Surge Protection 2016

Presented by:
Ken Pitt
TPS3 Product Manager
Agenda

• Why SPDs are necessary?
• Surges: causes & effects
• How a TVSS/SPD works
• Industry standards
• Specifying SPDs
• Products
Gamewell IF610 vs. Lightning. Got Surge Protection?

We just pulled out a Gamewell IF610-504 at a military base in California. Now they claim that lightning is the cause of the damage and from the looks of the board I could definitely agree. The fuse located directly to the left of the incoming 24VDC from the transformer was not blown which is a good indication that the surge was extremely powerful and quick. This power surge blew out the main board, the CPU, the display and the 4 SLC loop card even though the only visible damage was on the main board. It appears that the power surge was so powerful that it burned a hole through the Gamewell IF610 board. This is why it is so important to have Transient Surge Protection for your fire alarm systems.

Unfortunately for our customer these boards are not readily available from the Gamewell factory so the down time is about two weeks. Check out these pictures.
Internet of Things

Machines go Online

The number of everyday objects, or “things”, connecting to the Internet will exceed PCs and smartphones.


46% of recorded electrical disturbances were Transient Surges!

“...if the transient can be mitigated prior to reaching the PLC system, the odds for surviving such events increases dramatically.”
Insurance Claims

Lightning Sparks Concern For Insurance Industry, Homeowners Claims Rise Sharply Over Last Five Years

MARCH 31, 2010

I.I.I. Study Finds Insured Losses Overall Continue To Trend Upward, Despite ’09 Respite

NEW YORK, March 31, 2010 — They say that lightning never strikes in the same place twice, but for insurers it strikes hundreds of thousands of times annually, causing millions of dollars in damages. In fact, the average cost of homeowners claims for damage due to lightning strikes has increased significantly over the last five years, according to the Insurance Information Institute (I.I.I.).

An analysis of homeowners insurance data by the I.I.I. found there were 135,689 lightning claims in 2009 costing $298.8 million, with an average claim totaling $2,224. These losses ranged from damage to expensive electronic equipment to structural fires that destroyed entire homes.

Insured losses related to damage from lightning strikes topped more than $4 billion in the U.S. for the first time in 2008. The number of lightning claims and the dollar amount of these losses fell 25 percent from 2008 to 2009, reflecting fewer storms in 2009. The overall trend, however, shows insured losses continue to climb, with the average cost per claim up 39 percent over the past five years.

“Make no mistake, lightning plays a substantial role in the damage done to homes and businesses every year,” said Loretta W太阳城, vice president with the I.I.I. “But some losses are preventable when using the proper building protection systems such as surge protectors, lightning rods, conductors and ground rods.” Lighting not only damages properties, but can cause injury or death. According to the National Oceanic and Atmospheric Administration (NOAA), there were 94 lightning fatalities in the U.S. and Puerto Rico in 2009.

2010 - 213,278 Paid Claims

Insured losses

• 2010 - $1,033 Billion
• 2011 - $952.5 Million
• 2012 - $969 Million

Average Cost Per Claim

• 2010 - $4,846
• 2011 - $5,112
• 2012 - $6,400
What Is a Surge/Transient?

Super Bowl XLVII, February 3, 2013

“…power surge caused the outage.”

- James Brown, CBS halftime crew host
Surge Suppressors

- A SPD, TVSS or Surge Suppressor will **Not** effectively control:
  - Utility “swells” lasting several cycles
  - Utility “sags”
  - Harmonics
  - Certain noise problems
  - Not a substitute for Lightning Protection System
  - Will not save energy or lower utility billing
What Causes Surges/Transients?

- Lightning or Thundersnow
- Switching:
  - Load Switching – utility & customer
  - Motors, Large Loads, Faults, Fuse Operation
  - Source Switching
  - Smart Grid, Gensets, PV, Wind Turbine
- Internally generated surges: ≈70%
- Externally generated surges: ≈30%

In outdoor environment, this ratio probably reverses

Remember Differential Equations?
Solved for steady-state solution and transient solution
Math: \( v(t) = 3te^{-2t} + 2t - 1 \)
Dashcam Lightning
Effects of Transient Voltages?

- **Microelectronics Intolerant to Surges**
- **Disruption**
  - Lockups, Downtime & Interruption costs
  - Computing glitches and errors
- **Degradation**
  - Microelectronics
  - Slow & continuous damage to motor insulation
- ** Destruction**
  - Failed microelectronics, ballasts, motors, controllers, etc.

