2014 National Electrical Code and Surge Protective Devices

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The surge protection industry has undergone many changes over the last several years. The 2014 National Electrical Code (NEC) has introduced several new considerations for surge protective devices (SPDs). The SPD industry continues to be subject to interpretation and this paper will help provide some clarification. There are two major changes to the 2014 code. The articles changed are: 285.13 for component type SPDs and 700.8 for the inclusion of surge protection for emergency systems.

Component Type Surge Protection

NEC 285.13 covering Type 4 and Other Component Type SPDs states:

> *"Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer."* [1]

An understanding of SPD component assemblies is needed to help explain these new code changes. What is a component type and a component assembly? There are 2 standards to review. The NFPA 70 National Electrical Code and UL 1449, Standard for Surge Protective Devices. These standards are meant to work together; where UL 1449 is the supporting standard for NFPA 70. The NEC is currently on a three year revision cycle, where the UL 1449 document is revised to meet the safety requirements for this ever changing industry and is updated much more frequently. Due to these separate development cycles there is a bit of a discrepancy as to what is being used. Most devices used today are Type 1, Type 2 or Type 3 component assemblies. The UL 1449 current edition has expanded the use of SPD types and component assemblies. The general understanding of component assemblies is that they are installed into other electrical equipment. There have been many questions as to how these devices should be installed. Here is a quick explanation on what component assemblies represent. This new code requirement helps to clarify that an internally installed SPD should be part of the system design and intended to be part of the electrical listing.

Figure 1: Integrated Component Assembly

> *"Type 4 Component Assemblies – Component assembly consisting of one or more Type 5 components together with a disconnect (integral or external) or a means of complying with the limited current tests in 44.4."* [2]

A Type 4 component assembly device is generally a subassembly consisting of a surge component together with a disconnection method and is a fundamental structure for a Type 1, 2, 3 component assembly and a Type 1 or Type 2 SPD.

> *"Type 1, 2, 3 Component Assemblies – Consists of a Type 4 component assembly with internal or external short circuit protection."* [2]

These devices are generally a complete SPD, but intended for a specific application. The major difference between a Type 1 or Type 2 component assembly and a Type 1 or Type 2 SPD is that component assemblies have exposed terminals. Most component assemblies are intended for installation into a specific electrical appliance, like an electrical panel or into an electrical control cabinet. This is the intent of what NEC 285.13 is addressing. When a manufacturer designs and builds an integrated assembly, it is specific to the intended application with the appropriate connection methods. The distinction between a component assembly and a Type 1 or Type 2 device, is that the component assembly is to be installed inside a specific piece of elec-

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trical equipment; where as the Type 1 or Type 2 device is a stand alone device and is intended to be installed by itself. A component assembly is not meant to be universally applied as an external electrical product. A perfect example is the Surgelogic™ SurgeLoc device for Square D™ NQ panelboards. It is designed specifically to be installed in place of breakers mounted in the power distribution section of a panelboard. This device has very specific requirements which allow it to be used in this space by Square D. However, it must also meet all the safety requirements of UL. See Figure 1. The clarification in NEC 283.13 distinguishes why specific manufacturers products should not be installed into another location or electrical product.

Emergency Systems

A new section for surge protection has been added to 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 (COPS) where Article 708 requires systems to be continuously operated throughout an emergency.

The new addition to Article 700 is:

> *"700.8 Surge Protection: A listed SPD shall be installed in or on all emergency systems switchboards and panelboards."* [3]

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, 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

What Size and Type of SPD

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. Let us take a practical approach to installing surge protection in emergency systems. NFPA 780 covers Lightning Protection Systems and requires that surge protection be an integral part of the LPS installation.

"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." [4]

"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." [5]

Guidance can be taken from the lightning protection standard as it gives a minimum recommendation of 20 kA (In). In calling on recommendations for standard industry practices, Square D has also been an advocate of the American Institute of Architects (AIA) MasterSpec.[6] The Master specification for surge protection recommends a 240-250 kA SPD for a service entrance location and a 50 to 120 kA SPD for downstream panelboards. For additional information see the paper "Choosing the Right Level of Surge Protection" [7]

As to the Type of device to use, it is given to the

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designer or installer to choose. A Type 1 or a Type 2 device would be equally sufficient if they are listed with a 20 kA (In) rating. Several SPDs will be installed downstream from the service entrance; therefore, either a Type 1 or Type 2 SPD would be acceptable. The intent is to protect the emergency system from failure to function in any event.

Why the Change?

When dealing with critical power, it is best to cover all protection modes. IEEE establishes this practice in the standard for Powering and Grounding of Electronic Equipment, Standard 1100. 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."* [3]

SPDs are very effective in preventing transient overvoltages that may cause 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 very short, 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 systems, 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 cascaded approach for surge protection is recommended. The cascaded 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 be 240kA or less and SPDs at the downstream panelboards should be in the 50 to 120kA range.

When an SPD is selected, the maximum continuous operating voltage (MCOV) becomes an important consideration in addition to the surge 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. ie, the SPD is not operating on transients but is operating on power system swells. Normal tolerances for SPDs are up to 15% 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.

Conclusion

The 2014 edition of the National Electrical Code is going into effect now and will continue over the next few years. Each state has its own adoption policy for the inclusion of updates to the NEC. 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. Best practices are to update your surge protection specification with the following clause: Emergency systems shall include 240kA SPDs at the service entrance switchboard and between 50 to 120 kA SPDs in panelboards.

For questions or more clarification on any of the topics covered here, please contact a technical assistance expert at (800) 577-7353.

1. NFPA 70, National Electrical Code, 2014 Edition, p. 70-141.
2. Underwriters Laboratories, Standard for Surge Protective Devices (Fourth edition, revised August 20, 2014), p. 7
3. NFPA 70, National Electrical Code, 2014 Edition, p. 70-653.
4. NFPA Handbook 780-2011, Section 4.18.2
5. NFPA Handbook 780-2011, Section 4.18.3.1.1
6. American Institute of Architects (AIA) MasterSpec. Section 264313
7. Schneider Electric, Choosing the Right Level of Surge Protection Document # 9910-0004A, p 3.