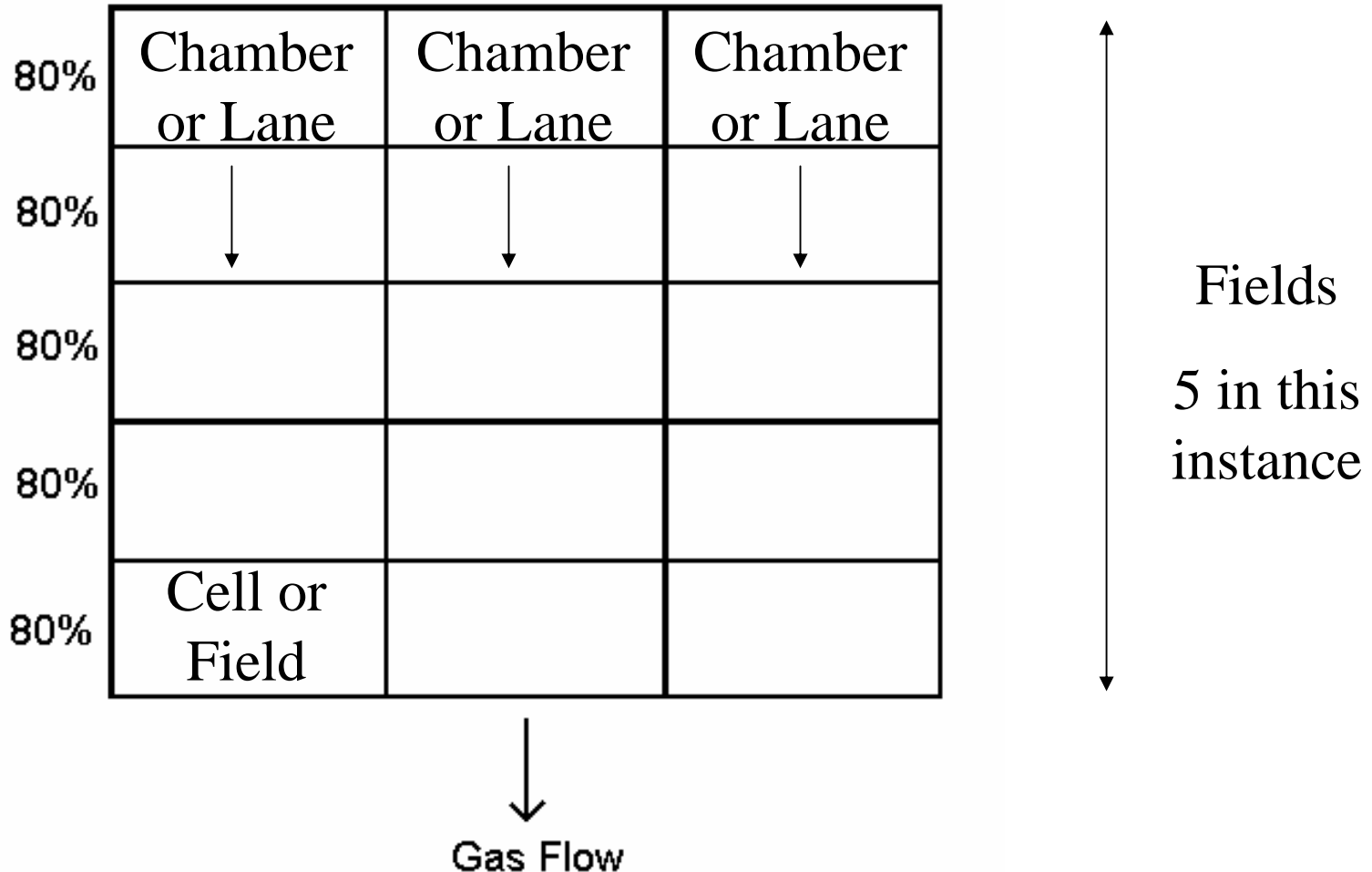


ESP Control Fundamentals

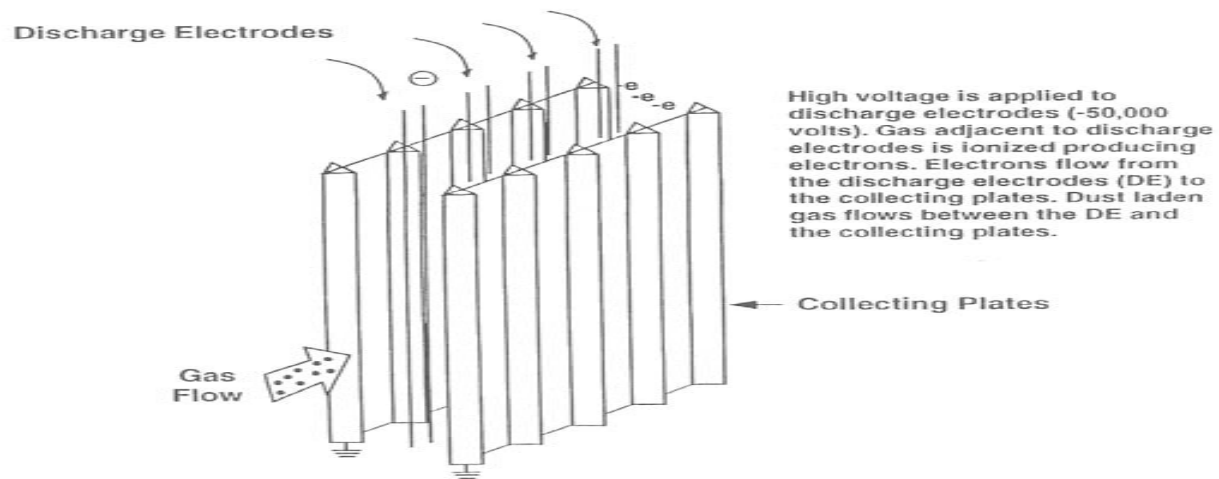
- What is an Electrostatic Precipitator & What Does it Do?
- Control Evolution.
- Voltage Control Performance
- Rapper Performance
- Troubleshooting & Performance Improvement
- New Technology

