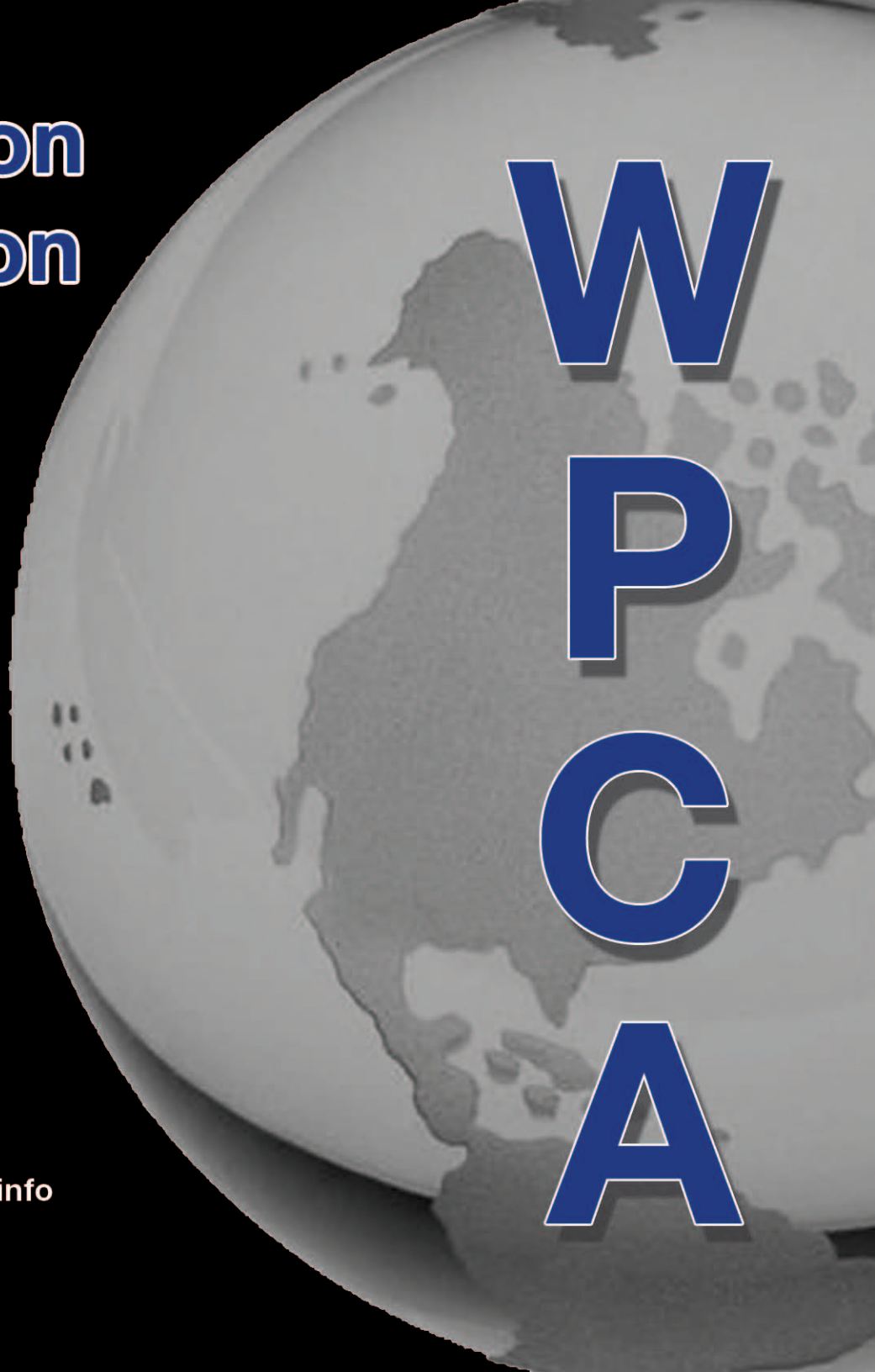
Worldwide Pollution Control Association



Duke Energy Seminar

September 3 – 5, 2008

Concord, NC

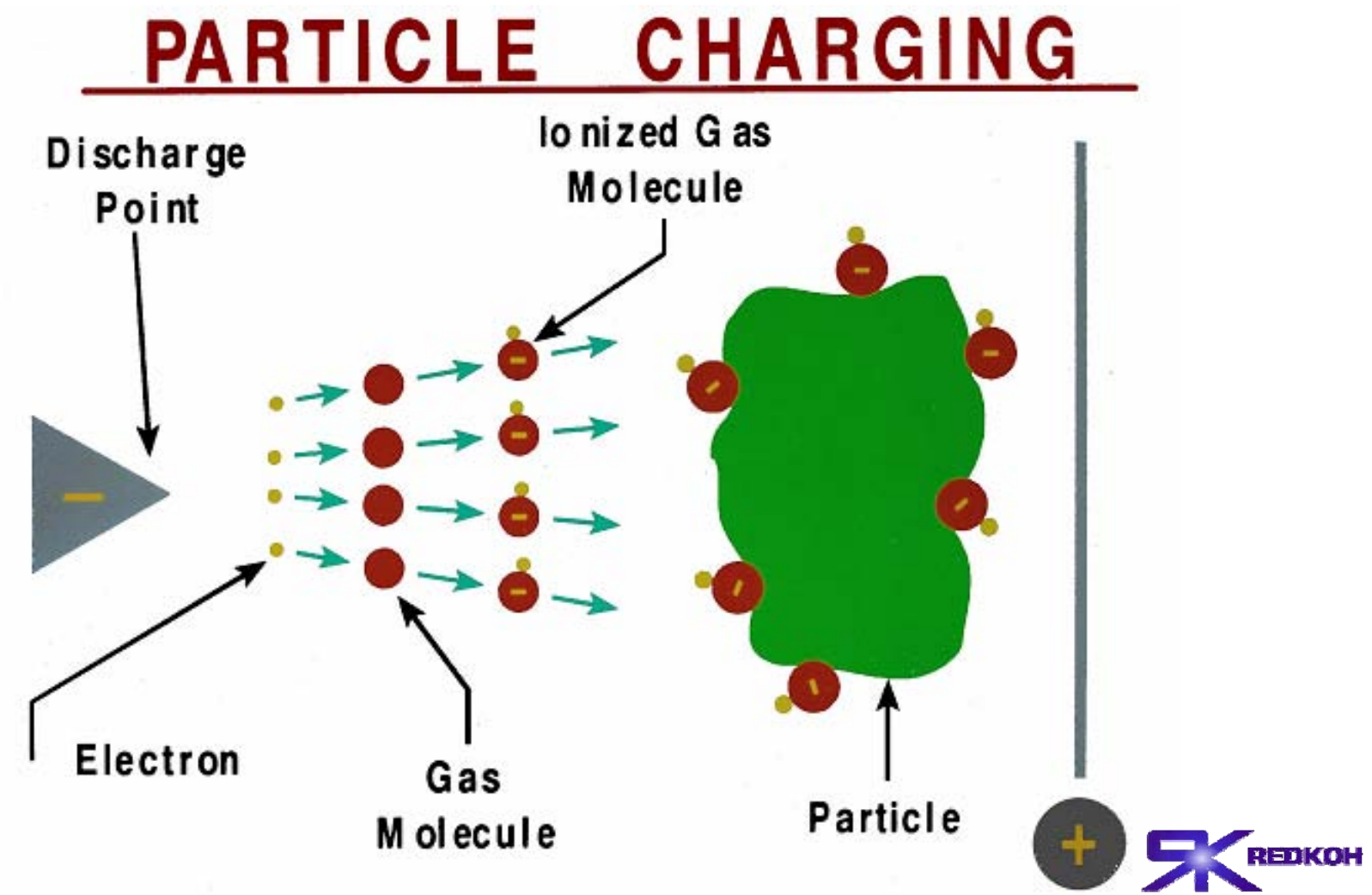
WPCA

Vist our website at www.wpca.info

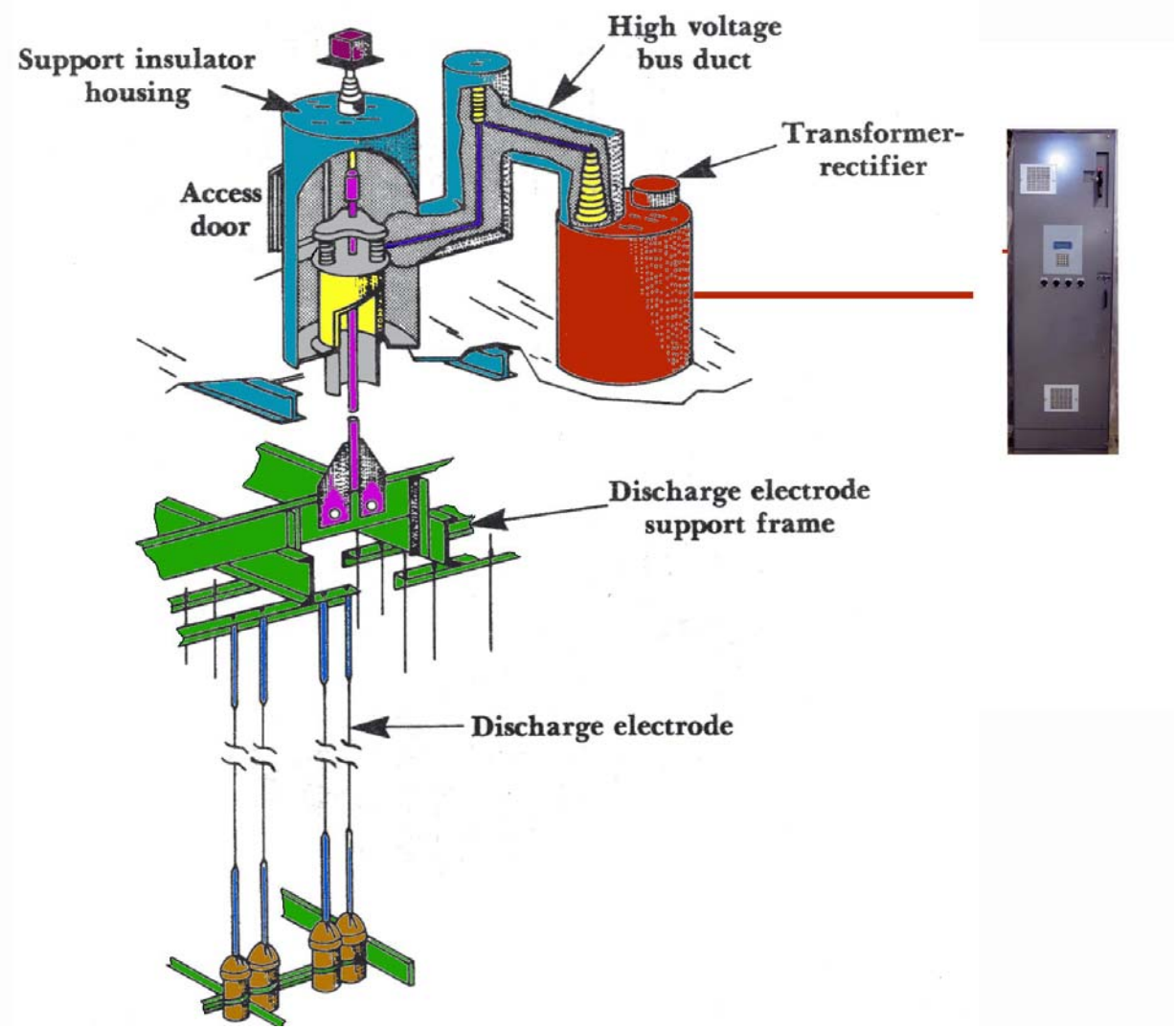
An Introduction to Precipitator Controls Systems

- The aim of this presentation is to:
  - Identify the global requirement of an ESP Control System
