



# Major Changes to Surge Protection Standards

March 16, 2009

# Agenda

---

- Review of existing terminology
- Surge protection standards with recent changes and updates
- Review of major changes to UL 1449

# Terminology review

- TVSS – Transient Voltage Surge Suppressor
- Secondary Arresters
- Lightning Arresters
- Single Impulse Wave Surge Current Test
- IEEE C62.41 Waveform

  - A1, A2, A3
  - B1, B2, B3
  - C1, C2, C3

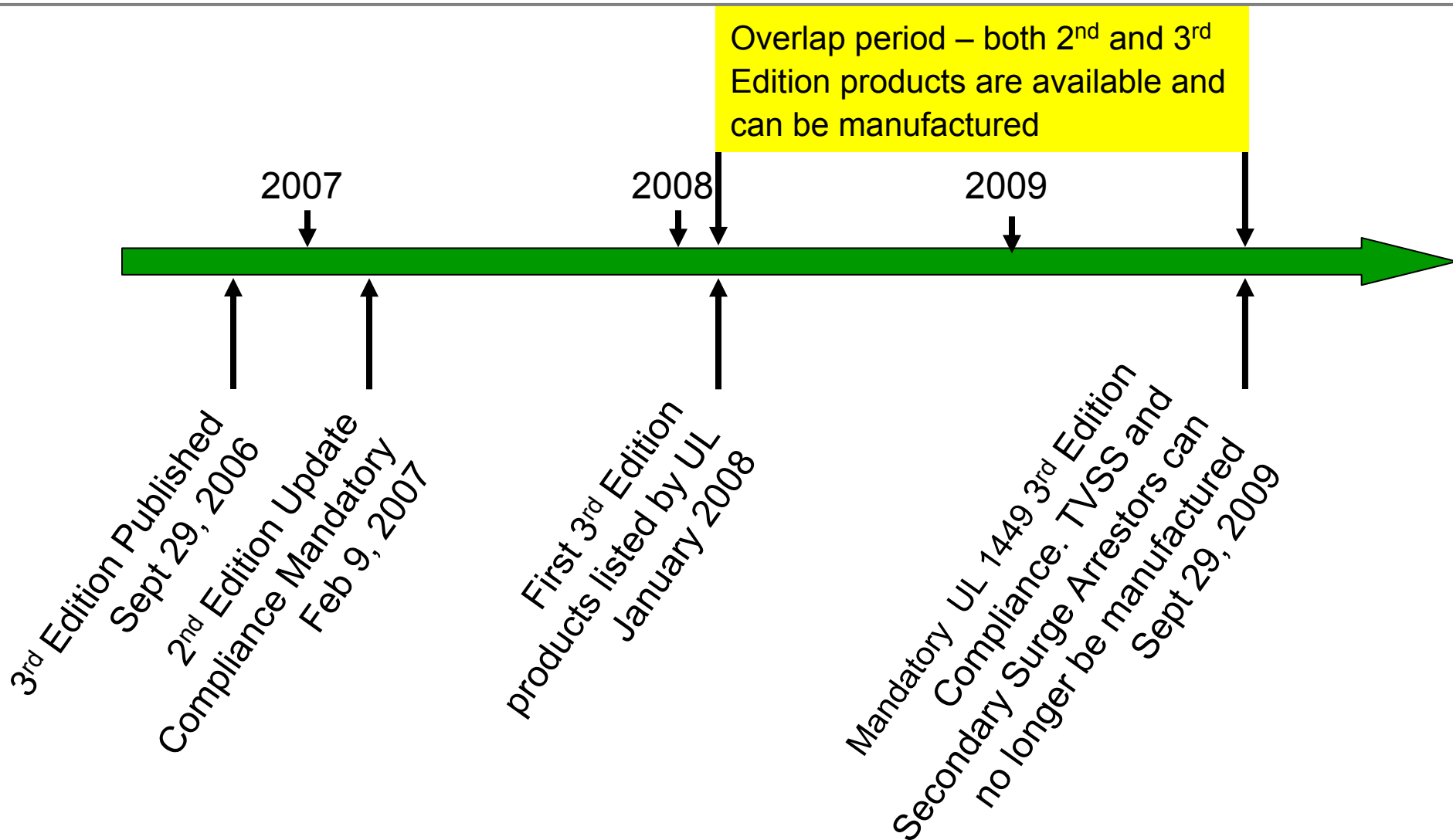
- SVR – suppressed voltage rating

# Changes to standard and terminology

---

- Numerous changes to a number of surge protection documents have been made:
  - UL 1449 – mandatory compliance 9/29/09
  - NEMA LS-1 – to be published in 2009
  - IEEE C62.41 - 2002
  - NEC 2008
  - UL 96A – Master Lightning Certificate
- Many terms used in the past are now obsolete or will become obsolete in the near future

# Timeline – UL 1449 – Safety Standard



# Three key changes to UL 1449 3<sup>rd</sup> Edition

---

- Terminology
  - SPD Types
- Voltage Protection Rating
- Nominal Discharge Current

# Terminology and how to specify – required marks

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

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.