ESP Configuration Definitions



What Does it Look Like?

OPERATING PRINCIPALS OF ELECTROSTATIC PRECIPITATORS



ESP Theory

■ Why Does Electrostatic Precipitation Work

ESP'S WORK BECAUSE OF THE BASIC PHYSICS INVOLVING THE ATTRACTION OF OPPOSING ELECTRICAL CHARGES

EVERY ESP HAS AN EMITTING SYSTEM COMPOSED OF EITHER WEIGHTED WIRES, RIGID PIPES OR SOME FRAME NETWORK. IONS ARE GENERATED FROM THESE EMITTERS USING THE POWER SUPPLIED FROM A TRANSFORMER/RECTIFIER SET. 99% ARE NEGATIVE IONIZATION SYSTEMS.

EVERY ESP LIKEWISE HAS A COLLECTING SYSTEM COMPRISED OF GROUNDED (POSITIVE) COLLECTING PLATES THE ATTRACTION OF THE NEGATIVE IONS (ATTACHED TO OR ABSORBED IN DUST PARTICLES) TO THE CE SYSTEM CAUSES PARTICLES TO MIGRATE TO THE PLATES

What Does it Look Like?



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Whose Bright Idea was This?

**Dr. Frederick Cottrell Patented the
First ESP on
August 11, 1908**

**The First ESP Removed Sulfuric Acid
Mist Particles from a Wet Industrial
Process**

Whose Bright Idea was This, cont.?

**Circa 1902, Sir Oliver Lodge
Invented a DC Rectifier using.....**

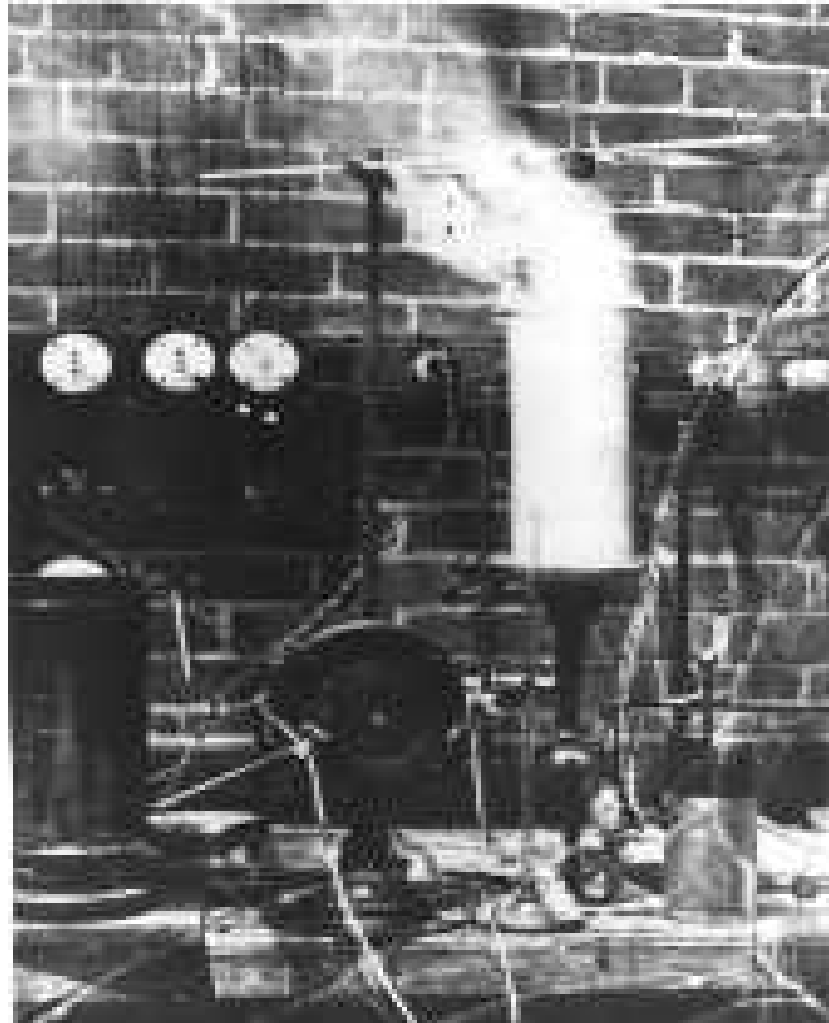
Rotating Cat Fur

**Sir Oliver Was Also Famous for
Strongly Believing in Psychic
Phenomenon**

Evolution of ESP's

- First Applications were Wet Process
- Typically Installed in Tanks w/ Round Tubes as Collecting Surfaces
- Weighted Wires Came Later (1930's & Beyond)
- Clean Air Act of 1970 Really “Got the Ball Rolling” for Big ESP's Commonly Used in Industry

The First One!



