

Lightning & Transient Overvoltage Protection - 127

Structural Lightning Protection

BS EN 62305:2011 (Protection against lightning) clearly advises strict adherence to the provision of a conventional (or Faraday Cage) lightning protection system (LPS).

External Lightning Protection System (LPS)

An external LPS is termed:

- 'Isolated' - typically a catenary system suspended over the structure
- 'Non-isolated' - typically a mesh system located directly on the roof of the structure

An external LPS consists of:

- Air termination system
- Down conductors
- Earth termination system

These individual elements of an LPS should be connected together using appropriate lightning protection components (LPC) complying with the BS EN 50164 series of standards. This will ensure that in the event of a lightning current discharge to the structure, the correct design and choice of components will minimize any potential damage.

Internal Lightning Protection System

The fundamental role of the internal LPS is to ensure the avoidance of dangerous sparking occurring within the structure to be protected. This could be due, following a lightning discharge, to lightning current flowing in the external LPS or indeed other conductive parts of the structure and attempting to flash or spark over to internal metallic installations.

Carrying out appropriate equipotential bonding measures or ensuring there is a sufficient electrical insulation distance between the metallic parts can avoid dangerous sparking between different metallic parts.

Lightning Equipotential Bonding

Equipotential bonding is simply the electrical interconnection of all appropriate metallic installations/parts, such that in the event of lightning currents flowing, no metallic part is at a different voltage potential with respect to one another. If the metallic parts are essentially at the same potential then the risk of sparking or flash over is nullified.

This electrical interconnection can be achieved by natural/fortuitous bonding or by using specific bonding conductors. In accordance with BS EN 62305, the use of lightning current/equipotential bonding surge protection devices (SPDs) is required where the direct connection with bonding conductors is not suitable - for example metallic power and telecommunication lines.

Classes of LPS

There are four classes of LPS (I, II, III, IV) which have corresponding mesh conductor sizes, down conductor spacings and where appropriate different rolling sphere radii.

Down Conductors

The down conductor spacings range from 10 m for a class I LPS up to 20 m for a class IV LPS.

BS EN 62305 permits the use of 'natural conductors' such as rebars and structural steelwork, provided that they are electrically continuous and adequately earthed.

Earth Termination System

The earth termination system is vital for the dispersion of the lightning current safely and effectively into the ground. Although lightning current discharges are a high frequency event, at present most measurements taken of the earthing system are carried out using low frequency proprietary instruments. The standard advocates a low earthing resistance requirement and points out that can be achieved with an overall earth termination system of 10 ohms or less.

BS EN 62305-3 recommends a single integrated earth termination system for a structure, combining lightning protection, power and telecommunication systems.

Two basic earth electrode arrangements are used.

(i) **Type A arrangement** - This consists of horizontal or vertical earth electrodes, connected to each down conductor fixed on the outside of the structure. This is in essence the earthing system used in BS 6651 where each down conductor has an earth electrode (rod) connected to it.

(ii) **Type B arrangement** - This arrangement is essentially a ring earth electrode that is sited around the periphery of the structure and is in contact with the surrounding soil for a minimum 80% of its total length (ie 20% of its overall length may be housed in say the basement of the structure and not in direct contact with the earth).

The ring electrode should preferably be buried at a minimum depth of 0.5 m and about 1 m away from the external walls of the structure.

Where bare solid rock conditions are encountered, the type B earthing arrangement should be used.

The type B ring earth electrode is highly suitable for:

- Conducting the lightning current safely to earth
- Providing a means of equipotential bonding between down conductors at ground level
- Controlling the potential in the vicinity of conductive building walls

Protection of Electrical & Electronic Systems

BS EN 62305-4 defines the protection against Lightning Electromagnetic Impulse (LEMP). The basic protection measures include:

- Earthing & bonding
- Magnetic shielding & line routing
- Surge protective device set

Earthing & Bonding

Sensitive electronic systems housed within a structure require a type B earthing arrangement. A low impedance-bonding network is required to avoid dangerous potential differences between all equipment housed within the inner zones of the structure.

