Power Protection Products, Inc.

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Presents

GAI Consulting –Lunch and Learn

April 14th 2026

Surge Suppression and the NEC

(Includes Updates for 2026)

Barry Wallace – P3

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Core Values

Blaze The Trail

Do the Right Thing

Be Humble and Honest

Create a Positive Influence

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Power Quality Monitoring

System analysis and evaluation of power quality issues to provide solution recommendations for the best possible performance from your existing power system.

The ability to quickly identify and remedy power quality problems will lengthen the life of electrical equipment and improve power system availability.

Our engineering technicians will help you understand your unique facility power system.

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Providing an educational environment for training, testing, and evaluation of today's power quality and data center solutions and equipment.

P3 leads Customer Education through Power Quality University (PQU):

- Highly Qualified, Expert Instructors
- Practical, Relevant Topics
- Continuing Education Credits (CEU's) *

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Surge Product Technology and NEC Code (Agenda)

- Understanding Transients
  - What are they, symptoms, and more..
- Surge Protection Applications
  - Typical Installation
- Market Approach and NEC Code

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What is a **Surge** or **Voltage Transient**

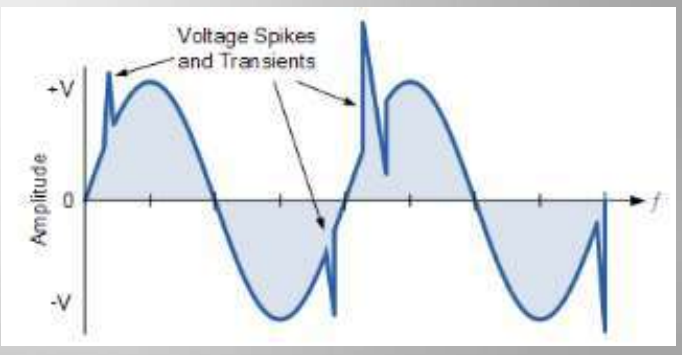
Definition:

A high rising voltage condition on one or more phases lasting 2 milliseconds or less

Time	Symbol	Number in 1 second
1 second		1
1 millisecond	ms	1,000
1 microsecond	µs	1,000,000
1 nanosecond	ns	1,000,000,000

Characteristics:

- Duration - 50ns to 2ms
- Rise time - 10ns to 100µs
- Frequency - 20Hz to 20MHz (ringing transients)
- Voltage - up to 20kV



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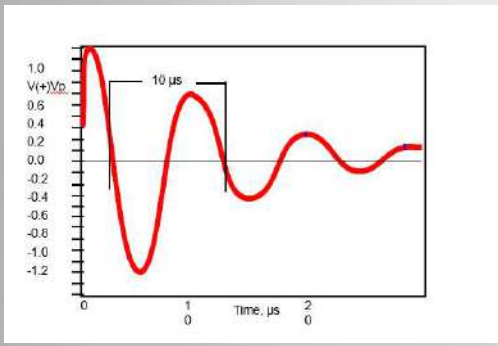
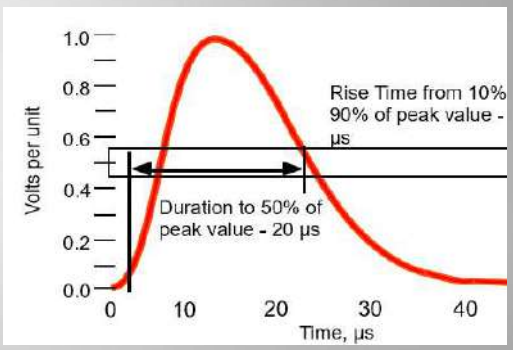
Types of Transients

Time	Symbol	Number in 1 second
1 second		1
1 millisecond	ms	1,000
1 microsecond	µs	1,000,000
1 nanosecond	ns	1,000,000,000

Impulse Waveform



Ring Waveform



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Where Do Voltage Transients Come From?

