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# **Mercury Control Technology R&D Program Review**

**Enhancing Carbon Reactivity for Mercury Control in  
Coal-Fired Power Plants: Results from Leland Olds,  
Stanton, and Antelope Valley Stations**

**Michael J. Holmes**

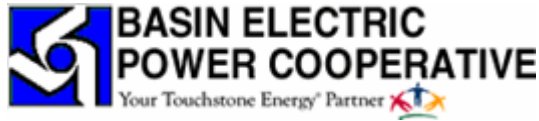
**DOE COR: Lynn Brickett**

**December 11, 2006**

# Members of the Lignite-Based Consortium



North Dakota Industrial Commission



Westmoreland Coal



# General Site Information

Plant	Coal	Boiler Type	Boiler Size <sup>1</sup> , MW	Particulate Control	SO <sub>2</sub> Control
LOS1 <sup>2</sup>	Lignite-PRB Blend	Wall fired	220 (110)	ESP <sup>3</sup> SCA <sup>4</sup> =320	None
SS10	Freedom	Tang. fired	60	FF <sup>5</sup>	Spray dryer
AVS1	Freedom	Tang. fired	440	FF	Spray dryer
SS1	PRB <sup>6</sup>	Wall fired	140 (70)	ESP SCA=470	None

1 Total size of the boiler with the value in parentheses being the test size.

2 Fires mostly ND lignite; however, periodically fires a 30% blend of PRB coal.

3 Electrostatic precipitator.

4 Specific collection area, ft<sup>2</sup>/1000 acfm.

5 Fabric filter.

6 Stanton Station switched from lignite to PRB coal in 2005.

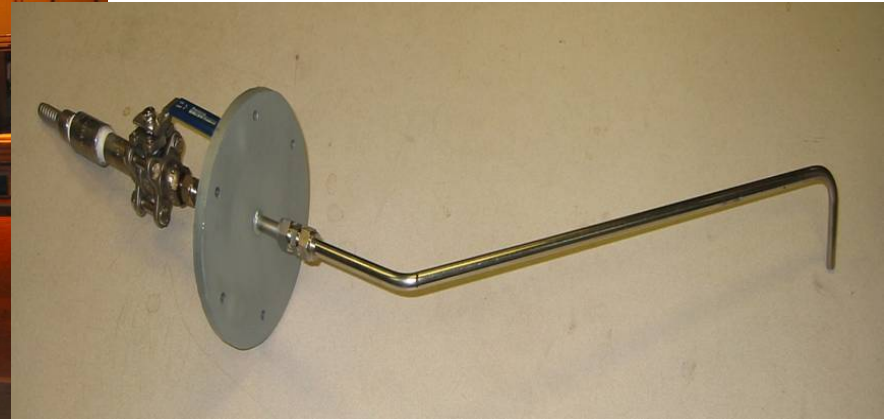
# Program Objectives

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- To demonstrate two enhanced sorbent injection technologies (treated carbons and SEA with carbon) to obtain greater than 55% Hg removal.
  - Measure technology performance
  - Evaluate balance-of-plant impacts
  - Conduct economic analysis of options



