

REINHOLD ENVIRONMENTAL Ltd.



**2014 APC Round Table
& Expo Presentation**

July 14-15, 2014, in Louisville, KY / Hosted by LG&E/KU

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ESP Electrical O&M and Troubleshooting

Gerry Klemm, Southern Company

2014 APC Round Table

July 15, 2014 – Louisville, Ky.

What does Winning at ESP O&M Mean?

- Lowest Emissions
- Lowest Input Power



ESP Removal Efficiency is governed by Drift Velocity which is governed by POWER

Deutsch Anderson ESP Efficiency Equation

$$EFF = 1 - e^{-\frac{A}{V}w}$$

$$W = \frac{E_o E_p a}{2 \pi \eta}$$

EFF = Fractional % Collected

A = Surface Area Collecting
Electrodes

V = Volumetric Flow Rate

w = Particle Drift Velocity
or Rate Parameter

E_o = Charging Fields $\frac{\text{Volts}}{\text{Distance}}$

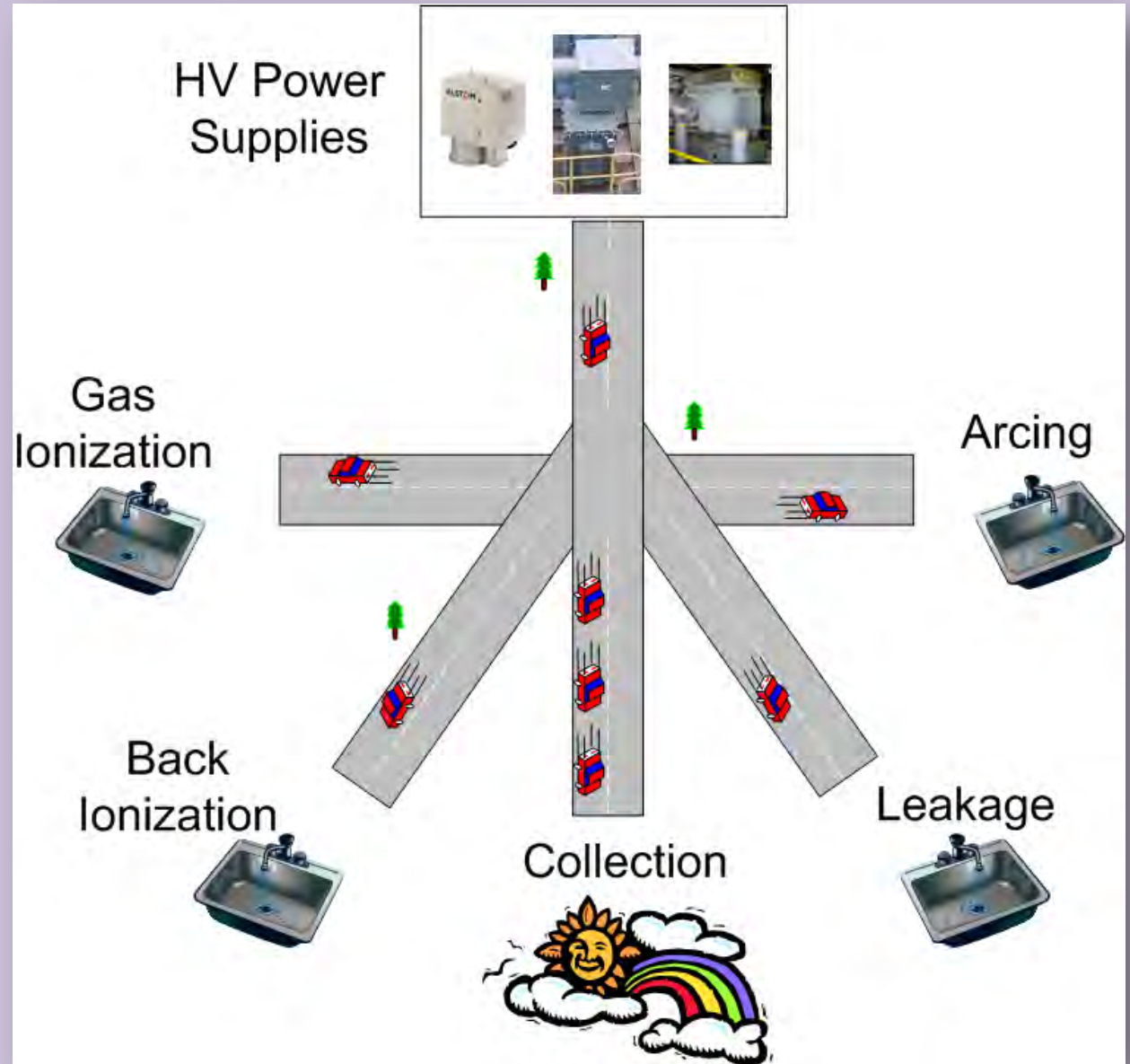
E_p = Collecting Field $\frac{\text{Volts}}{\text{Distance}}$

a = Particle Radius

η = Gas Viscosity

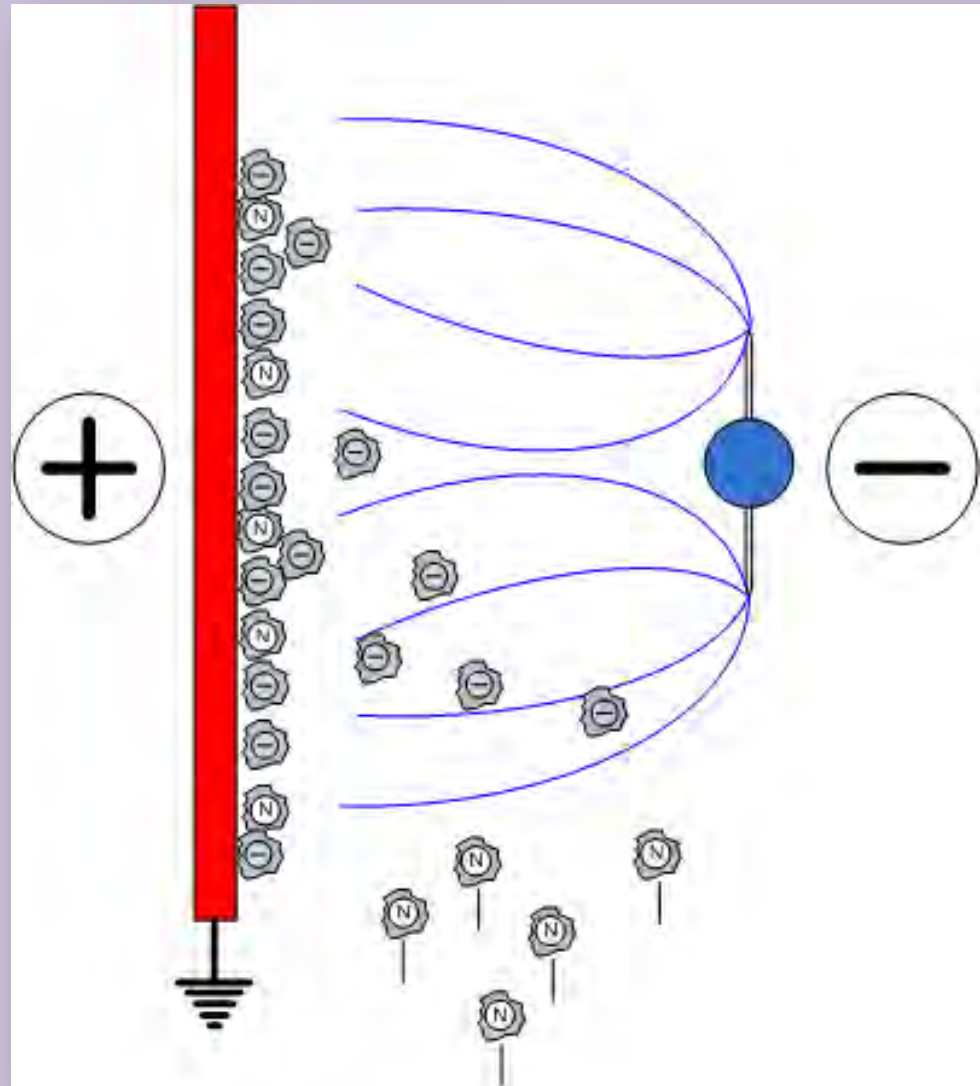
π = 3.1416

Where Can the Power Go?



