Western Mining Electrical Association

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The Next Generation in Surge Suppression

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Introduction

- Power Surges – the Problem
- Transient Voltage Surge Suppression
- Principles of Operation
- Conventional TVSS Designs
- Consequences of Failure
- An Engineered Remedy
- Conclusions

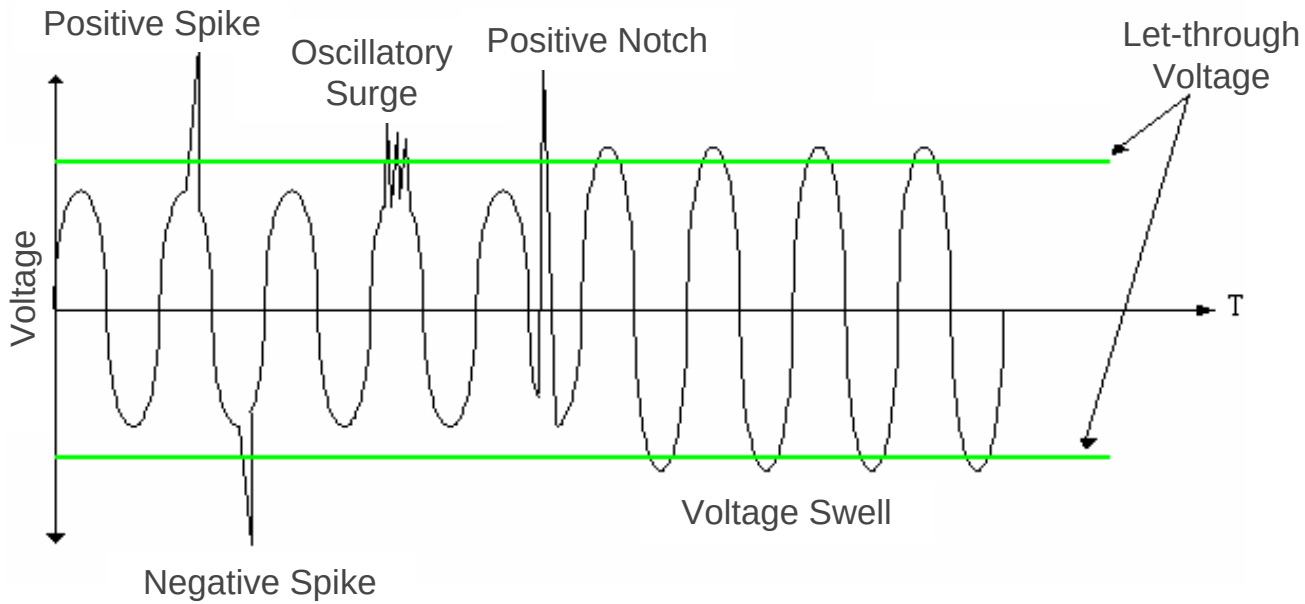
Why Install a Transient Voltage Surge Suppressor

- Transient Voltage Surge Suppressors are provisioned to protect electrical equipment from damaging surges.

- Electronic equipment such as VSD's, SM Power Supplies, and Computers have become more sensitive to surges as their efficiency has increased and the size and weight of the devices has decreased.
- We rely on electronic equipment to protect mission critical and production facilities from service interruptions.
- Down time is not an option!