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Control Evolution

- Analog Controls with SAT Core Reactor's Powering T/R Sets
- Analog Controls with SCR and CLR's Powering T/R Sets
- Digital Controls with SCR and CLR's Powering T/R Sets
- High Frequency Controls Powering High Frequency Power Supplies

■ What Does A Voltage Control Do ?

– Yes...It Controls Voltage

AN AVC REGULATES THE WAY THE POWER FROM A GIVEN TRANSFORMER/RECTIFIER SET IS APPLIED TO THE DISCHARGE ELEMENTS ELEMENTS ASSOCIATED WITH A PARTICULAR TR; THE CONTROL OF ESP SPARKING AND THE SUBSEQUENT DAMAGE TO THE ESP COMPONENTS OR EFFECIENCY IS IT'S PARAMOUNT TASK

SPEED OF VOLTAGE APPLICATION, RATE OF POWER REDUCTION AFTER A SPARK AND THE "TOP END" VALUE A T/R WILL ACHIEVE ARE ALL FUNCTIONS OF AN AVC CONTROLLER

ENERGY MGMT., POWER-OFF-RAPPING, REDUCED POWER RAPPING AND OTHER HIGHER LOGIC FUNCTIONS ARE TYPICAL DUTIES IN A MODERN AVC

■ What is a Spark and Why is it Important?

SPARKING IS THE INTERRUPTION IN THE FLOW OF ELECTRONS THAT OCCURS IN A PRECIPITATOR FIELD WHEN PHYSICAL OR ELECTRICAL CONDITIONS CAUSE A FLASH-OVER WITHIN THE INNER-ELECTRODE SPACE

EVERY INCIDENT OF A SPARK CUTS AWAY, TO SOME DEGREE, THE METAL THAT IS PART OF THE DISCHARGE ELECTRODE(S). MORE IMPORTANTLY, EACH OCCURANCE OF A SPARK REQUIRES THE PHASING BACK OF THE POWER IN THE ASSOCIATED SECTION, REDUCING THE OVERALL ENERGY AVAILABLE IN THE FIELD.

THE ABILITY TO RECOGNIZE AND MANAGE SPARKING DETERMINES HOW EFFECTIVE AN AVC REALLY IS.

LETS NOT FORGET ARCING WHICH IS LIKE A SPARK ON STEROIDS

What Makes Them Work Well?

- **POWER**
- **MORE POWER**
- **Fields in Direction of Gas Flow (Lots!)**
- **Low Quantity of ASH in Coal**

How Best to Achieve the Power

Minimize Bus Sections/TR Set

1000/1500 mA TR's on Inlet Not a
Good Sign

Sparking in a Very Small Area will
Limit Applicable Power in a Very
Large Area!

How Best to Achieve the Power

Sparking is Actually Good for the ESP

The Highest Achievable Power Level
is just Below the Sparking Point

Keep the Setback, Quench and
Recovery to Minimum Levels!

How to Keep it Clean

- **Don't Ignore Rapping!!**
- Make Certain Plate Rapping is Sufficient but Don't Over-Rap
- DE's Should be Cleaned Frequently
- Check Rapping Density (sq. ft of CE/Rapper)
Many Older ESP's are far Too High

Too Dirty



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Troubleshooting & Resistivity Determination

High Resistivity (Power Levels Drop Front-to-Back)

Sparking High

Rap Hard & Often

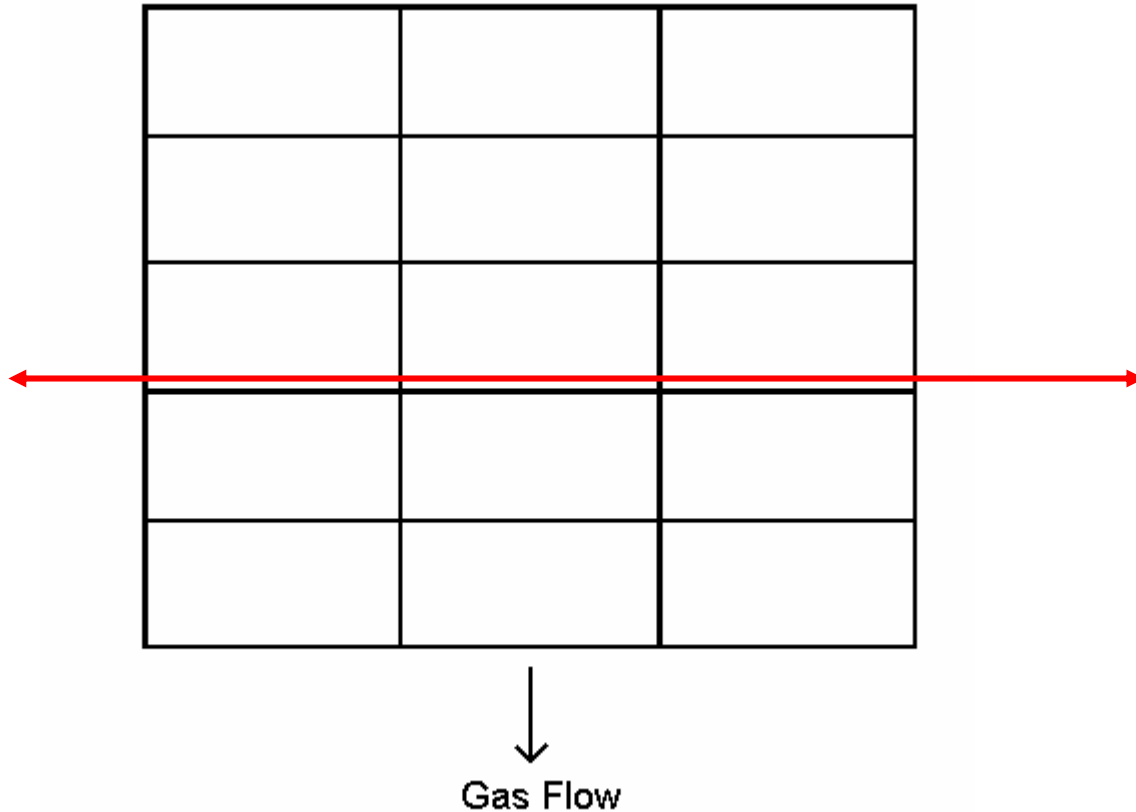
Low Resistivity (High Current with Low VAC & kV)

