BS EN 62305-4 Electrical and electronic systems within structures

Electronic systems now pervade almost every aspect of our lives, from the work environment, through filling the car with petrol and even shopping at the local supermarket. As a society, we are now heavily reliant on the continuous and efficient running of such systems. The use of computers, electronic process controls and telecommunications has exploded during the last two decades. Not only are there more systems in existence, the physical size of the electronics involved have reduced considerably (smaller size means less energy required to damage circuits).

BS EN 62305 accepts that we now live in the electronic age, making LEMP (Lightning Electromagnetic Impulse) protection for electronic and electrical systems integral to the standard through part 4. LEMP is the term given to the overall electromagnetic effects of lightning, including conducted surges (transient overvoltages and currents) and radiated electromagnetic field effects.

LEMP damage is so prevalent such that it is identified as one of the specific types (D3) to be protected against and that LEMP damage can occur from ALL strike points to the structure or connected services – direct or indirect – for further reference to the types of damage caused by lightning see table 1.
This extended approach also takes into account the danger of fire or explosion associated with services connected to the structure, e.g. power, telecoms and other metallic lines.

Motors create switching events

Lightning is not the only threat...

Transient overvoltages caused by electrical switching events are very common and can be a source of considerable interference.

Current flowing through a conductor creates a magnetic field in which energy is stored. When the current is interrupted or switched off, the energy in the magnetic field is suddenly released. In an attempt to dissipate itself it becomes a high voltage transient.

The more stored energy, the larger the resulting transient. Higher currents and longer lengths of conductor, both contribute to more energy stored and also released!

This is why inductive loads such as motors, transformers and electrical drives are all common causes of switching transients.

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Significance of BS EN 62305-4

Previously transient overvoltage or surge protection was included as an advisory annex in the BS 6651 standard, with a separate risk assessment. As a result protection was often fitted after equipment damage was suffered, often through obligation to insurance companies. However, the new BS EN 62305 standard's single risk assessment dictates whether structural and/or LEMP protection is required hence structural lightning protection cannot now be considered in isolation from transient overvoltage protection - known as Surge Protective Devices (SPDs) within this new standard. This in itself is a significant deviation from that of BS 6651.

> "BS EN 62305's single risk assessment dictates structural lightning protection cannot now be considered in isolation from transient overvoltage protection"

Surge Protection Devices

SPDs are vital in providing LEMP protection. Indeed, as per BS EN 62305-3, an LPS system can no longer be fitted without lightning current or equipotential bonding SPDs to incoming metallic services that have "live cores" – such as power and telecoms cables – which cannot be directly bonded to earth. Such SPDs are required to protect against the risk of loss of human life by preventing dangerous sparking that could present fire or electric shock hazards.

Lightning current or equipotential bonding SPDs are also used on overhead service lines feeding the structure that are at risk from a direct strike. However, the use of these SPDs alone "provides no effective protection against failure of sensitive electrical or electronic systems", to quote BS EN 62305 part 4, which is specifically dedicated to the protection of electrical and electronic systems within structures.

Lightning current SPDs form one part of a coordinated set of SPDs that include overvoltage SPDs – which are needed in total to effectively protect sensitive electrical and electronic systems from both lightning and switching transients.

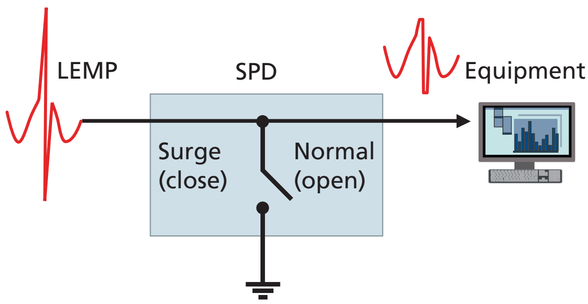

Figure 16: Principle of operation of an SPD

As figure 16 demonstrates, the function of an SPD is to divert the surge current to earth and limit the overvoltage to a safe level. In doing so, SPDs prevent dangerous sparking through flashover and also protect equipment.

Suitable SPDs can be selected for the environment within which they will be installed. For example, knowing the potential current exposure at the service entrance will determine the current handling capability of the applied SPD. Thus, a coordinated set of SPDs can be installed for thorough protection against lightning and transient overvoltage.