Model #: CVX100-208Y

SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)



# UL 1449 3<sup>rd</sup> Edition - Terminology

---

- The SPD type refers to the location where the SPD can be used
  - Type 1 – before the service disconnect overcurrent device
  - Type 2 – after service disconnect overcurrent device
  - Type 3 – a minimum 10m (30 ft) of conductor between service disconnect overcurrent device and SPD

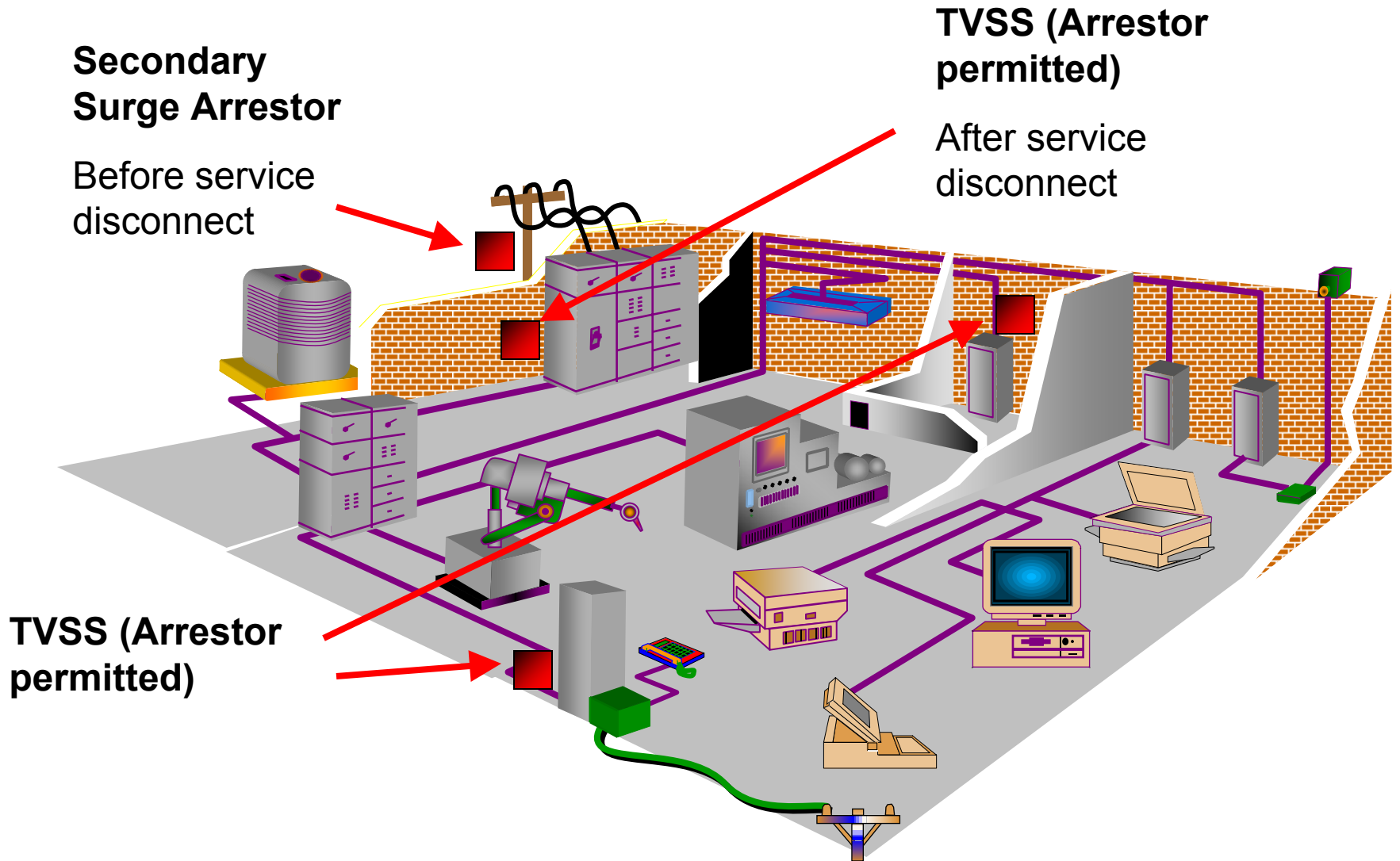


# UL 1449 3<sup>rd</sup> Edition - Terminology

---

- In relation to old terminology, i.e. pre-September 2009, the following general comparisons can be made
  - Type 1 – secondary surge arrester
  - Type 2 – Transient Voltage Surge Suppressor
  - Type 3 – plug-in surge strips, surge receptacles