  - Identify and discuss an Energization system
  - Build a circuit that discusses the function of each of the components required
  - Put the circuit into the precipitation application – and discuss some of the different techniques available

How an ESP Does its Magic

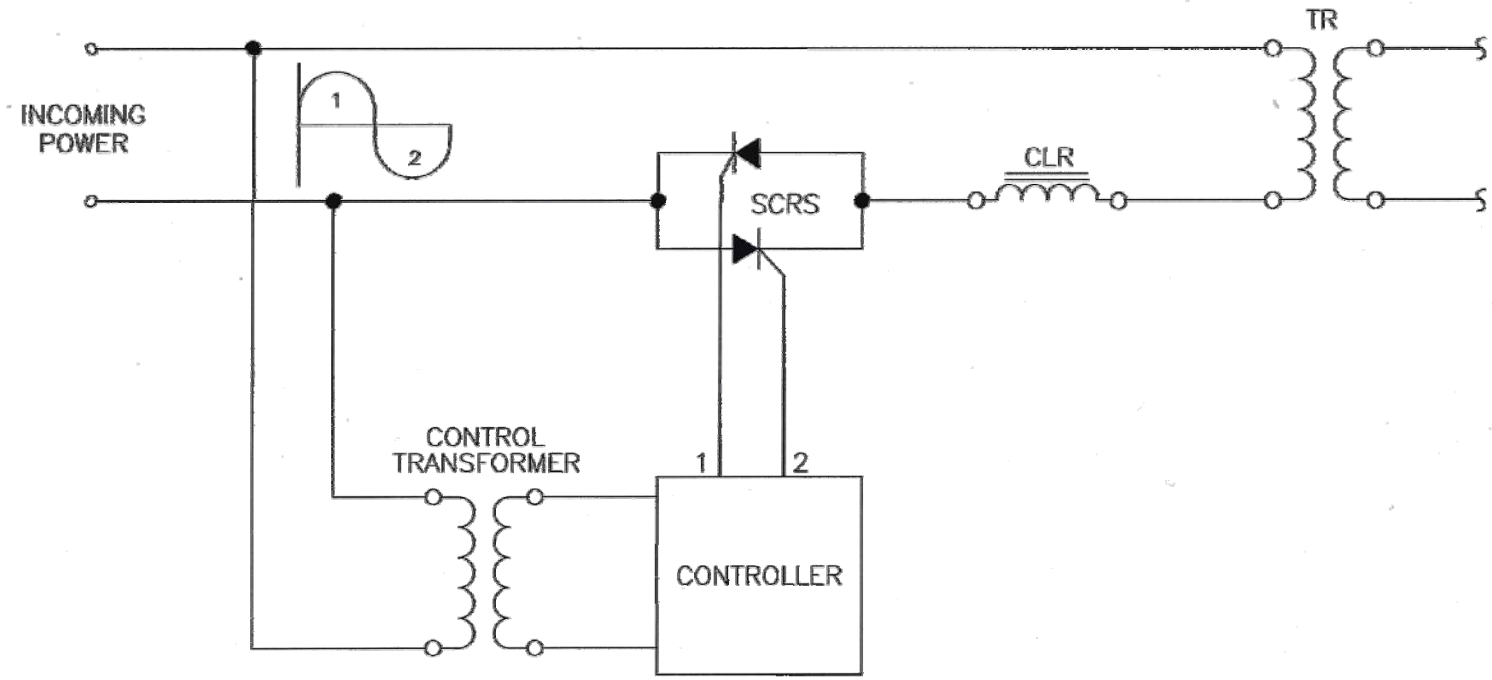


Where Does the High Voltage Come From?