TVSS Operation

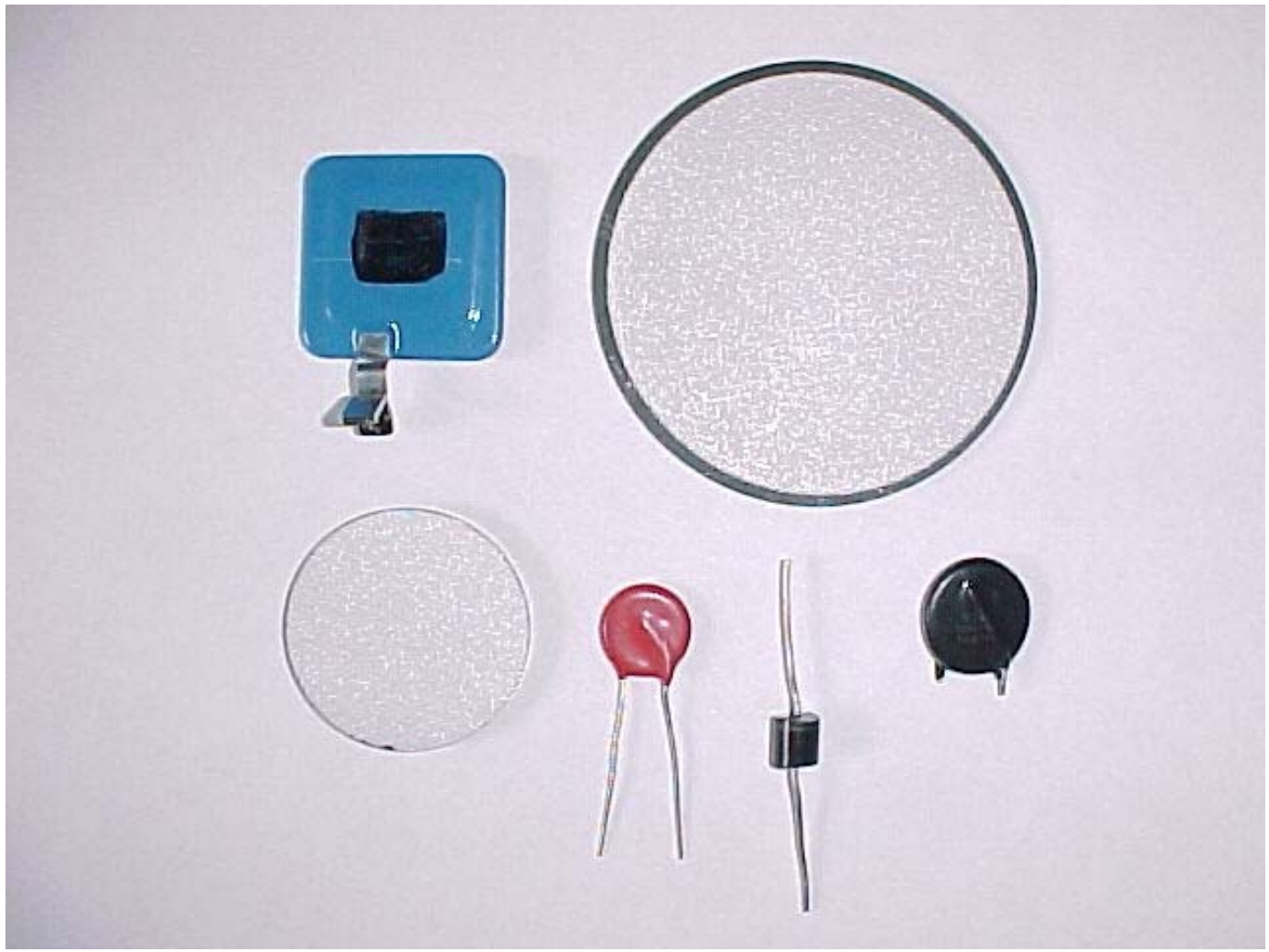
TVSS :A device which limits the voltage within an acceptable range:



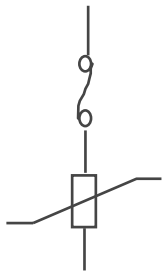
The **ideal TVSS** should:

- Absorb all energy above a preset voltage level and safely dissipate it.
- Not cause interruption of the normal function of the load
- Be reliable and work consistently without wearing out.

Suppression Components



Parallel Metal Oxide Varistors - MOV's



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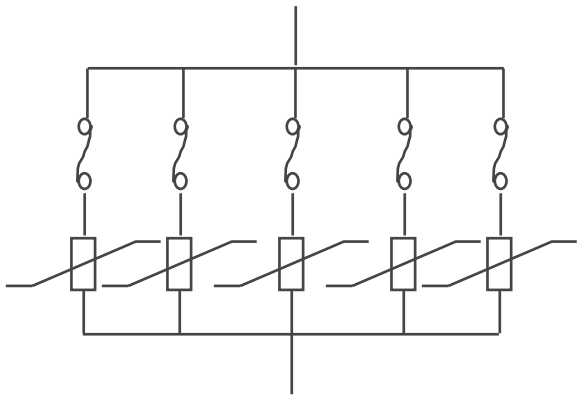
6,000A impulse



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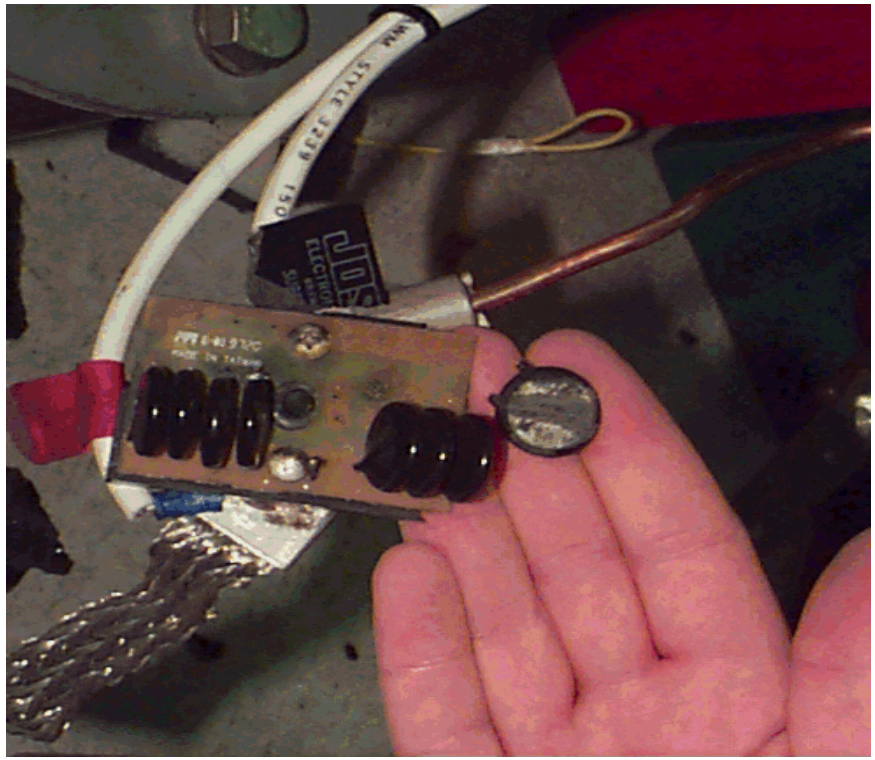
30,000A impulse