Coordinated and enhanced SPDs are considered further on in the ESP section.

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Lightning Protection Zones (LPZs)

Whilst BS 6651 recognises a concept of zoning in Annex C (Location Categories A, B and C), BS EN 62305-4 defines the concept of Lightning Protection Zones (LPZs). Figure 17 illustrates the basic LPZ concept defined by protection measures against LEMP as detailed within part 4.

Within a structure a series of LPZs are created to have, or identified as already having, successively less exposure to the effects of lightning. Successive zones use a combination of bonding, shielding and coordinated SPDs to achieve a significant reduction in LEMP severity, from conducted surge currents and, transient overvoltages, as well as radiated magnetic field effects. Designers coordinate these levels so that the more sensitive equipment is sited in the more protected zones.

The LPZs can be split into two categories – 2 external zones (LPZ 0_A, LPZ 0_B) and usually 2 internal zones (LPZ 1, 2) although further zones can be introduced for a further reduction of the electromagnetic field and lightning current if required.

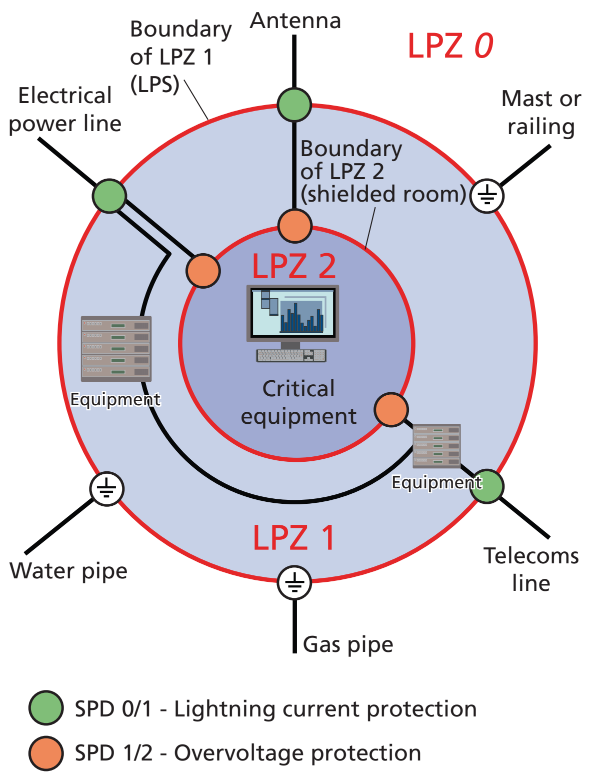

Figure 17: Basic LPZ concept – BS EN 62305-4

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External zones

LPZ 0_A is the area subject to direct lightning strokes and therefore may have to carry up to the full lightning current. This is typically the roof area of a structure. The full electromagnetic field occurs here.

LPZ 0_B is the area not subject to direct lightning strokes and is typically the sidewalls of a structure. However the full electromagnetic field still occurs here and conducted partial lightning currents and switching surges can occur here.

Internal zones

LPZ 1 is the internal area that is subject to partial lightning currents. The conducted lightning currents and/or switching surges are reduced compared with the external zones LPZ 0_A, LPZ 0_B. This is typically the area where services enter the structure or where the main power switchboard is located.

LPZ 2 is an internal area that is further located inside the structure where the remnants of lightning impulse currents and/or switching surges are reduced compared with LPZ 1. This is typically a screened room or, for mains power, at the sub-distribution board area.

Protection levels within a zone must be coordinated with the immunity characteristics of the equipment to be protected, i.e., the more sensitive the equipment, the more protected the zone required. The existing fabric and layout of a building may make readily apparent zones, or LPZ techniques may have to be applied to create the required zones.

Protection with LEMP Protection Measures System (LPMS)

Some areas of a structure, such as a screened room, are naturally better protected from lightning than others and it is possible to extend the more protected zones by careful design of the LPS, earth bonding of metallic services such as water and gas, and cabling techniques. However it is the correct installation of coordinated Surge Protection Devices (SPDs) that protect equipment from damage as well as ensuring continuity of its operation – critical for eliminating downtime. These measures in total are referred to as a LEMP Protection Measures System (LPMS).

When applying bonding, shielding and SPDs, technical excellence must be balanced with economic necessity. For new builds, bonding and screening measures can be integrally designed to form part of the complete LPMS. However, for an existing structure, retrofitting a set of coordinated SPDs is likely to be the easiest and most cost-effective solution.

