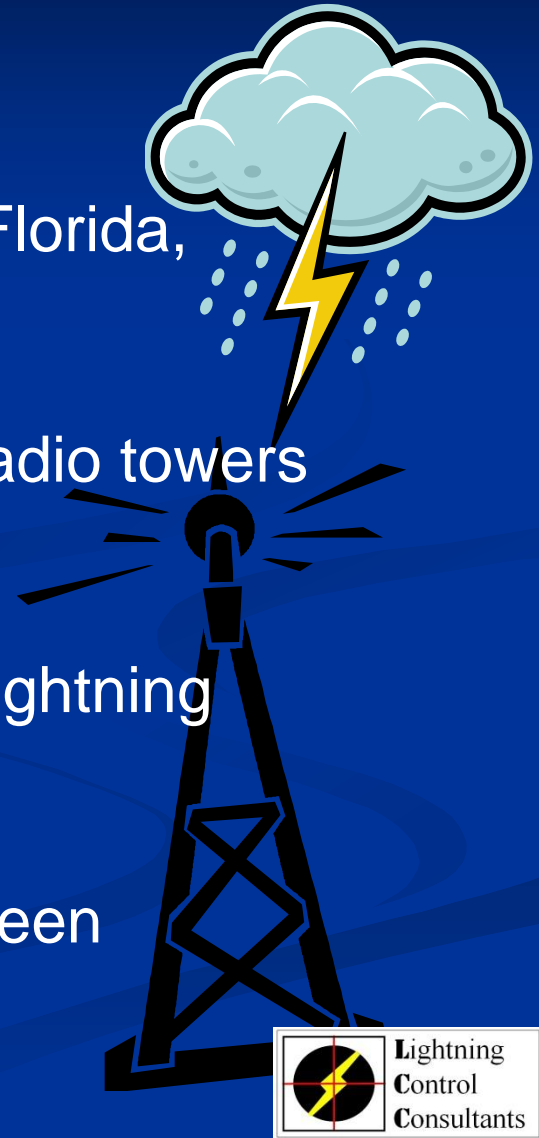


The Science of Lightning Protection.

A site can survive a direct Lightning Strike.

Evidence

- There are over 5,000 cellular towers in Florida, all with 100' towers
- The FDLE has over 230 microwave & radio towers that are 100 – 800' tall, in Florida
- Florida has a lightning density of 6 – 8 lightning flashes per square Km per year
- A tower in Florida is struck directly between 1 & 10 times a year



Do not accept that
you
cannot prevent
damage from
Lightning

Why do traditional solutions fail

- Focus on parts of the system, not the complete protection.
- Lack of understanding of the mechanisms that cause the damage
- Tradition – “we have always done it this way”
- Solutions are promoted by product vendors
- **TRIAL & ERROR** methodology
- Attitude - “you can’t do anything about a lightning strike”
- Specifications are outdated – Lightning Science is the key

Basic Rules to design a lightning protection system that will protect & survive

- Understand the amount of energy in a Lightning Strike
- Understand the relationship between Earthing & Surge Protection
- Understand the functions of a Surge Protection Device (SPD)
- Understand the coupling mechanisms that cause the damage
- Design the earthing system for immediate and long term performance
- Specify Surge Protection Devices (SPD'S) that will handle the surge loads
- Include SPD's on all circuits **TO** and **FROM** the site, cabinet and equipment
- Detail the earth system inter-connection to comply with equi-potential grounding and NEC Article 250

