

Protection of LV & ELV Systems against LEMPs

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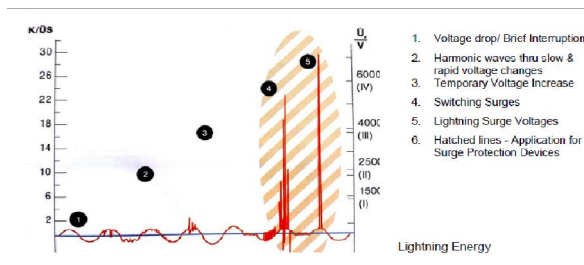


Introduction

Lightning Electromagnetic Impulse (LEMP) is the term given to the overall electromagnetic effects of lightning, including conducted surges (transient over voltages and currents) and radiated electromagnetic field effects.

Electronic systems operate on Low Voltages (LV) or Extremely Low Voltages (ELV). The direct loss due to LEMPs damaging electrical and electronic signalling and data systems is enormous. The indirect loss such as detention to trains due to damaged equipment and data losses will still be much higher. At present, no assessment of such losses in Indian Railways is available and as such losses seldom figure in any reporting systems.

LEMPs may not be catastrophic in nature; but may result in degradation of electronic circuitry. Repeated exposures to LEMPs may result in the permanent equipment failures. The cause of failure is hardly attributed to the correct source in



such cases. S&T Engineers may, therefore, may need to pay extra attention to protection LV & ELV equipment against LEMPs.

Protection Measures

Key to protection against LEMPs involves comprehensive and complex risk assessment and that this assessment not only takes into account the structure to be protected, but also the services to which the structure is connected. In essence, protection against transient over voltages or

electrical surges can no longer be considered in isolation, structural lightning protection is integral.

Protection against LEMPs can be achieved by providing protection devices such as Surge Protection Devices (SPDs) on power feeding lines or data lines. However, mere provision of such devices will not suffice to achieve effective protection. It is essential to understand what shall be the parameters of protection devices, where to place them, how to network and coordinate them. It is also important to know the proper practices for installing them.

Let us examine steps involved in achieving required protection for LV & ELV systems.

- Risk Assessment & Level of Protection
- Surge Protection Measures
 - External SPM
 - ◆ Air termination system
 - ◆ Down conductor system
 - ◆ Earth termination system
 - Internal SPM
 - ◆ Strategic location for protective devices
 - ◆ Recommended configuration of SPDs
 - ◆ Selection for protective devices
 - Internal LPS installation considerations
 - ◆ Lightning Equipotential Bonding
 - ◆ Earthing of SPDs
 - ◆ Length restriction of connecting wires
 - ◆ Integration of Earthing systems
 - ◆ Data Lines

Risk Assessment

IEC 62305 provides the guidelines to protect a structure or a service against LEMPs, as well as the selection of protection measure.

The ideal lightning protection for a structure and its connected services would be to enclose the structure within an earthed and perfectly conducting metallic (box), and in addition provide adequate bonding of any connected services at the entrance point into the shield. This in essence would prevent the penetration of the lightning

current and the induced electromagnetic field into the structure. However, in practice it is not possible or indeed cost effective to go to such lengths.

Protection measures, adopted in accordance with its recommendations, will reduce any damage and consequential loss as a result of a lightning strike. This reduction in damage and consequential loss is valid provided the lightning strike parameters fall within defined limits, established as Lightning Protection Levels (LPL).

There are four main sources of damage due to flashes. They are

- S1: Flashes to the structure
- S2: Flashes near to the structure
- S3: Flashes to a service
- S4: Flashes near to a service

Each source of damage may result in one or more of three types of damage -

- D1: Injury of living beings due to step and touch voltages
- D2: Physical damage (fire, explosion, mechanical destruction, chemical release) due to lightning current effects including sparking
- D3: Failure of internal systems due to LEMP

There are four types of losses/risks that may result from above damage:

