

**White Paper**

**Surge Protection:  
New Life Safety Requirements**

**Part 2 of 2**

**ASCO<sup>®</sup>**

## SURGE PROTECTION: NEW LIFE SAFETY REQUIREMENTS

### Electrical Code Safety Requirements

Although facility executives are well aware of the risks that surges pose to equipment, fewer seem aware of the importance of SPDs for life safety systems, the ASCO/BOM survey shows. As noted earlier, only 50 percent of respondents recognized the life safety risks of power surges. But those risks are so significant that they have led to code changes requiring expanded SPD use. The National Electrical Code (NEC®) sets minimum life safety requirements for electrical systems in facilities. Article 700.8, which requires SPDs on all emergency power system switchboards and panel boards, was added to NEC 2014, says Mark Earley, Chief Electrical Engineer for the National Fire Protection Association (NFPA®).

In an emergency such as a fire, a lightning strike, or even a power outage, electrical surges will occur. Nevertheless, emergency exit lighting must illuminate exits. Fire pumps must be ready to supply automatic sprinkler systems. Elevators must return to a building's main floor, where they can be operated by fire personnel. Fire doors must close, and alarms and emergency communications must all operate. When emergency equipment is compromised, the lives of building occupants are endangered. Protecting emergency equipment from damage or even destruction by transients during critical events is the role of surge protective devices.

"Emergency power systems are legally required to supply power automatically to designated emergency loads for illumination, power, or both when normal power is interrupted," explains Earley. "Emergency systems receive that classification by municipal, state, federal, or other codes, or by a governmental agency with jurisdiction." Such systems include emergency lighting, communication, fire control systems, and essential medical equipment.

While the NEC is a national code, each state can choose whether to implement it or use other requirements for life safety. According to the Electrical Code Coalition, the status of NEC adoption on January 1, 2017, was as follows:

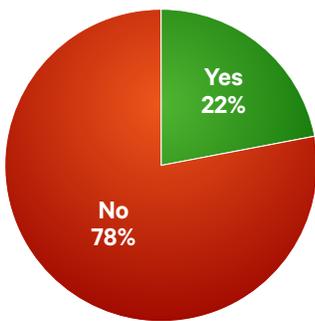
- Massachusetts had adopted NEC 2017
- Thirty-five states had adopted the 2014 code
- Five states observed NEC 2011
- Six states still used NEC 2008
- Arizona, Missouri and Mississippi relied on local jurisdictions to adopt the NEC

Many states are in the process of adopting newer versions of the NEC. According to the Electrical Code Coalition, as of January 1, 2017, 23 states were updating their statutes or administrative rules to reference the 2017 edition, four states were in the process of adopting NEC 2014, and one state was in the process of adopting NEC 2011.

What's more, NEC's 2017 edition, issued in September of 2016, added requirements for SPDs on disconnects supplying emergency systems in Article 620.51(E). This section addresses SPD requirements for elevators, escalators, moving walks, platform lifts, and stairway chair lifts. "Where any of the disconnecting means has been designated as supplying an emergency system load, surge protection shall be provided," says Earley.



Although the NEC has been widely adopted, many facility executives are unaware of its requirements, according to the ASCO/BOM survey. More than three quarters of the respondents were unaware of the recent NEC surge protection requirements. Two thirds were unsure if any of their facilities are located in states that have adopted NEC 2014. And more than three quarters didn't know whether NEC 2017 is poised to be adopted in any of those states within the next six months. Facility executives interested in the status of NEC adoption in their locations can contact their NFPA regional electrical code specialist.



*Are you aware of the recent 2014 and 2017 NEC requirement for surge protection on emergency circuits?*  
R=366



*Have any states in which you have facilities adopted the 2014 NEC?*  
R=370



*Is the 2017 NEC standard poised to be adopted within the next six months in any area where you have a facility?*  
R=370

There are special requirements for SPDs with patient care equipment. The National Electrical Code for Health Care Facilities (NEC Article 517) requires SPDs to protect medical equipment used in general or critical patient care areas. SPDs in these areas also must comply with the requirements of UL-60601 - Medical Electrical Equipment, Part 1: General Requirements for Safety and IEC 60601-1-1 - Medical Electrical Equipment - Part 1: General Requirements for Basic Safety and Essential Performance.