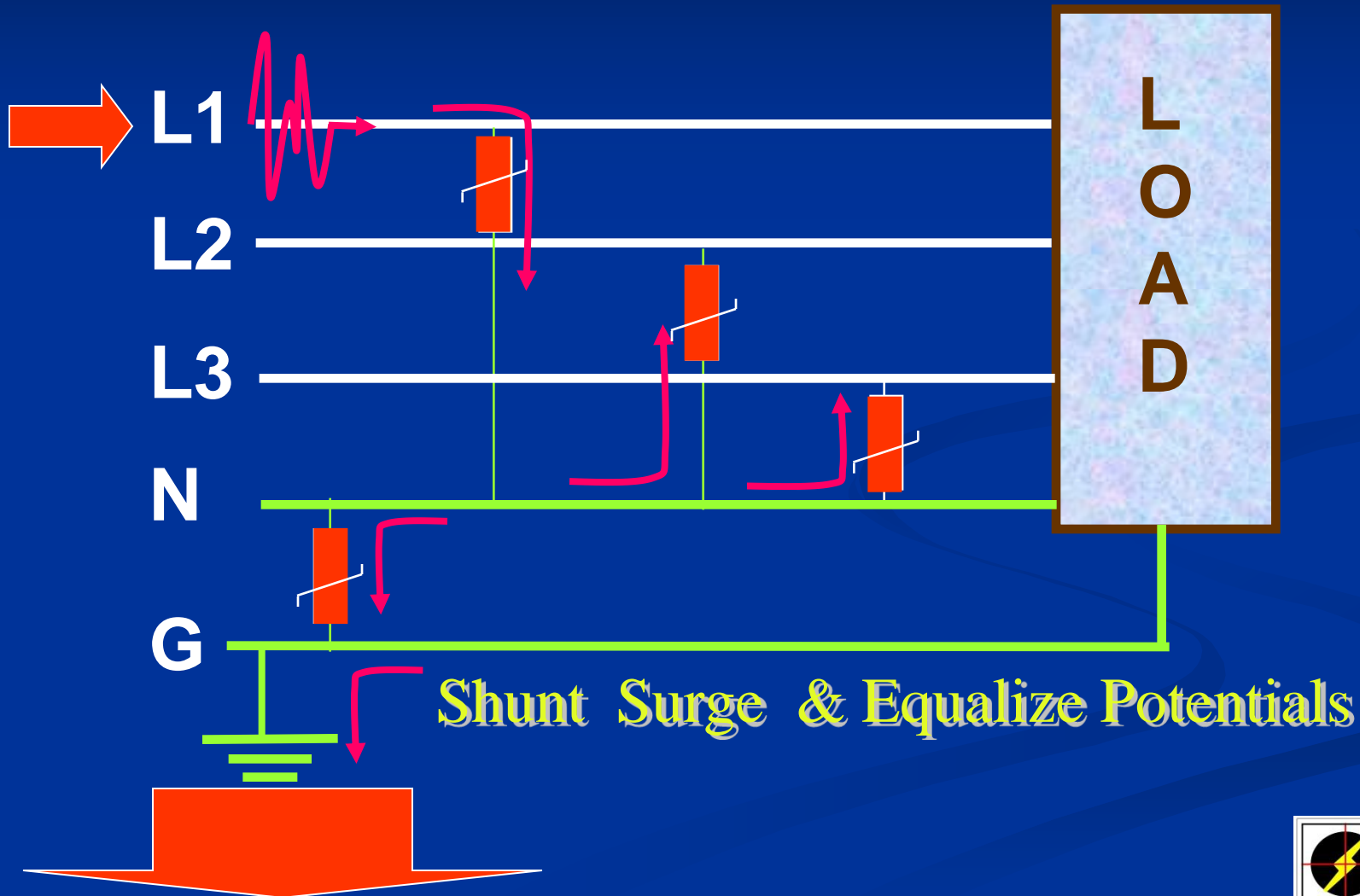
Magnitude of the Threat

- IEEE C62-41 tells us that the maximum surge is **10kA and 20kV**
- IEC 61312-3 tells us it is **200kA & 30 million volts**
- USA Lightning Detection Network tell us:
 - Negative Flash
 - Median = 35kA**
 - Less than 1% exceeds 120kA**
 - Positive Flash:
 - Median = 55kA**
 - Less than 1% exceeds 180kA**

Functions of a Surge Protection Device (SPD)

