Protection against lightning
A UK guide to the practical application of BS EN 62305

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Endorsement Notice

This application guide has been reviewed by and has the endorsement of GEL/81, British Standards Institute Lightning Protection Committee and the Association of Technical Lightning & Access Specialists (ATLAS), Lightning Protection Committee.

Foreword

In 2006 the International Electrotechnical Commission issued a new standard covering protection against lightning. This standard, IEC 62305, consists of four parts and was adopted in its entirety by the European Committee for Electrotechnical Standardization, CENELEC, and published as the EN 62305 series in 2006. Furthermore, as all member states of the EU are legally bound to embrace EN standards, the British Standards Institution adopted the standard with certain authorized National Amendments and published it as the BS EN 62305 series in August 2006.

BS EN 62305, *Protection against lightning*, consists of the following parts:

Part 1: General principles

Part 2: Risk management

Part 3: Physical damage to structures and life hazard

Part 4: Electrical and electronic systems within structures

The new BS EN 62305 series is the result of many years of detailed scientific research and study by worldwide experts. The document scientifically justifies, from first principles in some cases, risk assessment and protection techniques and satisfies many academic requirements. As the series is necessarily academic in its approach, it is largely impractical to apply without detailed knowledge of the subject or, alternatively, assumptions being made, the standard is also open to interpretation.

This guidance document is aimed at clients, architects, consultants, building and other contractors and practitioners specializing in the design, installation, testing and maintenance of systems of protection against lightning. Those wishing a more detailed insight into the academic background and scientific derivation of the application techniques should refer to the standards themselves.

This guidance document applies practical application interpretations to the academic approach of the standards in order to achieve a consistent approach to its use and application in the field. Application of this document in practical situations should offer risk assessment and protection technique outcomes in line with those that would be obtained by the application of the full standards themselves on the basis that this guide

applies sensible and reasonable assumptions in those areas where contractual and practical processes and limitations would otherwise make a consistent approach difficult.

For completeness, a client should refer to the standards for solutions. However, this route is likely to add unnecessarily to the economic costs of coordination, assessment and design.

In order to become a specialized designer or installer of lightning protection systems a thorough knowledge of the relevant standards and several years of experience is required.

This document will provide a practical application guide to the use of BS EN 62305 in order to ensure a consistency of approach, interpretation and outcome reflecting new and established custom and practice.

Introduction

The application of measures to protect against lightning and its effects are essential, as there are no devices able to change the natural weather phenomena in order to prevent lightning discharges. Lightning striking a structure, directly or nearby, can be hazardous to people, structures and their contents and services.

Initially the client or their engineering professionals should consider which risk they wish to protect against:

- R_1 - loss of human life;
- R_2 - loss of service to the public;
- R_3 - loss of cultural heritage;
- R_4 - loss of economic value.

The risks and need for protection measures should be determined using the risk assessment methodology in Section 2 of this guide or by means of commercially available software written specifically for the purpose. If using commercially available software, care should be taken to ensure that all indices used within the software are consistent with those in BS EN 62305, as some IEC or European versions for use in other countries may have different indices set by their own respective national authorities. Protection measures according to Sections 3 to 9 of this guide should be applied to reduce the risk of life hazard and physical damage and the risk of failure of electrical and electronic systems within structures as required.

Risk assessment together with the determination and application of measures to reduce the risk of damage to structure, services and life hazard should all be considered in order to comply with the requirements of BS EN 62305.

This guide covers the assessment and reduction of risk below tolerable levels, together with techniques for the protection against lightning and touch and step voltages of:

- structures, their services, contents and persons within;
- services connected to the structure.

Railway systems, vehicles, ships, aircraft, offshore installations, underground high pressure pipelines, piping and telecommunication lines not connected to the structure, distribution stations, storage tanks and pipelines are not covered by this guide. For details on these specialist areas, refer to BS EN 62305 and industry specific standards.

Where appropriate, references to the BS EN 62305 series are made throughout this guide adjacent to the relevant subject matter. This enables easier cross-referencing to the standard if a more detailed review of any subject matter is required.

Section 1 Basic considerations

It is important for regular consultation to take place between the various parties involved in the contractual chain. This should result in an effective lightning protection system (LPS) and lightning electromagnetic pulse measures system (LPMS) at the lowest possible cost. The coordination of LPS and/or LPMS design work with construction work will often reduce the need for some bonding conductors and the frequency of those that are necessary. [*BS EN 62305-3*, *E.4.2.2.1*]

In practice it has been difficult for the lightning protection contractor to obtain sufficient information at the tender stage of any project in order to offer precise designs. It is also impractical in many cases, due to the contracting process in the UK, for the lightning protection contractor to be allowed access to the client or their professional team at tender stage in order to obtain all of the detailed information needed to derive a complete design.

