BS EN 62305-3:2011

Part 3: Physical damage and life hazard

External Lightning Protection

Lightning strike to an agricultural building

Ref.: OÖ-Blitzschutzgesellschaft

Functions of a Lightning Protection System

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

BS EN 62305-3:2011
Air Termination systems

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:

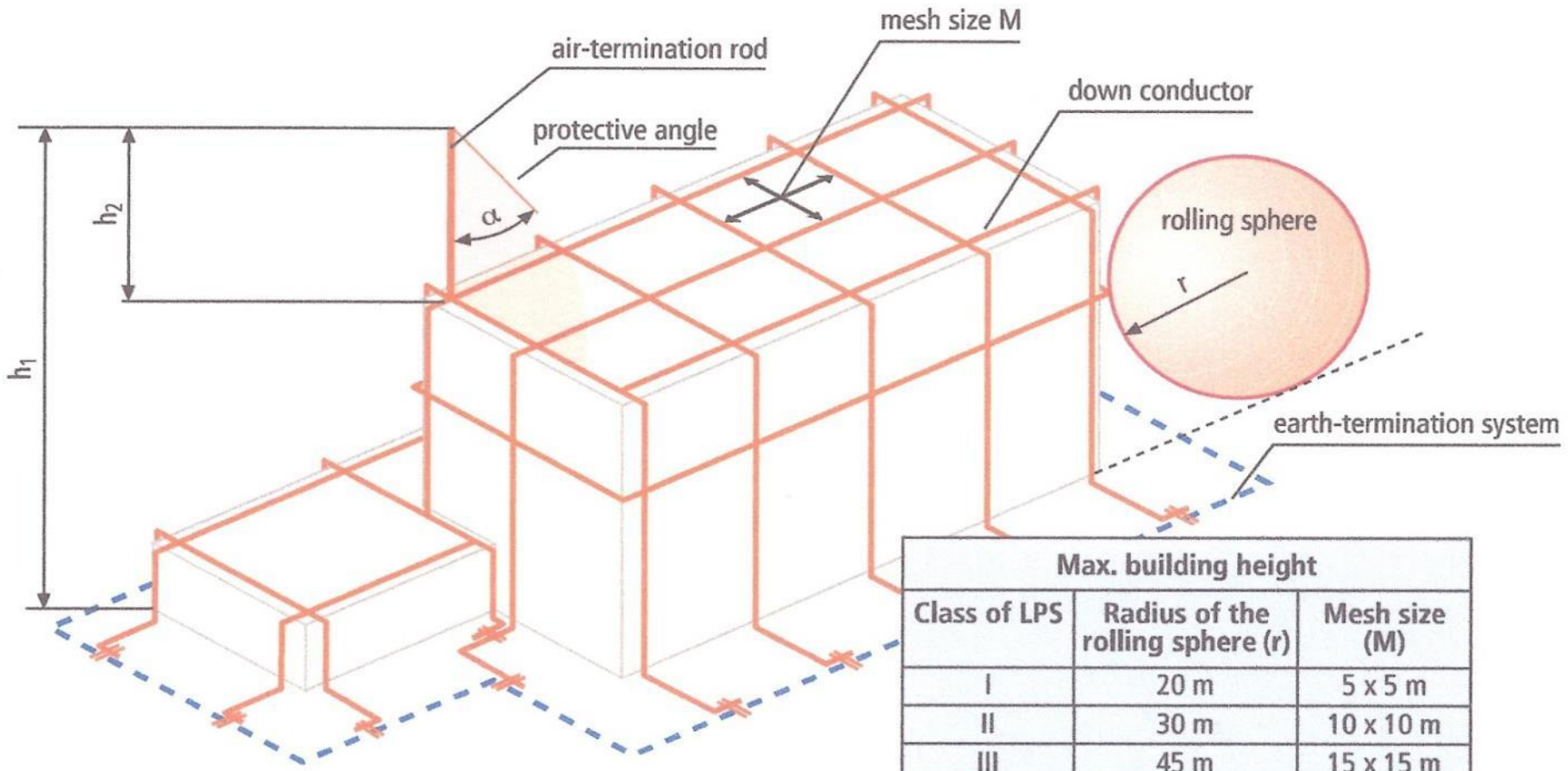
- the protective angle method;
- the rolling sphere method;
- the mesh method.

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.

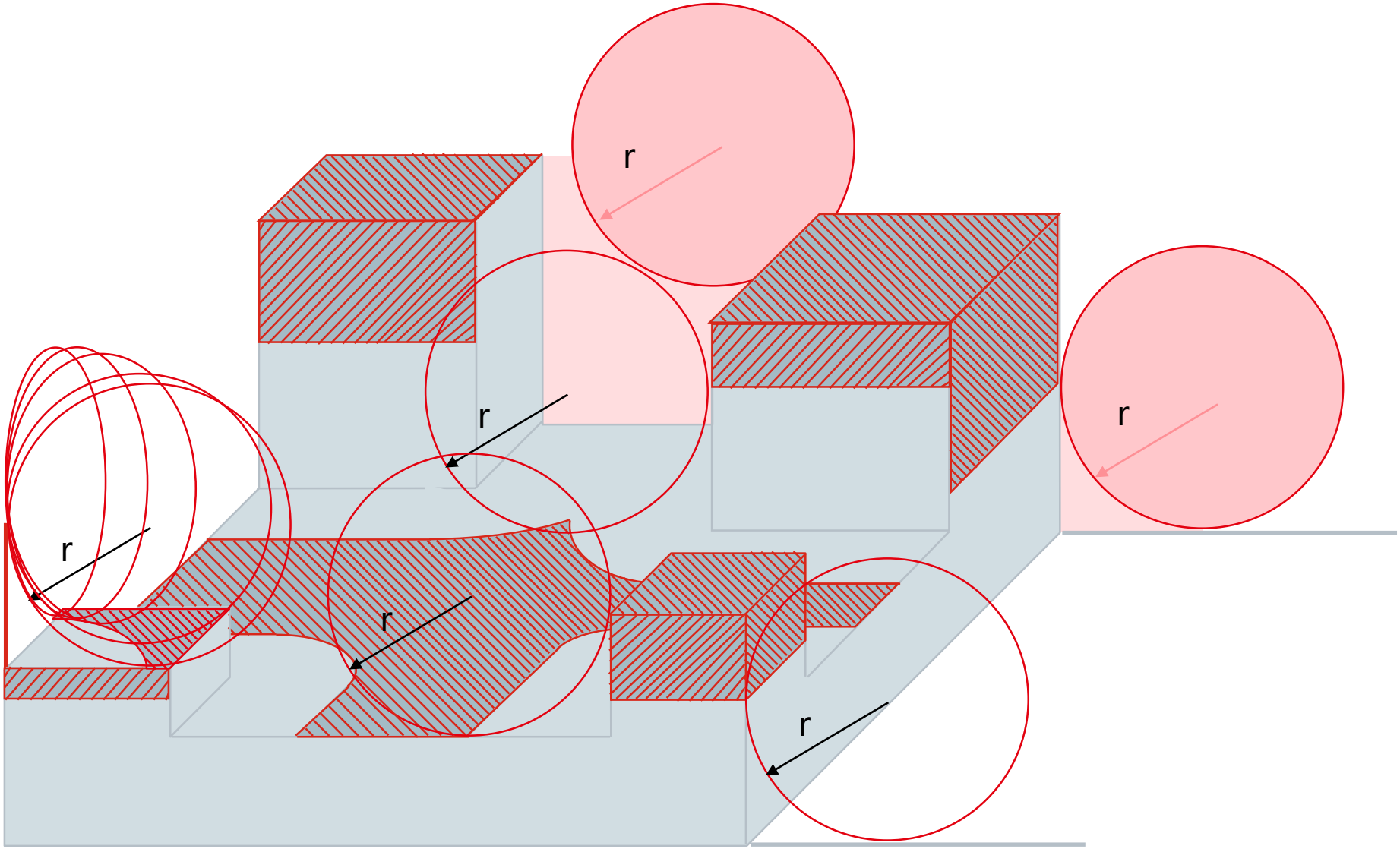
The mesh method is a suitable form of protection where plane surfaces are to be protected.

