Transient Voltage Surge Suppression

The 2002 National Electrical Code (NEC) will add a new article (285) on Transient Voltage Surge Suppression (TVSS). While commonly employed in traffic signal, residential, commercial and industrial applications, there have been no NEC rules for installation. Currently the only guidance for a TVSS installation is Article 280, Surge arrestors. The need for an article on TVSS was stated very clearly by the proposal submitter, Alan Manche, of the Square D Co, in Proposal 5-316 for the 2002 NEC.

SUBSTANTIATION: *The Transient Voltage Surge Suppressor has become a common component of the electrical distribution system in North America. Unfortunately, the NEC presently does not recognize the installation of a TVSS, which has unique performance and safety concerns in comparison to a Surge Arrester in Article 280. Manufacturers of TVSS products reference Articles 250 and 280 as part of their installation instructions, but installers, and inspectors find nothing in the NEC recognizing a TVSS. This new proposed Article 285 is intended to address the unique safety concerns of TVSS products.*
Transient Voltage Surge Suppressors (TVSS) are being installed in residential, commercial, and industrial facilities in order to protect sensitive electronic equipment. TVSS products function similar to surge arresters, however, in order to provide protection for electronic equipment, TVSS devices begin to operate (i.e. -conduct electricity), much closer to the system operating voltage than a typical surge arrester. The NEC does not recognize or address the unique safety implications associated with the TVSS operating characteristics and the UL 1449 safety standard. Surge arresters are evaluated using a variety of IEEE standards, not UL 1449. TVSS products are tested at much lower surge current levels compared to surge arresters, therefore the NEC needs to include the additional safety requirements specific to TVSS devices. The UL 1449 Safety Standard evaluates products with a maximum rating of 600V and assumes the TVSS is installed on the load side of the service disconnect and its overcurrent protection. The NEC must require that a TVSS be installed on the load side of a service disconnect's overcurrent protection device in order to preserve the safety requirements found in UL 1449. The overcurrent protection is necessary to protect the conductors and electrical equipment if the TVSS is subjected to a system over-voltage. The over-voltage can send the TVSS directly into conduction, as properly designed, but if the overvoltage continues for a period of time beyond its designed capabilities it can cause the TVSS to fail shorted.

Review of Article of 285

Note- See the 2002 NEC for the complete text of Article 285

Note- The 2002 NEC numbering format has changed, dashes have been replaced with dots. This article will use the 2002 NEC numbering format.

Article 285 - Transient Voltage Surge Suppressors (TVSS)
I. General.

285.1 Scope. This article covers general requirements, installation requirements, and connection requirements for Transient Voltage Surge Suppressors (TVSS) permanently installed on premises wiring systems.
Comment- The scope gives us the correct application for installation and inspections. Only permanently installed TVSS devices are covered.

285-2. Definition. A Transient Voltage Surge Suppressor is a protective device for limiting transient voltages by diverting or limiting surge current, and it also prevents continued flow of follow current while remaining capable of repeating these functions.
Comment-The definition assists the user and inspector in applying the correct code rules

285-4. Number Required. Where used at a point on a circuit, the TVSS shall be connected to each ungrounded conductor.
Comment- A single phase 120/240 volt circuit would require a two pole TVSS.

285-5. Listing. A TVSS shall be a listed device.
Comment- The listing is UL 1449, 2nd edition.

285-12. Routing of Connections. The conductors used to connect the Transient Voltage Surge Suppressor shall not be any longer than necessary and shall avoid unnecessary bends.
Comment-A longer connection lead length adds more impedance and reduces the effectiveness of the TVSS. Some wired in TVSS units only have an 18" lead length.

285-21. Connection of the TVSS. Where a TVSS is installed, the following shall apply:
(A)Location.
(1) Service Supplied Building or Structure. The TVSS shall be connected on the load side of a service disconnect overcurrent device required in 230-91.

(C) Connection Between Conductors. A transient voltage surge suppressor shall be permitted to be connected between any two conductors - ungrounded conductor(s), grounded conductor, grounding conductor. The grounded conductor and the grounding conductor shall be interconnected only by the normal operation of the TVSS during a surge.
Comment-TVSS units can operate in two modes:
- Common – Neutral to ground
- Normal – Phase to neutral

285-25. Grounding. Transient voltage surge suppressor grounding connections shall be made as specified in Article 250 unless otherwise noted in this article. Grounding conductors shall not be run in metal enclosures unless bonded to both ends of such enclosure.