# Current acceptable locations for TVSS and Secondary Surge Arrestors (2005 and 2008 NEC)



# Locations for SPD Types

## Type 1

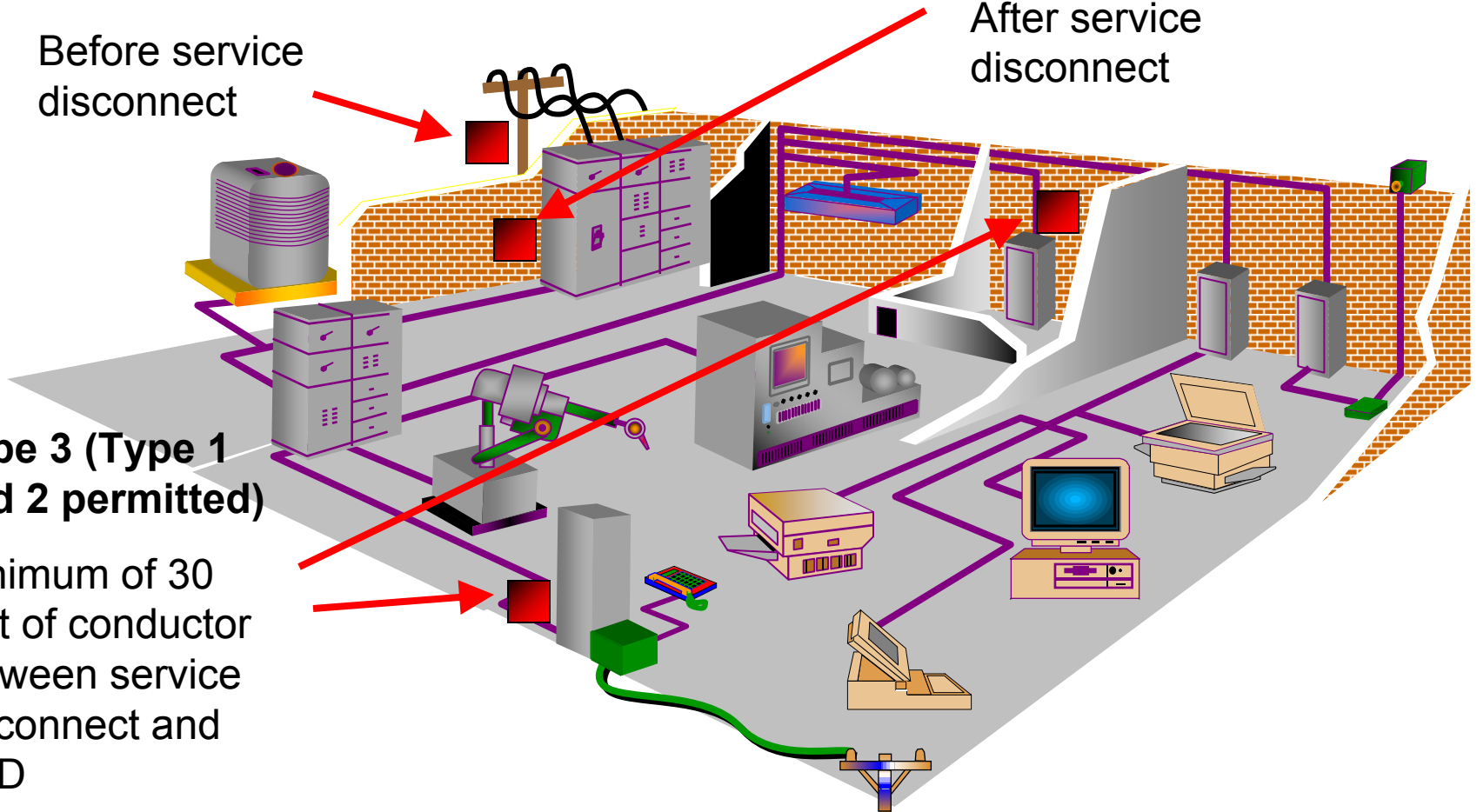
Before service disconnect

## Type 2 (Type 1 permitted)

After service disconnect

## Type 3 (Type 1 and 2 permitted)

Minimum of 30 feet of conductor between service disconnect and SPD



# UL category codes for low voltage (1000V and below) – Valid until September 2009

---

- UL category code XUHT
  - UL 1449 2<sup>nd</sup> Edition
  - Transient Voltage Surge Suppressors
  - NEC Article 285 (2005 and 2008 NEC)
- UL category code OWHX
  - ANSI/IEEE C62.11
  - Secondary surge arrestor
  - NEC Article 280 (2005 NEC only)

# Surge standards for low voltage (1000V and below) – Valid today and after September 2009

---

- Category code VZCA
  - UL 1449 3<sup>rd</sup> Edition
  - Surge Protective Devices
  - NEC Article 285 (2008 NEC only)

# Category OWHX

- Low Voltage (<1000V)  
UL Category OWHX  
devices can no longer be  
manufactured after  
September 29, 2009
- There are currently  
availability issues with  
OWHX surge arrestors  
from many  
manufacturers



# How to determine if an SPD is listed



## ONLINE CERTIFICATIONS DIRECTORY

**BEGIN A BASIC SEARCH**

To begin a search, please enter one or more search criteria in the parameters below.

