REINHOLD ENVIRONMENTAL ®

2026 Reinhold/PCUG Round Table Presentation

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to the next power

ESP Electrical Operation & Maintenance Reinhold Roundtable 2026

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Objective

- The purpose of this presentation is to provide practical guidance on the operation and maintenance of ESP electrical systems by discussing:
  - Electrical fundamentals that impact ESP performance
  - Common operating and maintenance challenges
  - Electrical assessment techniques
  - Aging equipment and modernization considerations

Electrical Inspections: The Other Half of ESP Maintenance

Mechanical inspections are well understood and widely practiced.

Effective ESP maintenance requires both mechanical and electrical inspections.

Mechanical

- ✓ Plates
- ✓ Electrodes
- ✓ Rappers
- ✓ Hoppers
- ✓ Gas Distribution
- ✓ Internals

Electrical

- ✓ Power Supplies
- ✓ Controls
- ✓ Grounding
- ✓ Calibration
- ✓ Performance Data
- ✓ V-I Curves

What Should Be Included in an Electrical Inspection?

Equipment Condition

- Cabinet cleanliness
- Loose or overheated connections
- Cooling fans and filters
- Grounding system
- High voltage cables
- Insulators and junction boxes

Electrical Performance

- Controller alarms and diagnostics
- Calibration verification
- Oil analysis results
- V-I curves
- Waveform review
- Operating data trends

An effective electrical inspection includes both equipment condition and operating performance.

Electrical Problems Are Often Hidden

Mechanical Problems

- Usually visible
- Can often be identified during an outage inspection

Electrical Problems

- Often hidden from view
- Require testing, measurements, and data analysis
- May remain hidden until performance or reliability is affected

Common Electrical Inspection Findings

- Overheated connections
- Failed or improperly sized CLR
- Oil contamination and insulation aging
- Grounding deficiencies
- Calibration drift
- Feedback signal issues
- Obsolete controllers and limited spare parts

Tools Used in an Electrical Inspection

Visual Inspection

- Cabinet condition
- Connections
- Grounding
- Cooling systems
- Thermal imaging

Testing & Measurements

- Oil analysis
- Calibration checks
- Waveform review
- Voltage and current measurements

Performance Assessment

- V-I curves
- Spark rates
- Operating trends
- Alarm history

Effective electrical inspections combine visual observations, testing and measurements, and performance assessment.

Deutsch-Anderson Equation

$$\eta = 1 - e^{\left\{-\left(\frac{Aw}{Q}\right)\right\}}$$

η = Collection Efficiency
w = Particle Migration Velocity
A = Collecting Plate Area
Q = Gas Flow Rate

Why Voltage (KV) Matters

Particle-Migration Velocity

$$w = \frac{(d_p E_o E_p)}{4\pi\mu}$$

$d_p = \ diameter\ of\ the\ particle, \mu m$

$E_o = \ strength\ of\ field\ in\ which\ particles\ are\ charged$
$(represented\ by\ peak\ voltage), V/ft$

$E_p = \ strength\ of\ field\ in\ which\ particles\ are\ collected$
$(normally\ the\ field\ close\ to\ the\ collecting\ plates), V/ft$

$\mu = \ gas\ viscosity, Pa \bullet s\ (cp)$

$\pi = 3.14$

Voltage (KV) is King

Indicators of Good Electrical Operation

Good Indicators

- Stable voltage
- Expected spark rate
- Repeatable V-I curve
- Consistent electrical progression through the ESP
- Minimal alarms and trips
- Stable voltage and current control

Warning Signs

- Reduced operating voltage
- Excessive or erratic sparking
- Sudden changes in V-I curve shape
- Recurring alarms or trips
- Unexplained performance changes
- Significant differences between similar fields

Changes in **operating data** often provide the **earliest indication** of developing electrical problems.

