White Paper

Surge Protective Devices in Automatic Transfer Switches

ASCO®

SURGE PROTECTIVE DEVICES IN AUTOMATIC TRANSFER SWITCHES

Standby power systems provide emergency power, legally required power, or optional standby AC power during utility outages. Standby AC power systems include those in healthcare facilities, emergency shelters, and other critical facilities, and are also required for lighting systems to enable safe egress of people from public and private buildings. To ensure that back-up power can be accessed with little or no disruption, an Automatic Transfer Switch (ATS) is typically installed to switch electrical loads from utility power to an on-site generator.

Automatic Bypass Isolation Transfer Switch

Codes and industry standards require that a facility's electrical system will be adequately protected from electrical transients using Surge Protective Devices (SPDs). However, if SPDs are deployed with inadequate consideration of voltage variations in utility and standby power systems, the SPDs could be damaged or destroyed, leaving equipment at risk of damage. Consequently, it's important to understand the voltage fluctuation characteristics of the primary and secondary power systems that feed an ATS to properly specify SPDs.

A Type 1 SPD in a NEMA 1/12/3R/4 Steel Enclosure

VOLTAGE FLUCTUATIONS

In primary AC power systems, the quality of the electrical power is generally determined by the electric utility. The utility manages voltages through components connected to a sophisticated control system with a number of redundancies. Although utilities attempt to regulate voltages within the specific ranges, standby AC power sources supplied by a generator do not have common voltage tolerance requirements. Voltage fluctuations on standby systems can exceed 20 percent of the nominal voltage during normal operation.

For example, significant voltage deviations can occur in standby power systems whenever the generator is step-loaded. Step loading occurs when there is a significant change in the current requirements of the facility. When the current demand is increased, the voltage and frequency of the AC power from the generator will diminish until the generator's control system corrects the condition. A similar condition occurs when loads are shed in a stepped fashion. As the current is decreased, the voltage and frequency increase until corrected.

In addition to normal fluctuations from standby AC power sources, there are abnormal conditions that can create voltage fluctuations. These include improperly grounded systems, improperly switched neutrals, and other causes. In addition, events such as lightning, utility switching, and accidents involving power distribution equipment may create voltage transients that can impact systems and load equipment.

SPDs IN STANDBY POWER SYSTEMS

Surge protective devices are voltage-sensitive. When an SPD's Maximum Continuous Operating Voltage (MCOV) is exceeded, the SPD will attempt to limit the overvoltage. SPD components are designed to limit transient overvoltages of short duration, typically less than 100 microseconds. When SPDs attempt to control overvoltages for sustained periods, the SPDs may be damaged. When an SPD is continuously exposed to voltage exceeding its MCOV, the SPD will most likely be damaged.

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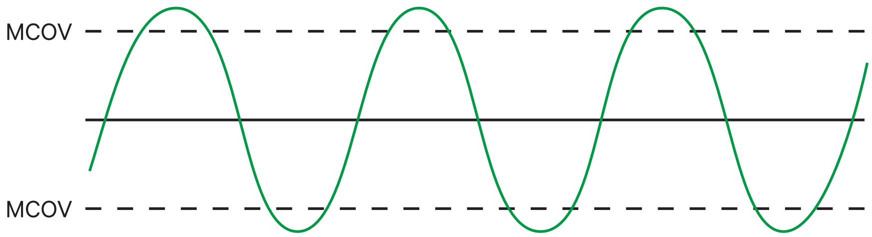
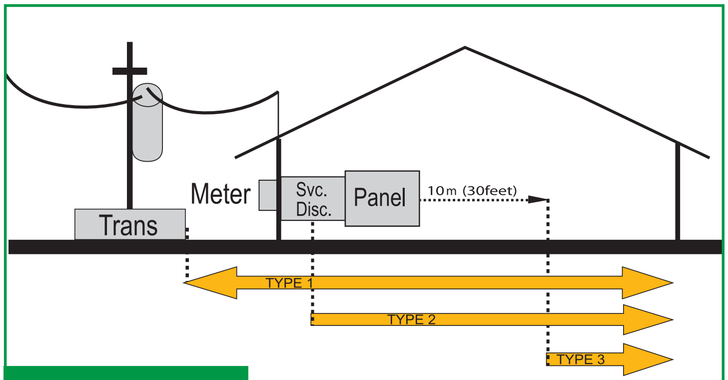


SPD Type

Underwriters Laboratories' *UL 1449 Standard for Safety, Surge Protective Devices* addresses types of SPDs for AC power. This is harmonized with National Electrical Code (NEC®) Article 285. Type 1 SPDs are intended for use between the utility transformer and the building's electrical disconnect at the service entrance. This is the utility's domain where a customer's downstream overcurrent protectors do not protect an upstream SPD. Type 1 SPDs thus include all UL-required safety apparatus within the unit. Consequently, using Type 1 units may simplify your SPD installation.



