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Separation from lightning conductors

The Rev Christopher Miles C Eng. FIET takes us through some important points on the requirements of providing separation from lightning conductors.

Because of the complexity of the requirements it is not possible to include full detail here. For more detailed information see the main Standard, BS EN 62305 *Protection against Lightning*. This article, therefore, aims to provide an insight into the separation requirement.

A lightning protection system and a mains electrical system are both concerned with the conduction of electricity. However, they deal with very different parameters. Lightning protection is concerned with very fast rising impulses and very high currents arising from:

- a direct lightning strike to a structure;
- a strike in the vicinity of the structure;
- a direct strike to a service cable supplying the structure; or
- a strike in the vicinity of a supply cable (for example, power supply, telephone, data and radio frequency signals).

Lightning protection is designed to protect:

- the structure;
- its environment;
- equipment in and on the structure; and
- people in, and in the immediate vicinity of, the structure.

On the other hand, a mains power system is designed to provide a constant supply of electricity, usually of alternating current, at a very low frequency and comparatively low voltage, to energise the equipment that provides services to the building.

There is, inevitably, a relationship between the two very different systems, and it is important that the two systems are co-ordinated in a safe manner. Surge protective devices (SPDs) are fitted into the mains system at the intake point, the service point and various other downstream points. SPDs are supported by screening and local bonding and are used to protect both the building from fire caused by sparking and to protect electrical and electronic systems from damaging surges. The two systems are bonded, at least at a low level, to bring them to a common potential at that level. Adequate separation, or separate bonding, should be provided at other levels to minimise the risk of flashover.

Many electricians are unaware that there is a requirement to provide adequate separation between conductors of a lightning protection system and other conducting material, such as electrical wiring. BS EN 62305 contains a simplified method for a formula, which takes into account:

- the number of down conductors on the building;
- the distance along the down conductor from the point where separation is being considered, to the point of connection of the cable that is bonding the lightning protection system to the main earth terminal point;
- the class of the lightning protection system (LPS); and
- the insulation value of the material (air, stone etc.) between the down conductor and the other conducting material being considered.

It is easy to assume that, because the lightning protection system is bonded to the main earth terminal (MET), there is no problem; everything is at the same potential. However, this assumption ignores the self-inductance of the down conductor (about 1 µH/m) and the very high rate of rise of current (perhaps 20 kA/µsec or even up to 100 kA/µsec). Thus, at a height of 10 m above the bonding point there may be a voltage difference of 200 kV, or even 1 MV, between the LPS and the building wiring, gas pipe, water pipe, telephone cable etc.

I have come across many installations where a TV aerial and its cabling, a telephone cable, wiring for external lamps etc., have been installed, probably for the sake of neatness, beside the lightning down conductor. In such installations, there is a very real possibility of sparking between the LPS and other conducting material during a direct lightning strike if neither the separation requirement is met, nor bonding at that point is applied. The separation requirement is particularly pertinent for buildings that have lightning protection with external conductors, rather than a system using the steel construction, or rebars in reinforced concrete, as down conductors where the lightning current is split into many conducting paths.

As an example, consider the lamp and its cabling on a church tower roof in the photograph below. At its closest point the cable has been routed neatly alongside the lightning ring conductor connecting the tower down conductors.

The formula for the simplified approach is:

$$s = (k_i \cdot k_c \cdot l) / k_m$$

where:

s = minimum separation required.

k_i relates to the class of LPS, 0.04 for LPS classes III and IV, 0.06 for Class II and 0.08 for Class I. Here k_j = 0.04 for a class IV LPS.

k_c relates to the number of down conductors.

k_c = 1 for *n = 1,* k_c = 0.5 for *n = 2* and k_c = 0.44 for *n* ≥ *3* with a Type A earthing system, provided the earth resistances are reasonably equal, no more than 2:1, otherwise k_c = 1. Here with 4 down conductors k_c = 0.44

k_m relates to the insulation value of the separating material, air = 1, stone, bricks and concrete = 0.5. Here k_m = 0.5 as it is over stone which is not as good an insulator as air.

l is the down conductor length to the bonding point. Here *l* = 18 m.

As a result, the separation required is given by:

s = (0.04 x 0.44 x 18)/0.5 = 0.63 m

(IEC 62305-3 *Protection against lightning Part 3 Physical damage to structures and life hazard* - clause 6.3).

As another example, consider a church with a broadband relay on the roof of a church tower, as shown in the above photograph.

Features to notice in this installation are:

(a) In the bottom left hand corner of the photograph the broadband supporting structure, correctly, is bonded to the lightning ring conductor around the inside of the parapet.
(b) The antenna feed cable is lying on the lead covering of the tower roof. Although not shown in the photograph the lead, correctly, is bonded to the lightning conductors.
(c) Across the middle of the photograph, the antenna feed cable has been routed along the lightning ring conductor.

During a lightning strike there would be a large voltage between the frame of the antenna and the antenna live feed. At present, the church has two down conductors, on opposite faces of the tower, with neither conductor bonded to the MET. The separation requirement is certainly not being met in this case. Although the requirement is difficult to meet for this installation, one solution is to fit a combined Type 1 and Type 2 SPD between the live feed and the shield (assuming that the shield is bonded to the frame). The SPD could be fitted at the amplifier, situated just inside the stair turret. It would still be good practice to separate the antenna feed from the lightning ring conductor by, for example, 250 mm.

Surge protective devices – especially relating to power circuits

A Type 1 SPD is designed to take partial lightning currents with the energy of a 10/350 μs waveform, and to protect both the structure from fire arising from sparking and people from electric shock.

A Type 2 SPD, connected downstream of a Type 1 SPD, is designed to handle surges with an 8/20 μs waveform and to protect electrical and electronic equipment against damaging surges.

In summary:

- at a low level, for example, up to 10 m height, a separation of 0.5 m should be quite adequate.
- in general, seek advice from a lightning protection specialist.
- avoid the neat but possibly dangerous practice of tying cables to a lightning conductor.

This article gives a basic overview of the simple approach to the requirements. For more details see BS EN 62305.