Setting the Standard for Automation™

Transient and Lightning Protection for the Water Industries

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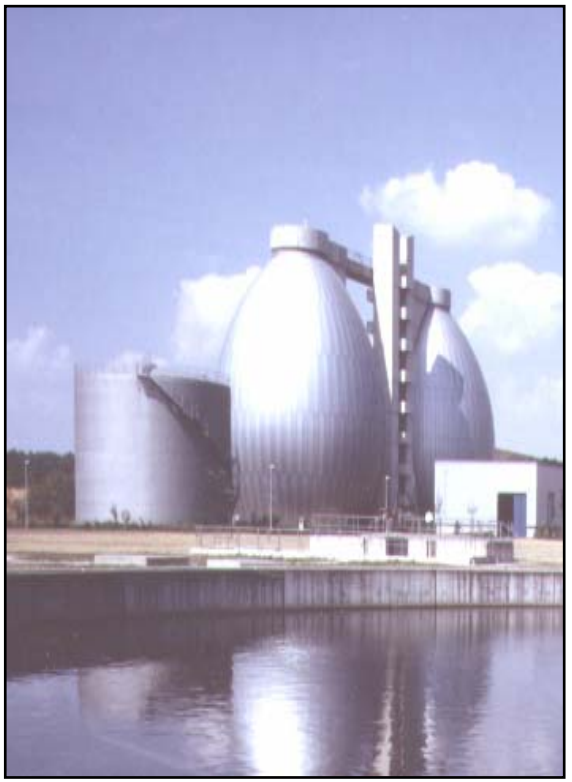
Agenda

- Who are we?
- Why protect equipment from transients?
- Likelihood of lightning
- Why are water plants so susceptible?
- Who is at the greatest risk?
- What can be done to prevent damage?



Presenter

- Mike Nager
- BS Electronics Engineering
- Senior Member ISA, IEEE
- Career with industrial control companies
- Published author
- Work in Phoenix Contact's North American Headquarters responsible for Industry Management

Our surge generator: 200 kA; 200 kV

Surge generator

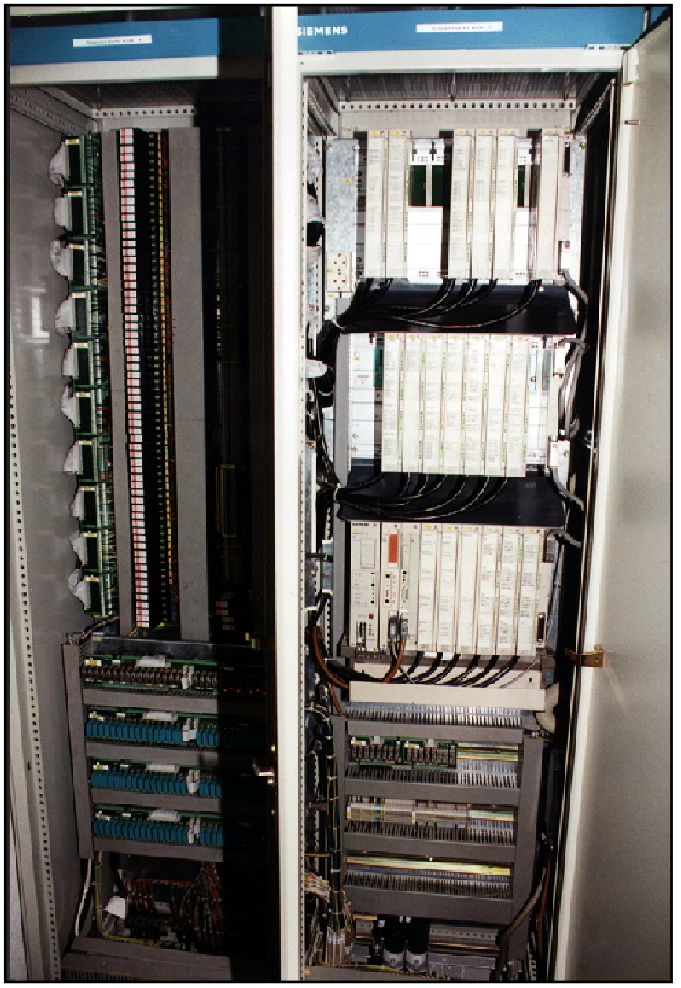
Desktop surge generator: 10 kA, 6 kV

Surge suppression in water treatment plants

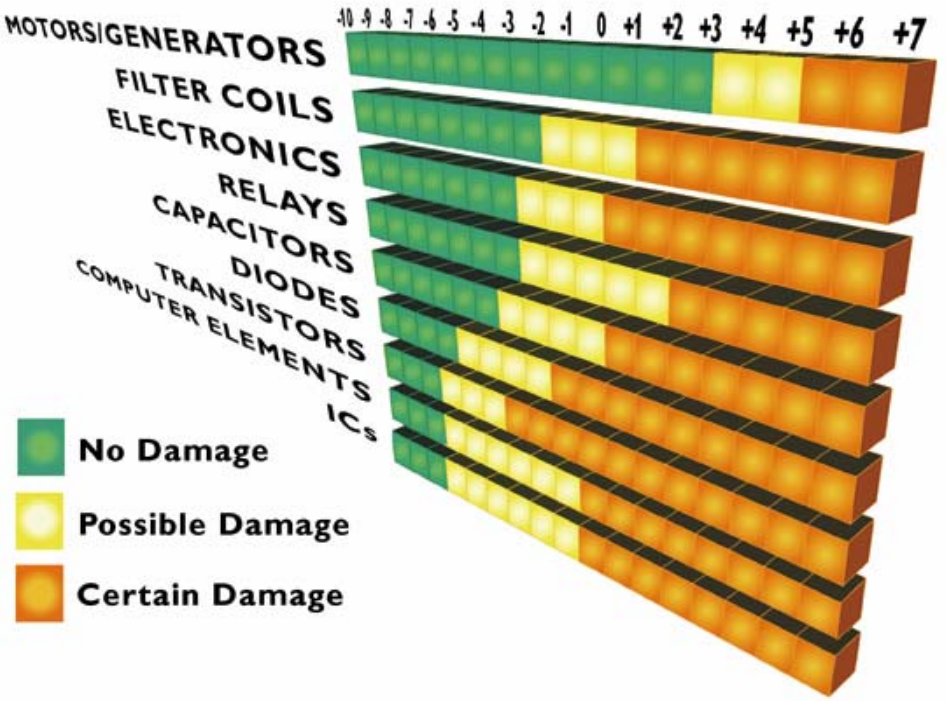
- Why protect equipment from transients?
- Why are plants so susceptible?
- Who is at the greatest risk?
- What can be done to prevent damage?

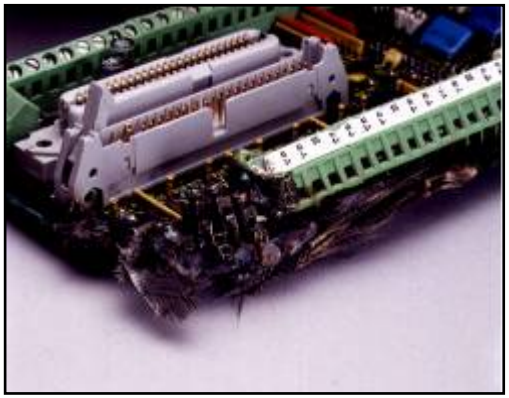
Why protect equipment from transients?

- Equipment is expensive
- Equipment is sensitive
- Labor is expensive
- Public demands no mistakes!
- A multitude of ROI and non-ROI drivers

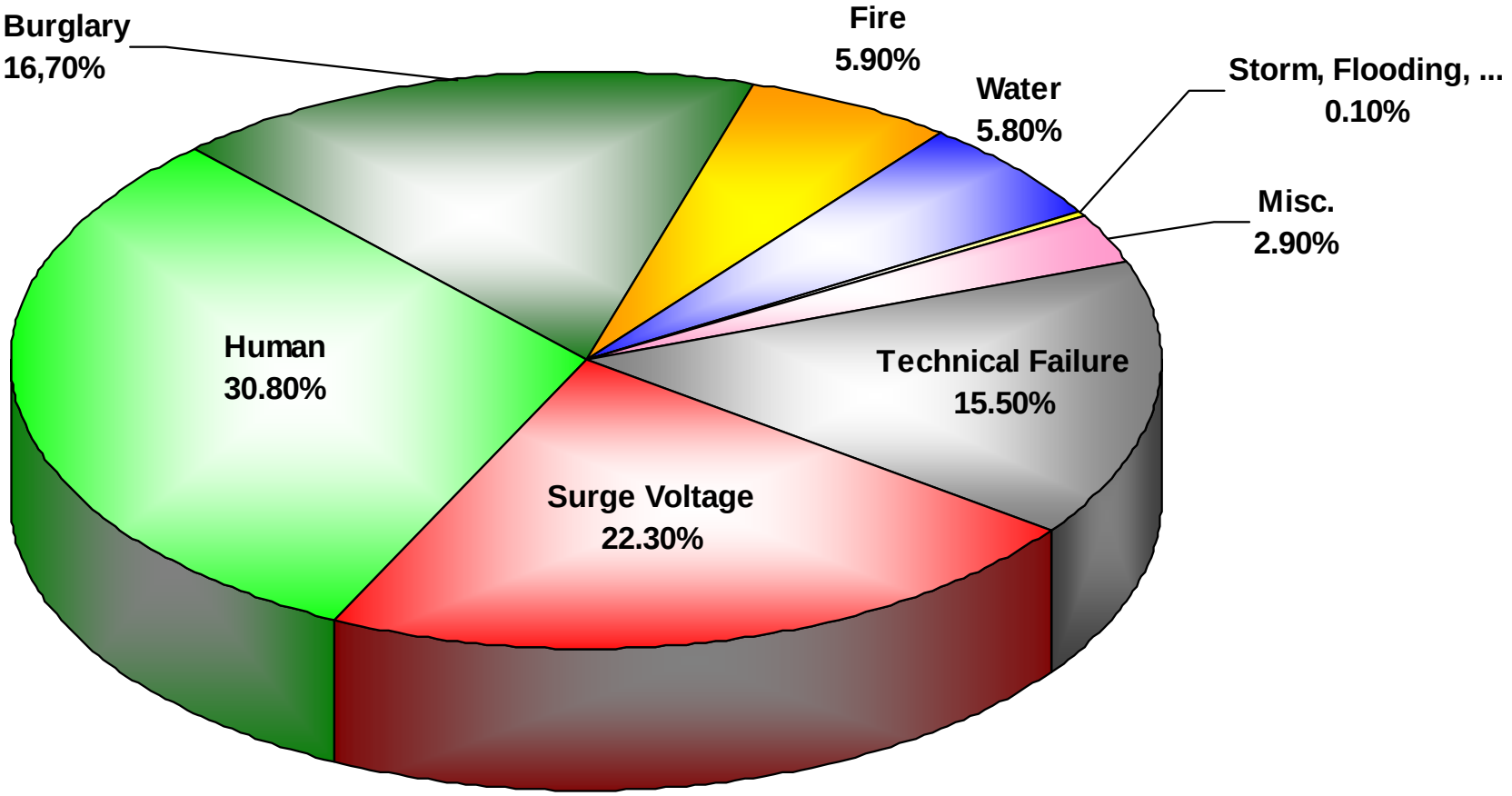


How sensitive is your equipment?