Design methods of air-termination systems

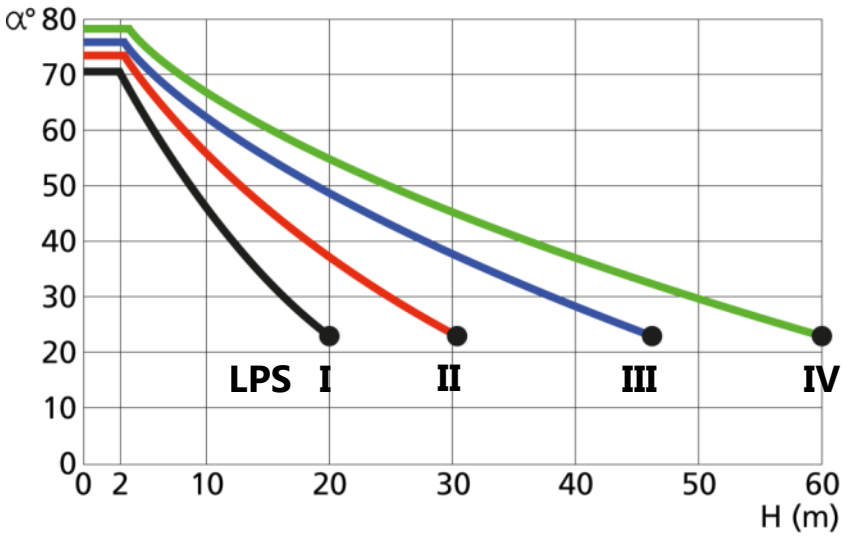


Max. building height		
Class of LPS	Radius of the rolling sphere (r)	Mesh size (M)
I	20 m	5 x 5 m
II	30 m	10 x 10 m
III	45 m	15 x 15 m
IV	60 m	20 x 20 m

Rolling sphere principle



Rolling sphere radius, protection angle, mesh size and typical preferred distances between down conductors

Class of LPS	Protection method			Typical distances (m)
	Rolling sphere radius r (m)	Protection angle α (°)	Mesh size w (m)	
I	20		5 x 5	10
II	30		10 x 10	10
III	45		15 x 15	15
IV	60		20 x 20	20

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

Class of LPS	Typical distances [m]
I	10
II	10
III	15
IV	20

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

Isolated LPS Definition
BS EN 62305-3:2011, Annex E

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

Isolated LPS references
BS EN 62305-3:2011

E.5.1.2 Isolated LPS

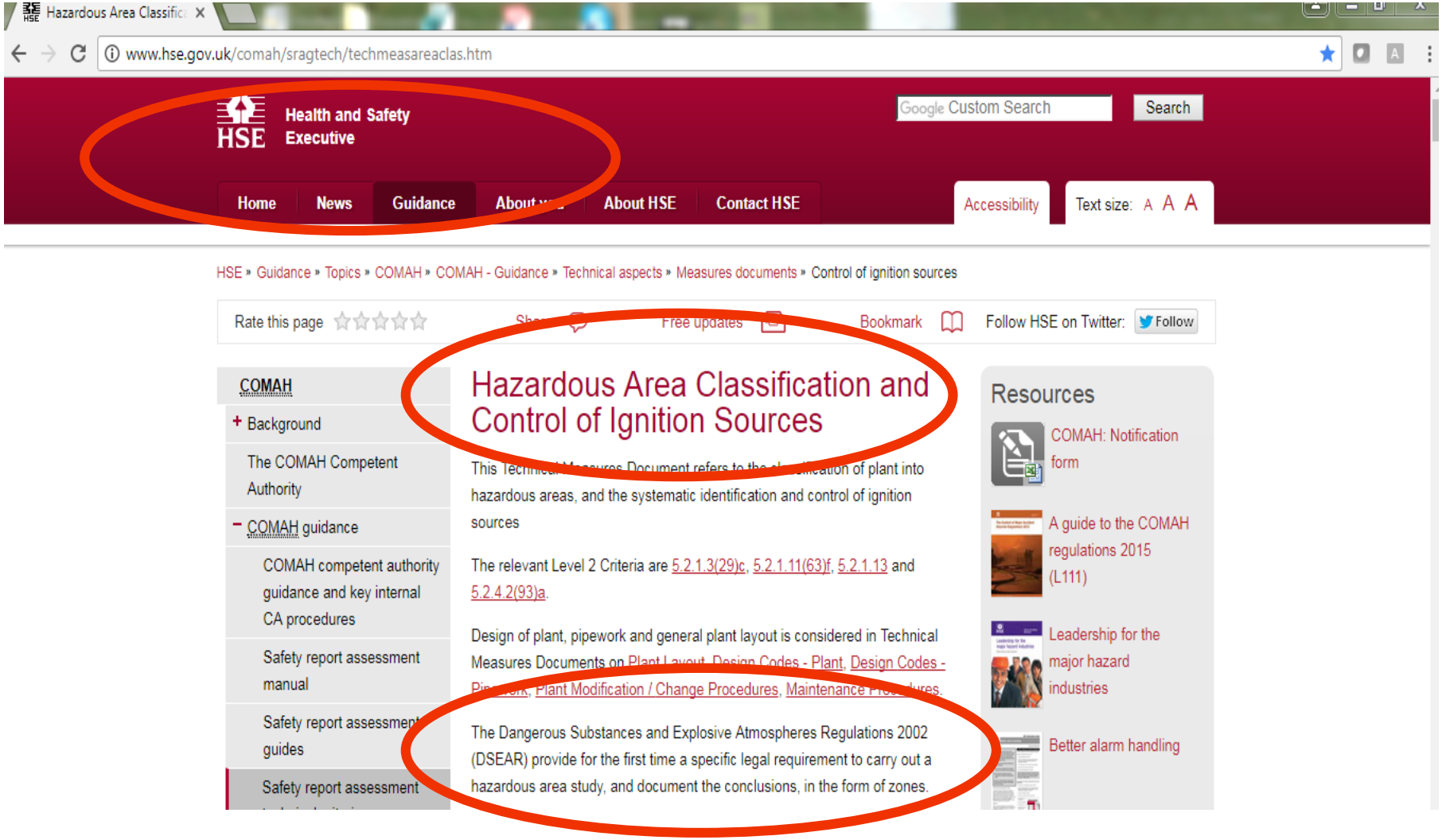
An isolated external LPS should be used when the flow of the lightning current into bonded internal conductive parts may cause damage to the structure or its contents.