- **Maybe analogous to:**
  - ‘Water hammer’ in a plumbing system
  - ‘Rust’ to microelectronics
Transient overvoltages can cause breakdown of insulation, resulting in either a temporary disturbance of device operation or instantaneous failure.
What Is a Surge/Transient?

- High amplitude, short duration overvoltage
- Can be positive or negative polarity
- Can be from energized or grounded conductor

Transient Overvoltage – Can be thousands of volts

Millionths of second
How Surges Propagate

Utility Power

External Wall

Switchgear in Outdoor Enclosure

Disconnect Switch

Transformer

Internal or External?

Switchboard

Internal SPD

Motor Control

External SPD

Power Panelboard

Lighting and Appliance Panelboard
Equipment will tolerate 500% overvoltage for 100\(\mu\)s

\[
5 \times 120V = 600V_{\text{rms}}
\]

\[
600V_{\text{rms}} \times 1.414 = 850V_{\text{peak}}
\]

Goal is to reduce transient overvoltages to tolerable level – in this case 850Vpeak
MOV - Metal Oxide Varistor

- Varistor - variable resistor
- Semiconductor; generally zinc oxide
- Connects parallel to load (not series)
- Thickness determines clamping voltage
- Diameter determines current capacity
MOV - Metal Oxide Varistor

MOV seeks to equalize overvoltage diverted through MOV as current
Voltage sensitive conductor: \( V = IR \) & \( I = \frac{V}{R} \)
At ‘low’ voltages: very high impedance, \( \approx 10^9 \Omega \): \( I \approx 0A \)
Above ‘threshold’ voltage: resistance approaches 0\( \Omega \): \( I = \text{high A} \)
Current diverts through MOV as \( I = \frac{V}{R} \) (high \( V \), low \( R \))
MOV does not ‘absorb’ surge, however, \( I^2R \) heat is retained
Bidirectional – Operates same for positive or negative surges
Creates a momentary short-circuit to pass transient energy to earth; analogous to water heater pressure relief valve

**Normal voltage**

\[
I = \frac{V}{R} = \frac{120V}{10^9 \Omega} = 0.12\mu A
\]

**Overvoltage**

\[
I = \frac{V}{R} = \frac{6000V}{1\Omega} = 6000A
\]

![Figure 1 Schematic depiction of microstructure of MOV](image)
SPD Operation

Power source voltage with a surge

Voltage

What the load sees with the MOV installed

Voltage

$V_{Load} = (V_{Source} + V_{Surge}) \left( \frac{Z_{Surge}}{Z_{Source} + Z_{Surge}} \right)$
MOV/SPD Acts as a momentary 'short circuit'
'short circuit' ≈ no overvoltage ≈ protected load
Modes of Protection

- ‘Mode of Protection’ is a surge path
- MOVs equalize potential across either side of MOV
- Various ways to connect MOVs, i.e., various Modes of Protection
  - L-N
  - L-G
  - N-G
  - L-L
- IEEE recommends defining modes: L-N, L-G, N-G, etc. (because ‘Common Mode’ and ‘Normal Mode’ mean different things to different folks)
- True 10-Mode Protection provides directly connected L-L MOVs
SPD/TVSS Terminology

- Let-through voltage, clamping voltage, suppressed voltage, measured limiting voltage (measured in Vpeak), used to assign Voltage Protection Rating
- Surge current, peak-amp current, maximum current, (measured in Apeak)
- MCOV - Maximum Continuous Operating Voltage of the electrical system (measured in Vrms)
Surge Current vs. Fault Current

**Surge Current** – Normal Operation - Momentary

MOV/SPD

Fault Current – Drawn by Failed SPD - Continuous

OV/SPD

SPD fails short-circuited and draws Fault Current

to be continued...
Can Anything Go Wrong?
(Good thing that will never happen to me… )
SPD/MOV Failures

Industry Issues – Lot of UL & NEC action
MOV is an expendable element - will protect or die trying
Failures caused by *Sustained Overvoltage* - TOV
• Can be as few as 2-3 cycles

  Sequence: MOV protects, fails, fails short, follow-on fault
current causes MOV to catastrophically overheat

Typical causes:
– Loss of neutral \((X_0\) not bonded to ground)
– Incorrect installation
  – 120V SPD on 277V system
  – Cross Phase with N or G
– Improper application
  – Ungrounded or impedance ground
– Genset or transfer switch related
Typical Sequence of MOV Failure

System level *Sustained Overvoltage* – TOV
Voltage exceeds MCOV – as little as 2-3 cycles
MOV attempts to protect
MOV fails towards short circuit
Follow-on/fault current causes MOV to catastrophically overheat
The Pin represents the system’s Neutral Bonding to Ground. If N-G Bond is made, the electrical system has a fixed reference to ground. The system will not ‘move’, from instability, resonance, arcing, etc. System voltages remain stable. A ground fault trying to short a Phase to Ground will Not skew the system, i.e., L-G voltages do not change.