Company Name

City

US State

US Zip Code

Country

Region

Postal Code (non-US)

UL Category Code [\(options\)](#)

UL File Number [\(help\)](#)

Keyword

- Go to [ul.com](http://ul.com) and click on the “certifications” link
- Type in the category code
- XUHT – TVSS
  - 165 results as of 3/16/09
- OWHX – Surge Arrester
  - 34 results as of 3/16/09
- VZCA – SPD
  - 32 results as of 3/16/09

# National Electrical Code implications

---

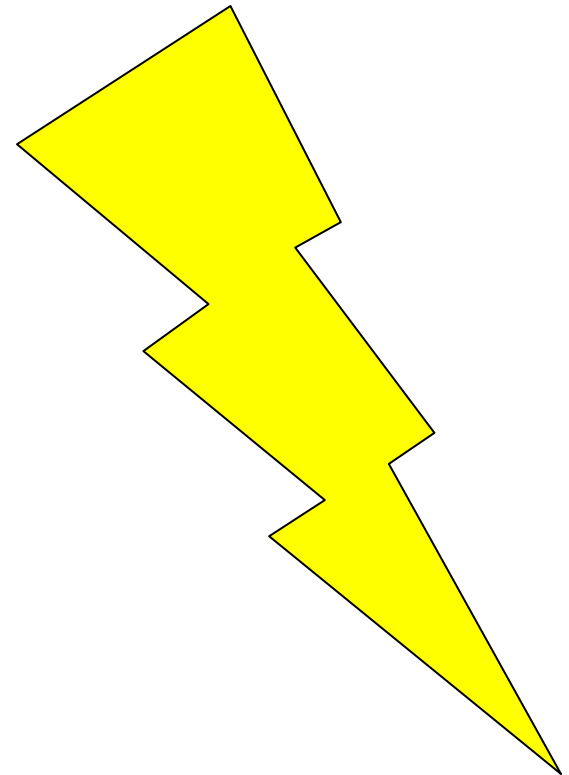
- Article 280 – Surge Arresters, over 1kV
  - Per 2008 NEC Article 280 now only applies to voltages over 1kV.
    - 2005 NEC Article 280 applied to all voltages
- Article 285 – Surge-Protective Devices (SPDs) 1kV or less
  - Per 2008 NEC Article 285 now applies to all surge devices less than 1kV including, surge arresters, TVSS, Type 1, 2 and 3 SPDs
    - 2005 NEC Article 285 applied only to TVSS



# Impact on Lightning Protection Systems

- UL 96A – Installation Requirements for Lightning Protection Systems
- UL 1449 2<sup>nd</sup> Edition TVSS can **NOT** be used to meet requirements of UL96A Master Lightning Protection Certificate unless specifically tested for Lightning Protection Systems
- UL 1449 3<sup>rd</sup> Edition Type 1 and Type 2 SPDS meet the requirements of UL 96A if properly rated

**UL 96A**  
**NFPA 780**



# Terminology and how to specify – required marks

- 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

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.

Model #: CVX100-208Y

SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)



# Nationally Recognized Testing Laboratory Mark - NRTL

- Other laboratories besides Underwriters Laboratories can test and list devices to be compliant with any standard, including UL 1449
- Only an SPD that is tested by UL is “UL Listed” –
- An SPD tested by another NRTL can be “Compliant to UL 1449” but will be “Listed” by the NRTL – e.g. “ETL Listed”, “CSA Listed”



# Terminology and how to specify – required marks

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

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.

Model #: CVX100-208Y

SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)



# Applicable current ratings for SPDs

---

- Peak surge current rating
  - Measure of life or longevity expectations of SPD
  - Also referred to as “single impulse rating”, “maximum current rating” or “life rating”
- Nominal discharge current rating
  - Measure of ruggedness or durability of SPD in the electrical system
- Short circuit current rating SCCR
  - Measure of how much current the electrical utility can supply during a fault condition

