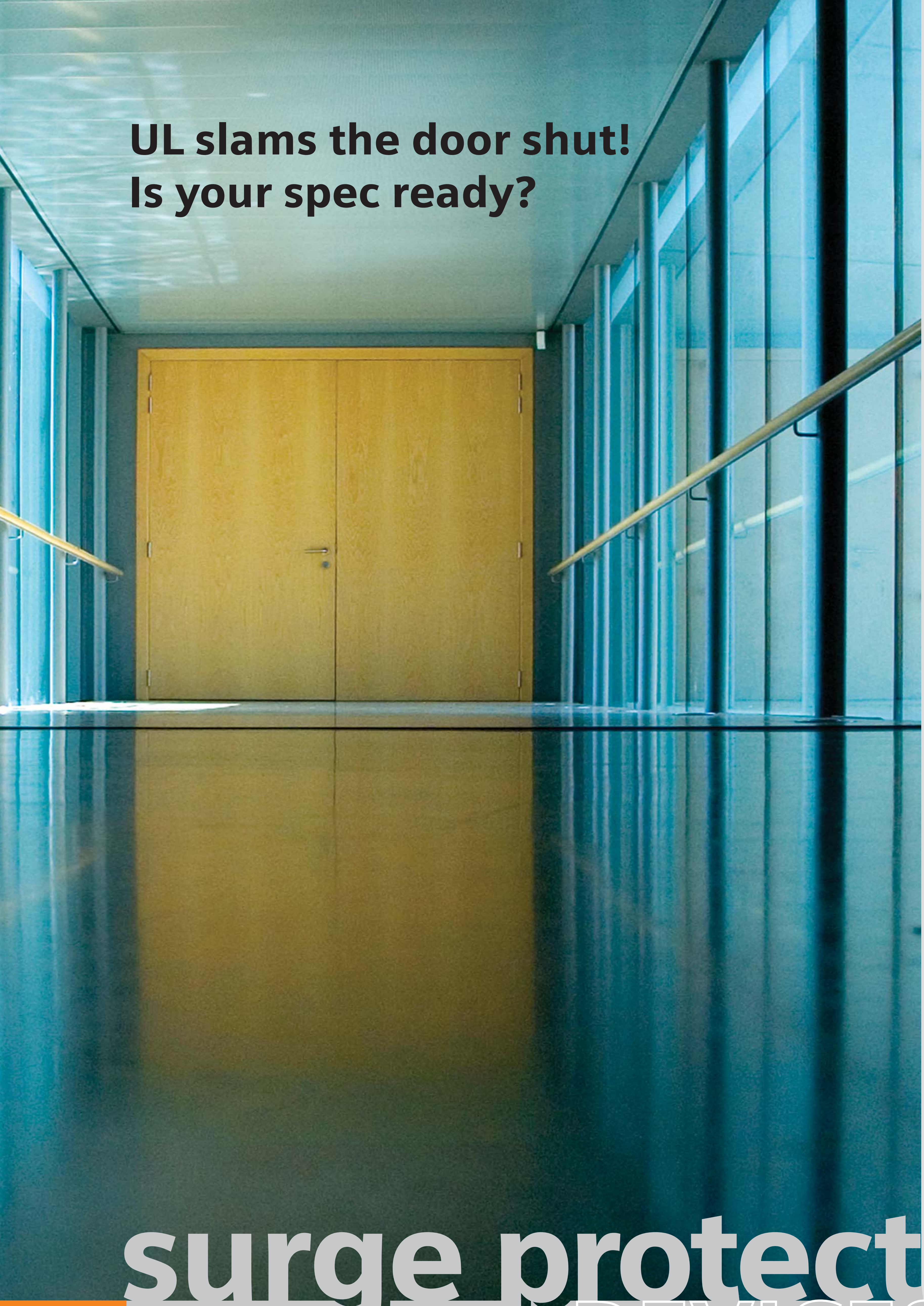
UL slams the door shut!
Is your spec ready?

UL 1449 Second Edition Revision Effective February 9, 2007 (aka UL 1449 Rev 2.5) Surge Protective Devices

White Paper



surge protective DEVICES

SIEMENS

Siemens Solution

In 1998, when UL 1449 Second Edition first introduced fault current tests, Siemens developed our TranSafe™ circuit solution comprised of coordinated internal fusing and thermal disconnectors. This superior design is one of the most effective in the market, and has stood the test of time. It has passed subsequent UL1449 revisions without modification.

