

IX
ICESP Conference on Electrostatic Precipitation

Protea Hotel Kruger Gate
South Africa
2004

Presented by
Helmut Herder
NWL

Performance Enhancements Achieved With High Frequency Switchmode Power Supplies

Abstract

For over 40 years the most commonly used device to power electrostatic precipitators were standard 50/60 Hz SCR Controller and Transformer/Rectifier sets. However, in the last 4 years a new Power Supply has been introduced to the ESP industry. This Power supply is based on High Frequency Switchmode technology. The new Switchmode Power Supplies are capable of dramatically different performance than the older, 50/60-hertz linear transformer/rectifier sets.

Recent comparative tests of the two technologies were performed in the USA at Southern Company's Savanna electric Plant Kraft 163 MW unit number 3. During a rebuild of the ESP on this unit, in the spring of 2002, standard 50/60 Hz transformer were installed on the east ESP casing and Switchmode Power Supplies were installed on the west casing. This modification also resulted in plate spacing change from 9" to 11.25" with ridged electrodes and a SCA of 322 ft²/1000 acfm. This paper will discuss the performance enhancements seen with the Switchmode Power Supply during testing conducted between the two sides using US EPA Method 17 particulate testing.

History of test done at Savanna Power Plant

Fall 2001 – NWL installed a test SMPS on Unit # 1

Results showed 77% power increase when connected to the outlet field and 121% when connected to inlet field

See Table 1

It was discovered that assistance was applied to all downstream T-R's by the SMPS when installed in the inlet field

See Table 2

Power comparisons between the standard T/R's and the Switchmode Power Supply over a 6 month period at the plant