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.

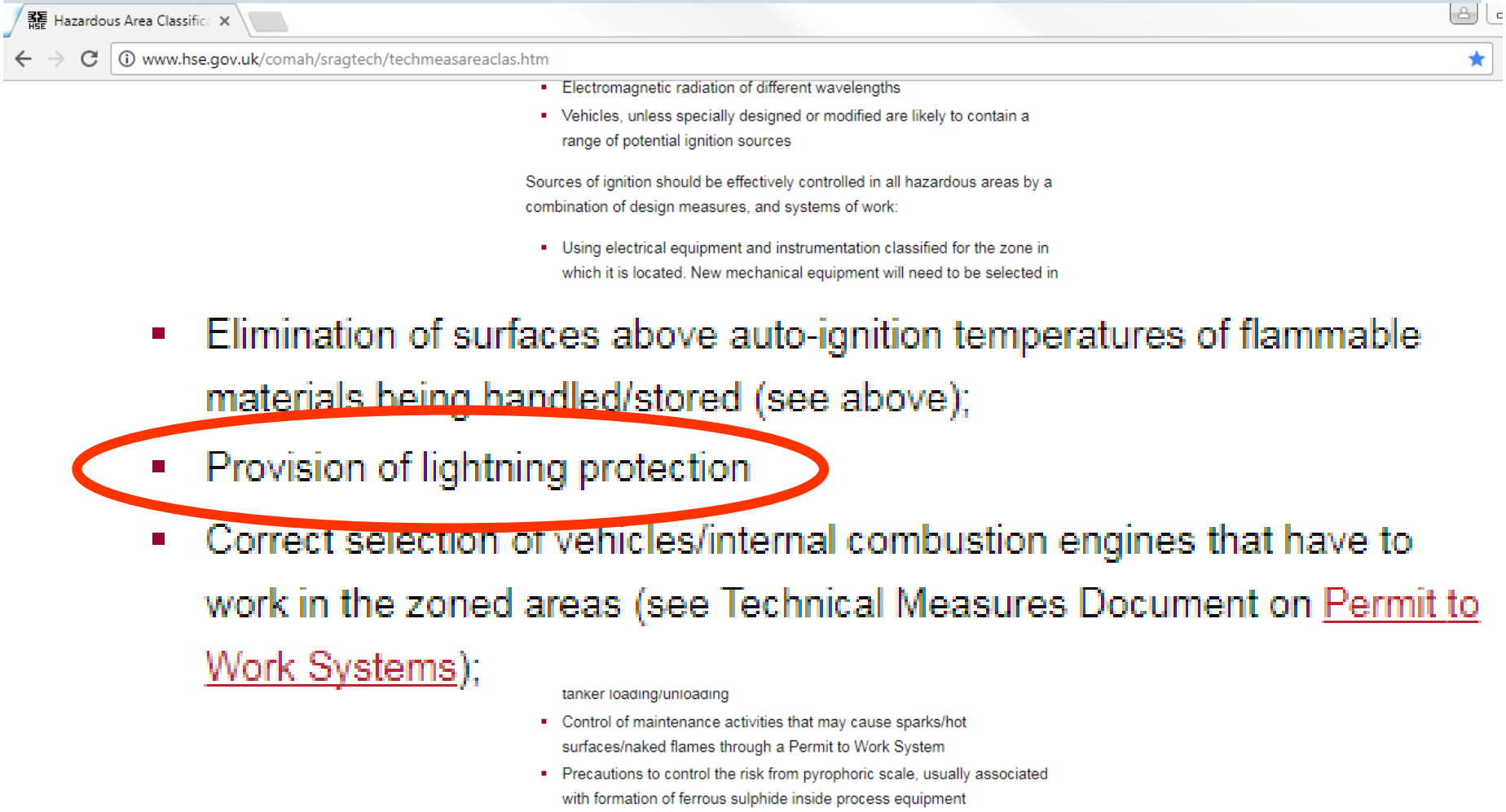
D.4 Structures containing solid explosive materials

For structures containing solid explosive materials, an isolated external LPS is encouraged.

DSEAR & LPS



DSEAR & LPS



DSEAR & LPS

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:

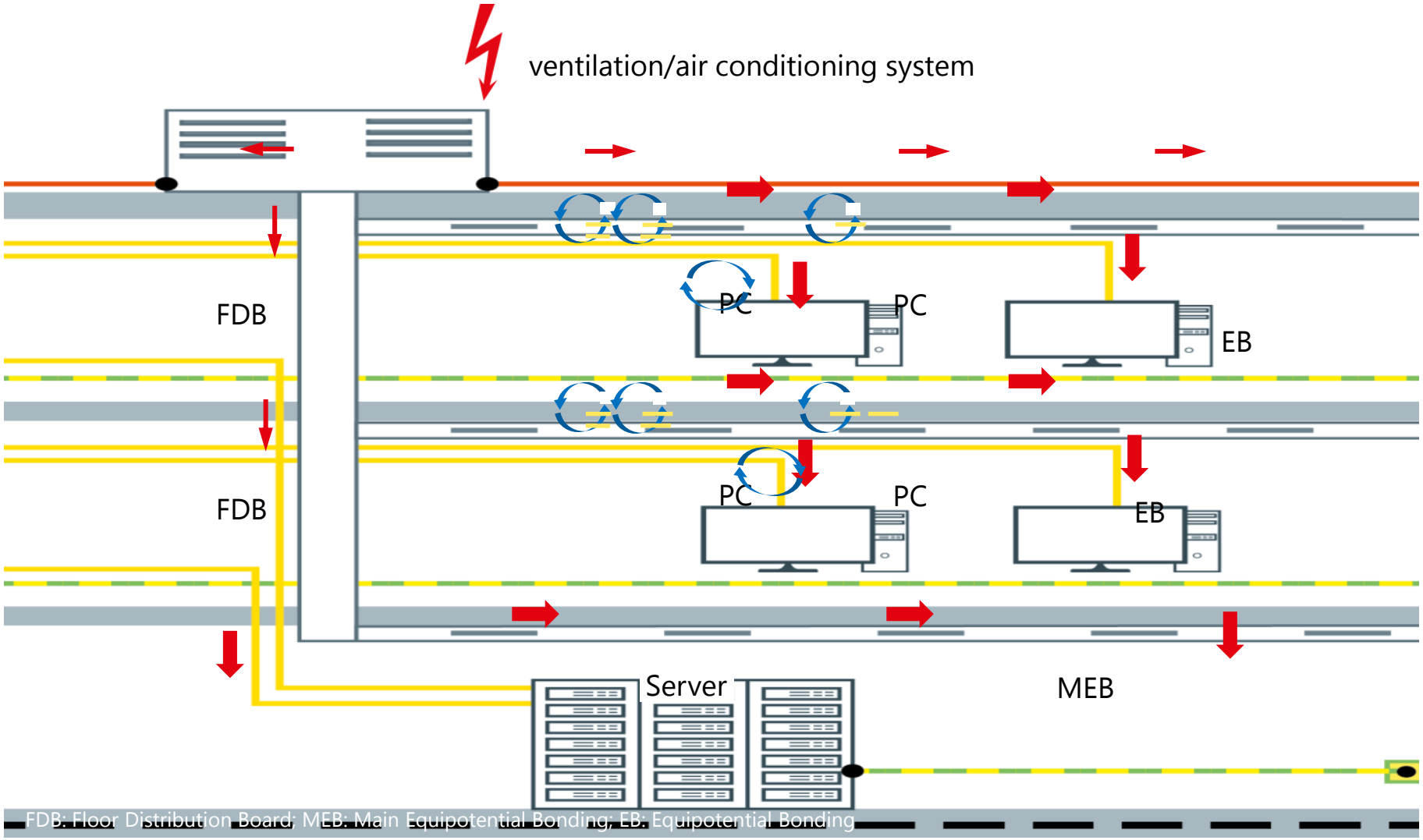
- identification of the components R_X which make up the risk;
- calculation of the identified risk components R_X;