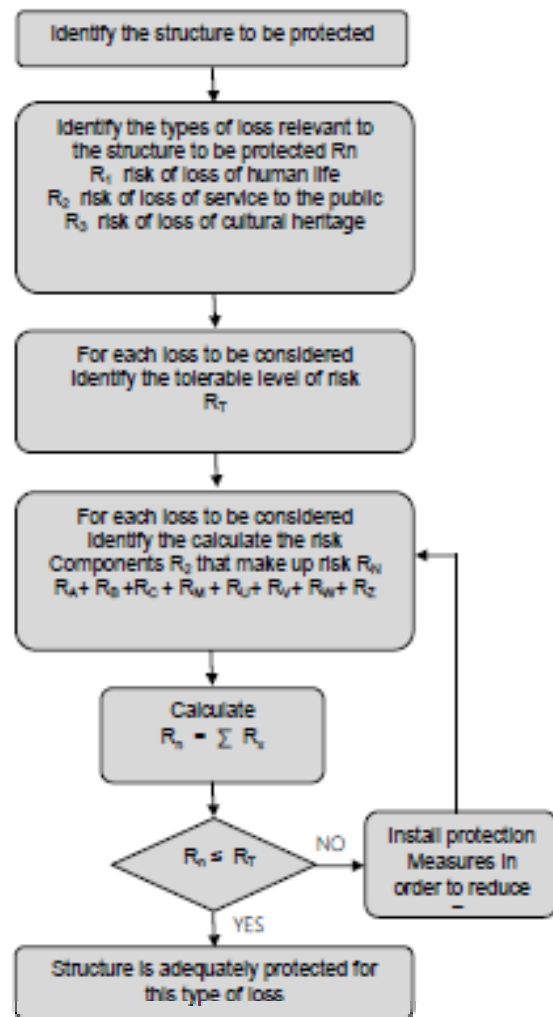
- R1: Loss of human life
- R2: Loss of service to the public
- R3: Loss of cultural heritage
- R4: Loss of economic value

The relationships of all of the above parameters is summarised

Point of strike	Source of damage	Type of damage	Type of loss/risk
Structure	S1	D1 D2 D3	R1 R1, R2, R3, R4 R1*, R2, R3
Near a structure	S2	D3	R1*, R2, R4
Service connected to the structure	S3	D1 D2 D3	R1 R1, R2, R3, R4 R1*, R2, R3
Near a service	S4	D3	R1*, R2, R4

* Only for structures with risk of explosion

Procedure for deciding the need for protection (risk calculation)



The first stage of the risk assessment is to identify which of the four types of loss, the structure and its contents can incur. The ultimate aim of the risk assessment is to quantify and if necessary reduce the relevant primary risks.

It is this iterative process that decides the choice or indeed Lightning Protection Level (LPL) of Lightning Protection System (LPS) and Surge Protective Measures (SPM) to counter Lightning Electromagnetic impulse (LEMP).

LPL/ Class of LPS	I	II	III	IV
Max Current (KA)	200	150	100	100

The RiskAssessment software packages such as StrikeRisk, LPCI RiskAssessment are available readily in the market. They are invaluable tools for undertaking the complex risk assessment calculations and it facilitates the

assessment of risk of loss due to lightning strikes and transient over voltages caused by lightning. Quick & easy to use, with full reporting capability, they automate risk assessment calculations and delivers results in minutes, rather than the hours or days it would take to do the same calculations by hand. Once the assessment has been made and Level of Lightning Protection Level will be known.

Loss of Human Life

Special Hazards to Life: No special hazards
 Life Loss due to fire: None
 Life Loss due to over-voltages: None

Loss of Cultural Heritage

Cultural Heritage lost due to fire: No heritage value

Economic Loss

Special Hazards to Economics: No special hazards
 Economic Loss due to fire: Other Structures
 Economic Loss due to over-voltage: Other Structures
 Step/Touch potential loss factor: No risk to livestock
 Tolerable Risk of Economic Loss: 1 in 1000

Loss of Essential Public Services

Services lost due to fire: Railway
 Services lost due to over-voltages: Railway

Calculated Risk

	Tolerable Risk (Rt)	Direct Strike Risk (Rd)	Indirect Strike Risk (Ri)	Calculated Risk (R)
Loss of Human Life	1.00E-05	1.832E-10	6.484E-09	6.647E-09
Loss of Public Services	1.00E-03	3.864E-07	2.049E-03	2.049E-03
Loss of Cultural Heritage	1.00E-01	0E+00	0E+00	0E+00
Economic Loss	1.00E-01	3.864E-09	2.049E-03	2.049E-03

UJ Consultants International Private Ltd (LPS) ©

Structure's Dimensions

Length of Structure(s): 8
 Width of Structure(s): 8
 Height of Roof Plane(s): 8
 Height of highest roof protrusion(s): 9
 *Measured from the ground
 Collection Area(s) (m²): 2390.23164668

Structure's Attributes

Risk of Physical Damage (i.e. fire): None
 Structure containing explosives: Average
 Internal wiring type: Screened
 Type of floor surface: Concrete, Agricultural