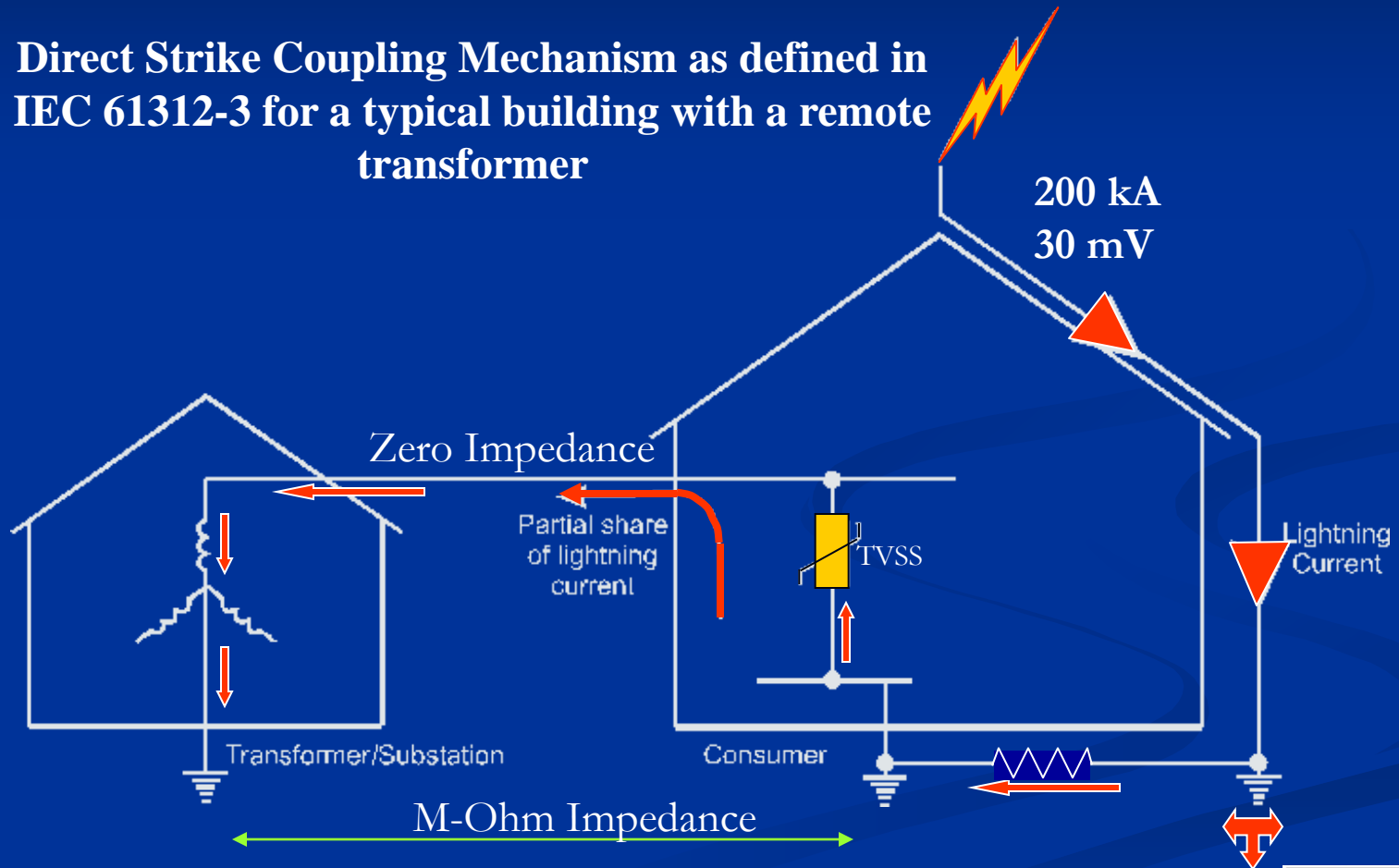
- Shunt the damaging surge “Current” to the site earth
- Equalize all “potentials” to the earth potential
- SAD’s function in a **BI-DIRECTIONAL** mode –
 - Shunt Surge on all connected line **TO** earth
 - Shunt Surge **FROM** an elevated ground potential to line