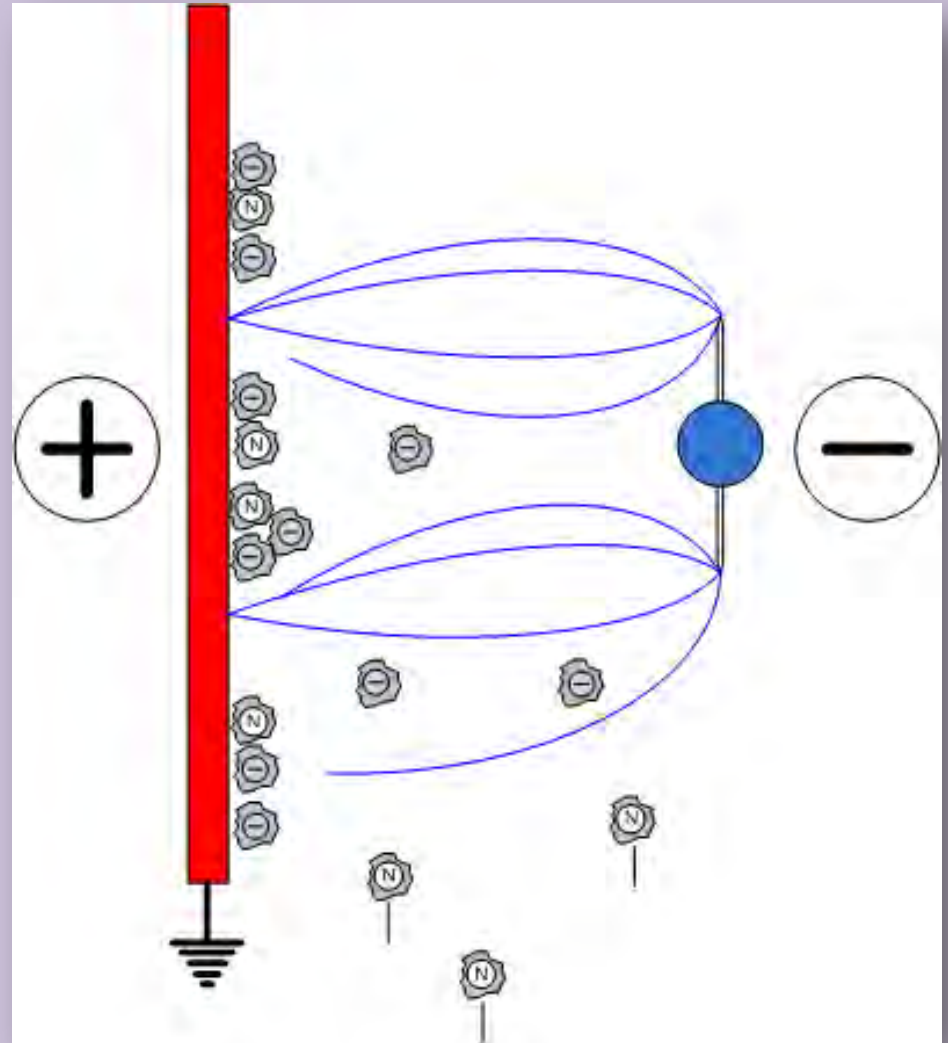
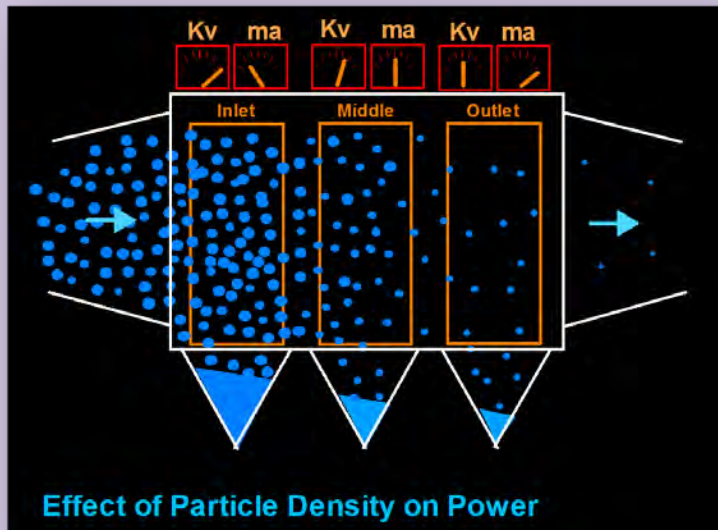
Collection

- Only beneficial use of power.
- Ionizes and polarizes particle so it can be collected on plate.



Gas Ionization

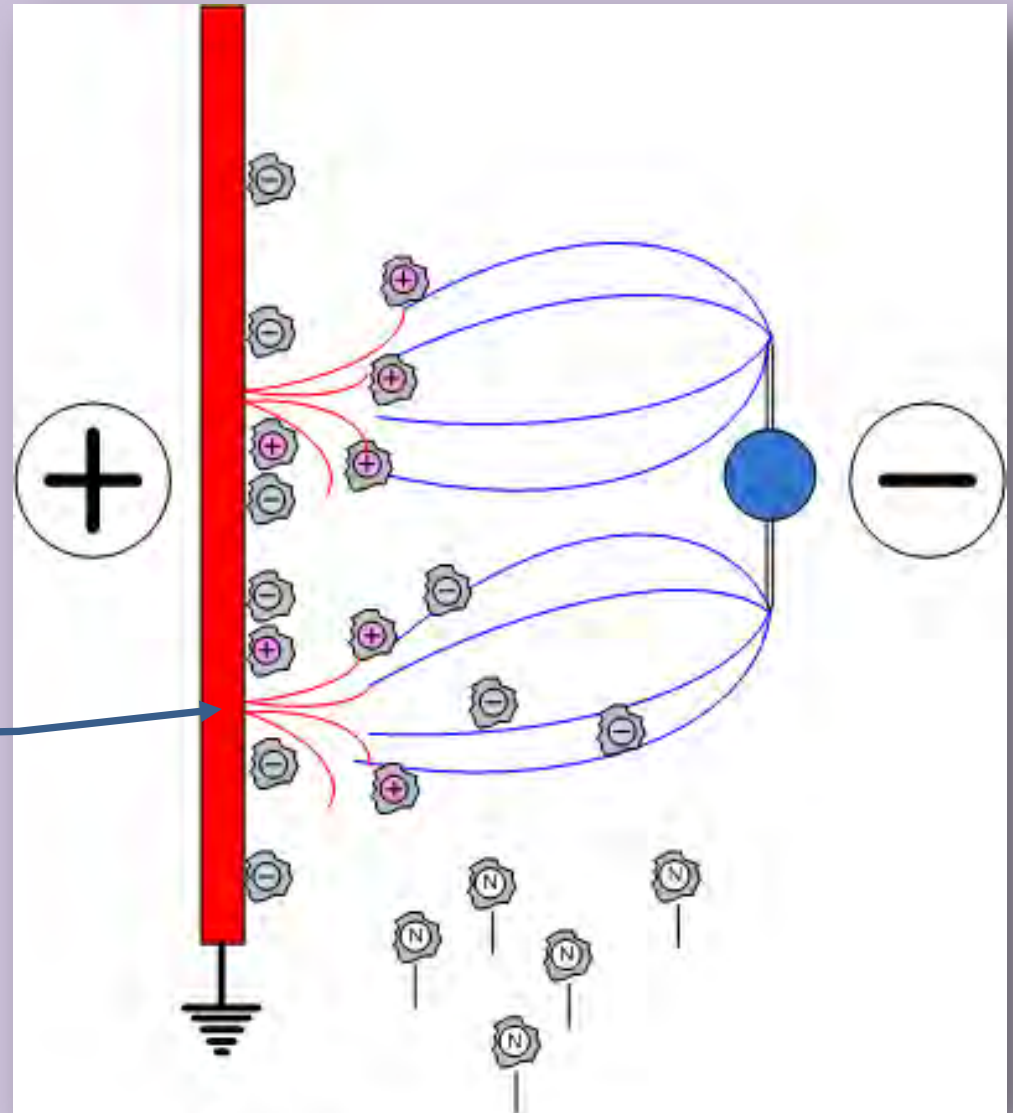
- Occurs mostly in outlet fields or at low load.
- No benefit, but some is unavoidable.