20% of surges are caused externally by:

- Lightning
- Utility Switching

80% are caused internally by:

- Load Switching
- Short Circuits
- Capacitor Switching
- Variable Speed Drives
- Imaging Equipment
- Arc Welders
- Light Dimmers

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Symptoms of Surge Activity

- Equipment damage
- Insulation breakdown on electrical conductors
- Premature aging of electrical and electronic equipment
- Process interruption
- Data loss and data transfer rate reduction

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Disruptive Damage

- Damage caused by transients that lock-up systems, create malfunction and can corrupt local files

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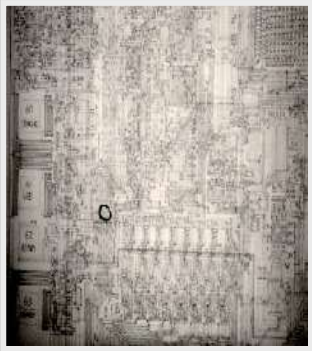
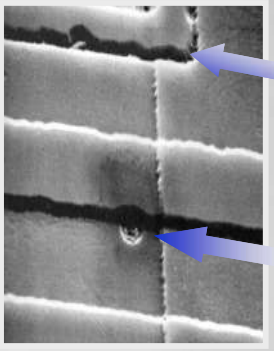
Dissipative Damage (Premature Aging)

Are you familiar with the subtle damage?





- Cumulative activity does not cause immediate failure. Cumulative activity is lower magnitude activity with more numerous instances of occurrence. Repeated exposure leads to premature failures.

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Destructive Damage

- Catastrophic damage to equipment can occur because of a high energy transient voltage event

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NEMA Surge Damage Survey

Below are interesting facts documented in the 2014 Surge Damage Survey conducted by NEMA with maintenance and facility managers regarding surge activity over the prior three year period:

- 75% of respondents experienced one or more incidents of surge damage in the past three years.
- 41% of respondent reported catastrophic damage due to a surge event
- 48% of respondents reported lost production ranging between $5,000 and $50,000.
- 61% of respondents reported equipment damage of $10,000 or less but 16% of respondents experienced equipment damage exceeding $150,000
- 38% experienced computer lock up as a result of a surge event

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SPDs Act As "Pressure Relief Valves"

- The ideal SPD shunts harmful surge current to **ground** under a surge condition and appears as a high impedance under normal operating conditions
- The SPD is a **self-sacrificing** device – bearing the brunt of harmful surge currents

Did you know?
Overcurrent devices do not provide protection from surges

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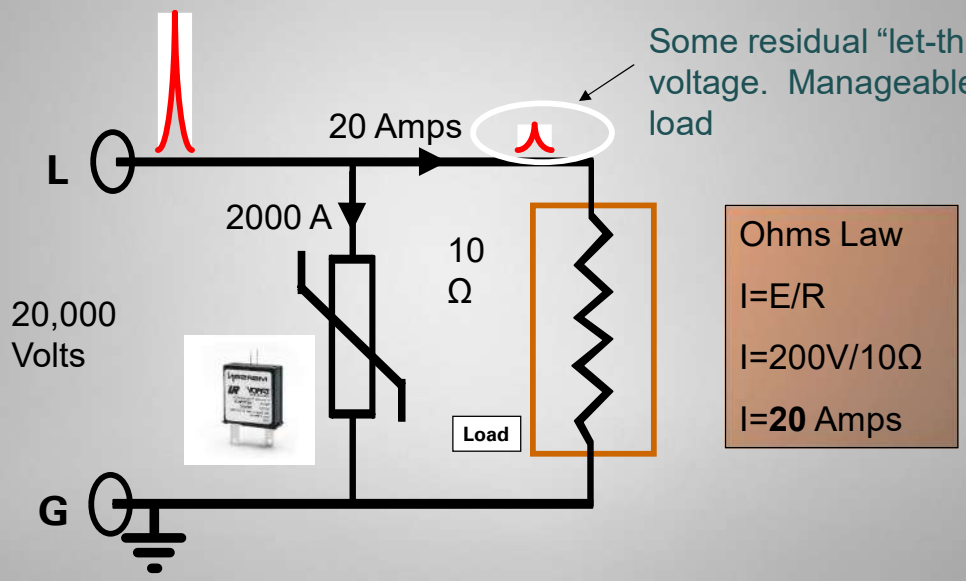
Voltage Event with Surge Protection