# SEA Skid and Injection Nozzle

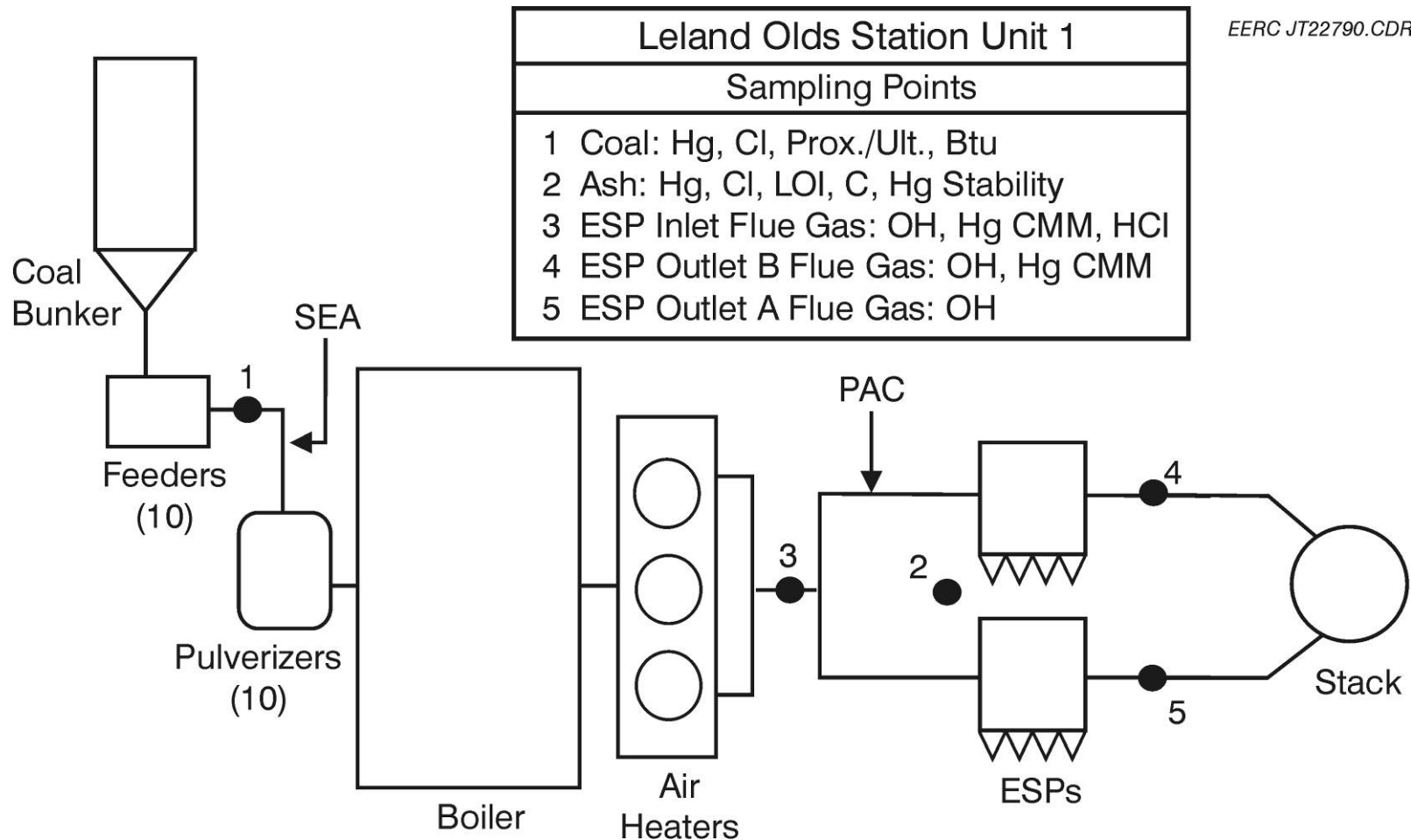




# PAC Storage Silo and Injection Equipment

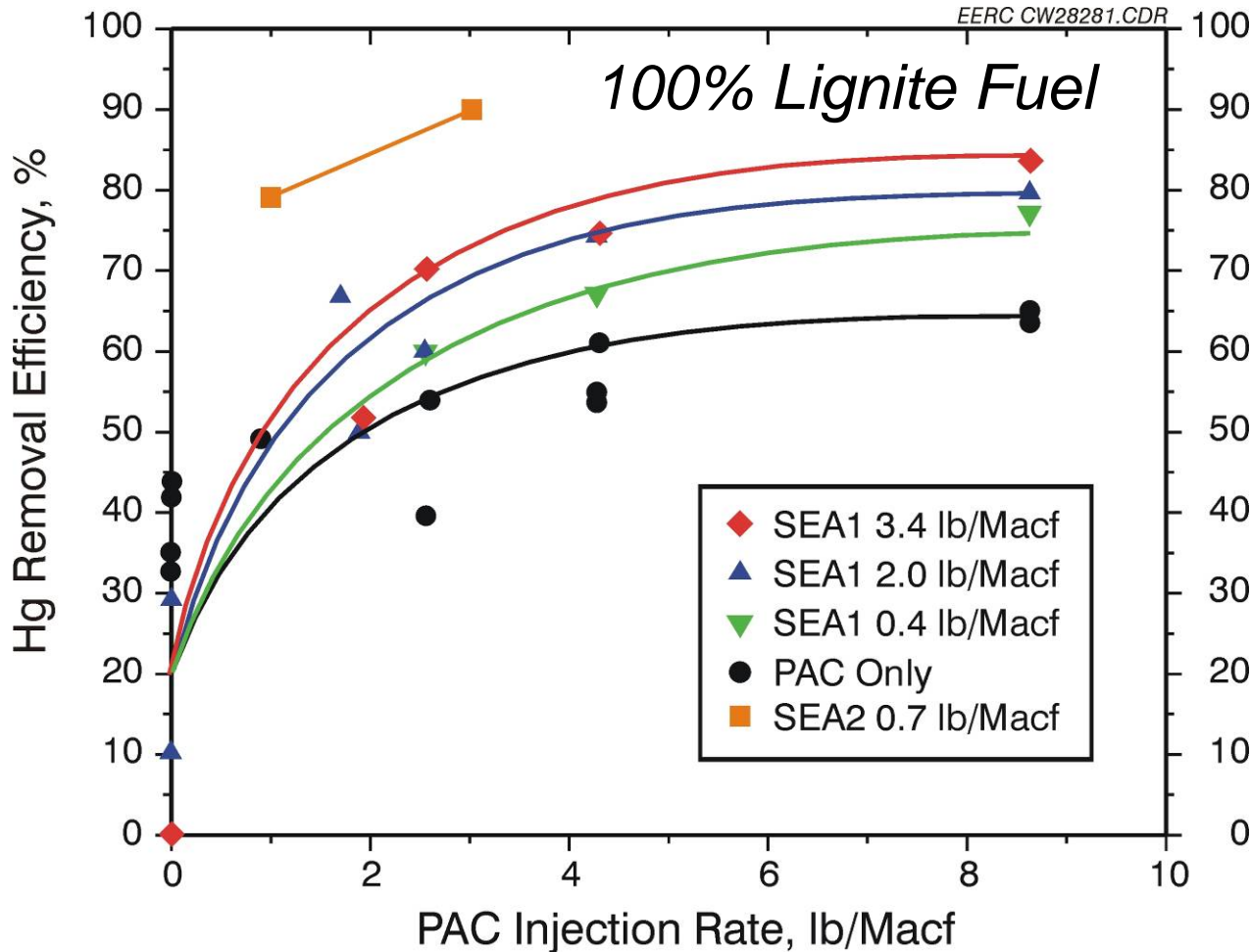


# Leland Olds Station (LOS) Unit 1



- 4% baseline Hg capture (ICR Basis)
- Testing occurred March–May 2004

# LOS Parametric Results

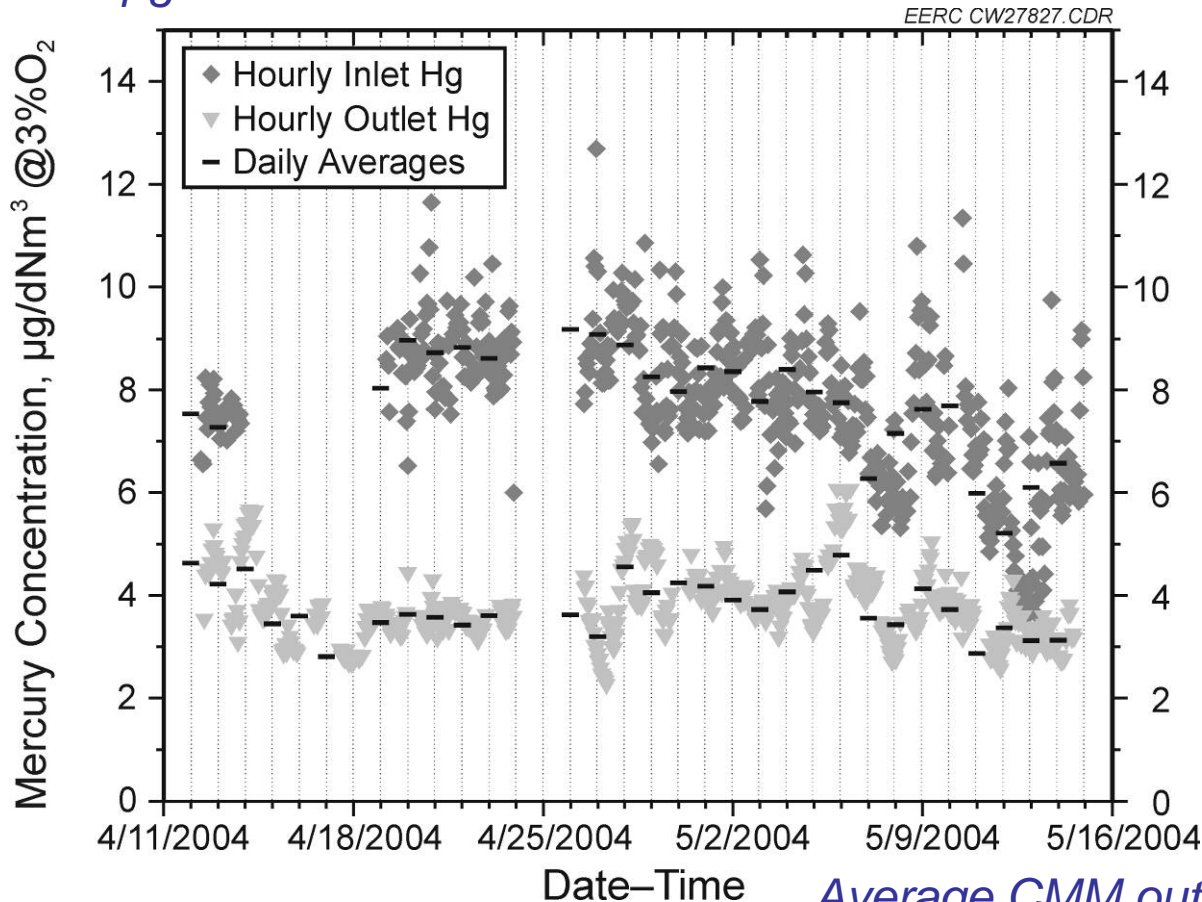


*Parametric testing of 30% PRB blended fuel showed similar results.*



# Results from LOS

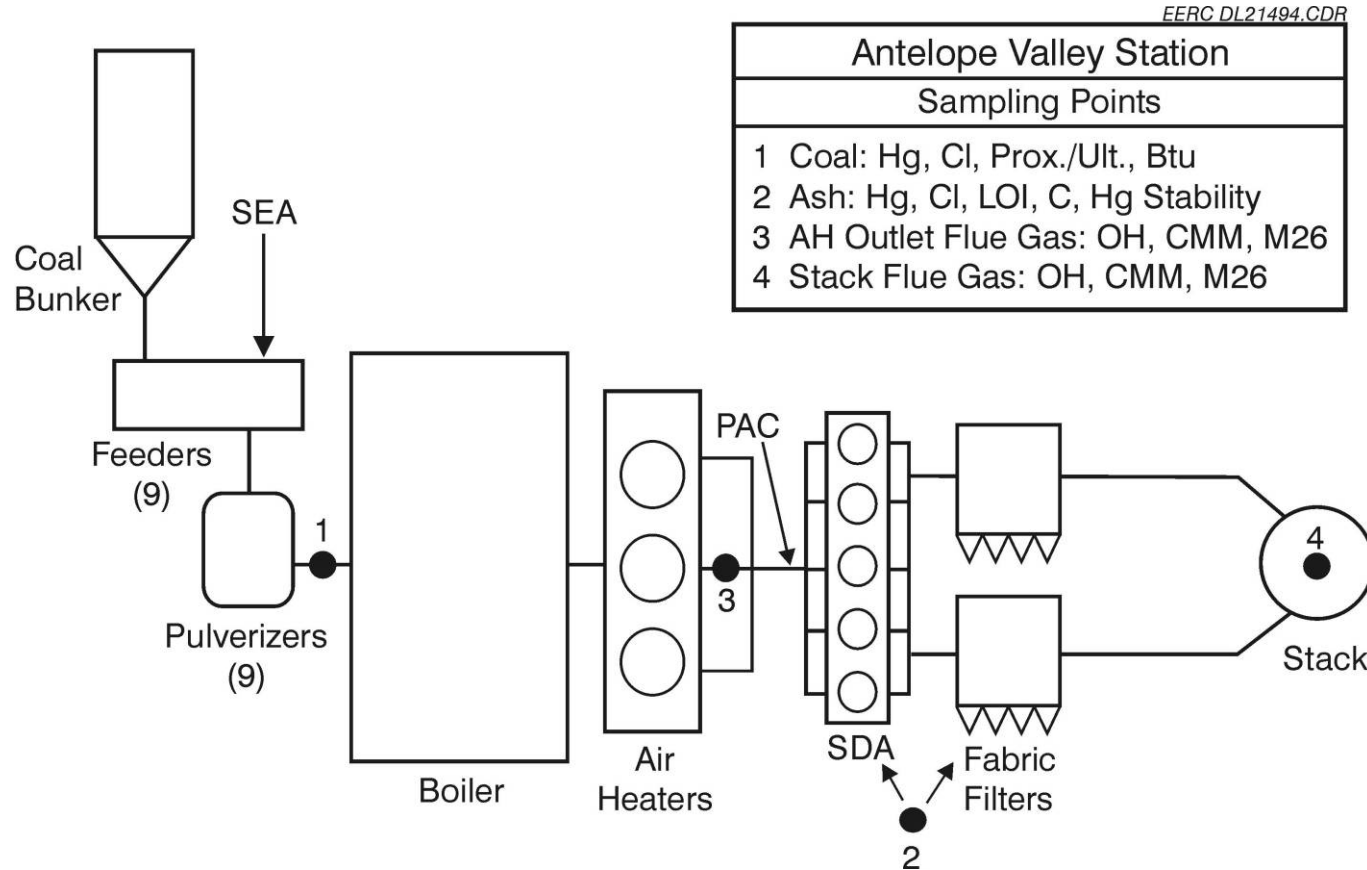
Average coal Hg:  
 $9.05 \mu\text{g/dNm}^3$