Back Ionization (Back Corona)

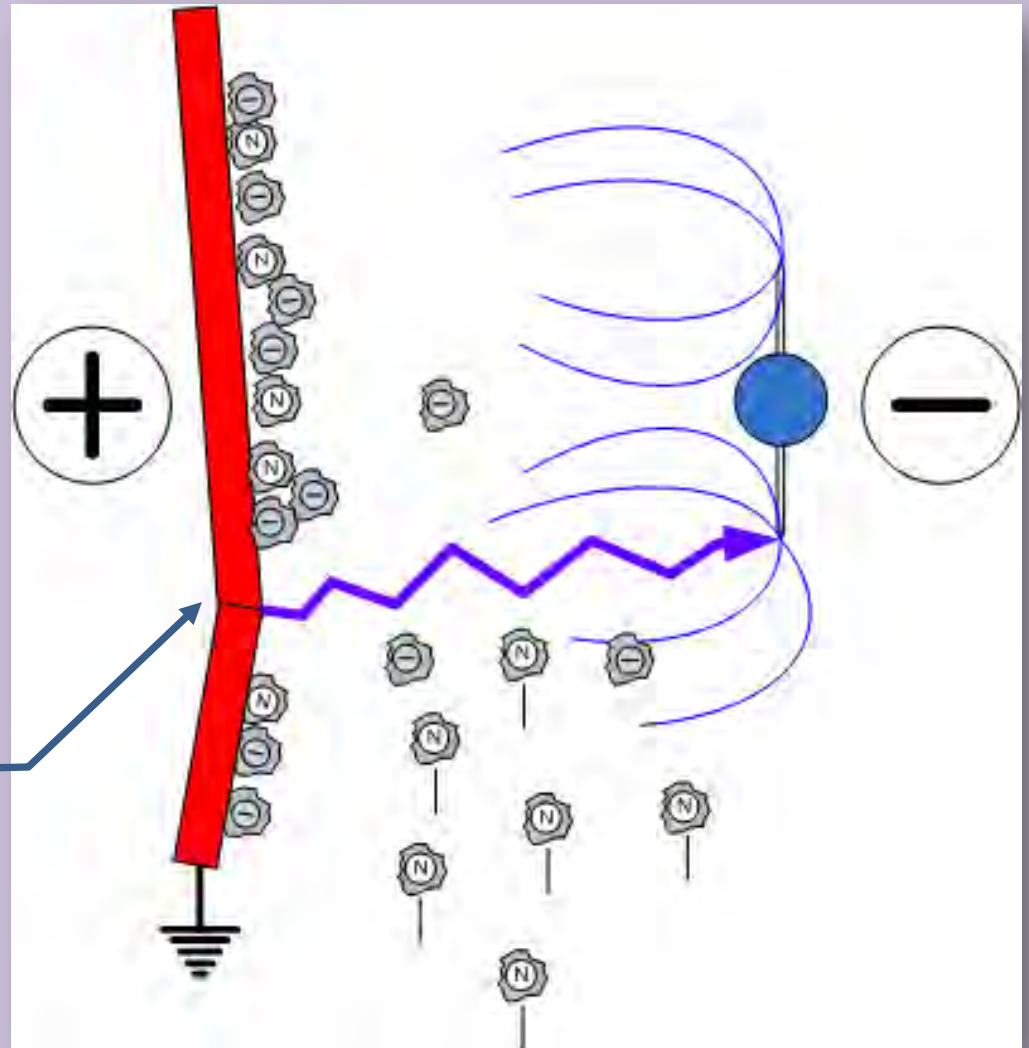
- Occurs mostly in inlet fields or at high gas temperatures (coldsides).
- Is detrimental and is to be avoided.

Positive Corona Hot Spot



Arcing

- Different than normal sparking.
- More intense and long lasting.
- Is detrimental and is to be avoided.



Arcing due to close clearance

Leakage

- Most often occurs on the surface of HV insulators
- Can be flashing or continuous
- Continuous is the most difficult to detect



Leakage

- Is not limited to insulators in the flue gas.
- Can also occur through ash in hoppers.



Extreme Leakage Plus Ionization

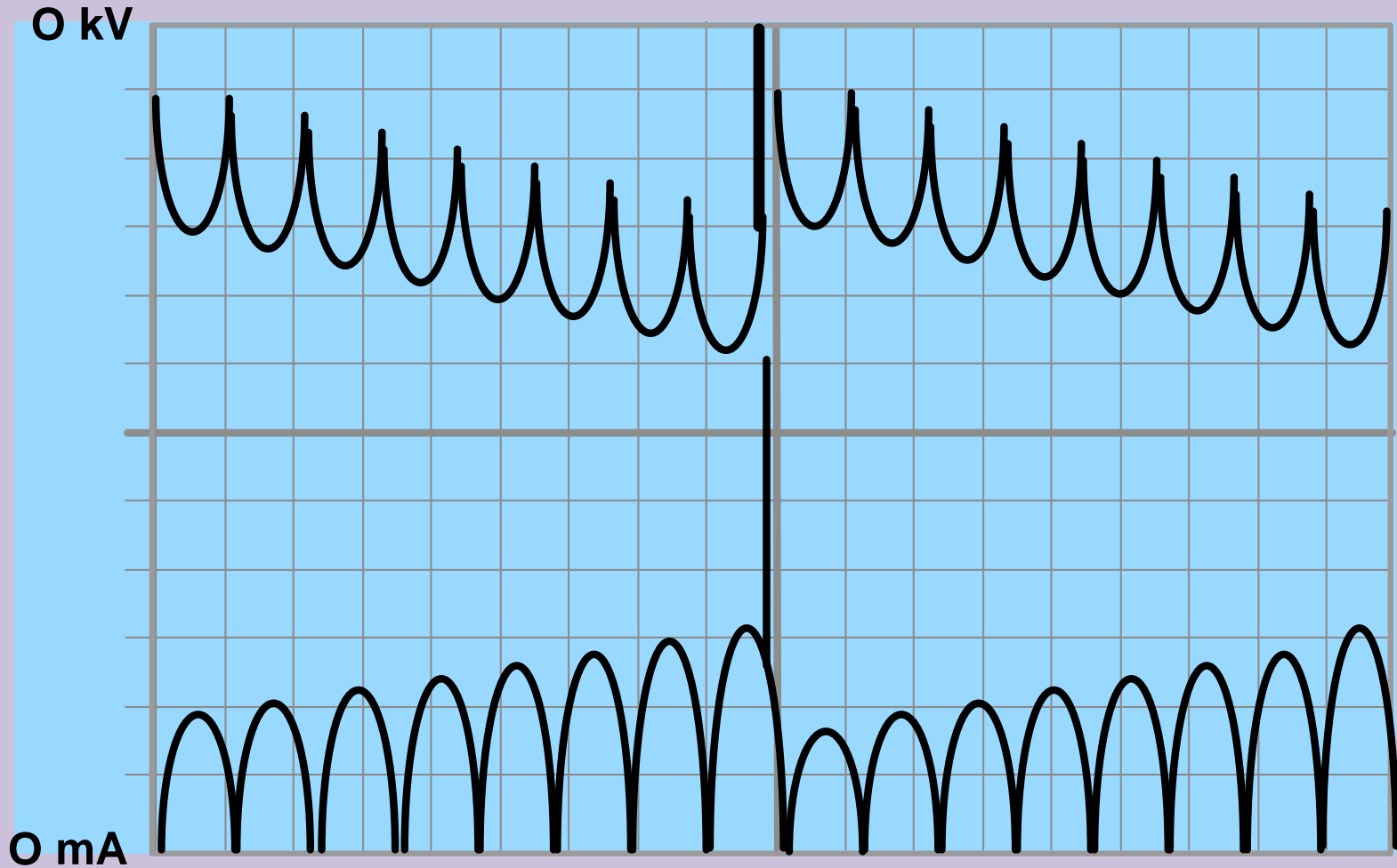
- If power is continuously applied, ionization can occur on surface of insulator
- Is aggravated if a conductive layer is present.
- Will fail the insulator due to excessive heat.