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.

– 23 – EN 62305-2:2012

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.

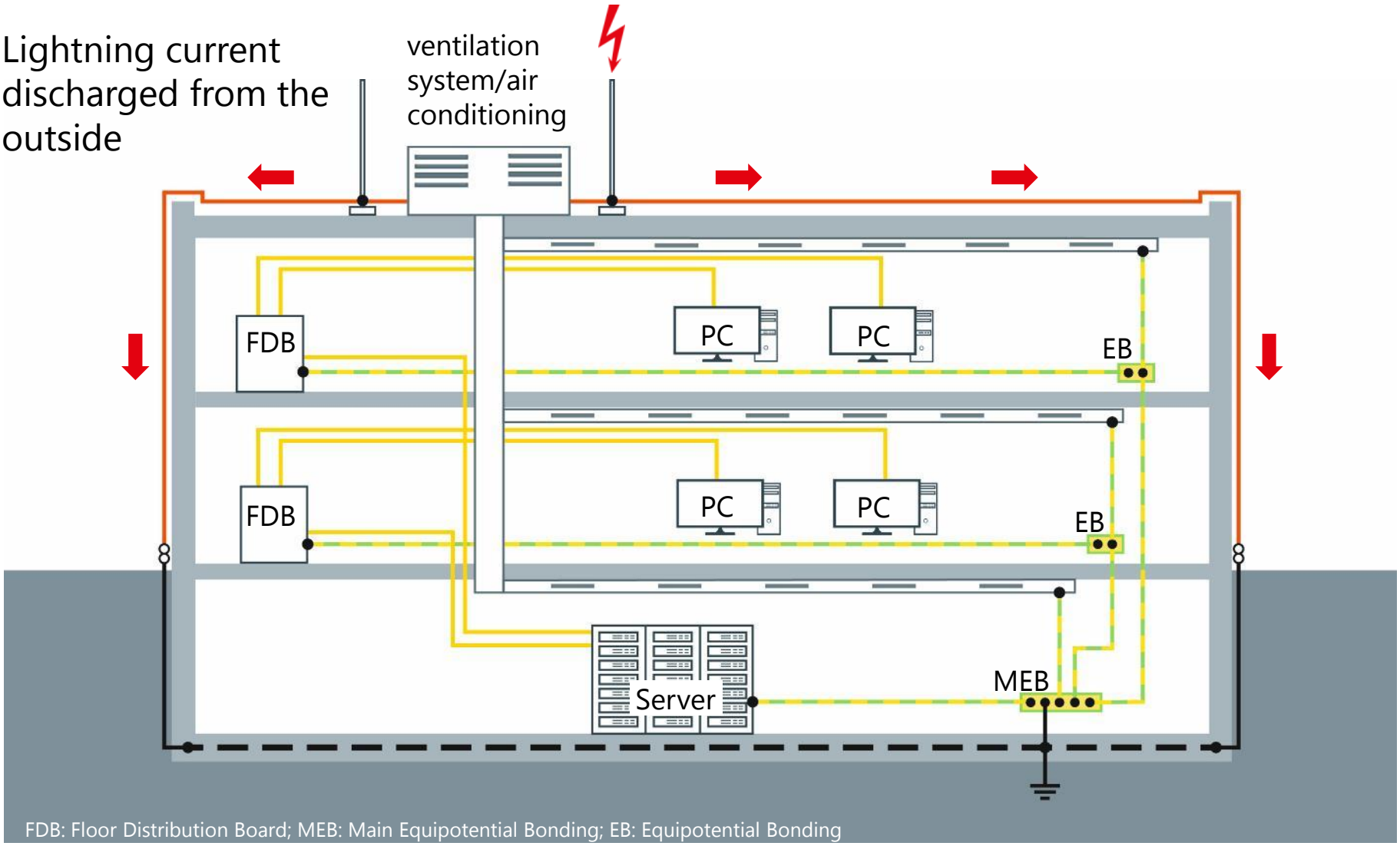
Cross Bonding of roof-mounted structures
Partial lightning currents inside the structure



FDB: Floor Distribution Board; MEB: Main Equipotential Bonding; EB: Equipotential Bonding