Environmental Influences

Location factor: Isolated Structure
 Environmental factor: Rural
 Structure's location: Bolder
 Annual Ground Flash Density: 1.6

Power Lines

Type of service to the Structure: Buried Cable
 Type of External Cable: Unshielded
 Presence of MV/LV Transformer: Transformer

Structure's Occupancy

Total No. of people in the structure: 16
 No. of people in the required zone: 0
 *To be filled if Risk Assessment is done for a particular zone in the structure. Inter3 otherwise.
 No. of days people are present in the structure (per week): 7
 No. of hours per day people are present in the structure: 24

Structure's Protection

Additional Protection measures: Soil equipotentialization
 Class of LPS: Class II
 Fire Protection/Provisions: Manual Systems
 Surge Protection: SPD1

Other Overhead Services

Number of conductive services: 0
 Type of External Cable: Shielded

Other Underground Services

Number of conductive services: 20
 Type of External Cable: Unshielded

External Surge Protection Measures

An external Lightning Protection System consists of

- Air termination system
- Down conductor system
- Earth termination system

These individual elements of an LPS should be connected together using appropriate lightning protection components (LPC). 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.

Air termination system

The role of an air termination system is to capture the lightning discharge current and dissipate it harmlessly to earth via the down conductor and earth termination system. Therefore it is vitally important to use a correctly designed air termination system.

Combination of any of the following components can be considered for the design of the air termination:

- Air rods (or finials) whether they are free standing masts or linked with conductors to form a mesh on the roof
- Centenary (or suspended) conductors, whether they are supported by free standing masts or linked with conductors to form a mesh on the roof
- Meshed conductor network that may lie in direct contact with the roof or be suspended above it (in the event that it is of paramount importance that the roof is not exposed to a direct lightning discharge)

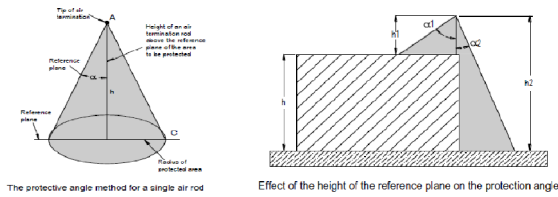
All types of air termination systems that are used shall meet the positioning requirements laid down in the body of the standard. It highlights that the air termination components should be installed on corners, exposed points and edges of the structure.

The two basic methods recommended for determining the position of the air termination systems are:

- The protective angle method
- The mesh method

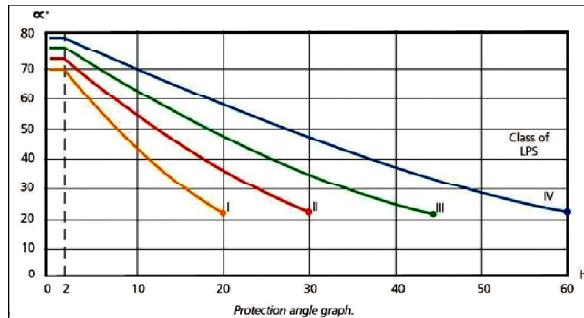
The protective angle method:

The protective angle method is suitable for simple shaped buildings. The protective angle (α) is the angle created between the tip (A) of the vertical rod and a line projected down to the surface on which the rod sits.



The protective angle afforded by an air rod is clearly a three dimensional concept whereby the rod is assigned a cone of protection by sweeping the line AC at the angle of protection a full 360° around the air rod.

The protective angle differs with varying height of the air rod and class of LPS. The protective angle afforded by an air rod is determined from Table



h is the height of air-termination above the reference plane of the area to be protected

The mesh method:

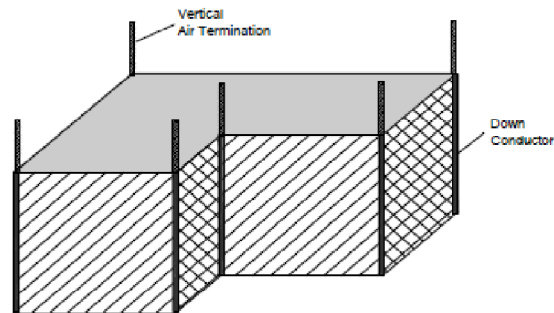
This is the method that was most commonly used and four different air termination mesh sizes are defined and correspond to the relevant class of LPS

Class of LPS	I	II	III	IV
Mesh size (m)	5x5	10 x 10	15 x 15	20 x 20

This method is suitable where plain surfaces require protection if the following conditions are met:

- Air termination conductors must be positioned at roof edges, on roof overhangs and on the ridges of roof with a pitch in excess of 1 in 10 (5.7°)
- No metal installation protrudes above the air termination system

Modern research on lightning inflicted damage has shown that the edges and corners of roofs are most susceptible to damage. So on all structures particularly with flat roofs, perimeter conductors should be installed as close to the outer edges of the roof as is practicable.