# Peak surge current rating

---

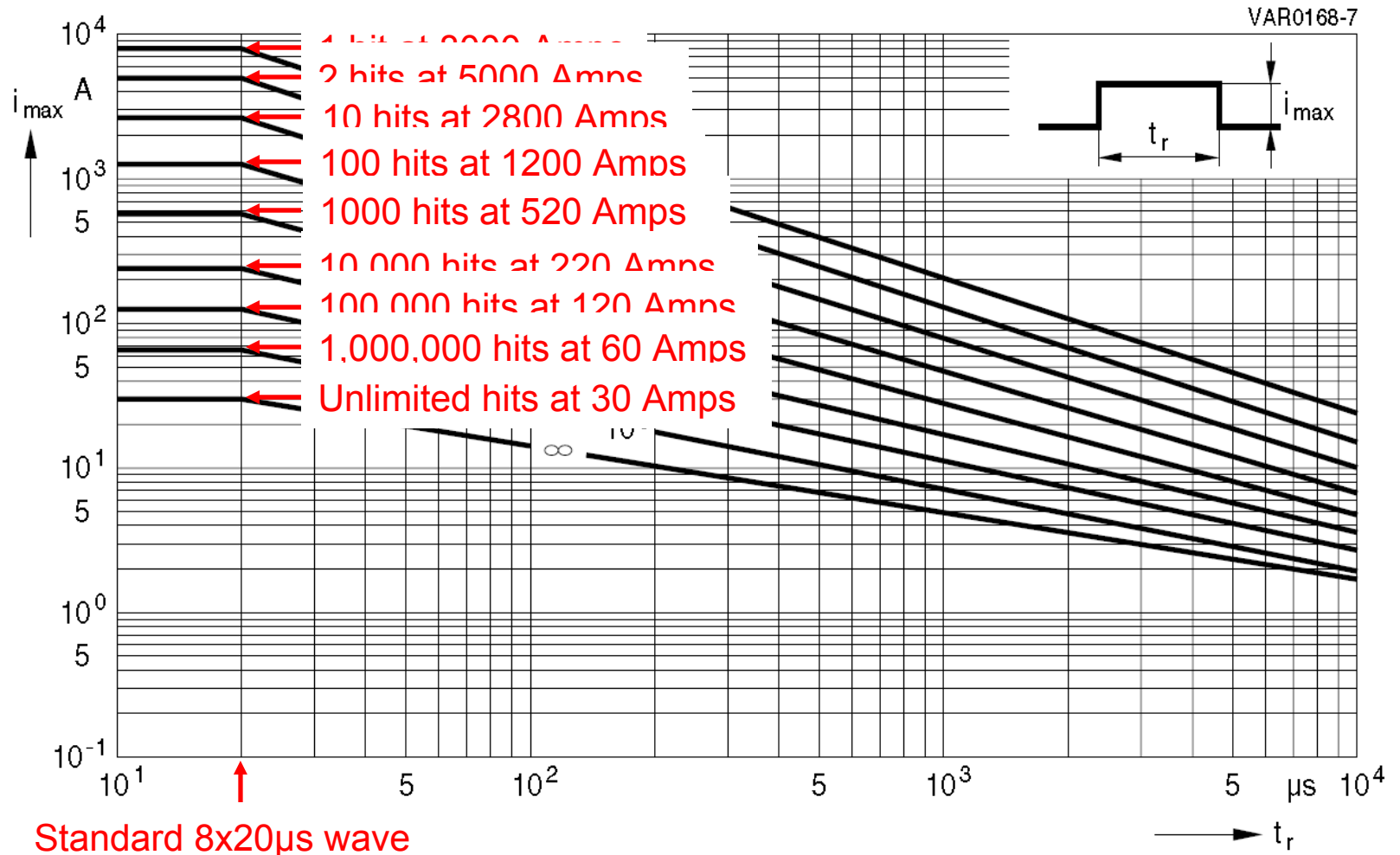
- This is how virtually all manufacturers rate or size their SPDs
- Also called:
  - Surge current capacity
  - Single pulse surge current
  - Maximum surge current
  - Peak surge current
- **Important note: it is never intended that an SPD is ever subjected to the peak surge current in actual installed conditions!!!**

# Peak surge current rating

- The peak surge current is a predictor of how long an SPD will last in a given environment
  - The higher the kA, the longer the life of the MOVs
- Similar to the tread on a tire
  - The thicker the tread, the longer the tire will last