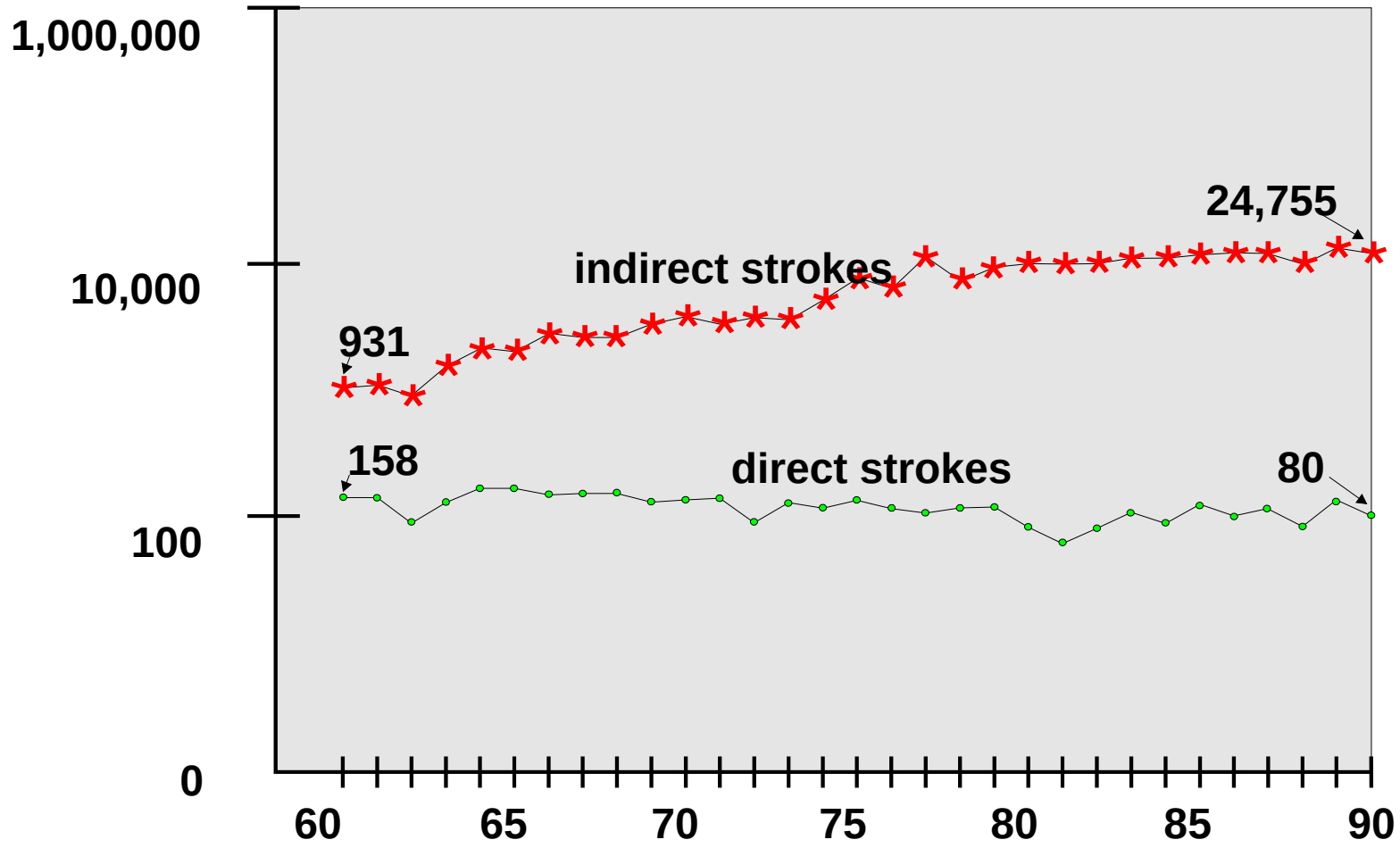


Transient insurance statistics



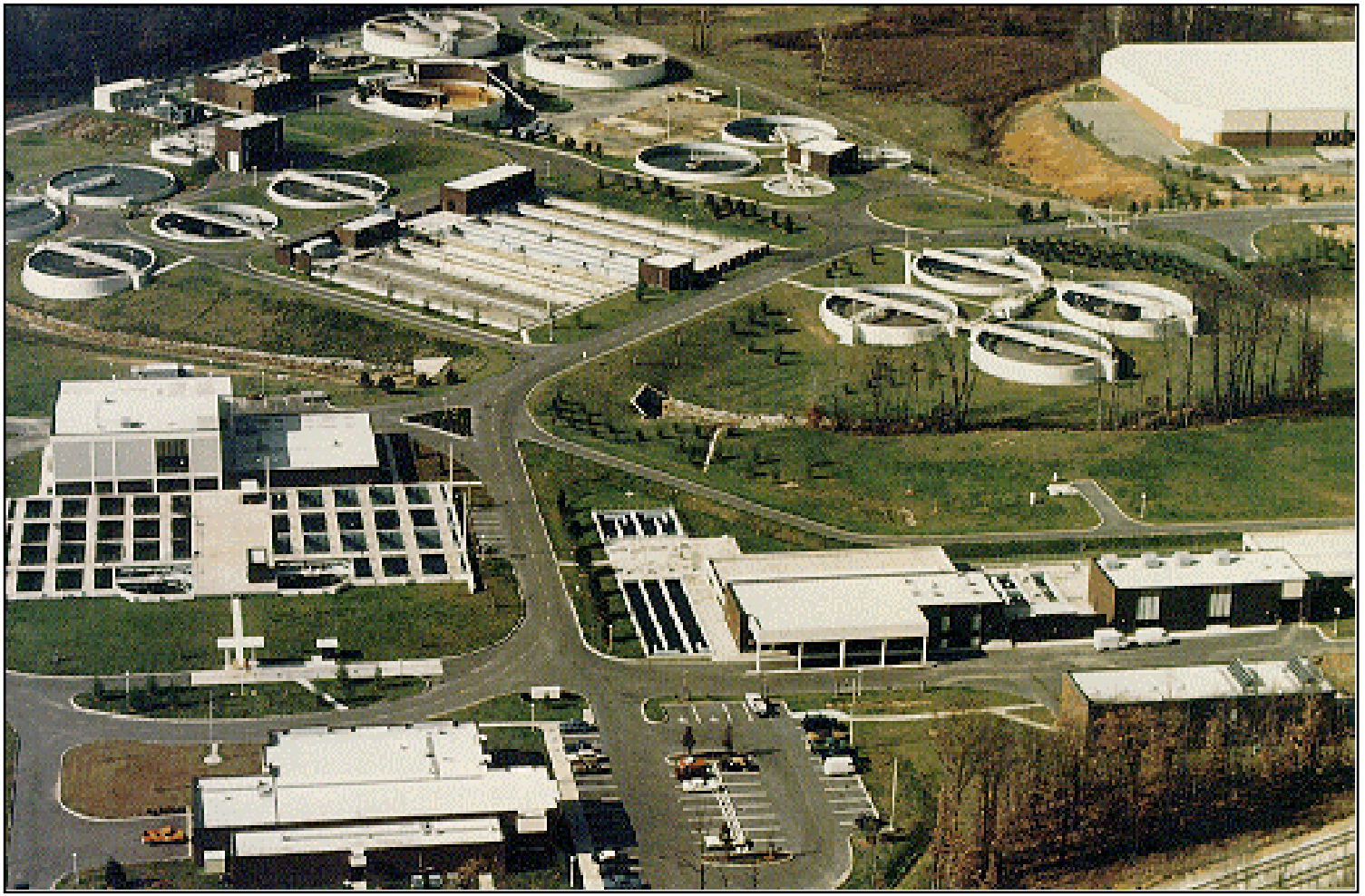
Source: WÜBA Versicherungs-AG, Niederlassung Frankfurt, wd 08. April 2002

Lightning damage (log chart)



Source: Gugenbauer,A./ Activity report, damage statistics,
Linz Fire protection Authority for Upper Austria

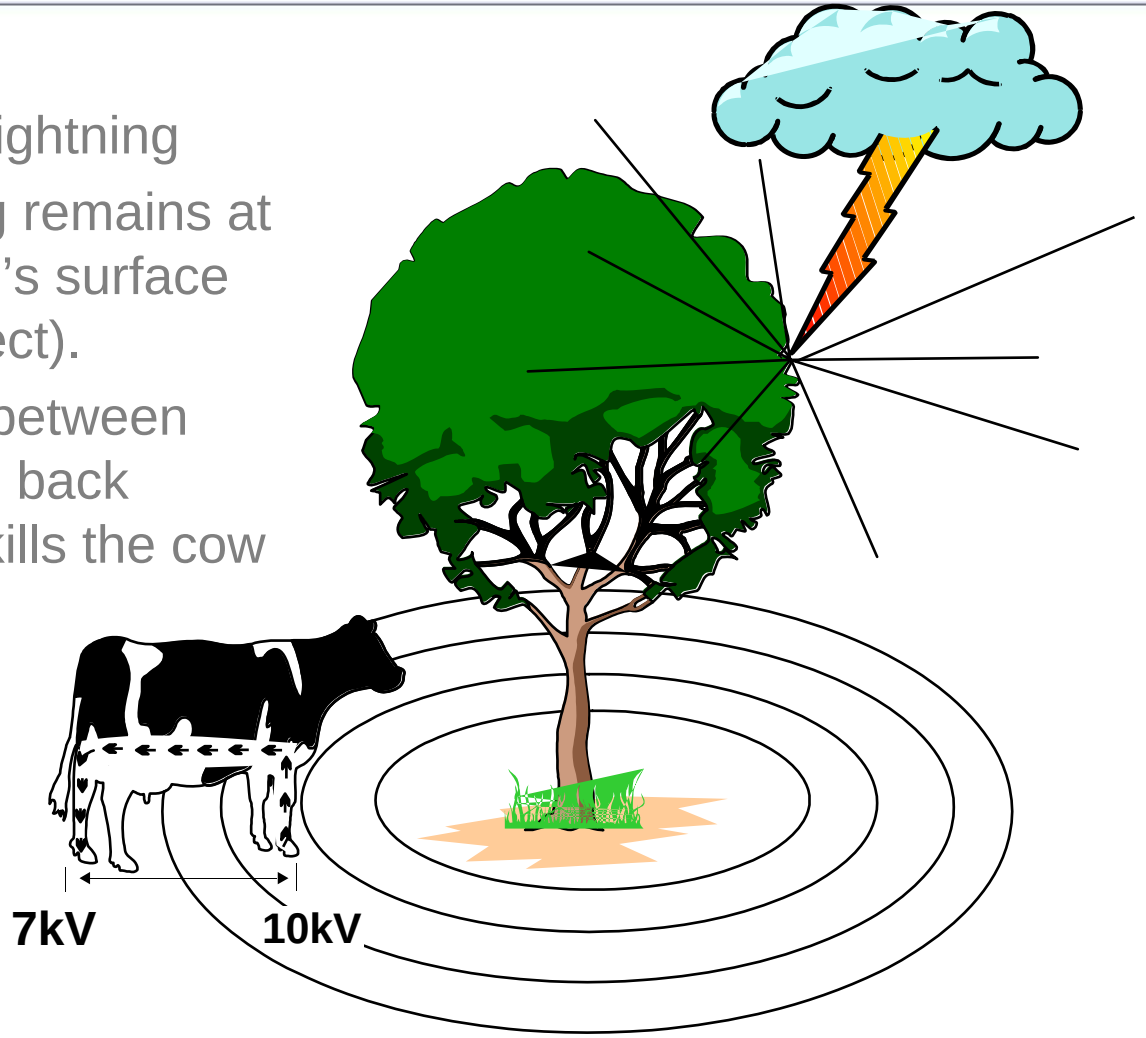
Why is this plant at risk?