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:

$$s = k_i \cdot \frac{k_c}{k_m} \cdot l$$

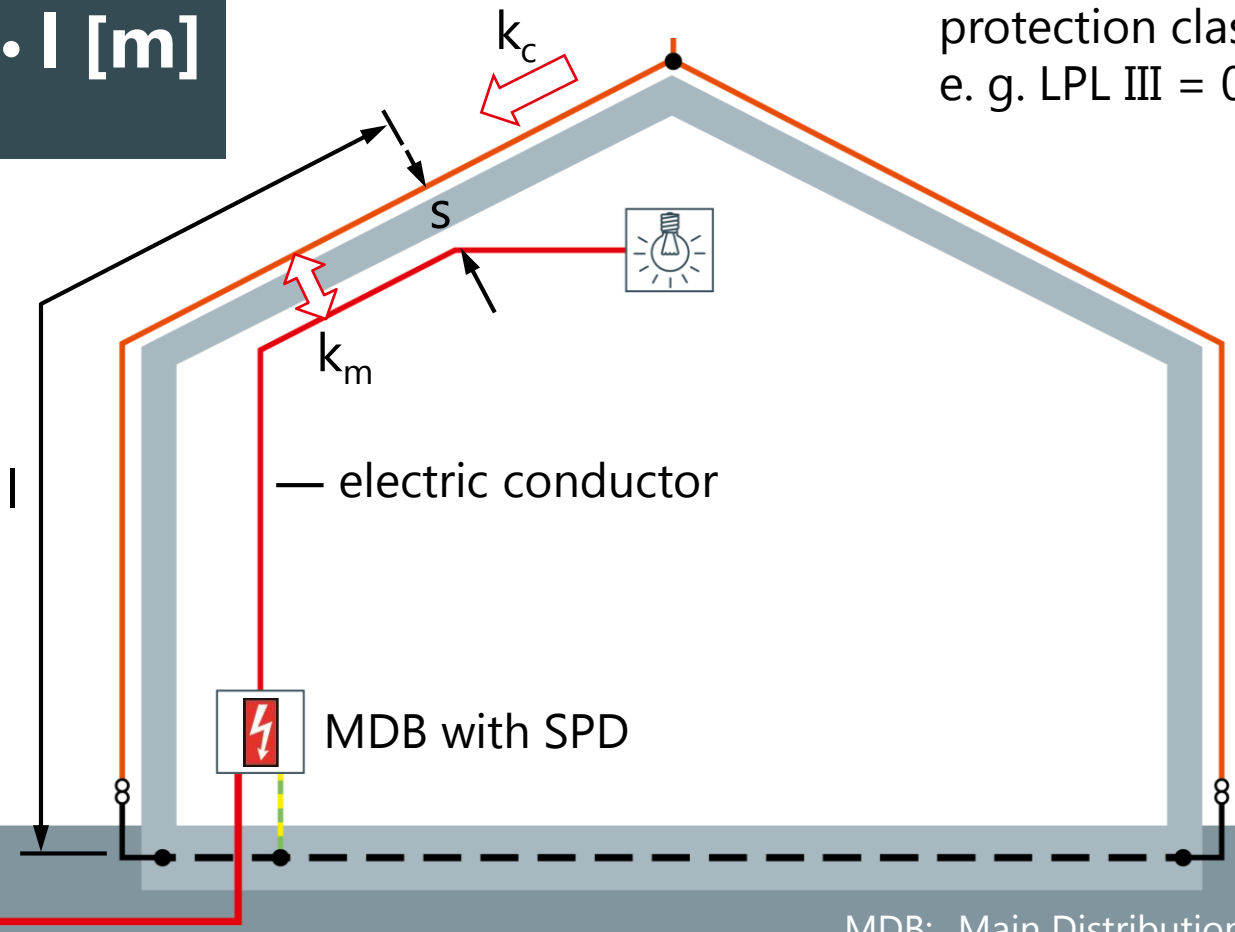
- k_i depends on the selected class of LPS (see Table 10);
- k_m depends on the electrical insulation material (see Table 11);
- k_c depends on the (partial) lightning current flowing on the air-termination and the down-conductor (see Table 12 and Annex C);
- l is the length, in metres, along the air-termination 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

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

k_i=dependent on protection class LPL
e. g. LPL III = 0.04



MDB: Main Distribution Board
SPD: Surge Protective Device

Ref.: BS EN 62305-3:2011; Annex E, Figure E.38 modified

Isolation of external LPS
Values of coefficients k_i and k_m

Class of LPS	k_i
I	0.08
II	0.06
III and IV	0.04

Insulating material	k_m
Air	1
Concrete, bricks	0.5
DEHNiso	0.7*

*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.

Ref.: BS EN 62305-3:2011-10,Table 10/11

Isolation of external LPS
Values of coefficient k_c

Number of down-conductors	k_c
1*	1
2	0.66
3 and more	0.44

* 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

Earth Termination Sytem

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

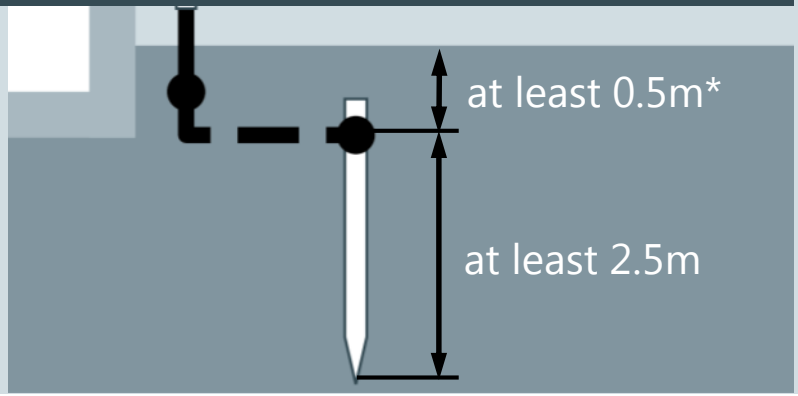
Earth Electrode: Arrangement Type B

Ring Earth Electrode or Foundation Earth Electrode

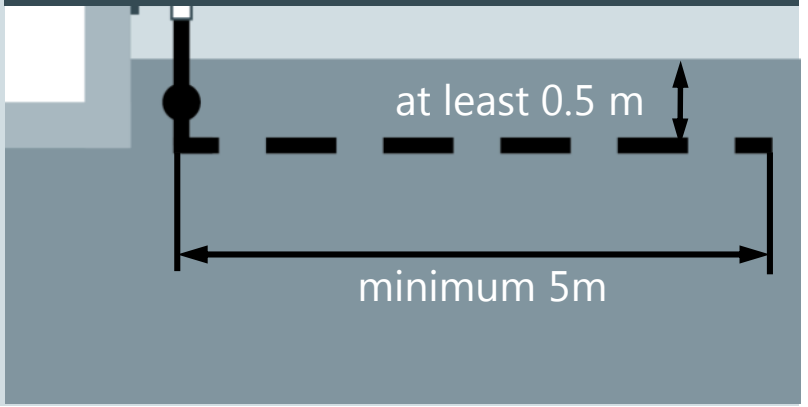
Arrangements of earth electrodes as per BS EN 62305-3:2011

type A

Vertical earth electrode (earth rod) per down conductor



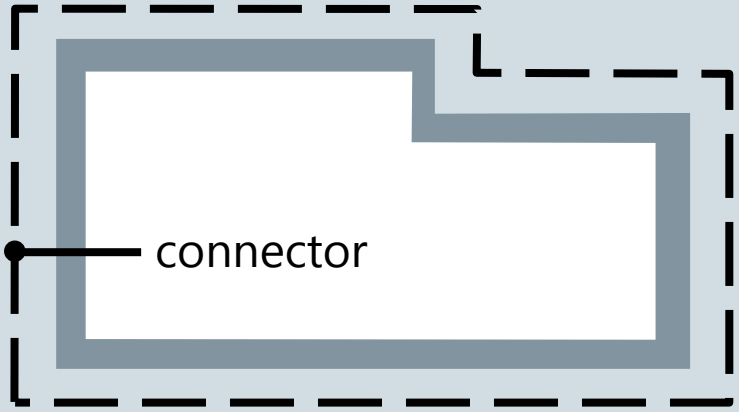
Horizontal (radial) earth electrode per down conductor