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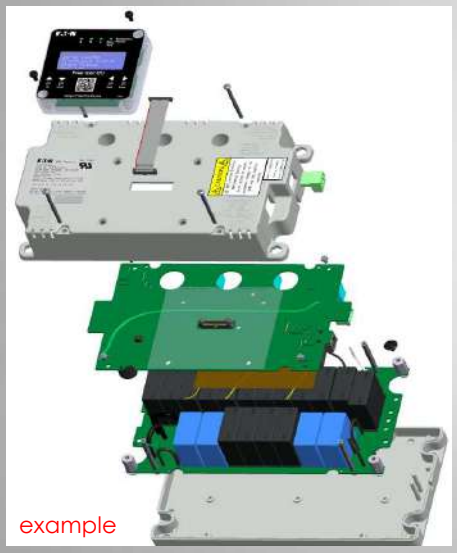
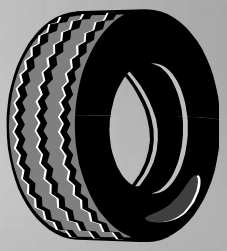
Surge kA Ratings Explained



- The peak surge current is a predictor of how long an SPD will last in each environment
  - The higher the kA rating, the longer the life of the MOVs



- Similar to the tread on a tire
  - The thicker the tread, the longer the tire will last

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Connector Lead Length

- **Absolutely Critical!**
- **Transients occur quickly-<.000028 sec.**
- **Each foot of conductor adds**
  ≈ 100V to 200V on the
  let through voltage
- **Need short, straight, lead lengths**

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Example

- Customer asked, "Why am I having surge damage even though I have an SPD?"
  - Note: Not Eaton Product or installation