Average CMM outlet:  
 $3.8 \mu\text{g/dNm}^3$

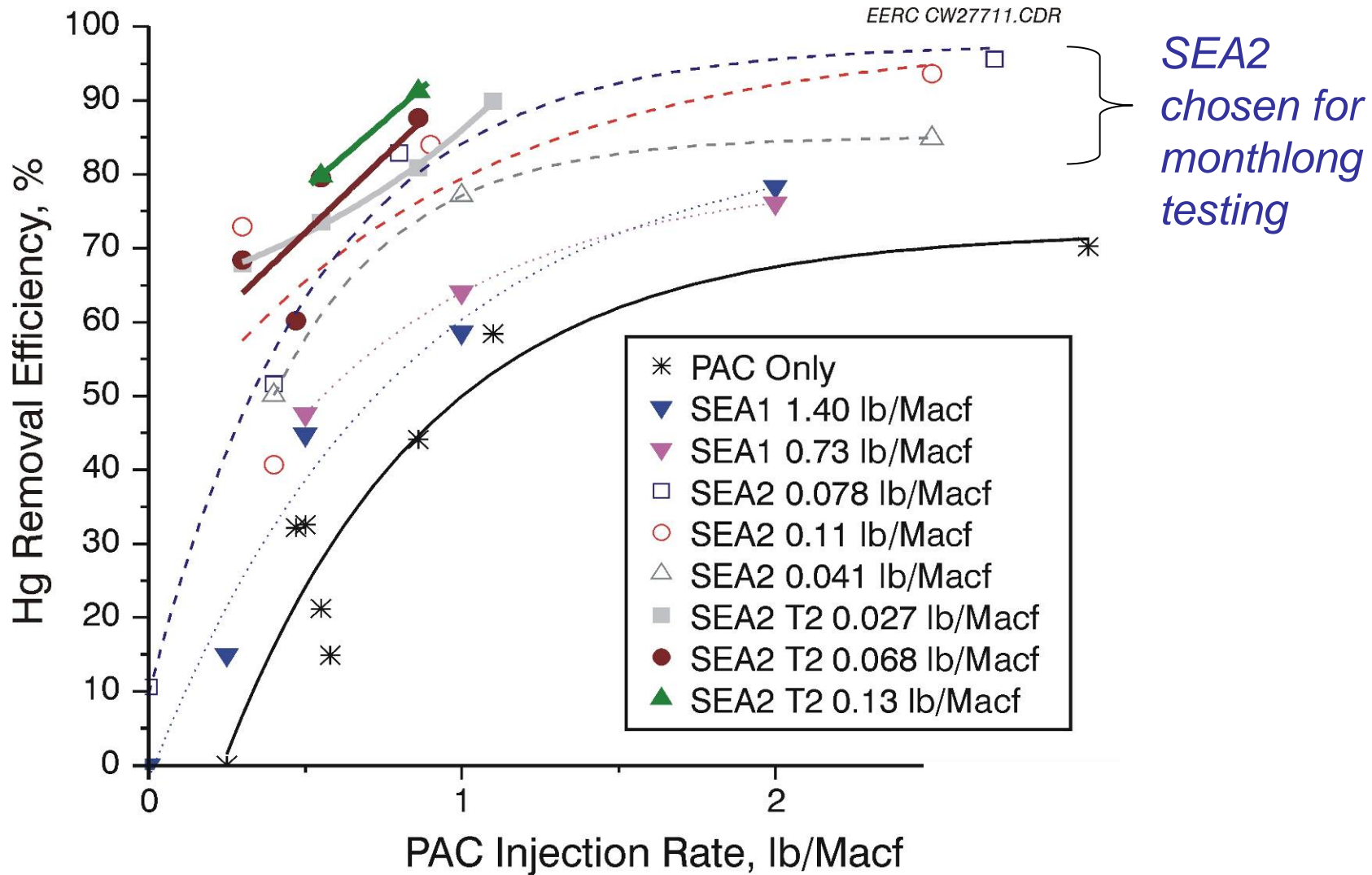
- Average injection rates
  - 2.9 lb/Macf SEA1
  - 2.7 lb/Macf PAC
- Overall 58% Hg capture across ESP
- Hg emission 2.14 lb/TBtu

# Antelope Valley Station (AVS) Unit 1



- **No native capture across SDA/FF (ICR Basis)**
- **Testing occurred February–April 2005**

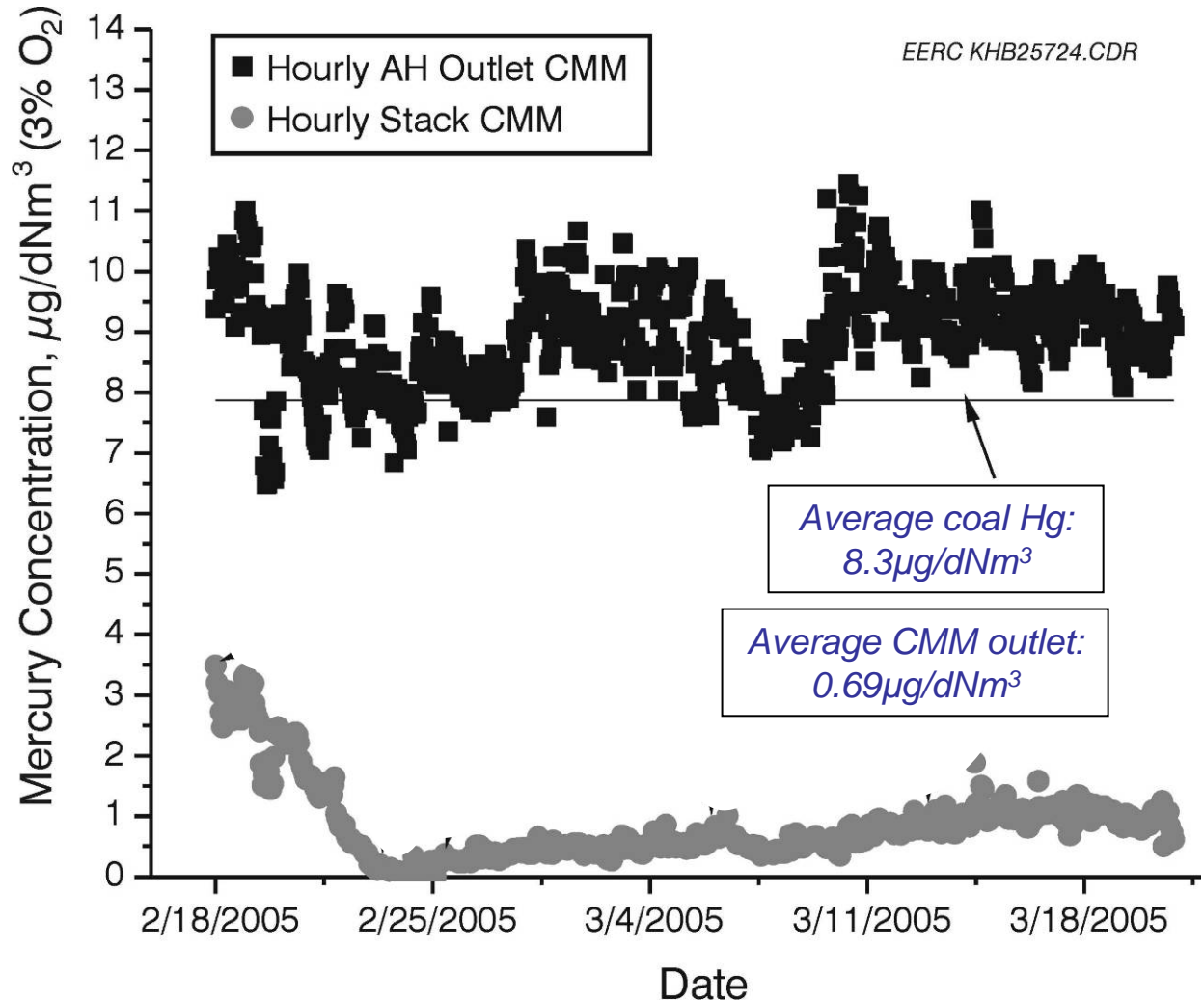
# Parametric Tests at AVS



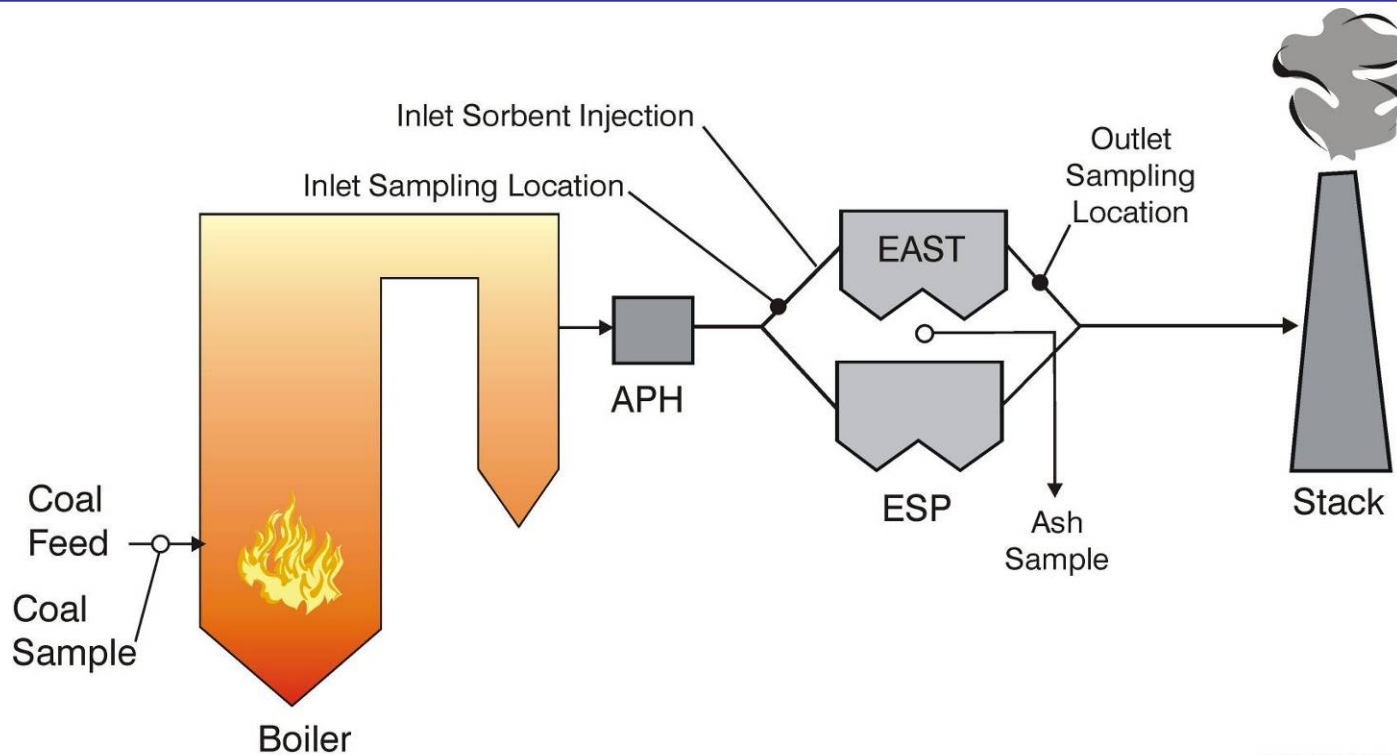


# Results from AVS

- Average injection rates
  - 0.81 lb/Macf PAC
  - 0.033 lb/Macf SEA2
- Overall Hg removal of 92% across SDA–FF
- Hg emission 0.55 lbTBtu