Air Termination Network

Vertical air rods (finials) or strike plates should be mounted above the roof and connected to the conductor system beneath. The air rods should be spaced not more than 10 m apart and if strike plates are used as an alternative, these should be strategically placed over the roof area not more than 5 m apart.

Down conductor system

Down conductors should within the bounds of practical constraints take the most direct route from the air termination system to the earth termination system. The greater the number of down conductors the better the lightning current is shared between them. This is enhanced further by equipotential bonding to the conductive parts of the structure.

The down conductor spacing should correspond with the relevant class of LPS.

Class of LPS	I	II	III	IV
Typical Distances between conductors (m)	10	10	15	20

There should always be a minimum of two down conductors distributed around the perimeter of the structure. Down conductors should wherever possible be installed at each exposed corner of the structure as research has shown these to carry the major part of the lightning current.

Earth termination system

The earth termination system is vital for the dispersion of lightning current safely and effectively into the ground.

Standard recommends a single integrated

earth termination system for a structure, combining lightning protection, power and telecommunication systems.

A good earth connection should possess the following characteristics:

- (a) Low electrical resistance between the electrode and the earth. The lower the earth electrode resistance the more likely the lightning current will choose to flow down that path in preference to any other, allowing the current to be conducted safely to and dissipated in the earth
- (b) Good corrosion resistance. The choice of material for the earth electrode and its connections is of vital importance. It will be buried in soil for many years so has to be totally dependable

The standard advocates a low earthing resistance requirement and points out that it can be achieved with an overall earth termination system of 10 ohms or less.

Internal Surge Protection Measures

Strategic location selection for protective devices

The general principle is that the equipment requiring protection should be located in an LPZ whose electromagnetic characteristics are compatible with the equipment stress withstand or immunity capability.

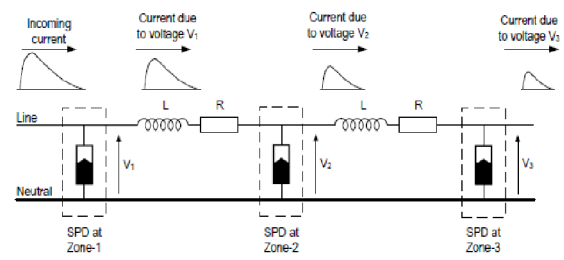
The concept caters for external zones, with risk of direct lightning stroke (Zone 0), or risk of partial lightning current occurring (Zone 1), and levels of protection within internal zones (Zone 1 & Zone2).

In general the higher the number of the zone (Zone 2; Zone 3 etc) the lower the electromagnetic effects expected. Typically, any sensitive electronic equipment should be located in higher numbered Zones and be protected against LEMP by relevant Surge Protection Measures.

Less sophisticated electrical items such as pump motors, machines, power tools etc., should be placed closer to the main distribution panel and more sophisticated equipment such as microprocessor based systems, medical equipment, communication equipment etc., should be located at inner rooms where power is provided from more inward power distribution boards. For this purpose, the installation should

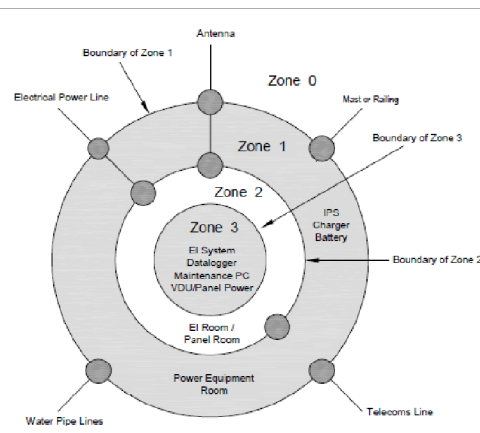
be demarcated as zones for placing the protection equipment. Zoning concept is essential as