If N-G Bond is NOT made, the system becomes Ungrounded. Ungrounded systems are inherently unstable. Nothing ‘holds’ or ‘stabilizes’ the system. If/when something happens, the system ‘moves’ and L-G voltages will fluctuate. The SPD will attempt to control these until the SPD’s L-G mode(s) fail.

Ground
MOV Failure Intensity Increases With The Amount of Fault Current Drawn by the MOV

‘Lower’ Fault Currents (0-20A)

‘Intermediate’ Fault Currents (20-1000A)

‘Higher’ Fault Currents (>1000A)
Surge Protection Codes and Standards

- IEEE C62.41 & C62.45; C62.43, C62.64, C37.90
- ITIC CBEMA POWER QUALITY CURVE
- IEEE 142, 1100, 1692
- UL 1449, 1283, 497, (UL 96A & NFPA 780)
- CSA 22.2 No.269.1-14, 2-14, 3-14, 4-14, 5-14
- NFPA 70: NATIONAL ELECTRICAL CODE
- NFPA 72: NATIONAL FIRE ALARM AND SIGNALING CODE
- NFPA 75: STANDARD FOR THE FIRE PROTECTION OF INFORMATION TECHNOLOGY EQUIPMENT
- NFPA 731: INSTALLATION OF ELECTRONIC PREMISE SECURITY SYSTEMS
- NFPA 780: STANDARD FOR THE INSTALLATION OF LIGHTNING PROTECTION SYSTEMS
- NFPA 1221: INSTALLATION, MAINTENANCE, AND USE OF EMERGENCY SERVICES COMMUNICATIONS SYSTEMS
Surge Protection Codes and Standards

*Common Communication SPD Standards:*

IEEE C62.43-2005: Guide for the Application of Surge Protectors Used in Low-Voltage Data, Communication and Signaling Circuits

IEEE C62.64-2009: Standard Specifications for Surge Protectors Used in Low-Voltage Data, Communication and Signaling Circuits

UL 497: Primary Protectors for Communications Circuits
UL 497A: Secondary Protectors for Communications Circuits
UL 497B: Isolated Loop Circuit Protectors - Protectors for Data Communications and Fire-Alarm Circuits
UL 497C: Primary Protectors for Coaxial Communications Circuits

Telcordia (Now Ericsson) GR-974-CORE: General Requirements for Telecommunications Line Protector Units (TLPUs)
Outlines Surge Environment

Differentiation between Transient & TOV

IEEE recognizes “Fuzzy boundary of real-world events”
• Ground/Earth cannot instantaneously and fully dissipate a direct stroke
• Causes Ground Potential Rise (GPR)
• Surge current will attempt to exit anywhere it can: power lines, communication lines, etc.
Ground Potential Rises (GPR’s):
Outdoor, Pole, Tower or ‘Backdoor’ Surges

Not from Utility Side
Back into electrical system unexpectedly
Through Ground
• Poles, Towers, Lighting
• Rooftop HVAC
• Exposed Pumps
• Data & Networks
• Irrigation lines/wires
• Turn Category A or B into Category C or higher

Tidbit:
Lightning came down pole & flash boiled water in concrete cracks; blowing concrete apart.