# Stanton Station (SS) Unit 1

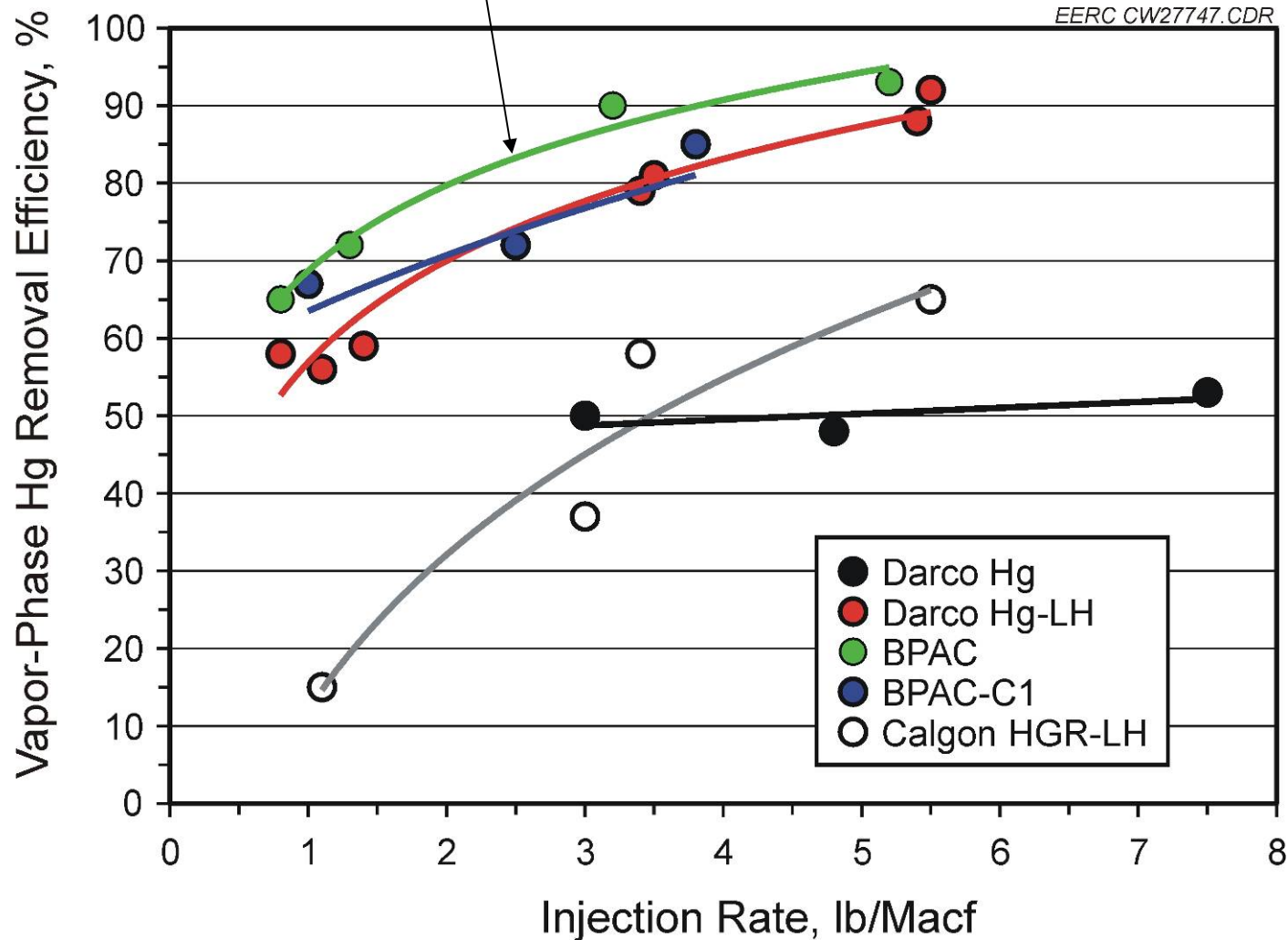


EERC DL21572.ODR

- **75%–90% elemental mercury at ESP inlet**
- **No baseline Hg capture (ICR basis)**
- **Testing occurred: July, September–October 2005**

