Evaluation of Sorbent Injection for Mercury Control

DOE/NETL's 2007 Mercury Control Technology Conference

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Project Co-funders

AmerenUE
American Electric Power
DTE Energy
Dynegy Generation
MidAmerican
Ontario Power Generation
Southern Company
TVA

ADA-ES
Arch Coal
EPCOR
EPRI
Babcock & Wilcox
NORIT Americas
Calgon Carbon

DOE Cooperative Agreement DE-FC26-03NT41986
DOE/NETL Project Manager: Andrew O'Palko
EPRI Project Manager: Ramsay Chang

Key Team Members

- ADA-ES
  - Sharon Sjostrom
  - Tom Campbell
- AmerenUE
  - Tom Orscheln
  - Brian Griffen
- Sargent & Lundy
  - Steve Wahlert (Retired)
  - Larry Illingworth
- EPRI
  - Ramsay Chang
- DOE NETL
  - Andrew O'Palko

Project Focus Areas (2003-2007)

- Evaluate effectiveness of sorbent injection for mercury control in unproven environments
  - Low halogen flue gas (PRB, SDA)
    - Holcomb, Laramie River, Meramec, Labadie
  - Mid-sized ESPs
    - Monroe
  - High sulfur flue gas or high SO_3
    - Conesville, Labadie

Goal: Reduce the uncontrolled mercury emissions by 50 to 70% at a cost 25 to 50% lower than DOE basis ($45,000/lb Hg removed)

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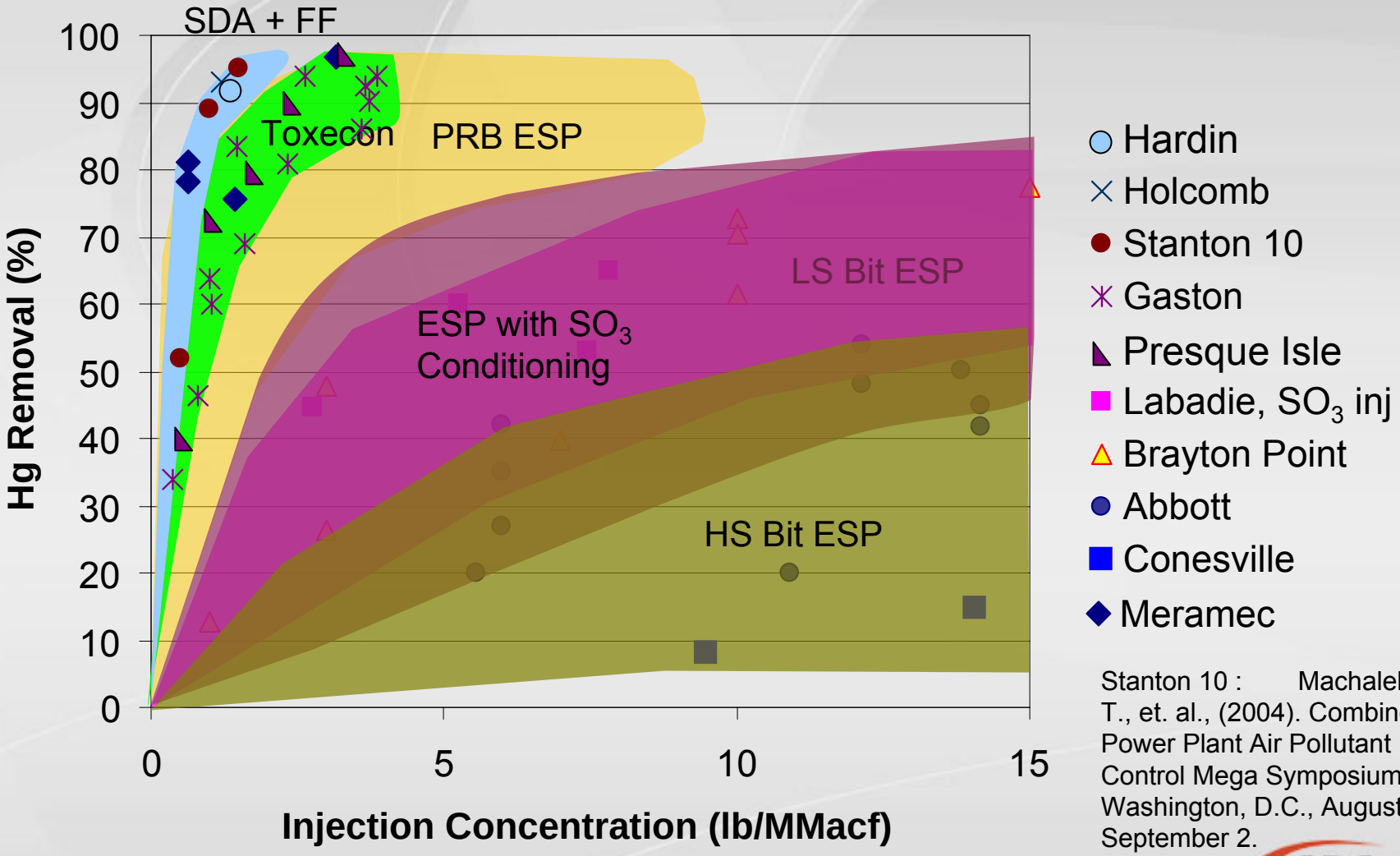
PAC Injection – Summary of Results



Stanton 10 : Machalek, T., et. al., (2004). Combined Power Plant Air Pollutant Control Mega Symposium, Washington, D.C., August 29–September 2.