Low or No Sparking

Rap Slow & Easy

Rapping Theory

Divide Box into Thirds

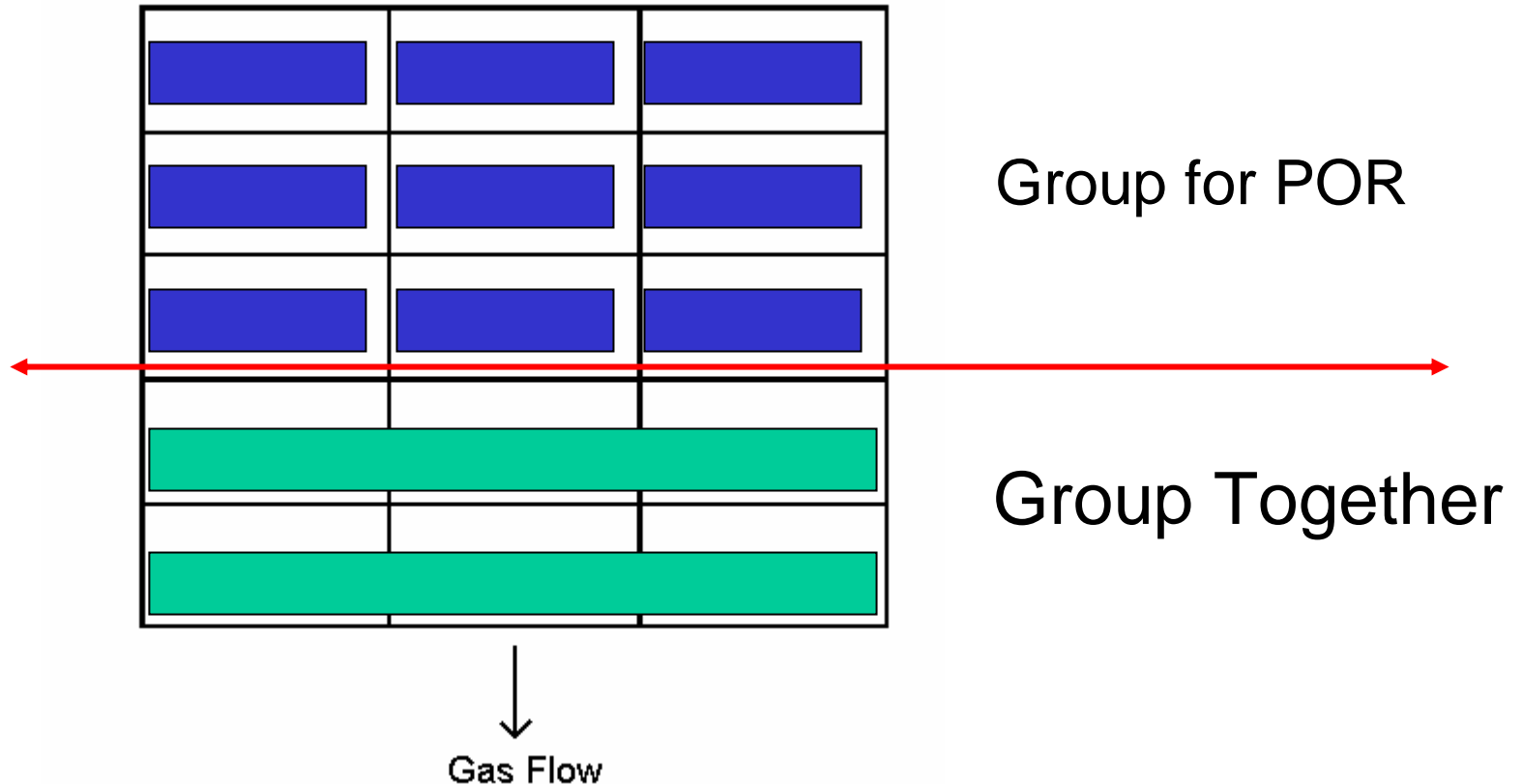


Rapping Theory

- Group Outlet Third of ESP Together
- Group Inlet Two Thirds of ESP for POR