(a) Finite impedance of SPDs: Although we assumed zero resistance for SPDs under low impedance mode, in reality they have finite impedance. Therefore, as the current flows through the SPD at low impedance mode, a potential difference builds up across each SPD which will be felt by the downstream equipment which are to be protected. A Large current results a large potential difference, hence we need SPDs in several stages to have a low output voltage to appear across the protected equipment



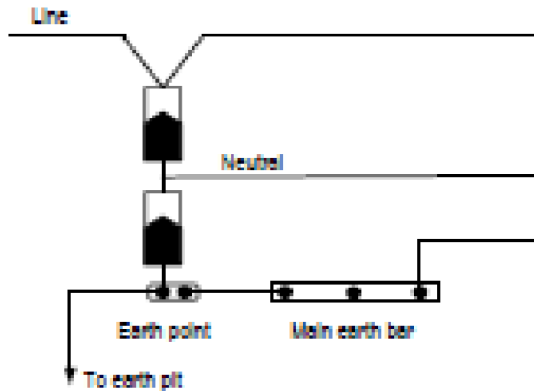
(b) Backdoor intrusion of lightning transients: In most of the building complexes one may find power panels from which electricity is fed into external devices such as Display boards, CCTVs, Security systems etc., Lightning current may enter the building via these electrical paths and affect the equipment connected to the power system even if the main panel is installed with SPDs.

(c) Transients generated within the building: Many switching operations, involved with large inductive and capacitive loads, generate fast transients that carry sufficiently high energy to affect sophisticated electronics. Only a properly coordinated network of SPDs will be able to prevent such transients from damaging the equipment



Zoning of Station provided with EI system

Recommended configuration of SPDs



Selection for protective devices

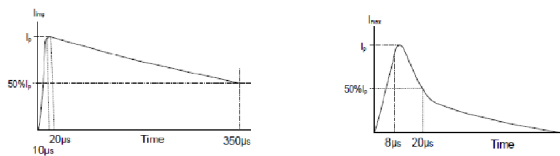
Four important parameters for Surge Protection Devices are

- Impulse Current
- Voltage Protection Level
- Response Time
- Max Continuous Operating Voltage

Impulse Current

In the selection of SPDs, the most exposed zone or Zone-1 needs SPDs with higher rating of impulse current handling. The Zone-2 and Zone-3 need sequentially reducing values of current handling capacity. The values of the current rating should be determined by following an appropriate standard and also taking into account the geographical location, thunderstorm density, equipment to be protected etc.

SPDs connected at Zone-1, known as Class I protectors, should be tested for the 10/350µs impulse while the SPDs of other classes should be tested for the 8/20µs current impulse. In most of the technical specifications published by the manufacturers the 10/350 µs waveform is referred as I_{imp} and 8/20 µs impulse by I_{max} .



The current handling capacity of SPDs will depend on the factors - Zone of consideration, Risk level and Lightning density.

Risk can be considered low for offices, factories, non-essential service providers,

domestic etc.

Risk can be considered high for hospitals, power generation and distribution, communication, broadcasting and other essential service providers

Areas are considered to be high lightning density areas where isokeraunic level is greater than 80 thunder days/year.

Areas are considered to be low lightning density areas where isokeraunic level is less than 80 thunder days/year.

Zone	High lightning density areas (Current in kA/Phase)		Low lightning density areas (Current in kA/Phase)	
	Low Risk	High Risk	Low Risk	High Risk
Main panel * (Zone-1)	40	60	30	40
Sub-panels ** (Zone-1)	30	40	15	20
Power feeder level ** (Zone-3)	07	15	03	07

*For 10/350 µs current impulse **For 8/20 µs current impulse

For example, at the main panel of a high risk location in an area of low lightning density for a single phase system from above table;

I_{imp} of SPD from line to neutral = 40 kA

I_{imp} of SPD from neutral to earth = (40×2) kA = 80 kA

Note that these are minimum values for the above installation.

The rated current, I_n is the maximum value of 8/20µs impulse, that the SPD can withstand if the impulse is applied 20 times consecutively. This specification is an indicator of the robustness of the SPD in withstanding multiple lightning currents.

Voltage Protection Level

Electronic equipment has a certain impulse withstanding voltage beyond which the equipment will undergo permanent damage or may temporarily malfunction.

Most of the modern day electronics - microprocessor based equipment and communication equipment have impulse withstand voltage values less than about 1.8 kV between line and neutral and 3.6kV between line and earth.

'Voltage Protection Level' or 'Protection Level' is one of the most important factors for selection of proper SPD. This is the minimum let-through voltage that will appear across the line and neutral (differential mode voltage) and that between the line/neutral and the earth (common mode

voltage).