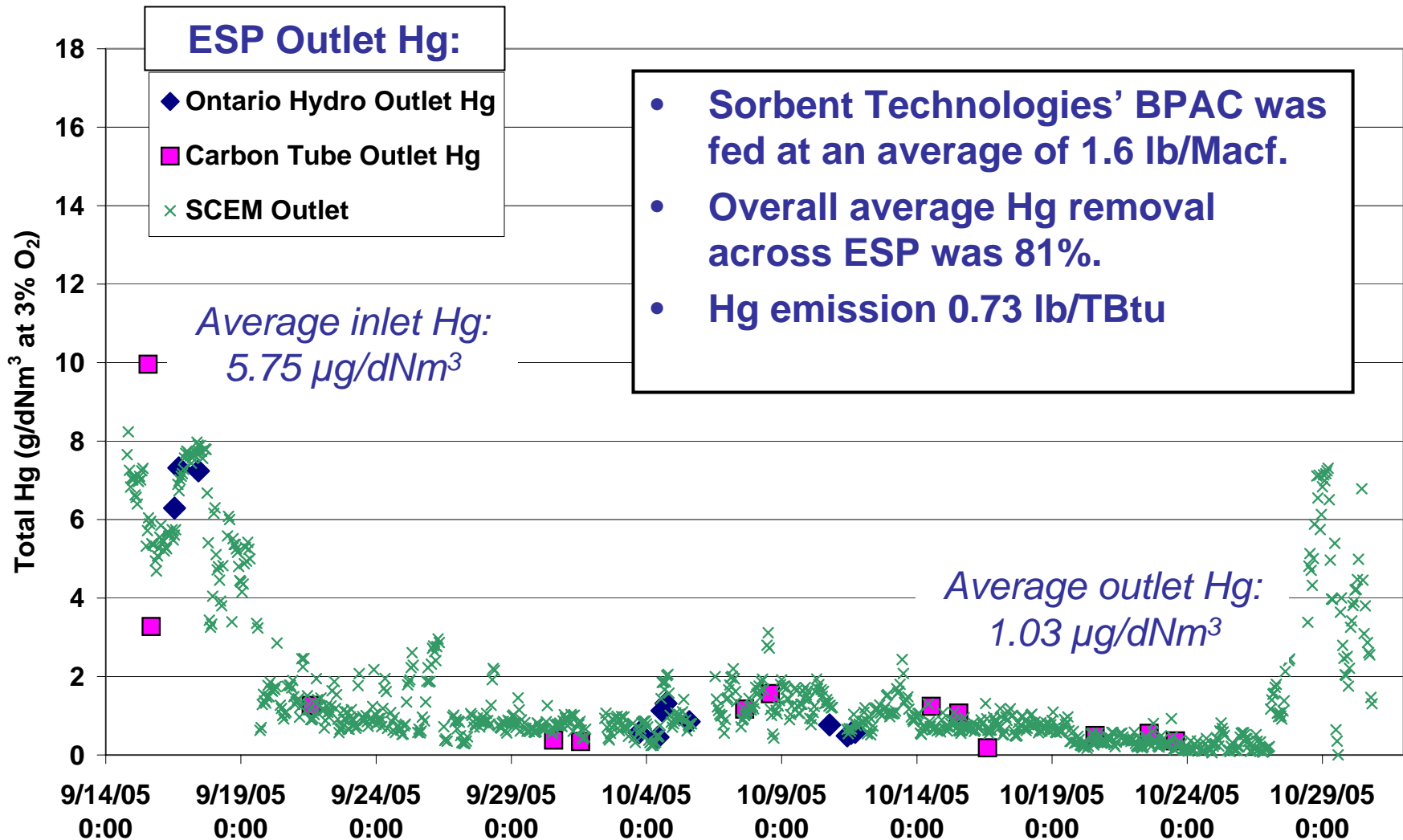
# Parametric Tests at SS1

## *BPAC Chosen for Monthlong Testing*



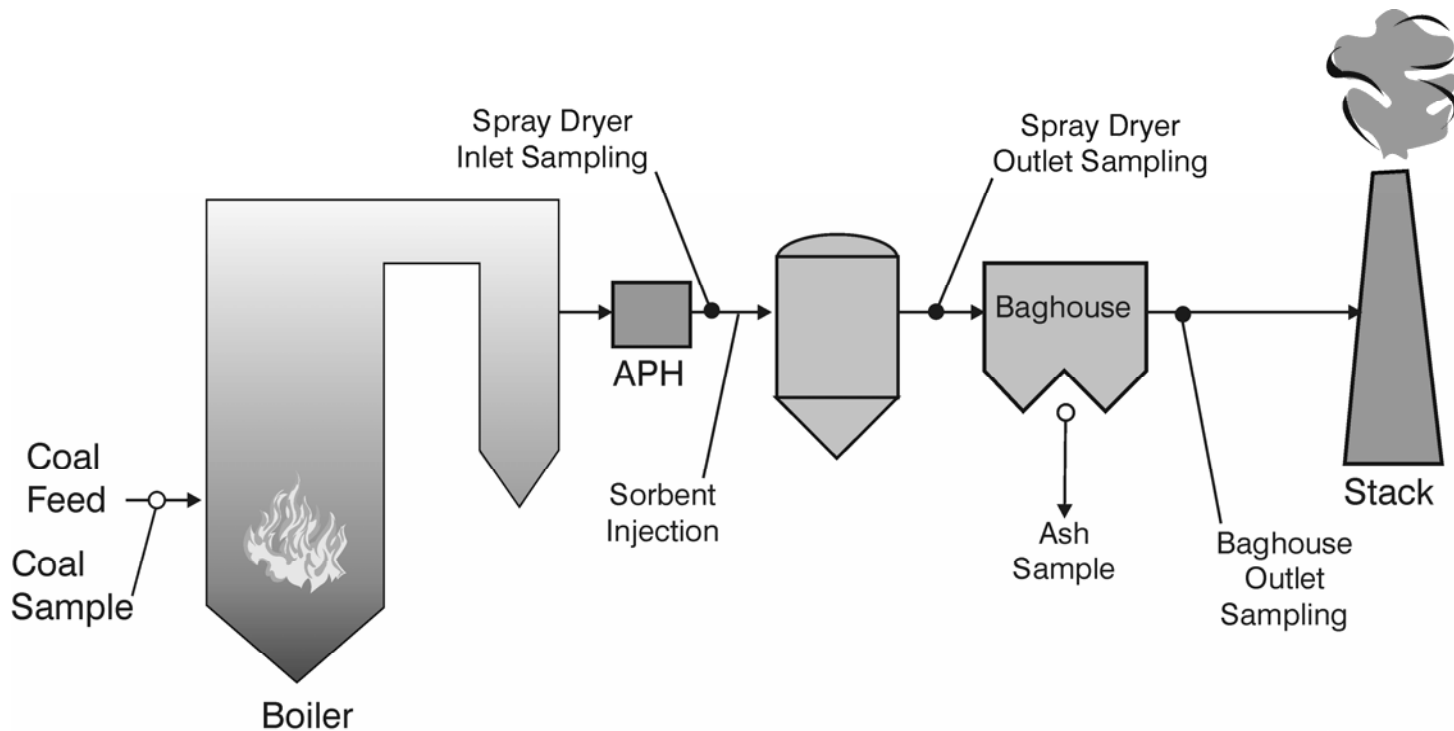


# Results from SS1



# Stanton Station (SS) Unit 10

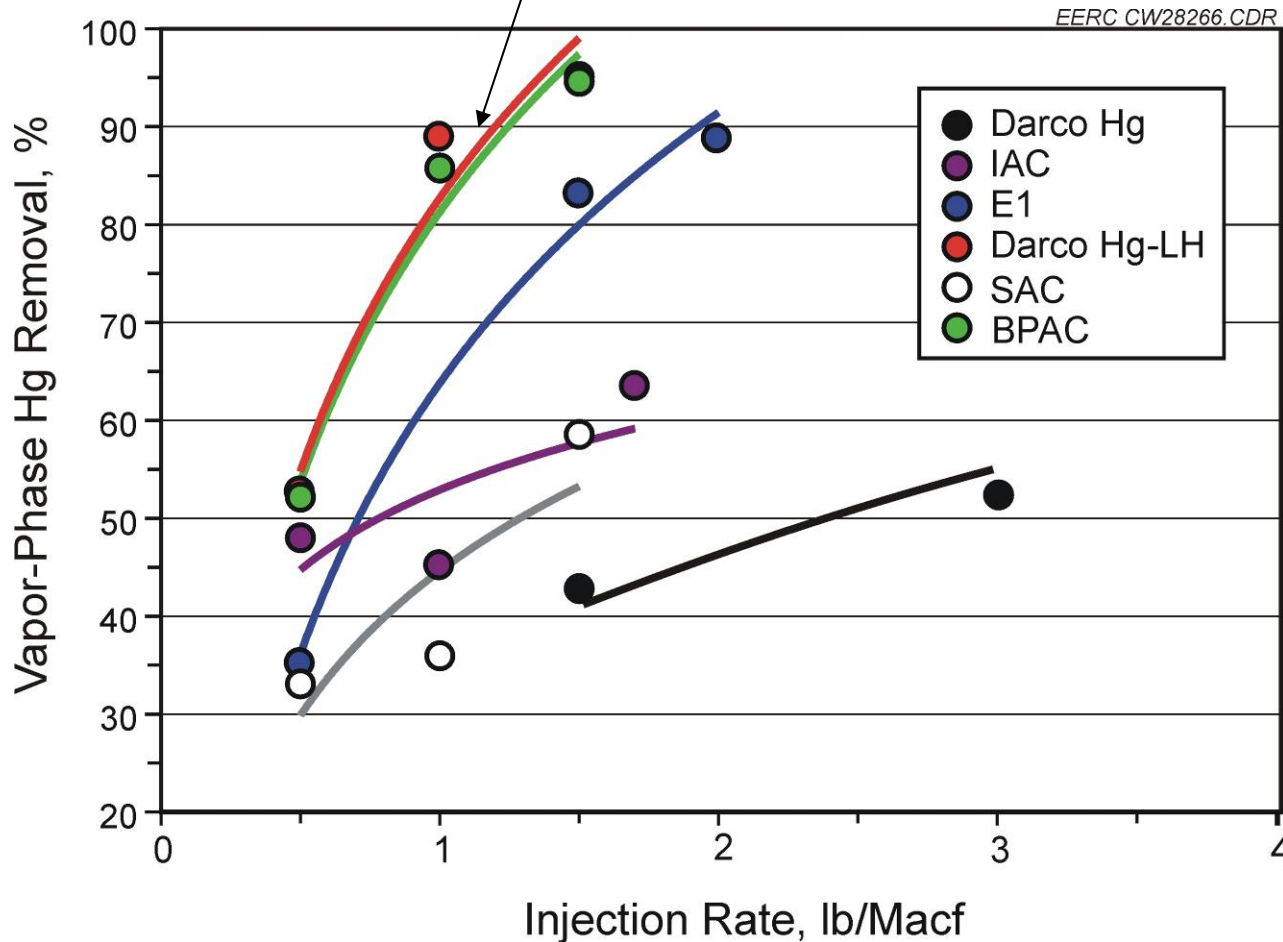
- 3% native Hg capture across SDA–FF system (ICR basis)
- Testing occurred March–April, June 2004



EERC DL21571.CDR

# SS10 Parametric Results

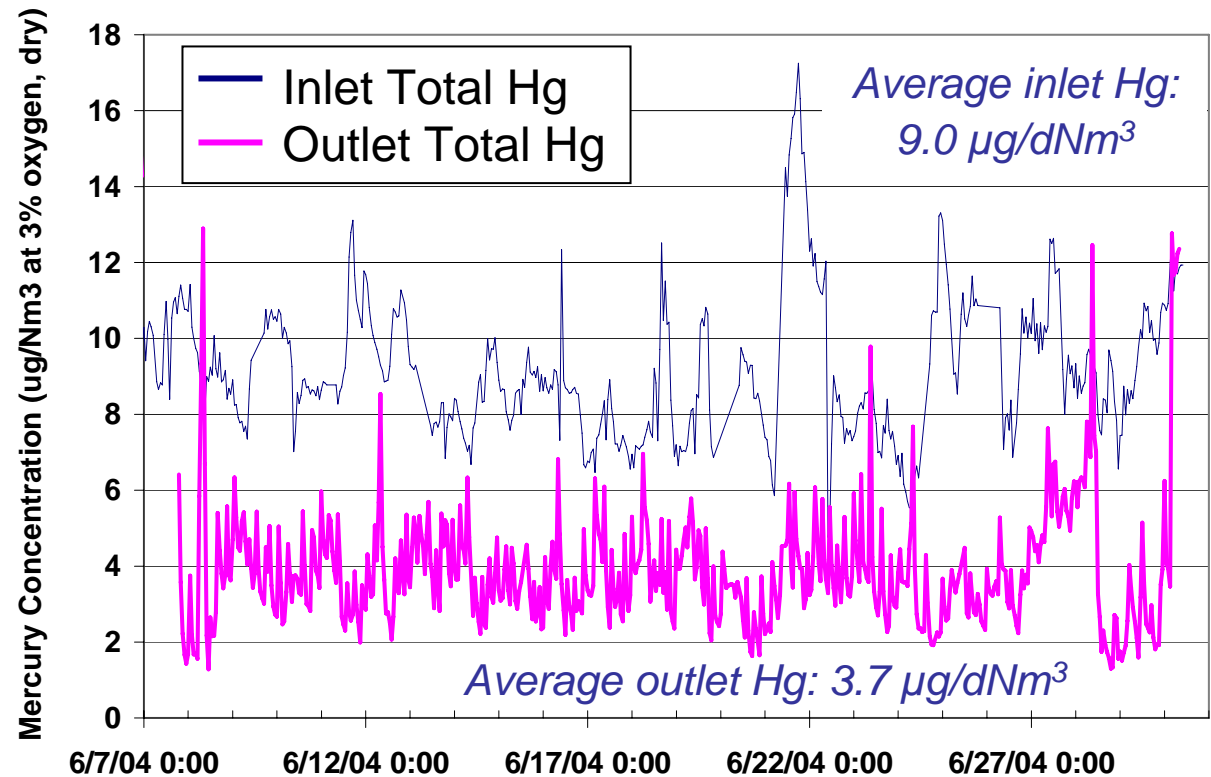
## DARCO Hg-LH Chosen for Monthlong Testing