This is a fundamental flaw in Ufer grounds for lightning protection
Ground Potential Rises (GPR’s):
Outdoor, Pole, Tower or ‘Backdoor’ Surges

Different References to Ground are Affected by Ground Potential Rise - GPR

At least Three Related Things Happen:
1.) Momentary Ground Voltage Rise at Struck Object
2.) Difference in Ground Voltages based on Distance
3.) Current flows in an attempt to equalize voltage

One reason to install SPDs at both ends of conductor

Creates Transient Voltage Difference I.e., Surge – could be 1,000’s of volts
• Outlines Surge Environment
• Technical explanations
• Definitions
• Location Categories
  - C, B & A
• Types of Waveforms
• Recommendations
• Applications
• Cascading

Figure 4 - The 100 kHz Ring Wave (voltage and current)
How Large are Surges?
IEEE Research

It takes 10kV to push a 10kA surge, 10 meters (0.1Ω/m)
It takes 27kV to push a 10kA surge, 30 meters (0.09Ω/m)
It takes 45kV to push a 10kA surge, 50 meters (0.09Ω/m)

Voltage becomes so high that it flashes over upstream, so surge current is not pushed as hard

Similar to shooting fire hose through soda straw – won’t all go!
"Expected voltages and current surges"

Table 4 – Scenario I tests for SPDs intended for Location Category C

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Standard tests</th>
<th>Optional test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.2/50μs Voltage generator</td>
<td>8/20μs Current generator</td>
</tr>
<tr>
<td>Minimum open-circuit voltage to be applied to SPD</td>
<td>Current to be driven through the SPD(^b)</td>
<td>100kHz Ring Wave for front-of-wave response evaluation</td>
</tr>
<tr>
<td>Low</td>
<td>6kV</td>
<td>3kA(^c)</td>
</tr>
<tr>
<td>High</td>
<td>10kV</td>
<td>10kA</td>
</tr>
</tbody>
</table>

Table 3 – Standard 1.2/50μs – 8/20μs Combination Wave
Expected voltages and current surges in Location Categories\(^a\) A and B\(^b\)
Single-phase modes\(^c\) : L-N, L-G and [L&N]-G
Polyphase modes: L-L, L-N, L-G and [L’s]-G
(See Table 5 for N-G modes)

<table>
<thead>
<tr>
<th>Location Category(^a)</th>
<th>Peak Values(^d)</th>
<th>Voltage (kV)</th>
<th>Current (kA)</th>
<th>Effective Impedance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>6</td>
<td>0.5</td>
<td>12(^f)</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^a\)IEEE C62.41.2 - 2002
\(^b\)Single-phase modes
\(^c\)Polyphase modes
\(^d\)Peak Values
\(^e\)IEEE C62.41.2 - 2002
\(^f\)IEEE C62.41.2 - 2002
IEEE C62.41.2 - 2002

Cat C High: 10kV, 10kA
Cat B: 6kV, 3kA
Cat A: 6kV, 500A

Tidbits:
- Wallplug flashes over at about 6kV
- Incandescent light fails at about 1500A surge

Watch Outdoor Loads that might ‘convert’ to Cat C High: 10kV, 10kA
How Large are Surges? Lightning Research

Depends On Who You Talk To, And Where the Surge Enters:

- **Lightning Trying to Get In on Power Lines**
- **Lightning to Ground Trying Get Out**
- Lightning can be large, but how much can actually propagate through wire?
  - IEEE Research generally focuses on surges entering on power line conductors. Their 10kA is substantially smaller than lightning.
  - IEC postulates high energy long duration impulses (10x350), but evidence supporting this is low and being questioned
  - Lightning Protection industry (NFPA 780 & UL 96) uses 20kA I-n
  - Recent findings in wind turbine, traffic/ITS, tall structures suggest that Ground Potential Rises (GPRs) from lightning ground-strikes can be very large. (An IEC standard might infer 100kA 8x20)
Flash Density: Flashes/km²/year
How Large are Surges? Lightning Research

Triggered lightning from a natural thunderstorm at the University of Florida's Lightning Research Center at Camp Blanding

- UNIVERSITY OF FLORIDA LIGHTNING RESEARCH GROUP
  http://www.lightning.ece.ufl.edu/
- Rocket pulls conductor into sky and draws lightning down.
  (Maybe don’t try at home)
- Recorded surge currents were between 6.8 to 34 kA
- When lightning hits the ground, surge current will seek lower potentials. The crystalized earth is called a Fulgurite

Triggering is accomplished by firing a rocket trailing a grounded wire toward the thundercloud. The straight line is the exploded wire and the tortuous channels are natural strokes.
Power Quality Tolerance Curve

Equipment will tolerate 500% overvoltage for 100μs

5 x 120V = 600Vrms
600Vrms x 1.414 = 850Vpeak

Goal is to reduce transient overvoltages to tolerable level – in this case 850Vpeak
Power Quality Tolerance Curve Incident Frequency

Figure 3-3
Projected 95% Probability for Any Site to Fall Within the Range of Events Shown in a Given Area
IEEE Emerald Book – Standard 1100

Section 7.2.4
“…Effective surge protection requires the coordinated use of large-capacity current diverting devices at the service entrance followed by progressively lower voltage-clamping devices applied strategically throughout the power system”

Section 8.6.4
“…it is recommended that additional surge protective devices….be applied to downstream electrical switchboards and panelboards…”

Section 8.6.6
“Electronic equipment containing both ac power and data cabling should be properly protected via surge protective devices on both the ac power and data cables.”

