

# Worldwide Pollution Control Association

FirstEnergy ESP Seminar  
November 27<sup>th</sup> – 28<sup>th</sup>, 2007

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# Understanding ESP Controls

Paul Ford, Redkoh Industries

First Energy

Akron, 2007



DESIGNED AND MANUFACTURED  
BY  
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AC SUPPLY		DC LOAD / TR RATING	
VOLTAGE	480V	VOLTAGE	65 KV
AMPERES	256A	AMPERES	1250MA
FREQUENCY	60 Hz		
PHASES	1PH		
AMB TEMP	45°C		

# What function does an ESP Power Supply fulfill

It provides a source of High Voltage DC to the discharge electrodes in an electrostatic precipitator.



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# What function does an ESP Control System fulfill

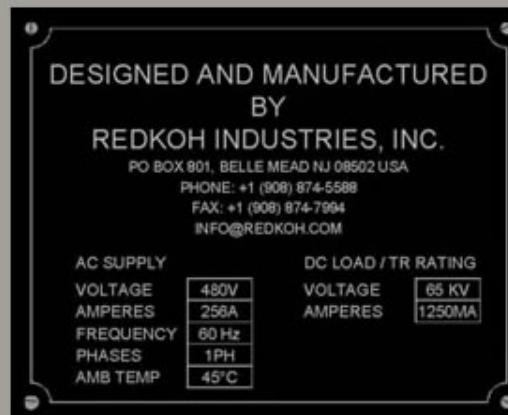
- To monitor and maximize the voltage and to ensure the minimum particulate emissions under all operating conditions
- A number of discrete devices working concurrently and in conjunction with one another to maximize the performance and efficiency of an Electrostatic Precipitator



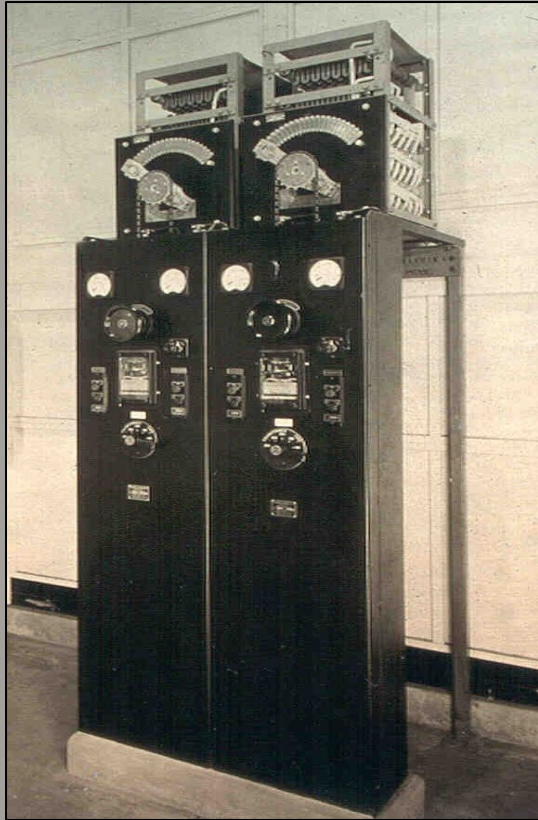
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# What are the most typical parts that make up an ESP Control System

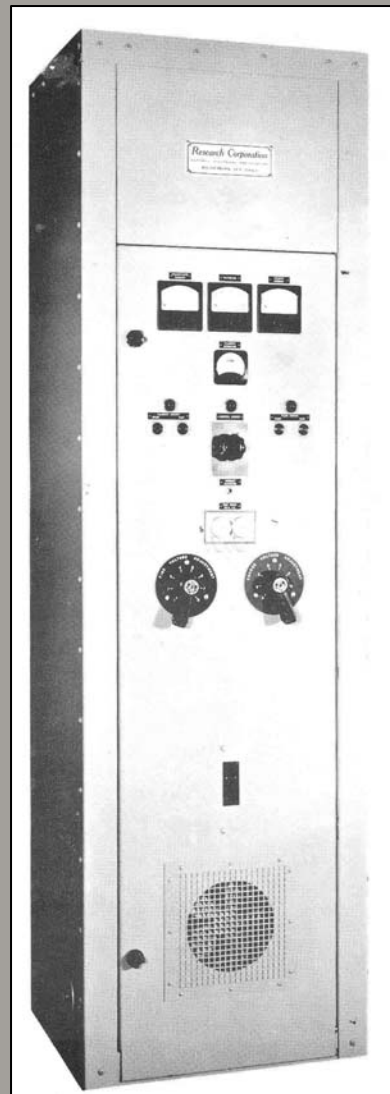
- TR Controllers
- TR Set / CLR's
- Rapper Controllers
  - Impact
  - Tumble Hammers
- Opacity Monitors
- Ash Handling
- Soot Blowing



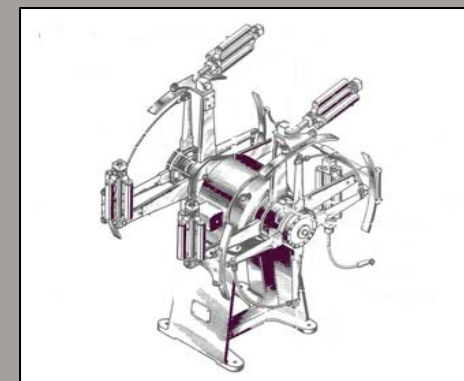
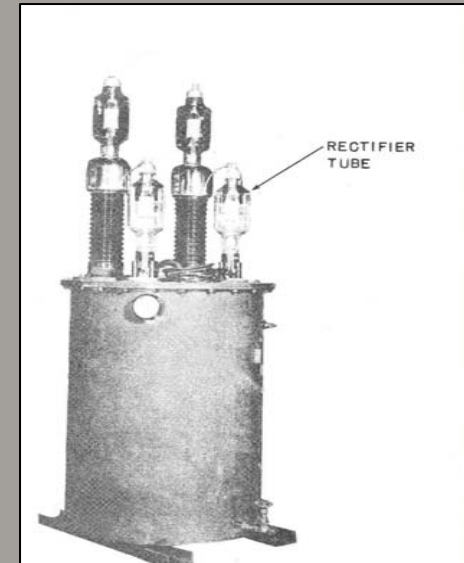
# How did they achieve this way back then!