The functions of a surge protector

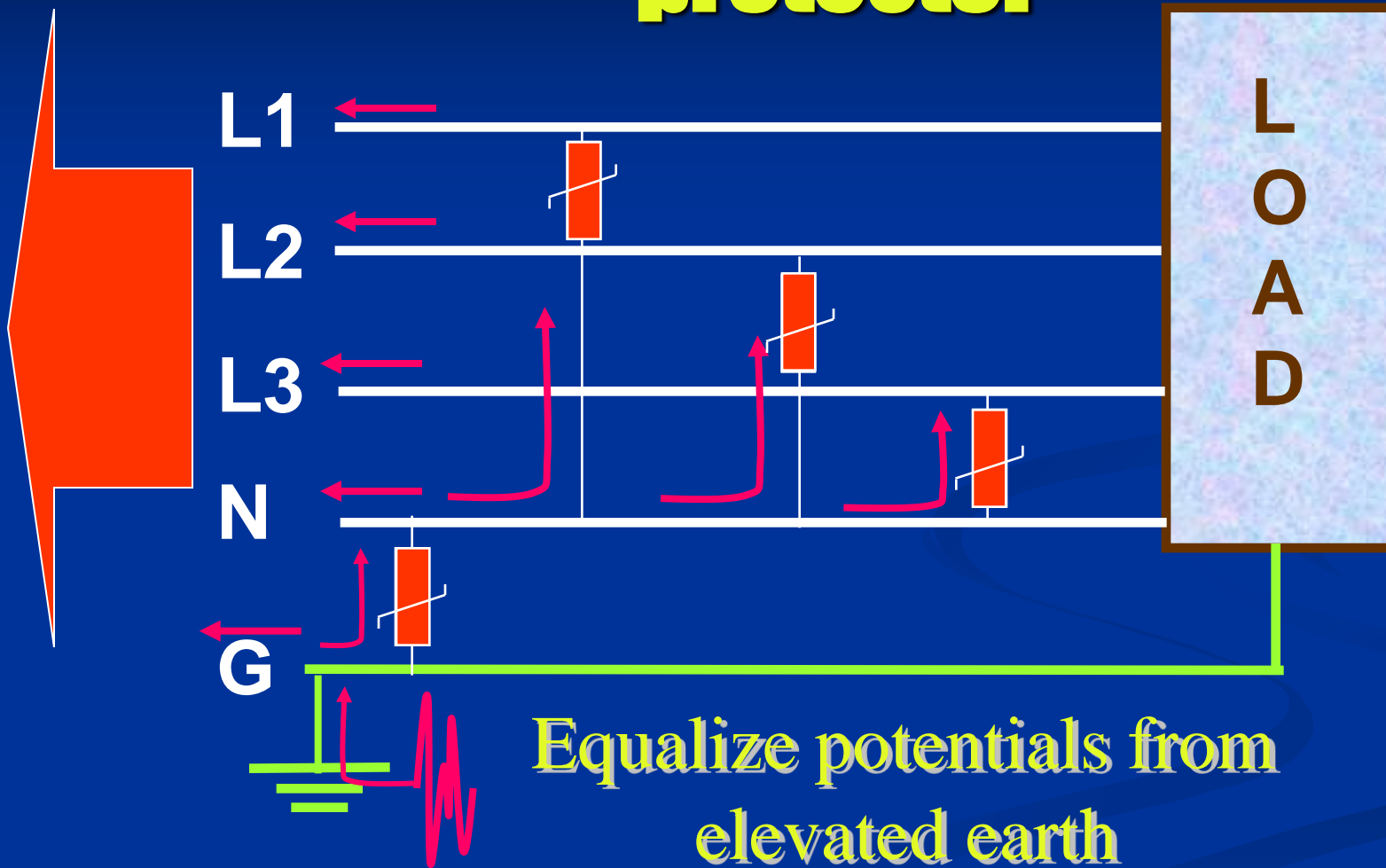


Direct Strike to a site

Direct Strike Coupling Mechanism as defined in IEC 61312-3 for a typical building with a remote transformer