This tolerable level should significantly be higher than the voltage protection level of the SPDs that one selects to protect the equipment. Therefore, SPDs with lower value of voltage protection level is better than that with a higher value.

For example, if SPD from line to neutral at a subpanel is rated for a protection level of 1.4 kV; i.e. under an impulse condition there is a possibility that a voltage of 1.4 kV appearing across the line and neutral and also across the neutral and earth. If this subpanel feeds equipment, a voltage of 2.8 kV will appear across the line and earth and 1.4 kV across line and neutral. If the impulse withstanding voltages of the equipment are higher than the above values the equipment will survive. Otherwise, irrespective of the investment on the SPDs the equipment will be damaged or most probably degraded, either due to over current through the load or insulation breakdown between line/neutral and earth.

Response Time

Lightning Impulses may have rise times that are in the order of sub-microseconds. Therefore the SPD should have appreciable speed in switching from high impedance to low impedance mode. This value may vary from several to several tens of nanoseconds depending on the technology used.

Maximum Continuous Operating Voltage

Under no-impulse conditions, the SPD remains almost open circuited. However, if the operating voltage 220Vrms is increased to a higher value for few cycles due to some fault, there is a chance that the SPD may switch into low impedance mode. If such transition takes place, a large current under nearly operating voltage will flow through the SPD which is not made to withstand such high energy. As a result the SPD may be totally damaged. The maximum of such operating voltage, only under which the SPD is safe, is termed the maximum continuous operating voltage (MCOV). As per the standards, the MCOV should be above 110% of the operating voltage. However, in countries where the power quality is not very reliable, a value of 300V or 320V is more appropriate. It can be seen that the larger the value of MCOV, the greater the let-through voltage of the SPD. Therefore, it is always advisable to

select an SPD with the least MCOV that can withstand a power quality of a given region.

Article number			5089796
Nominal voltage	U_n	V	230
SPD to EN 61643-11			Type 1-2
SPD to IEC 61643-11			Class III
Lightning protection Zone LPZ			072
Impulse discharge current (10/350)	I_{imp}	kA	100
Total discharge current (10/350)	$I_{Total 8/20}$	kA	100
Nominal discharge current (8/20)	I_n	kA	100
Arrester surge current (8/20) [peak]	$I_{Total 8/20}$	kA	100
Maximum discharge current	I_{max}	kA	100
Voltage protection level	U_p	kV	<1.3
Response time	t_A	ns	<75
Follow current interrupt rating	I_i	kA	25
Maximum back-up fuse		A	125
Temperature range	°	°C	-40 ~ +65

Typical SPD Specification Sheet

Internal LPS installation considerations

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 flashover is nullified.

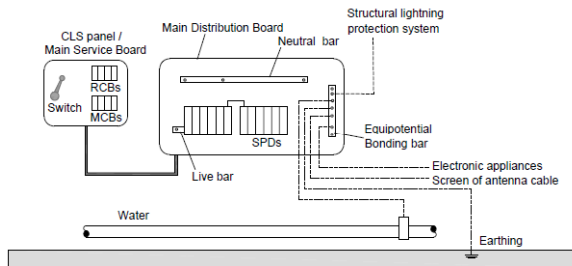
This electrical interconnection can be achieved by natural/fortuitous bonding or by using specific bonding conductors that are sized according to Tables 8 and 9 of BS EN/IEC 62305-3.

Bonding can also be accomplished by the use of surge protective devices (SPDs) where the direct connection with bonding conductors is not suitable.

Figure below is based on BS EN/IEC 62305-3, shows a typical example of an equipotential bonding arrangement. The gas, water and central heating system are all bonded directly to the equipotential bonding bar located inside but close to an outer wall near ground level. The power

cable is bonded via a suitable SPD, upstream from the electric meter, to the equipotential bonding bar. This bonding bar should be located close to the main distribution board (MDB) and also closely connected to the earth termination system with short length conductors. In larger or extended structures several bonding bars may be required but they should all be interconnected with each other.

The screen of any antenna cable along with any shielded power supply to electronic appliances being routed into the structure should also be bonded at the equipotential bar.