Variac and saturable core reactor systems

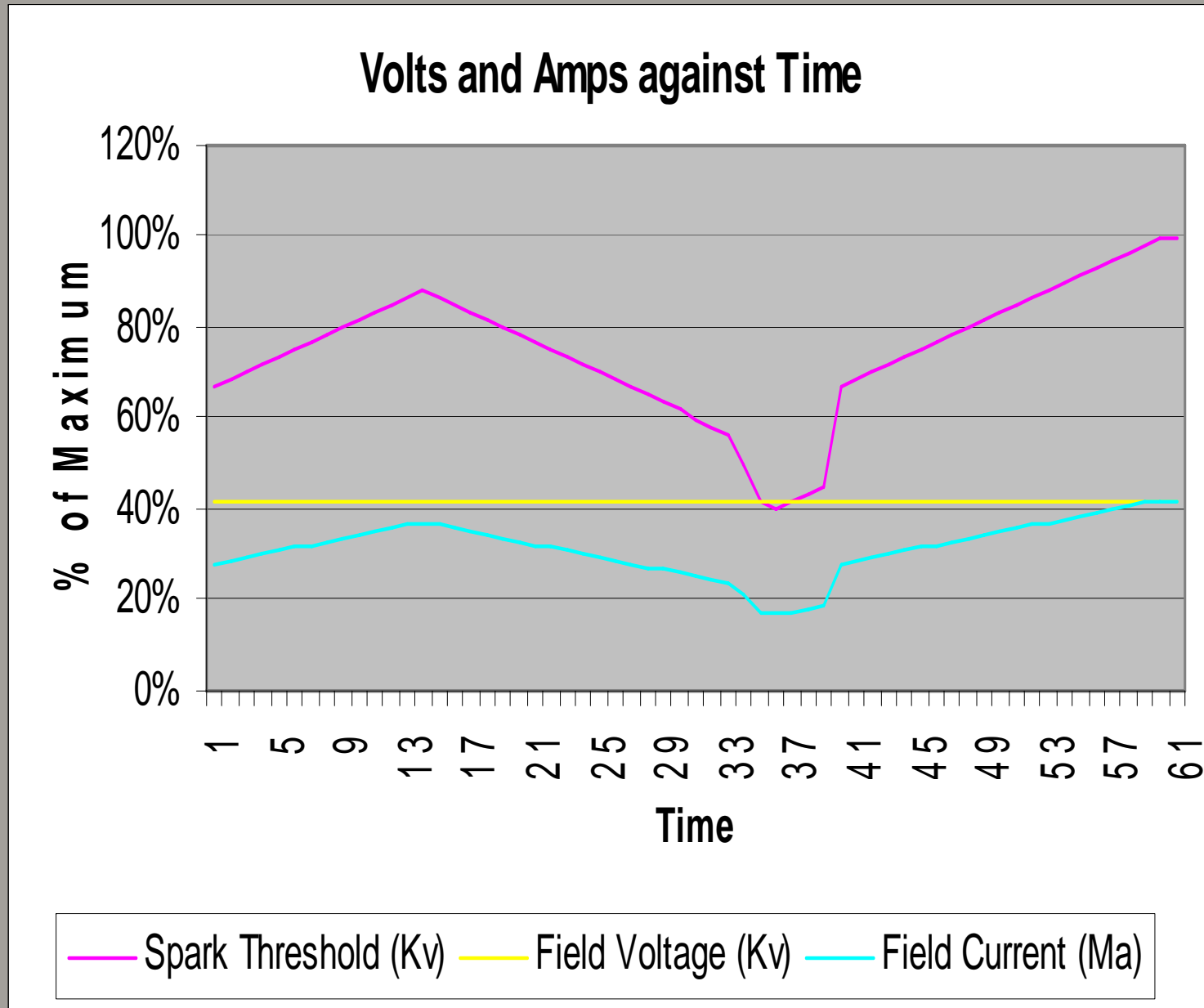


Tube Rectifiers



Rotary Rectifiers

# What is a poorly controlled precipitator



# How do we achieve this today



We use Modern Switchgear  
With Microprocessor controllers



# How do we achieve this today

We use Silicon Controlled Rectifiers (SCR)

**Puck and Stud  
SCRs**



**REDKOH**  
**Module Style  
SCRs**



**IGBTs**



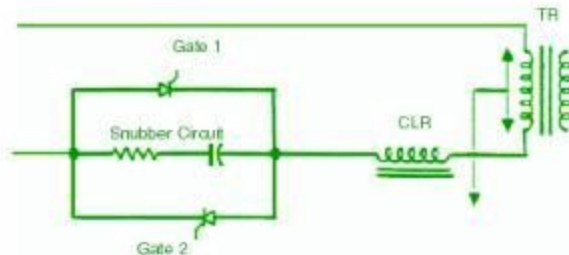
July 6, 2007

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# How do we achieve this today