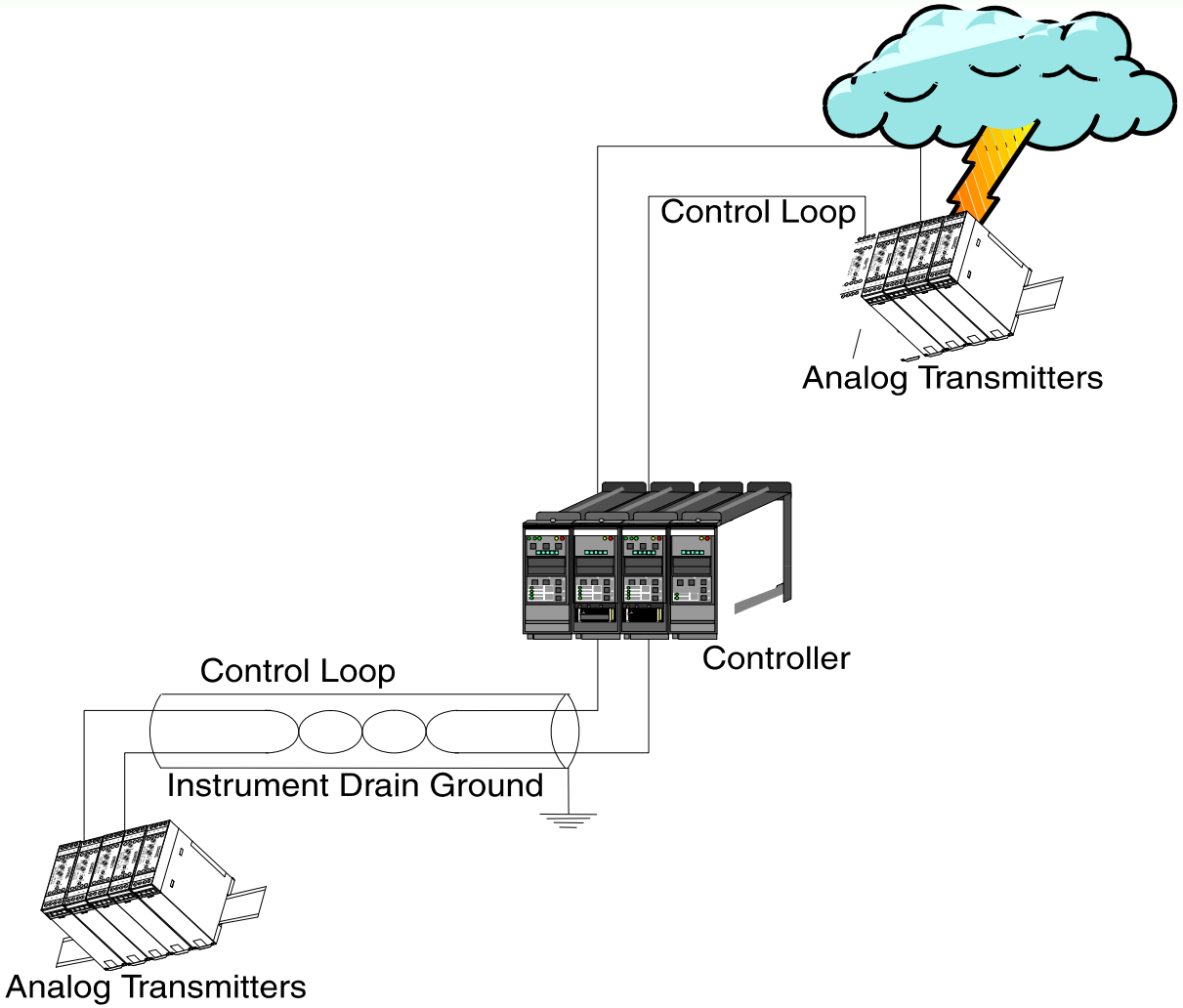
Surface discharge

Why does distance matter?

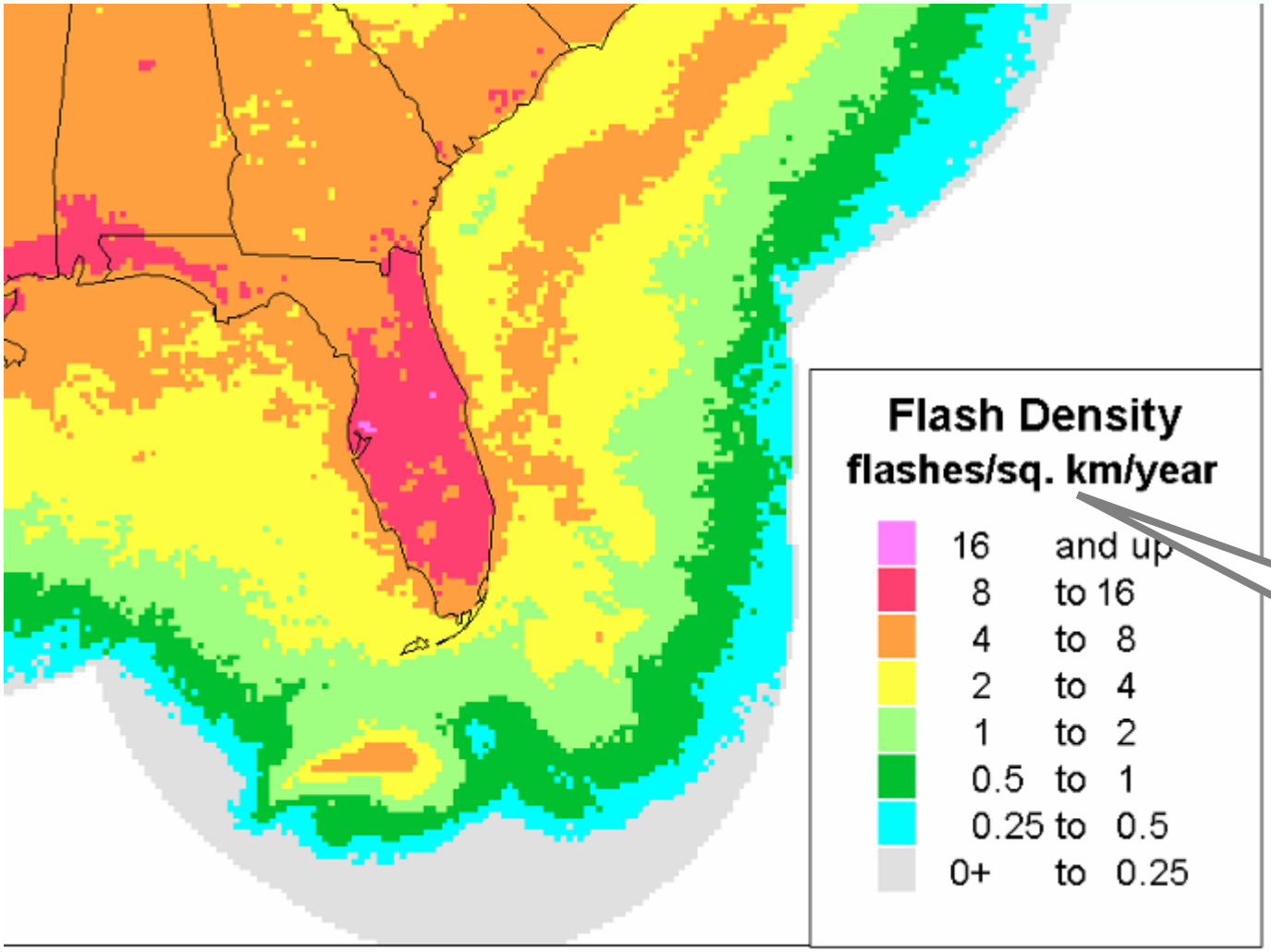
- Indirect lightning
- Lightning remains at the earth's surface (skin effect).
- Voltage between front and back hooves kills the cow



Why does distance matter?