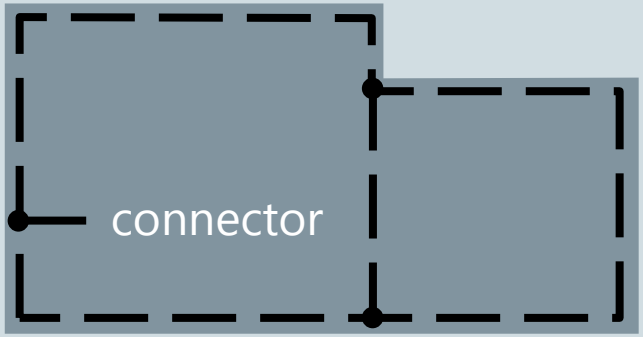
* Inspection housings can be surface mounted, add 0.5m to length of rod.

type B

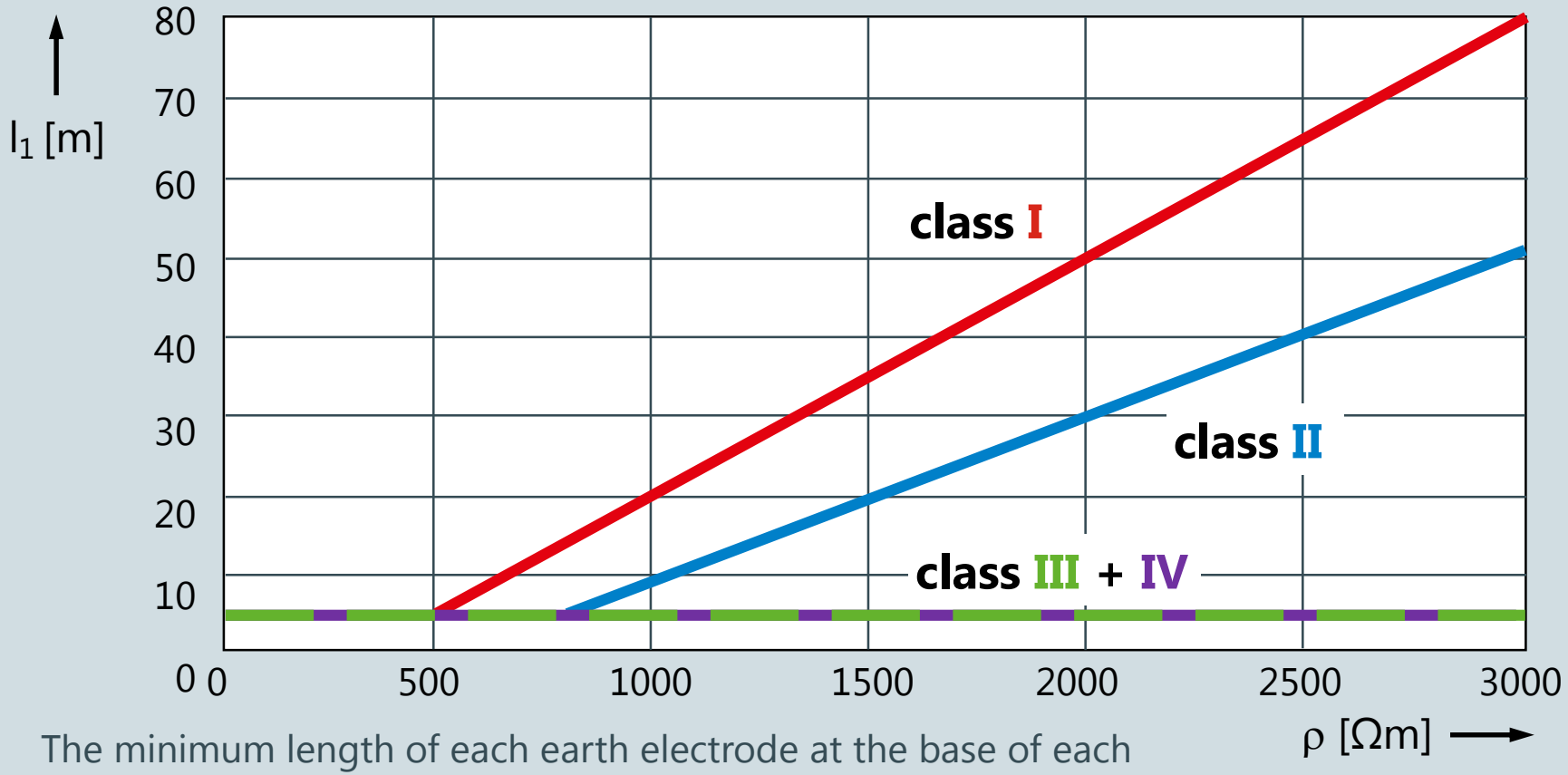
Ring earth electrode (at least 80% in soil)