For a TVSS operating in a common mode will need a ground connection with a low impedance. A grounding conductor run in a metal enclosure that is not bonded to both ends of the conductor will form a choke and severely limit the current flow – bonding metallic conduits at both ends is required by NEC Section 250-64(e) for grounding electrode conductors, this rule will required bonding at both ends for the TVSS grounding conductor. Bonding needs to be done for any raceway, and all intervening metal junction boxes.

Need for TVSS

Some states, such as Florida have a high incidence of lighting and use TVSS on all controller input and output lines. Areas with a low incidence of lighting may have TVSS on only the power input to the signal controller. The amount of TVSS installed is directly related to the potential for damage. In the Pacific Northwest the lighting exposure is low, but there are often cases of high voltage lines dropping onto to signal mast arms or service drops, causing the same damage as a lighting strike.

TVSS Standards

It can be difficult for the end user to compare different products without some type of standard. Many low end consumer TVSS tout a "nano-seconds" transient clamping time, but response time is almost irrelevant for TVSS selection.

The Institute of Electrical and Electronic Engineers (IEEE) in Standard C62.41, established uniform requirements for TVSS devices. The three general operating environmental categories are:

- Category C-Outside and Service Entrance;
- Category B-Feeders and short branch circuits;
- Category A-Outlet and long branch circuits.

One of the tests done in UL 1449 is the limiting voltage test, consisting of:
1) A 6,000 peak voltage 1.2/50 microsecond waveform surge with 500 peak ampere 8/20 microsecond waveform surge
2) 20 each 6,000 peak voltage 1.2/50 microsecond waveform surge with 3,000 peak ampere 8/20 microsecond waveform surge
3) Test 1 is repeated.

The device is not allowed to have an emission of flame, ignition of the enclosure or create exposure to live parts. The suppressed voltage rate is assigned by averaging the limited voltages observed during the test and assigning a voltage rating. The lowest rating available is 330 volts

Many TVSS devices sold at the consumer level are not listed to UL 1449 2nd Edition, but are UL listed as "Temporary Power Taps" with one or two metal oxide varistors (MOV's) installed and then sold as a 'surge strip'. The danger with this type TVSS is that the MOV can overheat and explode in a transient or overvoltage and the TVSS can start a fire. The limiting voltage test is quite severe and a non-UL listed device may fail.

An end user can be assured of a quality product by using a UL listed 1449, 2nd edition TVSS. Many manufacturers have warranties on the downstream devices.

What Protection is needed?

TVSS should be applied in stages meeting the IEEE C62.41 Categories. In TVSS applications more is better and you certainly get what you pay for. For high exposure and critical applications TVSS would be installed at the service entrance panel, distribution panels and at the end user device. The typical traffic signal application does not have a distribution panel panel, but protection can be applied at the service entrance and in the signal cabinet.

Typical Traffic Signal Applications

Most traffic signals (TS) cabinets are fed with a 120v, 40 ampere circuit from an exterior panelboard or electrical service. A TVSS is mounted inside the traffic signal cabinet downstream of the main circuit breaker.

Instead of depending on the one TVSS device inside the TS cabinet, more protection would be obtained by installing a UL listed TVSS right at the main electrical service. This would service to reduce the transient, the additional conductor length to the traffic signal cabinet would add impedance and further reduce the transient. Many types of TVSS devices are available that would be suitable for installing at the electrical service:

- A two pole circuit breaker type for installation in a panelboard, however this would be not suitable for a high transient, but would be better than nothing.
- A NEMA 3R style TVSS that could be mounted below the service panel
- A meter socket type that installs behind the power meter. This type TVSS has the advantage of very short lead length.

Some TVSS units are available with alarm contacts for remote monitoring. A TVSS will typically contain primary and secondary protection. In some transients the TVSS will be damaged and no longer provide full protection.

Application Tips

- Keep lead wires to TVSS units as short as possible, avoid sharp bends.
- Bond all metallic enclosures (raceways) at each end that containing grounding electrode conductors, in addition to those metallic enclosures with grounding electrode conductors.
- A low resistance ground of 5 to 10 ohms should be sought both for lightning protection and for a ground reference.
- Consider the Traffic Signal Cabinet as a Category 3 environment. Add a UL Listed protector outside of the cabinet on the service if possible.
- For critical applications, use a TVSS with dry alarm contacts that can be remotely monitored

NEMA 3R TVSS
Typical small NEMA 3R enclosure (exterior) TVSS suitable for 120/240 volt single phase service panels. Maximum surge current is 50,000 peak amps.
Courtesy of Leviton Manufacturing Co., Inc

Meter Socket TVSS
This TVSS installs between the meter socket and meter. If approved by a serving utility, it is very simple to install and is very effective as the lead length is effectively zero. Maximum surge current is 65,000 peak amps

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Byline:

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