See Table 3

Table 1

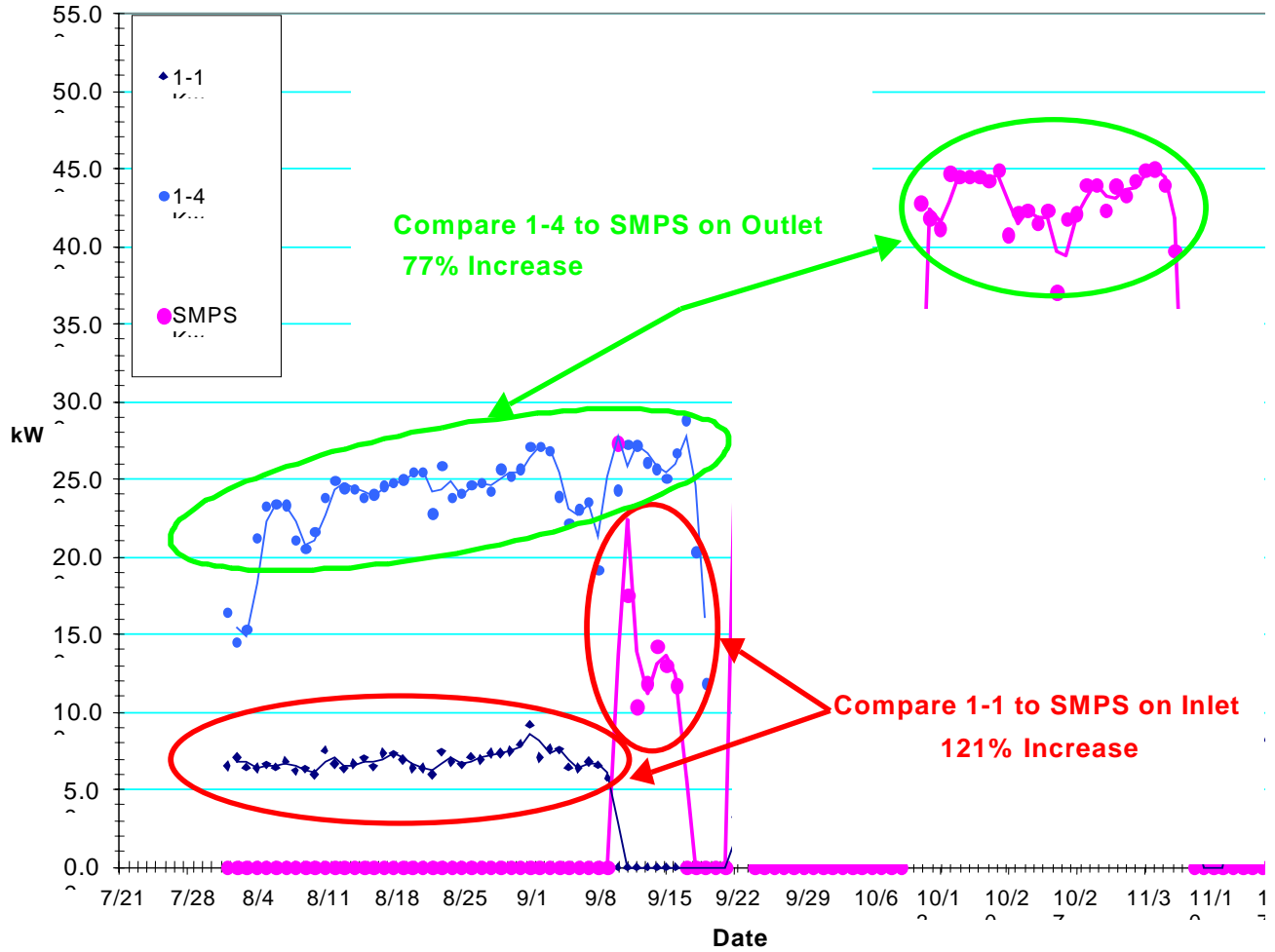


Table 2

Assist applied to downstream T-R's by SMPS

Average kW of T-R 1-2 Before SMPS on Inlet	11.19
Average kW of T-R 1-2 with SMPS on Inlet	14.38
Increase / Decrease (%)	28%
Average kW of T-R 1-3 Before SMPS on Inlet	17.91
Average kW of T-R 1-3 with SMPS on Inlet	20.34
Increase / Decrease (%)	14%
Average kW of T-R 1-4 Before SMPS on Inlet	23.38
Average kW of T-R 1-4 with SMPS on Inlet	24.96
Increase / Decrease (%)	

Key Parameter Comparison:

The Table below shows key Parameter comparison between High Frequency Switchmode Power Supplies and Conventional T/R Systems

PARAMETER	POWERPLUS 70 (typical)	CONVENTIONAL T/R SYSTEM
kVdc	70	65
mAdc	1000	1000
Output kW	70	65
Peak kV	71.8	109.2
% Ripple kVp-p	3-5	35-45
Input Vac	480	480
Number of phases	3	1
Iline (AAC)	94	227.1
Losses (kW)	3.6	3.5
Power Factor	.94	.63
Input kVA	78.7	109
Operating frequency	25 kHz	60 Hz
EMI filter	Yes	No
Arc shutdown time	30 usec	8.33 msec
Cooling	Forced Air (1/2 HP fan)	Natural Convection for Transformer Forced Air for Controls
Max. Ambient Temp. (deg C)	40	40
Volume envelope (cubic feet)	22	60
Plan envelope (square feet)	8	18
Weight (lb.)	1000	3860
Gallons of fluid	27	135
Wiring from T/R to control	Factory	Field

