

# Reinhold Environmental Ltd.

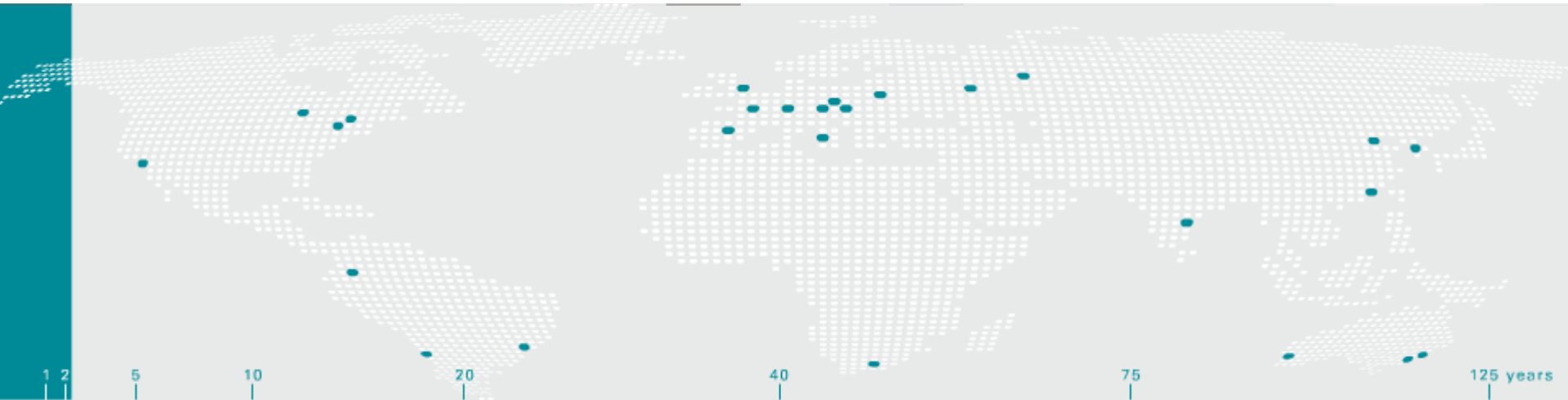


## 2009 APC Round Table & Expo Presentation

*July 12-14, 2009, in The Woodlands, TX*

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# Application, Reliability & Maintenance Issues When Choosing A High Frequency SMPS



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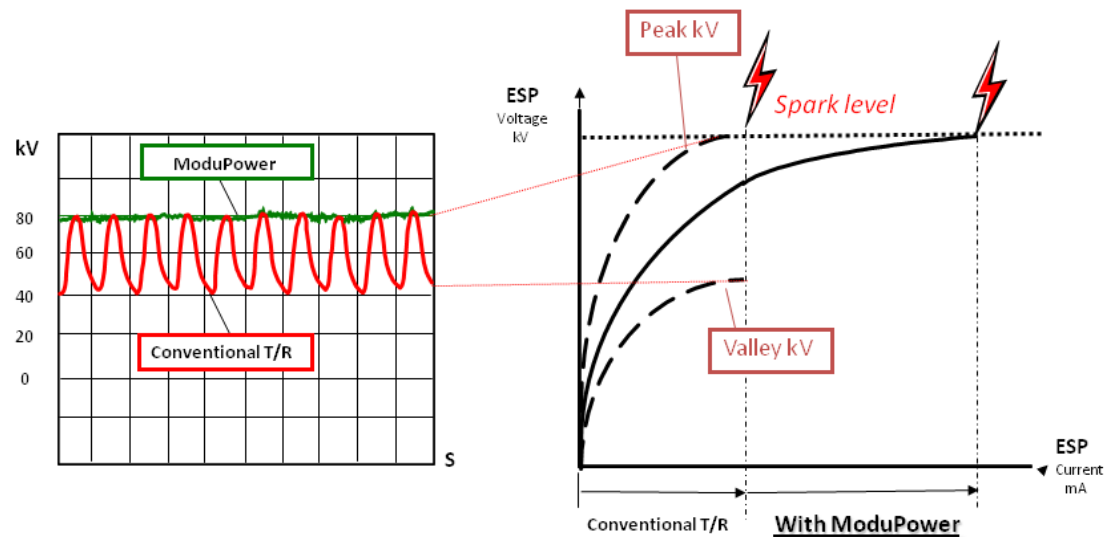
we make processes work

# SMPS... What and Why

SMPS stands for Switch Mode Power Supply. This term is used for any power supply converting AC to DC and then using semiconductors to switch it back to AC at a frequency higher than 25 kHz to be stepped up, stepped down, rectified, or regulated.