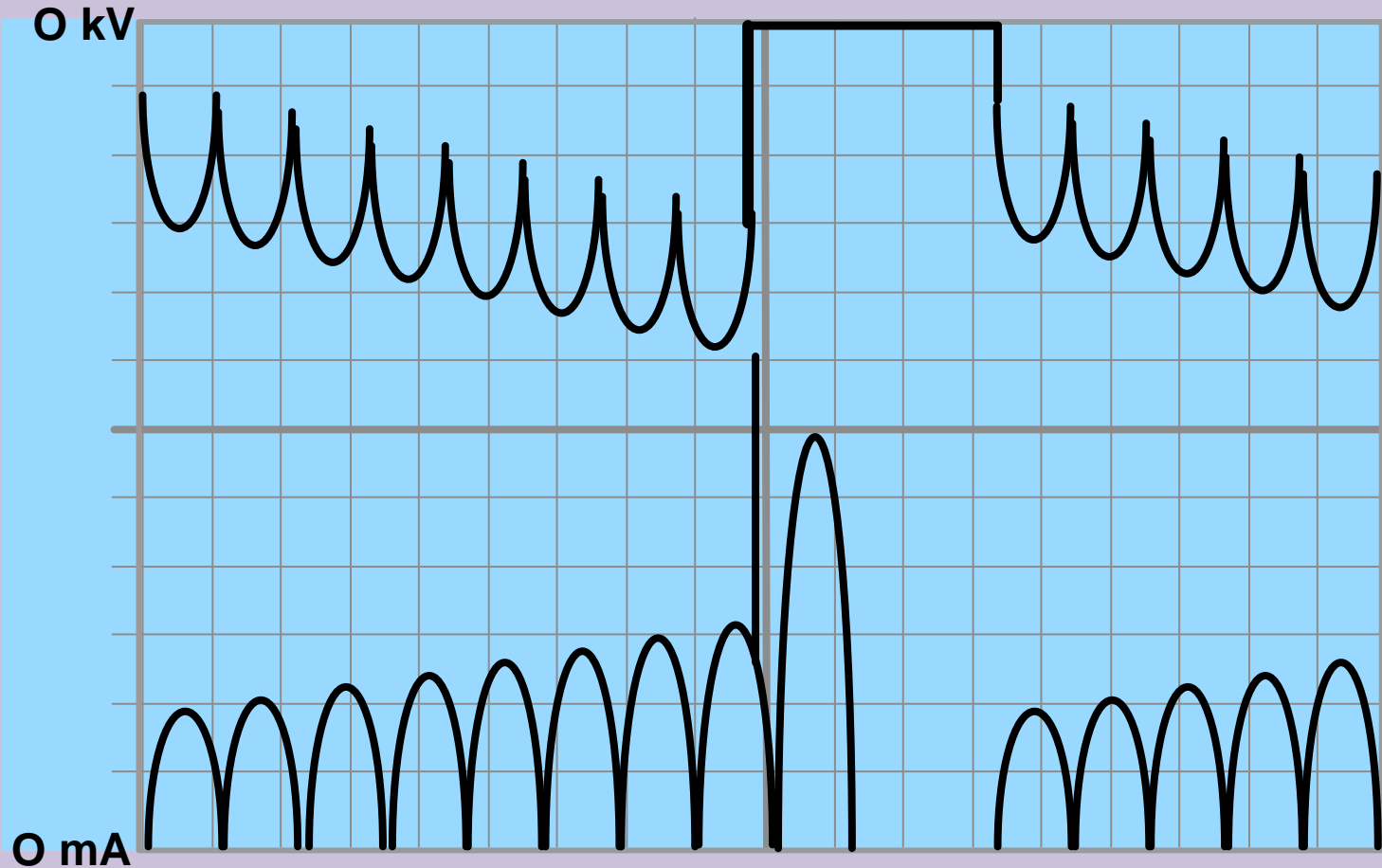
What can we do about these losses?



