BS EN 62305-3:2011
Part 3: Physical damage and life hazard
External Lightning Protection
Lightning strike to an agricultural building
A lightning protection system consists of an external and internal lightning protection system.

**Functions of an external lightning protection system:**
- Interception of direct lightning strikes by means of an air-termination system
- Conducting the lightning current to earth by means of down conductors
- Distribution of the lightning current in the earth by means of an earth-termination system

**Functions of an internal lightning protection system:**
- Prevention of dangerous sparking in the structure by establishing equipotential bonding or keeping a separation distance between the components of the lightning protection system and other conductive elements in the structure.
## Terms and definitions

### Lightning protection system

**Lightning protection** means protection measures against the harmful effects of lightning strikes to structures/buildings.

An external lightning protection system consists of:
- Air-termination system
- Down conductors
- Earth-termination system

### Earth-termination system

An **earth-termination system** includes all measures required for connecting an electrical part to earth and is an integral part in low-voltage and high-voltage systems as well as for the lightning protection system.
Air –Termination System
5. External lightning protection system
5.2 Air-termination systems
5.2.2 Positioning

Air-termination components installed on a structure shall be located at corners, exposed points and edges (especially on the upper level of any facades) in accordance with one or more of the following methods.

Acceptable methods to be used in determining the position of the air-termination system include:

- the protective angle method;
- the rolling sphere method;
- the mesh method.

The rolling sphere method is suitable in all cases.

The protection angle method is suitable for simple-shaped buildings but it is subject to limits of air-termination height indicated in Table 2.

The mesh method is a suitable form of protection where plane surfaces are to be protected.
Design methods of air-termination systems

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Radius of the rolling sphere (r)</th>
<th>Mesh size (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20 m</td>
<td>5 x 5 m</td>
</tr>
<tr>
<td>II</td>
<td>30 m</td>
<td>10 x 10 m</td>
</tr>
<tr>
<td>III</td>
<td>45 m</td>
<td>15 x 15 m</td>
</tr>
<tr>
<td>IV</td>
<td>60 m</td>
<td>20 x 20 m</td>
</tr>
</tbody>
</table>
Rolling sphere principle
## Rolling sphere radius, protection angle, mesh size and typical preferred distances between down conductors

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Protection method</th>
<th>Typical distances (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rolling sphere radius $r$ (m)</td>
<td>Protection angle $\alpha$ (°)</td>
</tr>
<tr>
<td>I</td>
<td>20</td>
<td>[Diagram showing relationship between $H$ and $\alpha$]</td>
</tr>
<tr>
<td>II</td>
<td>30</td>
<td>[Diagram showing relationship between $H$ and $\alpha$]</td>
</tr>
<tr>
<td>III</td>
<td>45</td>
<td>[Diagram showing relationship between $H$ and $\alpha$]</td>
</tr>
<tr>
<td>IV</td>
<td>60</td>
<td>[Diagram showing relationship between $H$ and $\alpha$]</td>
</tr>
</tbody>
</table>

Ref: IEC 62305-3:2010, 5.2.2 + Table 2 + Figure 1, 5.3.3 + Table 4
Down Conductor System
5.3 Down-conductor systems

5.3.1 General

In order to reduce the probability of damage due to lightning current flowing in the LPS, the down-conductors shall be arranged in such a way that from the point of strike to earth:

a) several parallel current paths exist;
b) the length of the current paths is kept to a minimum;
c) equipotential bonding to conducting parts of the structure is performed according to the requirements of 6.2.
Down-conductor systems
Typical preferred distances according to table 4

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Typical distances [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>10</td>
</tr>
<tr>
<td>II</td>
<td>10</td>
</tr>
<tr>
<td>III</td>
<td>15</td>
</tr>
<tr>
<td>IV</td>
<td>20</td>
</tr>
</tbody>
</table>

5.3.3 Positioning for a non-isolated LPS
For each non-isolated LPS:-

- Minimum 2 down-conductors
- Distributed evenly around perimeter where possible
- Installed at exposed corners where possible

Ref.: BS EN 62305-3:2011, Table 4
Isolated Systems
E.5.1.2 Isolated LPS

An LPS that is connected to conductive structural elements and to the equipotential bonding system only at ground level, is defined as isolated.

An isolated LPS is achieved either by installing air-termination rods or masts adjacent to the structure to be protected or by suspending overhead wires between the masts in accordance with the separation distance, section 6.3 (BS EN 62305-3:2011).
Isolated LPS Video

Lightning protection of roof superstructures and observance of the separation distance with HVI® light Conductor
E.5.1.2 Isolated LPS

An isolated external LPS should be used when the flow of the lightning current into bonded internal conductive parts may cause damage to the structure or its contents.

NOTE 1: The use of an isolated LPS may be convenient where it is predicted that changes in the structure may require modifications to the LPS.