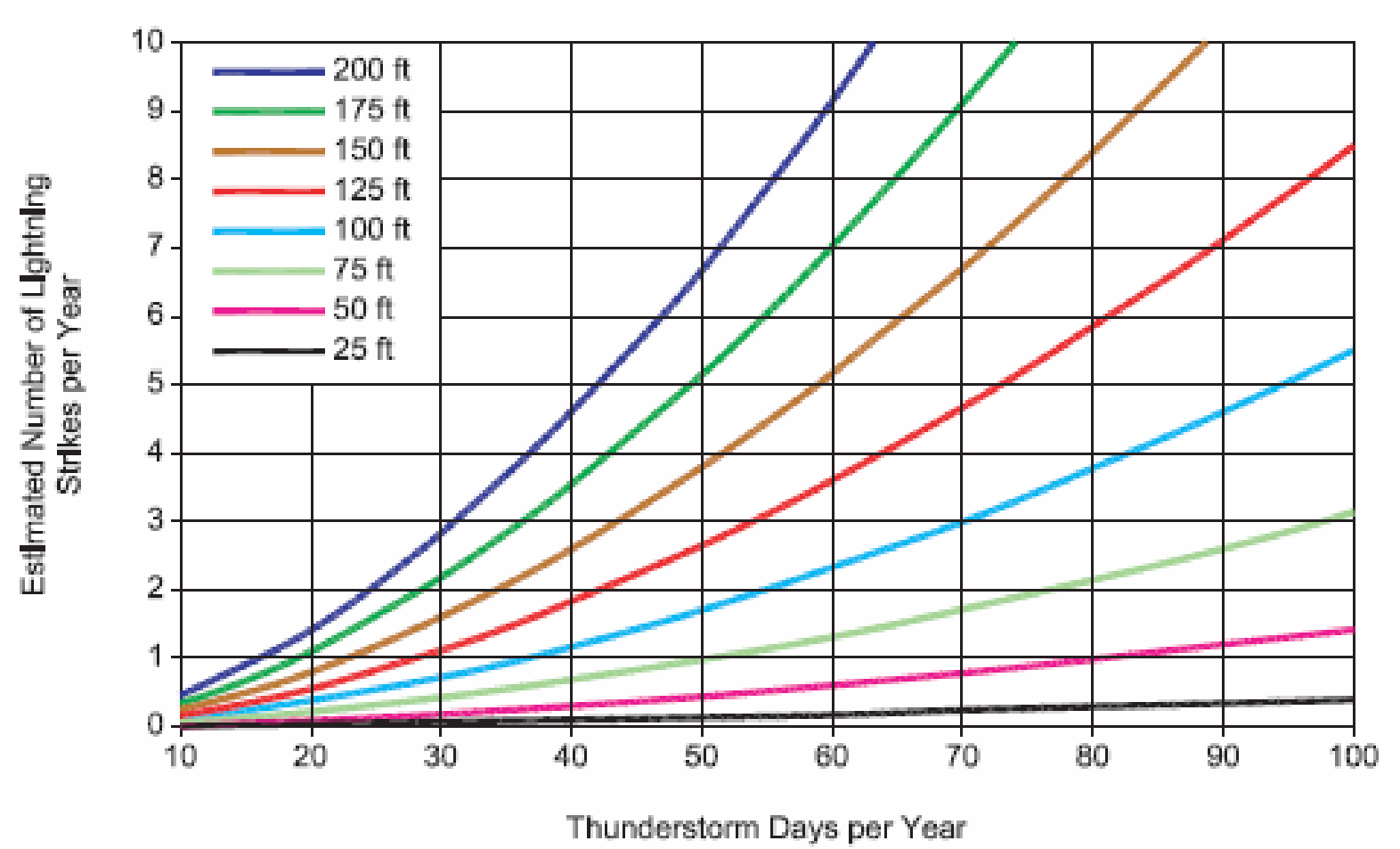
Flash density



1 sq. km = 247.1 acres

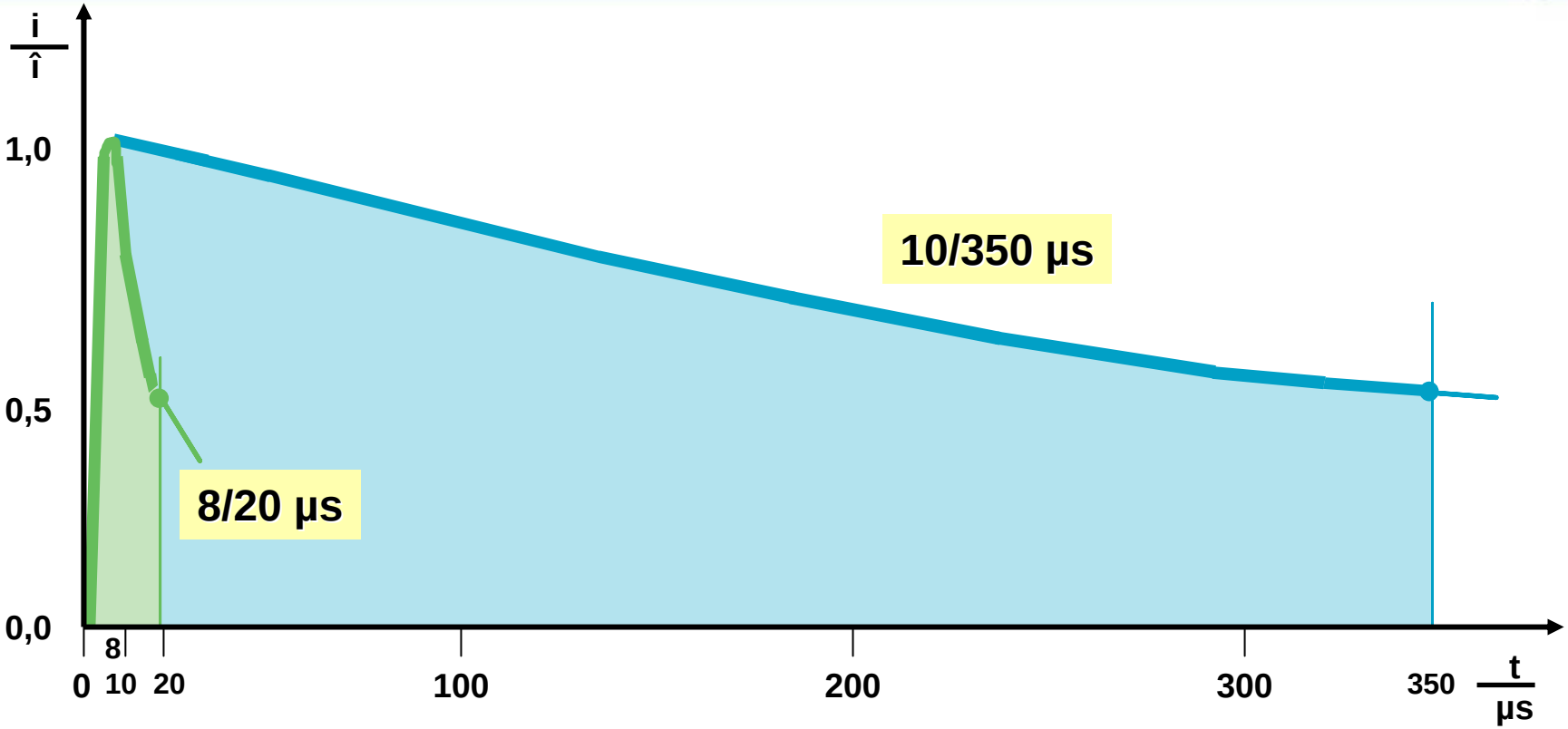
Activated sludge basin
Could there be a voltage difference?

Tower height and lightning strikes



From Estimated number of lightning strikes per year based on the number of thunderstorm days in your area and the height of your antenna. Based on information from Living with Lightning, Seminar Notes #ECP-826B Version F, GE Mobile Radio Technical Training, © GE 1985.

Surge current laboratory



8/20µs "IEEE Scenario I": Low-energy indirect lightning strike
SPD: single 8/20µs varistor

10/350µs "IEEE Scenario II": High-energy direct lightning strike
SPD: 8/20µs varistors in parallel or
10/350µs spark gap

Lightning current distribution

Testing at Camp Blanding, FL

Source: University of Florida

Lightning current distribution

Testing at Camp Blanding, FL

Source: University of Florida

Lightning current distribution

Testing at Camp Blanding, FL / Findings

the various paths in the overall system was analyzed. The ground rods at the test house appeared to filter out the higher frequency components of the lightning current, allowing the lower frequency components to enter the house's electrical circuit. In other words, the ground rods exhibited a capacitive rather than the often expected and usually modeled resistive behavior. This effect was observed for dc resistances of the ground rods (in typical Florida sandy soil) ranging from more than a thousand ohms to some tens of ohms. The peak value of the current entering the test house's electrical circuit was found to be over 80% of the injected lightning current peak, in contrast with the 25% or 50% assumed in two IEC-suggested scenarios. Also, the percentages of current flowing a) to the transformer secondary neutral and b) through the SPDs were observed to be approximately a factor of two to four greater than those assumed in the IEC hypothetical scenario illustrated in Fig. 1(a). Since the current waveshapes may differ considerably throughout the system, charge transfer is apparently a better quantity than the peak current for studying the division of lightning current among the various paths in the system.

Source: University of Florida

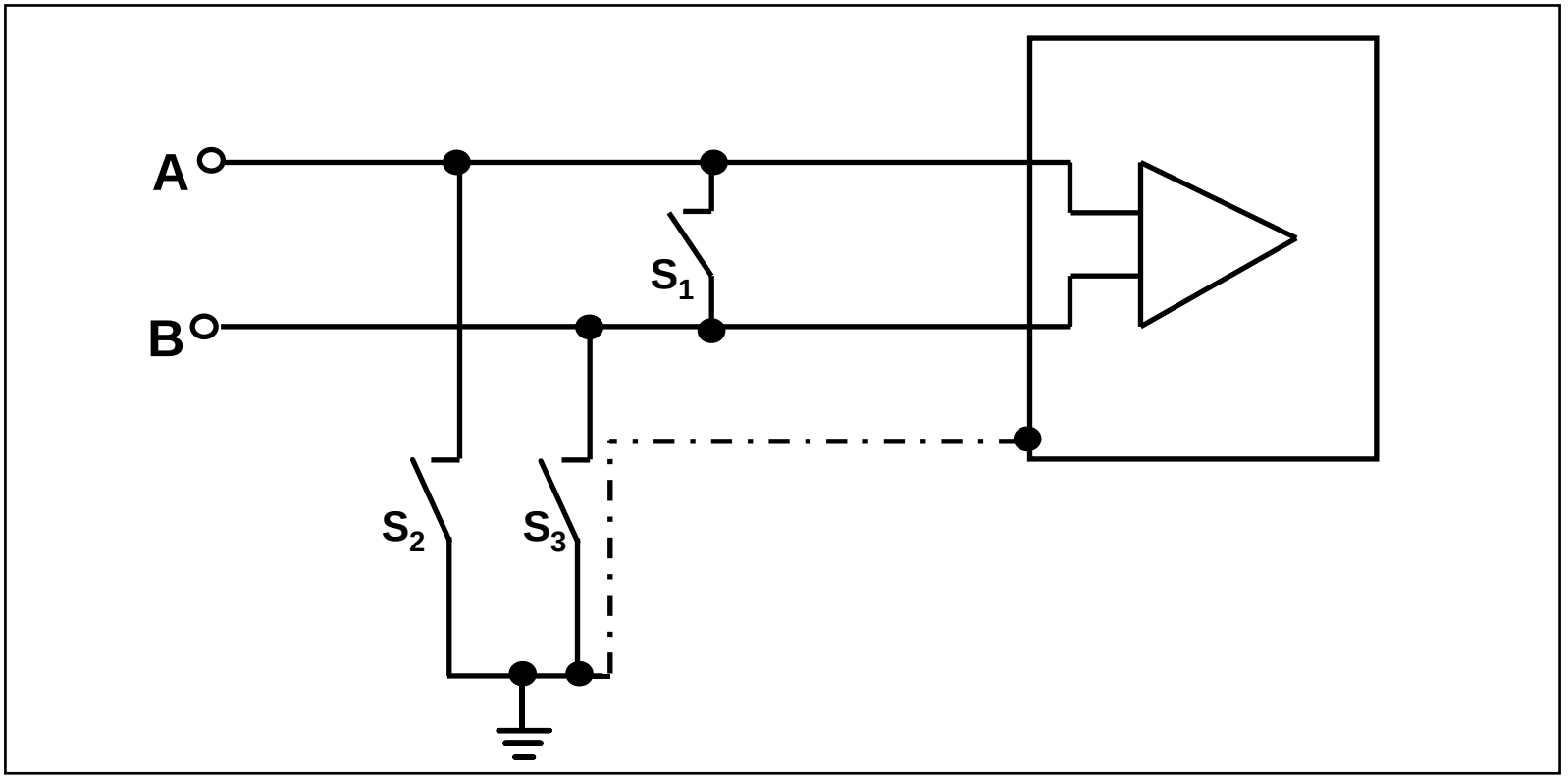
Bottom line?