## CLR

### Current Limiting Reactor



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

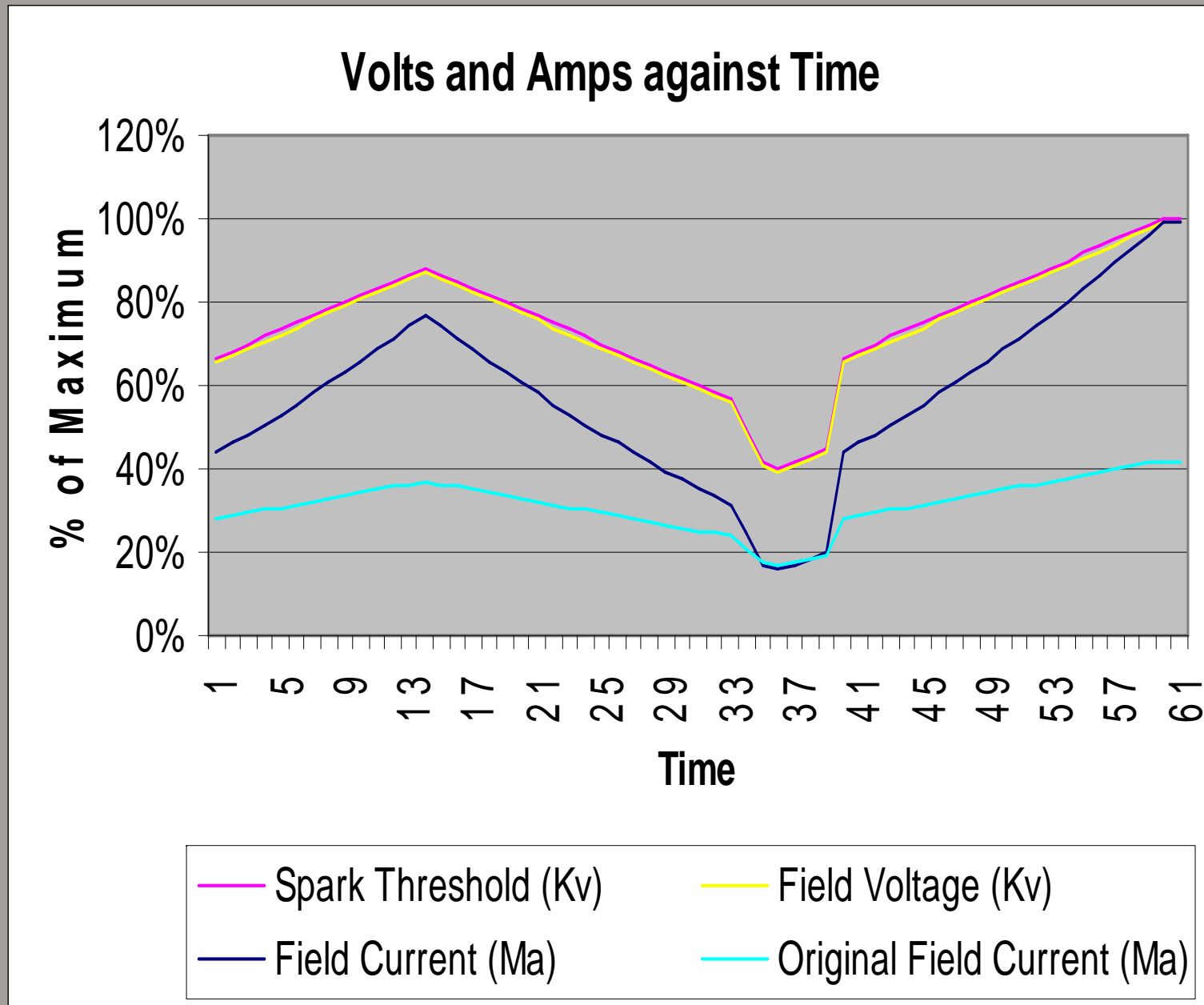
We use Current Limiting Reactors that may be designed with taps to help impedance matching

# How do we achieve this today

Conventional Transformer Rectifiers have not changed much over the years with the exception of improved silicon diodes, high voltage dividers and safer insulation fluids



# What is a well controlled precipitator

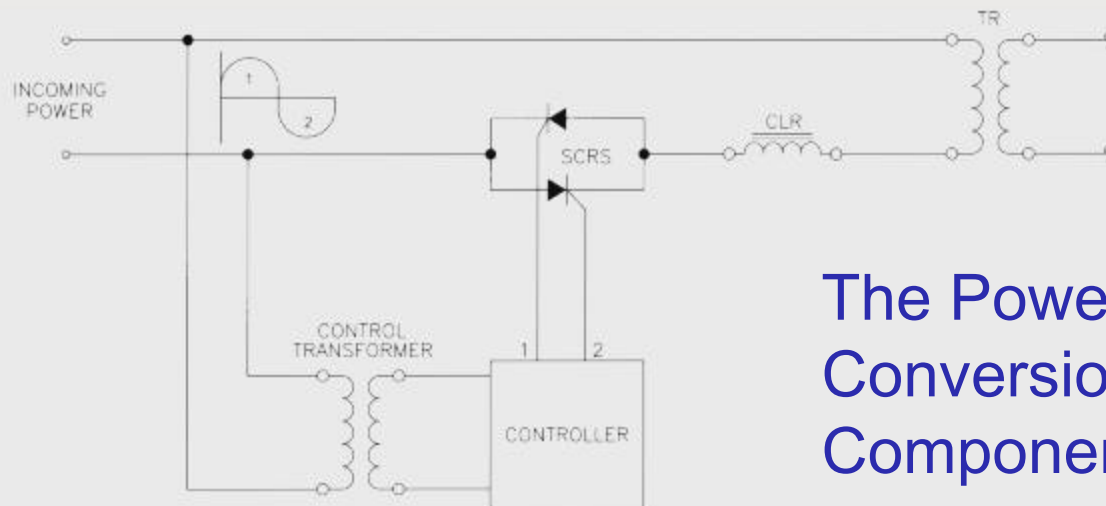
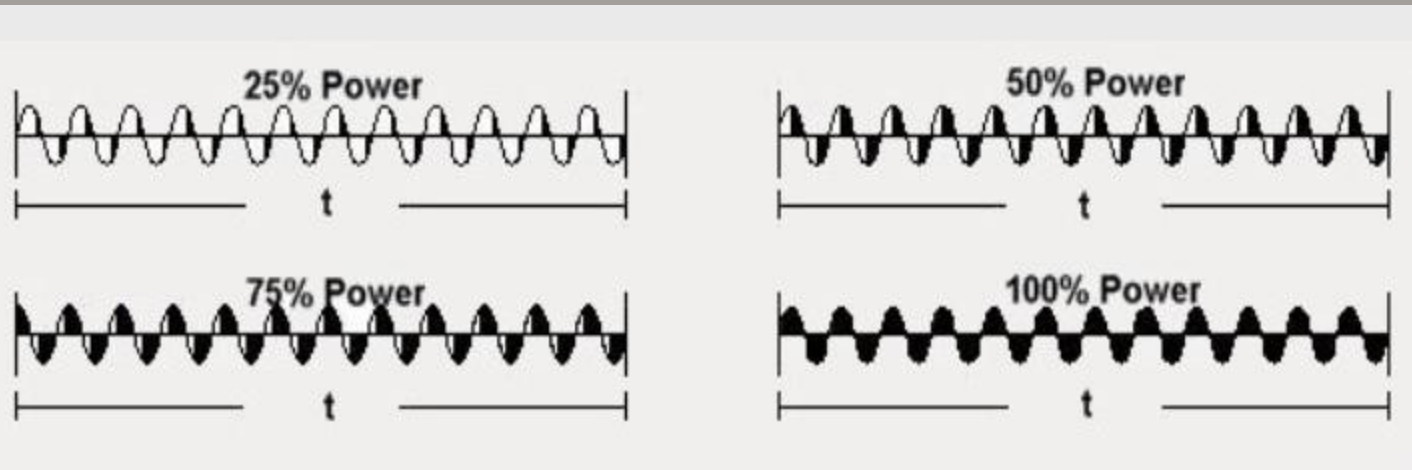


