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ELECTRICAL SOURCE

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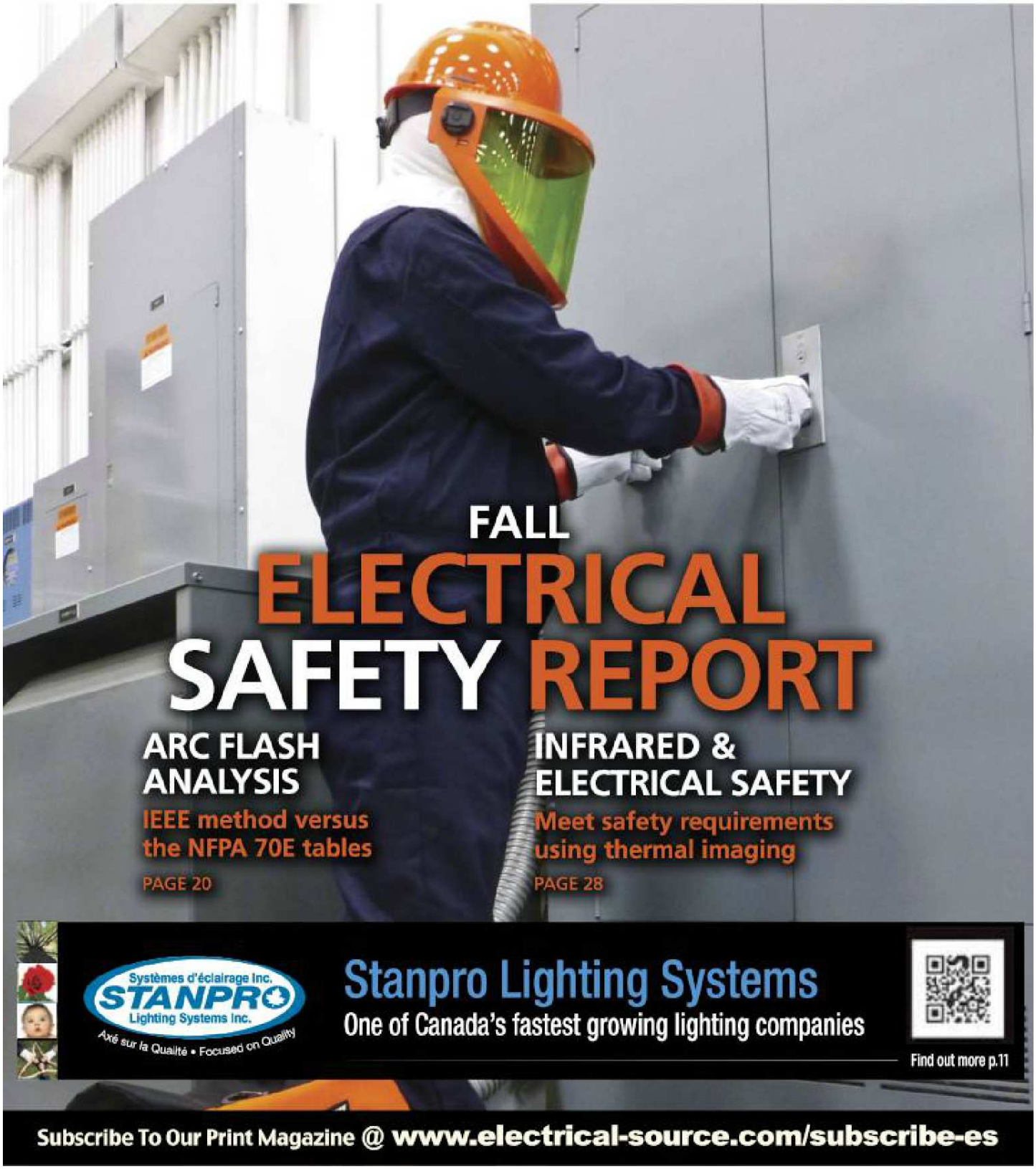

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PREVENT CATASTROPHIC FAILURES

How safe is your surge protection device?

