

Surge Protection

A General Overview

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Overview

- Presentation of the philosophy behind surge protection for potential equalization
- Discuss standards requirements
- Review protection of internal systems and equipment

Source and Type of Damage

- Flashes to a structure (S1)
- Flashes near a structure (S2)
- Flashes to an incoming service (S3)
- Flashes near an incoming service (S4)
- Injury to living beings (D1)
- Physical damage (D2)
- Failure of electrical and electronic systems (D3)

Lightning Current Distribution

- Simple Model
 - 50% thru LPS ground
 - 50% thru services
 - Services divided equally
 - Each line in a service divided equally
- Detailed Analysis
 - IEC 62305-1 Edition 1 Annex E

Surges due to flashes to structure

- When conducted to earth, current division between LPS ground and conductors attached characterized by
 - Impedance of LPS grounding system
 - Number and type of parallel paths
 - Above ground or underground
 - Impedance to earth of external parts or lines

Surges due to flashes to service

- Strike current will divide in both directions
- Consider breakdown insulation
- Peak current function of LPL
- Shielded cable reduces I_{pk} by 50%
 - Assumes $R_{shield} =$ parallel impedance of service conductors

Surge due to flashes near service

- I_{pk} lower than due to strike to service
- Same assumptions for shielded cable

Surges due to magnetic coupling

- Sources are currents in down conductors and nearby strikes
- Significant induced currents coupled onto internal wiring
- Coupling reduced by shielding provided by structure or other means
 - Establish new Lightning Protective Zone

Surge Protection Techniques

- Shielding, etc.
- Equipotential bonding
 - Crowbar Devices such as spark gaps
- Overvoltage
 - Metal Oxide Varistors, etc.
- Combination
 - Requires coordination to ensure proper operation

Classification of SPDs

- Type 1
- Type 2
- Type 3
- Type 4

UL 1449 SPD Types

- Type 1 – Permanently connected SPDs intended for installation on line or load side of primary service disconnect
- Type 2 – Permanently connected SPDs intended for installation on load side of primary service disconnect
- Type 3 – Cord connected, direct plug-in, or receptacle type point-of-utilization SPDs
- Type 4 – Component SPDs

SPD Standards - Power

- UL 1449, Edition 3 – Surge Protective Devices
- UL 1449, Edition 2 – Transient Voltage Surge Suppressors
- ANSI/IEEE C62.11, Standard for Metal – Oxide Surge Arresters for AC Power Circuits
- ANSI/IEEE C62.1, Standard for Gapped Carbide Surge Arresters for AC Power Circuits
- IEC 61643 – Low Voltage Surge Protective Devices
- NEMA LS-1 – Low Voltage Surge Protective Devices

SPD Standards - Communication

- UL 452 – Standard for Antenna Discharge Units
- UL 497 – Standard for Protectors for Paired-Conductor Communications Circuits
- UL 497C – Standard for Protectors for Coaxial Communications Circuits

Surge Protection Requirements

- SPDs shall be installed at all power (4.18.2.1) and conductive signal, data, and communication services (4.18.2.2) entrances
- SPDs shall be installed at all points where an electrical or electronic system conductor leaves a structure to supply another structure if the conductors or cables are run over 100 ft and are not buried or enclosed in grounded metal conduit or tubing (4.18.2.2)
- Allowance to provide other protection techniques to meet intent of the requirement (4.18.2.5)

Supplementary (Coordinated) SPDs

- Surge protection should be considered for installation at sub-panels or branch panels and at the point of utilization
- Can use risk assessment to determine need for supplemental protection
 - Function of routing of wiring, shielding, and breakdown level of equipment

Surge Protection Methods

- 4.18.2.5 allows elimination of requirement for equipotential bonding SPDs where surge threat determined to be negligible, the lines are equivalently protected or where installation compromises safety.
- Does not eliminate the requirement for surge protection but allows methods other than SPDs to accomplish protection

Surge Threat Levels

- SPDs at the power service entrance
 - I_{\max} rating of at least 40 kA 8/20 per phase or
 - nominal discharge current (I_n) rating of at least 20 kA, 8/20 μ s pulse per phase
- SPDs listed for the protection of signal, data, and communications systems
 - I_{\max} rating of 10 kA, 8/20 μ s pulse minimum installed at the entrance.

Facility Power Service Requirements

- SPD shall be listed for the protection of service entrances
- Short circuit current rating of the SPD shall be coordinated with available fault current rating of panel to which it is connected (in accordance with NFPA 70)
- MCOV selected to ensure it is greater than upper tolerance of the utility power system to which it is connected
- SPDs at grounded service entrances shall be wired in a line-to-ground (L-G) or line-to-neutral (L-N) configuration.
 - Additional modes, line-to-line (L-L), or neutral-to-ground (N-G) shall be permitted at the service entrance.
 - For services without a neutral, SPD elements shall be connected line-to-ground (L-G). Additional line-to-line (L-L) connections permitted.

Signal, Data, and Communications SPDs

- SPDs for data and signal line protection shall provide common mode protection
- SPDs selection shall take into consideration aspects such as the frequency, bandwidth and voltage.
- Losses (such as returns loss, insertion loss, impedance mismatch, or other attenuation) introduced by SPD(s) shall be within acceptable operational limits.
- SPDs shall be bonded to the point of grounding of the electrical service
 - If this point is greater than 6 m (20 ft) away, a supplementary earth electrode or electrode system shall be installed at the SPD location.
 - SPDs shall not be grounded through a down conductor of the lightning protection system.

SPD Installation

- Shall conform to the requirements of NEC
- SPDs shall be located and installed so as to minimize lead length.
- Interconnecting leads shall be routed so as to avoid sharp bends or kinks.
- SPD grounding conductor shall be installed in accordance with the manufacturer's instructions.
- SPD components shall be accessible for inspection and maintenance.

Miscellaneous Requirements

- Resistance of the earth electrode system used in the grounding of SPDs shall comply with NFPA 70 and manufacturer's recommendation
- SPDs shall have physical protection with consideration of the operational environment and according to the manufacturer's instructions.
- Enclosures and other ancillary equipment shall be listed for the purpose.

Questions or
Comments?