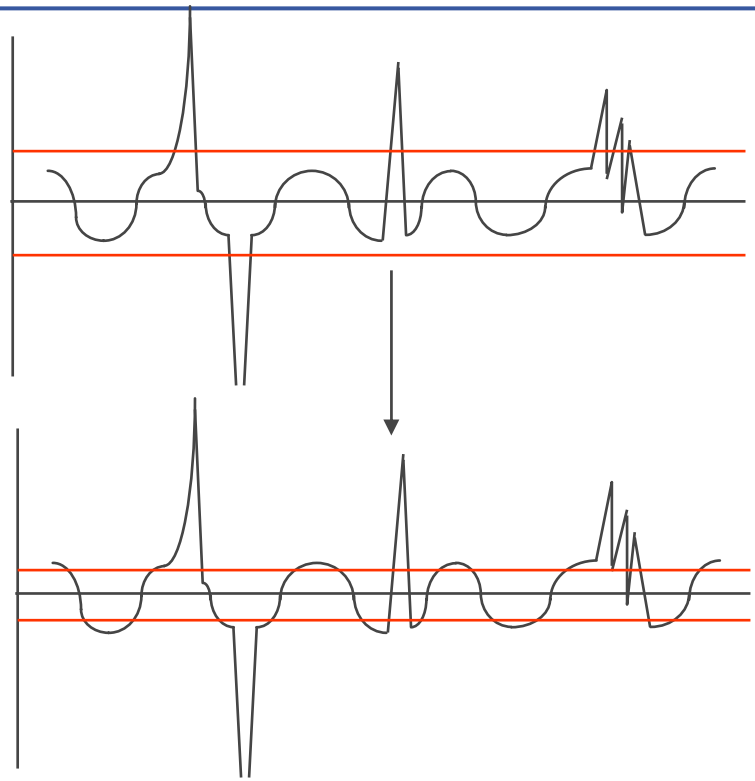
Why Do Protectors Fail?

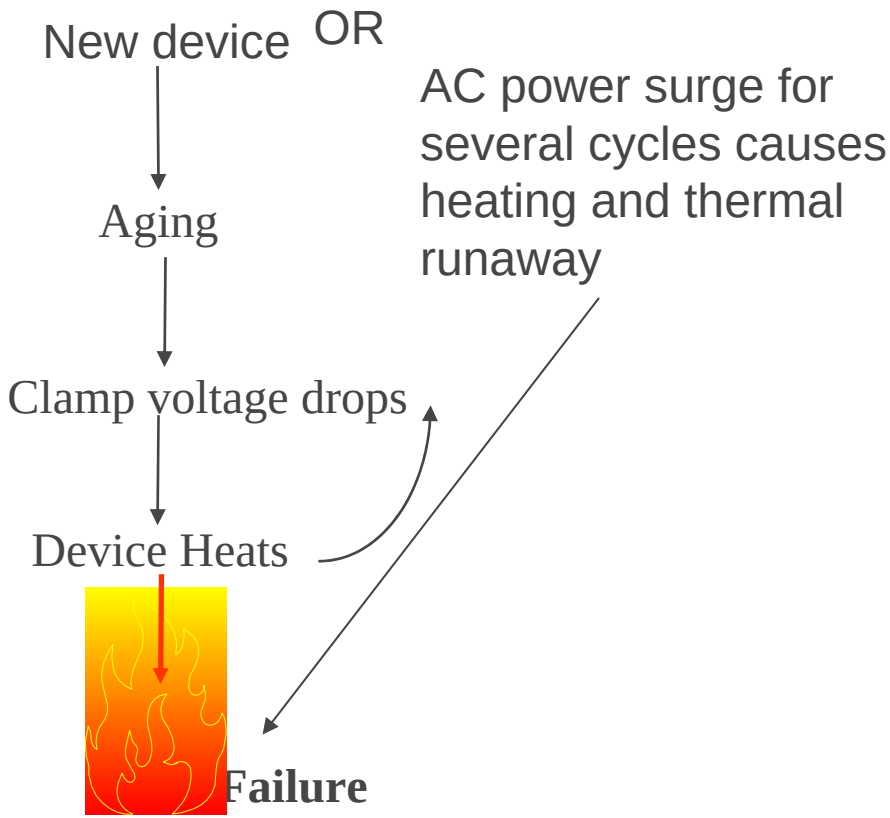
- Poor mechanical and electrical design.
  - Parallel, low rated devices assume equal current sharing and perfect matching during life time.
  - Weak fusing

Why Do Protectors Fail?