Arcing

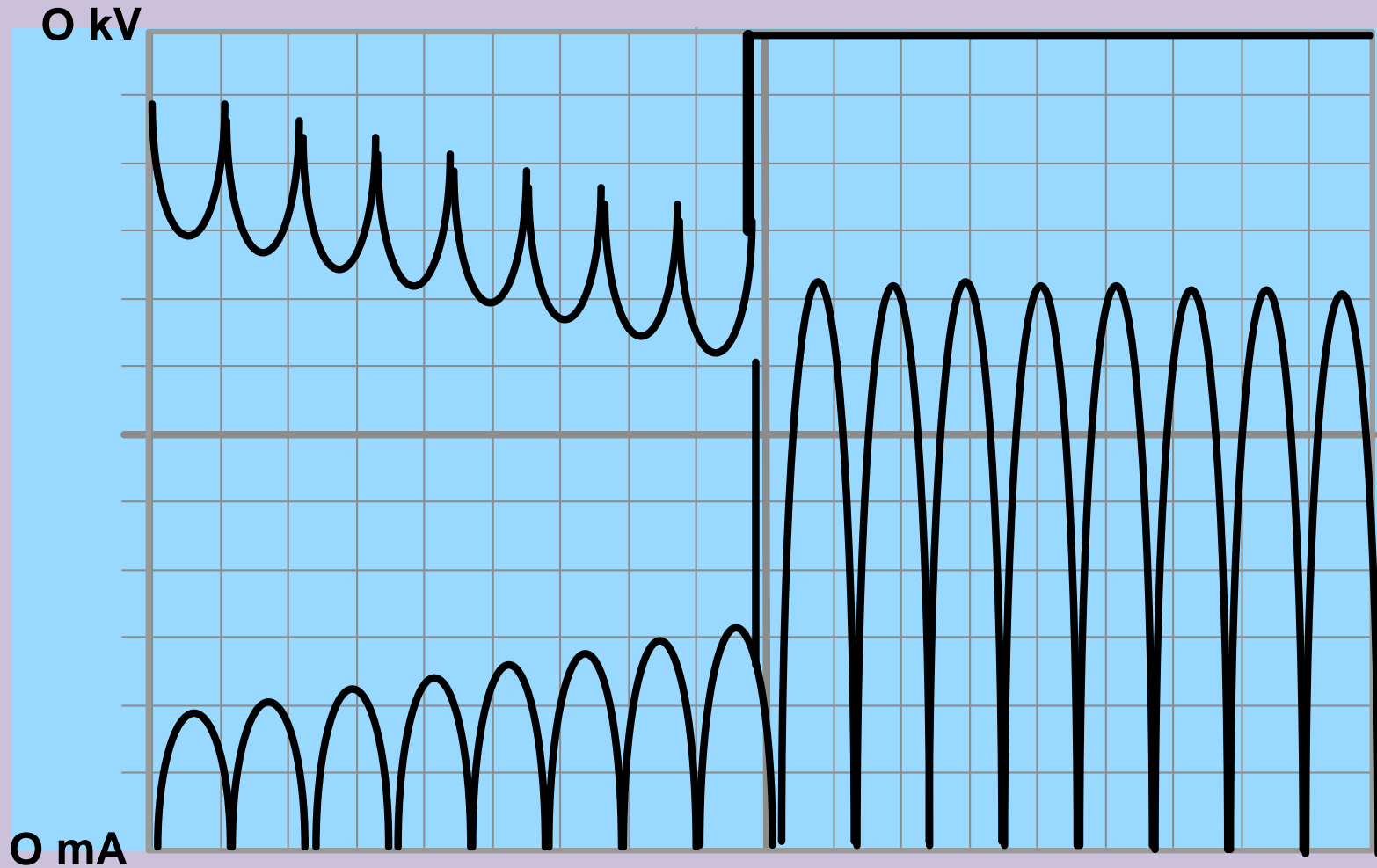


Arcing

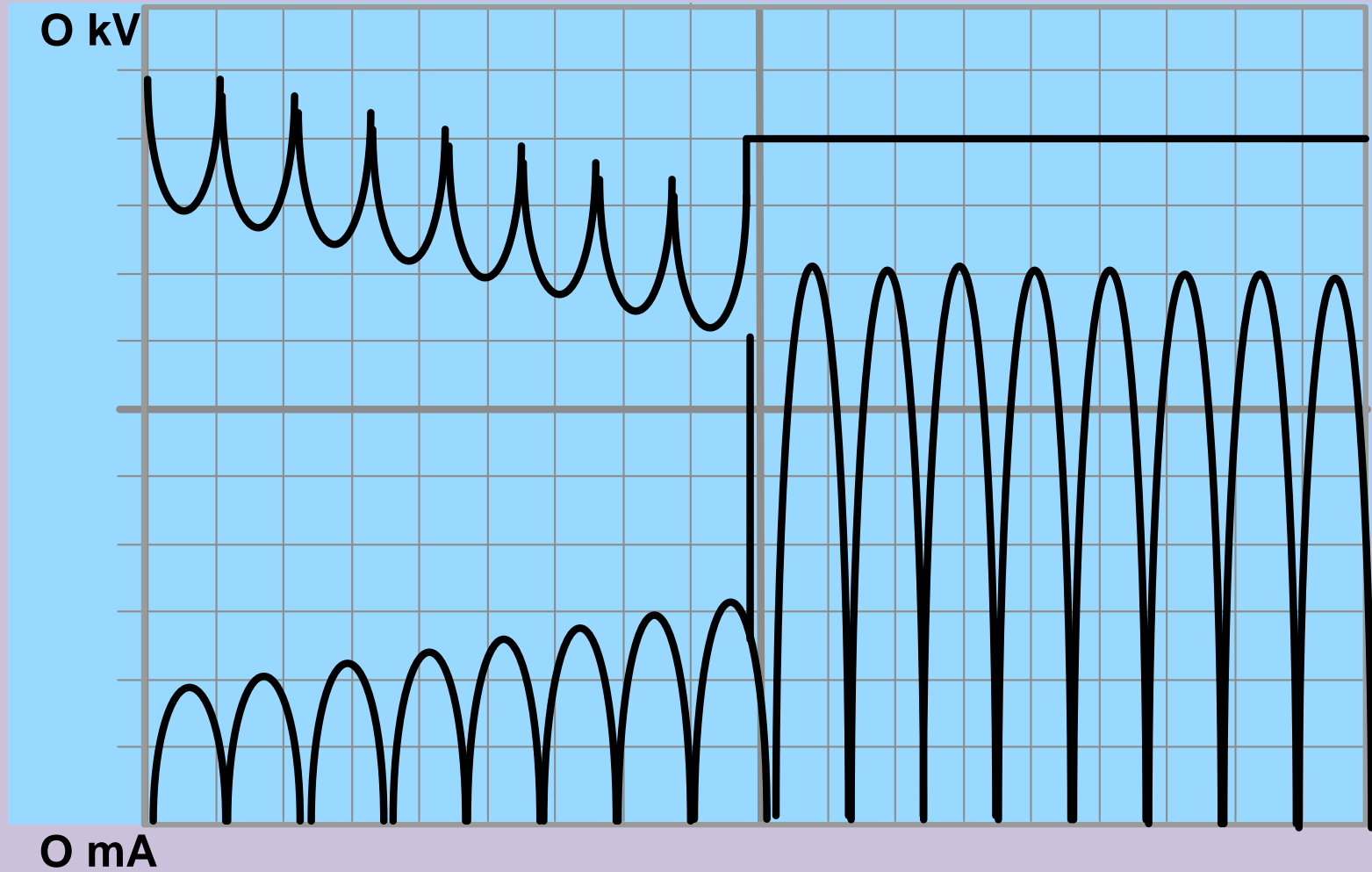


One Cycle Arc to Ground – No KW Registered

Arcing

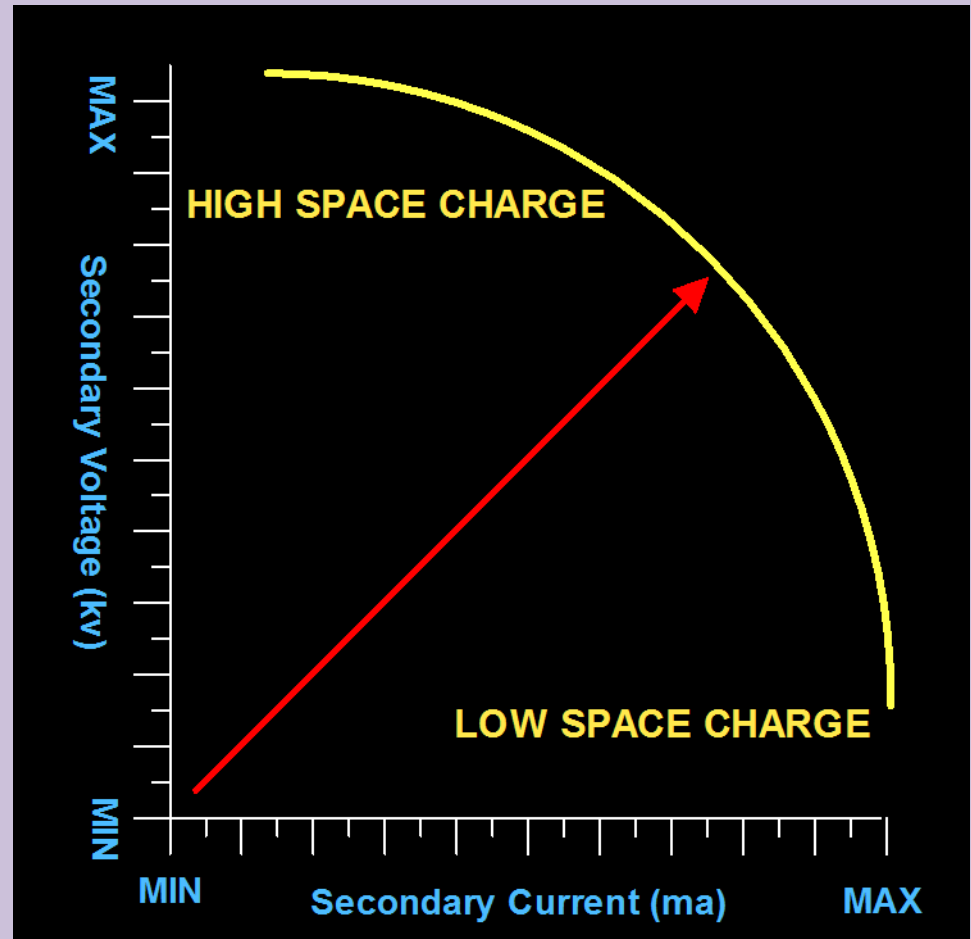


Arcing

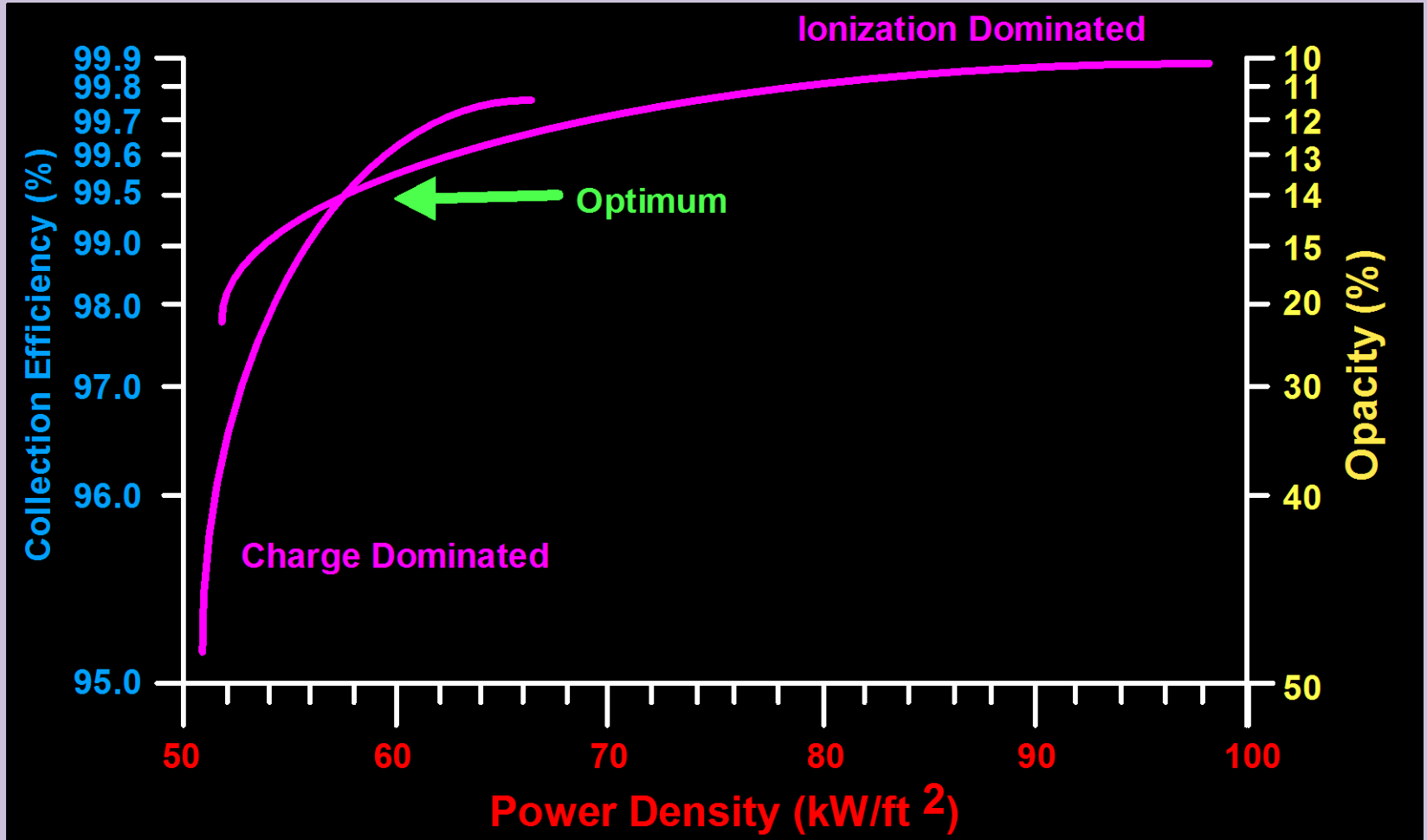


Gas Ionization

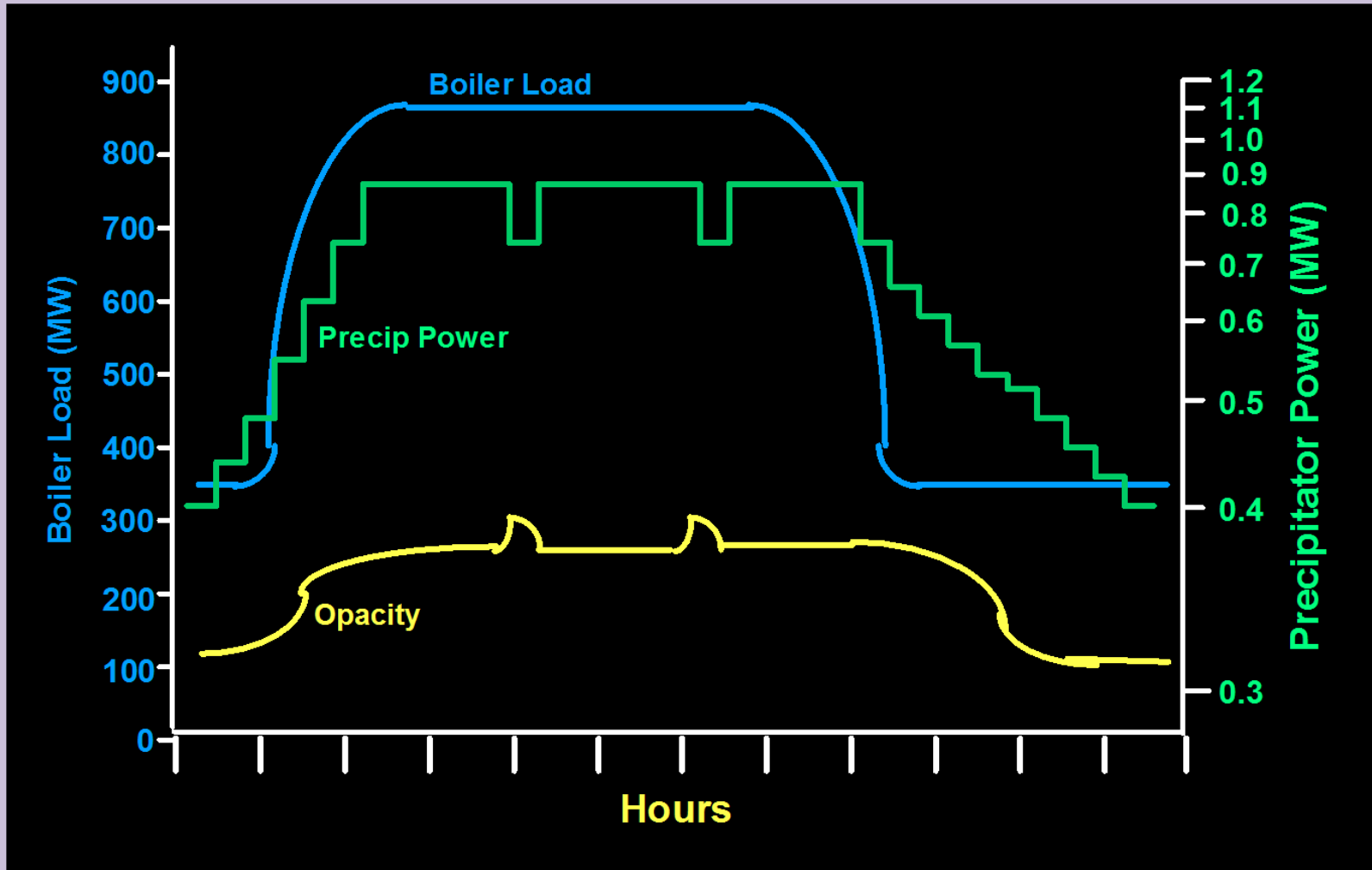