Earthing of SPDs

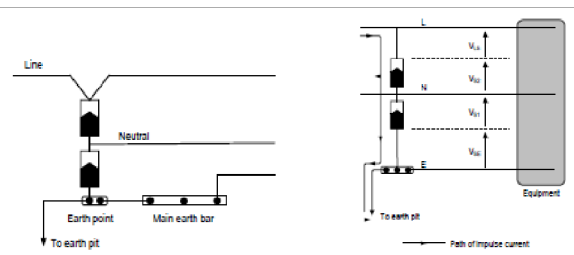
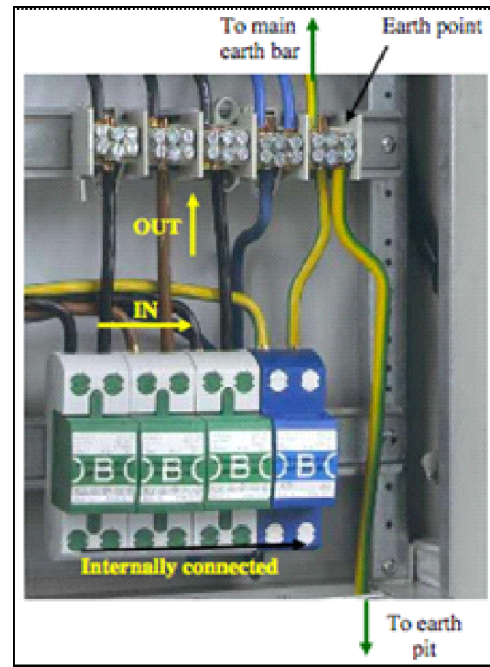
The installation of SPDs plays a vital role in the surge protection of equipment. It is highly recommended to have a single earthing point that runs out of the building (at the main distribution panel) of which the earth resistance should be kept below 100. In more specific cases such as safety critical systems, the required resistance may be lower than this value (even below 10 in some cases). The main distribution panel should be connected to the earth pit by conductors of cross-section not less than 35 mm². The earth bars of all sub distribution panels should be connected to the main earth bar (at the main panel) by 16 mm² cables. One has to make sure that the SPDs at a given distribution panel are connected to the earth bar of that panel itself.

All the equipment empowered by that panel should be provided with earth connection from that same earth bar. In building complexes, when the power is extended from one building to another, it is highly recommended to install a main earth bar at the power entrance of each building. This main earth bar should be connected to the mother earth as specified above.

In ordinary buildings it has been recommended to have extra SPDs if the wire length between two protected points is larger than 30m. This length needs to be significantly reduced if there is a tower in the site.

Length restriction of connecting wires

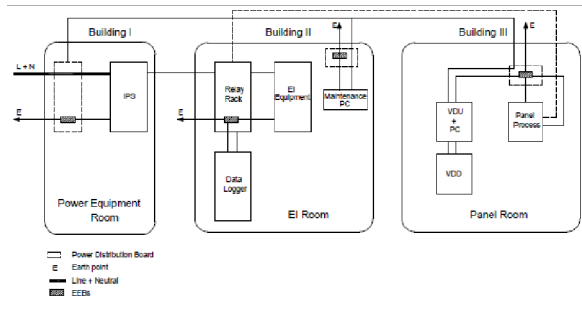
In the installation of the SPDs, it should be strictly adhered to the practice of using the shortest possible lengths of conductors in connecting the power lines to the SPDs and SPDs to the main earth bar. As per the IEC Standards, the length of wire in each of the above cases should not be greater than 50 cm. Otherwise even if one selects SPDs with lower voltage protection level, the actual let-through voltage will be much higher than what is expected.



Most often it will be somewhat difficult to achieve 50 cm limitation due to the space restrictions. Hence, it is recommended to connect the lines in "V" connection instead of "T" connection.

Note that in the V connection, the dirty "IN" lines and clean "OUT" lines are installed perpendicular to each other to minimize re-induction of transient energy. Similarly the earth lines that carry the transients to mother earth have kept far separated from the clean lines. Background picture was adapted from the

literature of OBO Bettermann Ltd.



Integration of Earthing systems

It is well understood that to prevent dangerous potential differences all metal parts of a given installation should be interconnected. In case that they cannot be integrated, they should be separated by a certain minimum distance.

Most often the manufacturers of digital equipment demand a dedicated or clean earth (isolated from other earths) for such equipment. These systems need a fixed earth reference; however the power earth potential frequently fluctuates by small voltages due to earth faults, loop currents etc under normal operation. Under such requirement the two earthing systems can still be integrated for safety purposes though a spark gap which is termed a transient coupler. The transient coupler keeps the two earthing systems separated under normal conditions but connects them under transient condition.



