; earth electrodes and bonds; are critical to the safe and effective dispersal of a lightning strike into the ground. The type of earth termination provisions will be influenced by the ability of the ground to conduct the lightning current. This will depend on factors such as moisture content and type, for example clay or stone. In the United Kingdom **BS 7430 - Code of Practice for Protective Earthing of Electrical Installations** provides recommendations on earthing.

Surge Arresters

Surge arresters protect against electrical surges and transient surges, including those caused by lightning. They operate by diverting the surge current to ground and are typically installed with electrical panels or items of equipment.

Renewable Energy Systems - Lightning Protection

Solar Photovoltaic (PV) Systems. Both ground and roof mounted Solar PV systems should be fitted with stable, low resistance and low impedance grounding systems to bond all electrically conductive surfaces together. In addition, alternating current (AC), and direct current (DC) surge protection devices (SPD) should be installed at key points such as inverter stations, transformers, combiner boxes, critical data circuits and uninterrupted power supplies (UPS) in the customer substation along with overvoltage and overcurrent relays to safely trip the switchgear.

Refer to Aviva Loss Prevention Standards **Roof Mounted Photovoltaic Solar Panel Systems - Installation and Construction** and **Roof Mounted Photovoltaic Solar Panel Systems -Installation and Ongoing Care** for further guidance.

Wind Turbines. Specific lightning protection should be installed via lightning receptors to the blades, and lightning rods to the nacelle. These devices should be connected to appropriate conductors and earth termination devices. As with Solar PV systems, SPDs should be installed to protect all electrically driven apparatus including controller cabinets, motors, monitoring equipment, UPS, etc., along with overvoltage and overcurrent relays to safely trip the switchgear.

Some wind turbine models may be fitted with lightning cards, essentially, thin sacrificial conductor 'cards' installed near key components which would partially melt/burn to provide a visual cue that a strike has occurred. Whilst offering some benefit, digital Lightning Event Counters (LEC) with the ability to provide lightning strike timestamps and intensity metrics are preferable and should be incorporated into monitoring systems e.g., Supervisory Control and Data Acquisition (SCADA) systems etc.

In addition to the original equipment manufacturers (OEM) recommendations and best practice measures outlined later in this document, lightning protection maintenance arrangements should include:

- Ensuring the seal around blade receptors are in good condition to help prevent water ingress between the receptor and the receptor block.
  - ✓ This can corrode the conductor and increase resistance or create voids between the contacts.
- Checks for any signs of discolouration or arcing on conductive bands.
- Applying/reapplying torque marks to lightning conductor terminals to indicate that these have been serviced.
- Measuring and/or replacing brushes where a slip ring is used.
- Checks and replacement of any lightning cards.

IEC 61400-24 Wind Energy Generation Systems - Part 24: Lightning Protection provides further guidance.

Inspection and Maintenance

Self-Inspection

Regular self-inspections should be carried out by suitably competent, qualified and experienced persons to confirm ongoing conformity with the design standard. These should be undertaken at least monthly and include, but not be limited to:

- Air and ground termination devices, and conductors for evidence of damage, corrosion, fraying or wear.
- Connections and joints for tightness.
- Post change inspections for correct installation, reinstatement of protections etc.
- Surge devices for correct installation and normal functionality.

Systems should be checked following a lightning event to identify areas of damage etc.

The results of the visual inspections should be recorded, together with a note of any parts of the installation that may not have been possible to inspect.

Formal Maintenance and Testing

Formal maintenance and testing should be carried out in accordance with local or national regulations, standards or codes by an accredited company or contractor.

The installation should be subject to an annual formal inspection to check the mechanical condition of all conductors, bonds, joints, electrodes and to ensure that all recently added services have been bonded as required.

This should be conducted on an 11-month schedule where possible, so that seasonal variations in conditions are observed.

The resistance to earth of each earth electrode, the resistance of the complete earth termination system and the measurement of electrical continuity of bonds and joints where necessary should be tested:

- On completion of the installation.
- After alterations, extension or modification.
- After a known discharge.
- On a regular basis (such as every 11 months).
- Full details of all tests should be recorded.

Key Actions

Whilst lightning is known to be a cause of loss or damage, including fires, there are a number of actions which an organisation can implement to reduce its exposure to this threat, as follows:

- For newly acquired premises, or following substantial changes to buildings and infrastructure, review the adequacy of lightning and surge protection systems.
- At least annually review lightning risk assessment, to ensure arrangements remain suitable and sufficient.
- Conduct routine self-inspections of lightning and surge protection systems to help identify damage, wear, loose connections, corrosion etc.
- Ensure lightning protection systems are subject to a formal maintenance arrangement in line with OEM and/or advice from accredited and qualified companies or contractors.

Checklist

A generic **Lightning Protection Checklist** is presented in Appendix 1 which should be undertaken in respect of all lightning protection systems and be tailored to your own organisation.

Specialist Partner Solutions

Aviva Risk Management Solutions can offer access to a wide range of risk management products and services at preferential rates via our network of Specialist Partners.
For more information please visit:
Aviva Risk Management Solutions – Specialist Partners

Sources and Useful Links

- Regulatory Reform (Fire Safety) Order 2005
- Fire (Scotland) Act 2005
- Fire Safety Regulations (Northern Ireland) 2010
- BS EN 62305: Protection against lightning
- IEC 62305-1: Protection against lightning - Part 1: General principles
- IEC 61400-24 Wind Energy Generation Systems - Part 24: Lightning Protection
- Electricity at Work Regulations 1989 (HSR25)
- RISCAuthority Risk Control document RC35 Protection of Buildings against lightning strike
- The Association of Technical Lightning and Access Specialists (ATLAS)

Note: Whilst UK standards and legislation are referenced in this document, other international standards and legislation should be referenced where applicable.