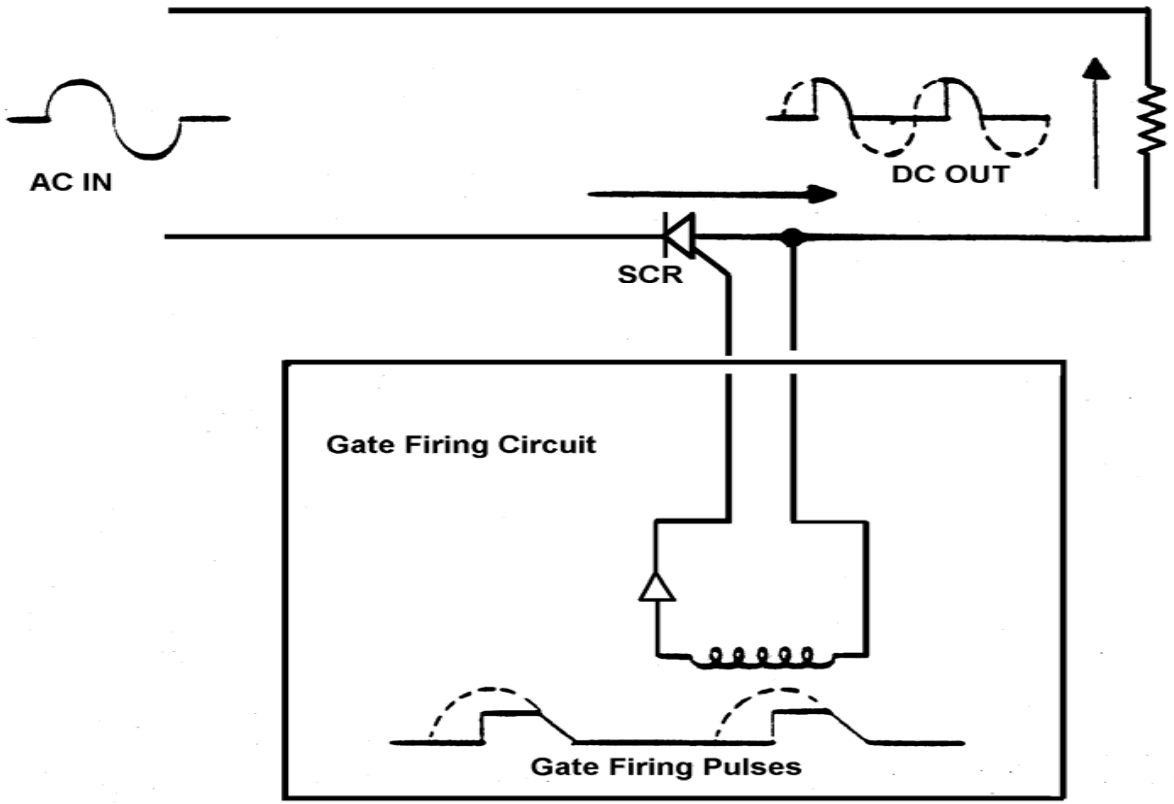


REDKOH

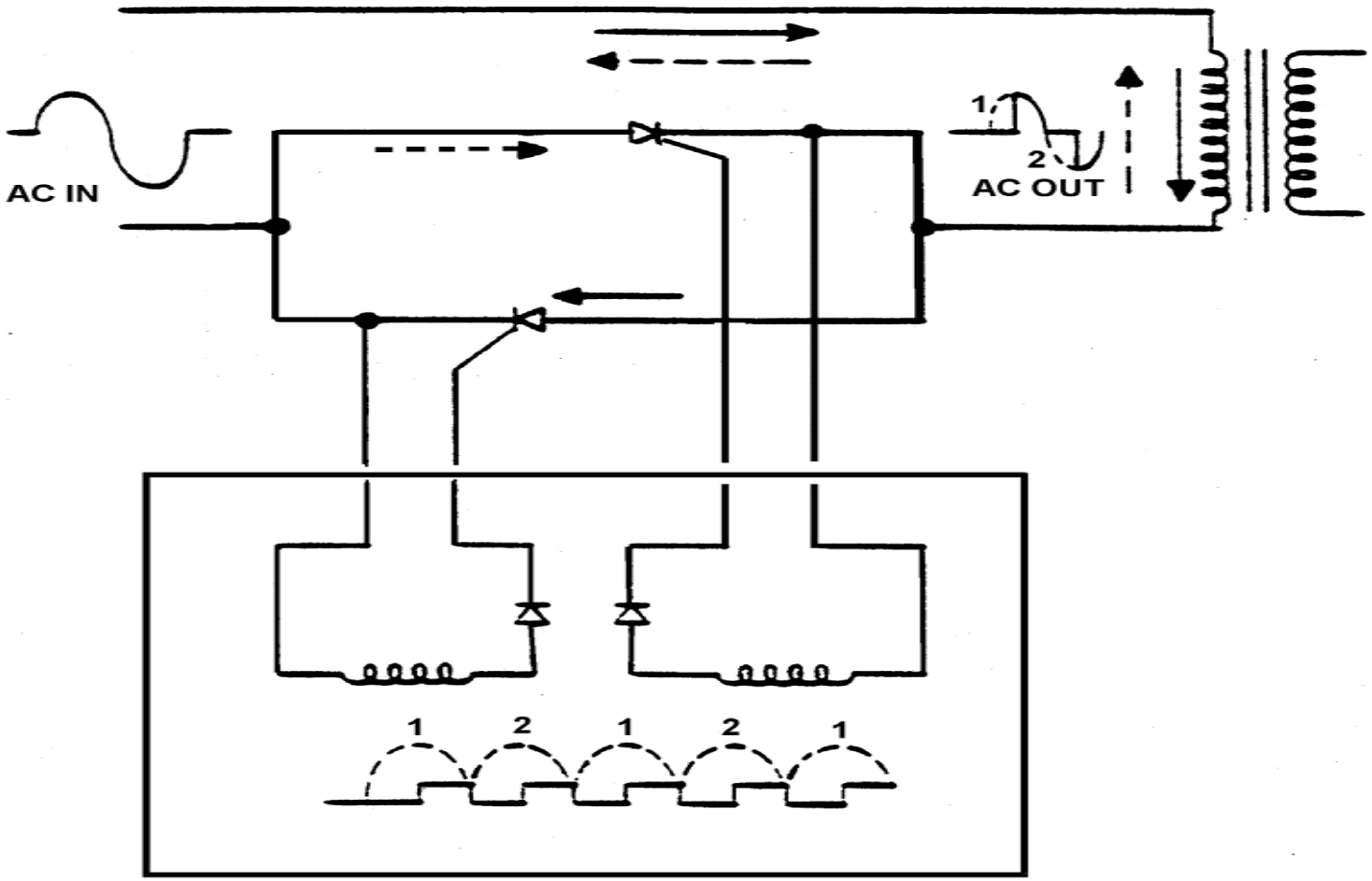
Basic Schematic



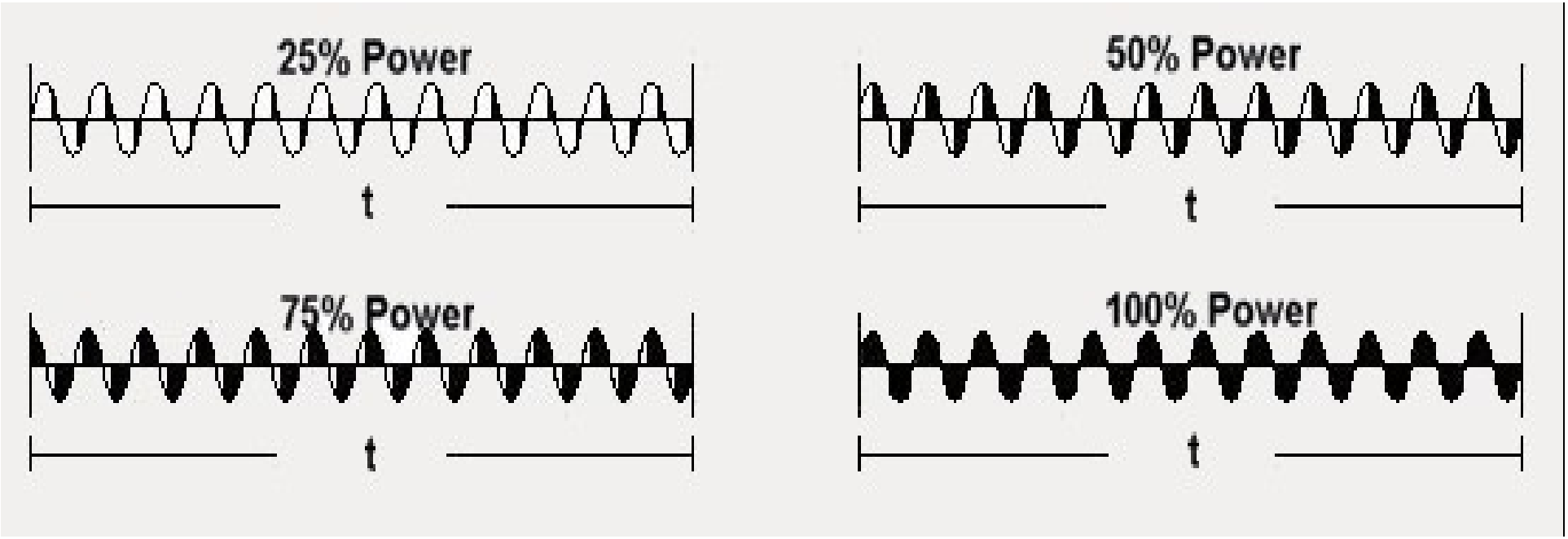
Single SCR Operation



Inverse Parallel SCR Operation



Inverse Parallel SCR Operation

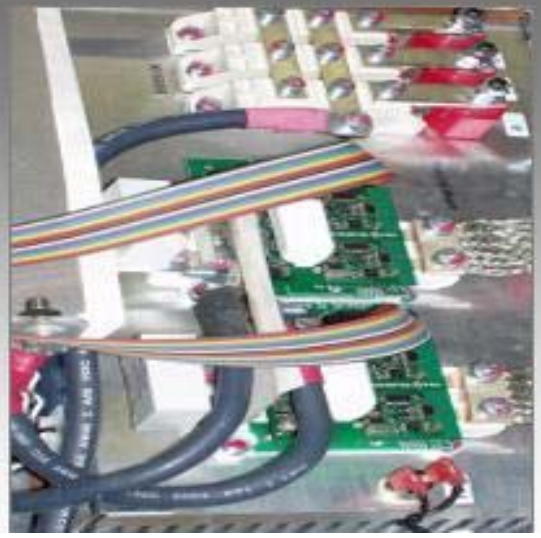


REDKOH

Puck and Stud SCRs

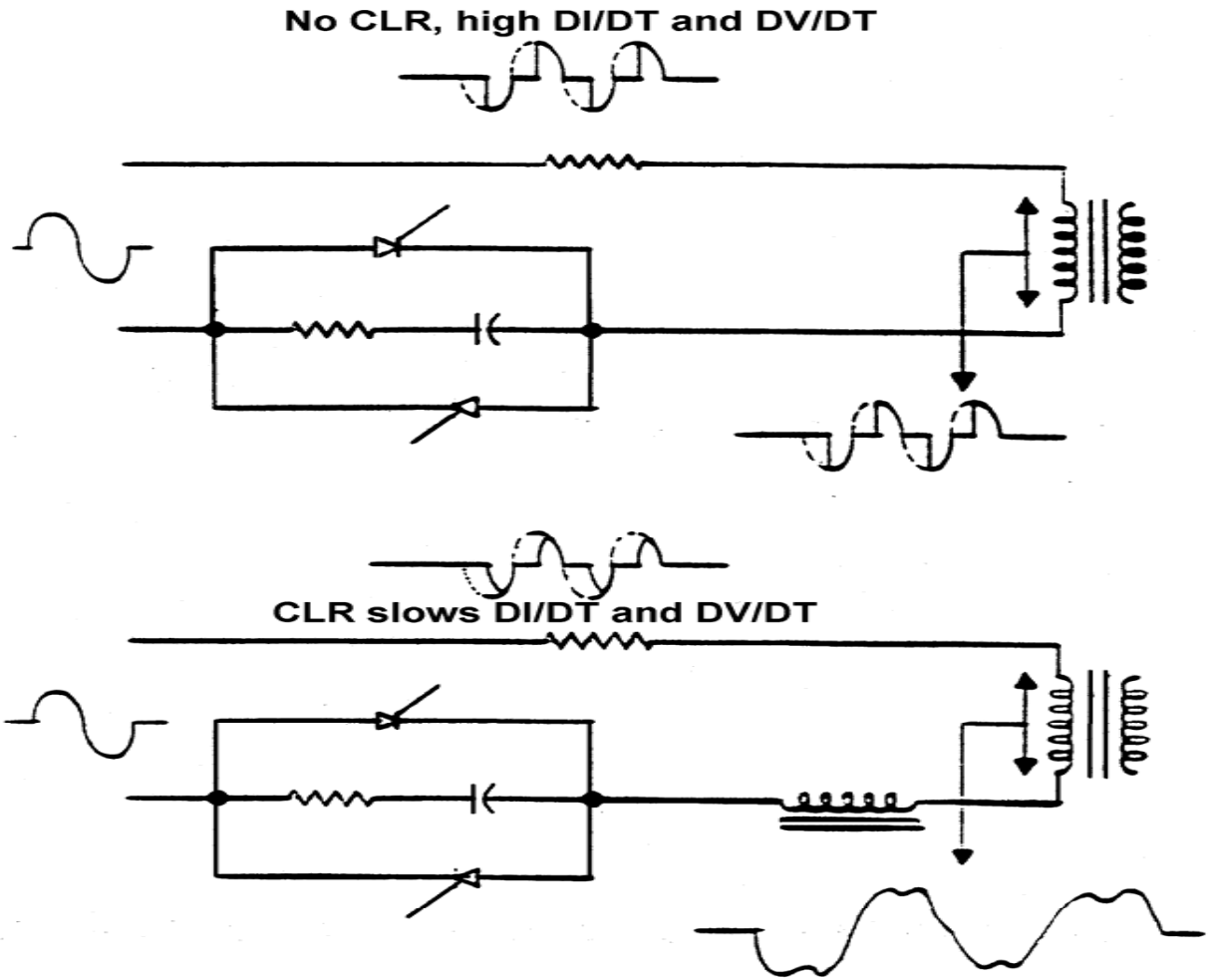
Module Style SCRs

IGBTs



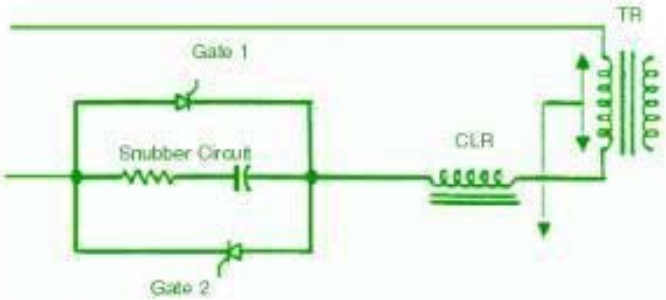