- Is a result of low space charge or particle density.
- Some is unavoidable to remove small particulate.



Gas Ionization



Gas Ionization



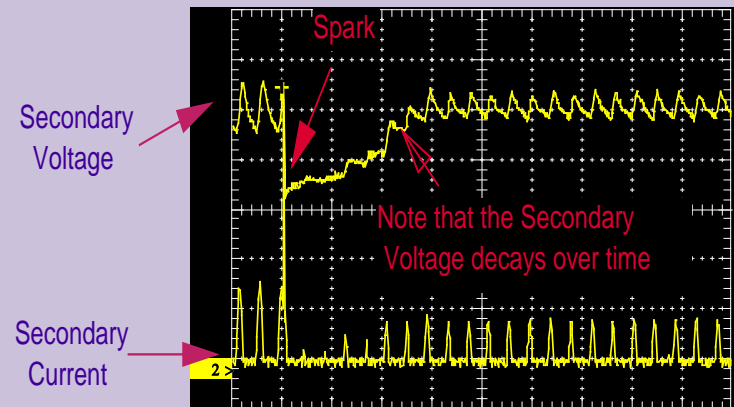
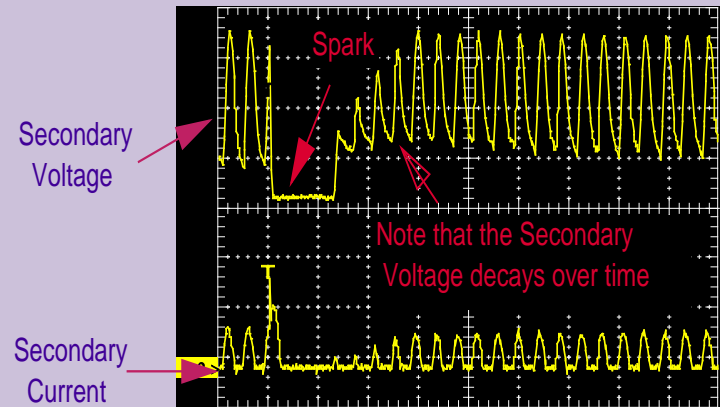
Using Energy Management to Balance Ionization