Rapping Theory

Divide Box into Thirds



Rapping Theory

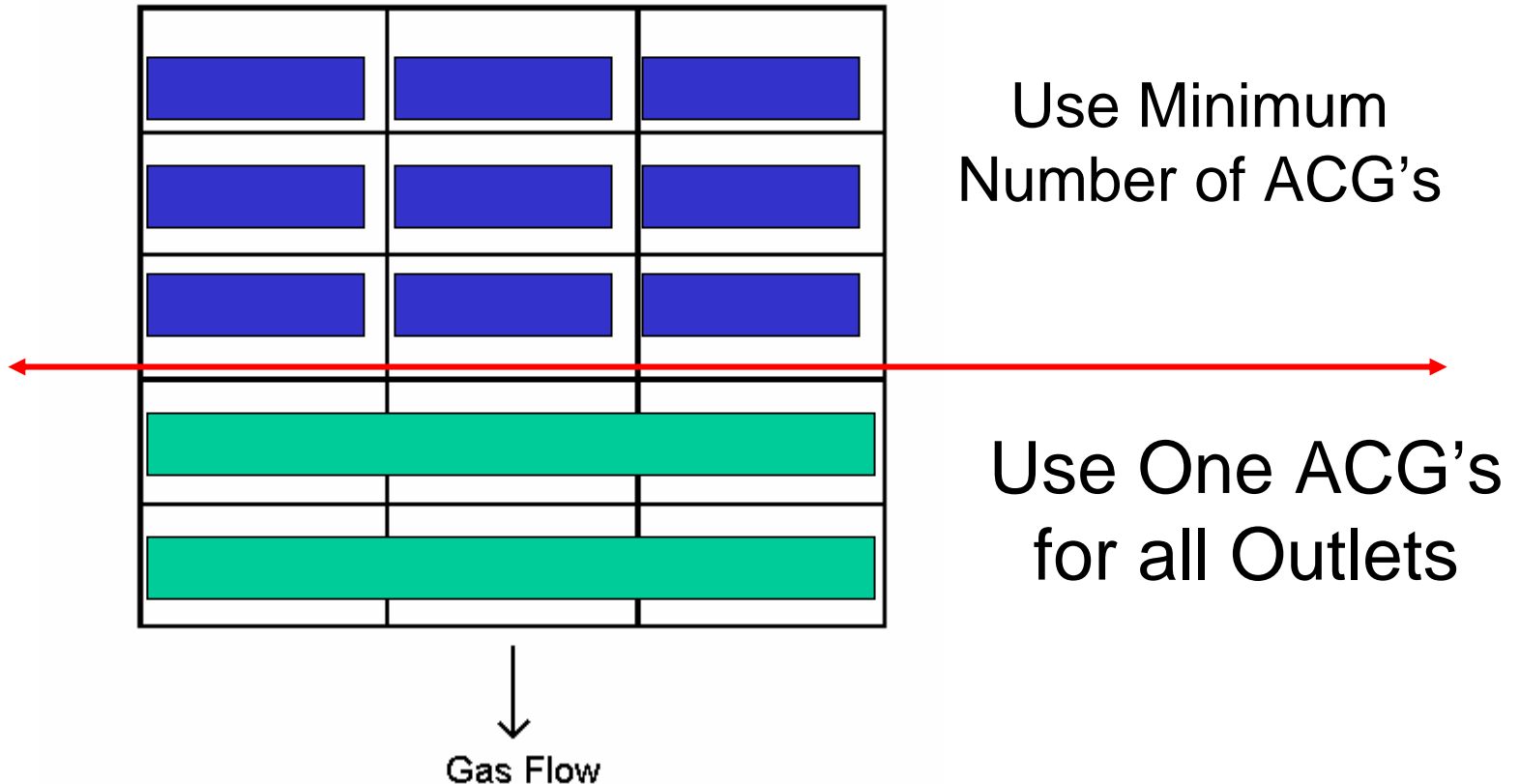
ACG's What are they?

- Keep Multiple Groups from operating together
- Must use some thought when setting up ACG's