Thermal Runaway

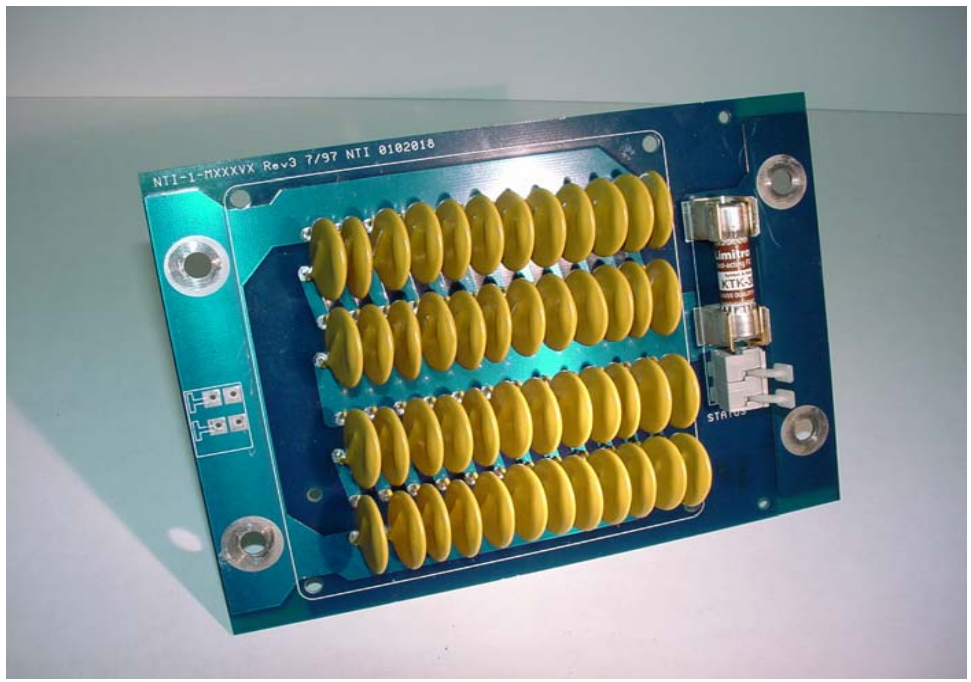




Current limiting and thermal fuses are being used to prevent thermal runaway. This fusing becomes the limiting factor for the suppression technology.

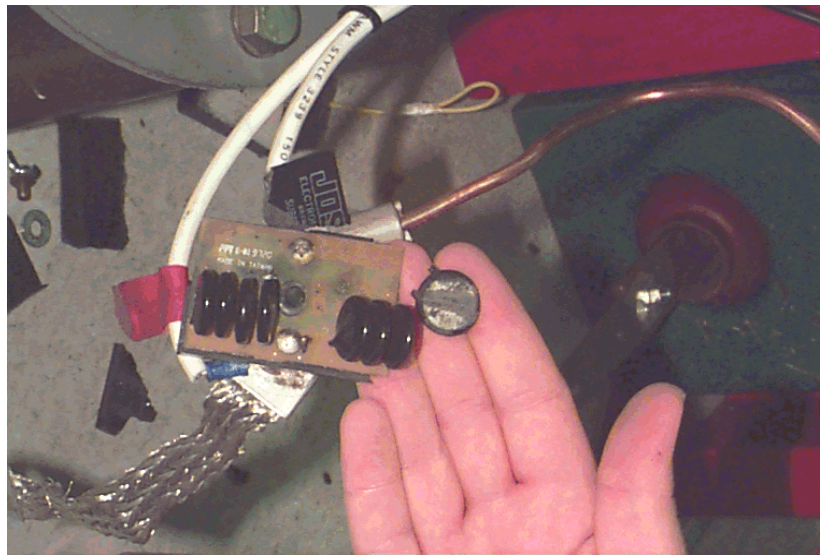
Parallel MOV’s

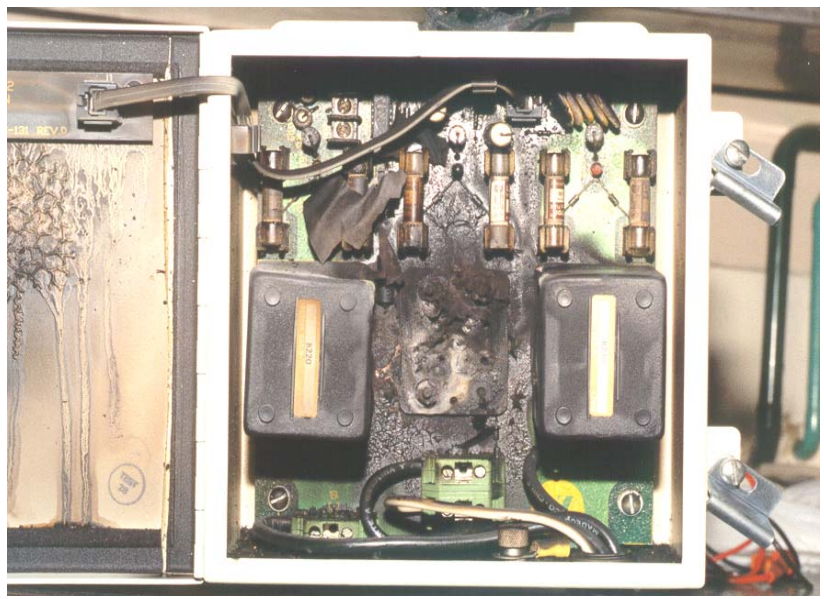
- Most TVSS devices use many metal oxide varistors (MOV's) connected in parallel in an attempt to achieve the required levels of performance.
- Different MOV’s have different turn on voltages and different ageing patterns resulting in unpredictable performance after installation. They don’t share current equally, and performance degrades when one MOV handles a large current surge.