Additional Information

Relevant Aviva Loss Prevention Standards include:

- **Electrical Installations - Inspection and Maintenance**
- **Electrical Installations - Partial Discharge and Monitoring**
- **Grid Scale Battery Energy Storage Systems**
- **Small Scall Battery Energy Storage Systems**

To find out more, please visit Aviva Risk Management Solutions or speak to one of our advisors.

Email us at riskadvice@aviva.com or call 0345 366 6666.*

*The cost of calls to 03 prefixed numbers are charged at national call rates (charges may vary dependent on your network provider) and are usually included in inclusive minute plans from landlines and mobiles. For our joint protection telephone calls may be recorded and/or monitored.

Appendix 1 – Lightning Protection Checklist

Location	
Date	
Completed by (name and signature)	

	Lightning Protection Requirements	Y/N	Comments
1.	Have the buildings been subjected to a lightning risk assessment as set out in local or national regulations, standards or codes e.g. BS EN 62305-2: Protection against lightning: Risk management?		
2.	Has risk analysis been used to determine the risk of a structure being hit by lightning?		
3.	Has an assessment been undertaken to determine the risk to all electrical and electronic equipment (such as CCTV, communications, and data processing equipment) from direct discharges and induced currents?		

	System Design	Y/N	Comments
4.	Has the zone of protection representing the extent that a lightning conductor, or assembly of conductors protects against a direct strike been determined?		
5.	In the case of new build projects, has lightning protection been considered at the building design stage?		
6.	• Has the design of the lightning protection system been undertaken by a suitably experienced engineer? • Has the appropriate protection level been determined in accordance with local or national regulations, standards or codes e.g. BS EN 62305, IEC 62305?		
7.	Is the whole of the structure protected?		

	System Components and Installation	Y/N	Comments
8.	Are conductors installed symmetrically around the outside walls of the structure, starting from the corners?		
9.	Do conductors follow the most direct path that avoids sharp bends or narrow loops?		
10.	Are down conductors spaced an average of 20m or less apart around the perimeter?		
11.	Are at least two down conductors provided for tall buildings where testing and inspection may be difficult (for example for tall chimneys)?		
12.	Are conductors joined to form a Faraday Cage to reduce the impedance and increase the number of paths for a discharge to follow?		

	System Components and Installation	Y/N	Comments
13.	Are natural conductors used where applicable?		
14.	Has consideration been given to the fact that the greater the number of interconnected down conductors provided, the lower the risk of side flashing occurring?		
15.	Are the fixing centres in line with the OEM design requirements, or local or national regulations, standards or codes? **Note:** There should be one down conductor for every 20m or part thereof of the property perimeter at roof or ground level (whichever is greater). These should be evenly spaced and distances apart of more than 20m avoided if possible. If the building is above 20m in height or of an abnormal risk, this distance should be reduced to 10m.		
16.	Has a combined resistance to earth of 10Ω or less been achieved for the whole of the earth termination network?		
17.	Is each down conductor provided with an earth terminal?		
18.	Is a common earth termination network provided for the lightning protection system and all other services?		
19.	Have suitable provisions been fitted to isolate earth terminals for testing purposes?		
20.	Are all metal parts of the building including utility services in contact with the ground suitably bonded?		

21.	Is all exposed metal attached to the outside surface of the building or protruding through walls regardless of any earth connection bonded?		
22.	Are materials used for bonding essentially similar to those used for air terminals and down conductors?		

	Inspection and Maintenance	Y/N	Comments
23.	• Are self-inspections conducted at least monthly, by suitably competent, qualified and experienced persons to confirm ongoing conformity with the design standard? • Do these include: ✓ Air and ground termination devices, and conductors for evidence of damage, corrosion, fraying or wear. ✓ Connections and joints for tightness. ✓ Post change inspections for correct installation, reinstatement of protections etc. ✓ Surge devices for correct installation and normal functionality. • Are the visual inspections recorded, together with a note of any parts of the installation that it may not have been possible to inspect?		
24.	Are the lightning protection systems checked following a lightning event in the location to identify any damage etc.?		
25.	• Is maintenance and testing conducted in accordance with local, national regulations, standard or codes at least annually (11 month is recommended)? • Does this include the resistance to earth of each earth electrode, the resistance of the complete earth termination system and the measurement of electrical continuity of bonds and joints?		
26.	Are full details of all tests recorded?		
27.	Additional Comments:		

Please Note

This document contains general information and guidance only and may be superseded and/or subject to amendment without further notice. Aviva has no liability to any third parties arising out of ARMS' communications whatsoever (including Loss Prevention Standards), and nor shall any third party rely on them. Other than liability which cannot be excluded by law, Aviva shall not be liable to any person for any indirect, special, consequential or other losses or damages of whatsoever kind arising out of access to, or use of, or reliance on anything contained in ARMS' communications. The document may not cover every risk, exposure or hazard that may arise, and Aviva recommend that you obtain specific advice relevant to the circumstances.

31st May 2025

Version 1.0

ARMSGI2442025