



UL 1449 Second Edition Revision - Effective Feb 9, 2007 (UL 1449 Rev 2.5)

Effective February 9, 2007, UL 1449 Second Edition Revision requires TVSS to pass new intermediate fault current tests. To limit safety and liability issues, consider updating specifications to require compliance.

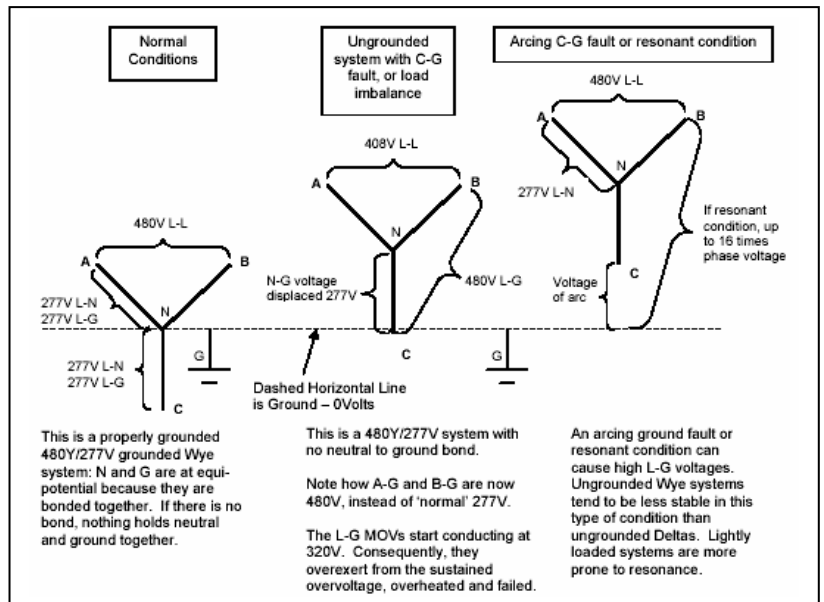
Why fault current test surge protectors? Surge protectors aren't loads

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. However, surge protectors are non-discriminatory. They can't tell the difference between a surge voltage and a sustained overvoltage caused by a distribution system anomaly. During a sustained overvoltage, internal suppression elements conduct current, causing them to generate heat. This can result in fire or rupture depending on severity, etc. Thus, if a suppressor's internal protection circuit is not coordinated properly, unsafe operation could occur, possibly compromising other parts of the electrical system. Note that 'sustained' overvoltage in this context can be cycles, seconds, minutes; all of which are 'sustained' relative to microsecond transients. This is sometimes labeled a temporary overvoltage, but not to be confused with a transient overvoltage.

As the proliferation of surge protectors has grown, field reports provide insight into the failure characteristics of surge protective devices. Evidence shows that the following electrical disturbances can cause surge protectors to see a sustained overvoltage resulting in premature failure:

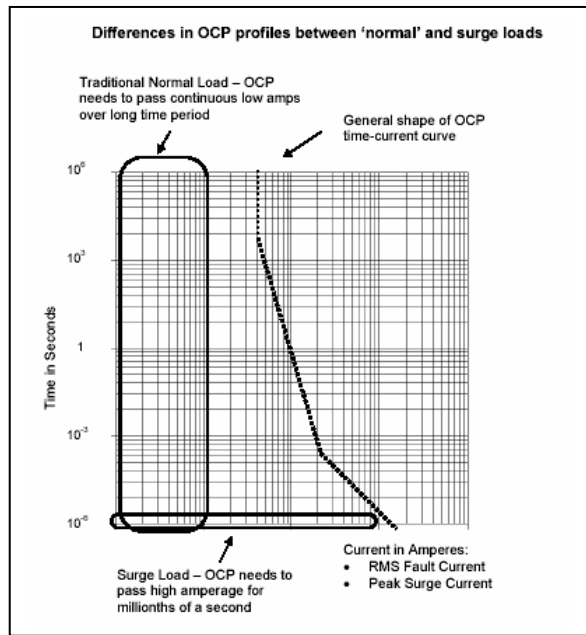
- Missing N-G bonding (system has no reference to ground, resulting in L-G overvoltages)
- Line to ground or line to line faults (system voltages skew due to fault)
- Misapplication (accidental 120V suppressor on 277V system)
- Poor voltage regulation (can raise voltage)
- Commingling (accidental contact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

Visual examples of sustained overvoltages from ground reference issues are shown at right:



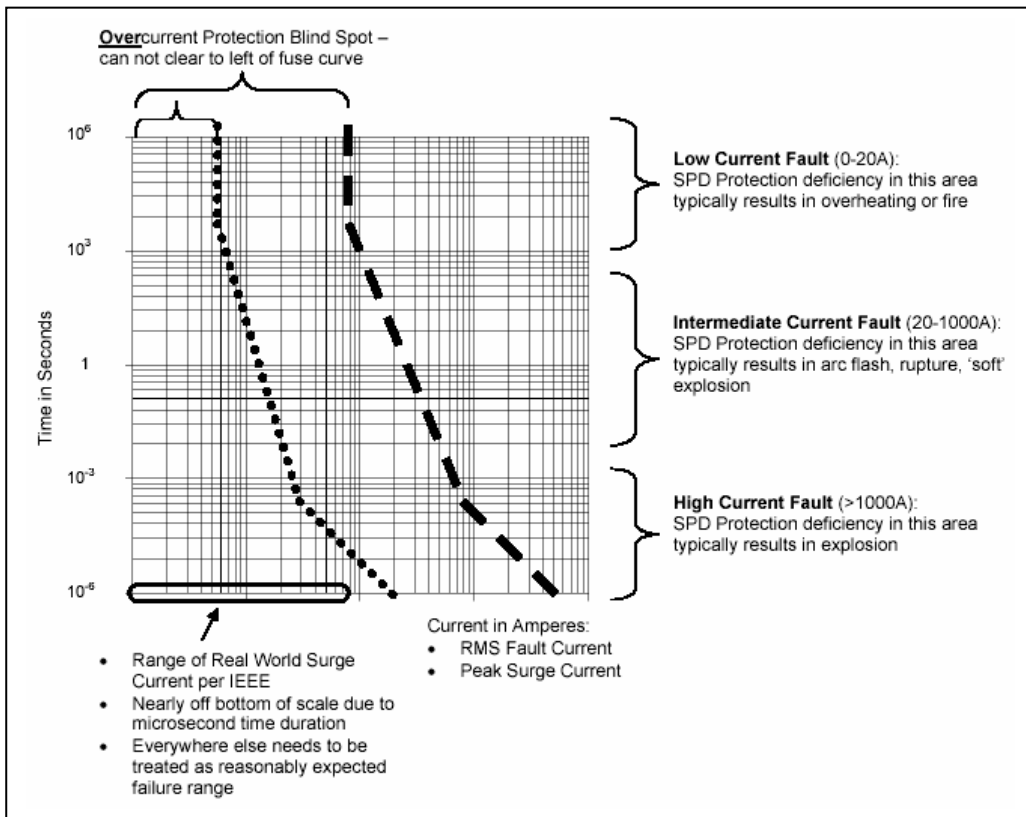
For years, one marketing bent within the surge industry is to claim that a suppressor can withstand enormous surge currents; those normally associated with lightning strokes. (Three successions of IEEE surge standards more accurately outline real-world surge threats.) In order to pass these large simulated lightning strikes, TVSS fusing was modified to pass large surge current without clearing. The implications to fusing & overcurrent protection (OCP) are substantial.

At right is a simplification of the load profile differences between surges and traditional loads. The variation is so dramatic that the load profiles are essentially perpendicular to each other:



Affects on clearing performance and safety:

Assume 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 SPD/TVSS 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 & field evidence. In each revision, new fault current testing was introduced. Manufacturers participate in this process and generally have multi-year compliance windows.

- 1998 - UL 1449 Second Edition – This introduced fault current testing for TVSS. 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 TVSS. Article 285.6 required SCCR to be equal or greater than available fault current. For example, if a suppressor is intended for a service entrance installation where the available fault current 100kA, then the suppressor needs to safely withstand UL's 100kA fault current test. UL 1449 adjusted and increased fault current testing levels up to 200,000A. Manufacturers could again select a fault current level 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) – Intermediate fault currents of 10A, 100A, 500A, and 1000A are added, and the 0.125A fault current test was deleted. In addition, all suppression components must conduct during fault current testing.

Why are changes and intermediate fault current testing being adopted?

Field evidence suggested failures in the gap or blind spot between low and high fault currents tested previously. This phenomena exposed safety coordination problems. Further investigation revealed that during fault conditions, suppressors do not become a perfect short circuit drawing the full available fault current. It turns out that failure impedance of variable impedance semiconductors varies too. They might only draw a portion of the available fault current. Thus, testing at intermediate fault currents is appropriate.

When fault current testing was introduced with UL 1449 Second Edition, manufacturers scrapped old designs for new ones that incorporated one of the following designs:

- 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 – UL intended for their fault current testing to turn on suppression elements so they would conduct. Thus failure mode could be observed. UL specified test voltages, typically phase to phase voltage, which exceeds the MOVs bias or turn-on point, better known as its Maximum Continuous Operating Voltage (MCOV).

This test had a loophole. If a manufacturer selected MCOV above UL's test voltage rating, the suppression elements did not turn on. The suppressor did not conduct, nor fail. Thus, the suppressor passed UL's pass/fail criteria, but did so by circumventing the intent of the test.

- 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.

Note how lower current faults below overcurrent protection's clearing threshold cause problems. For example, a 30A fuse can not 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. (APT uses this methodology).

To summarize UL 1449 Second Edition Revision changes:

1. Fault current testing of 10A, 100A, 500A, and 1000A are 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.

APT Solution

In 1998, when UL 1449 2nd Edition first introduced fault current tests, APT developed a protection solution using special internal fusing and thermal disconnectors. In conjunction with unique TranSafe™ circuitry and our voluntary above & beyond intermediate fault current testing, APT TVSS operate safely.

What Should You Do?

Be aware of potential snags:

- Based on industry practices when UL changed in 1998, old & obsolete stock may be pushed into the market. This is less safe product, and/or may not be supported or available into the future. We recommend that only UL 1449 Second Edition Revision (Rev 2.5) products be approved.
- Do you normally specify breaker sizes? Suppose you specify 30A or 60A breakers. Suppose certain TVSS now require 20A breakers to meet 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.

Consider revising your specification. APT can assist you in preparing or modifying a specification that meets YOUR needs.

Stay in touch with APT Engineering Sales at 800-237-4567, visit our website, www.apttvss.com, or email us at info@apttvss.com.