Ballengue is well aware that SPDs must meet specific hospital code requirements. "We have an audit every year to pull off any illegal surge protectors," he says.

## Emergency Circuits, Luminaires, Data Systems

Emergency systems under NEC 700.8 include branch circuit emergency lighting transfer switches, when they are connected on the load side of a branch circuit overcurrent protective device. Their purpose is to transfer emergency lighting loads from the normal electrical supply to an emergency supply.

Also included are emergency luminaires with a control input for an integral dimming or switching function that turns the lighting to full illumination when normal power is lost. Automatic load control relays are also used to reset dimmed or turned-off emergency lighting equipment to full illumination when normal power is lost, and to return the emergency lighting equipment to its normal status when normal power is restored. NEC Article 645.18 broadens the application of SPDs by specifying protection of critical data system equipment. The NEC states that Article 645.18 applies to “information technology equipment systems that require continuous operation for reasons of public safety, emergency management, national security or business continuity.”

In addition to common office equipment, other sensitive electronic equipment is covered by the NEC, according to Bolger. She points out that expensive hospital radiology equipment and life safety equipment, such as fire alarm systems, security systems, and fire pump controllers, require the surge protection specified for controllers in Article 695.15. Article 708.20 requires surge protection for public service notification equipment “at all levels of distribution.”

Many facility executives recognize the role of surge protection in the emergency management infrastructure. For example, Stolatis has installed SPDs to protect equipment used in organization’s emergency management system. He also uses SPDs to protect his facilities’ access control systems. But, according to the ASCO/BOM survey, more than half of respondents either do not have surge protection on emergency circuits or aren’t sure whether SPDs are present.

### Do you currently have surge protection on your emergency circuits? R=369



### Causes of Surges

NEMA estimates that between 60 and 80 percent of power surges originate within a facility. Common sources for surges are devices that switch power on and off. That could occur in a thermostat turning a heating or cooling element on or off, or a switch-mode power supply on the device itself.

Surges can be caused from both external and internal sources. “Common external sources include utility switching and lightning strikes,” says Bolger. “Common internal sources include faults, loose connections, power factor correction equipment (switching of capacitor banks), static electricity, operation of contactors, switching, etc.” Surges caused by switching power on and off may not immediately disrupt or damage equipment as quickly as lightning can. But their occurrence as part of everyday operations can take its toll over time.

When starting, high-powered electrical equipment uses large amounts of electrical power, explains Mojica. When they switch on, “they create sudden, brief demand for power that impacts the steady flow of voltage in the electrical system. These sudden surges can be severe enough to damage components immediately or gradually, since they occur regularly in most buildings’ electrical systems.”

Internal switching and oscillatory surges are caused by contactor, relay, and breaker operations; load factor correction by switching capacitor banks and loads; discharge inductive devices such as motors and transformers; starting and stopping loads; fault or arc initiation; ground fault arcing; fault clearing or interruption; power system recovery after an outage; and loose connections. Another source for internal facility surges is inductive coupling from building systems such as elevators, HVAC systems with variable drives, fluorescent light bulbs, copy machines, and computers.

In addition to internal power surges, facility executives must protect their facilities from transients that originate outside of buildings. Surges can result from direct contact between the facility’s electrical system and an energy source. More commonly, indirect or nearby lightning may induce surges into conductors in power or communication systems, as noted on the NEMA website.



“Overvoltages are the most severe types of surges caused by weather events such as direct lightning strikes,” explains Bolger. “In addition to high level overvoltages, indirect lightning strikes can also induce lower level overvoltages onto electrical cables, in both power and communication systems.”

“Overvoltages are the most severe types of surges caused by weather events such as direct lightning strikes...”

Outdoor cables and cameras are another source of potential surge problems. “Low voltage cabling can also transmit power surges into a building’s electrical system,” explains Bolger. “In addition to direct lightning strikes, exterior cameras, antenna towers, etc., which have buried low voltage components, can carry an induced surge from an exterior lightning strike inside a structure. It is important to protect all incoming electrical components, not just the power side, with surge protection.”

Surges also may come from utility grid and capacitor bank switching. For example, a fallen tree limb or a small animal can cause a fault on a line. Surges occur when the power is disconnected and then reconnected to the facility’s load.