Why V-I Curves Matter

Performance Assessment

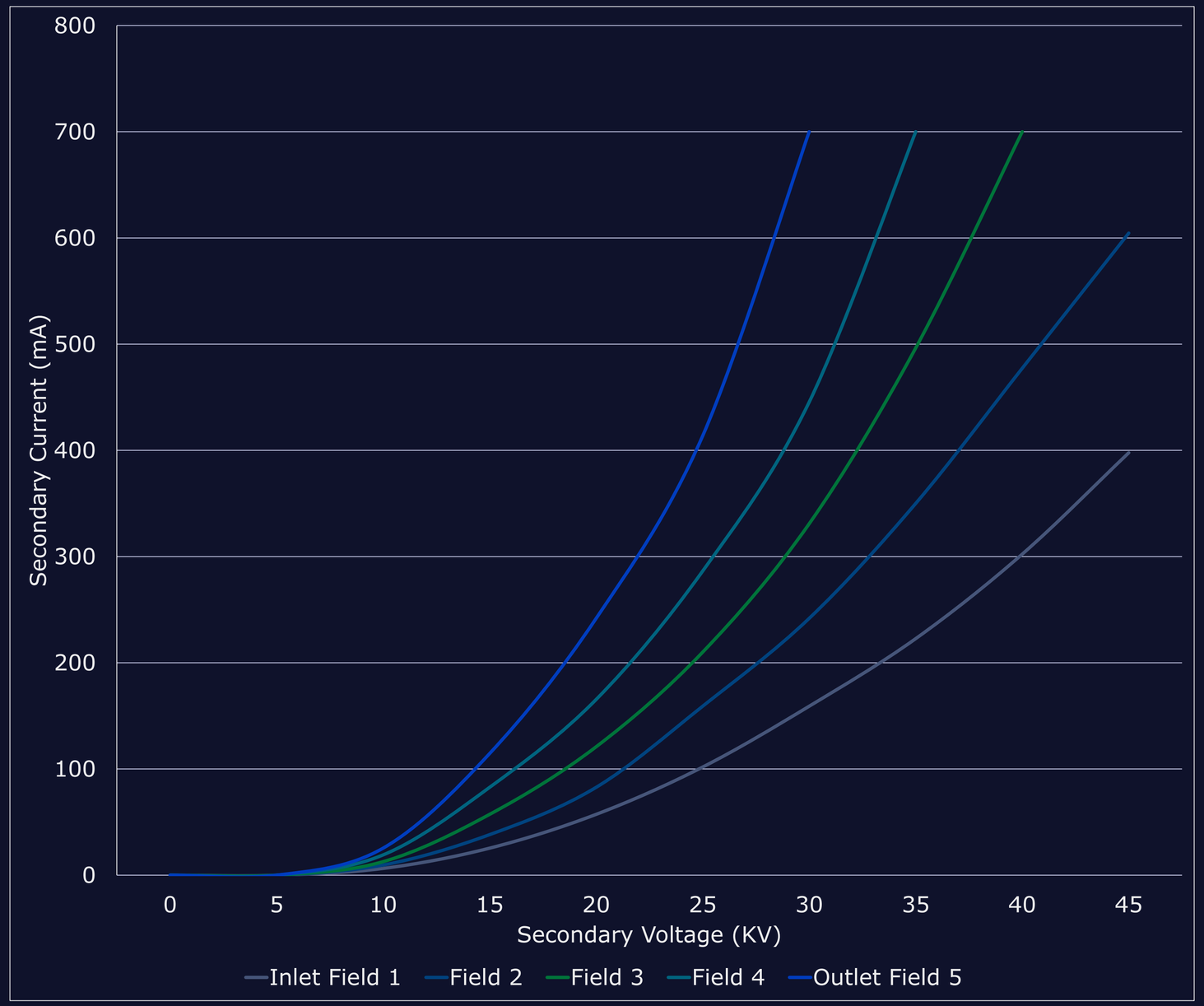
- Establish a performance baseline
- Compare similar fields and gas paths
- Track changes over time

