

# Surge Protective Devices—Key Components in Building Electrical Infrastructure

Andi Haa, Consultant, Quality Plus

Carey Mossop, Director, Surge Protection Business, Schneider Electric

Steve Rood, Director Codes & Standards, Legrand/Pass & Seymour

The types of loads we connect to a building's electrical system today vary greatly from what may have been connected 50 years ago. Today's buildings rely heavily on electronics, communications, and microprocessors for some of the most basic functions. These include electronic controls built into a compact fluorescent or LED (light-emitting diode) light bulb, as well as sophisticated building control and automation systems. Automated systems are incorporated in a building's emergency system as well.

This increased use of electronics demands an electrical infrastructure that takes into account the increased sensitivity of electronic loads to voltage transients that can enter the electrical system. These transients can enter through external sources such as lightning and other electrical faults occurring outside the building, as well as through the routine switching of loads inside the building that occur as part of normal operations.

## Emergency Systems

A new section requiring surge protection has been added to the *National Electrical Code*<sup>®</sup> (NEC) 700.8; Article 700 covers emergency systems. These systems cover illumination and power for essential equipment such as emergency lighting for egress. Emergency systems cover safety for human life where legally required by municipalities, state agencies, federal agencies, or local governments having jurisdiction.

A distinction is drawn between Articles 700 and 708 Critical Operations Power Systems in that Article 708 requires systems to be continuously operated throughout an emergency. The new addition to Article 700 is 700.8 Surge Protection, which states: "A listed SPD shall be installed in or on all emergency systems switchboards and panelboards."<sup>1</sup>

The intent of the new requirement is to illustrate the need for continued surge protection throughout emergency power distribution when critical power is required. Too often surge protection is installed at the service entrance only, with little regard for the critical requirements of life safety systems. It does not promote effective egress when the emergency system does not function due to damage from a transient event.

The addition of surge protection to NEC 700.8 addresses this issue by installing surge protection throughout the emergency power distribution network, thus eliminating the chance for the

emergency system to be made inoperable by a surge event that did not come directly through the service entrance conductors.

Additional equipment covered under this section may include:

- automatic transfer switches
- emergency warning systems
- emergency communications systems
- public egress / evacuation sites
- egress illumination
- fire alarm systems
- remote operated doors
- smoke alarms and detectors
- high-rise elevators
- fuel cell power systems
- UPS systems

## Missing Guidance

What the code does not include is guidance on what size and type of surge protection must be used. What are appropriate guidelines in setting the correct levels of surge protection to address this new code requirement?

Article 700.8 does not state a surge current rating for the SPD, nor are there any size recommendations provided elsewhere in the NEC.

Guidance is provided, however, in NFPA 780. This standard covers lightning protection systems (LPS) and requires that surge protection be installed as an integral part of the LPS system.

### NFPA 780 STATES:

"4.18.2 Surge Protection Requirements

Surge protection devices are intended to be installed ahead of the service entrance equipment and other incoming wiring to limit transient voltage by discharging or bypassing transient currents to ground. ... A fault can occur by lightning directly striking a phase conductor or striking a nearby-grounded object, such as a transmission shield wire or tower."<sup>2</sup>

and

<sup>1</sup> NFPA 70, *National Electrical Code*, 2014 Edition, p. 70-653

<sup>2</sup> *NFPA Handbook 780-2011*, Section 4.18.2

## “4.18.3.1.1 Surge Threat Levels

SPDs at the service entrance shall have a nominal discharge current (In) rating of at least 20 kA 8/20 μs per phase.”<sup>3</sup>

Guidance can be taken from the lightning protection standard as it gives a minimum recommendation of 20 kA (In).

When dealing with critical power, it is best to cover all protection modes. IEEE establishes this practice in Standard 1100 *Powering and Grounding of Electronic Equipment*.