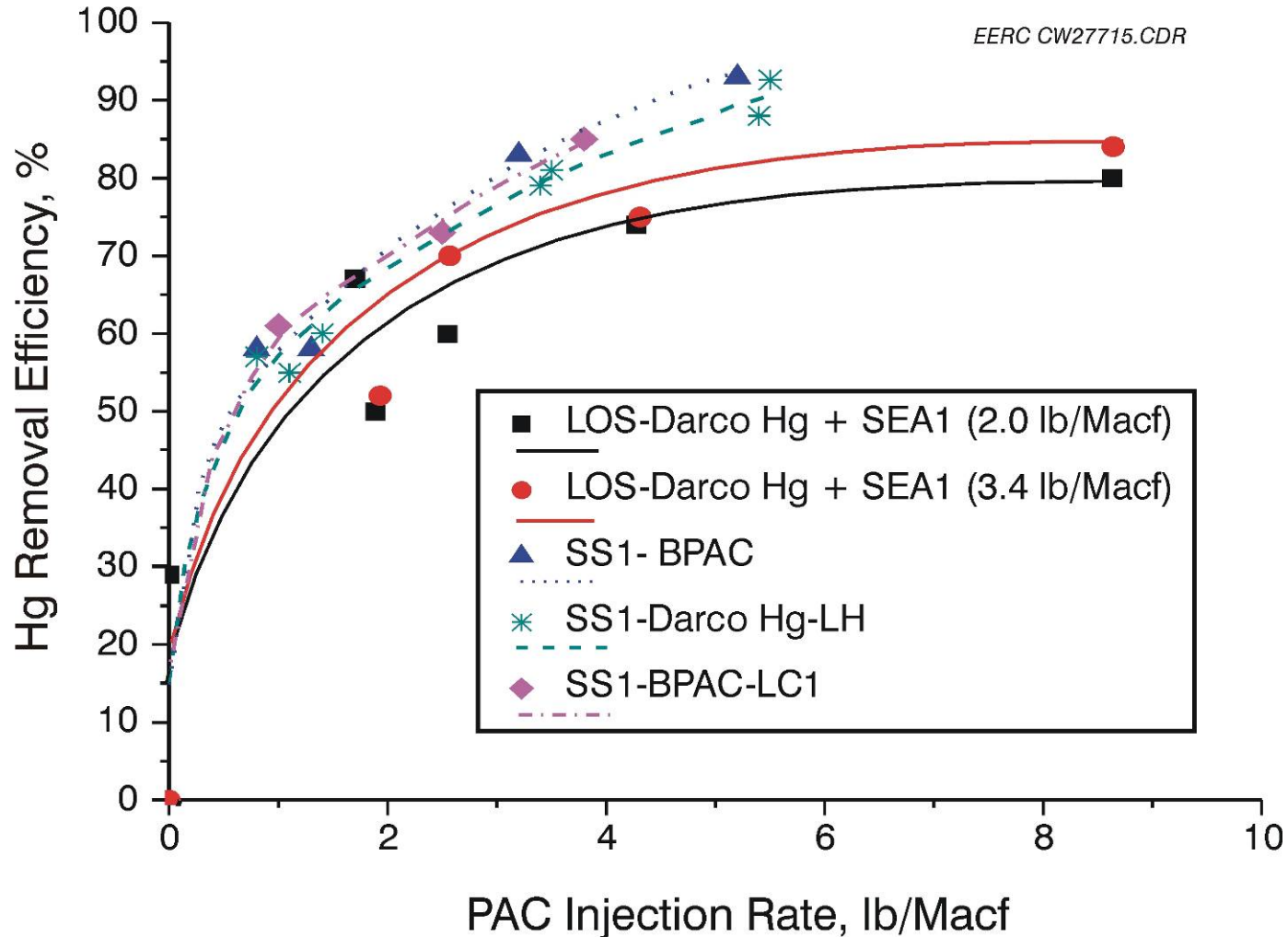


# Vapor-Phase Hg During Monthlong Testing at SS10

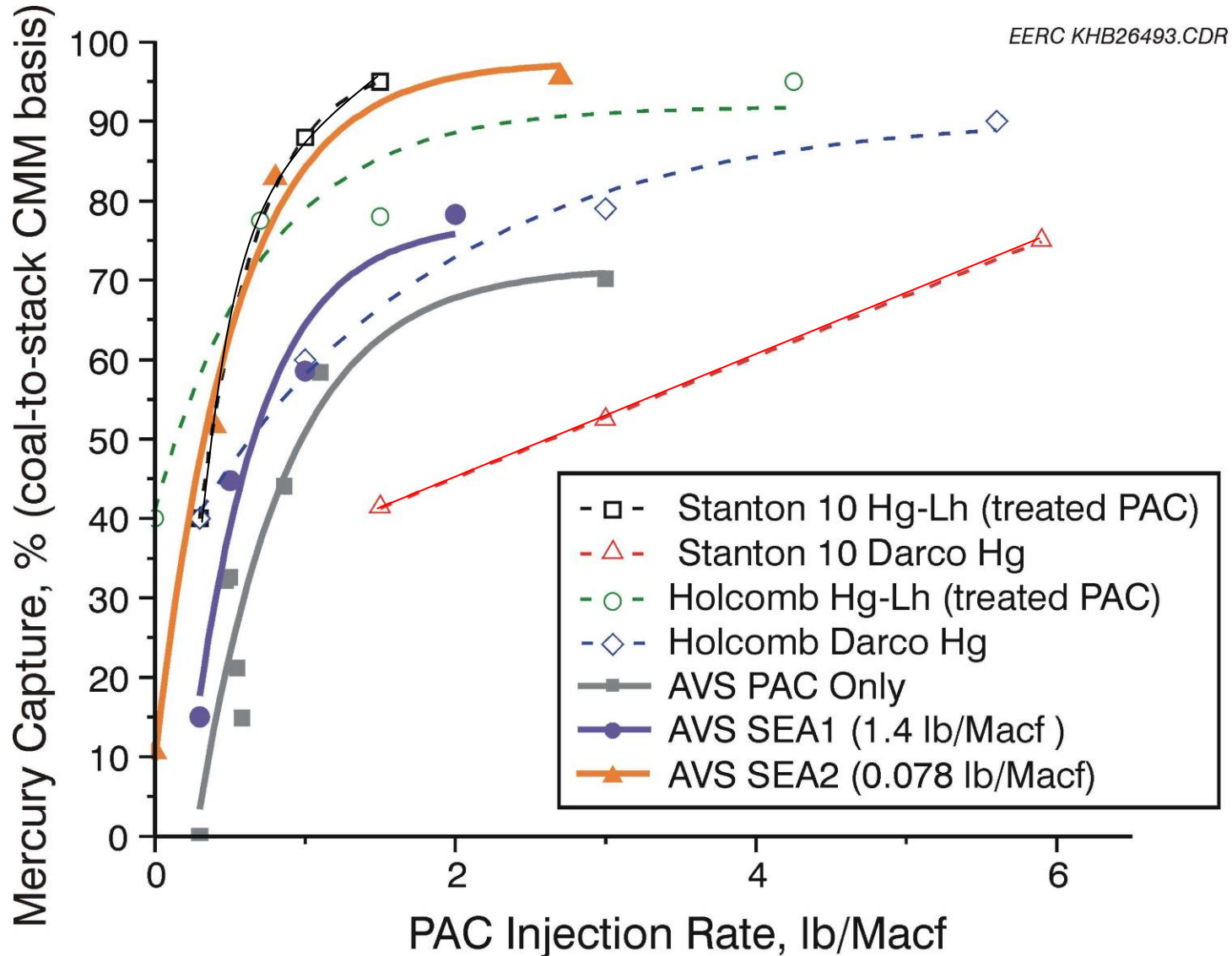
- Darco Hg-LH injected at an average of 0.7 lb/Macf
- Overall Hg capture across SDA–FF: 59%
- Hg emission 2.74 lb/TBtu