The Snubber at it's importance

Addition of CLR

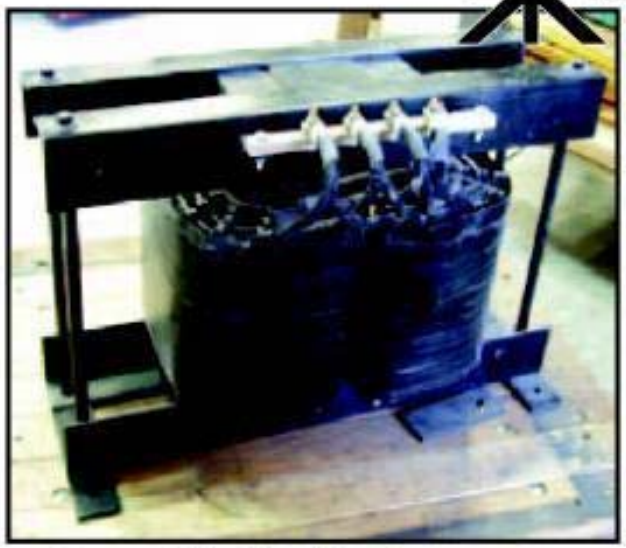


CLR

Current Limiting Reactor



REDKOH



Current Limiting Reactor

Time	Primary Volts	Primary Amps	Secondary Voltage (KV)	Secondary Current (ma)	Conduction Angle (degrees)
1	399	238	45	1500	155
2	395	236	44	1507	158
3	392	234	43	1500	162
4	382	228	42	1460	162
5	376	224	41	1430	162
6	362	215	40	1367	162
7	358	213	39	1350	162
8	338	202	37	1274	162