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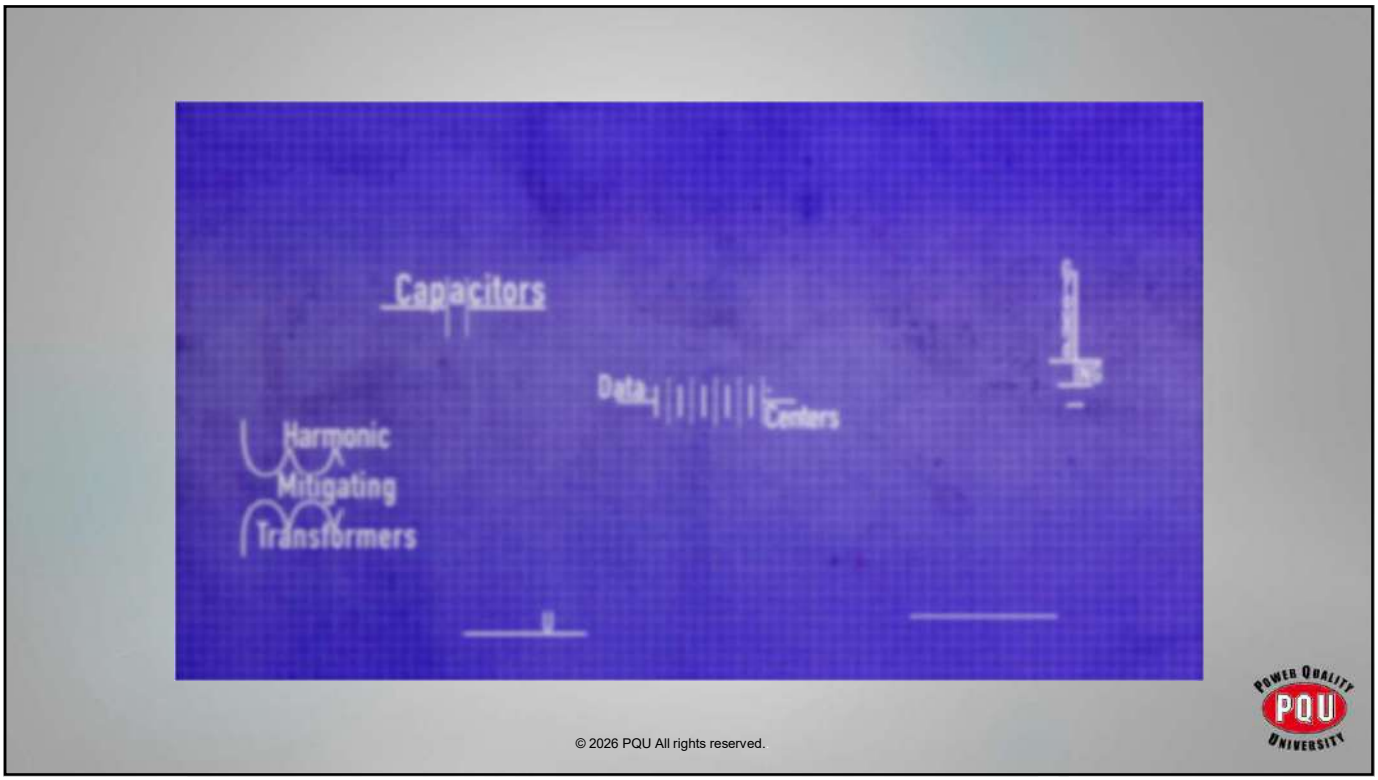

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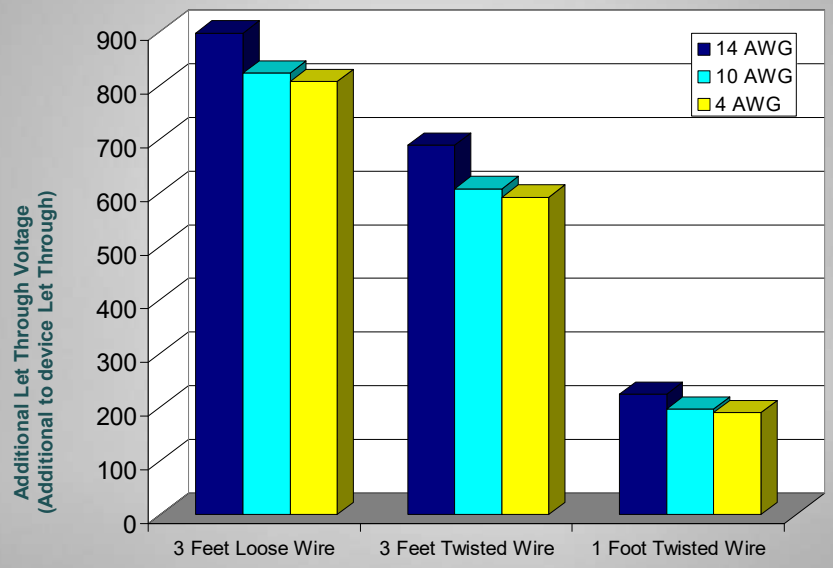
IEEE C1 (6000V, 3000A) Waveform