- All outdoor equipment is high risk
  - Lift stations, motors, tanks, transmitters, sensors
- Also all I/O lines that leave the building
  - Instrumentation, control lines

Now what?

How do I protect equipment?

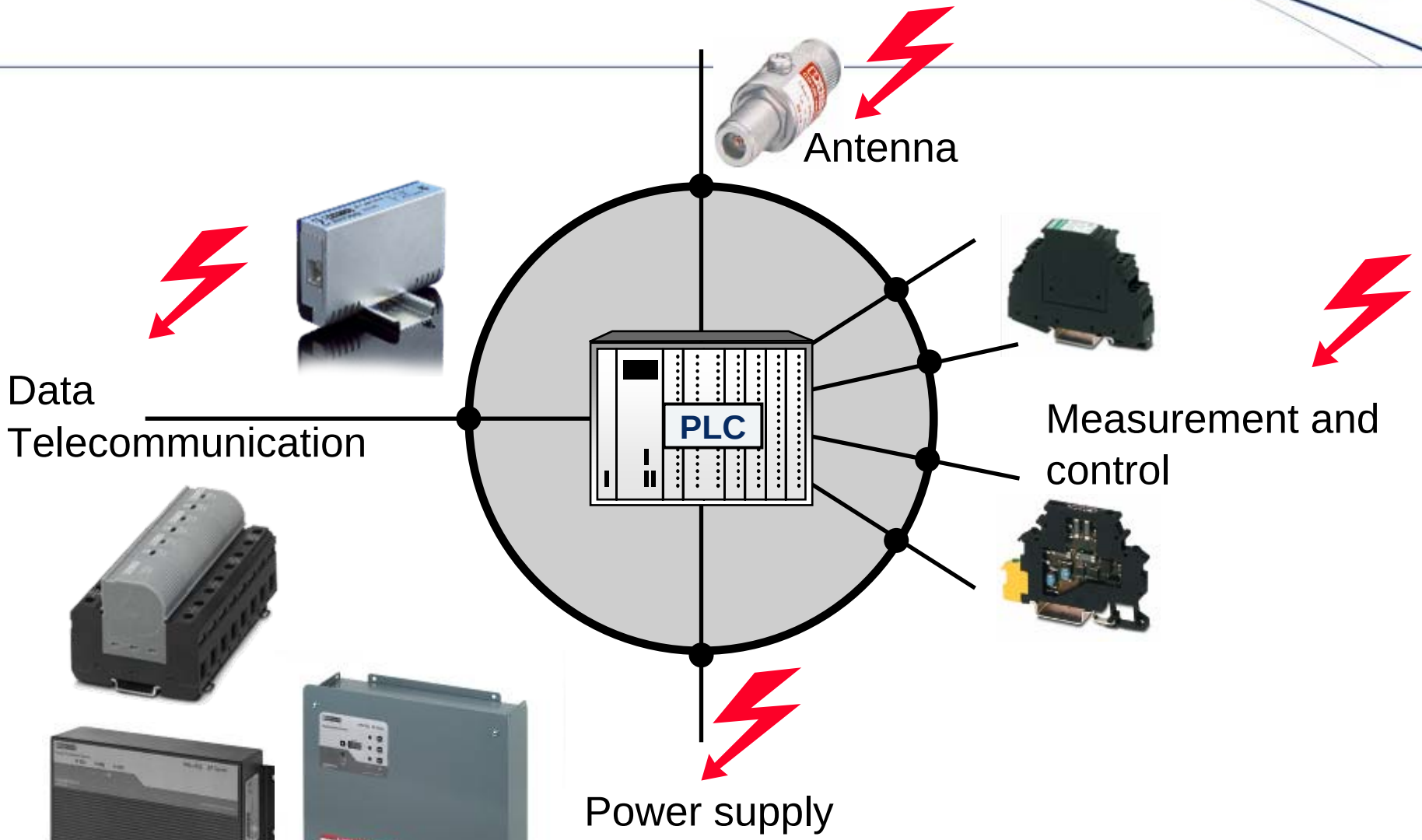
Surge suppression basics



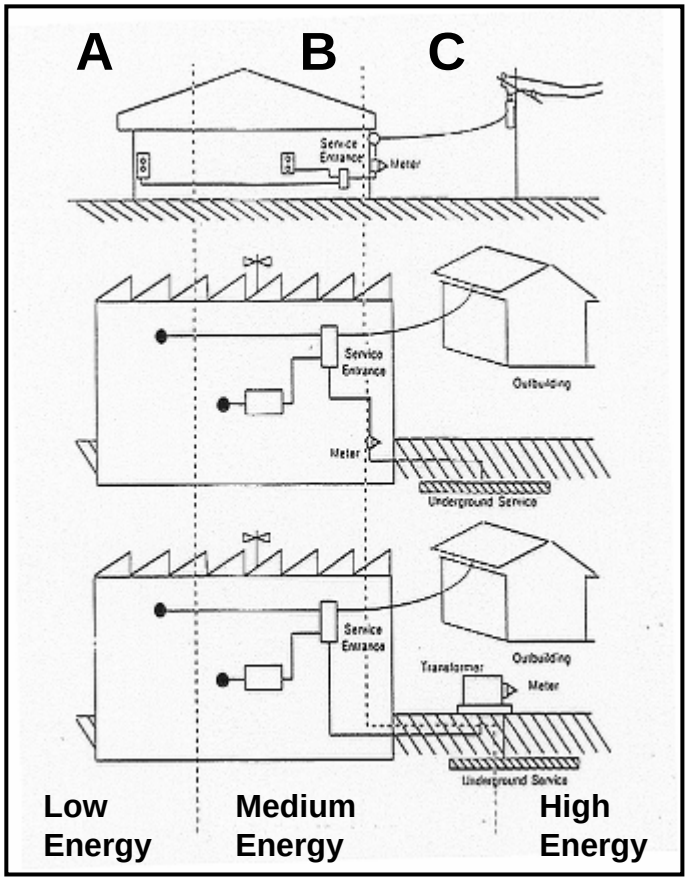
Lightning is load-independent

- Lightning currents are like fright trains – you can't stop them!
- Make sure that you get out of their way!
- Lightning currents have to be redirected so that nobody gets hurt! That's what lightning protection is about.

Protect all paths!



“Zone” defense!



A

Outlets and long branch circuits
All outlets at more than 30 feet from Category B
All outlets at more than 60 feet from Category C

B

Feeders and short branch circuits
Distribution panel devices
Bus and feeder industrial plants
Heavy appliance outlets with “short” connections to service entrance
Lighting systems in large buildings

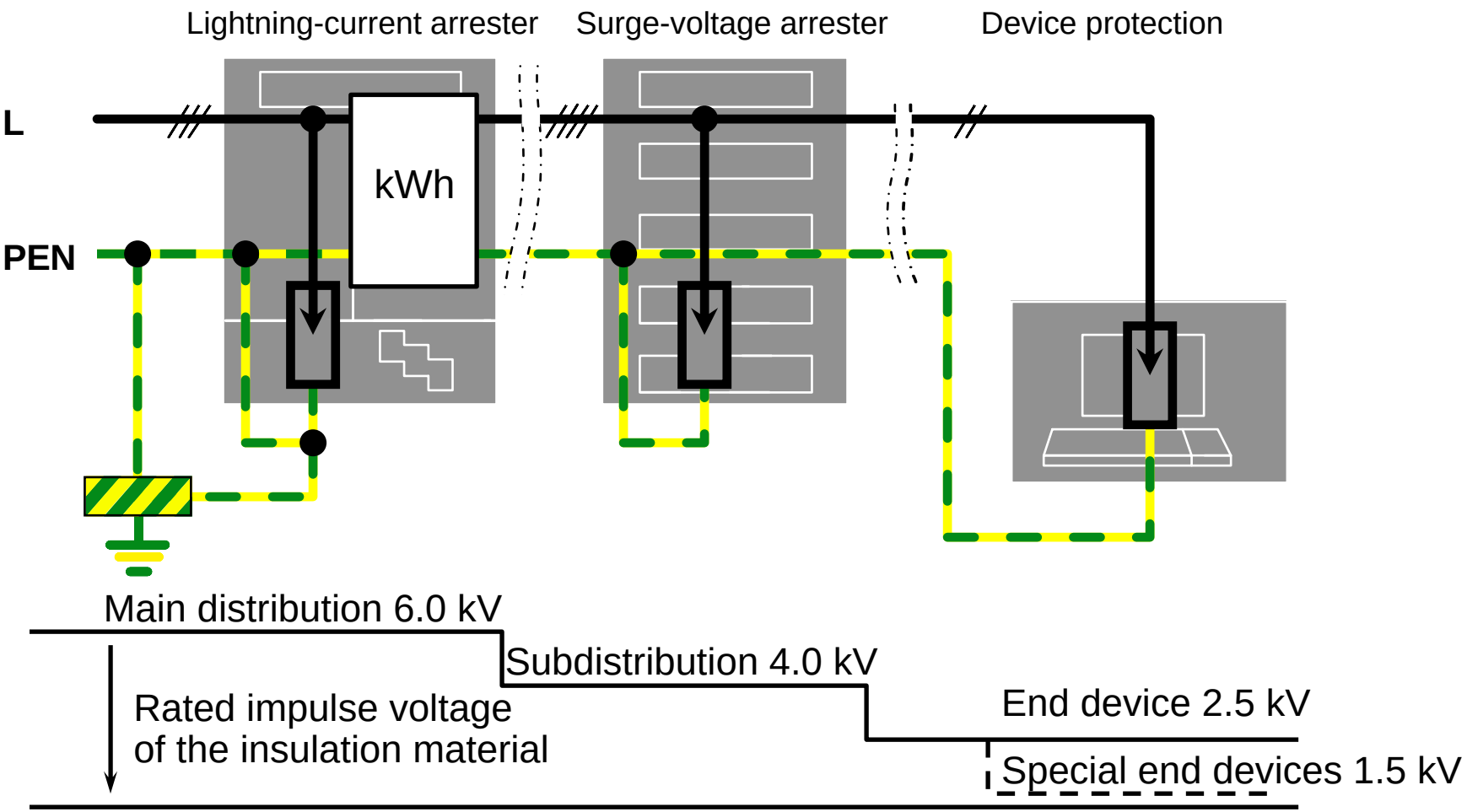
C

Outside and service entrance
Service drop from pole to building
Run between meter and panel
Overhead line to detached building
Underground line to well pump