Foundation earth electrode



Minimum length of each earth electrode according to the class of LPS

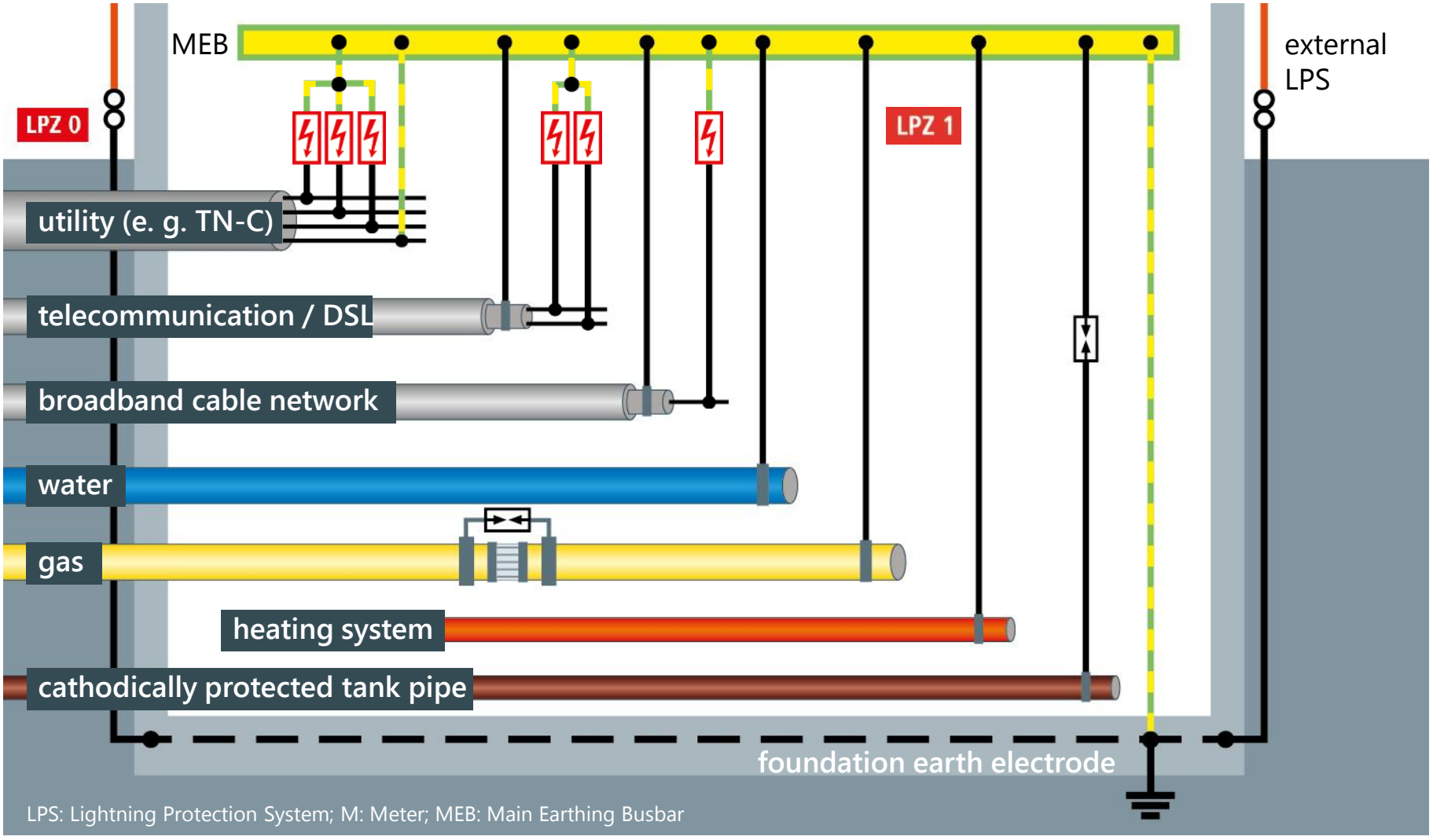


The minimum length of each earth electrode at the base of each down-conductor is L_1 for horizontal electrodes, or 0.5 l_1 for vertical (or inclined) electrodes.
*Minimum lengths may be disregarded once 10Ω is reached.

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

Lightning Equipotential Bonding

Lightning equipotential bonding for incoming lines

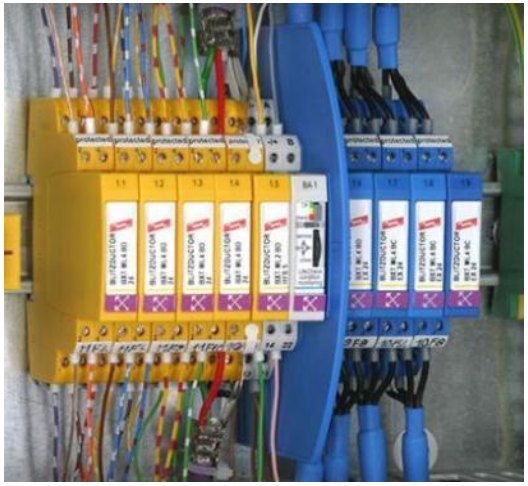


LPS: Lightning Protection System; M: Meter; MEB: Main Earthing Busbar

External Lightning Protection System
Lightning equipotential bonding

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®)

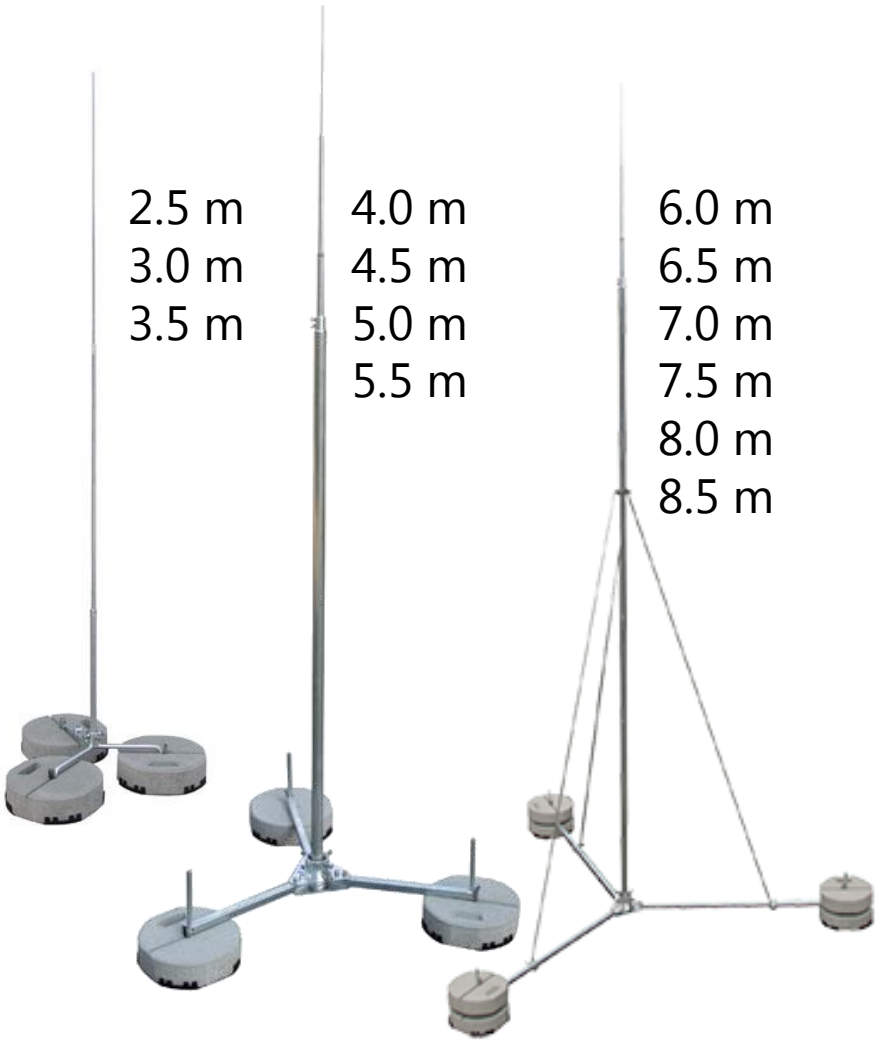
Isolated air-termination system with DEHNconductor system (total view)

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

HVI®long Conductor

Technical data		
Equivalent separation distance	s ≤ 0.75 m (air) s ≤ 1.50 m (solid material)	
Length	100 m	
Material of the conductor	Cu	
Cross section of the core	19 mm²	
Part No.	**819 135**	**819 136**
Conductor type	black	grey
Outer diameter of the conductor	20 mm	23 mm