SMPS' used for loads requiring rectified DC offer an advantage of extremely low ripple compared to conventional 60 Hz Power supply's.

Pulsed DC has shown to be more effective at charging particulate than pure or straight DC.



# Important Design & Selection Criteria

- What is the Application?
- What is the Operating Environment?
- Be Redundant in the Redundancy Department!
- Maintenance Requirements Different from TR Set?
- This Thing is Different - Train Your Staff!

# SMPS Basics

- Input
  - 300-480 VAC @ 50/60 Hz
- 3 Phase Rectifier
  - 302-483 VDC
- HF Switching / Transformer Input
  - 604-966 VAC @ > 20 kHz
- Transformer / Rectifier
  - 30 kV pulsed DC or higher @ >20 kHz

# Application Thoughts

- Designs Pre-2006 Limited to 1000 mA @ 60-70 kV
- Early Units Focused on “Current Hogs” i.e. Salt Cake in Effort to Maximize kV w/Respect to Current
- There was Reluctance to Use SMPS Units w/High Resistivity Dust
- Many Users Referenced SMPS Size Requirements vs. Conventional TR sets – OOPS, We need More Voltage/Current

# Application Thoughts – Cont.

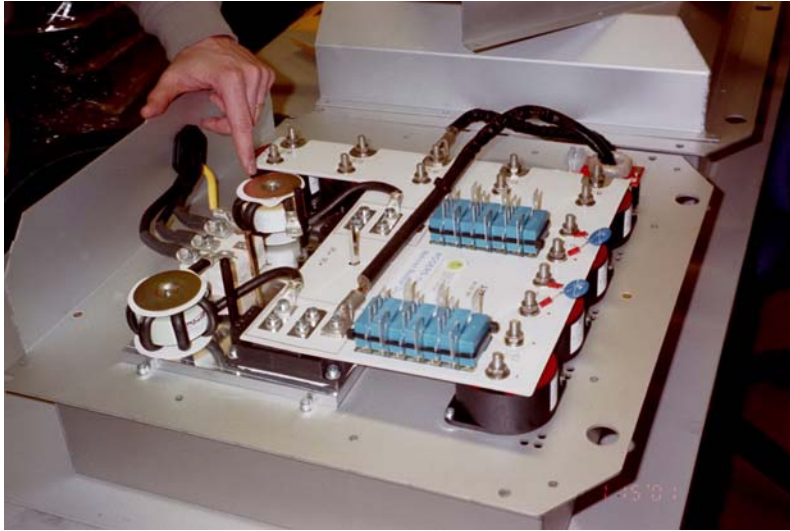


- Current Designs Available at up to 110 kV/3000 mA
- Performance Enhancement Realized on Nearly All Dusts
- Exceptional Reductions in Fine Particulate Have Been Achieved
- Built-In Redundancy Now Available via Series Connection Units that Share Bus Section Load
- Major Components Don't Need to be Disposable

# Operating Environment

- Ambient Conditions Can Weigh Heavily on Life Expectancy
- Temperature Excursions May (probably will) Shorten Component Life
- Air Cooled Systems Must be That, i.e. Air not GAS

# Avoid The Dirt!



# Avoid the Water!



# Operating Environment – Cont.

- Consider Water Infiltration Potential and is Steam Vented Nearby
- Are Filters Replaceable if Necessary for the Cooling System
- Is Direct Sunlight an Issue?
- Are there or will there be Flue Gas Leaks or Coal Dust Present?
- If Double-Decker....Will Hoppers be dumped on Units Below?
- How Clean is “Mains” Power and is Line Filtering Adequate to Handle Transients During all Plant Operating Conditions, i.e. ID/FD Fan Trips & Starts? Isolation & Filtering is Critical
- Will the System be Subject to Open Circuit Conditions at the ESP End? This is Instant Failure on Some Designs