For these reasons it is important for the LPS contractor to be clear with their direct contractual principal regarding the characteristics they have applied to the risk assessment process in order to derive a design – for example, the assumptions that have been made regarding the structure and line characteristics in the risk assessment in order to derive the level of protection, and the type of air-termination, down-conductor and earth-termination networks that have been allowed in the design. These all may have implications on the structure and services within it. Clarification should be sought regarding who is responsible for areas where there may be duplication – the equipotential bonding, for example.

The importance of human life and the advances in electrical and electronic technology, and its increased sensitivity and scope for increased consequential losses, together with the introduction of BS EN 62305, has further lifted the requirements for a professional approach to the provision of lightning protection. No longer is it acceptable for the professional team to ask in their tender specification simply for a 'lightning protection system to BS EN 62305' and leave it to the contractors at the lower levels of the contractual chain to derive what they think is appropriate with the information they have. The need for information to derive the requirements of the client and then to apply this to the new standard is a vital part of providing protection under BS EN 62305. Consulting engineers need to involve LPS contractors, and due to the greater technical involvement

necessary, to pay for their assessment and design expertise, during the early design phases of a project. Only if consulting engineers are prepared to do this will the requirements for protection against lightning be delivered in a non-confrontational and efficient manner.

The management of the process for determining the need and delivering an LPS to a structure and/or an LPMS to protect electrical or electronic systems within a structure would be most effective in the UK contracting sector if the process shown in Table 1.1 is followed.

Table 1.1 – Management of the process of providing LPS and LPMS

Step	Objective	Actions by
LPS		
Initial risk assessment	Check the need for an LPS and determine the level of protection required.	Client and consultant to decide which risks they wish to consider, provide detailed inputs to risk assessment and employ lightning protection experts to carry out risk assessment and derive need for protection and lightning protection level.
LPS planning	Consider options for protection.	Consulting engineer employs lightning protection expert to plan and undertake initial tender design. Both parties together with other appropriate members of the services design team discuss and determine requirements and most appropriate options for LPS and siting of services.
LPS tender stage design	Provide detailed design and specification for tender stage LPS, considering: • LPL design requirements; • appropriate air-termination design method; • inclusion of natural components for air-termination, down-conductor and earthing; • protection of roof mounted fixtures and bonding needs including surge protection devices (SPDs); • positioning of down-conductors; • positioning of test points; • soil resistivity; • appropriate earthing arrangements; • internal LPS, separation distances and bonding; • touch and step potential outside building;	Lightning protection expert carries out initial LPS design and provides to consultant for tender purposes.

Step	Objective	Actions by
	• other specific issues.	Consultant ensures coordination with all other services and any consequential amendments needed to tender stage design.
LPS tender	Obtain competitive market prices for compliant LPS installation from competent contractors.	Consultant or main contractor, depending upon specific contract administration, requests bids from approved contractors based upon accurate requirements.
LPS installation	Secure a good LPS installation coordinated with other services.	LPS contractor supervised ultimately by the consultant through the particular contractual chain.
LPS commissioning	Ensure LPS installation complies with the initial and developed design in accordance with BS EN 62305-2.	LPS contractor supervised by the consultant.
LPS documentation	Gather full information relating to the design parameters and as installed data for the project health and safety file and facilitate future maintenance. Project health and safety file passed to client upon project completion.	LPS contractor. Main contractor.
Recurrent inspections and electrical tests	Ensure continuing adequacy of LPS and compliance with legislation.	Client engages LPS contractor to undertake visual inspections, electrical tests and reports.
LPMS		
Initial risk assessment	Check the need for lightning electromagnetic pulse (LEMP) protection, and if needed, select suitable LPMS using the risk assessment method.	Client and consultant to provide detailed inputs to risk assessment and employ lightning protection expert to carry out risk assessment and derive need for protection and lightning protection level.
Final risk analysis	The cost/benefit ratio for the selected protection measures should be optimized using the risk assessment method again. As a result the following are defined: • lightning protection level (LPL) and the lightning parameters; • lightning protection zones (LPZ) and their boundaries.	Lightning protection expert and client/ consultant

Step	Objective	Actions by
LPMS planning	Definition of the LPMS considering: • spatial shielding measures; • bonding networks; • earth-termination systems; • line shielding and routing; • shielding of incoming services; • coordinated SPD protection.	Consulting engineer employs lightning protection expert to plan and undertake initial tender design. Both parties, together with other appropriate members of the design team and electrical or electronic equipment suppliers, discuss and determine requirements and most appropriate options for LPMS.
LPMS tender design	Provide detailed design and specification for tender stage LPMS.	Lightning protection expert Consultant ensures coordination with all other services.
LPMS tender	Obtain competitive market prices for LPMS installation from competent contractors.	Consultant or main contractor, depending upon specific contract administration, requests bids from approved contractors based upon accurate requirements.
Installation of the LPMS, including supervision	Ensure quality of installation and provision of documentation and, where necessary, revision of the construction drawings.	LPMS contractor supervised ultimately by the consultant through the particular contractual chain.
Approval of the LPMS	Checking and documenting the state of the system.	LPMS contractor supervised by the consultant.
Recurrent inspections	Ensuring the adequacy of the LPMS.	Client engages LPMS contractor to undertake visual inspection, tests and documentation.