Affect of Lead Length on Let-through Voltage



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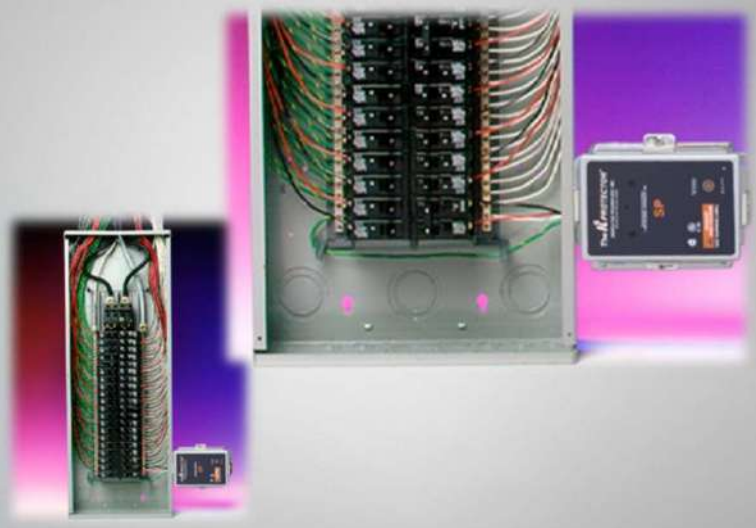
Typical Installations



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Typical Installations

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Performance/Application - Independent tests confirm better performance with integrated SPDs

Good → **Better** → **Best**

Side mount
Good let-though voltage if leads are short

Wired connection through a breaker
Better than side mount

examples

Direct bus connected
Up to **46%** better let-though compared to side mount.
Eliminates #1 Field Issue with Surge – Installation Errors.

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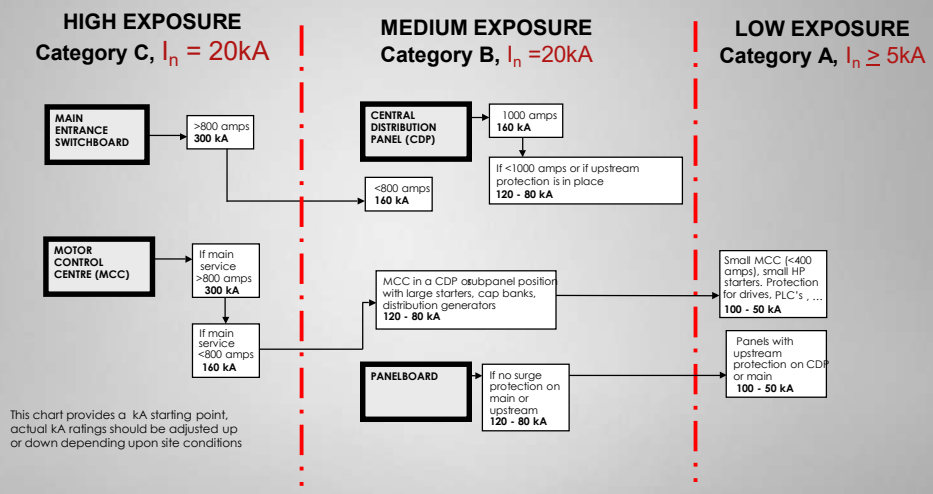
SPD Application Guideline