Even when electricity is provided without interruption, transients can result from normal operation of the electrical grid. Rather than make constant adjustments to generation equipment to respond to customer electrical needs, utilities switch power from one element of the grid to another to keep generation equipment running at optimal constant speeds. But switching from one grid element to another also can cause power disturbances, including transients, spikes, overvoltage, and undervoltage conditions. Without adequate surge protection, a facility’s electrical system could transmit these transients, causing damage or operational difficulties.

Of course, unforeseen events, such as vehicle crashes into power poles, also can result in two utility power lines contacting each other causing a surge, notes Mojica.

### **ANSI®/UL® Requirements for SPDs**

Many commercial SPDs are hardwired to a facility’s electrical system. An SPD’s primary function is to eliminate short duration voltage spikes by diverting excess voltage to ground.

The American National Standards Institute/ Underwriters Laboratories (ANSI/UL) Standard for Surge Protective Devices specifies a host of safety tests for SPDs. These include evaluations of Maximum Continuous Operating Voltage (MCOV), Short Circuit Current Rating (SCCR), and other tests. In addition, ANSI/UL 1449 specifies performance tests for Voltage Protection Rating (VPR) and Nominal Discharge Current Rating (In or I-nominal). VPRs result from UL’s evaluation of peak let-through voltage, plus the I-nominal duty-cycle test based on passing 15 consecutive impulses at an SPD’s specified current rating. A major revision to ANSI/UL 1449 took effect in 2009 (aka, Third Edition), while a minor Fourth Edition update in 2014 addressed direct current (DC) and photovoltaic DC SPDs.

According to NEMA, facility executives need to understand the difference between a “listed” SPD and a “recognized component.” A listed SPD meets all requirements of ANSI/UL 1449. A recognized component SPD may not have been subjected to all ANSI/UL 1449 testing, and is assigned “conditions of acceptability” relating to its use. Those conditions must be observed to avoid creating a hazardous condition.

## Types of SPDs

SPDs are widely used today, but the places where they are used vary among facilities. By far, the most common use is to protect servers. Other common uses include service entrance switchboard/switchgear, distribution panels, and surveillance cameras.

### Do you currently have Surge Protective Devices (SPDs) protecting the following?

Location	Yes, on half or more	Yes, on less than half	No	N/A	Res.
Service Entrance Switchboard/Switchgear	43%	14%	31%	12%	357
Distribution Panels	35%	21%	37%	7%	355
Branch/Lighting Panels	28%	15%	50%	7%	344
Rooftop Air Conditioning Units	28%	15%	47%	10%	349
Servers	79%	10%	6%	5%	367
External Lighting	18%	14%	62%	6%	344
Interior LED Lighting	19%	12%	59%	10%	343
Surveillance Cameras	40%	15%	35%	10%	352
Motors	24%	25%	40%	11%	352
Industrial Control Panels	23%	15%	37%	25%	351

Based on their installation locations, five SPD types are covered by codes and standards. “Surge-protective devices that facilities engineers and consulting engineers are primarily concerned with consist mainly of three types ...,” explains Bolger.

Type 1 SPDs are permanently connected between the secondary side of the service transformer and the line side of the building service overcurrent protective device or main breaker, explains Mojica.

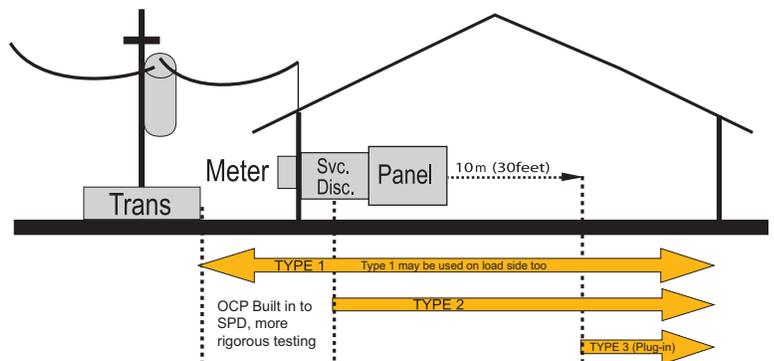
“Type 1 protects the electrical system from externally generated surge events,” Bolger says.