Section 8.6.8
“All exterior mechanical systems (e.g., cooling towers, fans, blowers, compressors, pumps, and motors) should be considered as targets for a lightning strike. It is recommended practice to individually provide surge protection on both the power input and data circuits connected to all such equipment.”
IEEE Emerald Book – Standard 1100
Cascade Protection

NEC & UL Types

Type 1

Type 2

Type 3

10m (30 feet)
UL 1449 3rd and 4th Edition

Combine TVSS and Surge Arresters into one UL Standard, UL 1449 3rd Edition renamed:

**Surge Protective Devices (SPDs)**
Effective: Sept 29, 2009

- New SPD Types: Types 1, 2, 3, 4 (& 5)
- New Voltage Protection Ratings (VPRs) replace Old-style Suppressed Voltage Ratings (SVRs)
- New I nominal ratings
- Bid Specifications Obsolete as product evaluation & ratings change
- (Expensive big deal to manufacturers)

UL 1449 4th Edition adds ‘DC’ voltage SPDs. AC SPDs remain unaffected.
Effective: March 26, 2015
UL 1449-3 & NEC Art. 285

• Changed term TVSS to SPD

Aligns with IEC, EN and international usage of term ‘Surge Protective Device’

• Old-style Surge Arrestors are now gone replaced SPD ‘Type’ classification

  Type 1 – 20kA or 10kA
  Type 2 – 20kA, 10kA, 5kA or 3kA
  Type 3 – 3kA
  Type 4 – Based on intended usage as Types 1, 2 or 3
  Type 5 – Suppressor components
UL 1449-3 & 2011 NEC Article 285

SPD Types: Types 1, 2, 3 & 4

Based on Location within electrical distribution system

- Type 1: OCP built in to SPD, more rigorous testing
- Type 2: Type 3
- Type 3
- Type 4 (Component) tested to Type 1 or Type 2
UL 1449 SPD Types (Also adopted in the 2008 National Electrical Code)

Type 1 SPD - Permanently connected on the secondary side of the service transformer and either the line side or the load side of the main service disconnect. Nominal discharge current \( (I_n) = 10 \text{kA or 20kA} \).

Type 2 SPD - Permanently connected on the load side of main service disconnect. Nominal discharge current \( (I_n) = 3\text{kA, 5kA, 10 kA, or 20kA} \).

Type 3 SPD - Installed at the point of use, a minimum of 10 meters of conductor length from the electrical service panel

Type 4 SPD - SPD component or assembly
UL 1449-3

I nominal Testing – In - (Nominal Discharge Current)
- New Concept to USA – Originated from IEC 61643
- Duty Cycle Testing
- 15 8x20μs surges through every mode of three samples used for VPR testing

Type 1 – 20kA or 10kA
Type 2 – 20kA, 10kA, 5kA or 3kA
Type 3 – 3kA or None
Type 4 – Based on intended usage as Types 1, 2 or 3
Performance Test Format Changed
New Testing uses Six (6) Times More Energy

- As surge amplitude goes up, clamping voltage goes up too
- Specs become obsolete
- Need new VPRs in specs

Old – 6kV / 500A
Suppressed Voltage Ratings (SVR)

New – 6kV / 3,000A
Voltage Protection Ratings (VPR)
497 Primary Protectors for Communications Circuits
Primary protection against surge from conductors = or > 300V.

497A Secondary Protectors for Communication Circuits
Telecomm networks that have are operating below 150 volts.

497B Isolated Loop Circuit Protectors
Data and Fire-Alarm Circuits that are exposed to conductors < 300V.

497C Primary Protectors for Coaxial Communications Circuits
Protection of coax against contact with conductors 300V or greater.
UL 96A Master Labeling

- Service entrance SPDs are no longer required in order to obtain Master Label certificate.
- NFPA 780 Lightning Protection Systems without service entrance SPDs installed will have the cautionary disclaimer added to their Master Label certificate.