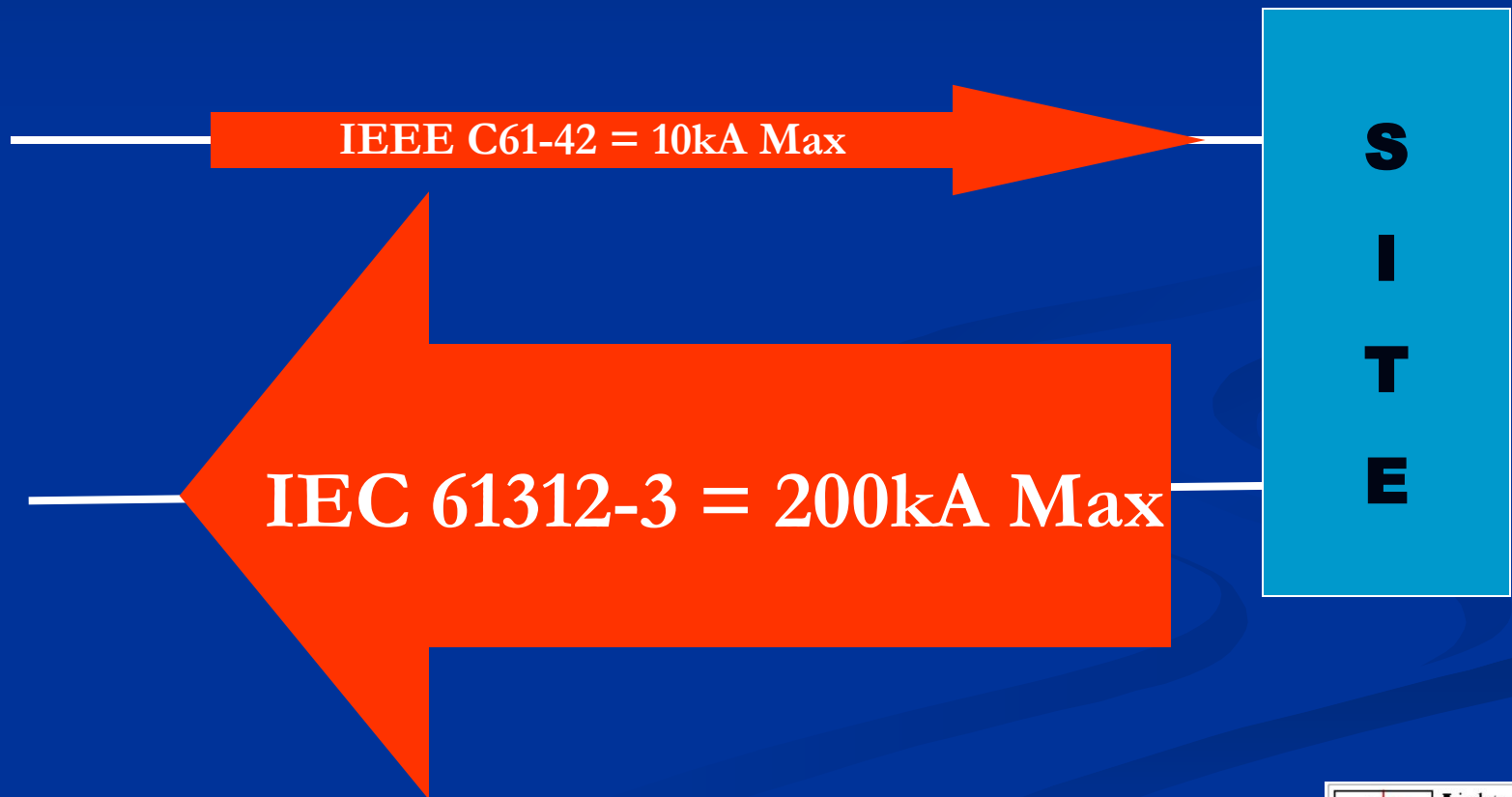


The "other" function of a surge protector



On & Off Site Surges

Comparison of specifications



Coupling mechanisms

- Surges on Connected Lines
- Induced Surges
- Elevated Earth Potential
 - Direct Lightning Strike
 - Nearby Lightning Strike