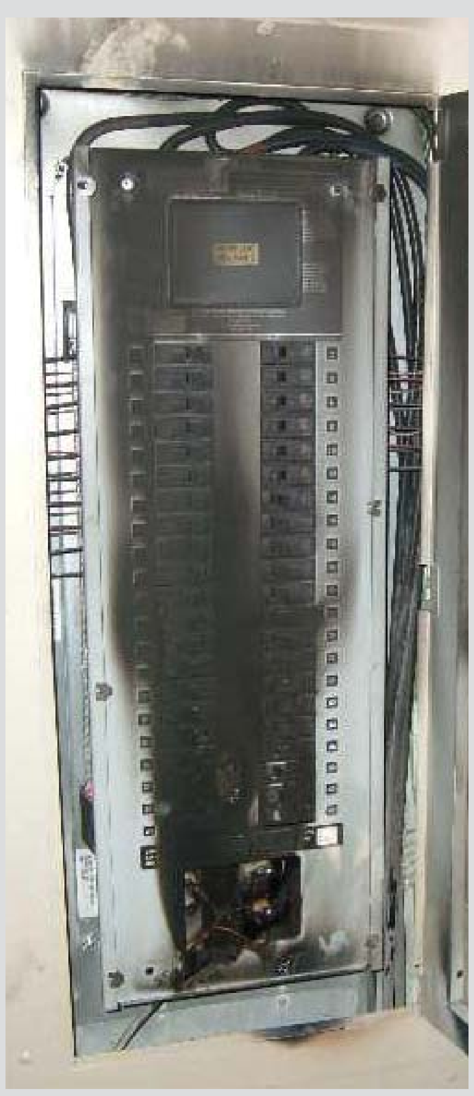
SPD Protection Blind Spots Eliminated

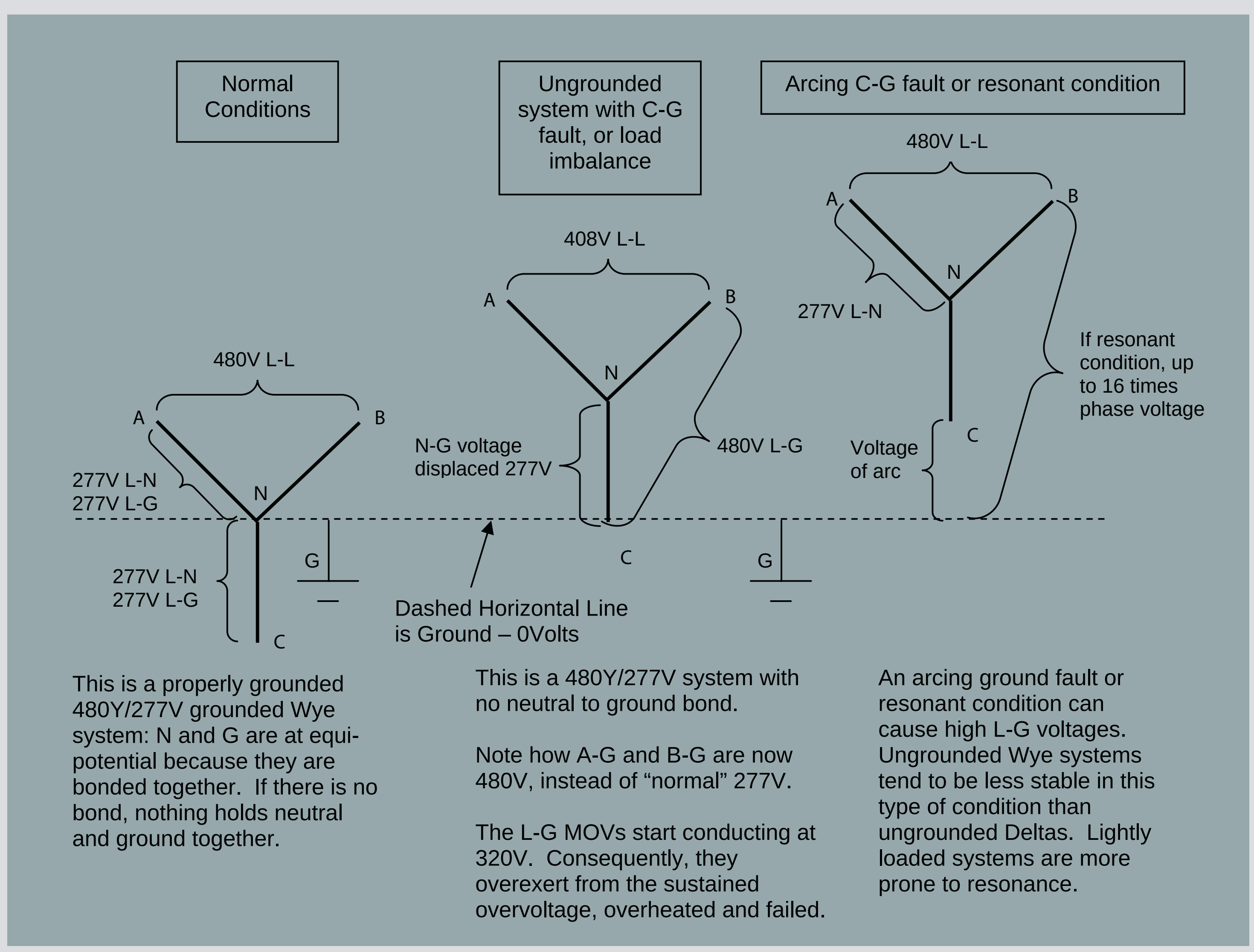
As the proliferation of surge protectors has grown, additional field reports provide insight into the failure characteristics of surge protective devices.