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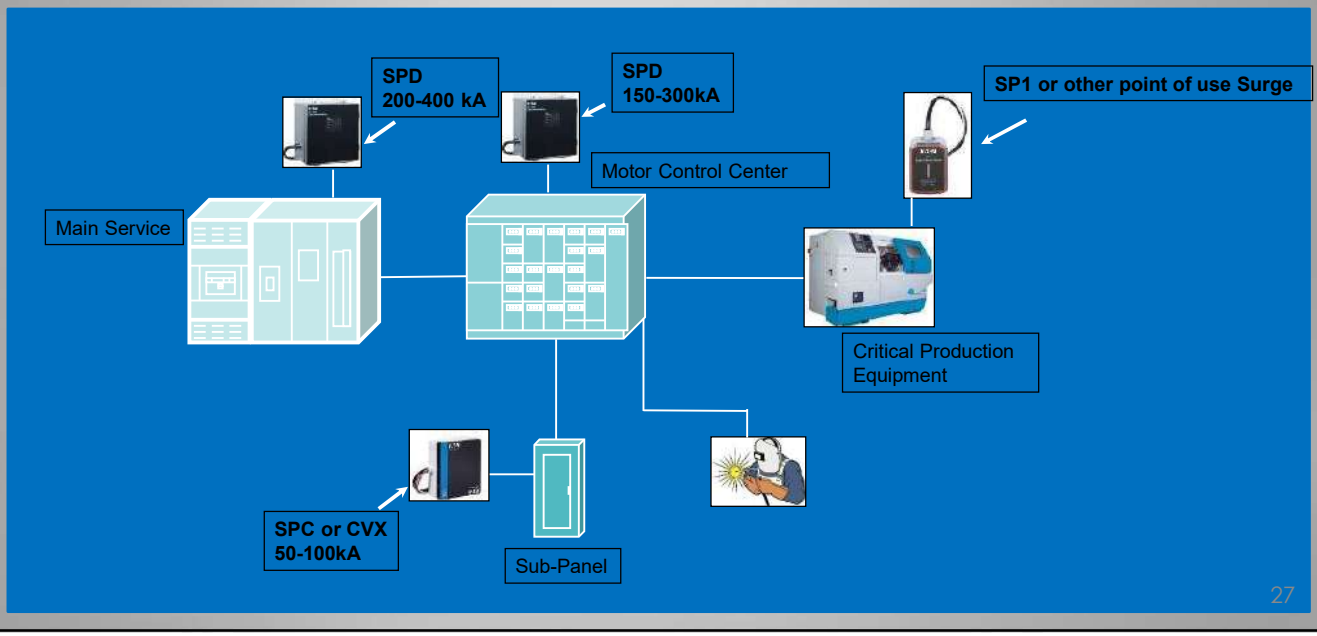
Typical Installation (cascade)



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Biggest News in Surge Protection – NEC Code Requirements

- Beginning 2008 the NEC began requiring surge protection. The first article added was **708.20** regarding Critical Operation Power Systems (COPS).
- NEC states at the beginning of Article 708 that Critical Operation Power Systems are those systems so classed by municipal, state, federal, or other codes by any governmental agency having jurisdiction or by facility engineering documentation establishing the necessity for such a system.
- These systems include but are not limited to power systems, HVAC, fire alarm, security, communications and signaling for designated critical operations areas

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2011 NEC Change – Wind Generation

- In 2011 the NEC began requiring surge protection for wind generation by adding **Article 694.7 (d)**
- This section was slightly updated in 2017 to add the word "wind" and now reads:

" A surge protective device shall be installed between a wind electric system and any loads served by the premises electrical system"

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2014 – Emergency Systems

- **Article 700.8** was added covering Emergency Systems. The NEC defines emergency systems in **section 700.1** as:
- "Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction."

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2014 – Emergency Systems (cont)

- According to the NEC, "These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life."

2014 **NFPA** Study found 34.7% of Smoke Detectors, 33% of emergency lighting and 18.7% CO2 Detectors were found to be damaged due to surge activity

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2017 NEC – 695.15: Fire Pumps

- **695.15** – A listed surge protection device shall be installed in or on the fire pump.
- A study conducted by the NFPA concluded that 12% of fire pumps tested had damage due to surge activity. Surge can damage motor windings and pump controls leaving critical equipment vulnerable during a critical emergency

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2017 NEC – 645.18 – Critical Data Systems

- Article **645.18** - Surge protection is required for critical operations data systems. The NEC defines these as:

"information technology equipment systems that require continuous operation for reasons of public safety, emergency management, national security, or business continuity."

