

The Locomotive

Guidelines for Providing Surge Protection

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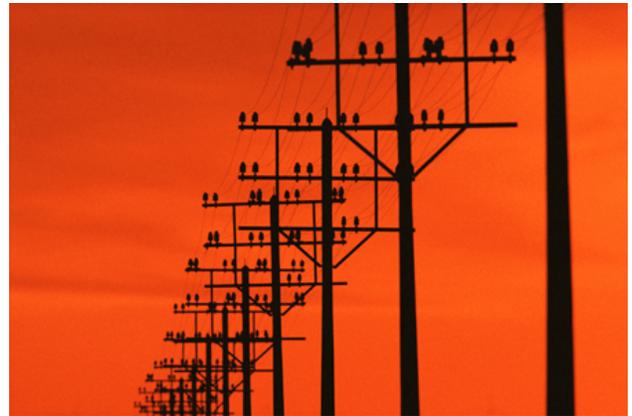
Introduction

Damage from electrical transients, or surges, is one of the leading causes of electrical equipment failure. An electrical transient is a short duration, high-energy impulse that is imparted on the normal electrical power system whenever there is a sudden change in the electrical circuit. It can originate from a variety of sources, both internal and external to a facility.

Not Just Lightning

The most obvious source is from lightning, but surges can also come from normal utility switching operations, or unintentional grounding of electrical conductors (such as when an overhead power line falls to the ground). Surges may even come from within a building or facility from such things as fax machines, copiers, air conditioners, elevators, motors/pumps, or arc welders, to name a few. In each case, the normal electric circuit is suddenly exposed to a large dose of energy that can adversely affect the equipment being supplied power.

The following is a guideline on how to protect electrical equipment from the devastating effects of high-energy surges. Surge protection that is properly sized and installed



is highly successful in preventing equipment damage, especially for sensitive electronic equipment found in most equipment today.

Grounding Is Fundamental

A surge protection device (SPD), also known as a transient voltage surge suppressor (TVSS), is designed to divert high-current surges to ground and bypass your equipment, thereby limiting the voltage that is impressed on the equipment. For this reason, it is critical that your facility have a good, low-resistance grounding system. Without a proper grounding system, there is no way to protect against surges.



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All recommendations are general guidelines and are not intended to be exhaustive or complete, nor are they designed to replace information or instructions from the manufacturer of our equipment. Contact your equipment service representative or manufacturer with questions.

Consult with a licensed electrician to ensure that your electrical distribution system is grounded in accordance with the National Electric Code (NFPA 70).

Zones Of Protection

The best means of protecting your electrical equipment from high-energy electrical surges is to install SPDs strategically throughout your facility. Considering that surges can originate from both internal and external sources, SPDs should be installed to provide maximum protection regardless of the source location. For this reason, a "Zone of Protection" approach is generally employed. The first level of defense is achieved by installing an SPD on the main service entrance equipment (i.e., where the utility power comes into the facility). This will provide protection against high energy surges coming in from the outside, such as lightning or utility transients.

However, the SPD installed at the service entrance will not protect against internally generated surges. In addition, not all of the energy from outside surges is dissipated to ground by the service entrance device. For this reason, SPDs should be installed on all distribution panels within a facility that supply power to critical equipment. Similarly, a third zone of protection would be achieved by installing SPDs locally for each piece of equipment being protected, such as computers or computer controlled devices. Each zone of protection adds to the overall protection of the facility as each helps to further reduce the voltage exposed to the protected equipment.

Coordination of SPDs

The service entrance SPD provides the first line of defense against electrical transients for a facility by diverting high-energy, outside surges to ground. It also lowers the energy level of the surge entering the facility to a level that can be handled by downstream devices closer to the load. Therefore, proper coordination of SPDs is required to avoid damaging SPDs installed on distribution panels or locally at vulnerable equipment. If coordination is not achieved, excess energy from propagating surges can cause damage to Zone 2 and Zone 3 SPDs and destroy the equipment that you are trying to protect.

