Worldwide Pollution Control Association

FirstEnergy ESP Seminar

November 27th – 28th, 2007

Visit our website at www.wpca.info

High Frequency
Switched Mode Power Supplies

- Where We've Been
- Where We Are
- Where We're Going

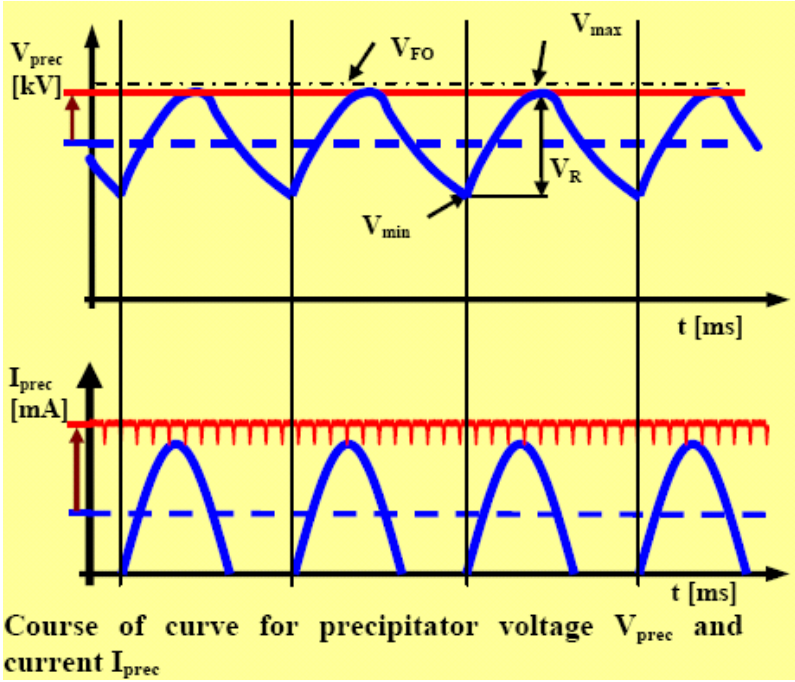
Power Supply Evolution

- Early Rotating Mechanical Rectifiers
- Vacuum Tube Rectifiers
- Saturable Core Reactor & TR Set Systems
- SCR/Thyristor & TR Set Systems
- High Energy Pulser Systems
- Switched Mode Power Supplies & Hybrid IGBT Systems

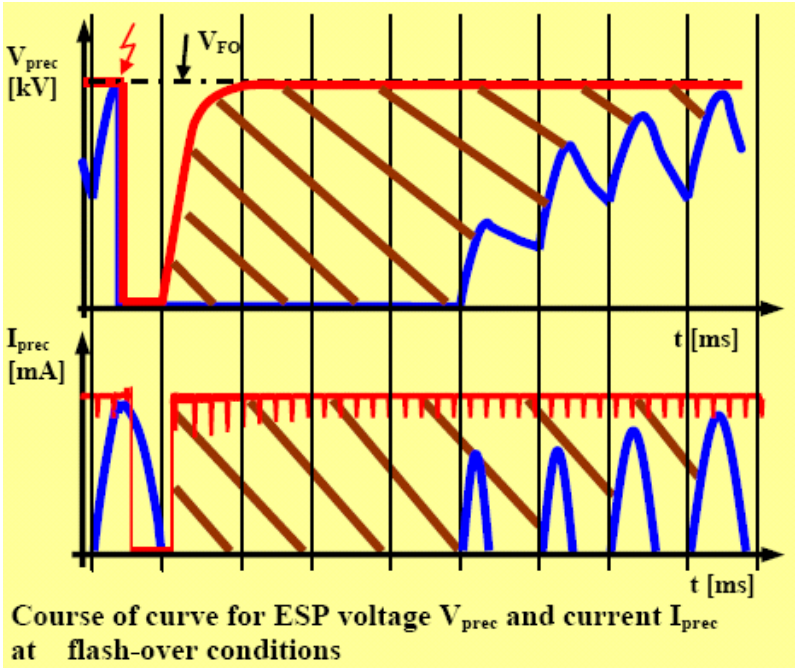
HF Power Supply History - Suppliers

- Alstom First Unit (SIR) in Service circa 1993
- NWL First Unit (PowerPlus) in Service circa 1999
- Siemens First Unit (PIC410F) in Service circa 1992

What's The Result?