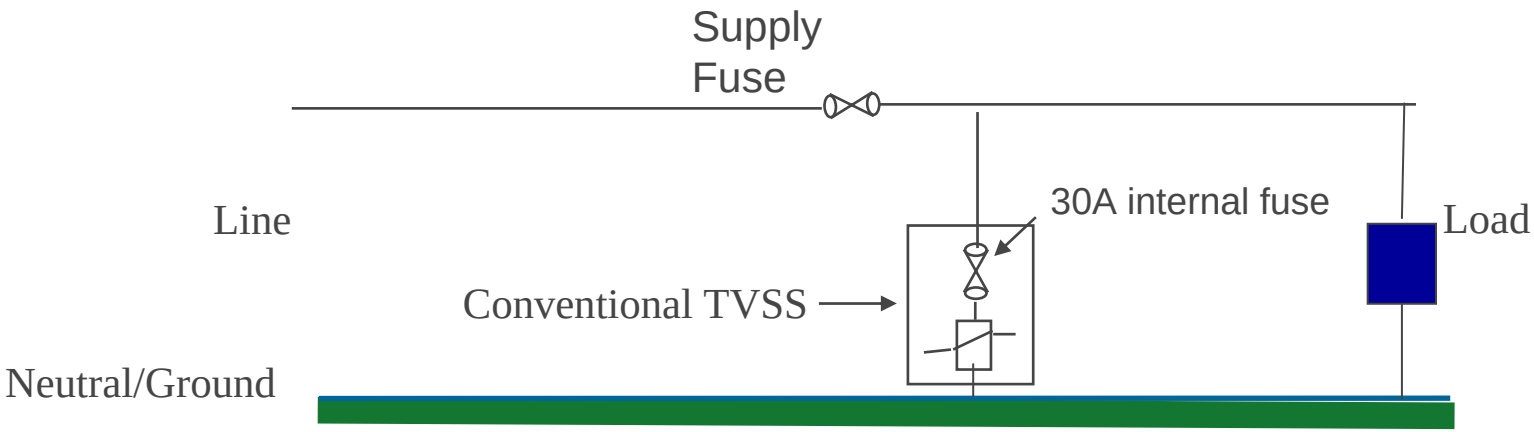
Why Protect the Protector?

- Rupture due to large electromagnetic forces generated by high current lightning surge
- Degradation in clamping performance due to ageing, and unequal surge current sharing
- Burning due to degradation in clamping voltage and thermal runaway





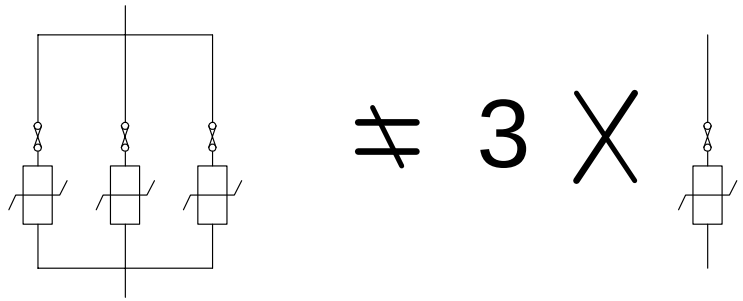
Why Does Protection Fail



1. Voltage on load equals protector voltage plus fuse voltage plus cable voltage. This can add thousands of volts to the protection level.
2. Operation of the fuse generates significant voltage across the load. Load is left unprotected for the next strike.
3. End of life mode is an open circuit.

Why Do Protectors Fail?

- Lack of, or inappropriate testing.
  - Extensive use of varistor math.
  - Misinterpretation of UL tests
  - Lab tests do not represent actual installations (lead length, point of measurement).



- Fusing.
  - Overcurrent fuses are often underrated to protect the TVSS.
  - Conventional thermal fuses are unreliable and suffer from aging.
  - Fuse operation generates surge that may damage load.

Why Does Protection Fail?

- Conventional installation can render protector useless.
  - Protector ratings do not allow “in line” connection.
  - Long lead lengths cause large inductive voltage to appear across the load.
  - Fuse operation disconnects the protection and leaves the load exposed.