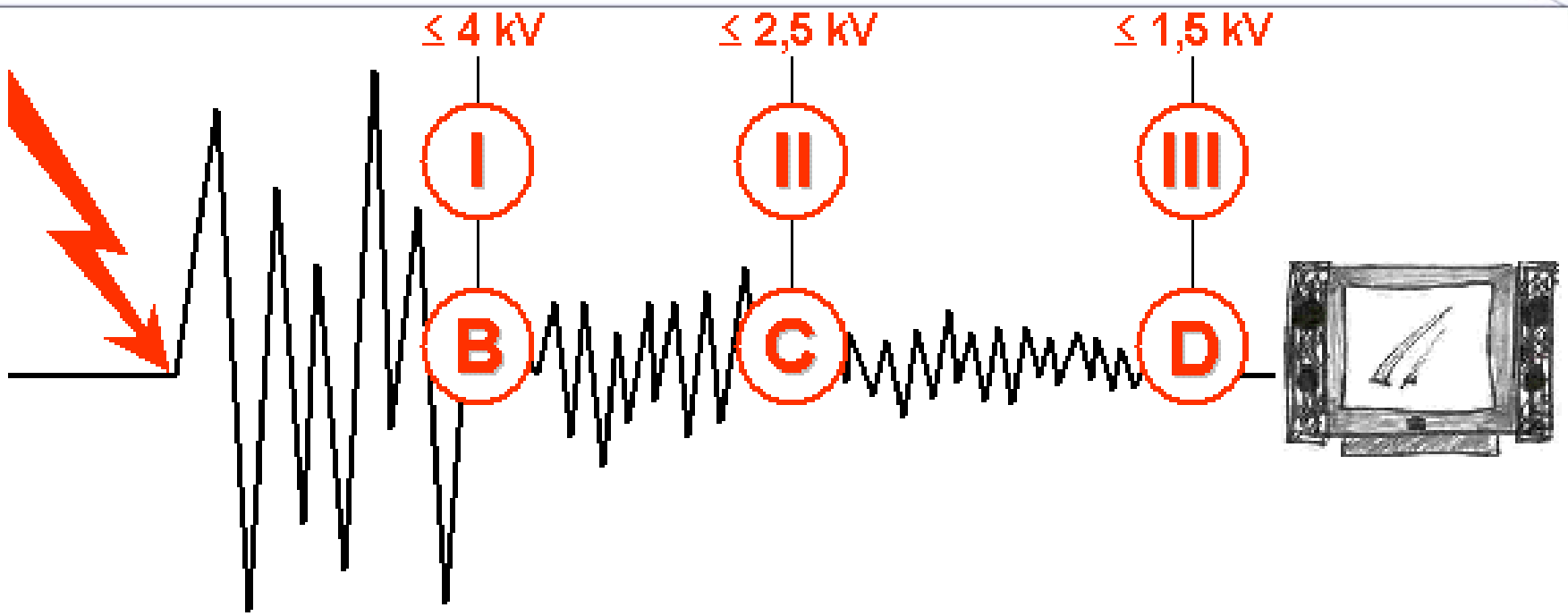
Insulation coordination

acc. to DIN VDE 0110 Part 1 and IEC 60664-1

for 230/400 V AC and 277/480 V AC



Multi-stage protection



Lightning-current arrester	Surge-voltage arrester	Device protection
EN Type 1	EN Type 2	EN Type 3
IEC Class I	IEC Class II	IEC Class III

Lightning protection:
Service entrance or outdoor equipment

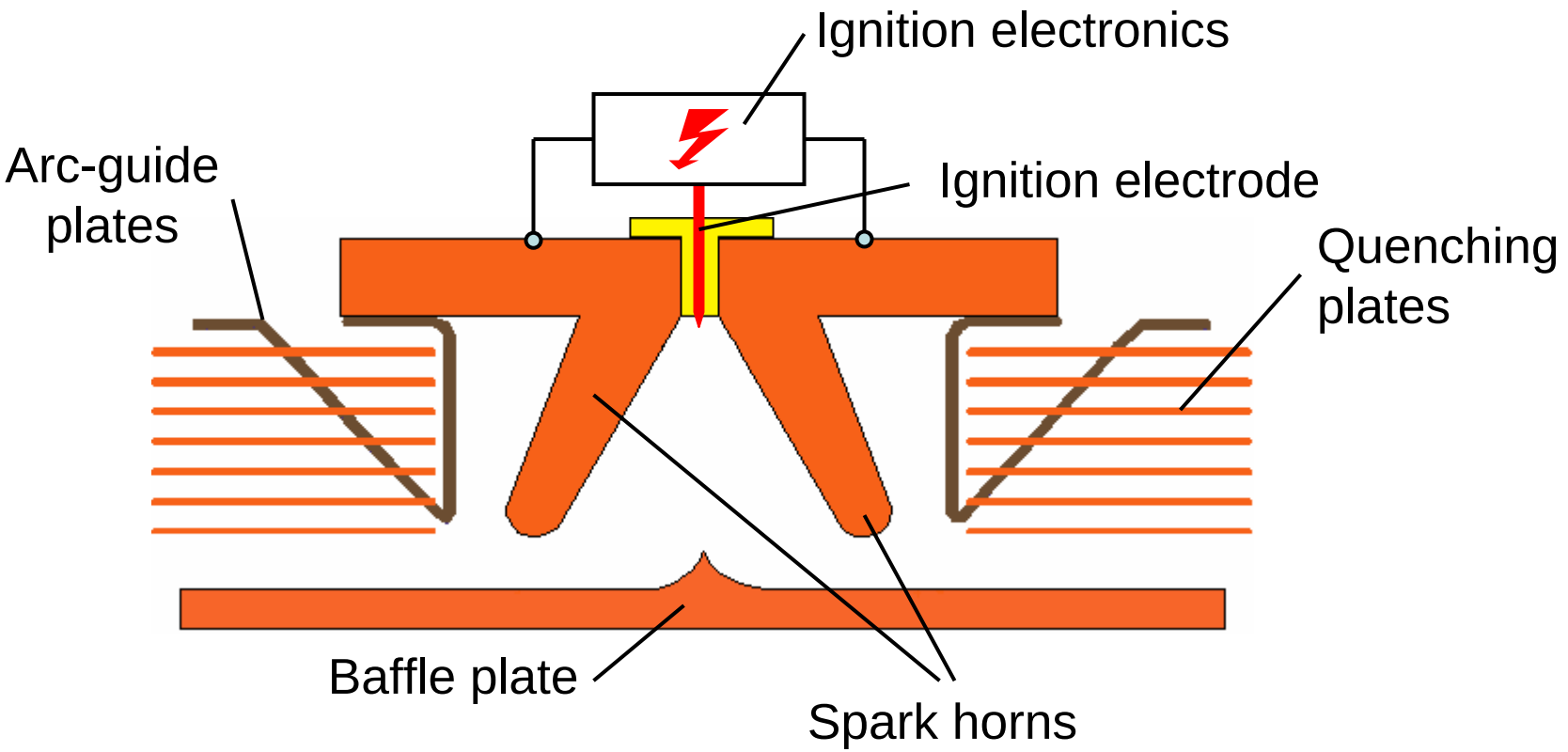
Requirements

- High surge currents from lightning
- Long duration surges
- Need automatic turn-off
- Need failure indication
- Sturdy construction

Lightning protection for AC power

Paralled MOVs or spark-gap technologies

Triggered arc gap



Lightning protection at lift station

Arc gap applications

Parallel MOV ‘NEMA’ style

Installed adjacent to an electrical panel or directly onto electrical equipment.

Compliant with UL 1449 3rd Edition.