SPD Type Locations

Type 2 SPDs are intended for use downstream of the service entrance disconnect. Type 2 SPDs may or may not contain all UL-required safety apparatus and are arguably tested to less rigorous standards. The UL 497 series of standards provides requirements for SPDs on low voltage data and communication circuits, such as those used to monitor and control ATSs and generators. Type 3 SPDs include cord-connected units at the equipment point of use.

Voltage Protection

Equipment that operates on utility power should be able to withstand normal utility voltage fluctuations. Standby AC power systems can present voltage fluctuations that exceed those of utility-sourced power systems. Higher quality voltage regulators on generators are typically more desirable. Select an SPD with an appropriate MCOV.

In general, SPDs at transfer switches should have Line-to-Neutral, Line-to-Ground, and Neutral-to-Ground protection to safeguard electrical equipment from power line and neutral switching transients, ground reference issues, and outdoor (lightning) transients.

Current Capacities

NEC® Article 285.6 requires that an SPD's Short Circuit Current Rating (SCCR) equal or exceed the available fault current. Designers should compare the available fault current to the SPD's SCCR to ensure this requirement will be met.

In general, SPDs with a surge current capacity of 80 to 200 kA per phase provide a sufficient margin of redundancy to properly handle transfer switch-related transients.

SPDs listed to UL 1449 are labelled with a nominal discharge current rating, also known as the I-nominal rating. This is essentially a duty cycle test of 15 consecutive impulses at the declared value. The 20kA I-nominal rating is the highest rating, suggesting the most robustness. Consequently, a 20kA I-nominal rating is recommended for typical ATS installations. (Lightning Protection standards require 20kA I-nominal ratings for the same reason.)

Serviceability

SPDs should be de-energized for service or replacement. Installing a dedicated circuit breaker or low-cost safety switch for each SPD facilitates service. Some SPDs are available with integral disconnect switches for this purpose.

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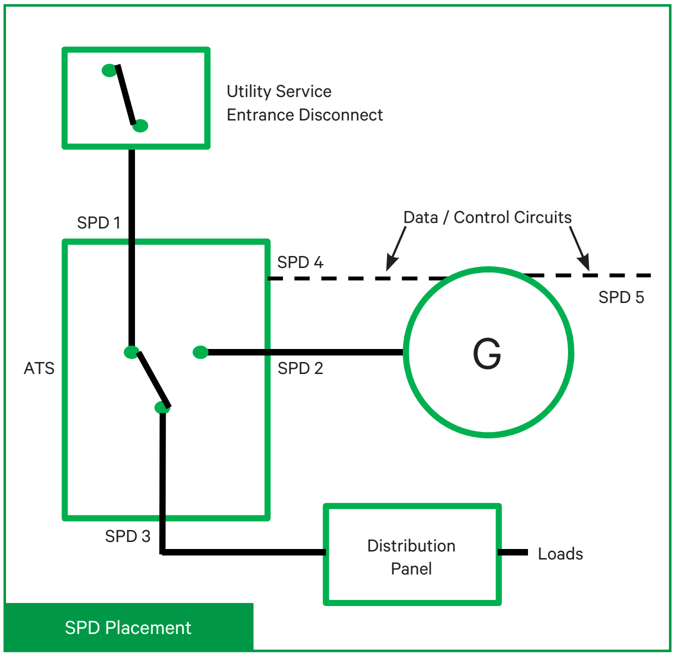
RECOMMENDATIONS

When designing a standby power system with an Automatic Transfer Switch, SPDs should be provided as follows:

- SPDs should be installed on the load sides of the service entrance, generator, and transfer switch, where shown at Positions SPD 1, SPD 2, and SPD 3, respectively, on the figure below. An existing service entrance SPD located near the transfer switch meets the intent of SPD 1. SPD 2 protects the generator. SPD 3 protects downstream loads and is arguably the most important SPD in this context.



- Because control and monitoring equipment are also susceptible to electrical transients, any data and control circuits leading from the ATS and generator should also be protected by SPDs, where shown at the positions of SPD 4 and SPD 5. Longer cable runs should include SPDs at each end. This is particularly important where conductors enter facilities from outdoor locations. Select SPDs and voltage ratings based on the communication protocol.

- Because Type 1 SPDs contain UL-required safety features that can simplify installation, Type 1 units should be considered for each location.

- The SPD MCOVs should provide sufficient 'voltage headroom' to accommodate voltage fluctuations. For typical 480Y/277V Grounded Wye systems with adequate voltage regulation, MCOVs of 320V for Line-to-Neutral, Line-to-Ground, and Neutral-to-Ground modes, and 552V for Line-to-Line modes should be considered. For 480Y/277V Grounded Wye systems having questionable voltage regulation, or for 480V ungrounded systems, use 552V. For other voltage and grounding applications, obtain recommendations from the manufacturer's application guide or customer support team.

- SPDs with 20kA I-nominal discharge current ratings offer the greatest robustness, and are well-suited for locations near service entrances and ATS equipment.

- To facilitate service, each SPD should be equipped an integral disconnect switch or installed with a circuit breaker or on-off safety switch.

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