# Life rating curve for 8kA MOV





# How much life do you need?

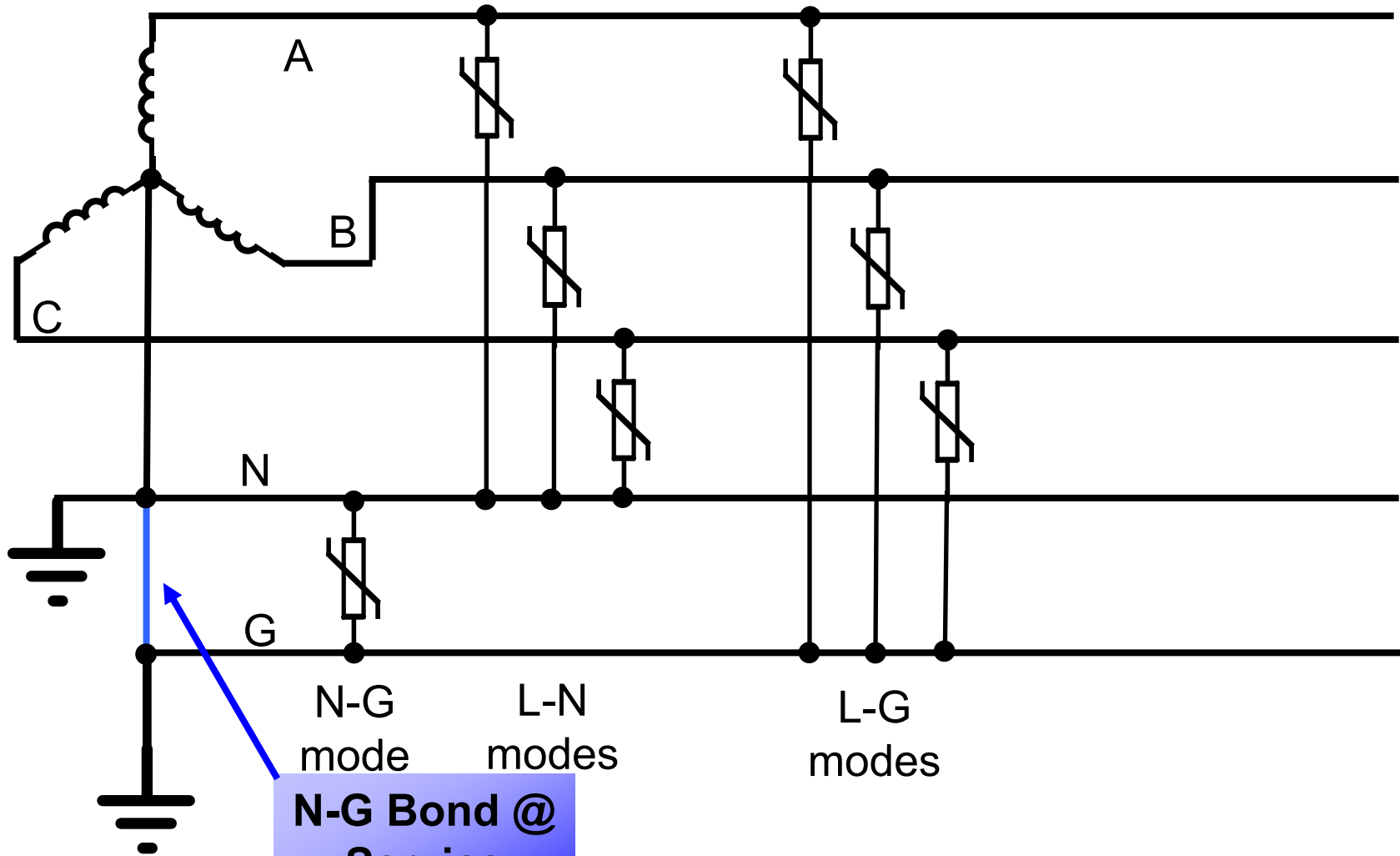
---

- On average electrical equipment has a design life of 30 years
- Experience has shown that 250kA – 300kA SPD at a service entrance can last the life of the electrical equipment in a high surge or high lightning area
- At a sub panel 120kA – 160kA provides good protection and life
- Point of use SPDs rated at 80kA – 100kA perform well