Consequence of Failure

- TVSS damage or destruction.
- Emission of gases, smoke and soot.
- Switchgear contamination by smoke and soot.
- Explosions, fires.
- Protected equipment damage
- Down Time $$$

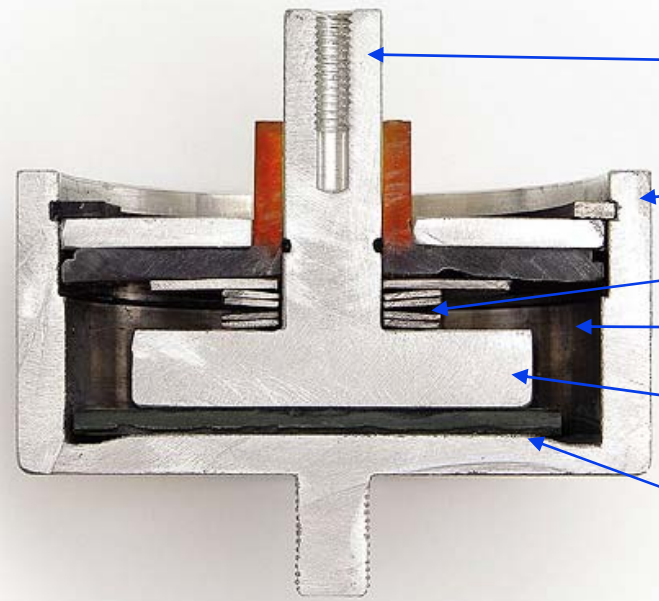
Protector Requirements

- The load should never be exposed to damaging transients/surges whatever the condition of the protector.
- The protector poses no additional safety risks e.g. Smoke, fumes, fire and explosion.
- The reliability and lifetime of the protector is greater than the equipment/load being protected.
- Installation should not affect the ability of a protector to perform its intended function.
- The protector should be able to deal with all abnormal line conditions and provide protection at all times.

Protector Features

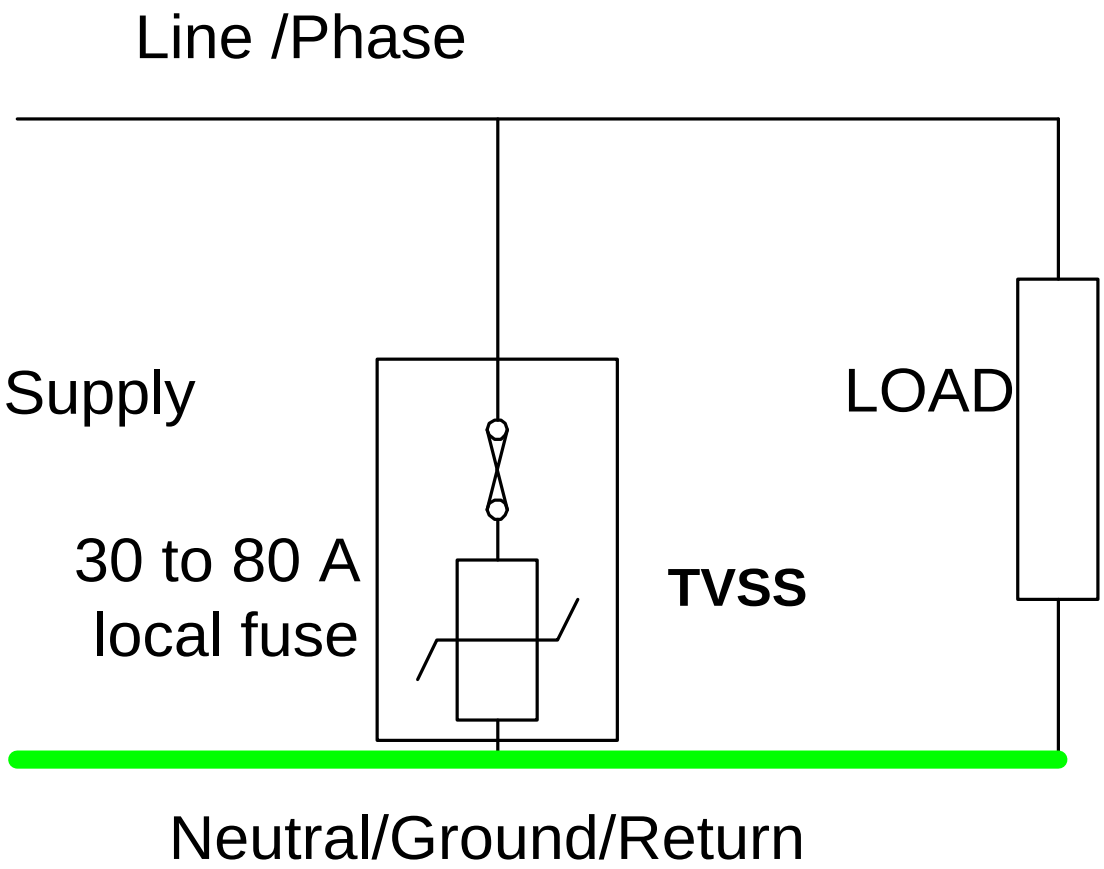
- No flammable material should be used in construction.
- Must be physically robust and not have an explosion hazard.
- Should require no internal fusing.
- Should have safe end of life, e.g. short circuit.
- Must be capable of installation using the “Kelvin” method.
- Must have a long life .
- Able to dissipate absorbed surge energy safely without undue heating.
- Must have low internal dynamic impedance.