Electrical readings that indicate a CLR failure

Size a reactor

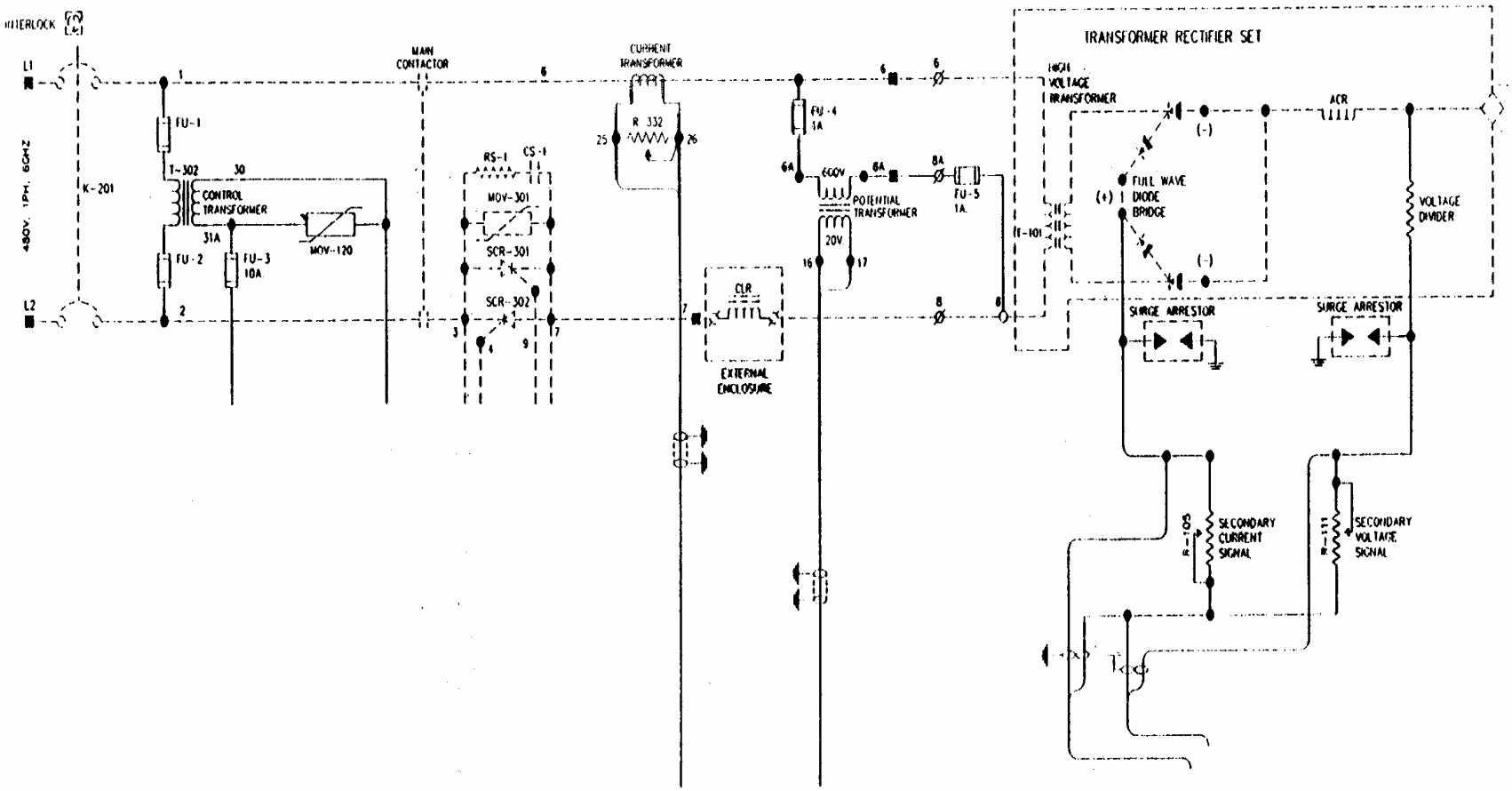
Spot a failing reactor

Failure modes

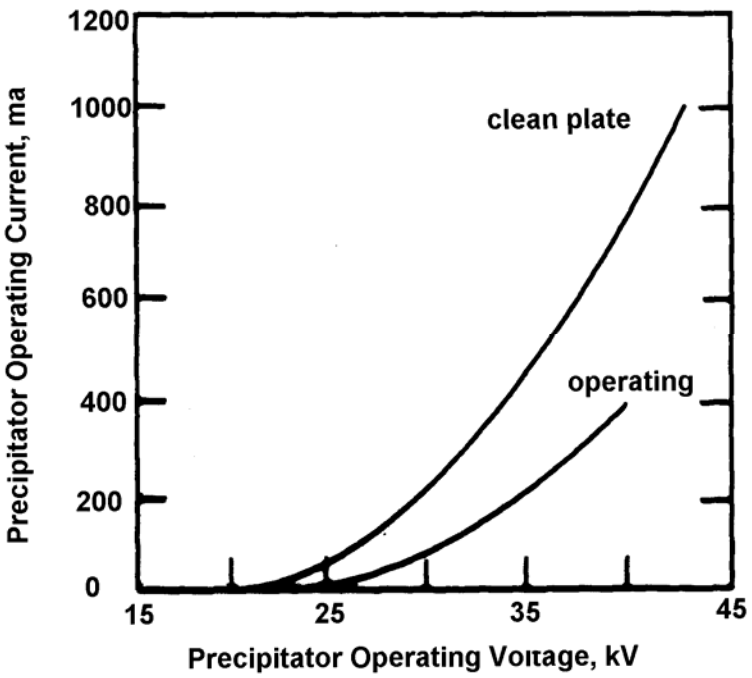
What are the feedback signals

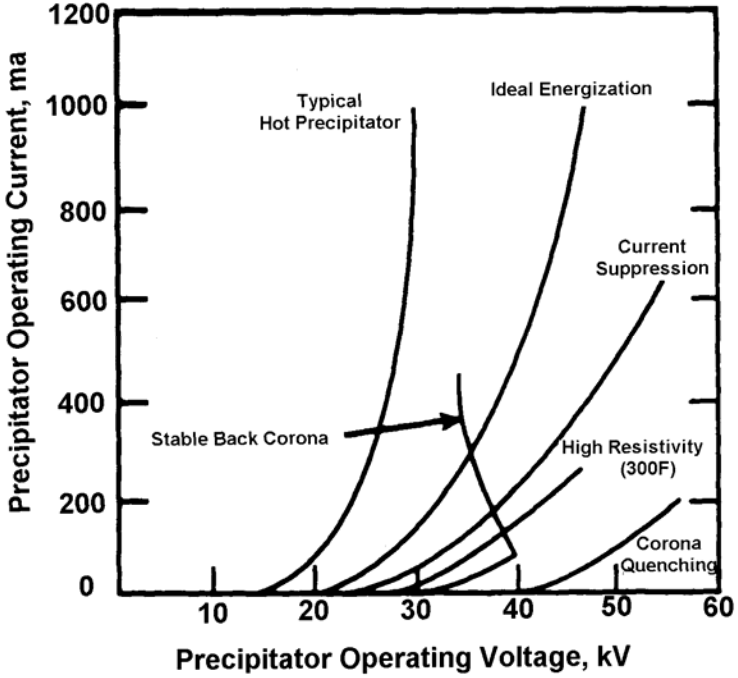
- These are the signals from which the control system makes all it's decisions
  - Primary Voltage - The voltage that appears across the transformer rectifier primary winding
  - Primary Current - The current that is drawn from the supply
  - Secondary Current - The current drawn by the ESP
  - Secondary Voltage - The voltage that appears on the ESP

Schematic with Feedback



VI Curves


Precipitator Operating Current, ma
1200
1000
800
600
400
200
0
clean plate
operating
15
25
35
45
Precipitator Operating Voltage, kV


Precipitator Operating Current, ma
1200
1000
800
600
400
200
0
Typical
Hot Precipitator
Ideal Energization
Current
Suppression
Stable Back Corona
High Resistivity
(300F)
Corona
Quenching
10
20
30
40
50
60
Precipitator Operating Voltage, kV

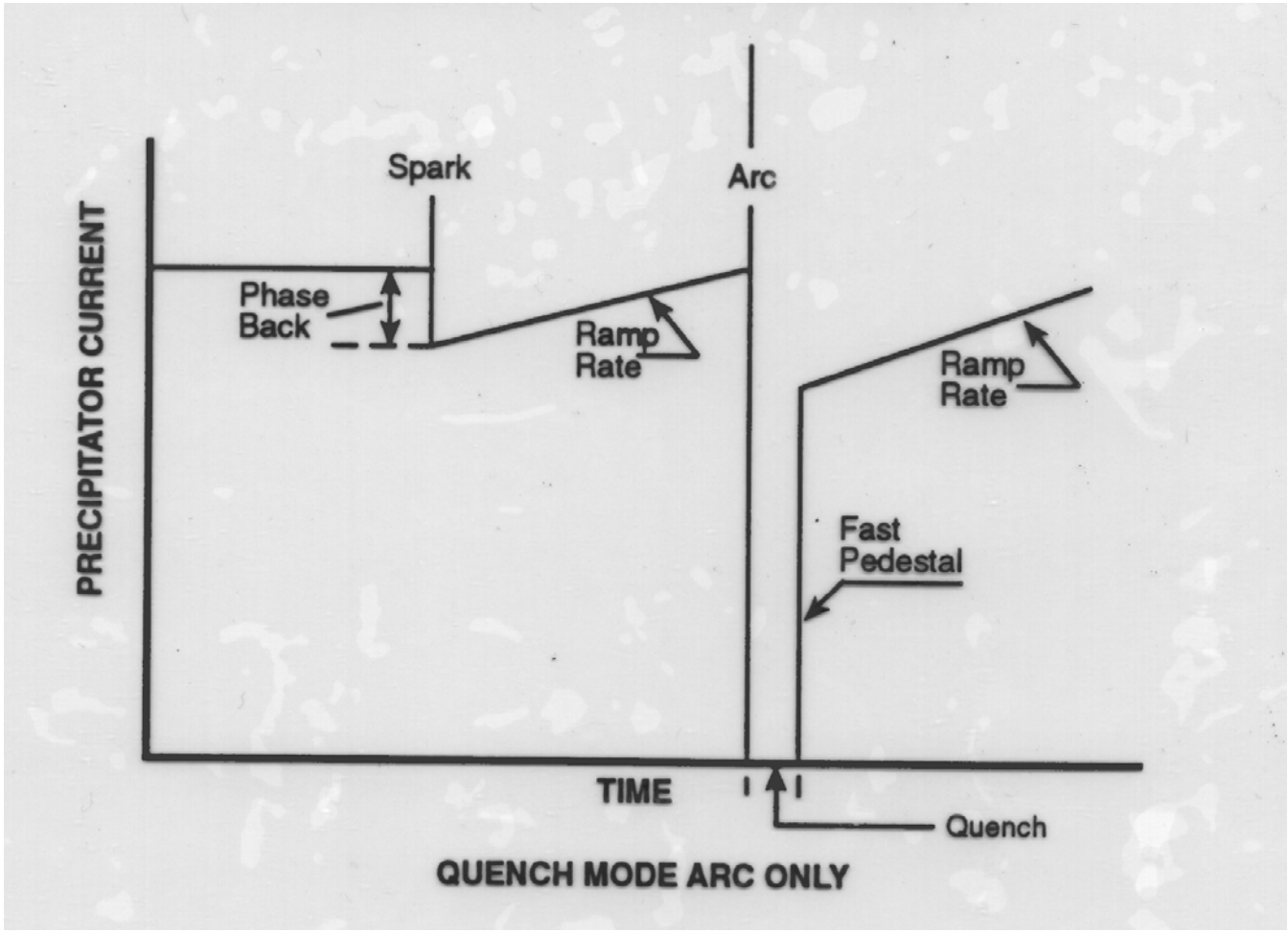
In Summary

- We have:
  - Identified the global requirement of an ESP Control System
  - Identified and discussed an Energization system
  - Built a circuit that discusses the function of each of the components required

An Introduction to Precipitator Controls Systems – Part 2

- In this part, we:
  - Put the circuit into the precipitation application – and discuss some of the different techniques available