- The NFPA survey conducted found (48%) of respondents noted that their facility had experienced unexplained process interruptions.
- More than a third (38%) noted the occurrence of lockup of computer or industrial process systems

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2017 NEC – 670: Industrial Machinery

- Article **670.6** addresses industrial equipment with safety interlock circuits. It states that "industrial machinery with safety interlock circuits shall have surge protection installed."

- The NFPA found that 27% of safety interlocking mechanism on machinery was defective due to surge activity in the facility

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2026 NEC – 230.67(A) – Residential Dwellings Requirement

- All services supplying dwelling units shall be provided with a surge protective device (SPD). Article **230.67(A)** requires a Type 1 or Type 2 surge protective device (SPD) to be installed for dwelling unit services.
- The SPD may be integral to or adjacent to the electrical service. Additionally, an SPD will be required when an existing service is replaced. This applies to all dwellings – single occupancy (home) or multiple dwelling (apartments)

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2026 NEC – 230.67(A) – Residential Dwellings Requirement

- All services supplying dwelling units shall be provided with a surge protective device (SPD). Ensure the new service equipment and feeder equipment surge requirements are not missed on projects. **Surge now required for services supplying:**
  - **Dwelling units**
  - **Dormitory units**
  - **Guest rooms and suites of hotels/motels**
  - **Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms**
- Specify the correct SPD: (E) **Nominal discharge current rating (In) of not less than 10kA**

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2026 NEC – 620.51(E): Elevators, moving sidewalks, escalators, and more…

- Article **620.51(E)** was added to address emergency system loads, such as elevators, escalators, moving walkways, and chairlifts. These are systems that are a matter of public safety. It states:

"Where any of the disconnecting means in **620.51** has been designated as supplying an emergency a standby system load, surge protection shall be provided."

- **620.51 Loads are: 1. Elevators Without Generator Field Control. 2.Elevators with Generator Field Control. 3.Escalators and Moving Walks. 4.Platform Lifts and Stairway Chairlifts.**
- The 2014 NFPA sponsored a survey to determine the damaging effects of voltage surges in various applications found 24% of responders to the survey reporting damage to elevator equipment from surge activity.

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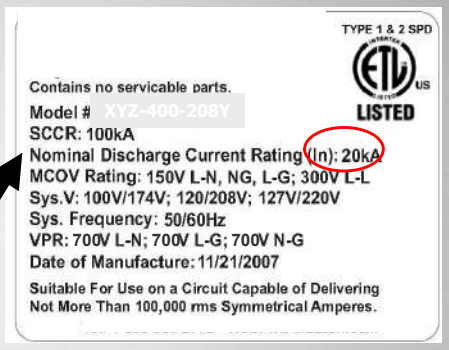
The Current UL1449

Current Edition Specification

- SPD Type
- NRTL listing mark
- Peak surge current per phase (not required)
- Short circuit current rating
- **Nominal Discharge Current Rating**
- System voltages
- System frequency
- Voltage Protection Rating



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The Current UL1449

UL Testing Procedure
Pick a Type: 1 or 2
Pick a Test: 3,5,10,20 kA
Pick overcurrent device (if any)
Test: at 6,000v and 3,000 amps
Record Result (let-through voltage)
Test: 15 times at 1 minute apart at desired test
Test: again at 6,000v and 3,000 amps
Record Result (let-through voltage)

Must not deviate by more than 10%
Assign to a grouping by VPR results (IE 700-800)

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Nominal Discharge Current - I_n

- Manufacturer chooses a current they want to test with:
  - Type 1 – 10kA or 20kA
  - Type 2 – 3kA, 5kA, 10kA or 20kA
- Complete SPD is tested along with any required overcurrent devices (fuse or breaker)
- Measured let through voltage for a 6000V 3000A surge is recorded
- SPD is subjected to 15 surges at chosen current one minute apart with rated voltage applied between surges
- **Measured let through voltage for a 6000V and 3000A surge is recorded again – let through voltage must not deviate more than 10% from original voltage (this is brand new!)**

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409.70 – Industrial Control Panels

409.70: "Safety circuits for personnel protection that are subject to damage from surge events shall have surge protection installed within or immediately adjacent to the control panel."

