

# SURGE PROTECTION 101 : AN INTRODUCTORY BRIEFING

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## 1. WHY SURGE PROTECTION?

Voltage surges can stress sensitive electrical/electronic equipment and interrupt operational continuity and/or cause arc and sparks and fires. There are several generated sources of over voltages or transients.

1. From outside -- utility company substation switching activities. (40%)
2. From outside – lightning strikes either direct or indirect. (20%)
3. From inside – internal compressor, motor and pump startups. (40%)

Industry sources (NEMA, Citel, Dehn, LPC, Schneider, Surgelogic, etc.) report that cascaded application of Surge Protection Devices (SPDs) to AC power and signal/data lines has reduced bulb and ballast replacement 50%, electric motor repairs 50% and a reduction in microprocessor circuit board replacement by 85%. Of course, good grounding is essential too.

## 2. HOW DO SPDs WORK?

SPDs monitor overvoltages and react much faster than fuses and breakers. SPDs clip, “knock down” or shunt surges to survivable levels for connected equipment. Since SPDs divert to ground it is essential that good bonding with equi-potential and low impedance grounding all combine in the SPD performance. SPDs work automatically and are self-restoring to pre-transient conditions. SPDs may degrade over time with repetitive surge activity. A hybrid or three stage design is recommended in most applications.

- 1) Silicon Avalanche Diodes (SAD) limits the amount of surge current to a level where
- 2) Metal Oxide Varistors (MOV) can impress the transient as heat and/or
- 3) Gas Tube Arrestors (GTAs) divert surges to ground.

## 3. WHERE SHOULD SPDs BE INSTALLED?

It is essential to install SPDs in a comprehensive, cascaded and redundant manner. Protect the Load Side and the Line Side with bi-polar SPDs. Protect the Mains/Incoming Panel (IEEE Cat. C/UL Type 1). Protect important Branch/Secondary Panels (IEEE Cat. B/UL Type 2) including the standby generator secondary panel. Protect sensitive equipment at Point of Utilization or wall outlets (IEEE Cat. A/UL Type 3). Protect all signal, data and communications circuits such as 2-way radios, CATV, CCTV, security sensors, incoming coaxial cables, monitoring equipment, etc. This “layered” defense strategy will optimized safety at all levels of the distribution system, providing protection from exterior let-through voltages as well as from those which are internally generated. Understand that UPSs are not SPDs and will not function when in a bypass mode.

#### 4. HOW ARE SPDs RATED BY INDUSTRY?

ANSI/IEEE, IEC, NFPA, UL , etc. all apply their own ratings for testing and survivability of SPDs. There is a maze of confusion amidst a handful of industry safety standards. A very important SPD rating without any industry standard is Peak Ampere Surge Current. A high rating with increased capacity and hybrid components translates into less stress and longer life expectancy for the SPD. While recommendations are site dependent, generally NLSI suggests the following Peak Ampere Surge Current Ratings:

Service Entrance, 250kA   Distribution Locations, 125kA   Branch Locations, 75-125kA

A specialized engineering analysis may be needed to provide sufficient SPD protection especially in geographic regions of high lightning risk.

#### 5. INSTALLATION ESSENTIALS.

- 5.1 Short (a few inches) lead lengths with no sharp bends.
- 5.2 Twist together the phase, neutral and ground conductors to reduce wiring impedance.
- 5.3 Connect SPD through a dedicated circuit breaker wherever possible.
- 5.4 Avoid Din-Rail SPDs inside electrical panels. Externally SPDs can be field-serviced without the hazard of working on an energized panel. The interior neutral bus bar may be too far away to enable very important short leads/no tight bends.
- 5.5 All-metal cabinet with gasketed front cover and clip/twist/lock type fasteners. No plastic boxes.
- 5.6 Diagnostics to include visual LED lights and audible/buzzer or equal audible alarms.
- 5.7 Maintain Electrical Room in compliance with NEC 110.26.

#### 6. HOW MANY LINES SHOULD BE PROTECTED?

Transients can take many routes to reach equipment. Accordingly each electrical path should be SPD-protected. Examples: A 3-phase wye system consists of ten modes (line to line X3, line to neutral X3, line to ground X3 and neutral to ground X1); A delta system may have seven modes (line to neutral X3, line to ground X3 and neutral to ground X1); There may be five modes (line1 to neutral, line to ground, line2 to neutral, line2 to ground, and neutral to ground); A three mode system would be line 1 to ground, line 2 to ground and neutral to ground. Regardless of the above systems configurations, All Mode Protection should be specified.

#### 7. SPD REQUIREMENTS PER NFPA-780 v. 2014. *(NLSI Note: NFPA-780 is weak on SPD subjects. Refer to IEEE 1100. Or contact NLSI.)*

- 5.1 All power service entrances (Mains). See 4.20.2.1.
- 5.2 All entrances to all communications systems. See 4.20.2.2.
- 5.3 At all locations when distance from Structure A to Structure B exceeds 100 ft. See 4.20.2.3.
- 5.4 SPDs are elective or optional at branch/subpanel and point-of-use locations. See 4.20.2.4
- 5.5 A waiver process exists in 780 for not requiring SPDs. See Annex A.4.20.2.5.