Typical Control Waveforms



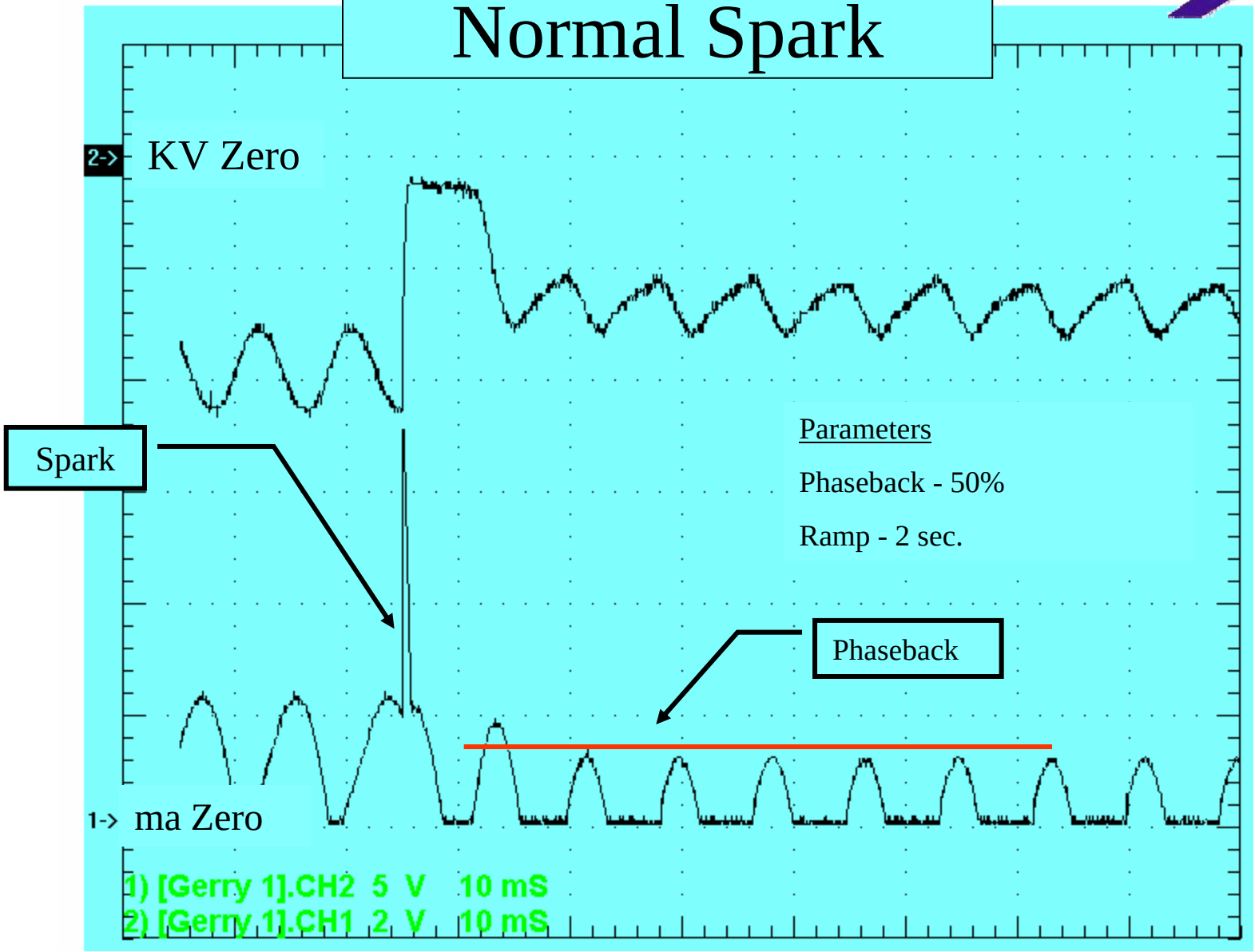
What is a spark

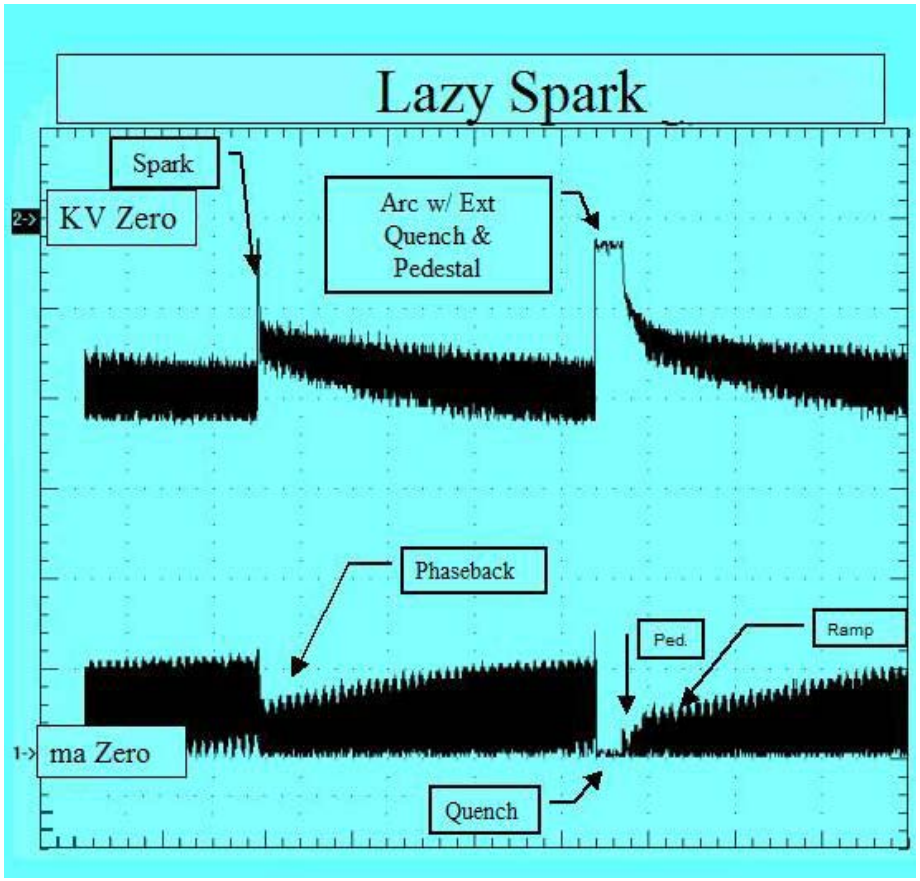
A Precipitator disturbance which causes a depression of the electrode voltage for not more than one half cycle of the supply

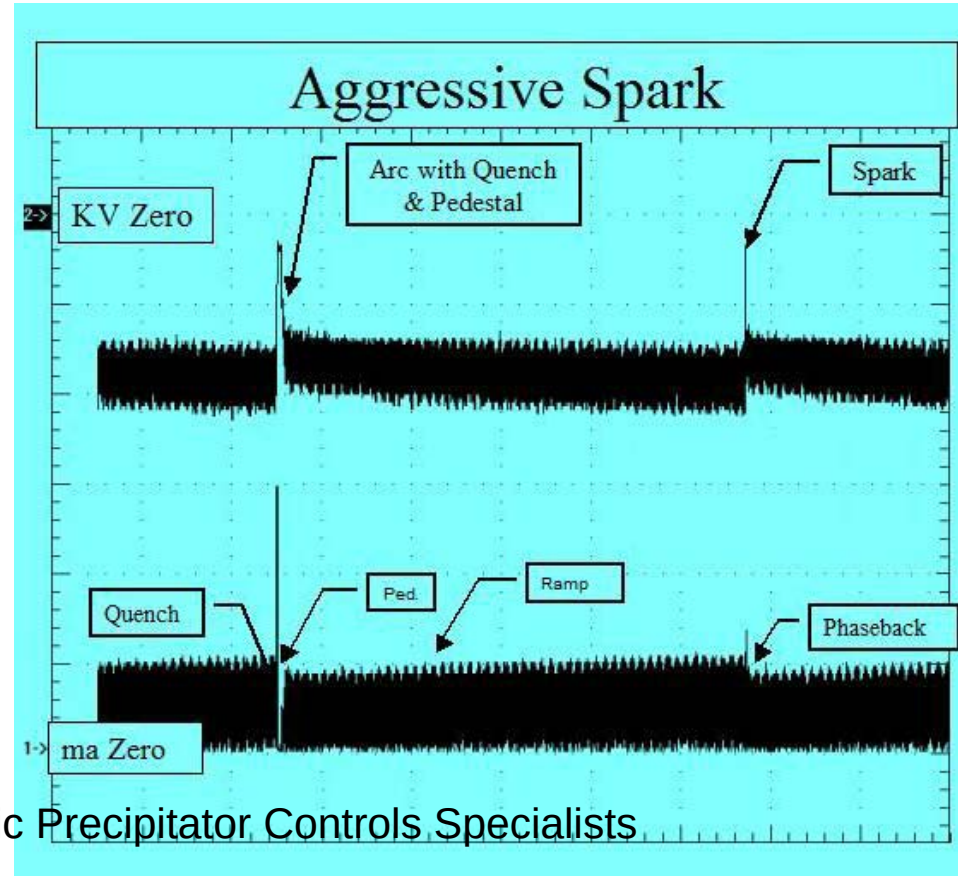
Spark Detection

- Sparks can be detected by a number of different methods and these include:
  - Looking for transients on the secondary current signal
  - Looking for substantial and instantaneous rises in the primary and secondary currents
  - Looking for sharp falling edges on secondary voltage signals.