Troubleshooting & Maintenance

- Identify electrical limitations
- Support troubleshooting efforts

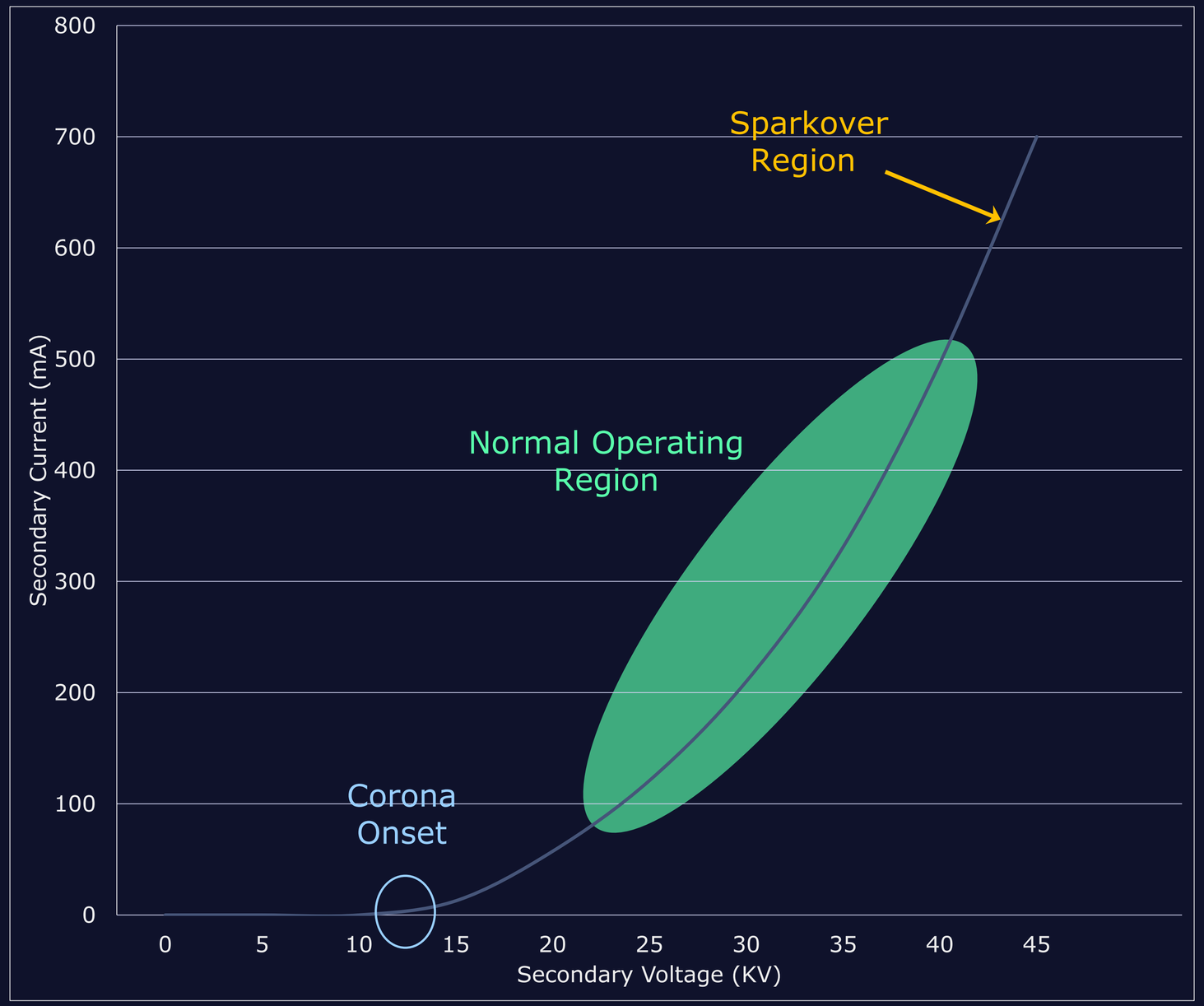
V-I curves are one of the most valuable diagnostic tools available for assessing ESP electrical performance.

Voltage vs Current Relationship (V-I Curves)