Type 2 SPDs also are permanently connected and are positioned on the load side of the main service overcurrent protection device, according to Mojica. These SPDs protect the electrical distribution circuits within a structure from both external and internal surges.

“Type 2 can also include SPDs at the branch panel level,” says Bolger.

Type 3 SPDs are portable devices that protect equipment, such as power strips. According to the Fourth Edition of UL 1449, approved by ANSI on March 17, 2016, Type 3 SPDs are point-of-use units. These SPDs may be cord-connected, direct plug-in, receptacle type, or SPDs installed at the equipment being protected.

“Type 3 is intended to be the surge protection closest to the equipment it is protecting,” says Bolger.



**SPD Types 1, 2, & 3**  
 Based on SPD Location within electrical distribution system.  
 (also coincides with ANSI/IEEE C62.41.2-2002 Categories C, B & A.)

Because SPDs are typed by their installation location within the facility’s electrical system, Mojica stresses the importance of selecting the correct type wherever these devices are used. “Specific applications must be customized to fit the unique needs of diverse operating environments and circumstances,” he says.

Beyond Type 1, Type 2, and Type 3, there are other types of SPDs, observes Bolger. “However, they are assembly and component protection-based and are addressed by equipment manufacturers.”



## Lightning Protection

According to the National Oceanic and Atmospheric Administration's National Severe Storms Laboratory (NSSL), about 20 million cloud-to-ground lightning strikes occur annually in the United States. Of these, approximately half involve more than one ground strike point.

"A lightning protection system provides a low resistance path for lightning to travel directly to ground in lieu of striking and entering a building or similar structure," explains Bolger. Along with SPDs, the system prevents induced voltage from entering into the building's electrical and communication systems.

SPDs in lightning protection systems must comply with UL 96A - Standard for Installation Requirements for Lightning Protection Systems and/or NFPA 780: Standard for the Installation of Lightning Protection Systems.

Among respondents to the ASCO/BOM survey, 51 percent reported that their facilities have lightning arrestors.

Mark DeVore, Chief of Engineering, in Delaware's Division of Facilities Management, says he has "surge suppressive panels and lightning arresters on equipment in certain cases."

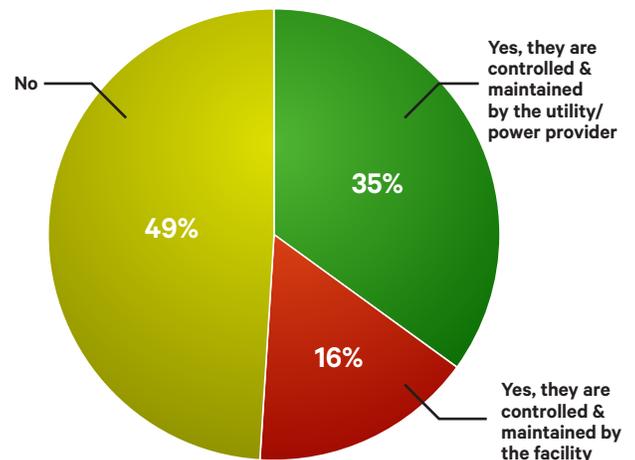
## Things to Consider

When considering installing an SPD, facility executives need to begin by assessing risk. Bolger suggests taking a critical look at the facility's location and whether it is prone to frequent power disturbances from lightning or an aging power distribution infrastructure. Engineers should also assess whether the distribution infrastructure is under constant construction, which can cause frequent utility switching.

Engineers should also evaluate the cost of equipment and the time that would be required to repair it. If the cost or the repair timeframe is great, the equipment may warrant protection using a SPD. If even short periods of downtime would result in adverse impacts to an organization's bottom line, the equipment probably should be protected with SPDs. Of course, if the equipment's failure would affect public safety, such as at hospitals and police stations, SPDs are a wise option and could be required by code.

Bolger also recommends a thorough examination of the equipment's limitations. "Can I install my SPD close to my main OCPD [Overcurrent Protection Device] in my distribution or does it need to be remote?" she asks.

Finally, SPDs themselves need to be evaluated. "Do I need to easily remove and replace my SPD without a lengthy equipment shutdown?" Bolger asks. "How often am I willing to replace my SPD? How do I protect my SPD? What is my available fault current where I am installing this equipment?"



Does your facility have Lightning Arrestors?  
R=376

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