Coupling mechanisms that cause the damage

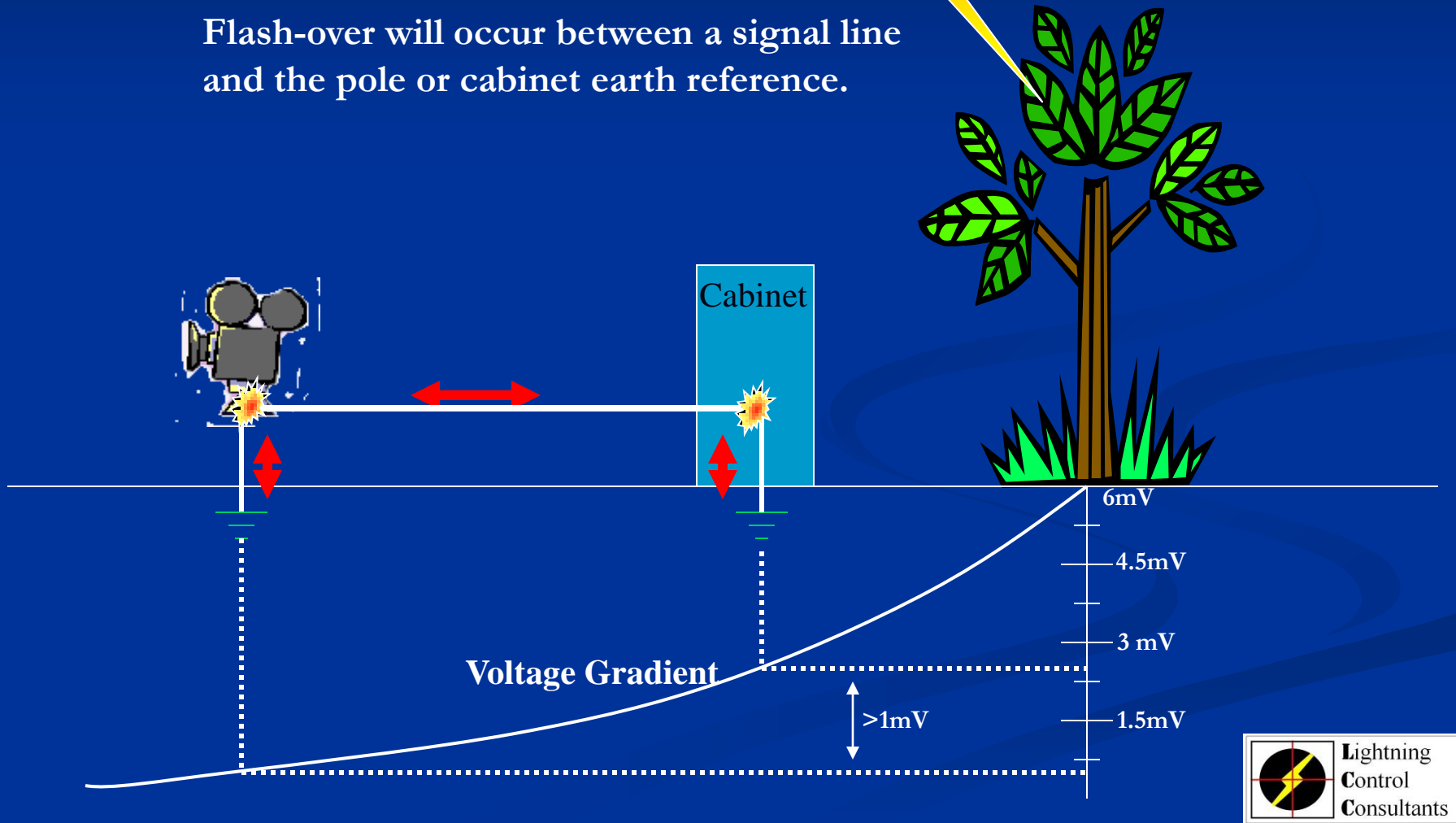
Induced Surges 1 – 5% (site specific)