# Cooling Options

- Earliest Systems Were Exclusively Ambient Air-Cooled
- Integrated Air-Conditioning Systems Evolved Later
- Fluid Cooling was/is Required for Higher Output Systems in IGBT/Driver Sections – Closed Loop or Circuit Cooling will Work
- Oil Cooling for High Voltage Section can be Accomplished via Heat Exchanger

# Department of Redundancy Department



- Early Designs Afforded No Redundancy Short of “Installed Spare” – Lose the SMPS...Lose the Field/Bus Section
- New, Modular Designs Accommodate Keeping Bus Sections Energized at Lower Output While Failed Section is Repaired or Replaced
- Spare Parts Inventory Should be Maintained for Critical Components
- Be Aware of Proprietary Component Content in Your SMPS Choice!

# Maintenance

## This is NOT Your Father's TR Set

- Pay Close Attention to Cooling System Operation
- If Air-Cooled, Clean Air Intakes Routinely and Clean Conductive Surfaces Whenever Possible
- Change Your Thinking on Oil Sampling....There's Not Enough to Go Around
- Make Certain that Connections on LV and HV side of the SMPS Stay TIGHT!.....Noise & Heat Can Be More than a Nuisance – It will Fail Components

# Maintenance – cont.

- Develop Resources to Repair the Critical Components....if Proprietary Content is Manageable, Some SMPS Units can be Fixed – It is NOT Rocket Science
- Keep Critical Sub-Components in Stores....Nobody Operates Conventional TR Control Systems without Spare SCR's, AVC's and Sometimes Even TR sets YET.....SMPS Users Often Keep Few if Any Spares

# Training

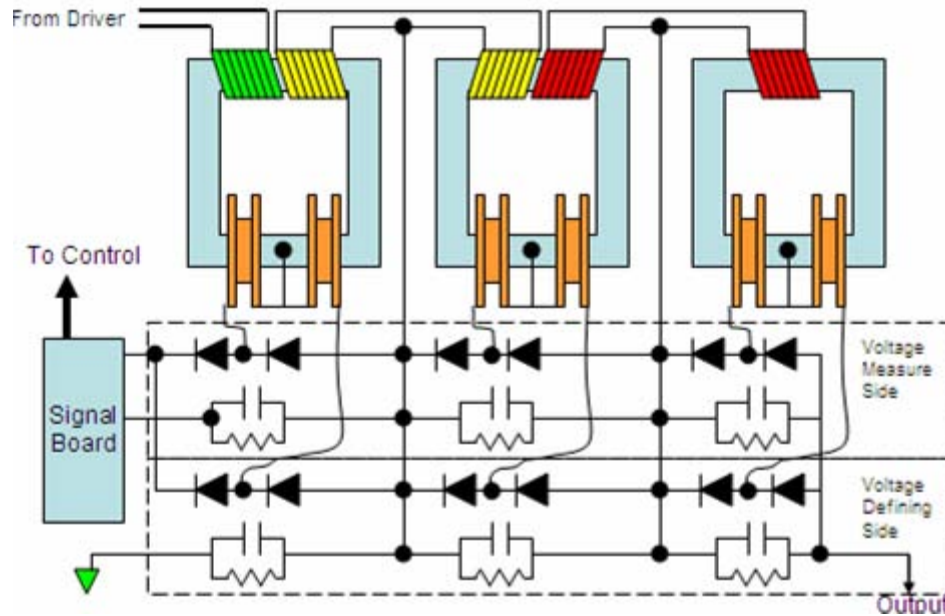
- Communicate the Differences between Conventional and HF Power Supplies – One is a Tank, the other a Ferrari
- Detail Why the Technology is Better....The Need for Increased Attention will be Better Tolerated if Staff Understand the Performance Benefits
- Change the Mindset from “Repair” to “Monitor” – On-Board Temperatures are as Important as Voltage & Current
- A Thorough Understanding of the Need for Cooling & Cleanliness is Critical