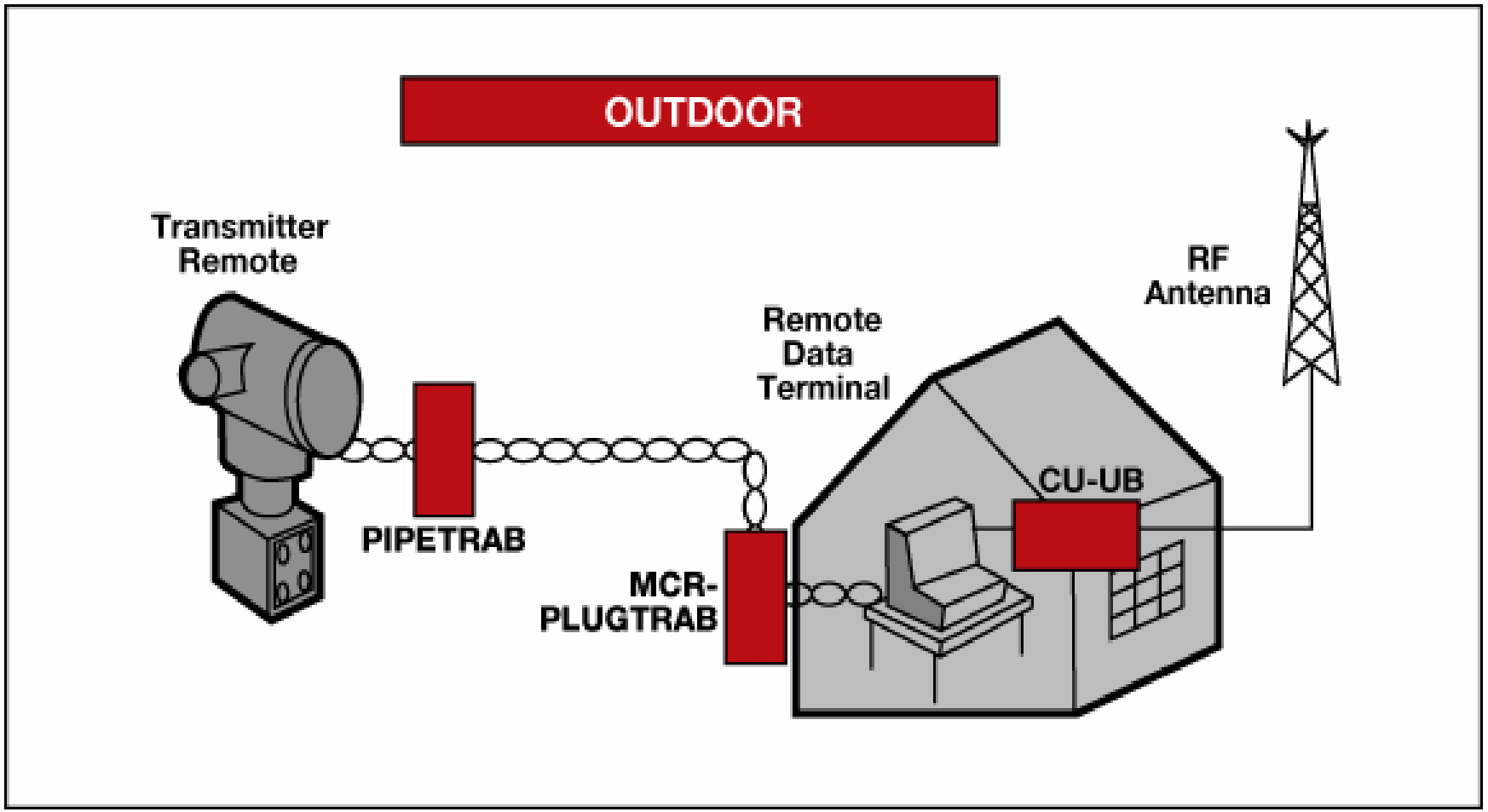
Safety lockouts available

Can be mounted to any panel…

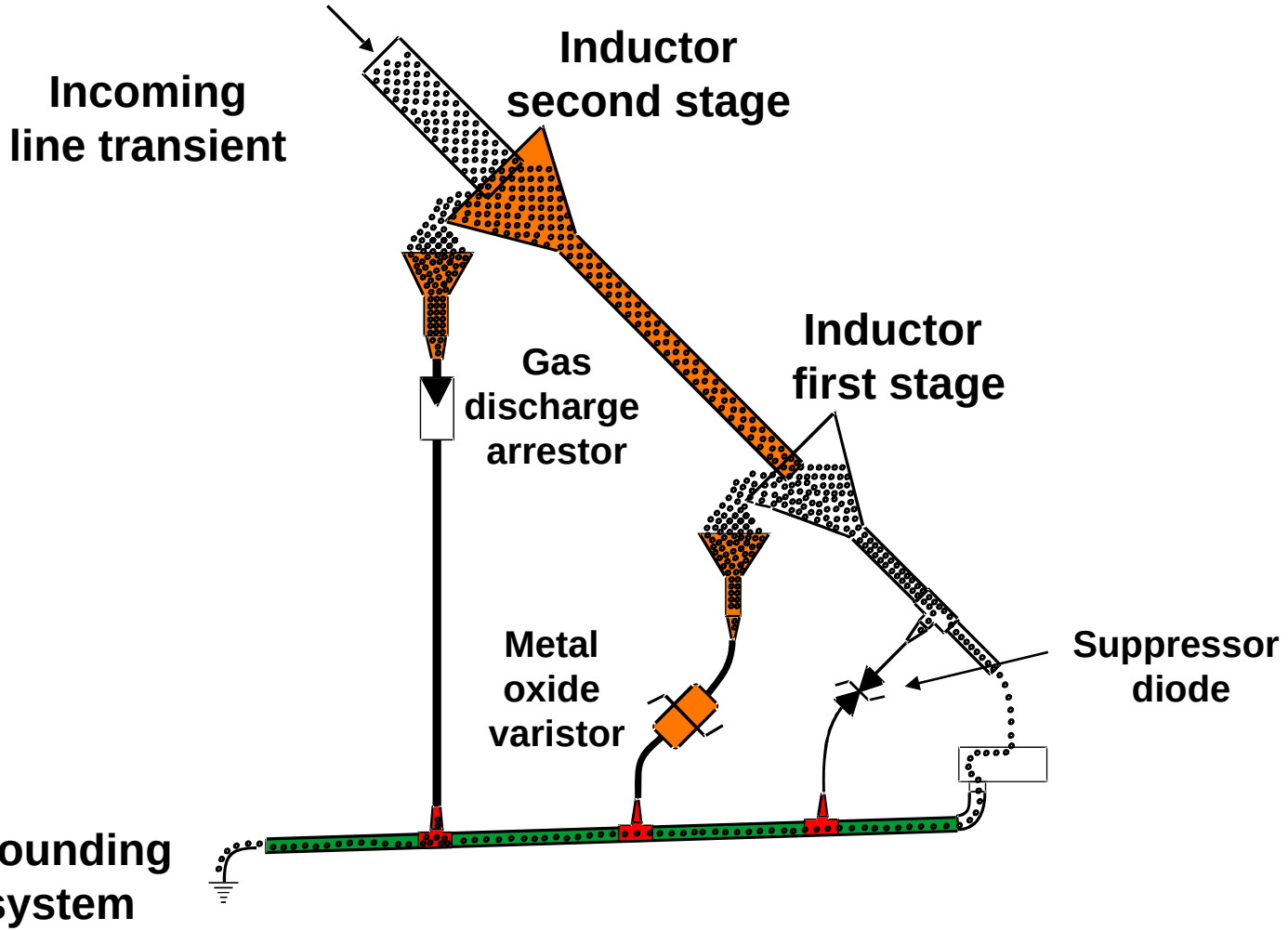
How about I/O systems?

- Must be robust – Protect against surges with 1000's of amps not 100's!
- Need to protect systems on both sides – one surge arrestor cannot protect both transmitter and receiver
- Need compact designs
- Easy serviceability

How about I/O systems?

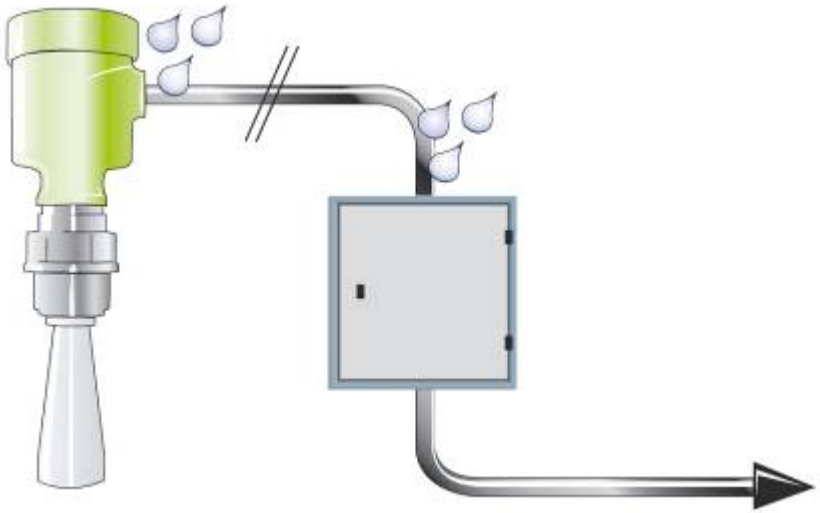


Multi-stage transient absorption system



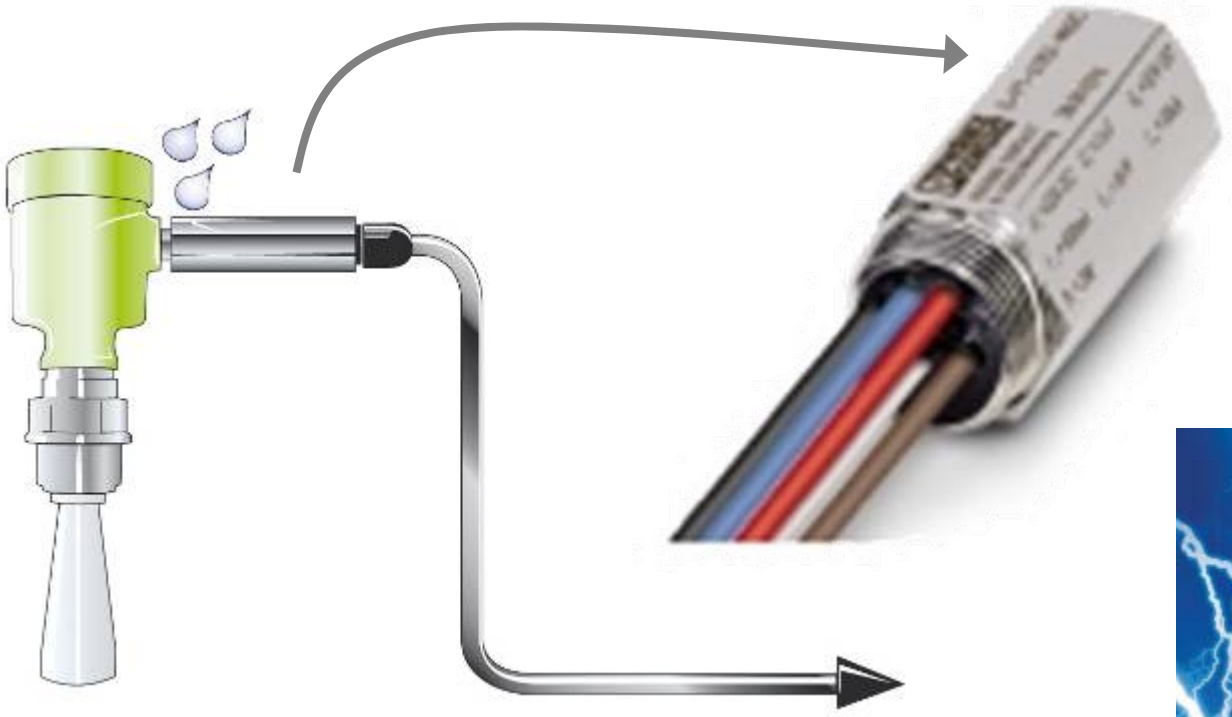
Transmitter protection panel installation

Standard installation



Control room

Transmitter protection inline installation



Surge protection inside control room

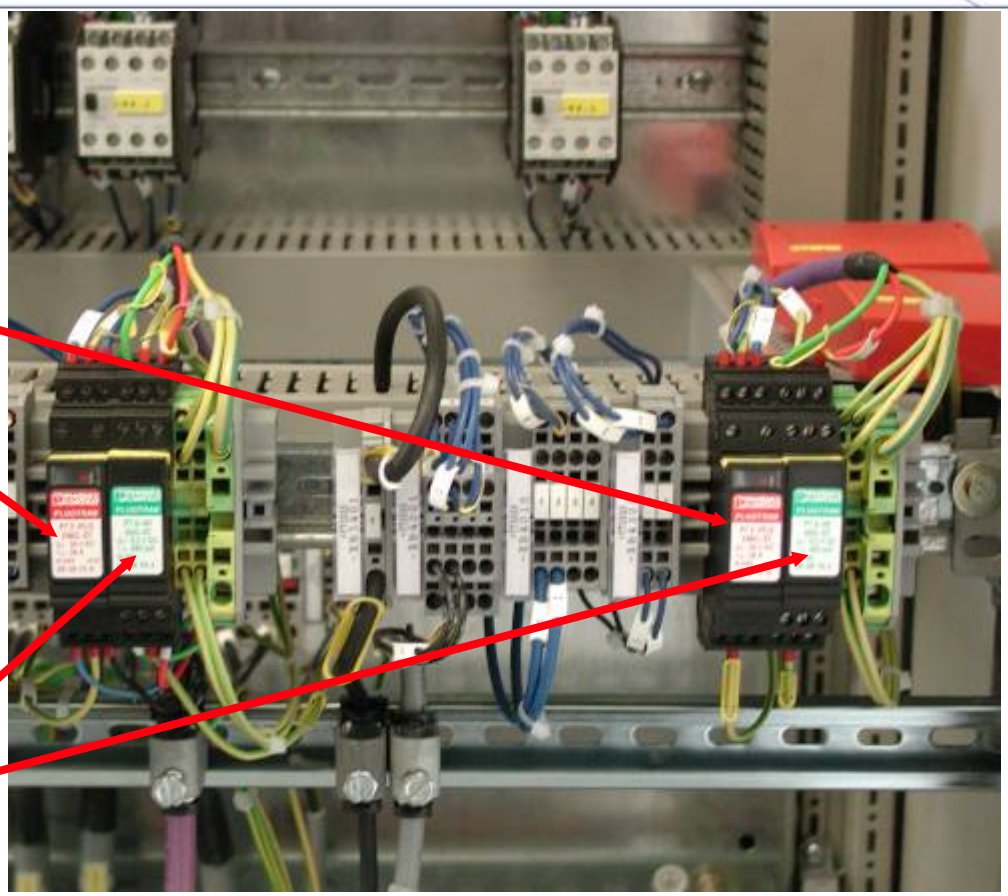
Examples:

PT 100
Digital input/output
S485 etc.
0/4 ... 20 mA

PLUGTRAB PT...

