Surge Protective Devices (SPDs) for Building Power Systems

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Fig. 1: 347/600V 1200A Main Distribution Panel with Type 2 SPD

What is an SPD?

A Surge Protective Device (SPD), also known as a surge protector, is an electrical component designed to protect equipment and systems from voltage surges. A voltage surge is a short-duration increase in voltage that can occur on a power system. These surges can be caused by external events such as utility switching and lightning strikes, or by internal events such as switching of large loads within a building (e.g., motors, transformers). SPDs work by diverting transient current (momentary deviation from the normal steady-state current) during voltage surges, thereby limiting the voltage that reaches the connected equipment. The primary purpose of an SPD is to help prevent damage to electrical equipment such as electronics, power supplies, computers, lighting, appliances, and other systems.

Types of SPDs

Typical Low-voltage SPDs used in commercial applications are designed for repeated suppression of voltage surges on 60 Hz power circuits not exceeding 750V. There are several types of Low-voltage SPDs, classified based on their location in the electrical system and their technology. The most common classification is by Type, as defined by standards such as CSA C22.2 No 269, UL 1449 and IEC 61643.

- **Type 1 SPDs**: These devices are typically installed at the service entrance of a building, before the main circuit breaker or service disconnecting means. They are designed to help protect against large, high-energy surges, such as those caused by direct lightning strikes on the power grid. Type 1 SPDs are typically installed without overcurrent protection.

- **Type 2 SPDs**: These are the most common type used in commercial buildings. These devices are installed downstream of the Type 1 device if present. Type 2 SPDs are installed after the main circuit breaker or service disconnecting means. They are designed to help protect against surges that originate by events external to the building or from internal events within the building itself. Type 2 SPDs are installed on the load side of the service entrance equipment with overcurrent protection.

- **Type 3 SPDs:** These devices are point-of-use protectors such as corded, direct plug-in, or receptable type SPDs with built-in surge protection. They are intended to be installed at least 10 meters (~30 feet) from the main distribution / panelboard. They are designed to protect individual electrical equipment / devices to provide a layer of protection against residual surges.

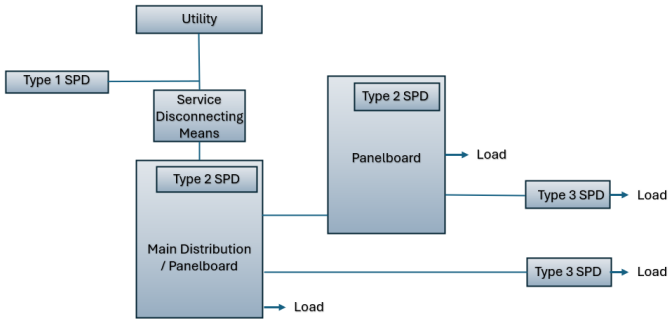

Fig. 2: SPD Typical Locations Within Power System

How SPDs Work

SPDs function by using one or more non-linear components to divert surge current. SPDs can have circuity ranging from basic single components to extensive elaborate circuitry. The most common component is the Metal Oxide Varistor (MOV).

- **Normal Operation:** Under normal operating conditions, the MOV has a very high resistance and acts as an open circuit. This means it allows the normal line voltage to pass through to the protected equipment without any interference.

- **Surge Condition:** When a voltage surge occurs, the MOV's resistance drops drastically and instantaneously. It effectively becomes a low-resistance path, diverting the surge current away from the connected equipment and safely to the ground. Once the surge has passed, the MOV's resistance returns to its high-resistance state, allowing the circuit to resume normal operation.

Each time an SPD diverts a surge it can degrade slightly. Most modern SPDs have indicators (lights, flags, or alarms) to signal when the device has reached the end of its life and needs to be replaced.

SPD Selection

The Technical Design Requirements for Alberta Infrastructure Facilities (TDR) outlines SPD locations for Alberta Infrastructure facilities.

Electrical equipment vendors have a large range of products to select from. Coordinating with an electrical consultant or product vendor helps assist narrowing the selection and aiming to attain a power system with the protection the user is expecting.

Common parameters:

- Voltage rating
- Maximum continuous operating voltage (MCOV)
- Operating frequency range
- Nominal current rating
- Short circuit current rating (SCCR)
- Maximum surge current kA rating range per phase
- Clamping voltage
- Response time
- Modes of protection - L-G, L-N, L-L, N-G

Common features in industry:

- Monitoring status indicator lights (one per phase)
- Status / dry relay contacts
- Surge counter
- Audible alarm, silence button

SPD Installation

Proper installation is critical for the effective functioning of an SPD. For example, the length of the conductor wires connecting an SPD to the electrical system is particularly important. Shorter wires provide a lower impedance path, which allows the surge current to be diverted more quickly and effectively. Long, coiled wires can introduce impedance, which can slow the diversion of the surge and render the SPD less effective. For new equipment, many manufacturers provide pre-installed SPDs. For site installed SPDs within equipment the installation involves a licensed electrician, and depending on the size and arrangement of the power system within the facility a consultant and manufacturer may be required to be involved.

Applicable code and standards for installation include CSA C22.1:24 Canadian Electrical Code, Part I (2024) sections / standards:

- Section 26-420 Low-voltage Surge Protective Devices
- CSA C22.2 NO. 269.1-17 – Surge Protective Devices - Type 1 – Permanently Connected
- CSA C22.2 NO. 269.2-17 - Surge Protective Devices - Type 2 – Permanently Connected
- CSA C22.2 NO. 269.3-17 - Surge Protective Devices - Type 3 – Cord Connected, Direct Plug-In and Receptacle Type

Further Information

https://www.nemasurge.org/
NEMA Surge Protection Institute (NSPI): An educational outreach initiative by the Low Voltage Surge Protective Devices Section of the National Electrical Manufacturers Association (NEMA).

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