Coordinated SPDs

BS EN 62305-4 emphasises the use of coordinated SPDs for the protection of equipment within their environment. This simply means a series of SPDs whose locations and LEMP handling attributes are coordinated in such a way as to protect the equipment in their environment by reducing the LEMP effects to a safe level. So there may be a heavy duty lightning current SPD at the service entrance to handle the majority of the surge energy (partial lightning current from an LPS and/or overhead lines) with the respective transient overvoltage controlled to safe levels by coordinated plus downstream overvoltage SPDs to protect terminal equipment including potential damage by switching sources, e.g. large inductive motors. Appropriate SPDs should be fitted wherever services cross from one LPZ to another.

Coordinated SPDs have to effectively operate together as a cascaded system to protect equipment in their environment. For example the lightning current SPD at the service entrance should handle the majority of surge energy, sufficiently relieving the downstream overvoltage SPDs to control the overvoltage. Poor coordination could mean that the overvoltage SPDs are subject to too much surge energy putting both itself and potentially equipment at risk from damage.

Furthermore, voltage protection levels or let-through voltages of installed SPDs must be coordinated with the insulating withstand voltage of the parts of the installation and the immunity withstand voltage of electronic equipment.

Appropriate SPDs should be fitted wherever services cross from one LPZ to another.

Design considerations

The designer must take into account the following when choosing and applying SPDs:

- withstand voltage of protected equipment
- immunity withstand voltage of equipment
- additional installation effects, such as voltage drop on connecting leads
- oscillation protective distance – if the distance from the SPD to the equipment is over 10m, oscillations could lead to a doubling of voltage

In these circumstances, only using standard SPDs could leave the indirect risk of LEMP damage too high. Where continuous equipment operation is critical, the use of enhanced SPDs to deliver a lower let-through voltage in both common and differential modes is preferable to a standard SPD.

Such enhanced SPDs can even offer up to mains Type 1+2+3 or data/telecom Test Cat D+C+B coordinated protection within one unit and are often the best choice to achieve cost-effective protection in addition to preventing costly system downtime.

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Enhanced SPDs

Whilst outright damage to equipment is not desirable, the need to minimize downtime as a result of loss of operation or malfunction of equipment can also be critical. This is particularly important for industries that serve the public, be they hospitals, financial institutions, manufacturing plants or commercial businesses, where the inability to provide their service due to the loss of operation of equipment would result in significant health and safety and/or financial consequences.

Standard SPDs may only protect against common mode surges (between live conductors and earth), providing effective protection against outright damage but not against downtime due to system disruption.

BS EN 62305 therefore considers the use of Enhanced SPDs (SPD*) that further reduce the risk of damage and malfunction to critical equipment where continuous operation is required. Installers will therefore need to be much more aware of the application and installation requirements of SPDs than perhaps they may have been previously.

Superior or enhanced SPDs provide lower (better) let-through voltage protection against surges in both common mode and differential mode (between live conductors) and therefore also provide additional protection over bonding and shielding measures. Such enhanced SPDs can even offer up to mains Type 1+2+3 or data/telecom Test Cat D+C+B protection within one unit. As terminal equipment, e.g. computers, tends to be more vulnerable to differential mode surges, this additional protection can be a vital consideration.

Furthermore, the capacity to protect against common and differential mode surges permits equipment to remain in continued operation during surge activity – offering considerable benefit to commercial, industrial and public service organisations alike.

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Furse only offer enhanced SPDs with industry leading low let-through voltage

Furse only offer enhanced SPDs with industry leading low let-through voltage, as they are the best choice to achieve cost-effective, maintenance-free repeated protection in addition to preventing costly system downtime. Low let-through voltage protection in all common and differential modes means fewer units are required to provide protection, which saves on unit and installation costs, as well as installation time.

Conclusion

Lightning poses a clear threat to a structure but a growing threat to the systems within the structure due to the increased use and reliance of electrical and electronic equipment. The new BS EN 62305 series of standards clearly acknowledge this. Structural lightning protection can no longer be in isolation from transient overvoltage or surge protection of equipment. The use of enhanced SPDs provides a practical cost-effective means of protection allowing continuous operation of critical systems during LEMP activity.