Effective February 9, 2007, UL 1449 Second Edition Revision requires Surge Protective Devices (SPDs) to pass new intermediate fault current tests. If your specification reads UL 1449 Second Edition, you may get older, untested and unproven SPDs. Your specification should read, "UL 1449 Second Edition Revision effective February 9, 2007, aka Rev 2.5 Listed" to ensure new standard compliant protectors are supplied to your projects. Why should you do fault current tests for surge protectors? Surge protectors aren't loads. The problem is that when surge protectors operate, they momentarily short circuit the distribution system to divert surges away from sensitive loads. Once a surge event is over, the suppressor resets to an open circuit condition. Surge protectors are non-discriminatory and cannot tell the difference between a surge voltage and a sustained over voltage caused by a distribution system anomaly. During a sustained over voltage, internal suppression elements conduct current, causing them to generate heat. This can result in fire or rupture depending on the severity. If a suppressor's internal protection circuit is not coordinated properly, unsafe operation could occur, possibly compromising other parts of the electrical system. Sustained over voltage in this context can be cycles, seconds, minutes; all of which are "sustained" relative to microsecond surges. This is sometimes labeled a temporary over voltage, but should not be confused with a transient over voltage. Evidence shows that the following electrical disturbances can cause surge protectors to see a sustained over voltage resulting in premature failure:

- Loss of secondary neutral; missing N-G bonding (system has no reference to ground, resulting in over voltages)
- Line to ground or line to line faults (system voltages skew due to fault)
- Misapplication (accidental 120V suppressor on 277V system)
- Poor voltage regulation (can raise voltage)
- Commingling (accidental contact with higher voltage circuits)
- Ferroresonance (This is a phenomenon characterized by sudden onset of very high sustained over voltages concurrent with high levels of harmonic distortion.)