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

HVI®long Conductor

HVI®power Conductor

HVI®light Conductor

HVI®long Conductor

HVI®power Conductor

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

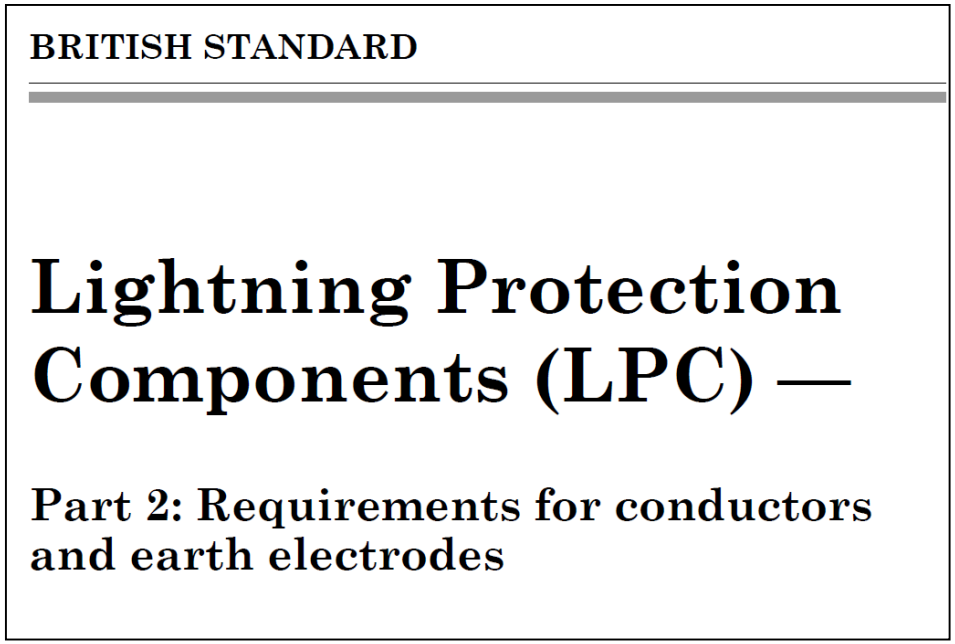
Part 4: Conductor fasteners

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

Clamps

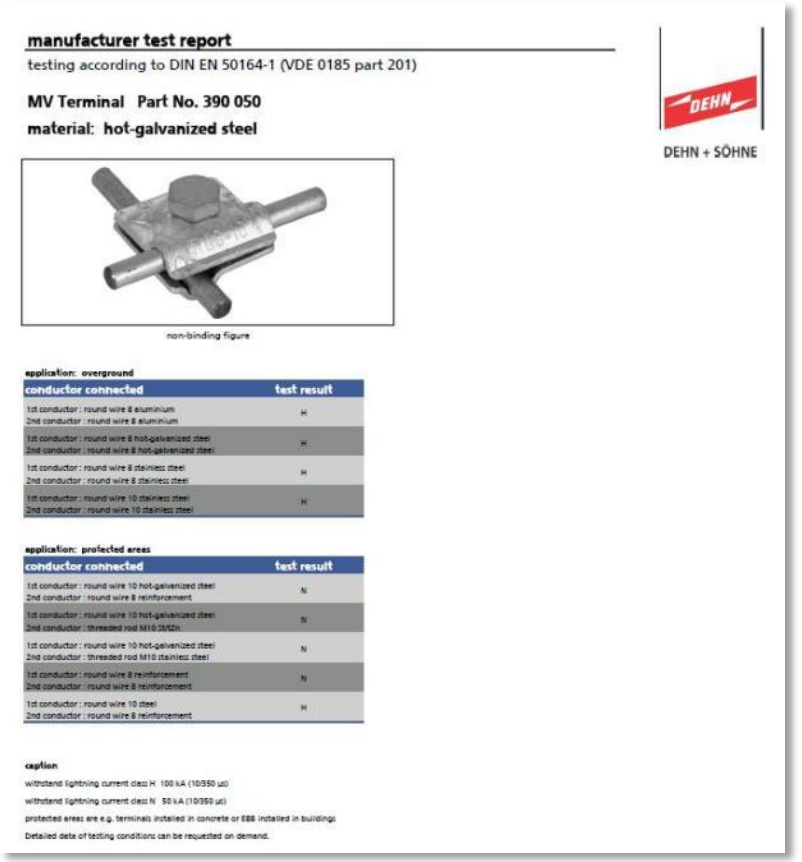
MV Clamps

Multipurpose connecting clamp for universal use as a cross clamp, T clamp and parallel clamp; two-part

With hexagon screw

Thread in the base part

Part No.	390 050	390 051	390 059	390 057	391 050	391 059	390 079
Material of clamp	St/tZn	Al	StSt	Cu	St/tZn	StSt	StSt (V4A)
Clamping range Rd	8-10 mm	8-10 mm	8-10 mm	8 mm	10 mm	10 mm	8-10 mm
Material thickness (t1)	2.5 mm	3.0 mm	2.5 mm	3.0 mm	2.5 mm	2.5 mm	2.5 mm
Screw	M10x30 mm	M10x30 mm	M10x30 mm	M10x30 mm	M10x35 mm	M10x35 mm	M10x35 mm
Material of screw/nut	St/tZn	StSt	StSt	StSt	St/tZn	StSt	StSt (V4A)



manufacturer test report

testing according to DIN EN 50164-1 (VDE 0185 part 201)

MV Terminal Part No. 390 050

material: hot-galvanized steel

DEHN + SÖHNE

non-binding figure

application: overground

conductor connected	test result
1st conductor : round wire 8 aluminium 2nd conductor : round wire 8 aluminium	H
1st conductor : round wire 8 hot-galvanized steel 2nd conductor : round wire 8 hot-galvanized steel	H
1st conductor : round wire 8 stainless steel 2nd conductor : round wire 8 stainless steel	H
1st conductor : round wire 10 stainless steel 2nd conductor : round wire 10 stainless steel	H

application: protected areas

conductor connected	test result
1st conductor : round wire 10 hot-galvanized steel 2nd conductor : round wire 8 reinforcement	N
1st conductor : round wire 10 hot-galvanized steel 2nd conductor : threaded rod M10 St/tZn	N
1st conductor : round wire 10 hot-galvanized steel 2nd conductor : threaded rod M10 stainless steel	N
1st conductor : round wire 8 reinforcement 2nd conductor : round wire 8 reinforcement	N
1st conductor : round wire 10 steel 2nd conductor : round wire 8 reinforcement	H

caption

withstand lightning current class H 100 kA (10/350 µs)

withstand lightning current class N 50 kA (10/350 µs)

protected areas are e.g. terminals installed in concrete or EBB installed in buildings

Detailed data of testing conditions can be requested on demand.

Manufacturer's test reports can be downloaded at www.dehn-international.com

Thank you for your attention