Precipitator Layout after modification in 2002



- Conventional T-R



- 800 Milliamp SMPS



- 1,000 Milliamp SMPS

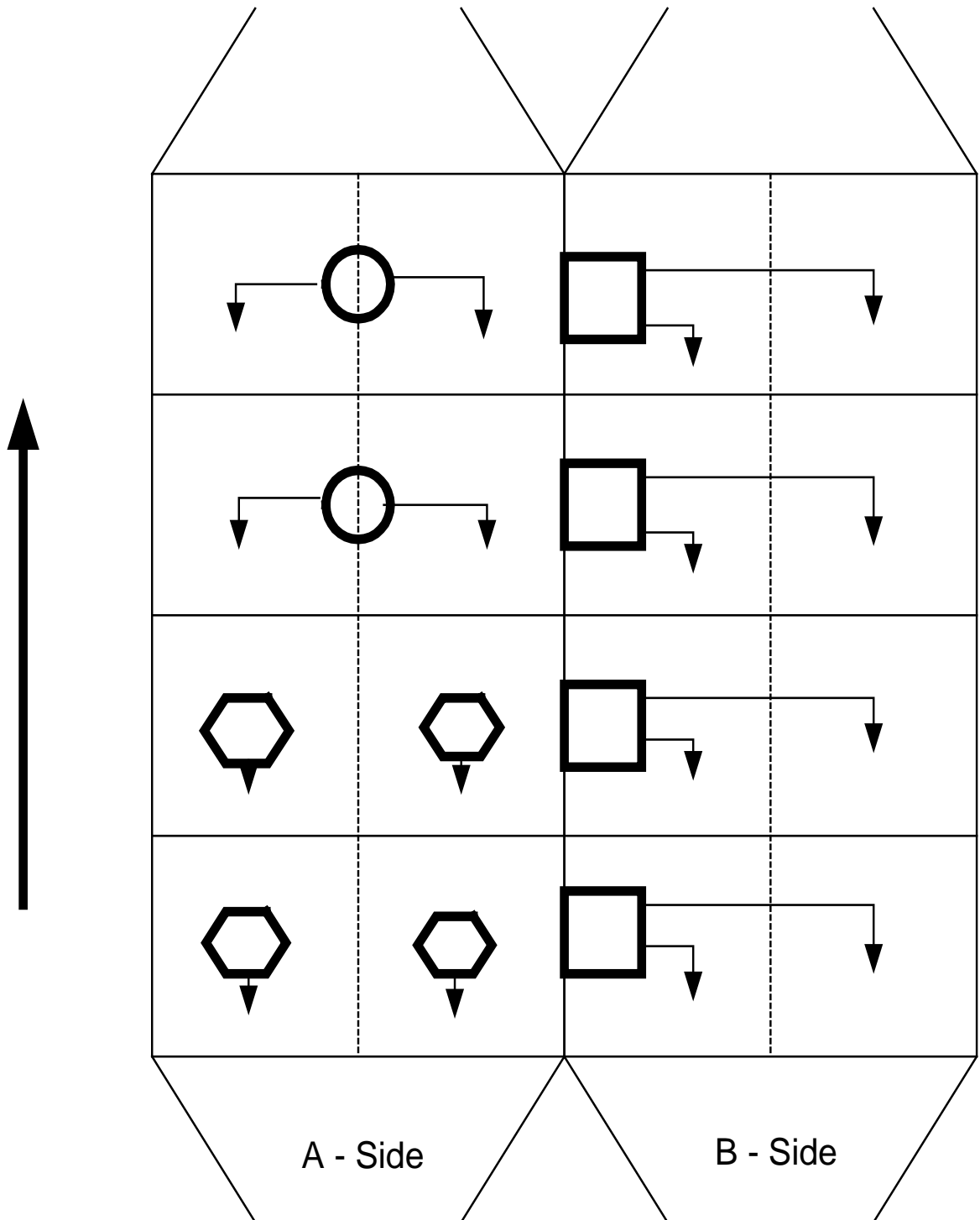
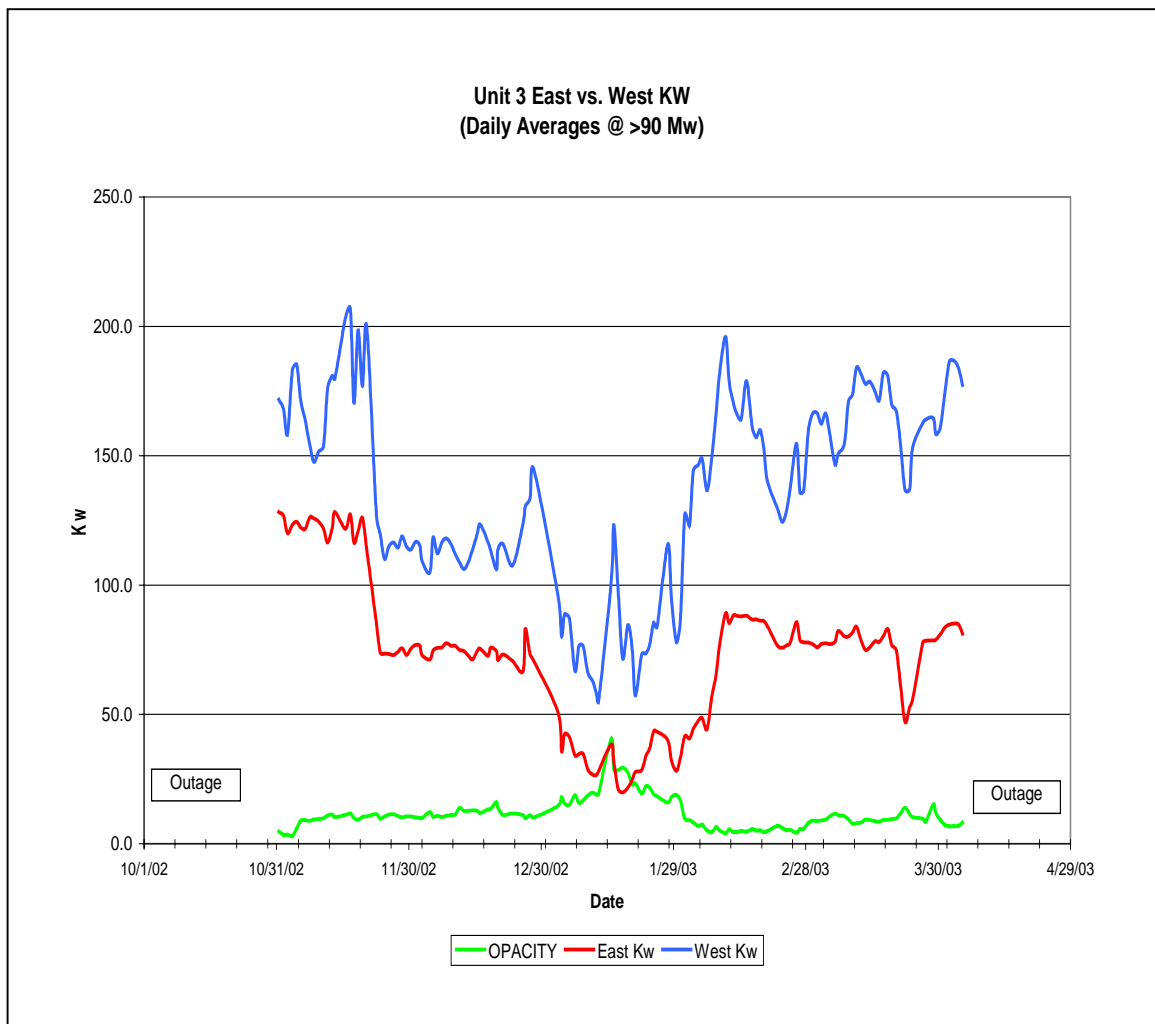