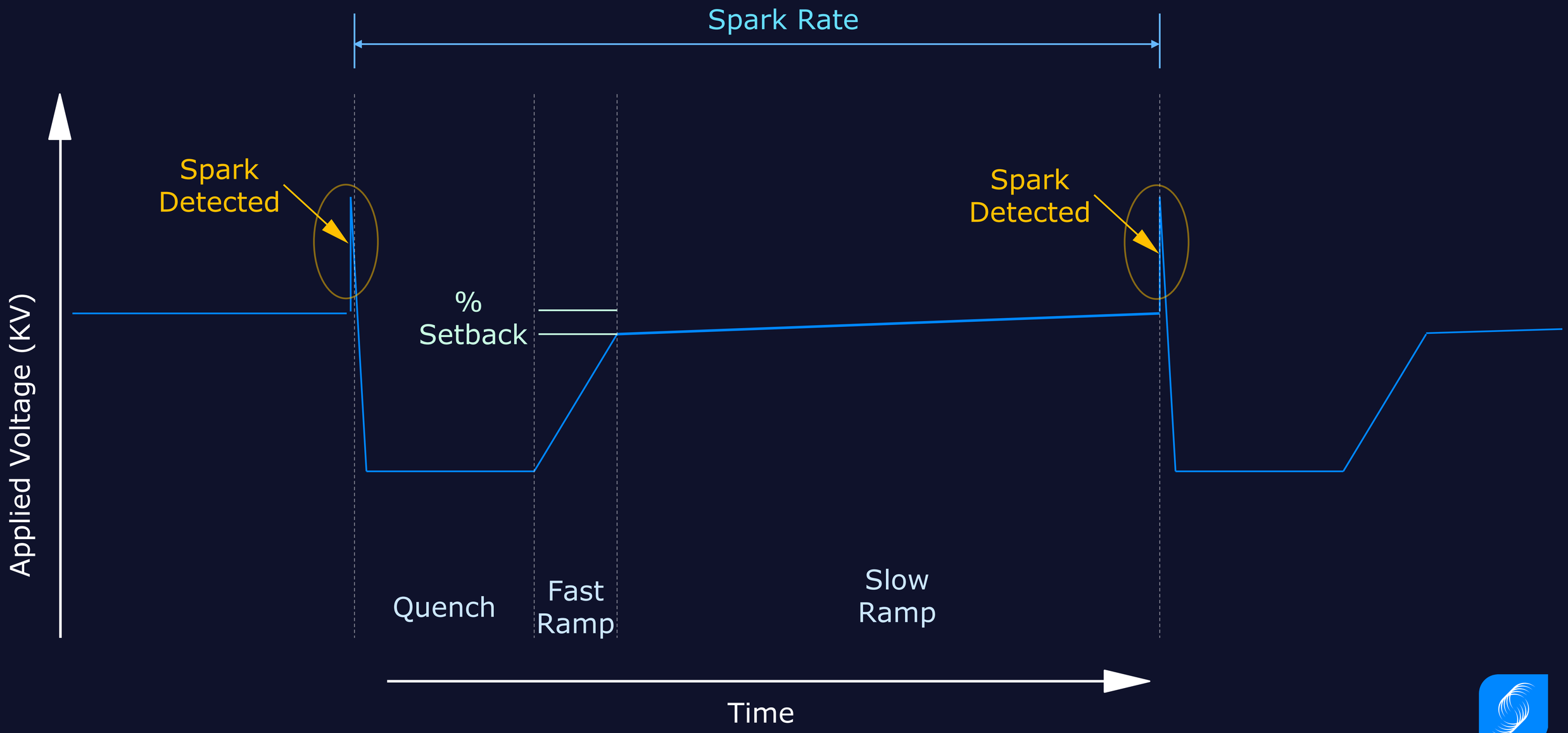
- Inlet fields typically operate at **higher voltage** with lower current
- Inlet fields are commonly **spark-limited**
- Outlet fields often operate near **current limit** with minimal sparking

Sparkover Region

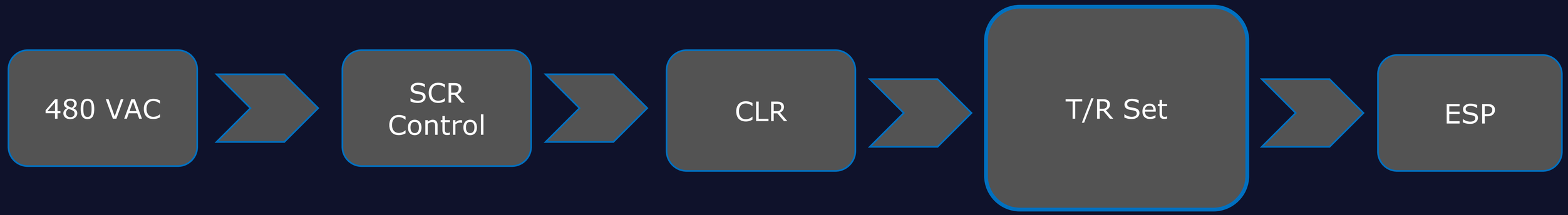


- Sparkover occurs when electrical breakdown happens in the gas path
- ESP controls maximize voltage while limiting excessive sparking
- Some spark activity is **normal and expected**