The Engineered Protector

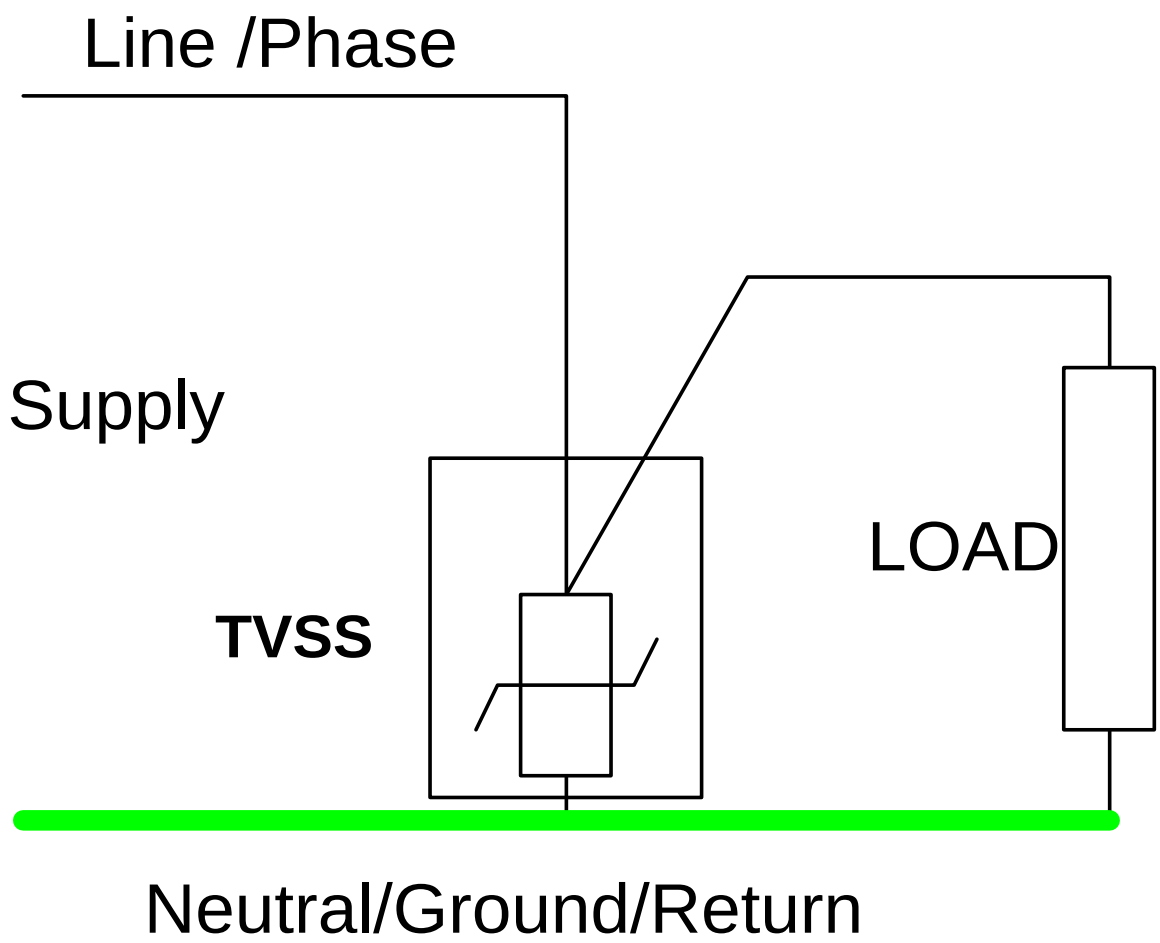


- Large Thermal Capacity Electrodes
- Strong Aluminum Housing
- 1500+ Pounds of Pressure
- No Fuel to Burn
- Low Dynamic Resistance & Low Residual Voltage
- Single, Distribution-Grade Varistor – No Parallel MOVs
- Fuseless Operation

