– the protection level U_P lower than the impulse withstand level of insulation between parts.

If protection against surges of internal systems connected to lines entering the structure is required, a coordinated SPD system conforming to the requirements of Clause 7 of IEC 62305-4:2010 shall be used.

NOTE When equipotential bonding is required, but an LPS is not required, the earth-termination of the low-voltage electrical installation can be used for this purpose. IEC 62305-2 provides information on the conditions where an LPS is not required.

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:

$$s = \frac{k_i}{k_m} \times k_c \times l \quad \text{(m)} \tag{4}$$

where

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.

Table 10 – Isolation of external LPS – Values of coefficient k_i

Class of LPS	k_i
I	0,08
II	0,06
III and IV	0,04

Table 11 – Isolation of external LPS – Values of coefficient k_m

Material	k_m
Air	1
Concrete, bricks, wood	0,5
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.	

In the case of the lines or external conductive parts entering the structure, it is always necessary to ensure lightning equipotential bonding (by direct connection or connection by SPD) at their point of entry into the structure.

In structures with metallic or electrically continuous connected reinforced concrete framework a separation distance is not required.

The coefficient k_c of the lightning current amongst the air-terminations/down-conductors depends on the class of LPS, on the overall number *n,* on the position of the down-conductors, on the interconnecting ring conductors and on the type of earth-termination system. The necessary separation distance depends on the voltage drop of the shortest path from the point where the separation distance is to be considered, to the ground electrode or the nearest equipotential bonding point.

6.3.2 Simplified approach

In typical structures for the application of Equation (4), the following conditions have to be considered:

k_c depends on the (partial) lightning current flowing on the down-conductor arrangement (see Table 12 and Annex C);

l is the vertical length, in metres, along the down-conductor, from the point where the separation distance is to be considered, to the nearest equipotential bonding point.

Table 12 – Isolation of external LPS – Approximated values of coefficient k_c

Number of down-conductors *n*	k_c
1 (only in case of an isolated LPS)	1
2	0,66
3 and more	0,44
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.	

Further information on partitioning of the lightning current amongst down-conductors is given in Annex C.

NOTE The simplified approach usually leads to results being on the safe side.

6.3.3 Detailed approach

In an LPS with a meshed air-termination system or interconnected ring conductors, the air-terminations or down-conductors have different values of current flowing down their lengths due to current division. In these cases a more accurate evaluation of the separation distance *s* may be performed by the following relationship:

$$s = \frac{k_i}{k_m} \times (k_{c1} \times l_1 + k_{c2} \times l_2 + \ldots + k_{cn} \times l_n) \quad (5)$$

When the air-terminations or down-conductors have different values of current flowing down their lengths due to interconnecting ring conductors, Figures C.4 and C.5 apply.

NOTE 1 This approach is suitable for evaluation of the separation distance in very large structures or in structures with complex shape.

NOTE 2 For the calculation of the coefficients, k_c on the individual conductors numerical network programs may be used.