# kA per Mode – kA per Phase

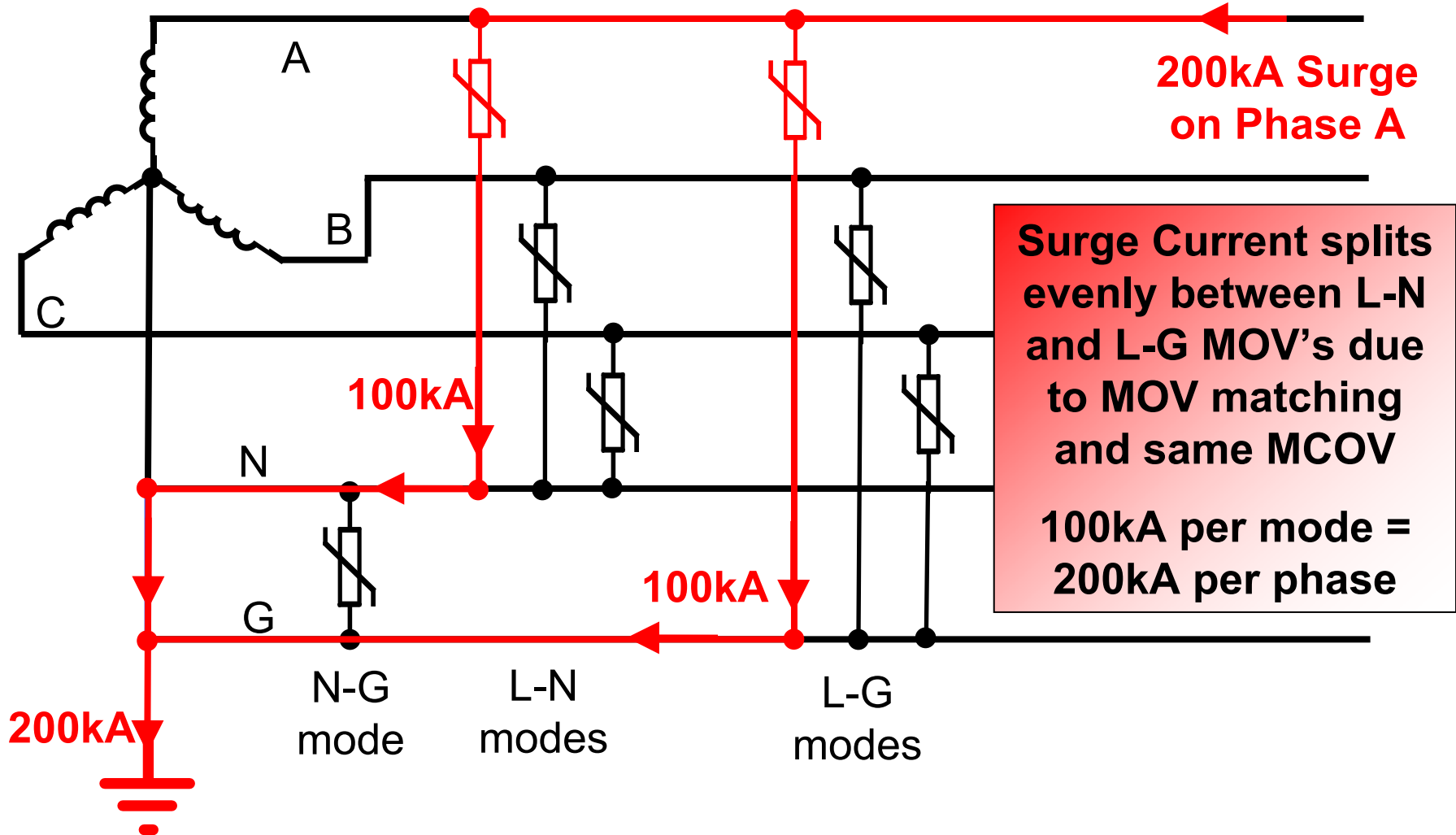
- A “mode” is a potential path for a surge to be diverted to
- Typical modes:
  - L-N, L-G, N-G
- The number of modes depends on the configuration of the electrical system
  - 1 $\Phi$ , 3 $\Phi$ , WYE, DELTA, etc
- NEMA standard nomenclature requires manufacturers to state their SPD units using kA per mode
- Many manufacturers also state their kA per phase
  - Purpose of listing kA per phase is to express the maximum amount of surge current a SPD can shunt to ground during a surge event on one phase

# 3 Phase – 4 Wire System



**N-G Bond @  
Service  
Entrance**

# 3 Phase – 4 Wire System



# Nominal Discharge Current - $I_n$

---

- New rating introduced with UL 1449 3<sup>rd</sup> Edition
- Measure of the “ruggedness” or “robustness” of an SPD
- Measure of how the SPD performs when installed and subjected to operating scenarios closer to real life situations
- “Stress test” – SPD is subjected to 15 surges, one minute apart, with rated voltage applied between surges

# Nominal Discharge Current - $I_n$

- Nominal discharge current tests the complete SPD under strenuous “real life” scenarios
  - MOV’s, circuit protection, leads, resistors, circuit boards, etc.
- Similar to a test track or road test for an auto



# Nominal Discharge Current test

---

- 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

# $I_n$ compared to other ratings

---

- Nominal Discharge Current Ratings – UL 1449
  - Type 1 – 10kA or 20kA
  - Type 2 – 3kA, 5kA, 10kA or 20kA
- NFPA 780 (Lightning Protection Systems) requires 20kA nominal discharge current
- IEEE C62.41 – 200Amps to 10,000Amps



# IEEE C62.41 Waveforms

100kHz Ring Wave		
Location Category	Peak Values	
	Voltage	Current
A	6kV	200A
B	6kV	500A

Combination Wave		
Location Category	Peak Values	
	Voltage	Current
A	6kV	500A
B	6kV	3000A

Combination Wave		
Location Category	Peak Values	
	Voltage	Current
C low	6kV	3kA
C high	10kV	10kA

# Recommendation

---

- All things being equal, customers and specifiers should choose  $I_n$  of 20kA
- Energy =  $I^2 \cdot t$ 
  - 10kA SPD can only take 25% of the energy of 20kA
  - 5kA SPD can only take 6.25% of the energy of 20kA
  - 3kA SPD can only take 2.25% of the energy of 20kA
- Unless there is a **significant** difference in cost between a 20kA  $I_n$  SPD and a lower  $I_n$  SPD our recommendation is to choose the 20kA SPD

# Short Circuit Current Rating

---

- Every electrical system has an available short circuit current. This is the amount of current that can be delivered by the system at a particular point in a short circuit situation
- Typical available short circuit currents are:
  - Residential – 5-10kA
  - Small commercial – 14-42kA
  - Large commercial/industrial – 42kA-65kA
  - Large industrial/utility/downtown in large cities – 100kA-200kA

# Terminology – required marks

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

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.