BY DAVID KOMM, Mersen Electrical Protection

Surge protective devices (SPD) play an important role in protecting critical electronic components. However, all SPDs are sacrificial devices and, depending on the design and construction of the device, when it reaches end-of-life it could cause harm to your system.

SPD BACK STORY

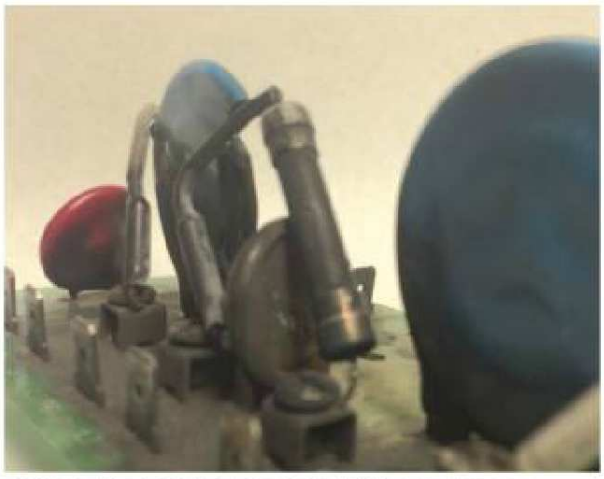
Historically, SPDs have provided adequate protection against high-level surges, however, they were also known for failing catastrophically. As a result, most SPDs were mounted on the equipment externally to help minimize component damage. In 2006, Underwriters Laboratories (UL), an international standards organization, updated their UL 1449 standard: *"Surge Protective Devices"*, which helped prevent the occurrence of catastrophic failures. When it was first introduced, many manufacturers struggled to pass the more stringent testing requirements in the updated UL 1449 standard.

METAL-OXIDE VARISTORS

Metal-oxide varistors (MOV) are the most commonly-used overvoltage technology in SPDs because they are cost effective and provide surge-limiting capability. An MOV's basic construction is a ceramic disc made up of various metal oxides sandwiched between two metal plates with leads and then covered with an insulating coating. MOVs come in several different shapes and sizes. Their performance is directly dependent on size. A larger diameter will result in a larger surge current rating and a thicker MOV will have a higher voltage rating.

Under normal operating conditions, a metal-oxide varistor has a high resistance and does not conduct current, although it does have a small value of leakage current. As the line voltage exceeds the MOV's maximum continuous operating voltage (MCOV), its resistance lowers which allows the MOV to shunt excess voltage to ground. Depending on the size of the surge and MOV, it will likely be capable of performing this operation several times before replacement is necessary.

A failed 40mm MOV that was "protected" by a thermal fuse



A failed 20mm MOV that was "protected" by a thermal fuse

INHERENT FLAWS

MOVs are very good at limiting surge currents, however, as described in the IEEE C62.72 standard: *"Guide for the Application of Surge Protective Devices for Low Voltage (1000 Volts or Less) AC Power Circuits"*, published by the IEEE, once they reach end-of-life the device fails as a short circuit. When the MOV fails, it will continually conduct current which causes the device to heat up. The heating condition is referred to as a thermal runaway; this presents a safety concern because, if left unprotected, the MOV will self-destruct.

Destruction of the metal-oxide varistor can result in varying degrees of explosion, the release of conductive ionized gases and thick smoke. This presents a hazard for any personnel that maybe be nearby and could create a failure in the connected equipment. For this reason, containment and failure prevention technologies are utilized.

A typical 34mm thermally protected MOV

The two aforementioned methods are designed to contain explosions within the enclosure, not to prevent the MOV from self-destruction. An important note to consider with these methods is that they may allow the MOV to vent conductive gases which poses as a safety concern.

A current-limiting fuse is also typically used to disconnect the MOV from the circuit when the device self-destructs. This presents a concern because current-limiting fuses published characteristics are not applicable for surges because they are tested for 60-hertz (Hz) or direct-current (DC) applications. The fuse must be sized properly to ride through a surge and only operate in the event of a failure. If the fuse tries to operate on a surge, it may not be able to absorb the surge energy and could explode. Some fuse manufacturers have developed specialty surge-rated fuses which are specifically designed to ride through a surge.