# Comparison – Parametric Tests at ESP Sites (LOS and SS1)

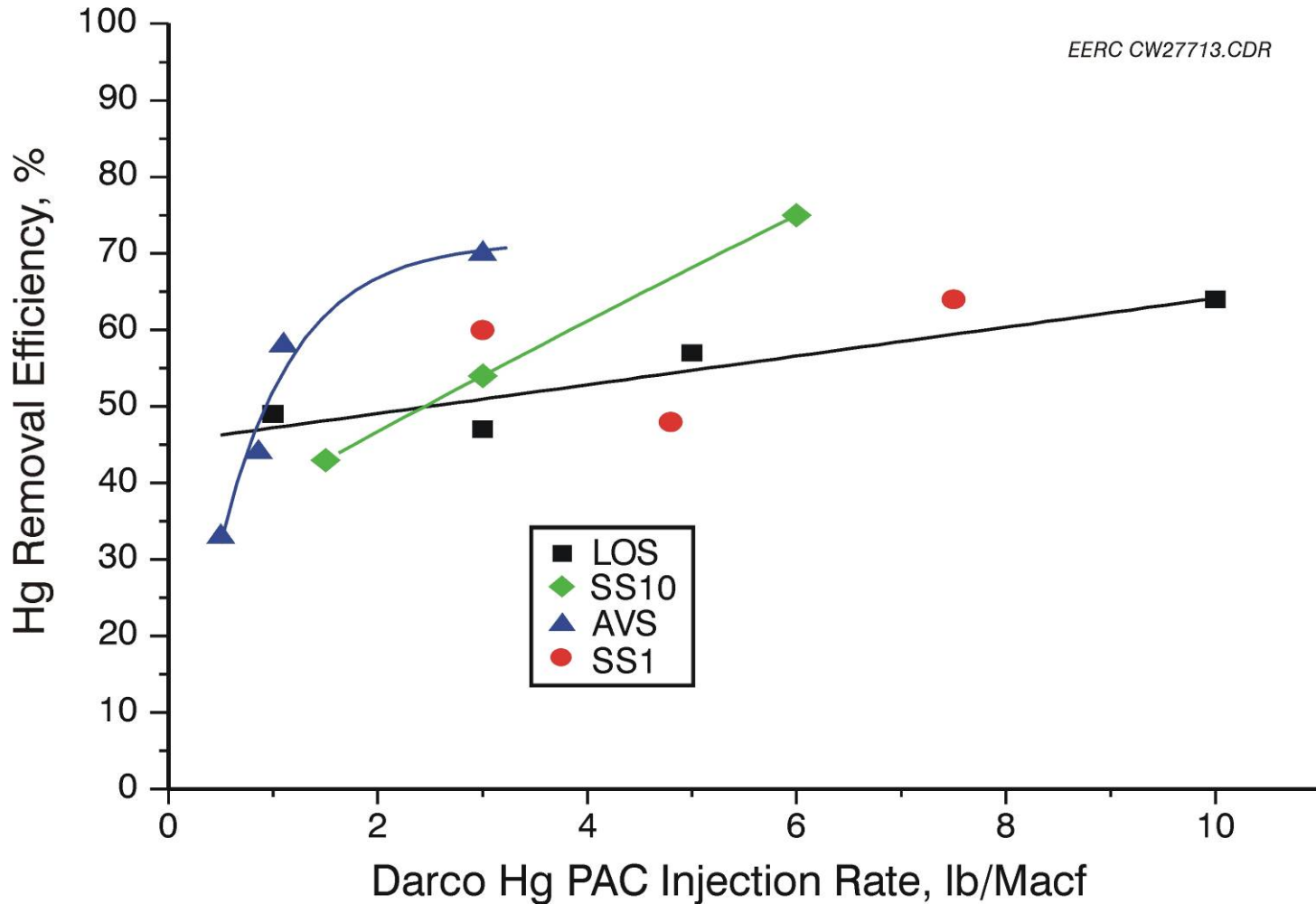


# Comparison – Parametric Tests at Three SDA–FF Sites

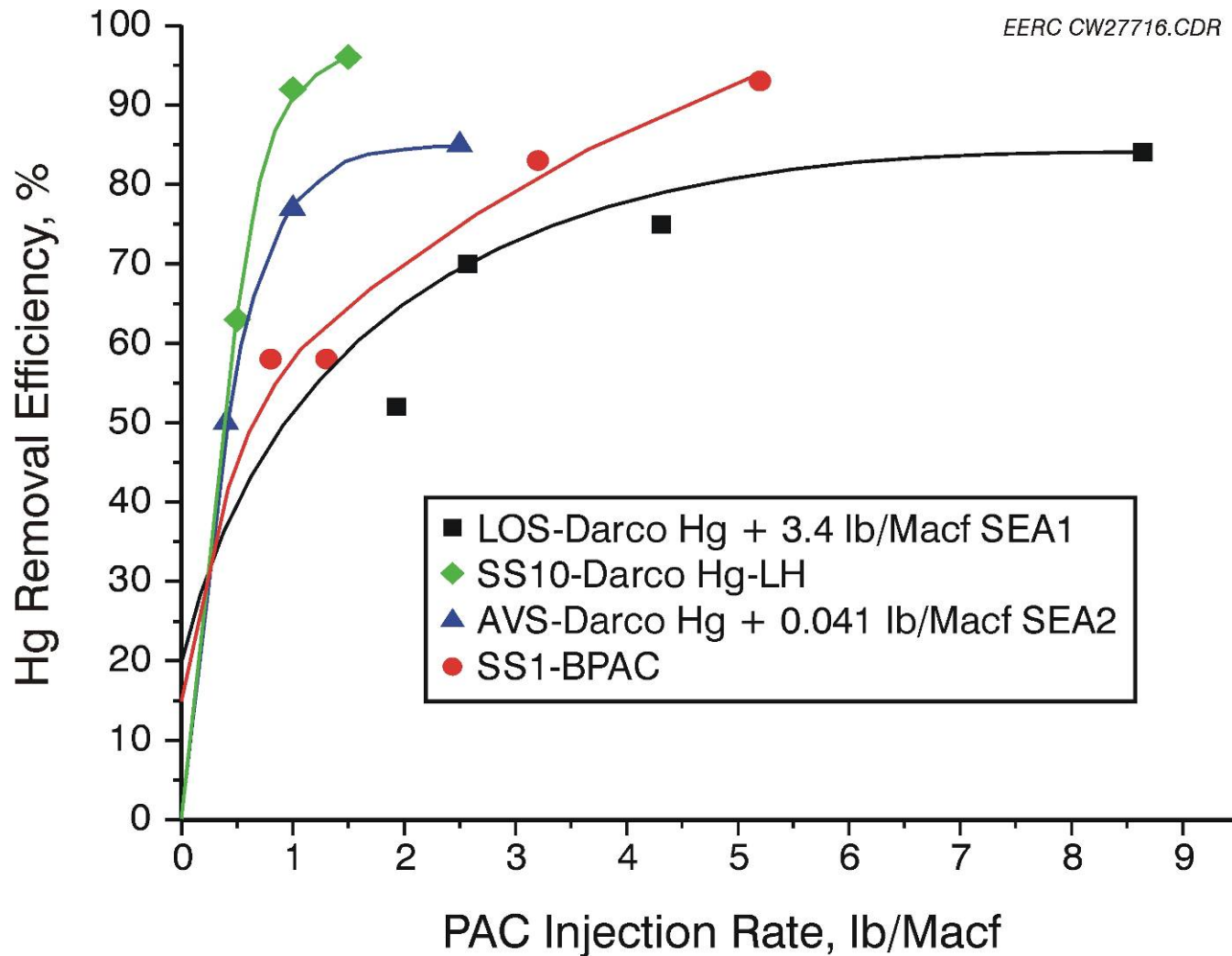




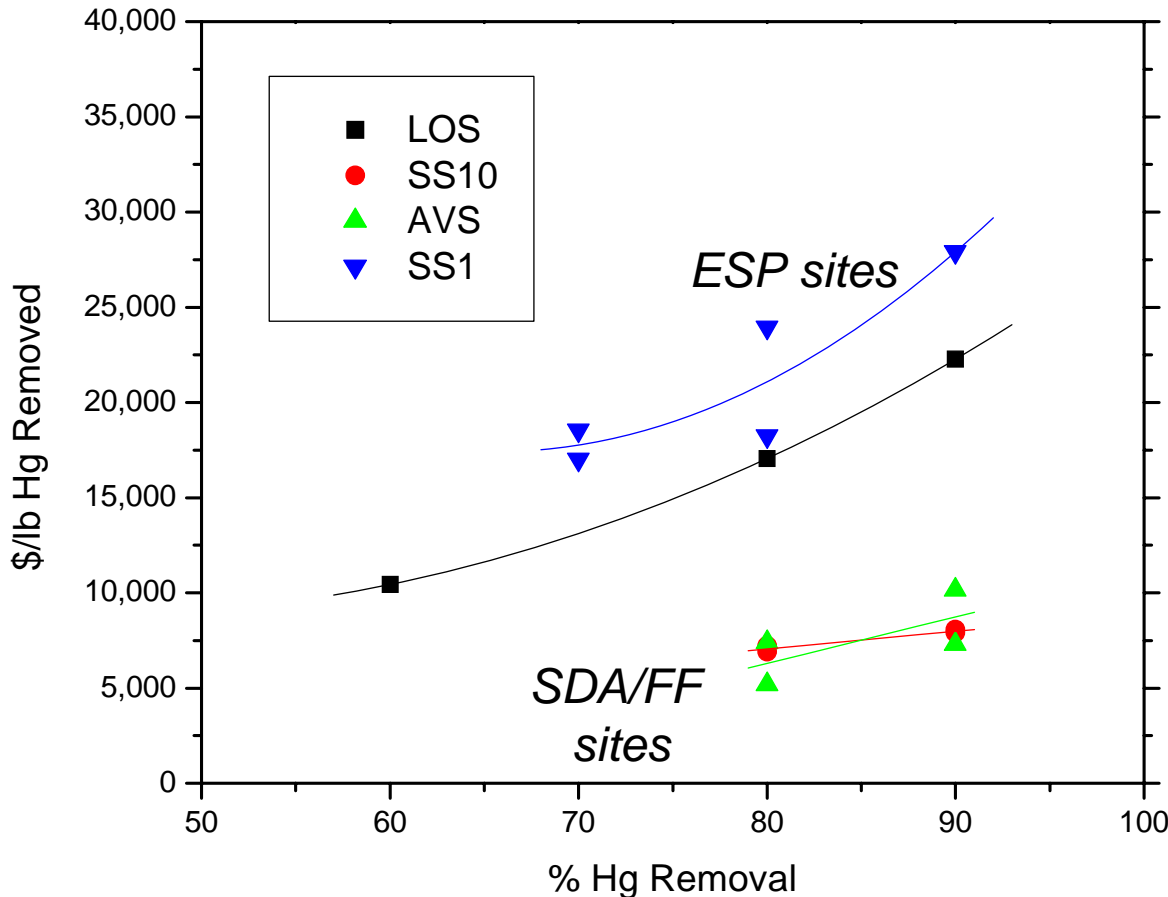
# Parametric Test Results – Darco Hg



# Parametric Test Results – All Sites



# Hg Reduction Cost/lb for Halogenated PAC and SEA+PAC



- Cost of PAC only, per lb Hg removed
  - LOS: \$69,168 (50% removal)
  - SS1: \$57,500 (60% removal)
  - AVS: \$18,032 (70% removal)
  - SS10: \$14,710 (70% removal)