D.4 Structures containing solid explosive materials

For structures containing solid explosive materials, an isolated external LPS is encouraged.
Hazardous Area Classification and Control of Ignition Sources

This Technical Measures Document refers to the classification of plant into hazardous areas, and the systematic identification and control of ignition sources.

The relevant Level 2 Criteria are 5.2.1.3(29)x, 5.2.1.11(63)x, 5.2.1.13 and 5.2.4.2(93)a.

Design of plant, pipework and general plant layout is considered in Technical Measures Documents on Plant Layout, Design Codes - Plant, Design Codes - Piping, Plant Modification / Change Procedures, Maintenance Procedures.

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) provide for the first time a specific legal requirement to carry out a hazardous area study, and document the conclusions, in the form of zones.
Elimination of surfaces above auto-ignition temperatures of flammable materials being handled/stored (see above);

- Provision of lightning protection

Correct selection of vehicles/internal combustion engines that have to work in the zoned areas (see Technical Measures Document on Permit to Work Systems);

- Control of maintenance activities that may cause sparks/hot surfaces/naked flames through a Permit to Work System
- Precautions to control the risk from pyrophoric scale, usually associated with formation of iron sulphides inside process equipment
5.4 Specific procedure to evaluate the need of protection

According to EN 62305-1, risks $R_1$, $R_2$ and $R_3$ shall be considered in the evaluation of the need of protection against lightning.

For each risk to be considered the following steps shall be taken:

- identification of the components $R_X$ which make up the risk;
- calculation of the identified risk components $R_X$;

NOTE 2: Where protection against lightning is required by the authority having jurisdiction for structures with a risk of explosion, at least a class II LPS should be adopted. Exceptions to the use of lightning protection level II may be allowed when technically justified and authorized by the authority having jurisdiction. For example, the use of lightning protection level I is allowed in all cases, especially in those cases where the environments or contents within the structure are exceptionally sensitive to the effects of lightning. In addition, authorities having jurisdiction may choose to allow lightning protection level III systems where the infrequency of lightning activity and/or the insensitivity of the contents of the structure warrants it.
Cross Bonding of roof-mounted structures
Partial lightning currents inside the structure

- **FDB**: Floor Distribution Board
- **MEB**: Main Equipotential Bonding
- **EB**: Equipotential Bonding

ventilation/air conditioning system

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Protection of roof-mounted structures with Isolated air-termination system

Lightning current discharged from the outside

FDB: Floor Distribution Board; MEB: Main Equipotential Bonding; EB: Equipotential Bonding
6.3 Electrical insulation of the external LPS

6.3.1 General

Electrical insulation between the air-termination or the down-conductor and the structural metal parts, the metal installations and the internal systems can be achieved by providing a separation distance, s, between the parts. The general equation for the calculation of s is given by:

\[ s = k_i \cdot \frac{k_c}{k_m} \cdot l \]

- \( k_i \) depends on the selected class of LPS (see Table 10);
- \( k_m \) depends on the electrical insulation material (see Table 11);
- \( k_c \) depends on the (partial) lightning current flowing on the air-termination and the down-conductor (see Table 12 and Annex C);
- \( l \) is the length, in metres, along the air-termination and the down-conductor from the point, where the separation distance is to be considered, to the nearest equipotential bonding point or the earth termination (see E.6.3 of Annex E).

NOTE The length l along the air-termination can be disregarded in structures with continuous metal roof acting as natural air-termination system.
Separation distance (s)
Problematic installation of metal conductors

\[ s = k_i \cdot \frac{k_c}{k_m} \cdot l \ [\text{m}] \]

- \( k_i \) = dependent on protection class LPL e. g. LPL III = 0.04
- \( s \) = separation distance
- \( k_c \) = protection factor for conductors
- \( k_m \) = protection factor for metal parts
- \( l \) = length of conductors

Ref.: BS EN 62305-3:2011; Annex E, Figure E.38 modified
Isolation of external LPS
Values of coefficients $k_i$ and $k_m$

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>$k_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.08</td>
</tr>
<tr>
<td>II</td>
<td>0.06</td>
</tr>
<tr>
<td>III and IV</td>
<td>0.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insulating material</th>
<th>$k_m$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>1</td>
</tr>
<tr>
<td>Concrete, bricks</td>
<td>0.5</td>
</tr>
<tr>
<td>DEHNiso</td>
<td>0.7*</td>
</tr>
</tbody>
</table>

*value of DEHNiso determined by DEHN in laboratory tests

NOTE 1 When there are several insulating materials in series, it is a good practice to use the lower value for $k_m$.

NOTE 2 In using other insulating materials, construction guidance and the value of $k_m$ should be provided by the manufacturer.
Isolation of external LPS
Values of coefficient $k_c$

<table>
<thead>
<tr>
<th>Number of down-conductors</th>
<th>$k_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0.66</td>
</tr>
<tr>
<td>3 and more</td>
<td>0.44</td>
</tr>
</tbody>
</table>

* only in case of an isolated LPS

“NOTE  Values of Table 12 apply for all type B earthing arrangements and for type A earthing arrangements, provided that the earth resistance of neighbouring earth electrodes do not differ by more than a factor of 2. If the earth resistances of single earth electrodes differ by more than a factor of 2, $k_c = 1$ is to be assumed.”