Back Ionization

Follow Russ Ridgeway's Advice in Detecting Back Corona

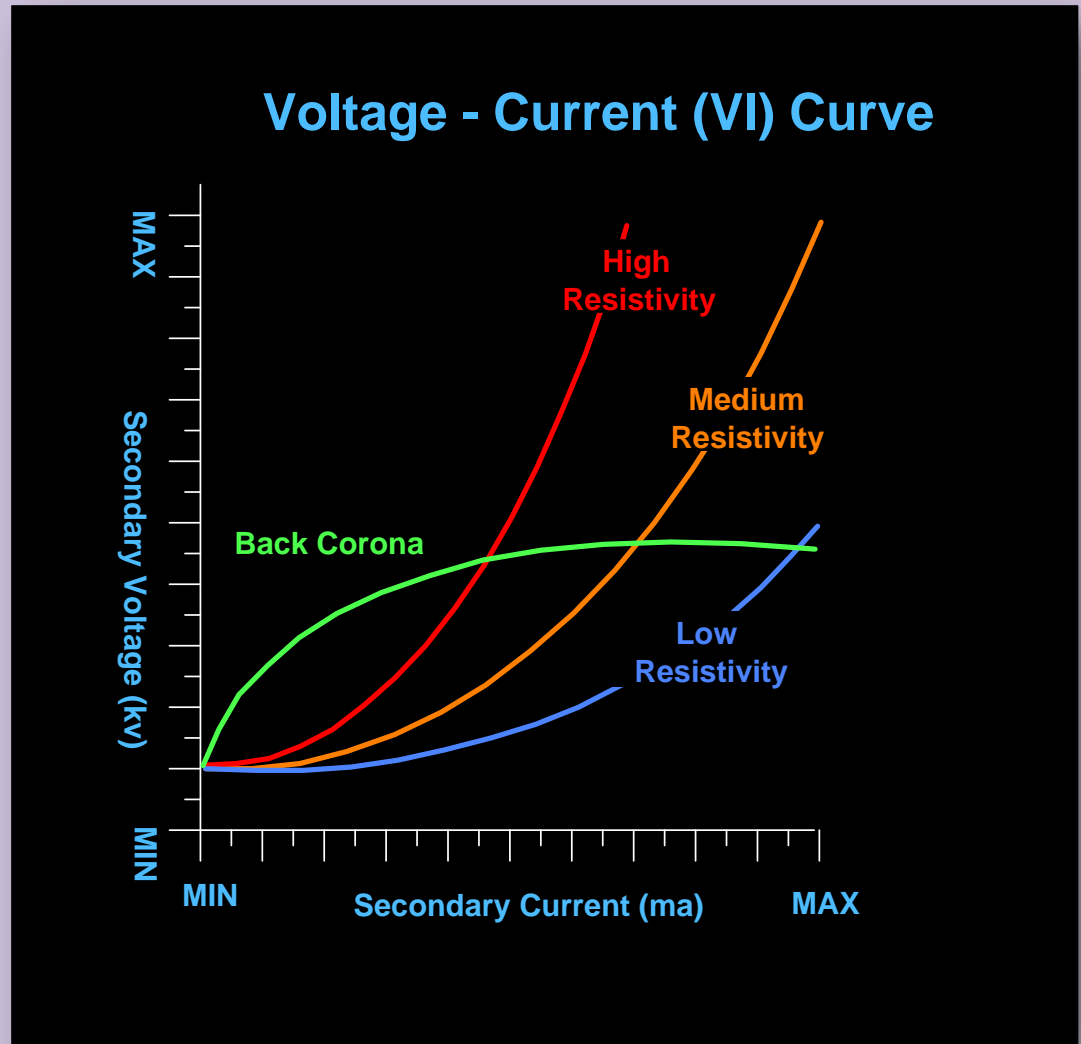
The two scope traces shown here also have signs of back corona. The upper trace has the classic decay in the trough of the KV signal indicating back corona. However it has a second symptom which is a spread between the peaks and troughs as time progresses. Both of the symptoms of back corona noted here are easily noted.

The lower scope trace is a little more difficult to observe the back corona symptoms. If one only looks at the post spark portion of the waveform, it is difficult to note the back corona. However if the steady state condition before the spark is evaluated, it can be seen that the spread between the peak and troughs have increased over time as well as the decay in the troughs. Both are signs that this bus section is in the early stages of back corona.



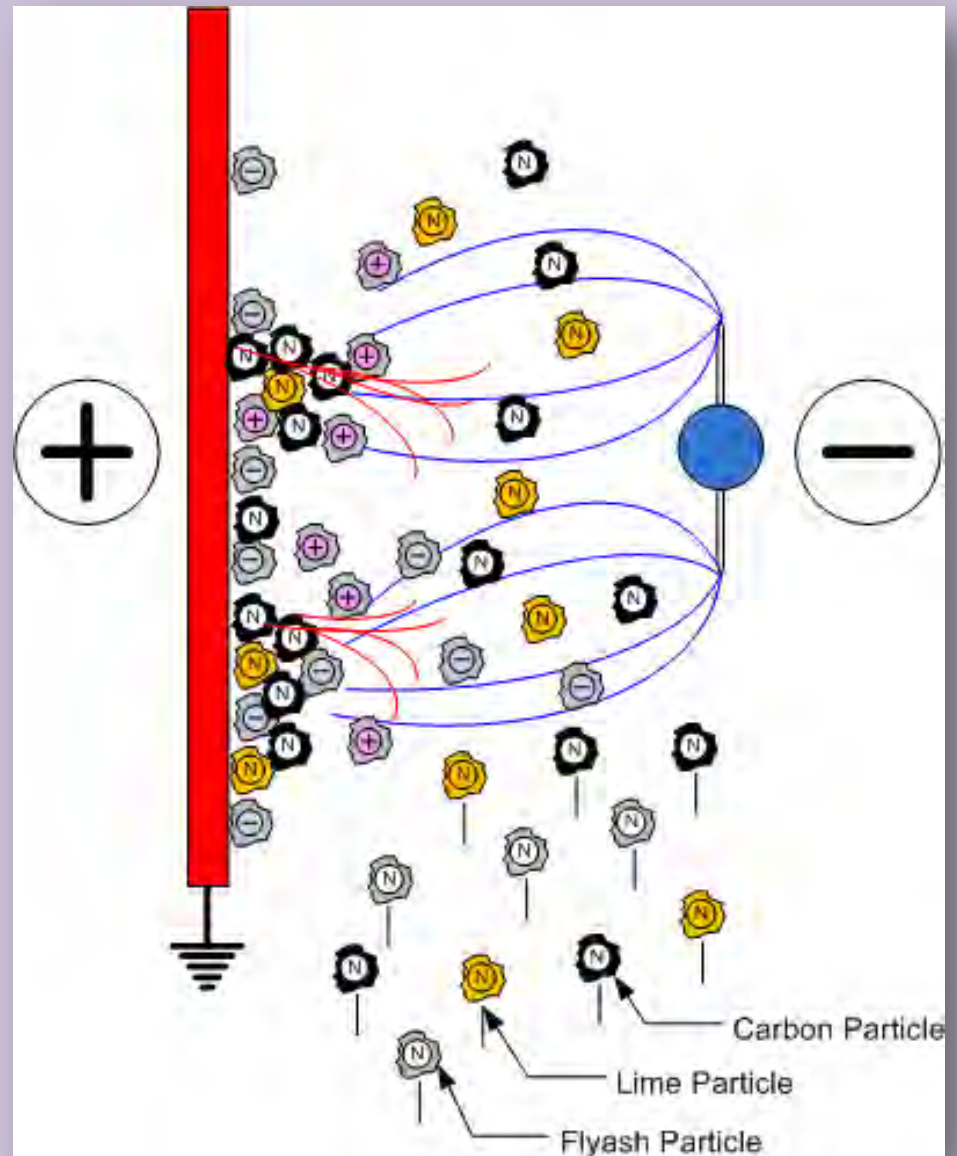
Back Ionization

- Serious degrees of back Corona can also be seen on VI Curves.