Surges on Connected lines 1 – 20%

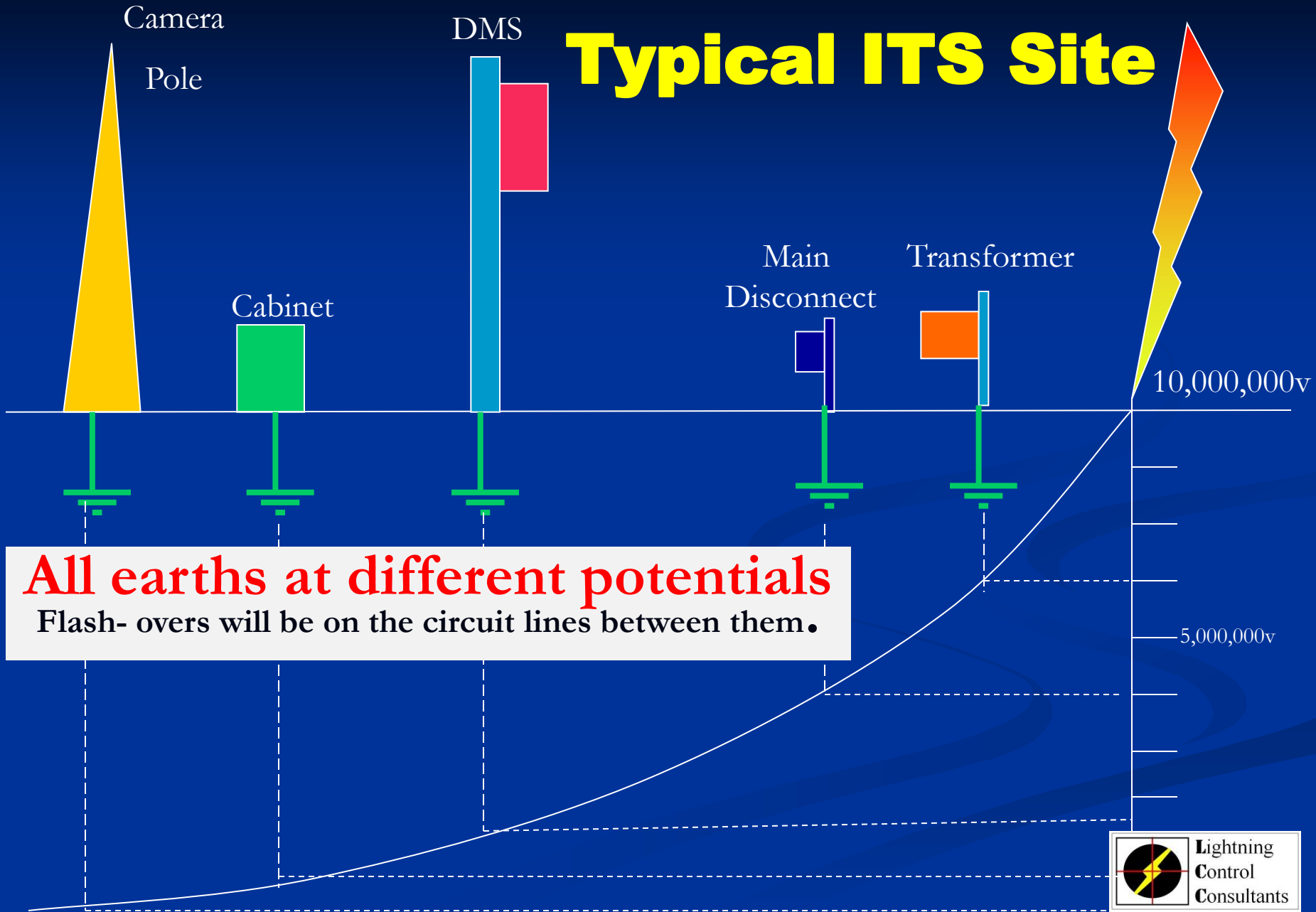
Elevated Earth Potentials 75 – 95%

Equi-potential Earth Problems

Flash-over will occur between a signal line and the pole or cabinet earth reference.