SPD Ratings

When selecting an SPD for a given application, there are several considerations that must be made:

- **Application** – Ensure that the SPD is designed for the zone of protection for which it will be used. For example, an SPD at the service entrance should be designed to handle the larger surges that result from lightning or utility switching.
- **System voltage and configuration** – SPDs are designed for specific voltage levels and circuit configurations. For example, your service entrance equipment may be supplied three phase power at 480/277 V in a four-wire wye connection, but a local computer is installed to a single-phase, 120 V supply
- **Clamping voltage** – This is the voltage that the SPD will allow the protected equipment to be exposed to. However, the potential damage to equipment is dependent on how long the equipment is exposed to this clamping voltage in relation to the equipment design. In other words, equipment is generally de-signed to withstand a high voltage for a very short period of time, and lower voltage surges for a longer period of time. The Federal Information Processing Standards (FIPS) publication "Guideline on Electrical Power for Automatic Data Processing Installations" (FIPS Pub. DU294) provides details on the relationship between clamping voltage, system voltage, and surge duration.

As an example, a transient on a 480 V line that lasts for 20 micro-seconds can rise to almost 3400V without damaging equipment designed to this guideline. But a surge around 2300 V could be sustained for 100 microseconds without causing damage. Generally speaking, the lower the clamp voltage, the better the protection.

- **Surge current** – SPDs are rated to safely divert a given amount of surge current without failing. This rating ranges from a few thousand amps up to 400 kiloamperes (kA) or more. However, the average current of a lightning strike is only approximately 20 kA., with the highest measured currents being just over 200 kA. Lightning that strikes a power line will travel in both directions, so only half the current travels toward your facility. Along the way, some of the current may dissipate to ground through utility equipment.

Therefore, the potential current at the service entrance from an average lightning strike is somewhere around 10 kA. In addition, certain areas of the country are more prone to lightning strikes than others. All of these factors must be considered when deciding what size SPD is appropriate for your application.

However, it is important to consider that an SPD rated at 20 kA may be sufficient to protect against the average lightning strike and most internally generated surges once, but an SPD that is rated 100 kA will be able to handle additional surges without having to replace the arrester or fuses.

- **Standards** – All SPDs should be tested in accordance with ANSI/IEEE C62.41 and be listed to UL 1449 for safety.

Data Line Protection

Electrical transients are not confined to the electrical distribution system. They can enter a facility through phone/fax lines, cable or satellite systems, and local area networks (LAN). Therefore, in order to achieve maximum protection from surge damage, SPDs should be installed on all systems susceptible to electrical transients.

Installation

For maximum protection, SPDs should be installed as close to the equipment being protected as possible. Cable lengths should be as short and straight as possible to minimize the resistive path of the circuit to ground. A solid connection to the system grounding conductor is essential for proper operation of the SPDs. The surge protectors should be equipped with indicators that show if the circuit is grounded and operating properly, and the units installed so these indicators can be easily inspected.

All service entrance and distribution panel SPDs should only be installed by a licensed electrician familiar with the equipment and its use. In addition, Hartford Steam Boiler strongly recommends that a professional engineer experienced with surge suppression technology be retained to design the protection scheme for your facility to ensure all SPDs are properly sized and coordinated.

Pricing

Depending on the application and ratings, SPDs for service entrance equipment range from \$500–\$6,500. Data line and AC receptacle protection ranges from \$20 – \$150.

About the Author

Matthew Glennon is a registered Professional Engineer in New Jersey with over 12 years of experience in electric power engineering and construction. He is a magna cum laude graduate of Manhattan College where he earned a Bachelor of Engineering degree in electrical engineering. In addition, he holds a Master of Engineering degree in electric power engineering from Rensselaer Polytechnic Institute (RPI) in Troy, N.Y., and an MBA in Finance from Rutgers University. He is a member of IEEE, NFPA, and the National Society of Professional Engineers (NSPE), as well as a Correspondent to the National Academy of Forensic Engineers (NAFE).