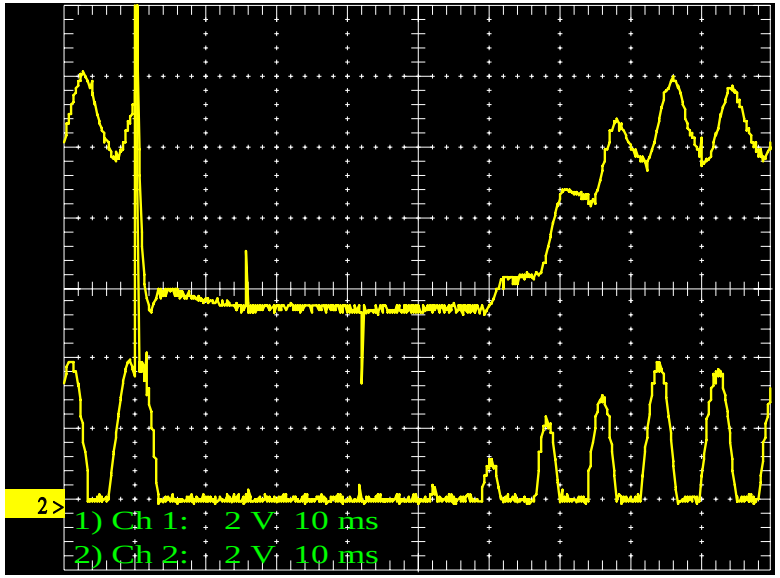
Course of curve for precipitator voltage V_{prec} and current I_{prec}



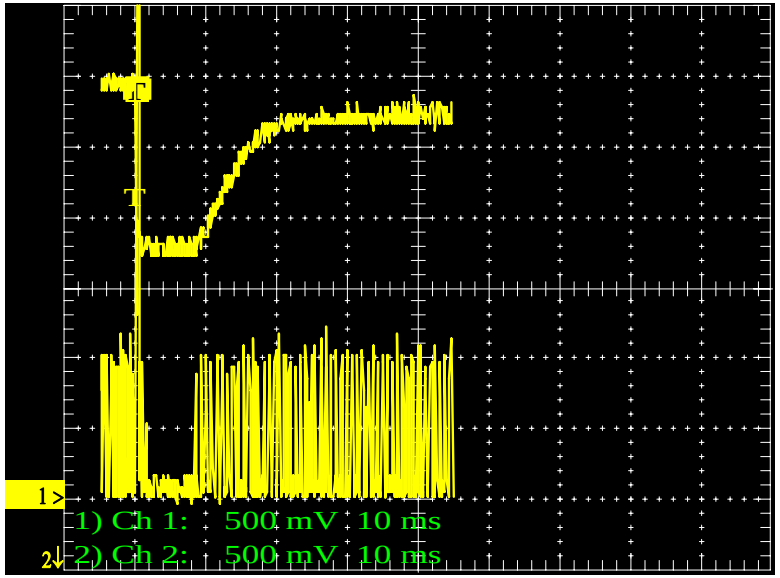
Course of curve for ESP voltage V_{prec} and current I_{prec} at flash-over conditions

What's The Result? cont.

Conventional



HF



More Power – Improved Performance

HF History

Good

- Great Increase in Input Power & ESP Performance
- Smaller, Lighter Weight Footprint
- Commercially Acceptable Price Points

Bad

- Typical+ Problems of a New Invention
- Failure Rates of “Scaled up” Units High
- Production Rates Difficult to Maintain as Demand Rose

HF History cont.

Difficult

- Assembly Sub-Suppliers Dictate Parts Availability
- Component Sub-Suppliers Arbitrarily Stop Manufacturing
- Market Acceptance is Demanding Output Levels that Available Components Struggle to Support
- Design Changes Required Due to the Above Represent the *Potential* to Repeat the Cycle
- OEM's NOT Calculating Advantages into New ESP Designs

Early Designs

- Small <500 mA
- Cooled by Fluid Circulation or Fans
- High Voltage Transformer Types Varied by Manufacturer

Next Generation – i.e. Present Day

- Outputs Increased to 60/70 kV and 800-1000 mA
- Scaled-up Models Saw Component Stresses Due to Significantly Higher Power
- Component Issues were Managed in IGBT & Diode Areas

Current Installed Base

- Alstom – 1350 Units Worldwide (610 in US)
- NWL – 600th Unit will Ship in ’07
- Siemens – 200 Units inc. IGBT Upgrades

What's "New" Now?