# What Parts Make Up The TR Control System

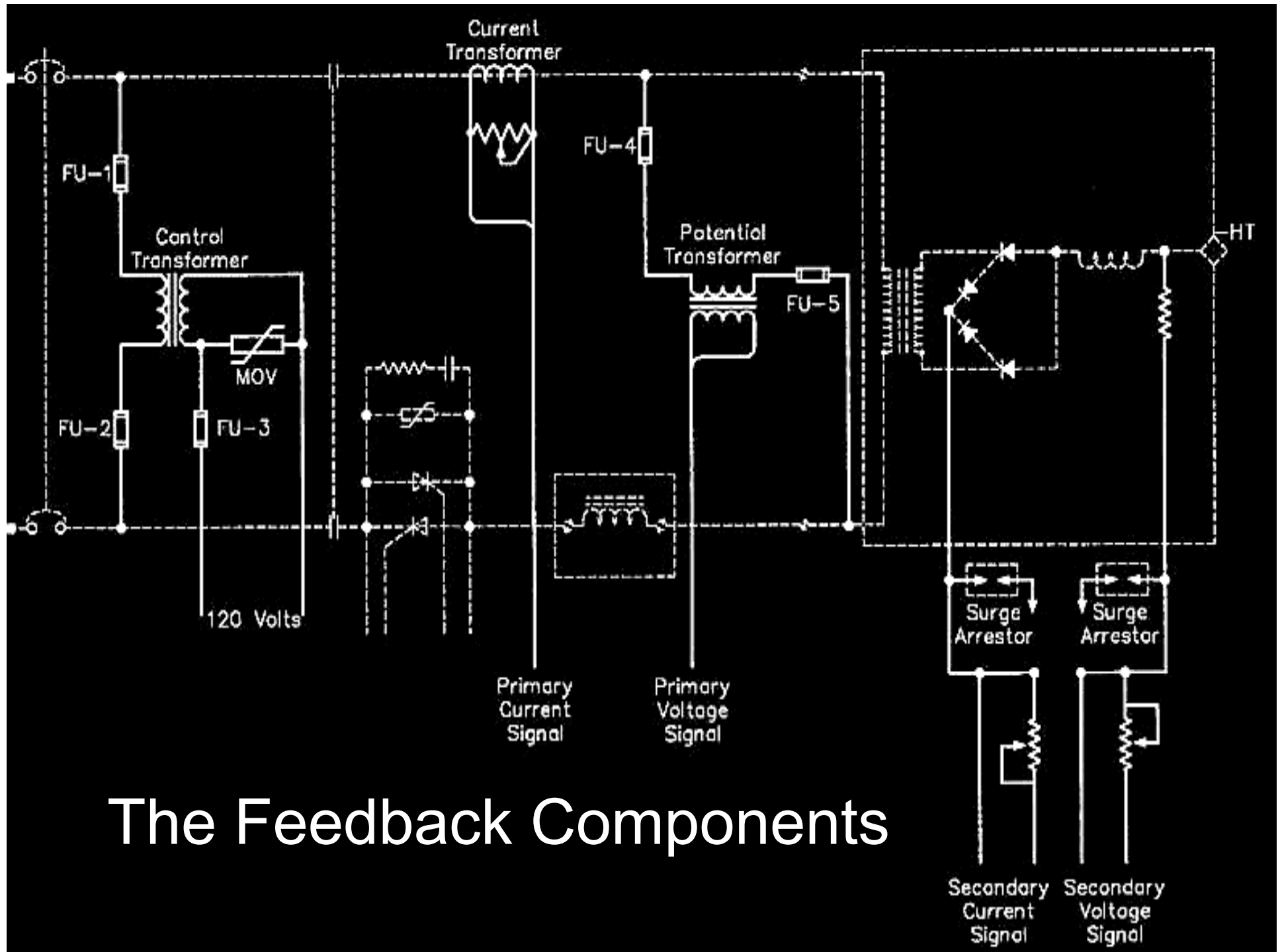
- Switchgear Section
- The Power Conversion Section
- The Feedback and Monitoring Components
- The Automatic Voltage Controller
- The HMI
- The Communications System