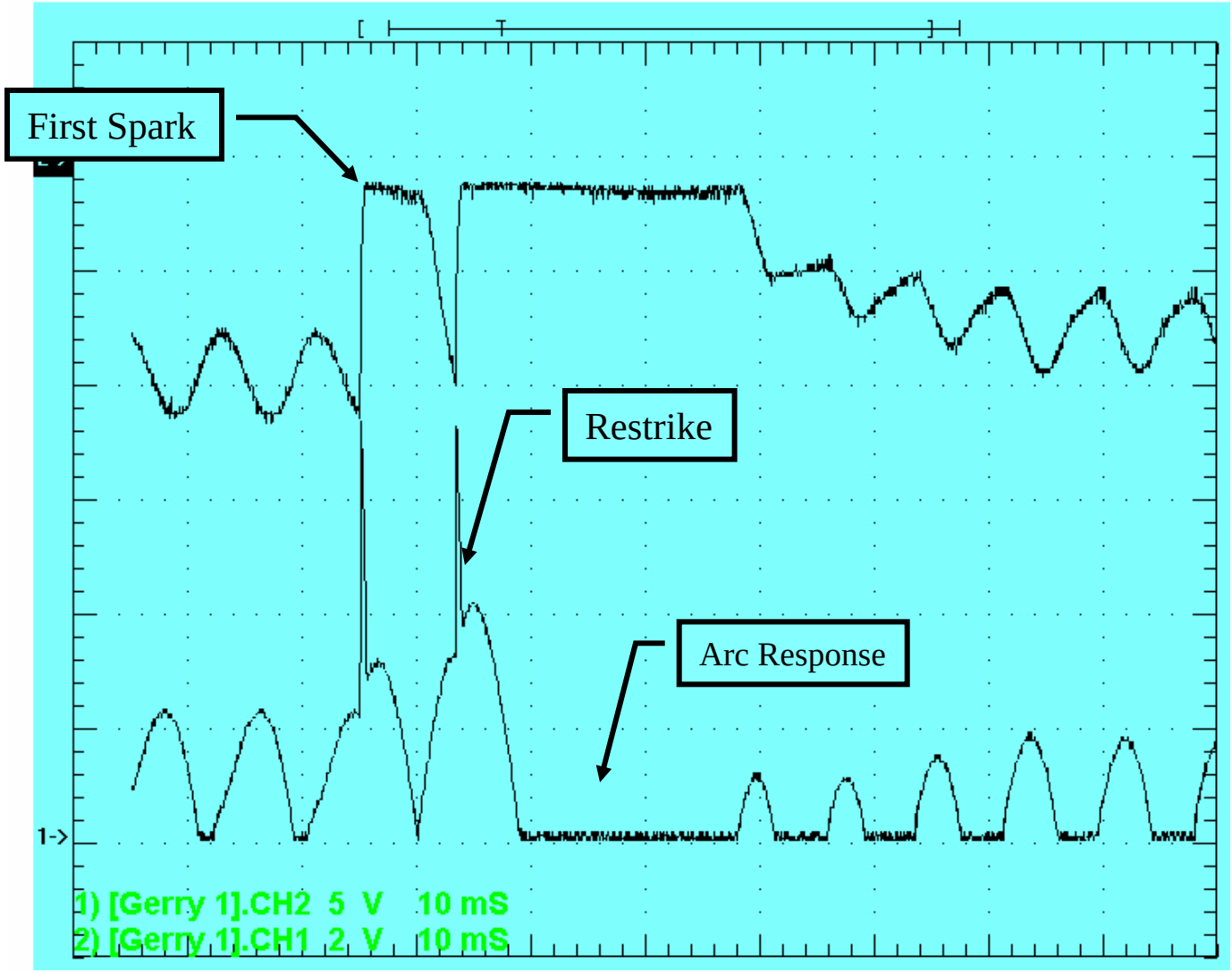
Normal Spark




Lazy Spark
Spark
KV Zero
Arc w/ Ext
Quench &
Pedestal
Phaseback
Ped.
Ramp
ma Zero
Quench

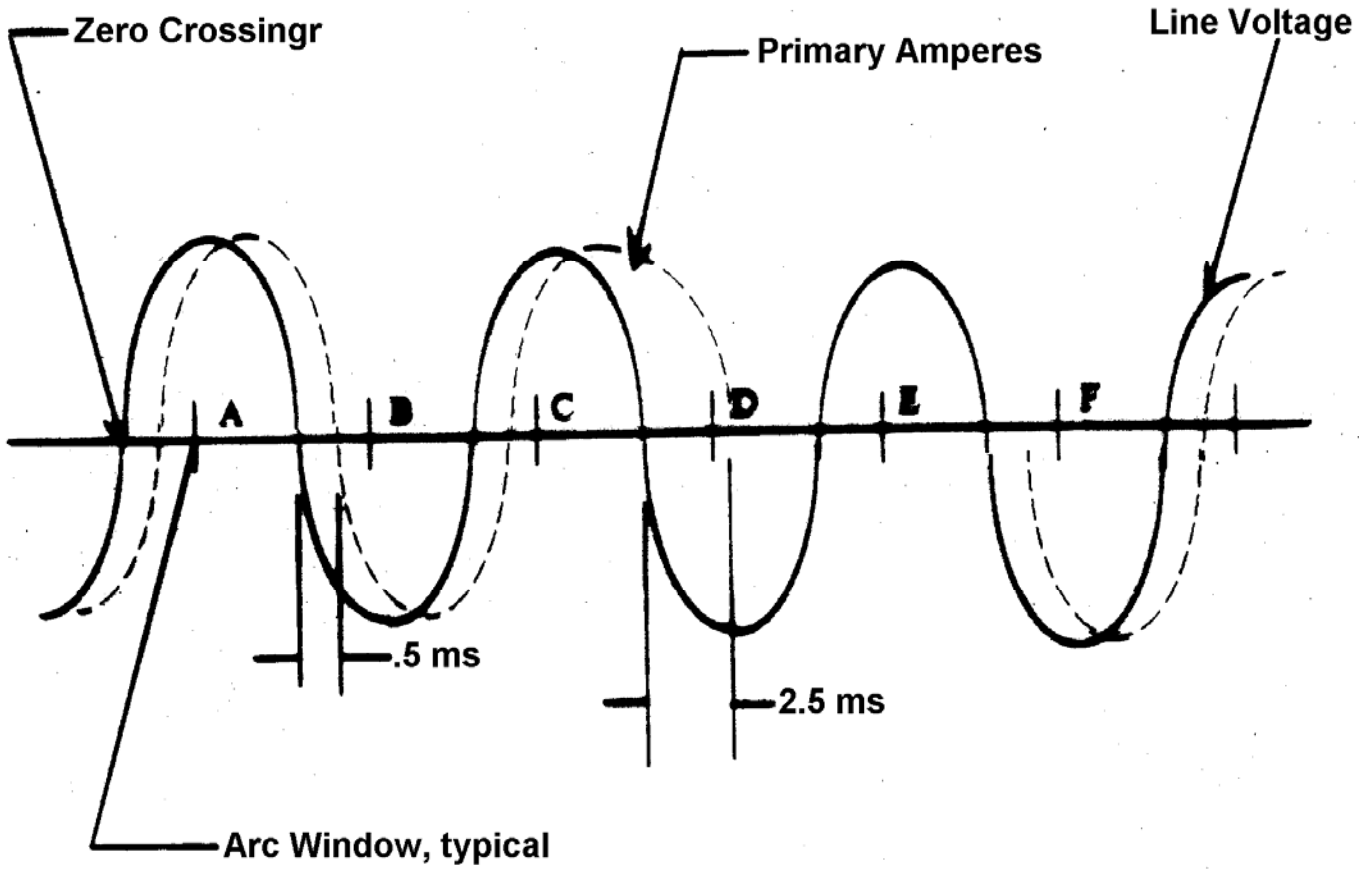

Aggressive Spark
Arc with Quench
& Pedestal
Spark
KV Zero
Quench
Ped.
Ramp
Phaseback
ma Zero

What is an Arc



A Precipitator disturbance which causes successive or a continued depression of the electrode voltage

Arc Detection

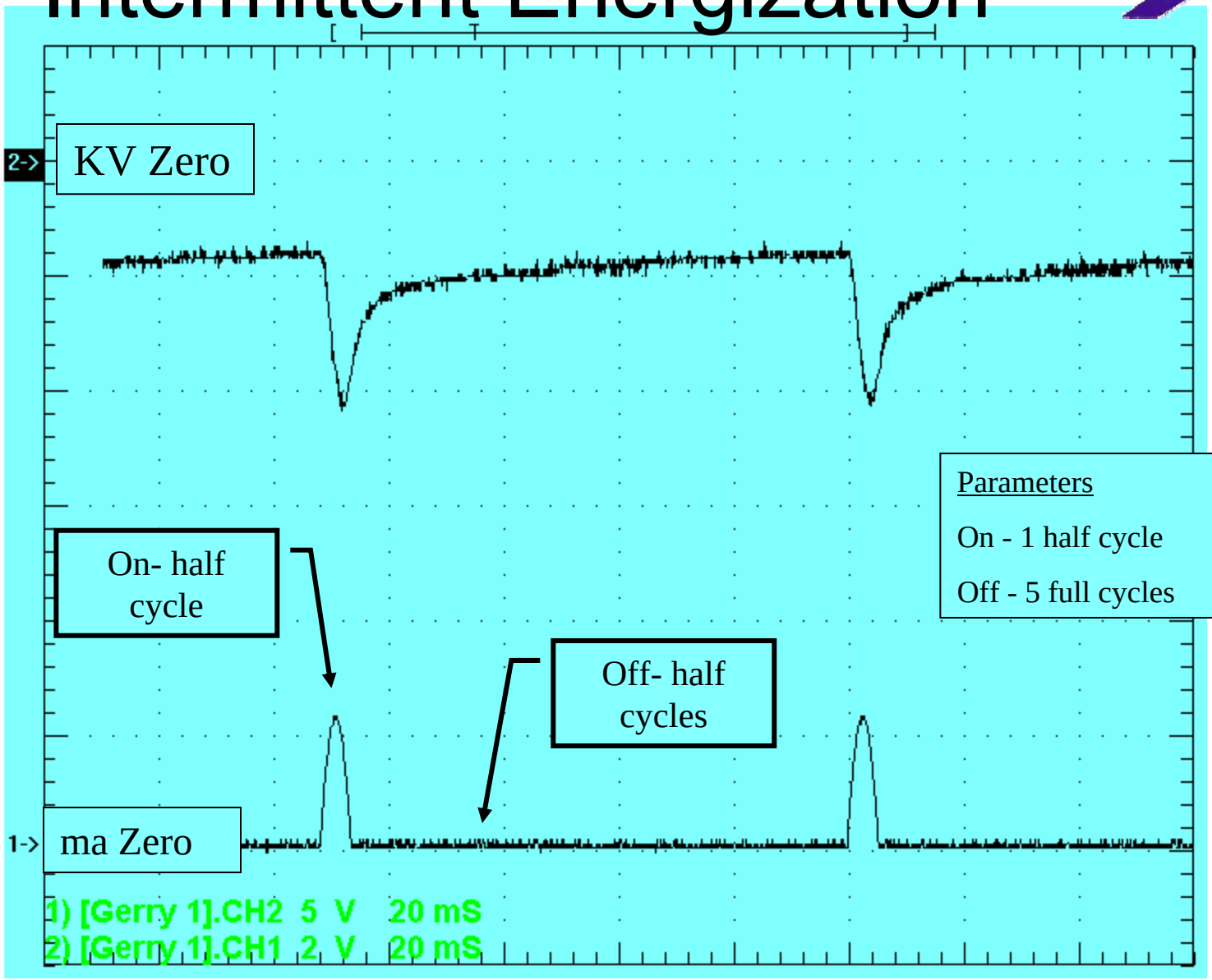


What is the difference between Continuous Energization and IE (Intermittent Energization)