Fuse operation will typically occur after the MOV has already failed and causes a current spike. Figure 1 shows a standard 34 millimeter (mm) 320 volt (V) MOV used in conjunction with a surge-rated VSP10 fuse. The MOV entered the thermal runaway and ruptured causing a spike in current (5,000 amperes). When the spike occurred, the fuse opened and imposed a voltage spike on the system (1,000 volts).

PREVENTION OF FAILURE

A proven way to eliminate the MOV from self-destructing at its end-of-life is for the device to have an integral thermal link. This method is often referred to as a thermally-protected metal-oxide varistor. Since the thermal link is integral, it will disconnect the MOV from the circuit as it begins to approach a thermal runaway condition. This design method prevents MOV destruction across the entire fault spectrum ensuring safe operation at end-of-life without venting conductive gases.

CODES AND STANDARDS

SPDs listed to UL 1449 will have passed rigorous tests to ensure that the SPD will either have the ability to prevent the MOV from self-destructing or to contain an explosion if the MOV does self-destruct. At this point, the standard does allow SPDs that vent conductive gases through a connection opening. Any conductive gases that are allowed to escape into the panel may cause a cascading failure, such as an arc flash, between exposed conductors.

When purchasing any surge protection device, it is highly recommended that the device be listed by Underwriters Laboratories to UL 1449 standard. Keep in mind that just because an SPD is UL listed, it doesn't mean it will prevent MOV failure, it may only contain the failure. It is recommended that you inquire about the construction method used by the SPD manufacturer to ensure that all MOVs utilize an integral thermal link to prevent explosions that cause possible cascading failures. ES

David Komm is the technical services supervisor for Mersen in Newburyport, Massachusetts. He is also a member of Electrical Source's Editorial Advisory Board. For information on the original Thermally Protected MOV (TPMOV®) and SPDs utilizing TPMOV® technology visit www.ep-us.mersen.com.

COMMENTS: david.komm@mersen.com

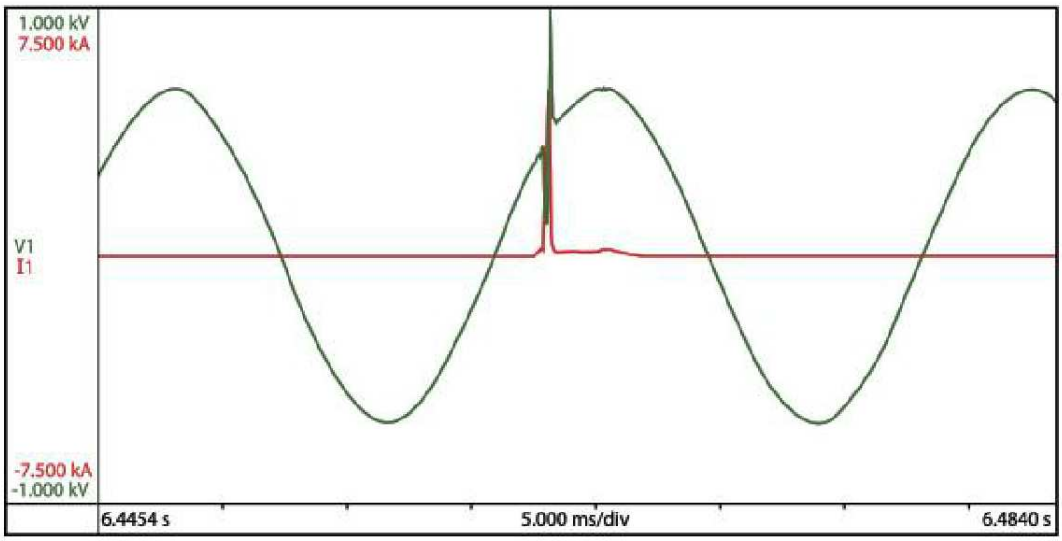


Figure 1: 34mm 320-volt MOV in series with a VSP10-2 tested at 480VAC 100kA