Table 3



Test Protocol

The main requirement of this test series was to determine the efficiency of each side (The East Side with the conventional T-R's and the West Side with the SMPS units) of the precipitator. Second; further test runs were planned to determine the best operating conditions for each type of power supply. Third; the performance of each side was planned to be measured under equalized conditions using primary power, secondary power and other variables as deemed appropriate.

All testing was performed at full load (~106 Mw). Coal samples were taken at 15-minute intervals; ash samples were taken from the inlet and outlet hoppers. Precipitator data was compiled by the PCAMS data management system.

Test condition's

Conditions 1

Location:	Simultaneous West Side Inlet and Outlet
Date / Time:	12/16/03 8:20 AM – 12:20 PM
Number of Runs:	2
Set Up:	Equal kW on Both East and West Sides
Comments	All PowerPlus operating in pure dc mode, current limited so as to supply equal Power in East & West fields

Conditions 1

Location:	Simultaneous East Side Inlet and Outlet
Date / Time:	12/16/03 2:10 PM – 5:05 PM
Number of Runs:	2
Set Up:	Equal kW on Both East and West Sides
Comments	All PowerPlus operating in pure dc mode, current limited so as to supply equal power in East & West fields

Conditions 2

Location:	Simultaneous East Side Outlet
Date / Time:	12/17/03 9:00 PM – 2:05 PM
Number of Runs:	3
Set Up:	Full DC Mode,
Comments	Setup to maintain 8 sparks per minute

Condition 3

Location:	Simultaneous West Side Outlet
Date / Time:	12/17/03 9:00 PM – 2:05 PM
Number of Runs:	3
Set Up:	Full DC Mode,
Comments	Setup to maintain 8 sparks per minute

Conditions 4

Location:	Simultaneous East and West Outlet
Date / Time:	12/17/03 12:05 PM – 1:05 PM
Number of Runs:	1
Set Up:	Full Power DC Mode, rappers off
Comments	Setup to maintain 8 sparks per minute

Conditions 5

Location:	Simultaneous East and West Outlet
Date / Time:	12/17/03 12:05 PM – 1:05 PM
Number of Runs:	1
Set Up:	Full Power DC Mode, rappers off
Comments	Setup to maintain 8 sparks per minute

Conditions 6

Location:	Simultaneous East and West Outlet
Date / Time:	12/17/03 4:45 PM – 5:30 PM
Number of Runs:	1
Set Up:	All PowerPlus in IE mode
Comments	Tuned IE to simulate Conventional T-R (120Hz ripple).