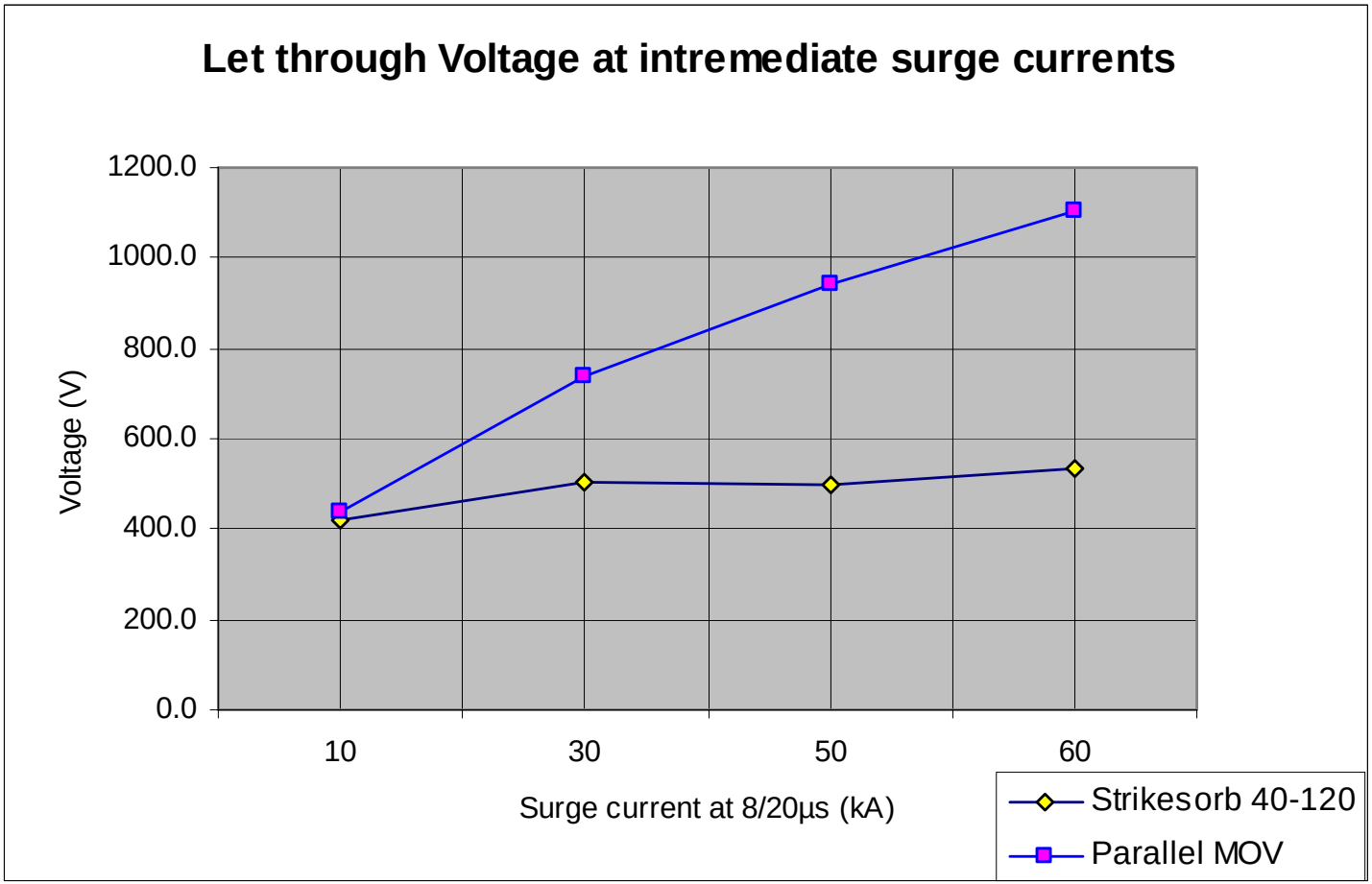
Conventional Protection



Total Protection

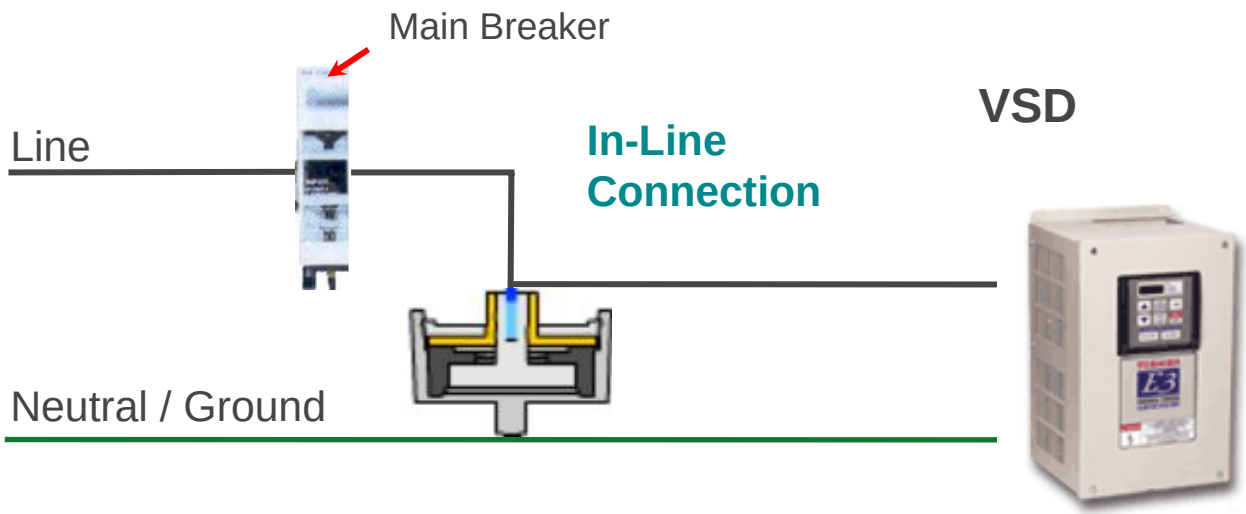


The Engineered Protector



Optimum “In Line” Installation

Optimum installation



Tested, Not Calculated, Performance

- Energy handling: 250 x 1000A @ 2000μs
- High current impulses:
  - 200kA - 8/20μs
  - 100 x 65kA – 8/20μs
  - 2000 x 20kA – 8/20μs
  - 25kA – 10/350μs
- Dynamic resistance: < 5mΩ

Conclusions

- It is possible to provide the correct protection even in the most extreme conditions.
- Fire and explosions can be prevented using good engineering practice.
- It is possible to provide protection that never gives up and never exposes equipment to excess energy.