Ref.: BS EN 62305-3:2011-10, Table 12

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Earth Termination System
5.4 Earth-termination system

5.4.1 General

When dealing with the dispersion of the lightning current (high frequency behaviour) into the ground, whilst minimizing any potentially dangerous overvoltages, the shape and dimensions of the earth-termination system are the important criteria.

In general, a low earthing resistance (if possible lower than 10 Ω when measured at low frequency) is recommended.

From the viewpoint of lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems).
Earth Electrode arrangements

**Earth Electrode: Arrangement Type A**
Surface Earth Electrode or Deep-Driven Earth Electrode

**Earth Electrode: Arrangement Type B**
Ring Earth Electrode or Foundation Earth Electrode
**Arrangements of earth electrodes as per BS EN 62305-3:2011**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>Vertical earth electrode (earth rod) per down conductor</td>
<td>at least 0.5m* at least 2.5m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>Horizontal (radial) earth electrode per down conductor</td>
<td>at least 0.5 m minimum 5m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ring earth electrode (at least 80% in soil)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foundation earth electrode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector</td>
<td></td>
</tr>
</tbody>
</table>

* Inspection housings can be surface mounted, add 0.5m to length of rod.
The minimum length of each earth electrode at the base of each down-conductor is $L_1$ for horizontal electrodes, or 0.5 $L_1$ for vertical (or inclined) electrodes.

*Minimum lengths may be disregarded once $10\Omega$ is reached.

Ref.: BS EN 62305-3:2011, 5.4.2.1 Figure 3

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Lightning
Equipotential Bonding
Lightning equipotential bonding for incoming lines

- utility (e.g. TN-C)
- telecommunication / DSL
- broadband cable network
- water
- gas
- heating system
- cathodically protected tank pipe

LPS: Lightning Protection System; M: Meter; MEB: Main Earthing Busbar

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3 - BS EN 62305 Physical damage to structure
Lightning equipotential bonding reduces the potential differences caused by the lightning current.

This is achieved by connecting all isolated conductive parts of the installation directly by means of lines in case of passive parts or by surge protective devices in case of active lines.
Installation examples
Isolated systems
Hazardous area:-
DEHNconductor system (HVI®)
Isolated air-termination system with DEHNconductor system (total view)
Isolated System Components
Self-supporting air-termination rods

Self-supporting air-termination rod

- Tripod for protecting roof-mounted structures
- Adaptation to the roof pitch up to max. 10°
- For wind load zone II + III
- Heights from 2.5 m to 14 m
Telescopic Lightning Protection masts with screw-in foundation

**Telescopic lightning protection mast**

- Protection against direct lightning strikes
- For special systems, such as
  - Biogas plants
  - Ground-mounted PV systems
- Installed in a screw-in foundation
- No excavation or foundation work required
- Heights from 6 m to 11 m
## Technical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent separation distance</td>
<td>s ≤ 0.75 m (air)</td>
</tr>
<tr>
<td></td>
<td>s ≤ 1.50 m (solid material)</td>
</tr>
<tr>
<td>Length</td>
<td>100 m</td>
</tr>
<tr>
<td>Material of the conductor</td>
<td>Cu</td>
</tr>
<tr>
<td>Cross section of the core</td>
<td>19 mm²</td>
</tr>
<tr>
<td>Part No.</td>
<td>819 135 819 136</td>
</tr>
<tr>
<td>Conductor type</td>
<td>black  grey</td>
</tr>
<tr>
<td>Outer diameter of the conductor</td>
<td>20 mm  23 mm</td>
</tr>
</tbody>
</table>

- On-site assembly
- Drum dimensions: approx. Ø 800 x 485 mm
Isolated down-conductor

Installation of the distance holder

Ref.: Wettingfeld GmbH + Co.KG, Krefeld

HVI® installation on the facade
Component Test Standards
BS EN 62561-x standard series
Lightning protection system components

Part 1: Connection components
Part 2: Conductors and earth electrodes
Part 3: Isolating spark gaps
Part 4: Conductor fasteners
Part 5: Earth electrode inspection housings
Part 6: Lightning strike counters
Part 7: Earthing enhancing compounds
Part 8: Components for isolated LPS (out for public comment)

BRITISH STANDARD

Lightning Protection Components (LPC) —

Part 2: Requirements for conductors and earth electrodes
Manufacturer’s test reports for connecting components as per EN 50164-1

Symbol in the main catalogue: DEHN tested

Manufacturer’s test reports can be downloaded at www.dehn-international.com
Thank you for your attention