Surge protection for instrumentation

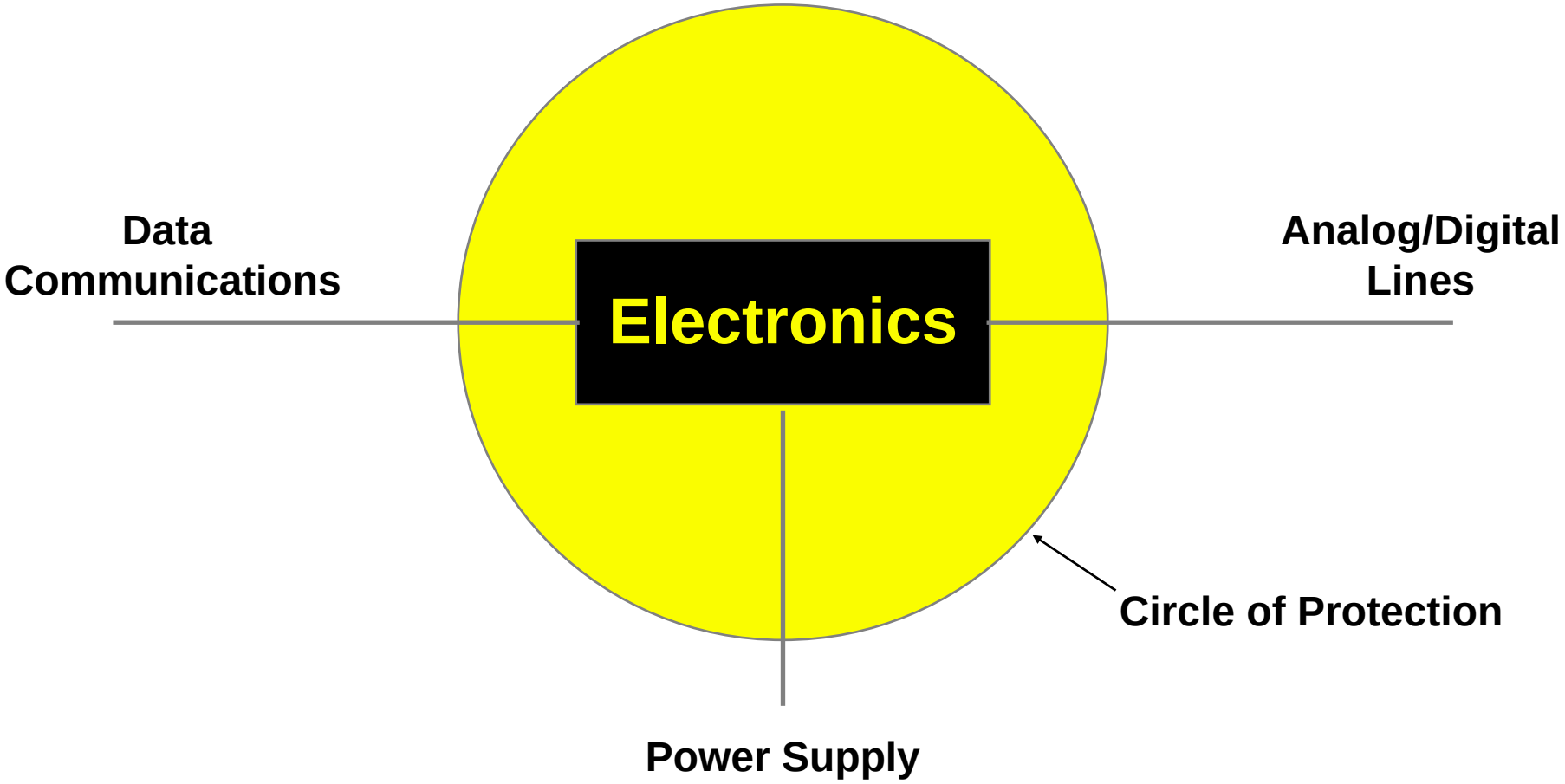
For the
power supply



For the bus system
with PLUGTRAB PT...

Protection of I/O in control cabinet

Conclusion:
Protect against every surge path!

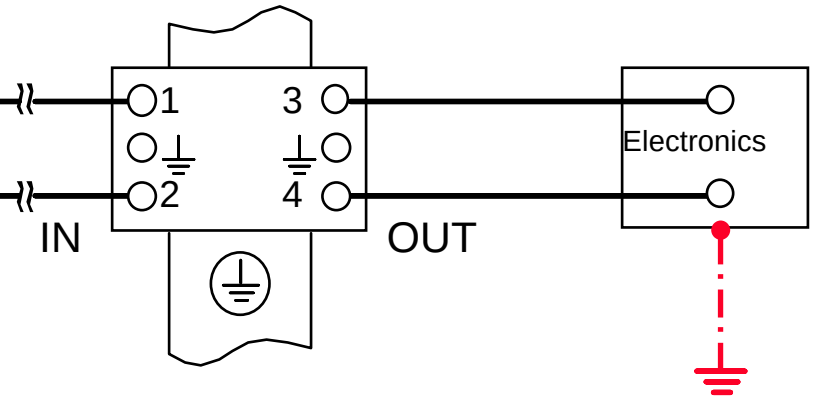


Appendix

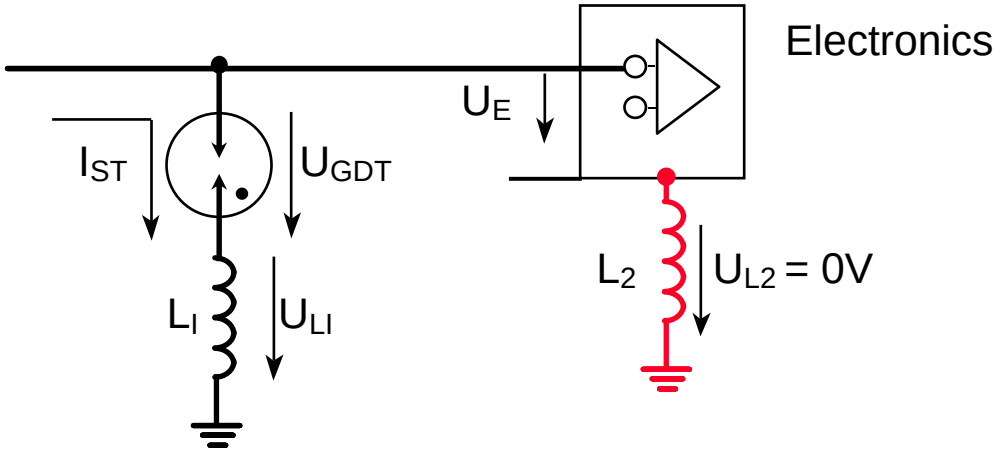
- Grounding methodology
- Florida lightning testing facility

Grounding of SPDs

Example I: Wrong



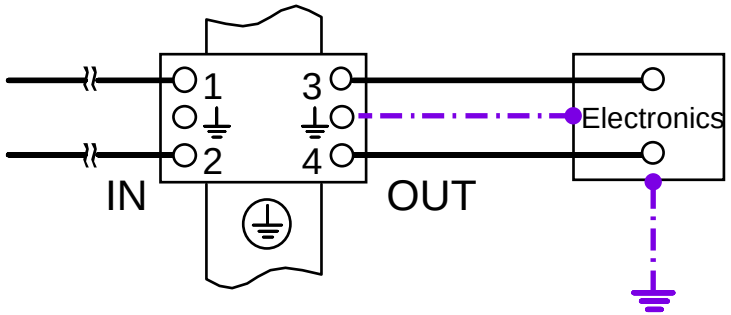
Simplified circuit diagram

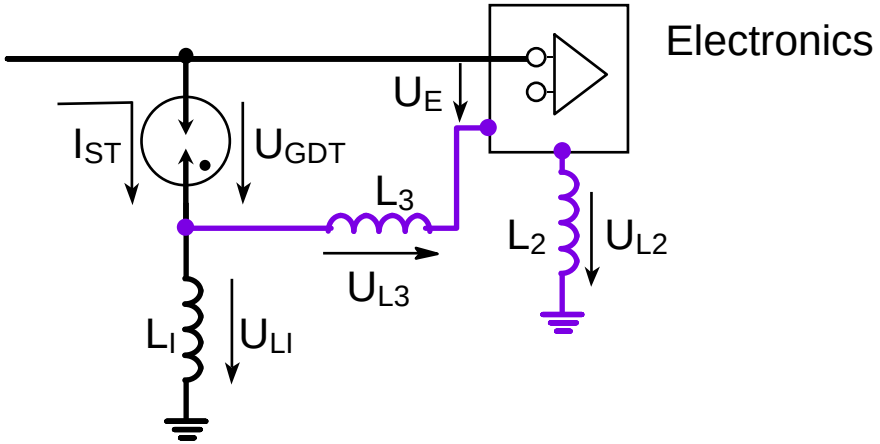


Grounding

Example 2: Better

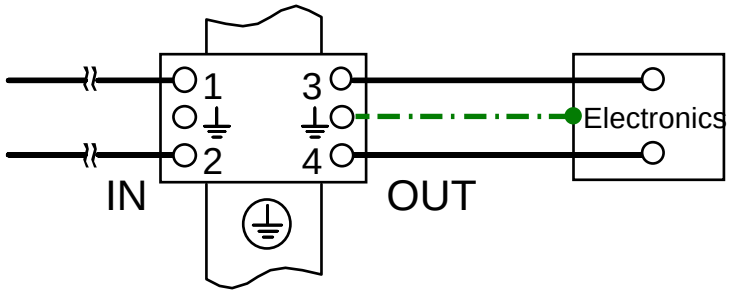
Simplified circuit diagram





Grounding

Example 3: Best practice



Simplified circuit diagram