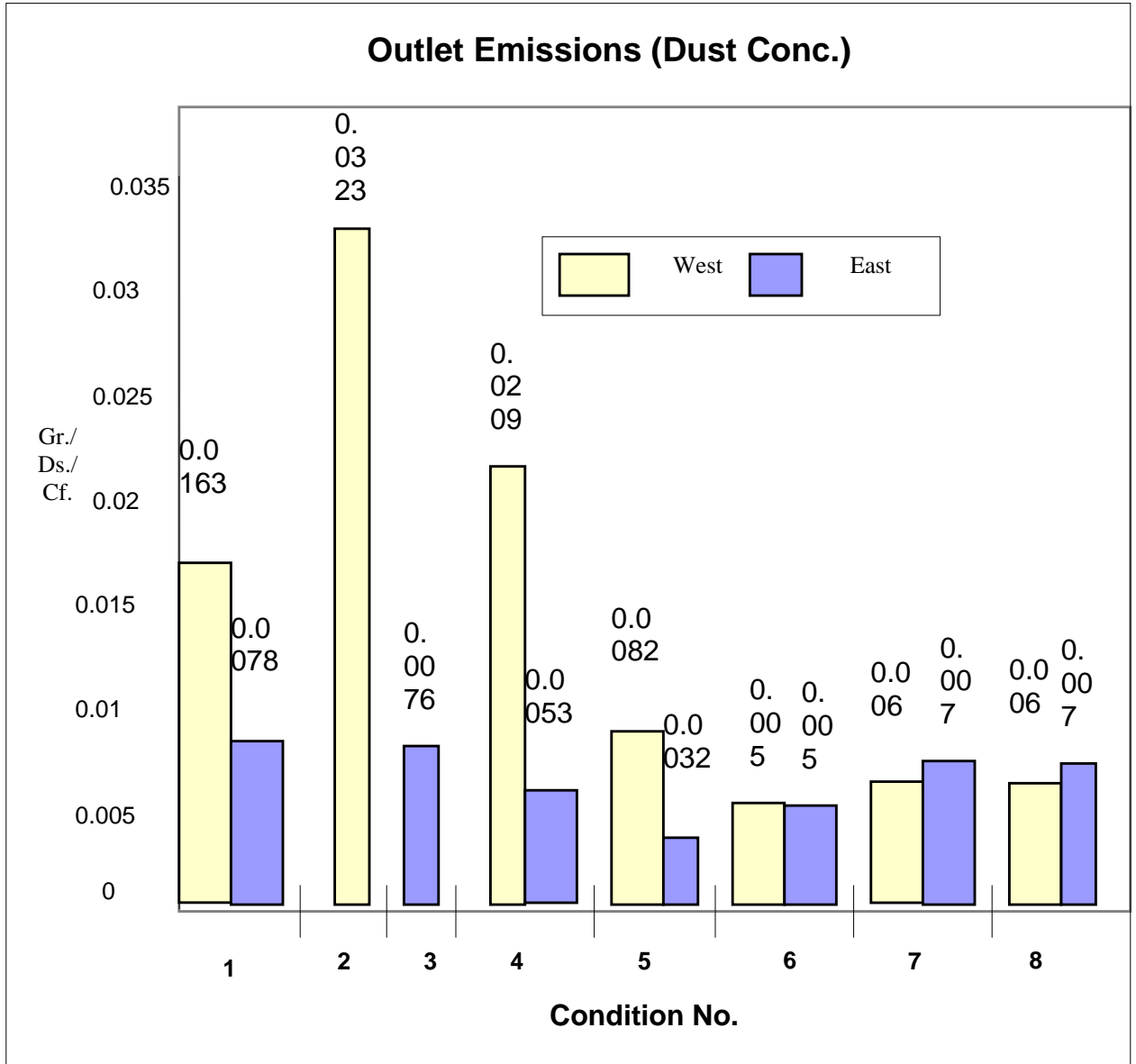
Conditions 7

Location:	Simultaneous East and West Outlet
Date / Time:	12/18/03 8:45 PM – 3:25 PM
Number of Runs:	2
Set Up:	Equalized Power By kW
Comments	Tuned IE for to simulate Conventional T-R (120Hz ripple).