# What's New – Yes This is an HF, SMPS

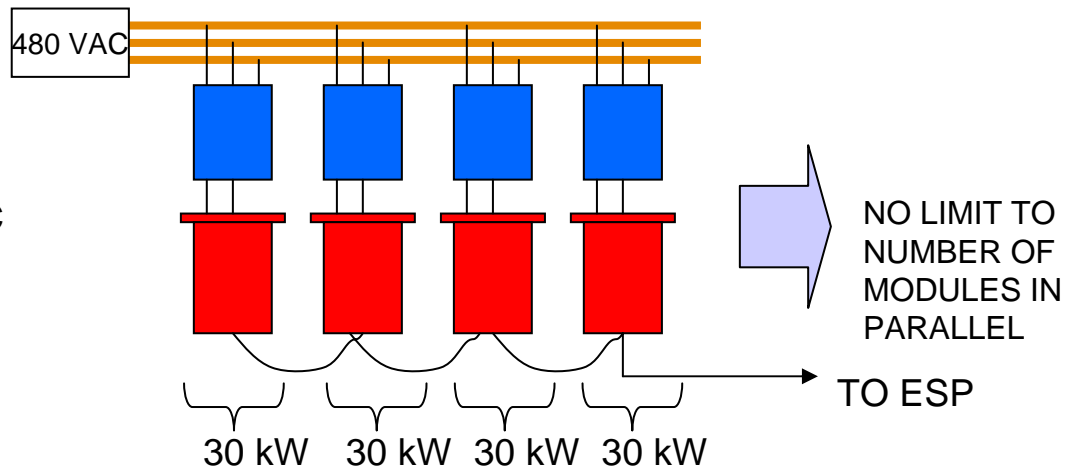


# Building Up Modules

## HV Unit Diagram



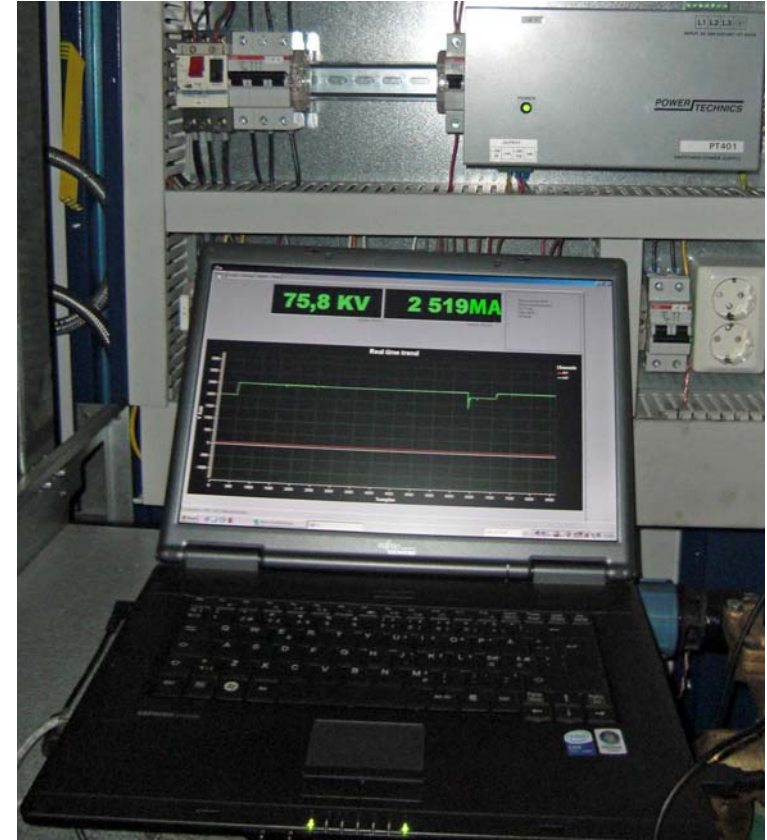
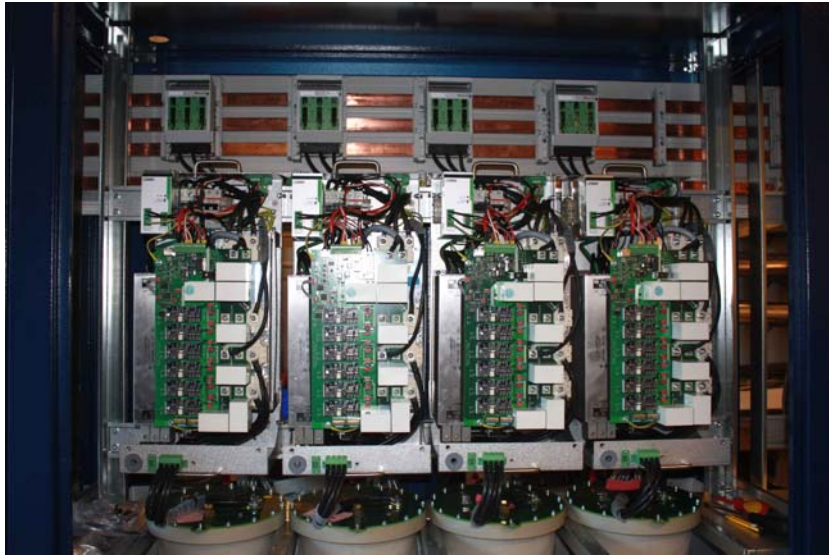
## Overall Schematic