Rapping Theory

Divide Box into Thirds

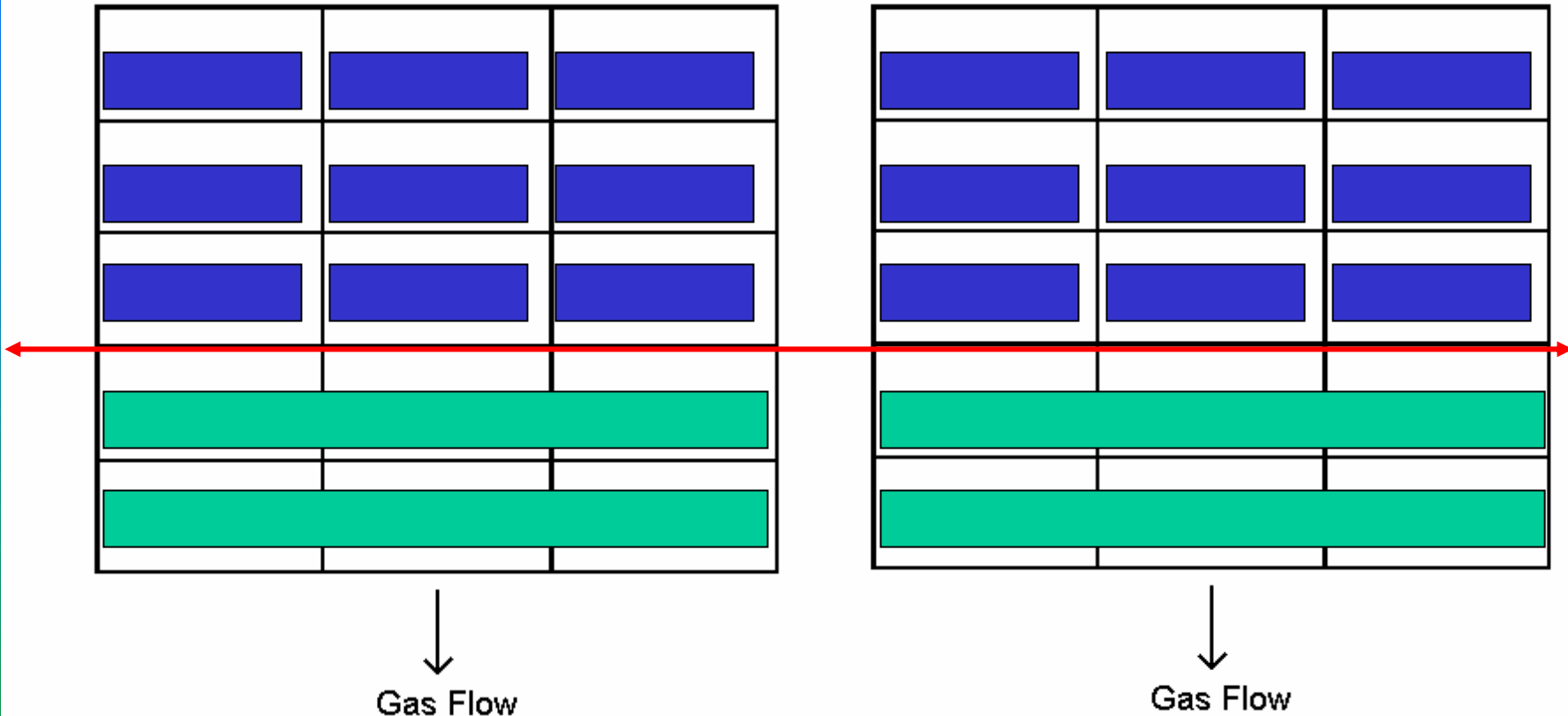
Start in the outlet and work towards the Inlet



Rapping Theory

Multiple ESP Boxes Use the Same Principles

Start in the outlet and work towards the Inlet



Rapping Theory

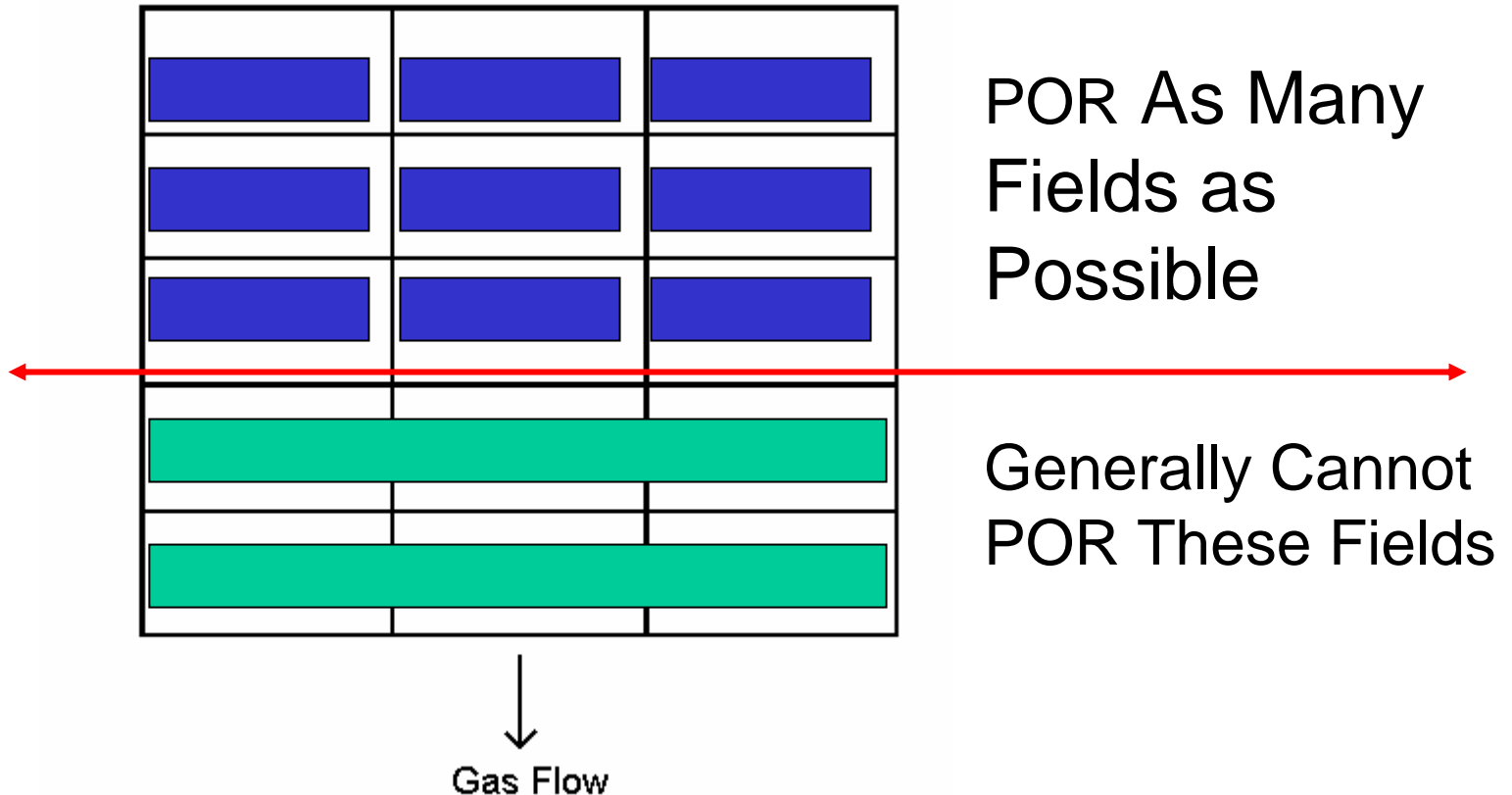
Power Off Rapping!