A transient coupler which interconnects the two earthing systems

The transient couplers will also be very useful in interconnecting conducting parts made of different metals which need to be equipotentialized under transient conditions to prevent dangerous sparking.

Data lines

Lightning surges may also enter the equipment through data and communication lines. In most of the instances the lightning energy couples with these data lines in the form of induced voltages. The normal operating voltage of such lines is in the range of few to few tens of Volts and the operating current is from milli-Amperes to few Amperes. These systems are also called as

extremely low voltage (ELV) systems. Therefore, even voltage or current pulses which are not that significant in LV power systems may damage or cause data losses / memory upsets in ELV systems.

Most of the SPDs that protect data and communication lines have a series component that attenuates the energy and a shunt component that diverts the energy. Therefore in such cases one has to pay extra attention on several additional specifications which are not significant in power system protection. These parameters are -

- Insertion loss and Bandwidth
- Connector type and number of wires/pins
- Operating current and voltage

Insertion loss and Bandwidth

Signal communication systems transfer information at much higher frequencies than the transmission of power which takes place at frequencies up to about 50 Hz. Therefore, the inductive component connected in series and the parasitic capacitance of the shut components limit the applications of an SPD in signal systems.

SPDs meant for CAT-5 cable if used on CAT-6 cable, no protection will be available for the equipment and the equipment may get damaged or may malfunction.

Category	Upper cutoff frequency	Category	Upper cutoff frequency
CAT-3	16 MHz	CAT-6	250 MHz
CAT-4	20 MHz	CAT-6a	500 MHz
CAT-5	100 MHz	CAT-7	600 MHz
CAT-5e	250/350/ 400/ 550 MHz	CAT-7a	1000 MHz

The upper cutoff frequency of different categories of data line cables

Note that different manufacturers produce CAT-5e cables of several upper cut off frequency as they claim. As of today, CAT-5e are the most commonly used type of Ethernet cables, hence the protection system designer is cautioned to check the actual bandwidth of the cable and select a suitable SPD for the purpose.

Connector type and number of wires/pins

Connector type and number of wires/pins: Signal systems consist of various types of connectors (BNC, RJ 45, RJ 11, 10 pair Kroner type etc.) and different numbers of lines. This yields a range of connector types in the i/p ports of SPDs designed to protect such systems. Hence the SPDs should be selected as per the connector type of the equipment.

Operating current and voltage

As the SPDs for signal systems consists of both series and shunt components, they should be compatible with the operational current and voltage of the protected system

Conclusion

A comprehensive guidance has been given in this paper for field engineers who are involved in designing and implementation of surge protection systems for LV and ELV networks, especially in regions where TT wiring system is practiced. Protection against transient over voltages or electrical surges can no longer be considered in isolation, structural lightning protection is integral Level of Protection required for an installation has to be assessed reiterative risk assessment, suitable air termination, down conductors and earthing systems shall be considered.

A zonal approach to the protection scenario has many advantages. While the current handling capacities of SPDs are important parameters in selecting the appropriate SPD system for a given installation, the highest priority should be given to the let through voltage felt by the downstream equipment. Both voltage protection level of SPDs and the wire lengths of installation are equally important in reducing the final let through voltage. In regions where power quality is not very high, the MCOV of the SPDs should be selected appropriately; not so low that the SPD will be damaged under sustained over voltages and not so high as to increase the voltage protection level significantly.

In the protection of signal systems one has to pay extra attention on bandwidth of the SPD so that it is well above the upper cutoff frequency of the data cables in the system. Sites close to large metal towers need higher level of concerns in the planning of surge protection system. The abnormalities and irregularities of electrical network of the building should be rectified before the installation of the SPDs to have the optimum gain of installation.

Source References:

IEC 62305 - Part 1 : Protection against lightning: General principles

IEC 62305 – Part 2: Protection against lightning: Risk management

IEC 62305 - Part 4 : Protection against lightning: Electrical & electronic systems within structures

IEEE C62.41-1991 : IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

IEEE 1100-2005 : Recommended Practice for Powering and Grounding Electronic Eqpt (Emerald Book)

Technical paper by Centre of Excellence on Lightning Protection, University Putra, Malaysia

Risk Analysis by Mr. R. Ganesan, Consultant, Lightning Protection Consultants India, Chennai, India

Furse: Guide to BS EN 62305 Protection Against Lightning

LittleFuse Inc. Specification sheet, Radial lead varistors, C-III Varistor Series, June 2009

OBO Betterman SPD Specifications