NWL

kW	7	21	28	56	70	56	70
kVdc	70	70	70	70	70	83	83
mAdc	100	300	400	800	1000	675	843

kW	105	105	105
kVdc	83	95	70
mAdc	1240	840	1500

What's "New" Now?

Alstom

Rating	Introduced
80 kV 250 mA	1993
70 kV 400 mA	1997
70 kV 800 mA	1998
70 kV 1000 mA	1999
70 kV 1700 mA	**2006**

What's "New" Next?

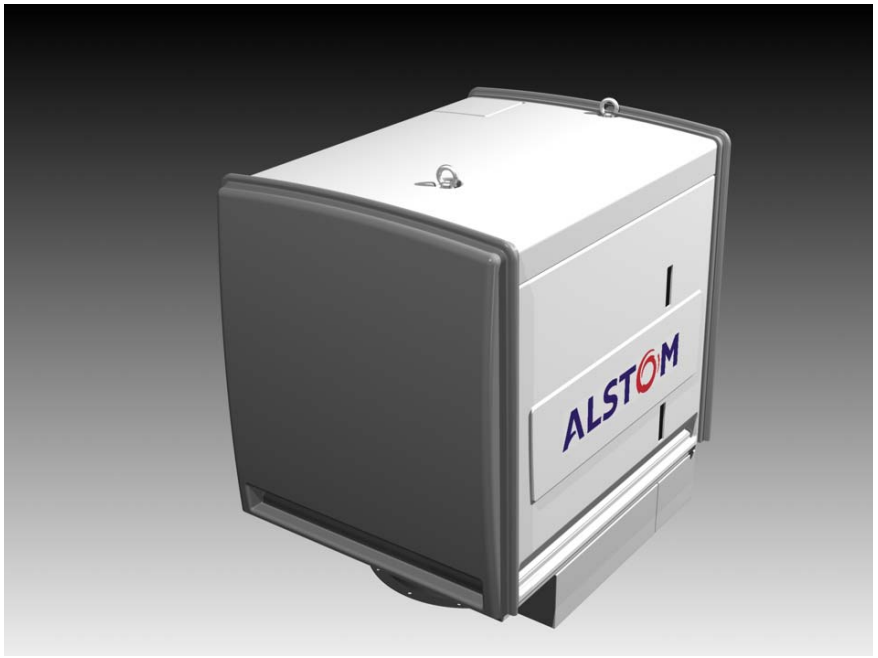
NWL

kW	kV	mA
105	95	1100
120	95	1250
120	70	1700
120	83	1400

What's "New" Next?

Alstom

Rating	Introduced
70 kV 1700 mA	**2006**
100 kV 1200 mA	**2007/2008**



What's "New" to U.S.

Hybrid IGBT Technology

- Used in Conjunction w/Existing TR or New TR
- Existing Cabling Can Be Used
- Current Outputs in Excess of 2500 mA

What's "New" to U.S. cont.

Mains voltage 380-500 V – 3 - phase	Type	prec. current (mA_{arithm})	Power (kVA)	Cubicle weight (kg)	Transformer weight (kg)
Type PIC410F ❑ 90 kV ❑ 110 kV	PIC90000/600	**600**	55	280	970
	PIC90000/1500	**1500**	135	280	1630
	PIC90000/2200	**2200**	200	280	1630
	PIC110000/500	**500**	55	280	970
	PIC110000/1500	**1500**	165	280	1160
	PIC110000/2000	**2000**	220	280	1330
	PIC110000/2500	**2500**	275	300	1450

Overall Results

- Performance Improvement Undeniable
- Significant Generation has been Recovered
- TR Mindset Comparisons a Challenge
- Early Reliability Issues Curtailed Acceptance Roughly 200 Units per Year Over Last Decade
- End-User Demand & Component Issues Result in Long Lead Times
- Larger Units Will be More Readily Accepted

Thank You!!