# How do the individual parts of the TR Control System fit together

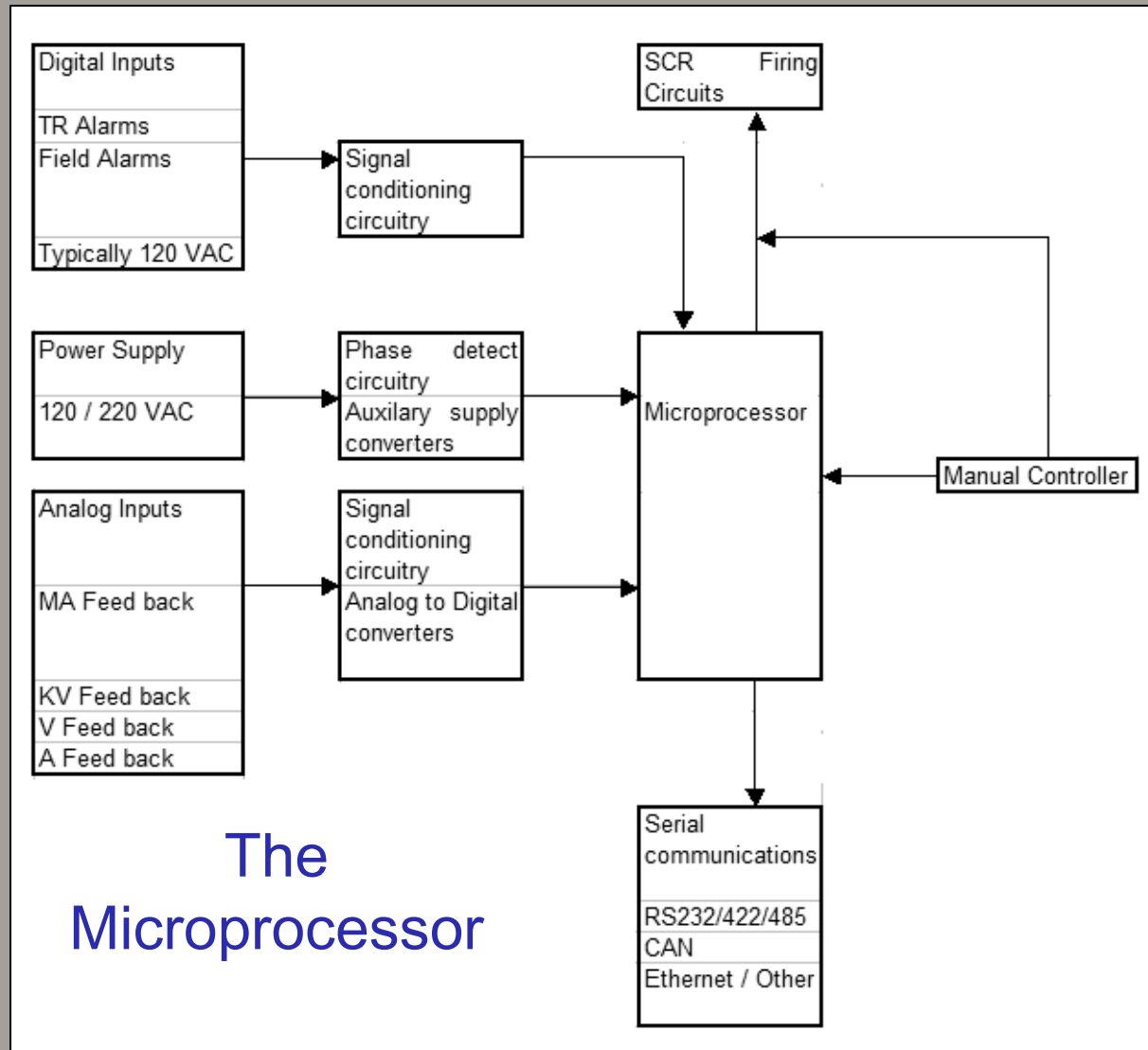


The Power  
Conversion  
Components

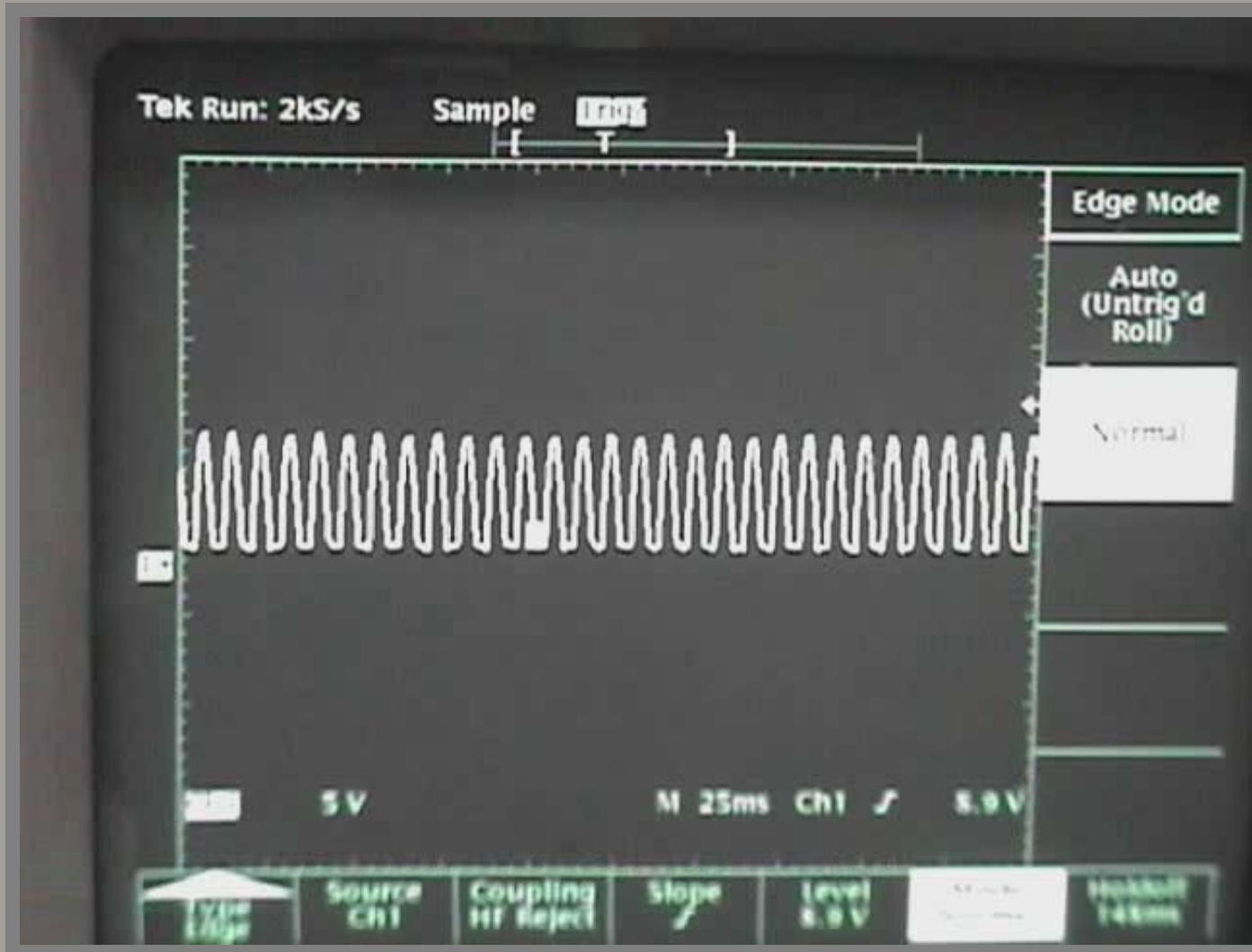


# The Feedback Components

# The Automatic Voltage Controller

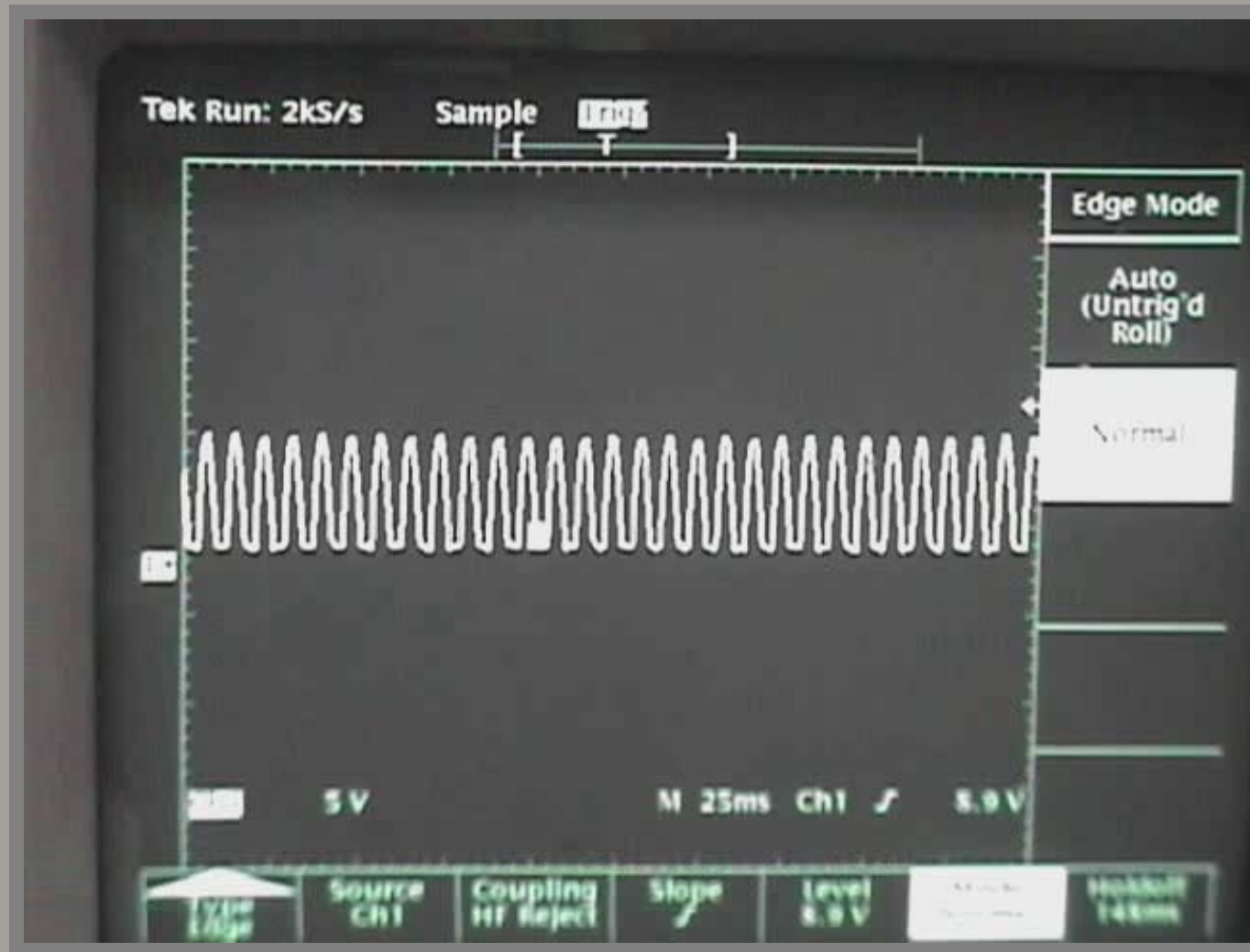


# Scope signal showing genuine spark



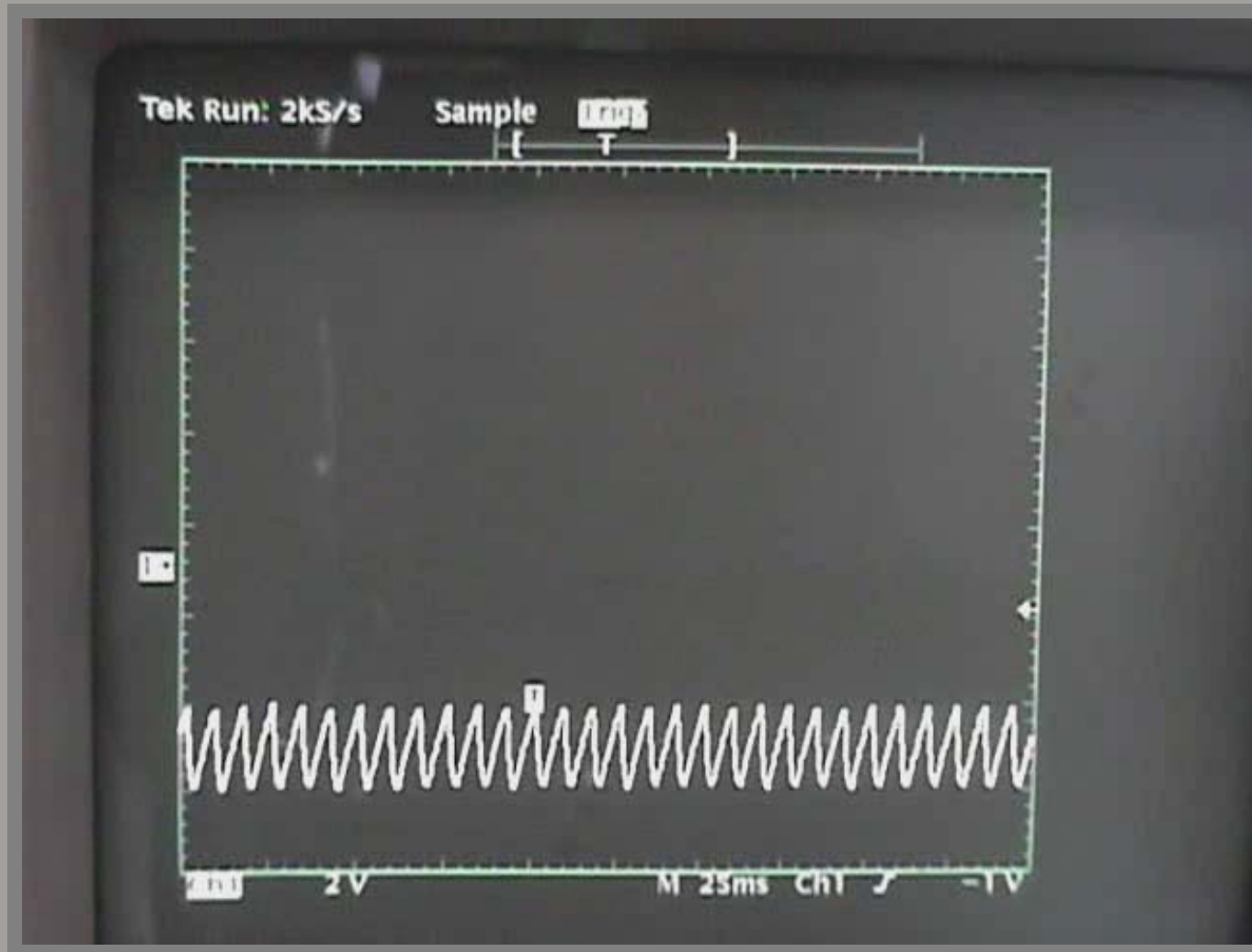
