GE Energy
Digital Energy

Power Quality
Surge Protective
Devices (SPD)

application notes: replaceable modules

GE's SPD designs are non-modular with regards to individual protection modes or phases. They are designed with high surge energy, low component count, 40mm or larger Metal Oxide Varistor (MOV) arrays that will not fail or require replacement at levels equal to or lower than the rated and tested maximum single impulse surge level.

Additionally, the surge life ratings of GE's SPD products range from 3,500 to 20,000 IEEE® Cat. C3 repetitive surge impulses per mode. This tested rating directly relates to the transient surge life expectancy of the SPD. According to IEEE C62.45, the average expected frequency of a Cat. C3 (10kA) surge impulse at high risk locations, is at best on the order of less than 10 times annually. (Based on this empirical study of surge life and comparison to IEEE surge risk data, the theoretical surge life expectancy of many SPDs can be measured in the hundreds of years).

The majority of all industrial grade SPD devices have evolved dramatically in the past 10-15 years with regards to surge ratings and surge life expectancy. Even modular SPD designs that utilize a large number of smaller paralleled 20mm MOV arrays now have respectable surge life numbers. And with these impressive surge life numbers, one might wonder why a SPD manufacturer would promote a per phase or per mode replaceable surge module design?

The answer to this can be for one or more reasons. Some manufacturers can generate respectable revenue in the after-market module replacement business as a result of promoting "preventative maintenance" for their SPD products. Other manufacturers might have simply yielded and provide a modular option simply to meet specifications that have been influenced by manufactures that aggressively promote a modular design. And there are still others that will provide this option because they fully understand their product has some design limitations (such as underrated component level fusing) that will need to be replaced prematurely.

Many high-energy rated SPDs are available from reputable manufactures, and regardless of the design approach, are very robust and should not require routine or preventative maintenance. Their repetitive surge numbers would normally indicate that the suppression circuitry is more than adequate even under the most extreme surge conditions that a SPD could be potentially exposed to. Per NEC Article 285, Type 2 SPDs (formerly called TVSS) devices can only be installed on the load side of an electrical systems primary overcurrent device (Service Main Breaker). Conversely, the maximum tested surge ratings of almost all high-energy rated SPDs are normally at a level that would greatly exceed the insulation breakdown levels and propagation capability of electrical system wiring and distribution equipment. In other words, the SPD should never be exposed to a transient voltage potential that will exceed the maximum surge rating of the SPD due to the inherent voltage sparkover clearances of typical service entrance distribution equipment.

IEEE C62.41 standard, suggests that the nominal voltage sparkover at service entrance is approximately 10kV. If one assumes an electrical system load impedance, even as low as 1 ohm, a 10kV transient voltage potential would only yield a transient current of 10kA. This is well below the tested, per mode maximum surge levels of most high energy SPD devices that can range from 40kA to 300kA per mode and higher.

So, with all of this in mind, how does a SPD typically fail....?

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The overwhelming majority of SPD failures occur as a result of being exposed to an electrical system phase overvoltage. This is when the normal operating threshold of the SPD is exceeded for just a few cycles of abnormally high phase voltage that is usually well beyond 115% of the nominal level. This condition happens most frequently at electrical system startup or within a few weeks of installation on a newly installed electrical system. In a lot of cases, the cause is improper or non NEC-compliant grounding and bonding practices that cause the electrical system to become unstable and "float" with respect to ground. Other events might include utility overvoltage (swells).

In the event of a SPD failure caused by an abnormal phase overvoltage, all protected modes and all fusing integral to the SPD should be replaced. This functionally equates to a complete SPD replacement and should be specified regardless of design type....modular or non-modular. To understand this better, one must look at how SPD units are evaluated by UL for safety. The overvoltage/fault current test is intended as an end-of-life test for SPD. It is not a test that demonstrates the capability of the SPD to be repaired and placed back into service. UL does not evaluate the clamping performance of a SPD after an abnormal overvoltage failure event.

Once a SPD has been subjected to an abnormal phase overvoltage, the entire SPD should be considered for replacement. This is because when the SPD interrupts a system fault current, not only the Metal Oxide Varistors (MOVs), but other components within the suppression pathway can be damaged or altered. As just one example, an integral SPD that includes a disconnect switch that is not replaced after a system overvoltage with SPD fault failure, may experience contact pitting or other damage that will not be readily apparent. But even the slightest contact contamination or erosion might cause reduced surge clamping performance....even if the suppression module and fusing are replaced as new.

imagination at work

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