“At the request of the installer, surge protection may be excluded from the scope of the inspection. The Certificate specifically states this exclusion with one of the following statements, as applicable:

"Surge protection was not inspected."

"The electrical service entrance surge protection system was not inspected."

"The communication surge protection system was not inspected."

The above wording is followed by the cautionary statement:

"Surge protection devices are an integral component of a complete lightning protection system and should be provided on all incoming and exiting electric power, data, and communication services."
CSA C22.2, No.269.1-14, 2-14, 3-14, 4-14, 5-14

- Replicates ANSI/UL 1449
- Splits 1449 into standards based upon SPD Type, 1, 2, 3, 4, and 5
- UL can conduct equivalent testing during UL 1449 evaluation. cUL will be assigned upon successful evaluation.
NFPA 70, NEC 2011, Article 285 – Key Points

- **285.3** Uses Not Permitted. An SPD (surge arrester or TVSS) shall not be installed in the following:

  On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems.

- **285.5** Listing. An SPD (surge arrester or TVSS) shall be a listed device.

- **285.6** The SPD (surge arrester or TVSS) shall be marked with a short circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.
NEC 285 - SPD Connector Leads

- Need short lead lengths!
- NEC 285.12: “The conductors used to connect the SPD (surge arrester or TVSS) to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends”
- Industry typically states: Each foot of conductor adds 100 - 170V to clamping voltage
- No Sharp bends or kinks
- No Wire Nuts!
- Right Hand Rule – can cancel inductive effects by bundling, tie-wrapping conductors together
708.2 Definitions:

Critical Operations Power Systems (COPS). Power systems for facilities or parts of facilities that require continuous operation for the reasons of public safety, emergency management, national security or business continuity.

708.20(D) Surge Protective Devices. Surge protective devices shall be provided at all facility distribution voltage levels.
700.8 Definitions:

• Voltage surge protective devices (SPD’s) are required to be installed for all switchboards and panelboards of emergency systems.

• These surge protection devices and products must be listed. Doesn’t specify ‘Type’

Reasoning

• Implementation of this rule could prevent damage to emergency power controls and critical electronic loads, thereby enhancing the reliability of emergency systems.
708.20 Sources of Power(D) Surge Protection Devices. Surge protection devices shall be provided at all facility distribution voltage levels. Communication Circuits
800.90 Protective Devices: (A) Application: A listed primary protector shall be provided on each circuit run partly or entirely in aerial wire or aerial cable not confined within a block.

...where there exists a lightning exposure, each inter-building circuit on a premises shall be protected by a listed primary protector at each end of the inter-building circuit.
NFPA 72, 2013 Ed.

Requires Surge Protection for the following:

- High Power Speaker Array
- Supervising Station Alarm Communication Lines
- Public Emergency Alarm Reporting Systems
- A new requirement has been added in paragraph 12.2.4.2 MANDATING transient protection be provided for all signaling system circuits ENTERING or LEAVING a building
- Requires SPD inspection
- Identical stipulation required in NFPA 70, 72, 75, 731, and 1221
FBC 419.3.15.6 – All low-voltage system main or branch circuits entering or exiting the structure shall have surge suppressors installed for each pair of conductors and shall have visual indication for protector failure to the maximum extent feasible.
AHCA Interpretation of FBC 419.3.15.6

SPD at Panel to be used. Maintain lead lengths per manufacturer’s requirements.

☐ This would apply to:

- Rooftop AHU, exhaust fans, exterior lighting, exterior receptacles, exterior pumps, etc.

- Low voltage systems would include fire alarm, telephone system, network cabling, etc.
Selecting kA Ratings

- Realistic kA Per Phase ratings:
  - Service Entrance: 200kA-300kA per phase
  - Distribution: 100kA-200kA per phase
  - Point of Use: 50kA-100kA per phase

  kA buys redundancy - up to a point

Not carved in stone:
- Consider upsizing at critical loads, larger panels, outdoor loads, isokeraunic activity, etc.

  Consider downsizing based on value, budget, etc.

- Specific Modes? L-N, L-G, N-G, L-L

Tire Tread Analogy:
- Thicker the tread, the longer it lasts & harder to get a nail through
- Bigger SPDs are more robust and withstand more abuse
Case Study – LED Failures
Cascading Protection for Office Building

**Service Entrance** – Applying surge protection at the incoming electrical service “Stops Surges Before They Get In.” These types of surges contain the largest surge energy warranting 300kA or more of surge current redundancy.