Scope is monitoring ESP Current

# Scope signal showing false spark



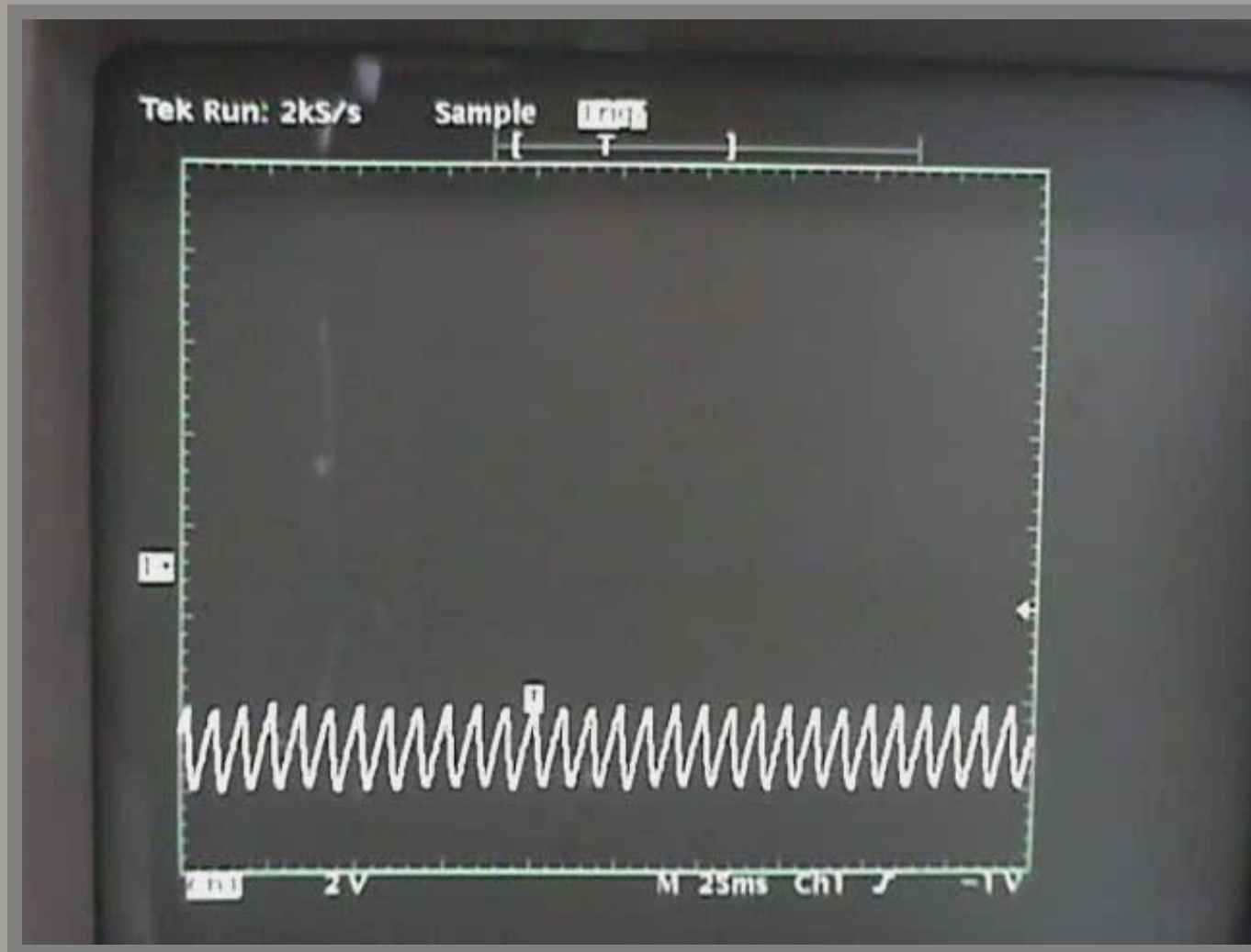
Scope is monitoring ESP Current

# Scope signal showing genuine spark



Scope is monitoring ESP Voltage

# Scope signal showing false spark



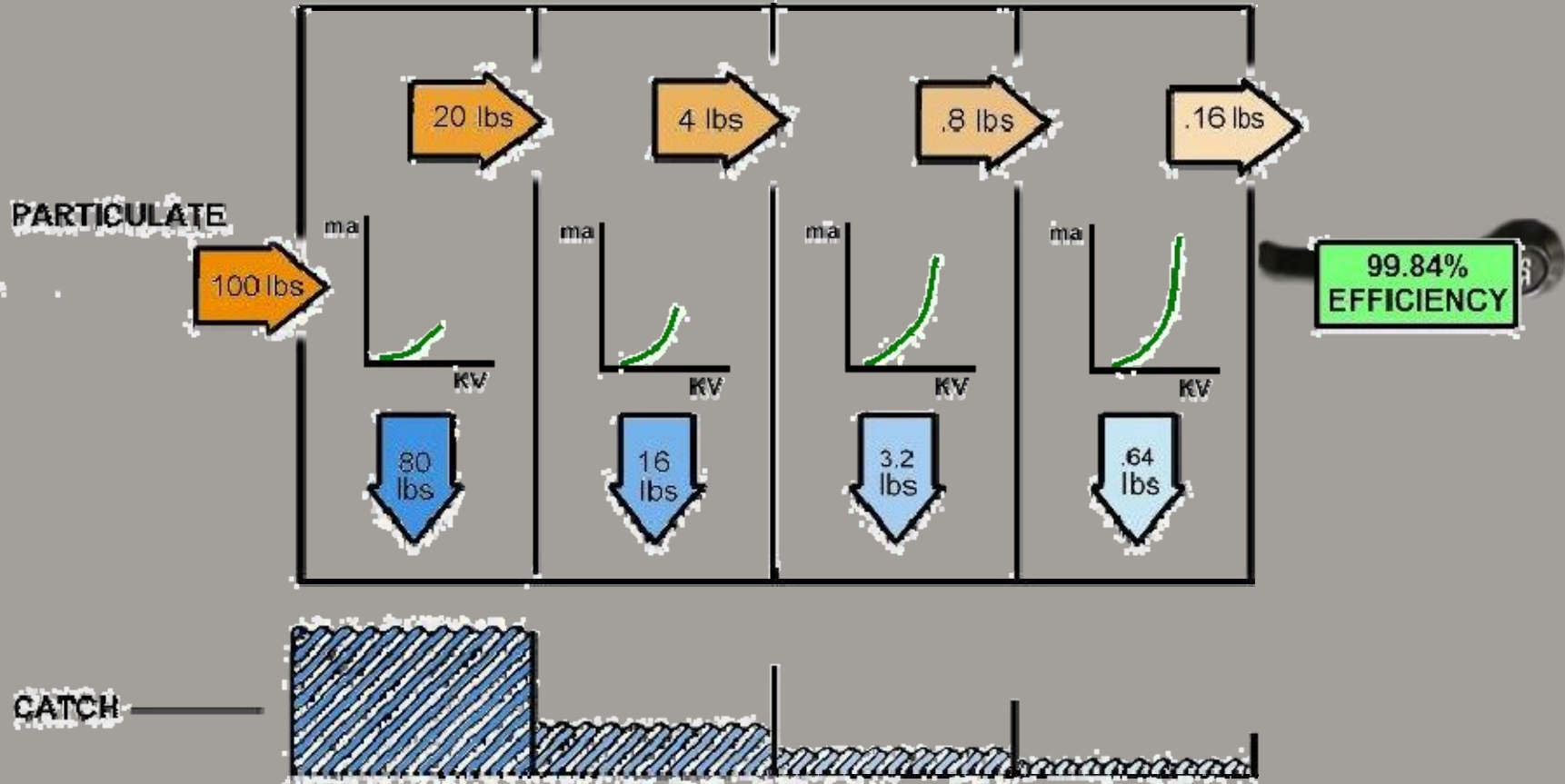
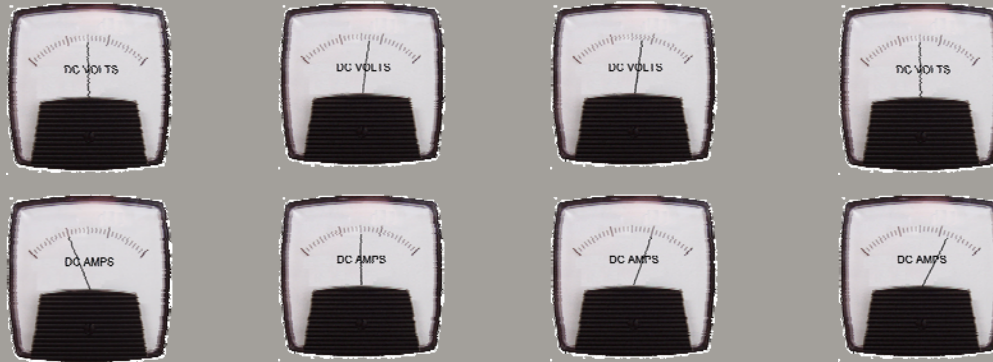
Scope is monitoring ESP Voltage

# Tasks The Controls Must Perform

- Control and Protect the Switchgear
- Control the SCRs
- Detect and respond to all the Sparks and Arcs
- Monitor the Transformer Rectifier and CLR
- Provide Alternate methods of Energization
- Be capable of responding to different application requirements
- Supply the user with information on all facets of the operation
- Supply the Plant IT systems with the supporting data required for EPA and QA



# Typical Power Distribution



# Reasons To Keep Your Controls Up To Date

- Stricter enforcement of the Clean Air Act
- Greater flexibility in fuel purchase/process operation
- Need for remote control/data acquisition
- Reduce energy usage and cost
- Standardization of controls
- Controls are old and unreliable
- Obsolescence