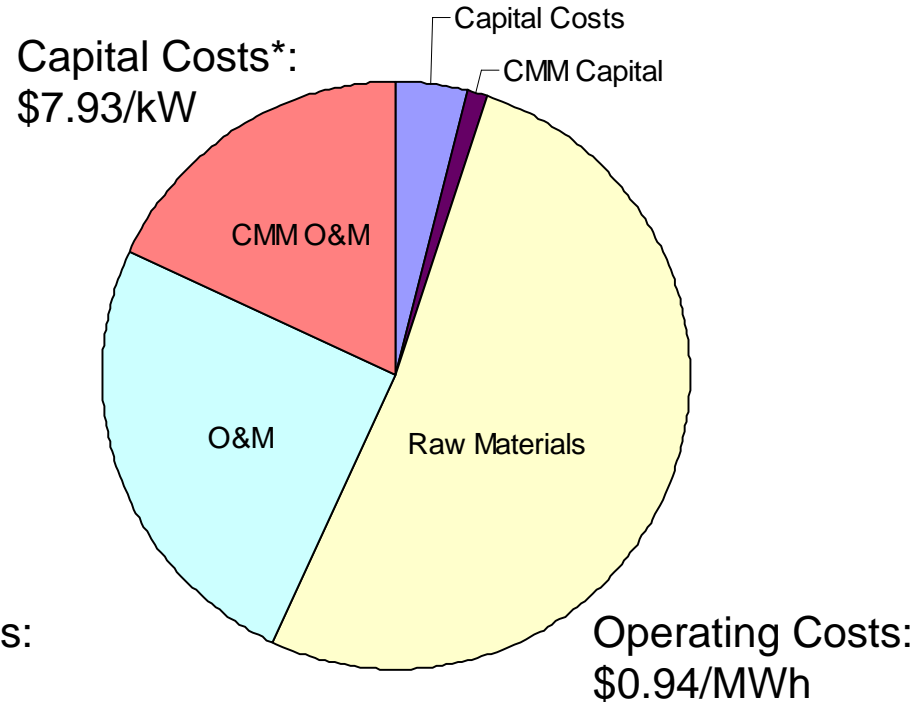
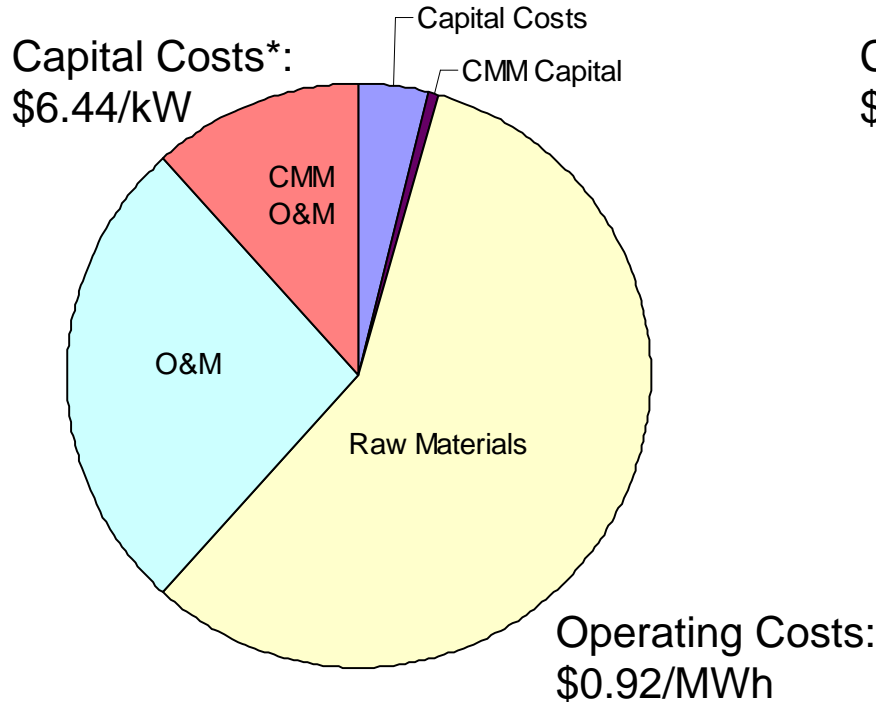
# Cost Breakdown for ESP Sites

LOS – Darco Hg and SEA2

Total Cost: \$19,103/lb Hg Removed  
(at 80% removal)

SS1 – BPAC

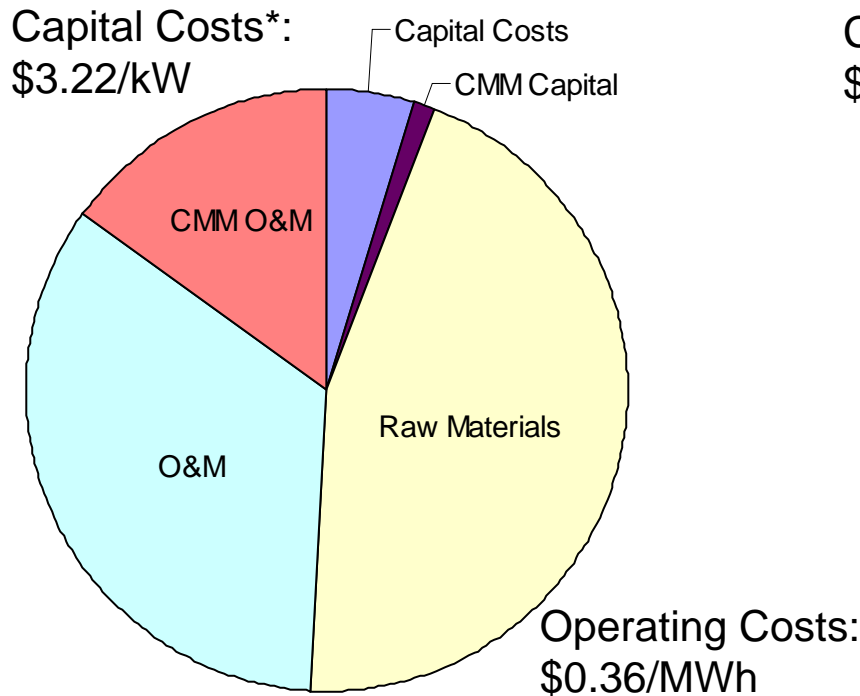
Total Cost: \$21,949/lb Hg Removed  
(at 80% removal)



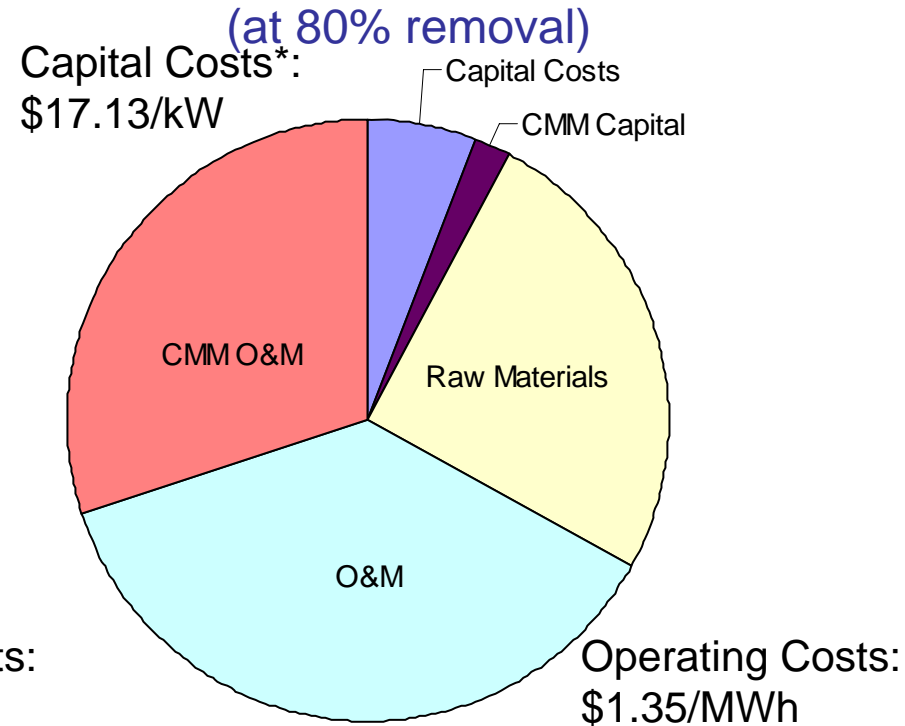
\*Capital costs amortized over a 20-year period.

# Cost Breakdown for SDA-FF Sites

AVS – Darco Hg and SEA2  
 Total Cost: \$6,054/lb Hg Removed  
 (at 80% removal)



SS10 – DARCO Hg-LH  
 Total Cost: \$10,464/lb Hg Removed  
 (at 80% removal)



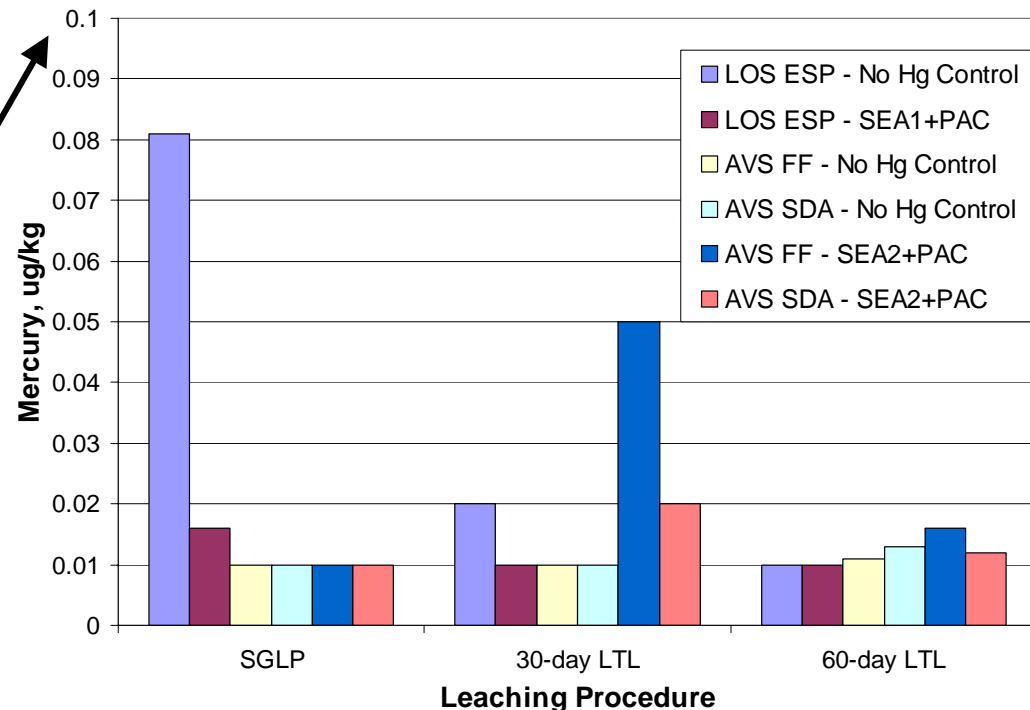
\*Capital costs amortized over a 20-year period.



# Mercury Stability in Coal Combustion Byproducts (CCBs)

- Baseline and monthlong CCBs were tested.
  - Ash from ESP at LOS
  - Ash from FF and solids from SDA at AVS
- Leaching results were all below 0.1 ug/L Hg.
- The primary drinking water limit is 2 µg/L.
- Most Hg was thermally desorbed between 300° and 370°C.

Mercury Leaching - Coal Combustion Byproducts



# Balance-of-Plant Impacts

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- No measurable changes in
  - Corrosion
  - Opacity
  - Pressure drop
  - ESP and FF operation



Corrosion/deposition probe assembly

*Much longer operation is needed to fully characterize the long-term effects of PAC and SEA injection.*

Final program report under review.