**Outside Loads** – SPDs should be installed at distribution panels feeding rooftop HVAC, elevators, parking lot lights, etc. to prevent back feeding surges entering the main building.

**Lower Voltage Panels** – If the facility is supplied with a higher system voltage (i.e. a 480Y/277V service), 120V panels need SPDs to condition residual surges leaving the service entrance SPD as well as any internally generated surges. Examples could be panels powering in house data center, administrative offices, or any other panels powering sensitive, electronic-rich class locations.

**Individual Critical Loads** – Even if surge protection is applied at the previous locations, redundant protection maybe warranted for sensitive, costly equipment. This may include security and fire alarm panels, security access, cameras, gensets, etc.

**Data** – Security, fire alarm, and telephone systems using copper communications lines need protection especially for computers and automation control circuits.
Surge Sources are widely distributed in a facility
SPDs for Office Building

Parallel connected SPD
- Service Entrance Panels
- Ahead of critical loads (UPS, ATS)
- Protects from large surges

Series Filter
- HVAC Control panels
- Broadcast transmitters
- Cleans high frequency noise on the power line

Data Signal
- SLC Loops
- Security lines
- Control wires
Siemens Solution

- Becoming popular in SPD industry
- Large 34mm sq. MOV
- TPMOV Optimizes Thermal Protection to double-function as Overcurrent Protection
- Each MOV is individually fused
- Robotized assembly minimizes tolerances between fuses, MOVs, and thermal disconnectors (more consistent)
- TAC switch allows for individual monitoring of each MOV
Integral SPDs

- SPDs available for Switchgear, Switchboards, MCCs, Power Panels, Bus plugs, Power Mod, and Panelboards
- UL/cUL 1449 Recognized/Listed and Labeled
- UL 1283 Recognized
- Integral - Type 4 tested as Type 1 or 2 (TPS3 05 - Type 1 or 2)
- 20kA I-nominal
- 200kA Short Circuit Current Ratings (SCCR)
- Low UL 1449 Voltage Protection Ratings (VPRs)
- Surge Current Ratings from 100kA up to 1000kA
- Standard 7 modes of protection
- True 10 mode protection available
- Equipped with GIM Diagnostics
- Full selection of options: Internal disconnect switch, Dry Contacts, Surge Counter, etc.
Wall Mount SPDs

- UL/cUL 1449 Listed and Labeled
- UL 1283 Recognized
- Type 1 or 2 SPD
- 20kA I-nominal
- 200kA Short Circuit Current Ratings (SCCR)
- Low UL 1449 Voltage Protection Ratings (VPRs)
- Surge Current Ratings from 50kA up to 1000kA
- Standard 7 modes of protection
- True 10 mode protection available
- Equipped with GIM Diagnostics
- Full selection of options: Internal disconnect switch, Dry Contacts, Surge Counter, etc.
Monitoring Features

- Dry Contacts
- Surge Counter
- Remote Monitor
- NEMA Enclosure Ratings
- Flush mounting
- Interfaces
- N-G Voltage Detection
Simplifying Suggestions

- Select UL 1449-3 Listed SPD having ‘UL/cUL Mark’
- Select SPD with 20kA In rating
- Select high Short Circuit Current Rating (SCCR)
- Select low Voltage Protection Ratings (VPRs)
- Select Type 1 SPD
- Ensure short leads
Key Specification Parameters

- **Realistic kA Per Phase ratings:**
  - Service Entrance: 300-200kA, maybe 200-150kA outside Gulf rim states
  - Downstream: 200-100kA
  - Branch: 100-50kA
  - kA buys redundancy - up to a point

- **Specific Modes?** L-N, L-G, N-G, L-L

- **Noise Filtering:** -50dB @ 100kHz

- **Safety Related:** Thermal Cutouts & MOV size

- **Submittal requirements** – UL File (needed to confirm SCCR, which is not posted @ ul.com) & clearly identify Overcurrent Protection

- **External Mount Considerations**
  - 24” or less leads - have Contractor try to meet this.
  - Gently twist leads
  - Indicate Contractor can move SPD breaker in panel
  - Disconnect means for servicing and overcurrent protection
SIEMENS Here to Help

- Application Assistance
- Training
- Sounding Board for issues
- Competitive crosses or analysis
- General Help
- On-Line Live Support
- Forensic Testing & Analysis of failed SPDs
- Etc.