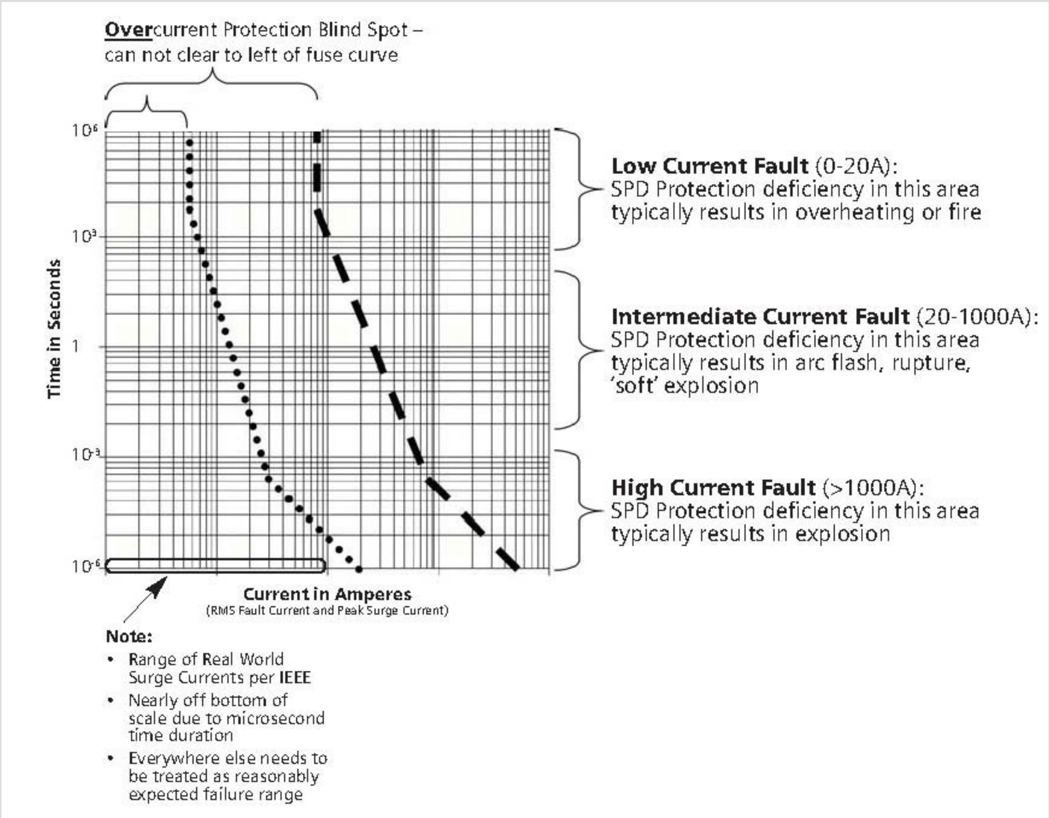
Visual examples of sustained over voltages are shown below:





How did we get here?

During the early developments of the surge protection industry, safety was un-emphasized. This was done because it was thought that surge suppressors only operated during surge conditions. Providing protection from electrical disturbances other than surges was deemed as an "upgrade" to standard unprotected designs. Under this notion, marketing efforts took precedence. One marketing direction that was adopted within the surge industry was to claim a suppressor can withstand large lightning strikes. Without standards support, suppliers turned to independent testing to bolster their claims. Surge protectors were sized to withstand test pulses as large as 200kA. In order to pass these large simulated lightning strikes, SPD fusing was modified to pass large surge current without clearing. Because fusing becomes a limitation, this type of marketing and testing relies on over-rated fusing or no Over Current Protection. Safety consequences are demonstrated in the fuse chart shown on the next page.



UL revised 1449 three times in efforts to shore up surge protector safety based on new scientific and field evidence.

This chart shows two different fusing selections; dotted on the left, dashed on the right. Note the Real World Surge Current window in the bottom left of the grid. The dashed curve will pass more surge current, at the expense of slowing clearing times and the larger blindspot in the upper left. At right are generalized failure descriptions based on fault current. In recent years, UL revised 1449 three times in efforts to shore up surge protector safety based on new scientific and field evidence. In each revision, new fault current testing was introduced. Manufacturers participate in this process and generally have multi-year compliance windows. The following summizes what fault current tests were adopted for each revision:

- 1998 — UL 1449 Second Edition – This introduced fault current testing for SPDs. Suppressors were subjected to low current 0.125A, 0.5A, 2.5A and 5A faults. High current withstand was demonstrated by the manufacturer selecting among test values of 5,000A, 10,000A or 25,000A, which became the Short Circuit Current Rating (SCCR). This corresponds to the Low and High Fault Current Testing depicted above.

- 2002 — NEC Article 285 was introduced to address SPD installations. Now SPDs were to be fault current tested as an entire device. The fault current rating of the internal fuse protection was no longer relied upon as evidence in the ability to clear faults safely. Once confirmed, an SPD is given an SCCR. Article section 285.6 requires SPDs to carry SCCRs that are equal or greater than available fault current where they are to be installed. Consequently, UL 1449 was adjusted and increased fault current testing levels up to 200,000A. Manufacturers could again select fault current levels and demonstrate withstand capability. This SCCR was posted on each device, so inspectors could verify compliance to NEC 285.6. This corresponds to revised High Current Fault Testing depicted above.