Typical ITS Site



Surge Protectors - Surge Current Capacity (kA)

AC Power surge protectors should be rated at a minimum of 50kA per phase – preferably greater

Data, communications & video surge protectors should be rated at a minimum of 10 kA but no more than 20 kA

The Earthing Array

Earthing System:

- Provide an Electrical **SAFETY** Earth
- NEC Article 250 bonding
- Equi-potential earth (single point grounding)
- Dissipate Surges coupled by the Surge Protector

Design Requirements:

- Array should have **at least** 2 ground rods
- Ground rods 20 - 40 feet long
- Spaced 40 – 80 feet apart
- Ground rods accessible for ongoing PM cycles
- Use exothermic welds for all connections
- specify 5 ohms resistance

Earthing System for Traffic Signals

Incorporate the ground rod under each mast arm into the grounding array

Benefits:

- Complies with NEC Article 250 – (Bonding)
- Provides a low resistance earth array with minimum effort
- Provides an equi-potential earthing array
- Multiple ground rods minimizes the deterioration of the resistance

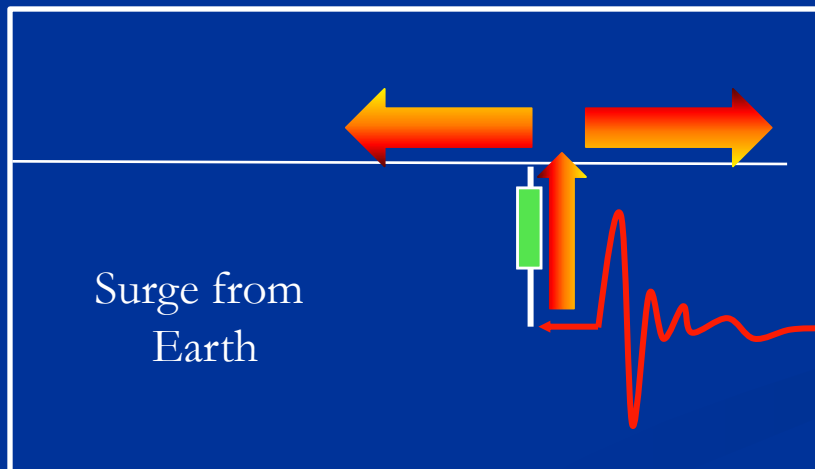
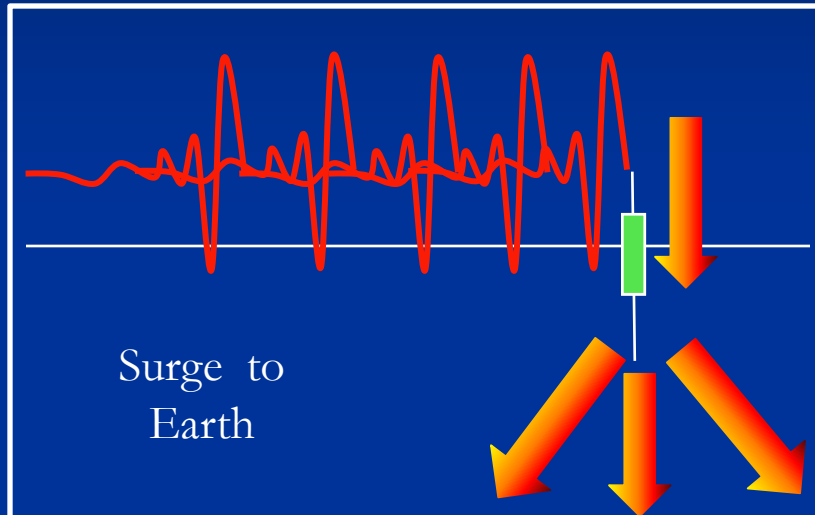
Deterioration of the Earthing Array

The earthing system begins to deteriorate the day it is installed.

- Corrosion of the ground rods and copper wire
- Catalytic effects depending on the soil moisture
- Stress from diverting high surge currents

Relationship between earth and surge protectors

Surge Protectors and earth work as a team



- Surge Protection without good earthing diminishes the ability to shunt damaging currents
- Earthing without Surge Protection cannot equalize potentials when the ground potential gets elevated

What doesn't work



Early Streamer Emission Devices
----- or -----
Lightning Dissipation Arrays

Surge related Damage

- If you have surge damage at a site it **MEANS** that the protection system is **DEFECTIVE**
- If you do not investigate and repair the protection system, the damage will happen **AGAIN & AGAIN.**

Lightning Control Consultants Inc.

Thank you:

Any Questions ??

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