- Why Should we do POR
- Why Does POR Work?
- How Does POR Work?

Rapping Theory

Power Off Rapping!

Divide the Box Into Thirds



Rapper Theory

Use Several Different Rapper Programs for POR

- 1st Program POR All Fields Possible (1-4)
- 2nd Program POR Fields 1-3
- 3rd Program POR Fields 1-2
- 4th Program POR Field 1 only
- Use Load Signal to Operate the Various Programs

KISS!!

**The Voltage/Current
Relationship!!!**

Troubleshooting & Resistivity Determination

270 Vac 180 AAC 35 kV 1000 mA 08 SPM	300 Vac 150 AAC 40 kV 800 mA 30 SPM	260 Vac 180 AAC 33 kV 1000 mA 00 SPM	220 Vac 180 AAC 28 kV 1000 mA 0 SPM
280 Vac 50 AAC 34 kV 200 mA 35 SPM	300 Vac 40 AAC 31 kV 205 mA 35 SPM	270 Vac 160 AAC 39 kV 910 mA 05 SPM	240 Vac 180 AAC 31 kV 1000 mA 0 SPM
300 Vac 110 AAC 39 kV 690 mA 18 SPM	300 Vac 88 AAC 38 kV 400 mA 33 SPM	290 Vac 155 AAC 40 kV 770 mA 10 SPM	260 Vac 180 AAC 34 kV 1000 mA 0 SPM
310 Vac 92 AAC 41 kV 480 mA 22 SPM	220 Vac 34 AAC 33 kV 190 mA 35 SPM	320 Vac 125 AAC 41 kV 560 mA 22 SPM	330 Vac 155 AAC 40 kV 780 mA 08 SPM
320 Vac 60 AAC 43 kV 330 mA 30 SPM	300 Vac 48 AAC 41 kV 290 mA 33 SPM	335 Vac 110 AAC 44 kV 490 mA 28 SPM	360 Vac 140 AAC 41 kV 520 mA 29 SPM

290-320F

265-290F



Troubleshooting & Resistivity Determination

For all Cases...Review Power Front-to-Back

Nothing's Etched in Stone but.....

Voltage & Current Relationship Should Track

Removal in Direction of Gas Flow is Logical

Lay Out Readings Visually to See "Hot Spots"

Resistivity

As a General Rule...

Low Sulfur Fuel Can Result in High Resistivity Ash

High Exit Gas Temperatures (>300f & above) in
Conjunction w/Moderate and Low Sulfur Fuels Can
Result in High Resistivity Ash

Troubleshooting & Resistivity Determination

Track Power Levels Carefully.....

Resistivity (High or Low) will Show A Pattern

Good Performance will Show A Pattern

Internal Trouble will **NOT** Follow Trends

Troubleshooting & Resistivity Determination

Address What You Can Control!

Exit Gas Temperatures

Rapping

Hopper Evacuation

Excess Air

New Stuff!!