Notes

BS EN 62305-4 calls for a lightning protection expert to undertake initial designs and independent final commissioning. This additional contracting member is not currently custom and practice in the UK and, in practice, the consulting engineer would perform this service with some input from a lightning protection contractor or surge protection specialist. It is unlikely that a client would wish to incur additional expense employing a lightning protection expert, however it would be prudent to ensure that any party undertaking detailed design and commissioning works, either directly or indirectly, are covered by professional indemnity or other appropriate forms of insurance.

For direct contracts between client and the LPS expert, the LPS contractor may replace the consultant on the basis that the contractor will have direct contact with the client in this case for the purposes of establishing exact requirements.

It is customary in the UK for the lightning protection contractor simply to be asked to ‘provide a design and quotation for a system to BS 6651’, with little input data to assist. A simple request through the conventional contractual chain, typically from the electrical contractor, for the lightning protection contractor to ‘provide a design and quotation for a system to BS EN 62305’ is likely to lead to a system that does not totally concur with the requirements of the new standard and one that is poorly coordinated with other services. These circumstances, or others where insufficient information is available, are covered in the risk assessment by applying a default to the calculation.

Table 1.1 suggests a route that would lead to a fully coordinated optimum engineering solution. There will be circumstances in which the client does not wish to follow this route and prefers the more conventional request to a lightning protection specialist for 'a system to BS EN 62305'. In this case, the client will as a minimum need to provide the lightning protection contractor with the details shown in Table 1.2 if they wish any proposed risk assessment or solution to be remotely appropriate.

In Table 1.2, the risks to be considered are defined as:

- R_1 = risk of loss of human life;
- R_2 = risk of loss of service to the public;
- R_3 = risk of loss of cultural heritage;
- R_4 = risk of loss of economic value.

Table 1.2 – Information required to enable accurate risk assessment by type of risk

Information required	R_1	R_2	R_3	R_4
Type of structure or service (for example, school, offices, hospital or warehouse).	X	X	X	X
Does the structure contain explosives?	X	X		X
Is the structure in an area where it is higher than or the same height as other structures or is it isolated or located on the top of a hill or knoll?	X	X	X	X
What is the postal address of the structure?	X	X	X	X
Dimensions of structure, length, width and heights. Provision of scaled roof plans and elevation drawings detailing the structural and external make up of the structure and showing details and locations of all services and equipment, especially that equipment located externally to the structure.	X	X	X	X
What are any rooms internal to the structure housing electronic equipment constructed of and what are the dimensions of the internal structures?	X*	X		X
For service lines the following is required:				
Number of service lines feeding the structure?	X	X	X	X
Is the power line single or three phase, overhead or underground, does it have armouring or other mechanical protection and if so what is the resistance of this in Ω/km?	X	X	X	X
For telecommunications lines, how many, how many pairs within the line, is it overhead or underground, does it have screening and if so what is the resistance of the screening in Ω/km? If the lines are overhead, what are their heights from the ground?	X	X	X	X
What are the lengths of all the lines between the structure to be assessed for protection and the telephone exchange or substation feeding the lines? What are the lengths, widths and heights of these structures?	X	X	X	X

Information required	R_1	R_2	R_3	R_4
Do the lines run through areas where they are higher than or the same height as other structures or are they isolated or located on the top of hills or knolls?	X	X	X	X
Do the lines run through urban areas with tall buildings or an ordinary urban environment or do they run through suburban or rural areas?	X	X	X	X
For power lines, is there a transformer provided to the structure or is there a service line only?	X	X	X	X
Where telecommunication/data systems are installed within the structure, will routing precautions be taken to avoid induction loops, for example by routing cables away from external walls and running together power and data cables feeding the same equipment? Will the cables be shielded or run in mechanical protection offering shielding against LEMP effects? If so what will the resistance of the shielding be in Ω/km?	X*	X		X
How many floors does the structure have and how many people will be in it? Are there likely to be any difficulties of evacuation, for example aged or infirm people in hospitals? Are there likely to be any hazards or contamination for the surroundings or environment in the event of a strike?	X	X		X
What is the value of the soil resistivity in Ω/m?	X**	X**	X**	X**
What are the design voltage withstand levels for the power and electronic systems within the structure?	X	X	X	X
What are the floor finishes inside the structure and outside in the zone up to 3 m away from the structure?	X			X***
What provisions are fitted to protect against fire risk?	X	X	X	X
What is the fire loading of the structure?	X	X	X	X
Separate costs of the structure, contents, systems within the structure and any animals on site.				X
The interest and amortization rates applicable to the total costs of structure, contents and systems.				X

X = Required information.
* Only required for this risk if the structure is a hospital or contains explosives.
** Only required where the services feeding the structure are underground or where risk component R_A (relating to the zone three metres outside the structure – see Table 2.9 of this guide for further detail) is to be considered.
*** Only required for this risk where there is a risk of loss of animals.