- Industrial Control Panels are defined in Article 100 Industrial Control Panels as:
  - 1) Power circuit components only, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers:
  - 2) Control circuit components only, such as push buttons, pilot lights, selector switches, timers, switches and control relays;
  - 3) A combination of power and control circuit components.
- "Safety circuits for personnel protection" is an extremely vast interpretation. Industrial panels with indicating lights is considered a safety circuit to the safe operation of the equipment. Therefore, Eaton's interpretation is the virtually all industrial panels need protection.

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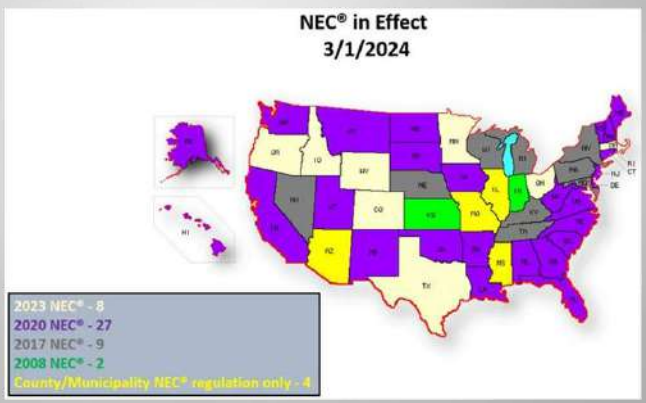
NEC Requirements

- NEC Code Requirements
  - 2020 change brings total number of surge requirements to 8.
  - Impossible to construct building without surge protection
  - 2023 Code will have more requirements – trend won't stop!
  - Adoption Map:



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What is the Power Xpert SPD

- Advanced monitoring display
  - Tri colored LED indicator lights status per phase
  - Surge magnitude categorization into low, medium and high categories as well as total surge counts
  - Time/date stamped event log
  - % protection remaining per phase

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What is the Power Xpert SPD

Tri – colored Indicator lights

Catalog number
Device name
Time
Firmware version

QR code

Input Buttons

- Fully Protected
- Less than 100% protection remaining, unit still providing protection on all modes
- Unit no longer providing protection on all modes, replace unit

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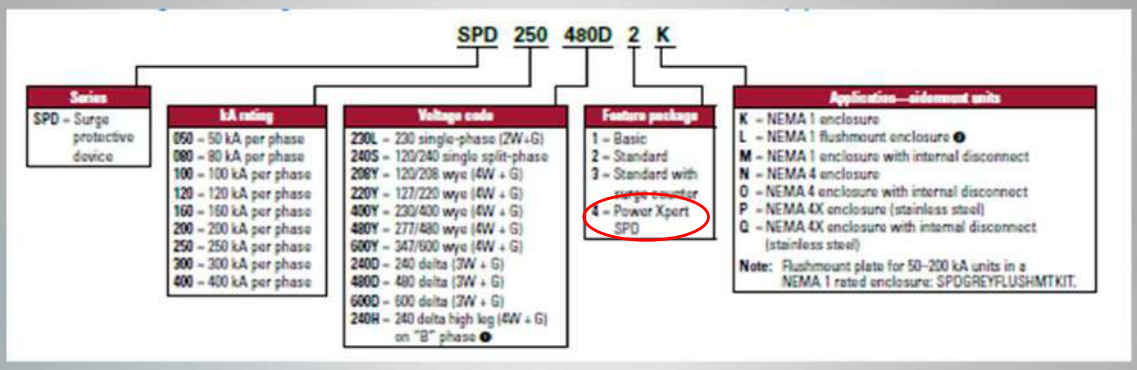
What is the Power Xpert SPD



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Other Sources of Information

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