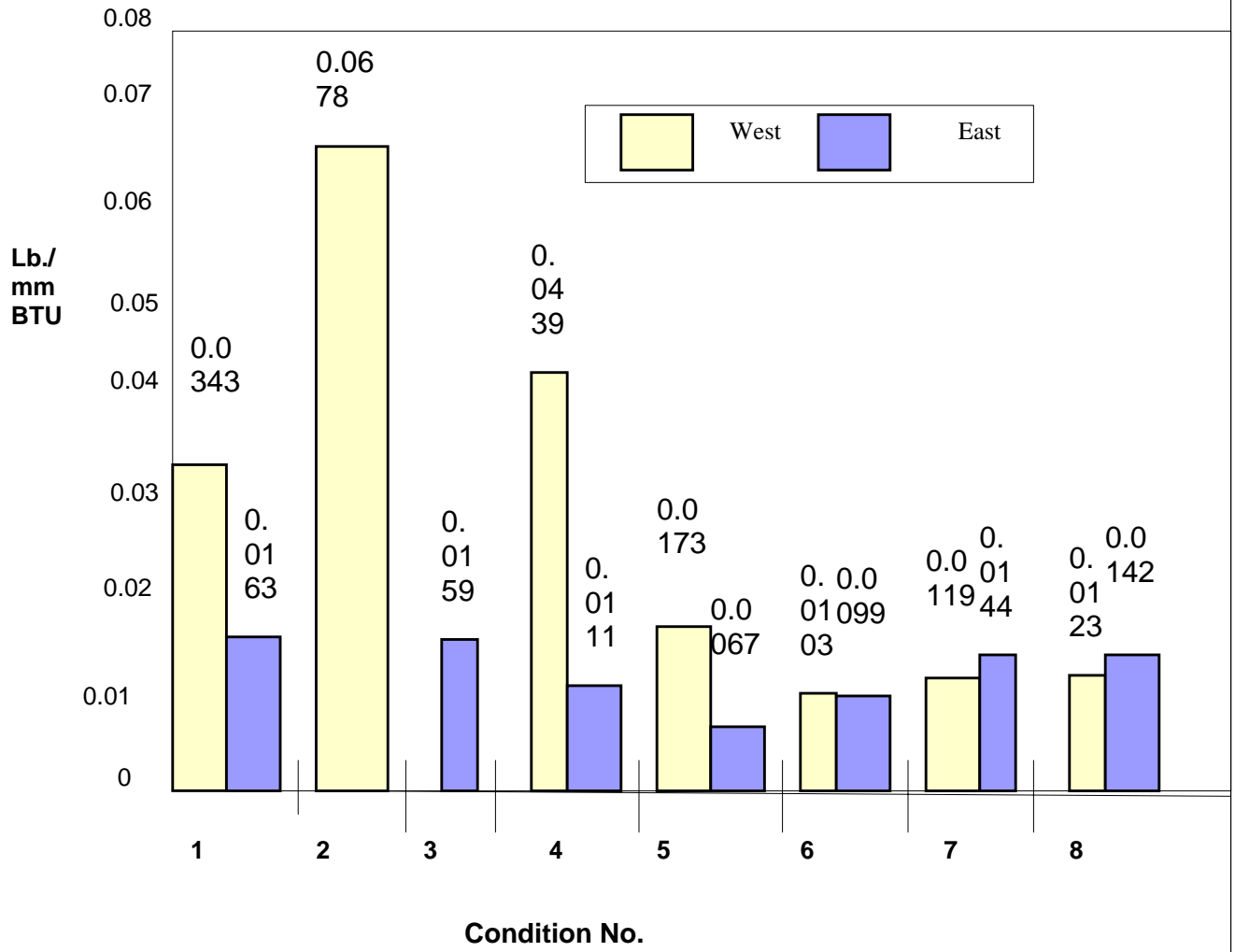
Conditions 8

Location:	Simultaneous East and West Outlet
Date / Time:	12/18/03 12:25 PM – 3:00 PM
Number of Runs:	2
Set Up:	Equal kV products of (kV peak * kV average)
Comments	All PowerPlus operating in dc mode

Result's



Outlet Emissions (Mass)



Concluding Remarks

Test data shows that the Switchmode Power Supply does put more Power in to the West chamber than the standard T/R's put in to the East chamber. Even so there is more Power put in to the precipitator on the west side the Switchmode supply uses less input KVA because of the .94 % Power factor.

Data shows that virtually all inorganic material, Flyash is collected. However more carbon is coming through on the West Side this phenomenon has not been explained and needs to be further investigated. The LOI at this plant runs above 30%

Finally, for reasons not understood the collection improves on the West Side during the IE mode of operation and is as good as on the East Side and further more During the IE mode of operation further power savings are realized.

Acknowledgements

The Author acknowledges that major support was provided by Gerry Klemm of the SouthernCompany. Additional support was provide by Ralph Altman of EPRI