High Frequency Power Supplies

Wet ESP's



High Frequency Power Supply

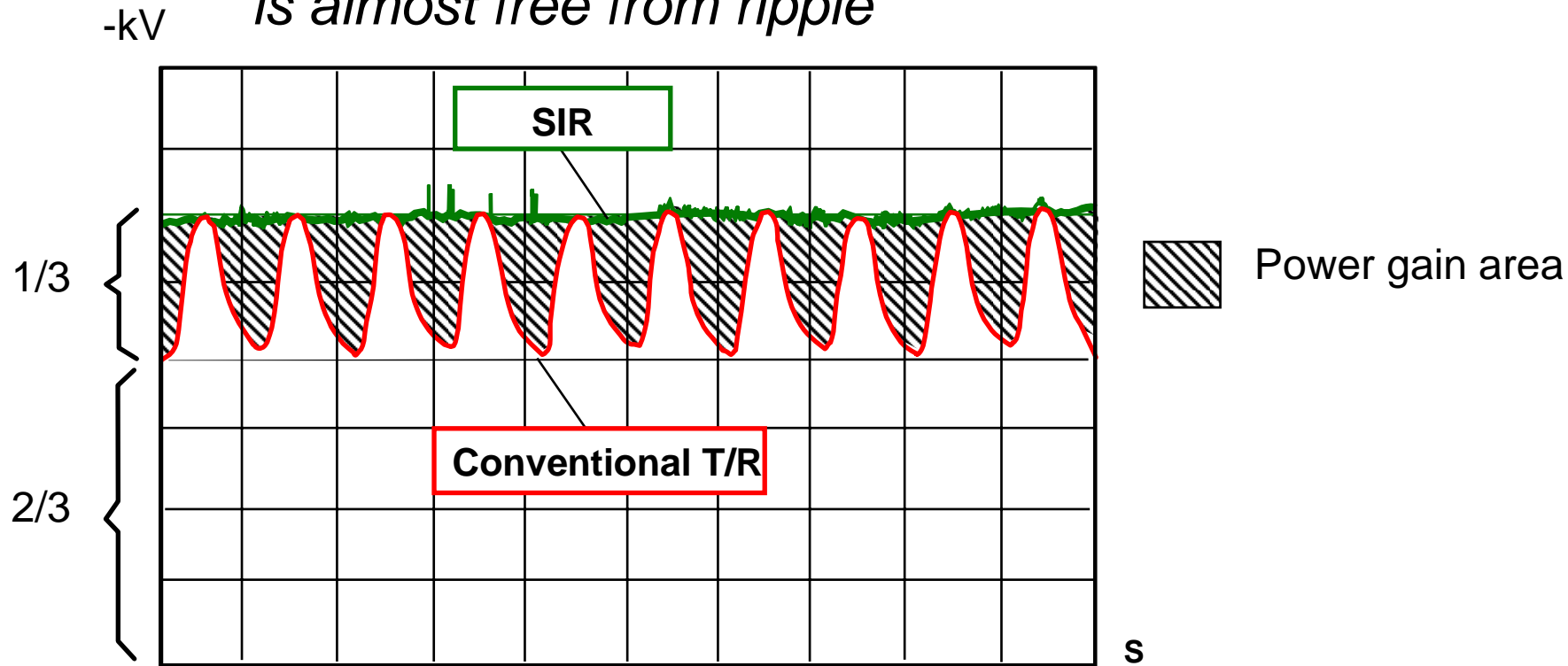


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High Frequency Power

*High Frequency Power Supply
is almost free from ripple*

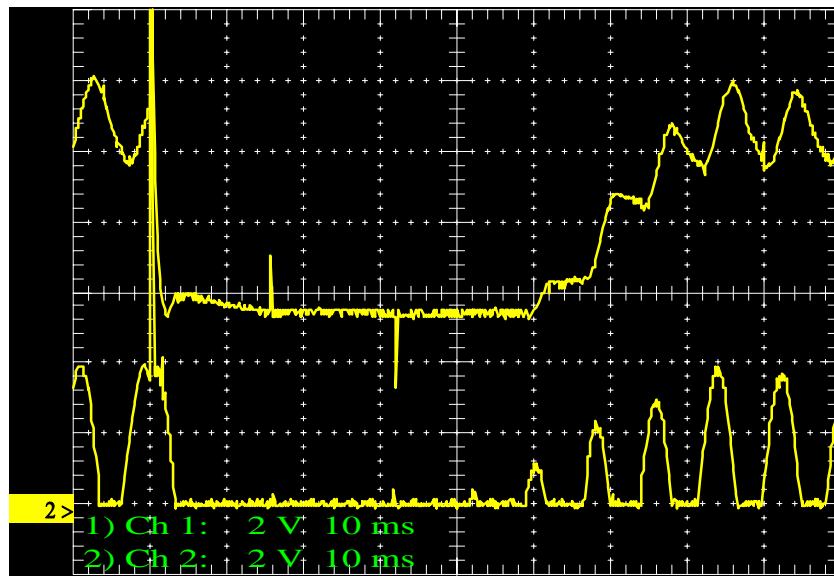


This Will give more power into an ESP field

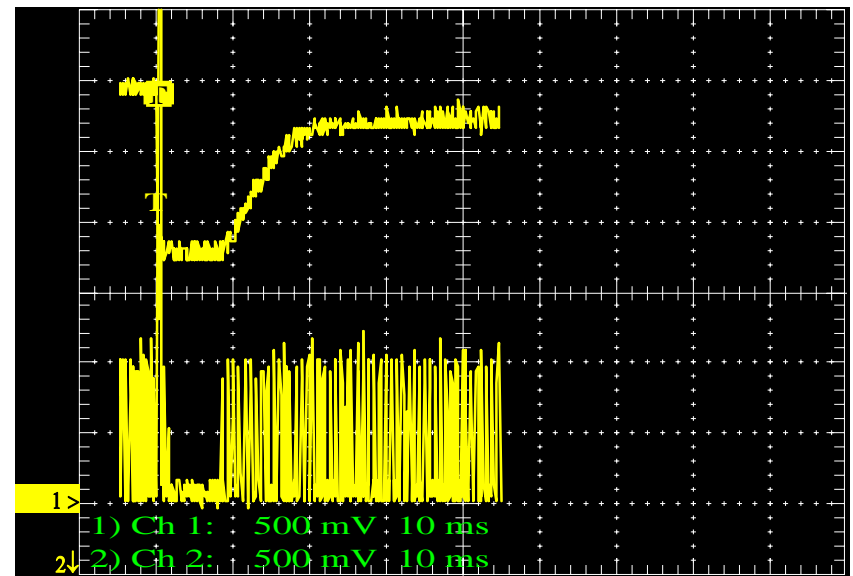
High Frequency Power

Spark Response

Conventional
TR Set



High Frequency
Power Supply



THANK YOU!