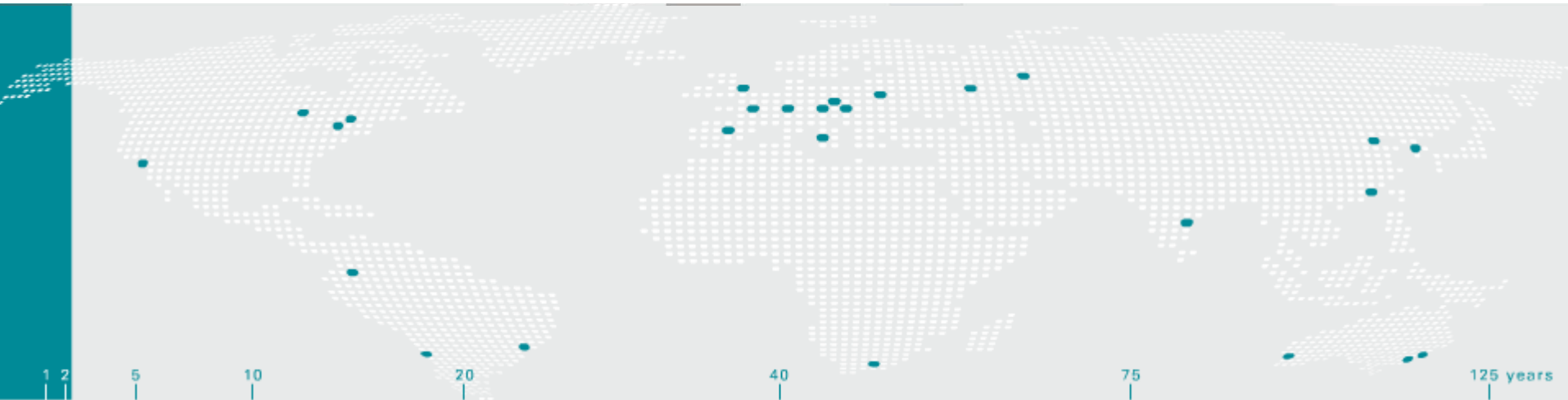
# Technological Improvements Over Early Designs

- Modularity allows for ratings that meet the application.....both current & future and for failure tolerance
- No insulator at output for soldered connection to leak oil
- Driver has liquid cooled cooling block vs. air cooled.... No fins to plug with ash
- Transformer oil is cooled via liquid to liquid heat exchanger... No fins on HV tank either
- Less complex topology
- Capacity can be added / taken from each bus section as needed
- Use of HV cable instead of bus duct and solid conductor allows power supplies to be located at grade. Less 480 VAC cable pulls, controls are at grade, less affected by environmental conditions

# Modular Construction



# Thank You!!



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**STOCK EQUIPMENT COMPANY**  
16490 Chillicothe Road  
Chagrin Falls, OH 44023-4398  
[stock.sales@stockequipment.com](mailto:stock.sales@stockequipment.com)  
+1 440 543 6000  
+1 800 289 7326  
+1 440 543 5944 FAX  
[www.stockequipment.com](http://www.stockequipment.com)  
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