Magnetic Shielding & Line Routing

The following measures will significantly reduce the surges/transient overvoltages entering the structure.

The use of reinforcing bars, stanchions etc to create a spatial shield or screen.

Suitable routing of internal lines minimizes induction loops and reduces internal surges.

The shielding of cabling and equipment by use of metallic cable ducts and metallic enclosures.

Effective Earthing

The dangers posed to both life and equipment by poor earthing make effective earthing essential. Given the complexity of national and international standards in earthing system design, material specification and installation, it makes sense to talk to Furse.

Furse design and model earthing electrode systems in compliance with BS 7430:1998, IEEE standard 80:2000, BS 7354:1992, EATS 41-24:1992 and other accepted standards. The comprehensive Furse range of earthing equipment includes solid copper, stainless steel and copperbond earth rods and accessories, high copper alloy bonds and clamps, earth pits, solid copper plates, lattice mats, earth rod seals and the FurseWELD exothermic welding system.

Using & Choosing Surge Protection Devices (SPDs)

Damaging transient overvoltages caused by lightning (or electrical switching) can be conducted into electronic equipment on mains power, data communication, signal and telephone lines. Therefore, as a general rule, SPDs should be fitted to all cables that enter a building, or travel between buildings. The exception is fibre optic cabling, which, of course, is a non-conductive medium.

A number of products are available which claim to protect electronic equipment against lightning induced transient overvoltages. However, tests have shown that many of these units have unacceptably high 'let-through' voltages, which leave the electronic equipment open to damage.

In order to provide effective protection, an SPD should:

- Have a low 'let-through' voltage for all combinations of conductors
- Be compatible with the system it is protecting
- Survive the transient
- Not leave the user unprotected as a result of failure, & be properly installed

'Let-through' Voltage (Protection Level)

The larger the transient overvoltage reaching the electronic equipment, the greater the risk of disruption, degradation or physical damage to its components. Thus the let-through voltage of the SPD should be lower than the level at which interference or component degradation may occur.

The let-through voltage should be equally low between any two conductors. Because transients can exist between any pair of conductors (phase and neutral, phase and earth, neutral and earth on mains power supplies, and line to line and line to screen/earth on data communication, signal and telephone lines), the let-through voltage between any pair should be below the level at which the system can suffer damage. BS EN 62305 recognizes SPDs with low let-through voltages as "enhanced" SPDs, which further minimize the risk of damage and disruption.

Compatibility

It is important that the SPD does not interfere with or restrict the system's normal operation.

- Mains power SPDs should not disrupt or corrupt the continuity of the supply, nor introduce high earth leakage currents
- Data communication, signal & telephone SPDs should not impair or restrict the system's data or signal transmission, as a result, for example, of the SPD's maximum operating voltage, current rating, in-line impedance or bandwidth

Survival

Although lightning discharges can have currents of 200 kA, transient overvoltages caused by the secondary effects of lightning are unlikely to have currents exceeding 10 kA (8/20 waveform). The SPD should therefore be rated for a peak discharge current of not less than 10 kA. Lightning is a multiple pulse event, and so the protector should not fail after the first transient.

Protection Failure

When in-line SPDs fail - for example those used on data communication, signal and telephone lines - they take the line out of commission, thereby preventing damage to the system. However, it is unacceptable for SPDs on mains power distribution systems to fail by short circuit. It is therefore important that SPDs for mains power distribution systems have a properly indicated pre-failure warning, whilst protection is still present.

Installation - BS 7671:2008 +A1:2011 Section 534

The performance of SPDs is heavily dependent upon their correct installation. For example, to gain maximum protection, the length of the SPD connecting leads need to be kept as short as possible to minimize additive inductive voltage dropped by these leads. Thus, SPDs must be supplied with detailed installation instructions (in-line with Section 534 of BS 7671) and installed as per these instructions.