- 2007- UL 1449 Second Edition Revision (also known as Rev 2.5) – added intermediate fault current tests of 10A, 100A, 500A, and 1000A, and the 0.125A fault current test was deleted. The raised MCOV loophole which is explained later was closed with the requirement that all suppression components must conduct during fault current testing.

Why intermediate fault current testing?

Post UL 1449, Rev. 2002, field evidence suggested SPD fault current failures were still happening. Further investigation revealed that suppressors do not become perfect short circuits drawing the full available fault current due to the nature of the variable impedance semiconductors (MOVs, SADs, etc...).Failure impedance were not fixed but fluctuating. This warranted the adoption of intermediate fault current tests closing the gap between low and high fault current testing.

When fault current testing was first introduced with UL 1449 Second Edition, 1998, manufacturers modified or scrapped old designs for ones incorporating the following. It is unknown if variations of these designs are able to pass UL 1449 Second Edition, February 9, 2007 Revision intermediate fault current tests:

- Containment – Fusing was modified with heavy reliance on enclosure design to ensure conductive material and fire hazards would be contained.
  Over time, blind spots in this protection scheme were identified.

- Raised MCOV - Part of the UL fault current testing required phase to phase voltage to be applied to SPDs in order to simulate worst case fault conditions. Typically, phase to phase voltage would exceed a MOV's bias or turn-on point, better known as its Maximum Continuous Operating Voltage (MCOV). This then caused a suppressor to conduct current, which in turn would test the SPD's internal fault protection circuitry. Some manufacturers circumvented the intent of this test by just raising the MOVs Maximum Continuous Operating Voltage to above UL test voltage. This enabled existing SPDs to pass without the need for redesigns utilizing coordinated fault current protection.

- Coordinated Fuse and Thermal Protection – Since UL tested for low and high fault currents, coordinated protection between overcurrent protection and thermal cutouts ensures benign fault current operation over the entire fault current spectrum. Higher current faults are cleared by overcurrent protection. However, lower current faults below overcurrent protection's clearing threshold can cause problems. For example, a 30A fuse cannot clear a 20A fault. Internal suppression elements would overheat and catch fire. One solution is thermally sensitive disconnectors that open as suppression elements overheat. When coordinated correctly, safety protection blind spots are eliminated. (Siemens uses this methodology).

To summarize UL 1449 Second Edition Revision changes:

1. Fault current testing of 10A, 100A, 500A, and 1000A is applied for 7 hours or until the suppressor disengages or meets thermal equilibrium.

2. Surge protection elements must be driven into conduction so failure can be observed.

Most previous surge protector designs are not equipped to clear these currents. Fuses sized to pass large surge currents will have difficulty clearing intermediate fault currents. A fuse won't clear a 100A fault if it is sized to pass a 200,000A surge.

Be aware of potential liability

- If a specification still references the older "Second Edition," suppliers and contractors are within their rights to install units tested and listed under the obsolete, less safe standard. Because there is a cost advantage to providing the outdated units, this practice will continue until all old stock is depleted. The engineer must specifically call out "Second Edition Revision, effective February 9, 2007" to get the current, safer units. It's in the engineer's interest to use the most current standards and the safest equipment, and avoid the impression of endorsing equipment listed under the outdated standard.

- Do you normally specify breaker sizes? Suppose you specify 30A or 60A breakers. Suppose certain TVSS now require 20A breakers to meet the new UL. If a 60A breaker is installed, did the specifier unintentionally or unknowingly violate the UL listing? If 60A breakers are shipped to site, and 20A breakers are needed later, is the specifier liable for a change order? We recommend that submittals be required to include this information to avoid surprises.

- Be aware, some third party suppliers are claiming this new version of UL 1449 bans the use of surge protective devices integrally mounted within electrical distribution equipment. This is not the case. UL sets safety levels and how to test to these levels. But they do not get involved in design or installation.

What Should You Do?

To avoid liability and project complications, consider revising your specification. Contact your local Siemens Consulting Account Manager for assistance. In addtion, consider issuing addenda on existing projects requiring SPDs to comply with UL 1449 Rev.2.5. For assistance, discussion, or to avoid post UL 1449 Rev. 2.5 problems, please contact Siemens TPS Technical Support Group at (888) 333-3545.

Siemens Energy & Automation, Inc.
3333 Old Milton Parkway
Alpharetta, GA 30005

1-800-964-4114
info.sea@siemens.com

www.sea.siemens.com/power

PBFL-SURGE-0108 New 1M0108CW Printed in USA