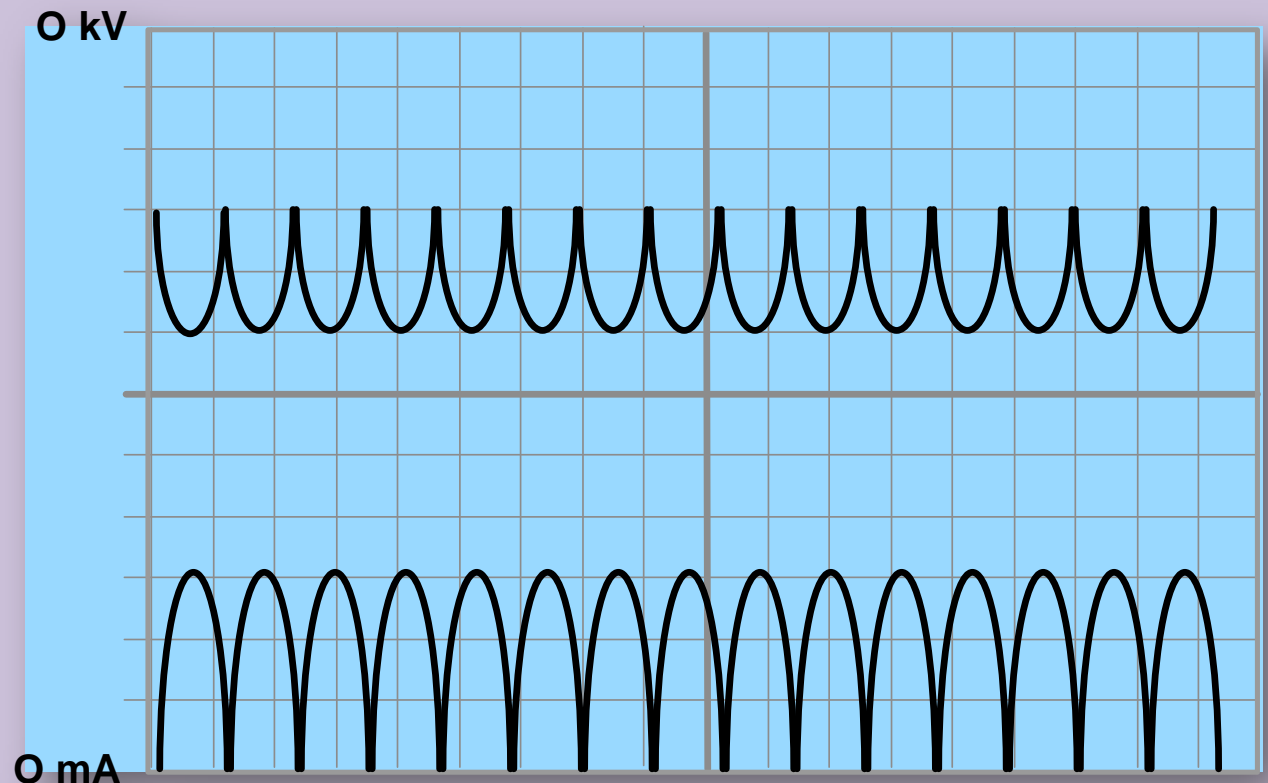
Back Ionization

- Dustcake makeup can also contribute to back corona when composed of widely differing bulk resistivities.
- May be undetectable by either waveform or VI diagnostic methods.



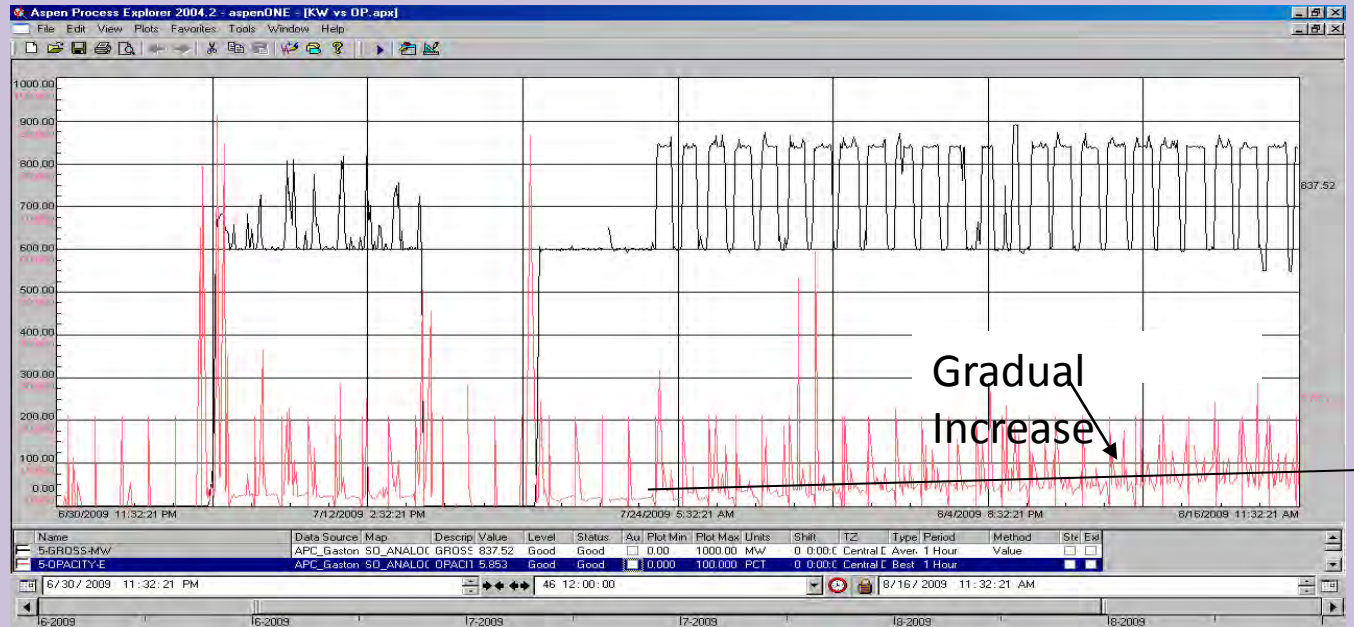
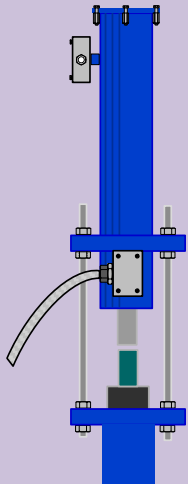
Back Ionization

- One solution may be to reduce power manually or by power savings means.



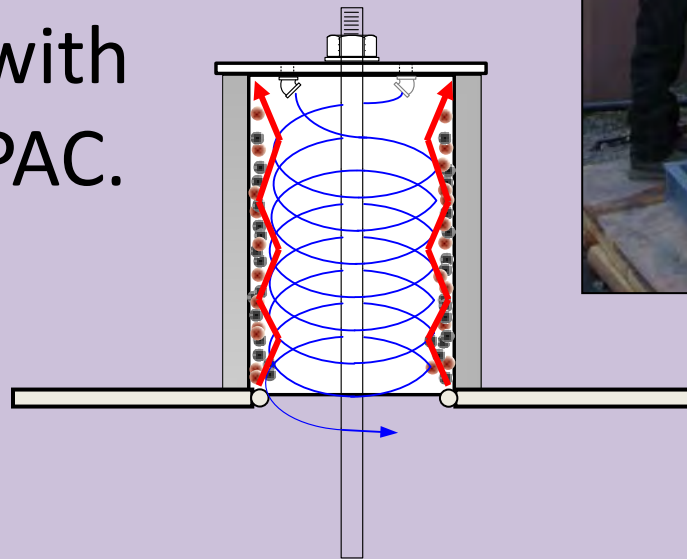
Back Ionization

- Another solution may be to optimize rapping



Leakage

- On support insulators heat and purge air are important.
- This is especially important with the use of PAC.



Leakage

- On stabilizer insulators, switching to long vertical shafts helps.
- In extreme cases the stabilizers may have to be removed entirely and the power operated at sub-sparking levels.



Thank You – Questions?