Spark Response

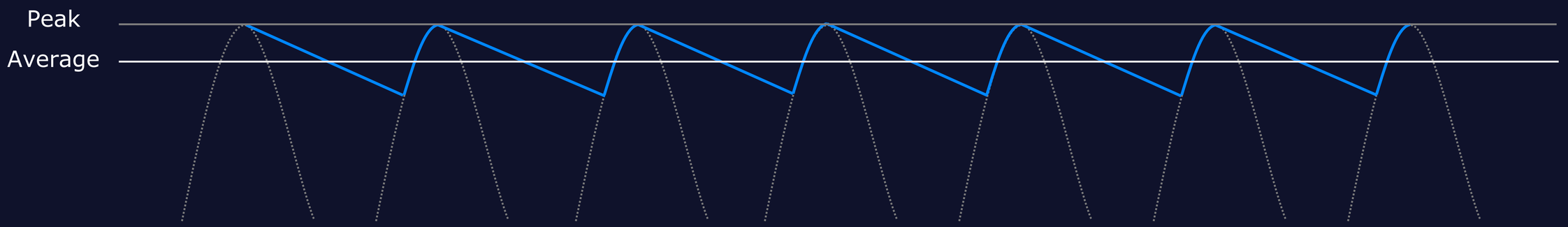


Conventional 60 Hz T/R Set



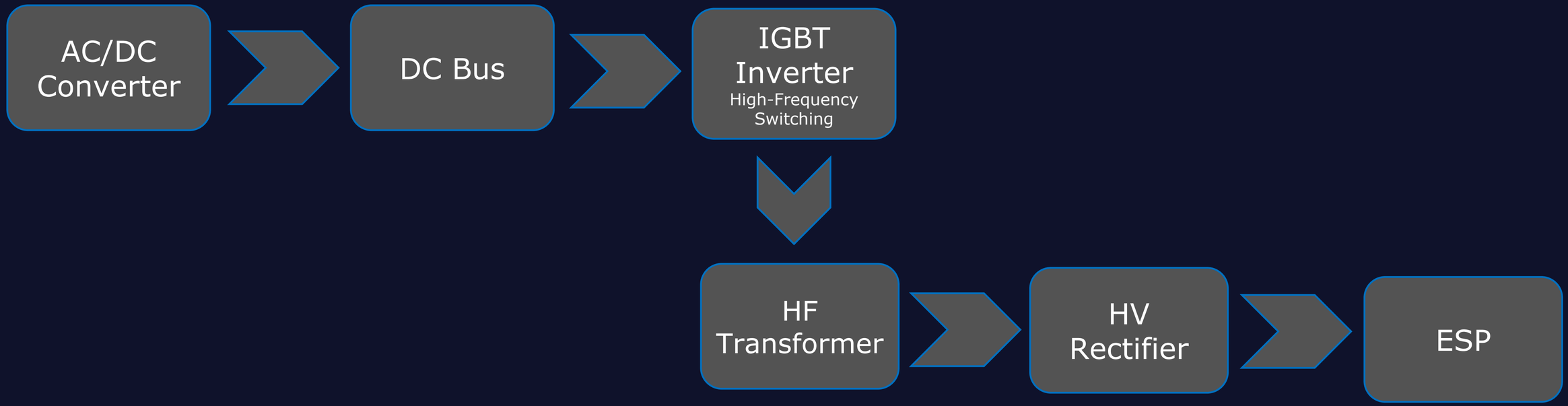
SCR phase-angle control regulates the voltage applied to the ESP.

Conventional T/R Set Output Ripple



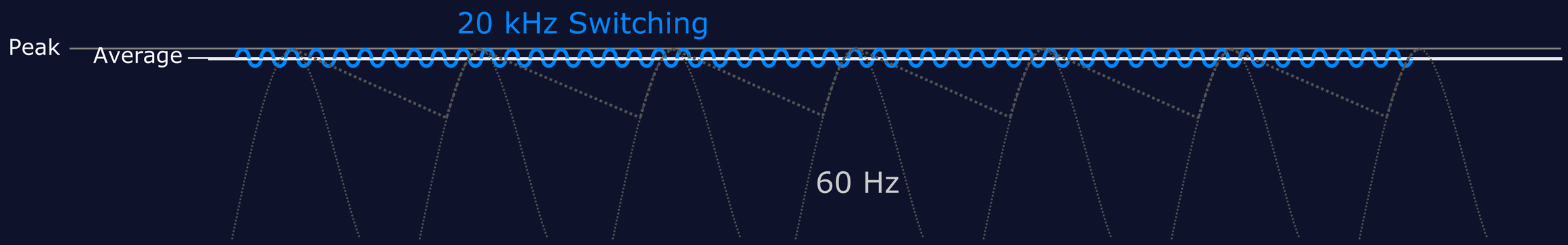
Higher ripple reduces the average voltage applied to the ESP.

SMPS Power Supply



High-frequency switching reduces output ripple and improves ESP performance.

SMPS Reduced Ripple



Reduced ripple allows higher average operating voltage.

Conventional T/R vs SMPS

Conventional 60 Hz T/R	SMPS
• Higher output ripple	• Reduced output ripple
• Lower average KV • Lower collection efficiency	• Higher average KV • Improved collection efficiency
• Larger transformer design • Separate Control Cabinet	• Compact integrated design
• Slower recovery time	• Faster recovery time
• 60 Hz operation	• 20 kHz switching

Key Takeaways

- Effective electrical inspections combine observation, measurement, and performance assessment
- Changes in operating data often provide the earliest indication of developing problems
- ESP performance depends heavily on operating voltage
- V-I curves are among the most valuable diagnostic tools available
- Modern power supplies and controls can improve reliability and performance

KV is King

Thank You

to the next power

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