### SECTION 8.6.3 STATES:

“In addition to SPDs installed in the service entrance equipment, it is recommended that additional SPDs of listed Category B or Category A, as specified in IEEE Std C62.41,1 be applied to downstream electrical switchboards and panelboards, and panelboards on the secondary of separately derived systems if they support communications, ITE, signaling, television, or other form of electronic load equipment.”<sup>4</sup>

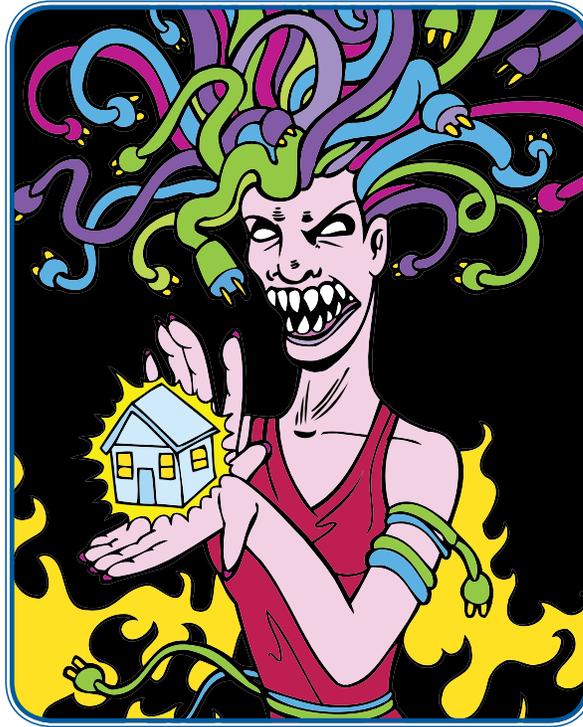
SPDs are very effective in mitigating transient overvoltages thus preventing equipment damage or malfunctions caused by excessive voltage being driven into equipment from switching, direct or indirect lightning strikes, or high voltage power lines crossing into low voltage power lines. Any of these events can cause the system voltage to abruptly spike.

The nature of a transient event is a very short, fast event, generally in the 5 to 200 microsecond range. This momentary increase in voltage may create a permanent conductive path resulting in an electrical component’s destruction.

For emergency system installations, this is not acceptable. These systems must have reliable power. An unwanted transient overvoltage should not be allowed to cause an emergency power system to become inoperable. That is why the cascade approach for surge protection is recommended.

The cascade approach is simply layering SPDs throughout the electrical system, starting at the service entrance and

including the downstream panelboards. The key is to identify where electrical equipment is used, and install SPDs in those distribution panels. SPDs used at the service entrance should have a nominal discharge current rating of 20 kA and the distribution panels should have a nominal discharge current rating of 10 kA or 20 kA.



When an SPD is selected, the maximum continuous operating voltage (MCOV) becomes an important consideration in addition to the nominal discharge current rating (kA). When the MCOV exceeds the line voltage with an excessive level, the SPD will allow low-amplitude transients to pass through into the equipment.

If the SPD is selected with an MCOV that is too low, or too close to the operating voltage, the SPD may turn on for events that are not transients but are fluctuations in the normal power system. This operation would result in an untimely end of life for the SPD. The end of life is caused by the SPD attempting to become a voltage regulator for the power system. When this happens the SPD will not last as intended due to its operation (conducting rated fault current) when the normal power system voltage is within predictable tolerances, I.E., the SPD is not operating on transients but is operating on power system swells.

Normal tolerances for SPDs are up to 15 percent above the nominal incoming voltage. The SPD must be installed with appropriate voltage and surge current ratings. The SPD needs to be able to handle the voltage tolerance of the power system and be able to withstand the surge current expected at that location in the power distribution system.

## Keeping Emergency Systems Safe

The 2014 edition of the *NEC* is now in effect in nearly half the states and continues to be adopted nationwide over the next few years. Each state has its own adoption policy for the inclusion of updates to it. The inclusion of multiple levels of surge protection will be a great improvement to keeping the emergency system operational at all times. These changes are important for consulting and specifying engineers to incorporate into their specifications now. ☺

*Ms. Haa, Mr. Mossop, and Mr. Rood are members of a task force within the Industry Development Committee of the Low Voltage Surge Protective Devices Section.*

<sup>3</sup> *NFPA Handbook 780-2011, Section 4.18.3.1.1*

<sup>4</sup> *IEEE Standard 110-2005 Recommended Practice for Powering and Grounding Electronic Equipment, Section 8.6.3*