- Continuous Energization:
- The controls seek to maintain a high average voltage and hence power to the ESP by firing the SCRs every half cycle of supply unless a recognized event within the system determines otherwise.
  - The ESP is by all accounts continuously energized

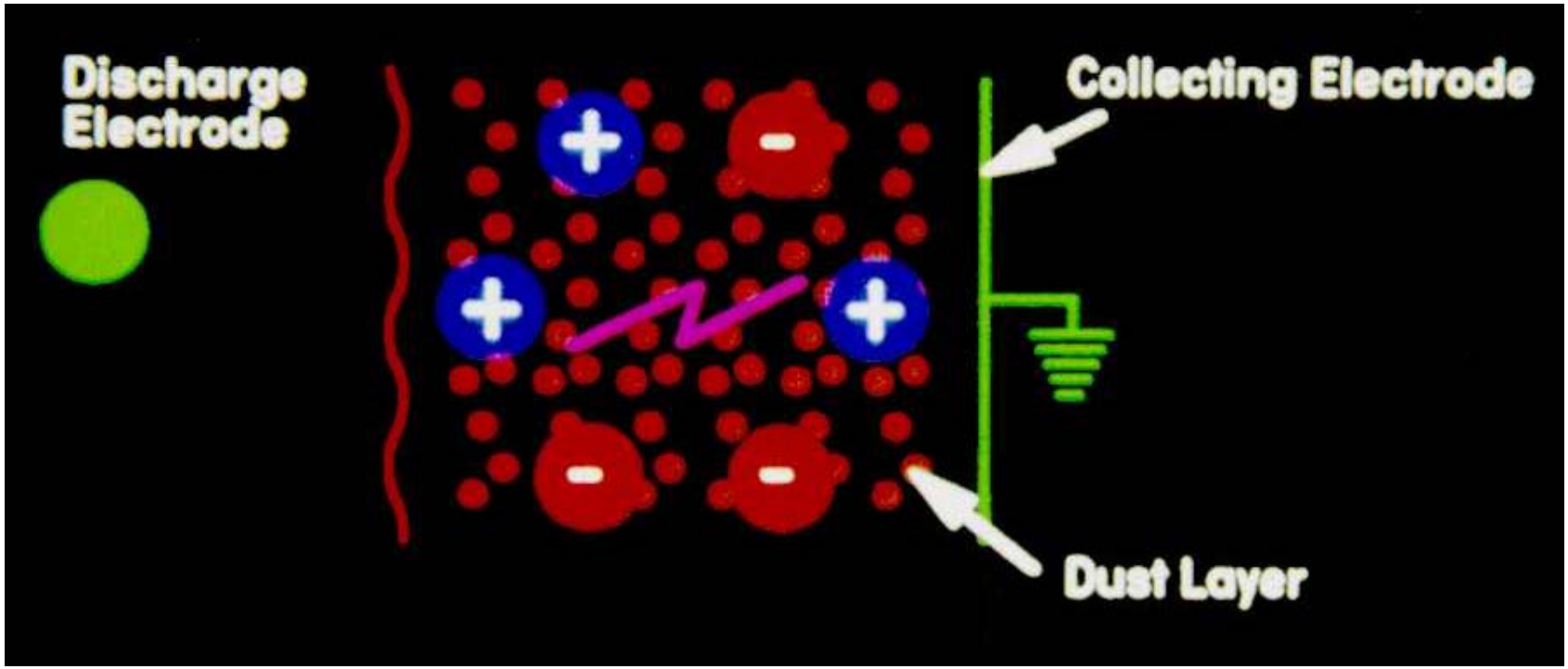
- I.E
- Is achieved by alternately energizing the T/R set with a high firing angle for a specified number of half cycles and a low firing angle for a specified number of full cycles (unless a recognized event within the system determines otherwise)

Intermittent Energization



When do we use I.E?..

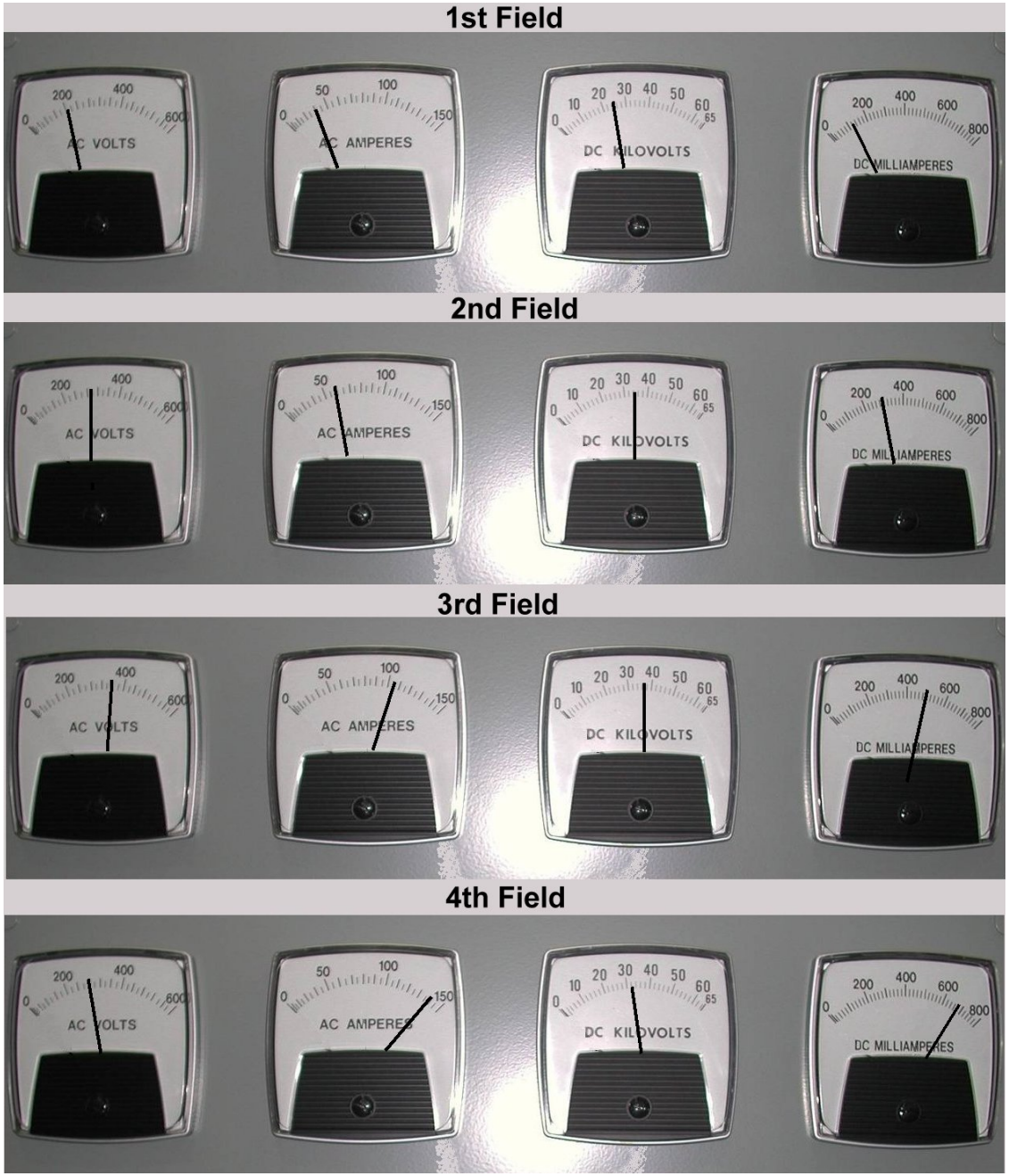
When there's Back Corona!!



Detrimental Effects of Back Corona

- Oppositely charged particles collide and cause charge neutralization
- The back corona may have with sufficient strength to cause the particles to collect on the discharge electrodes.
- Excessive dust to build up on the DEs causes poor current distribution which reduces ionic emissions.
- The DEs may now need more frequent rapping and so increased mechanical wear and process instability may result.
- The dust layer on the collector plates does not discharge completely by virtue of the retained potential so the rapping efficiency is reduced. Reduced power rapping may become required
- The current from the supply often increases and power consumption increases.

The Meters


1st Field
AC VOLTS
AC AMPERES
DC KILOVOLTS
DC MILLIAMPERES
2nd Field
AC VOLTS
AC AMPERES
DC KILOVOLTS
DC MILLIAMPERES
3rd Field
AC VOLTS
AC AMPERES
DC KILOVOLTS
DC MILLIAMPERES
4th Field
AC VOLTS
AC AMPERES
DC KILOVOLTS
DC MILLIAMPERES

Is Training Important?

- The output of your operation depends on the cleanliness of your stack.
- The cleanliness of your stack depends on the ESP operating at optimum efficiency.
- Optimum efficiency will not occur unless the controls are optimized.

YES it is important!