Model #: CVX100-208Y  
SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)



# Maximum Continuous Operating Voltage

- The maximum rms voltage that can be applied to each mode of the SPD
- This is a manufacturer selected value
- Users and specifiers should make sure there is enough “head-room” so that normal voltage fluctuations do not exceed the MCOV

## Typical MCOVs

120V system – 150V MCOV

240V system – 320V MCOV

480V system – 550V MCOV

# Terminology – required marks

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

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.

Model #: CVX100-208Y

SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)



# System voltages and frequency

---

- It is very important to select the correct voltage configuration for the application
  - Wye or Delta? Single phase or three phase?
- Applying an SPD with too low of a voltage rating will result in SPD failure
- Applying an SPD with too high of a voltage rating will result in high let-through voltages, reduced protection and diagnostics failure

# Terminology – required marks

- 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**

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.

Model #: CVX100-208Y

SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)



**LISTED**



# UL 1449 Voltage Protection Rating

- VPR is a rating published and marked on all UL 1449 listed SPDs
- Residual voltage for a 6000 V, 3000 A 8/20  $\mu$ s surge waveform impulse

**EAT•N** | **Cutler-Hammer** TYPE 1 & 2 SPD

Surge Protective Device.  
Contains no servicable parts.



Model #: CVX100-208Y

SCCR: 100kA

Nominal Discharge Current Rating (In): 20kA

MCOV Rating: 150V L-N, NG, L-G; 300V L-L

Sys.V: 100V/174V; 120/208V; 127V/220V

Sys. Frequency: 50/60Hz

VPR: 700V L-N; 700V L-G; 700V N-G

Date of Manufacture: 11/21/2007

Suitable For Use on a Circuit Capable of Delivering  
Not More Than 100,000 rms Symmetrical Amperes.

Tel: 1-800-809-2772 • Web: [www.Eaton.com](http://www.Eaton.com)

# UL 1449 test for VPR uses 6" of external lead length

- In order to have consistency in VPR voltage levels, UL specifies that six inches of lead length is protruding from SPD



# Voltage Protection Rating

- Voltage Protection Rating is assigned to an SPD model by UL from a table based on the average of the measured limiting voltage from 3 impulses of a 6000V/3000A surge

Measured Limiting Voltage	Voltage Protection Rating
330 or less	330
331 - 400	400
401 - 500	500
501 - 600	600
601 - 700	700
701 - 800	800
801 - 900	900
901 - 1000	1000
1001 - 1200	1200
1201 - 1500	1500
1501 - 1800	1800
1801 - 2000	2000
2001 - 2500	2500
2501 - 3000	3000
3001 - 4000	4000
4001 - 5000	5000
5001 - 6000	6000

# Typical VPR values

---

- Typical VPR values based on manufacturer's data on UL.com
  - 120/240V system – 700V L-N
  - 277/480V system – 1200V L-N
- In other words, you could expect the residual let-through voltage to be 700V when an SPD is subjected to a 3000Amp impulse on the L-N mode
- VPR gives an indication of the quality of construction and expected performance

# Voltage Protection Rating

---

- Voltage Protection Rating (3<sup>rd</sup> Edition) replaces Suppressed Voltage Rating (2<sup>nd</sup> Edition)
- Suppressed Voltage Rating – 2<sup>nd</sup> Edition
  - 6000 Volt **500** Amp 8x20µs
- Voltage Protection Rating – 3<sup>rd</sup> Edition
  - 6000 Volt **3000** Amp 8x20µs
- This results in higher Voltage Ratings
  - Higher current results in higher suppressed voltage

# VPR vs. SVR

## Typical SVRs

120/208V Y

- L-N = 400V
- L-L = 700V

277/480V Y

- L-N = 800V
- L-L = 1500V

## Typical VPRs for same device

120/208V Y

- L-N = 700V
- L-L = 1500V

277/480V Y

- L-N = 1200V
- L-L = 2000V

# Summary

---

- Many changes in key surge protection standards
  - UL 1449
  - NEMA LS-1
  - IEEE C62.41
  - National Electrical Code
- Major changes to UL 1449 are:
  - New terms – SPD types
  - New parameter -nominal discharge current rating
  - Changed measured limiting voltage test - VPR

**EATON**

*Powering Business Worldwide*