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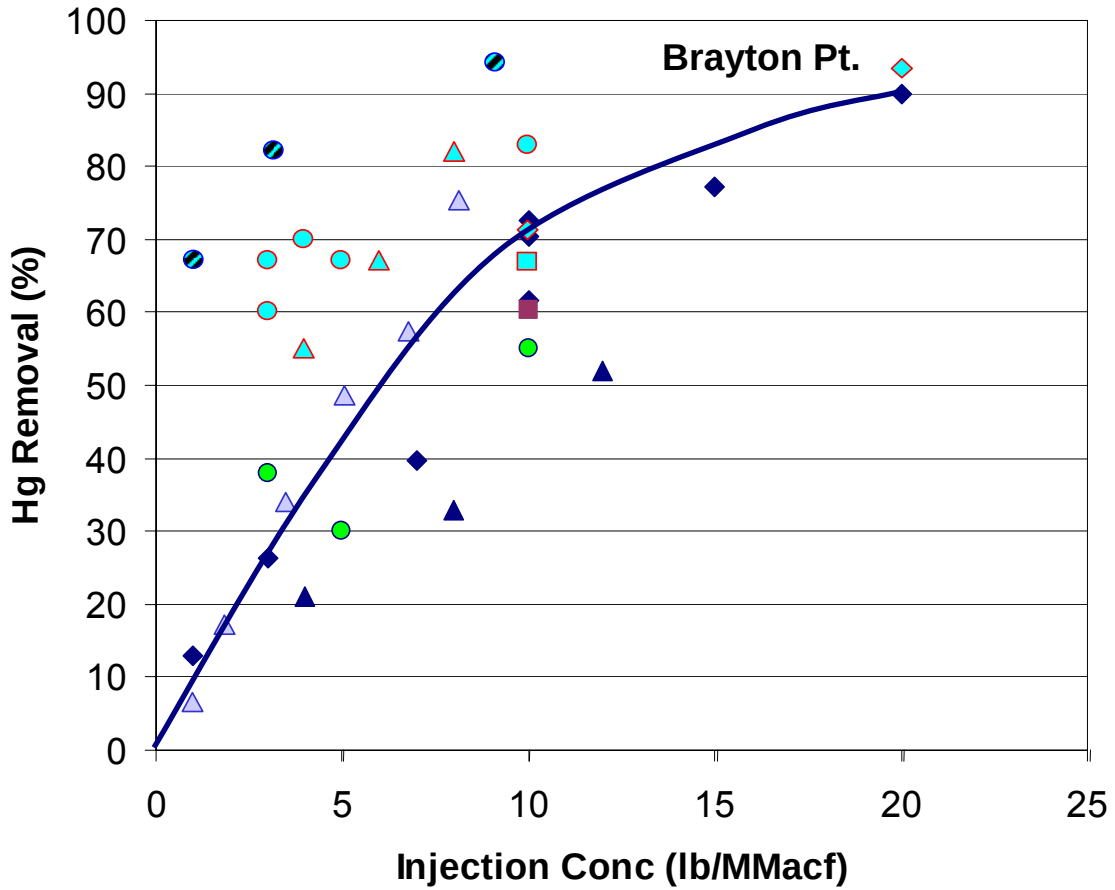
Impact of SO_3 Injection on Hg Removal ESP Results, PRB and Bituminous Coals



Lee Station U1 : DOE and Sorbent Tech DE-FC26-05NT42308 1Q06 Report

Plant Daniel: Berry, M. presented at The Mega Symposium, Baltimore, MD, August 28 31.

- Brayton Pt, SO3
- Lee, SO3
- Daniel, SO3
- PPPP, SO3
- Labadie SO3
- Brayton Pt, No SO3
- Lee, No SO3
- Daniel, No SO3
- PPPP, No SO3
- Labadie No SO3

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AmerenUE Labadie Power Plant Unit 2

- 630 MW
- Coal: PRB from various mines
- NOx control:
  LNB + SOFA
- SO_2 control:
  Compliance Coal
- Particulate Control:
  - Cold-Side ESP (SCA = 279 ft^2/kacfm)
  - SO_3 injection for FGC

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Labadie Goals

- Determine low cost and the effects of sorbent injection for control of mercury in stack emissions.
- Evaluate the effects of sorbent injection on the ESPs at varying SO_3 concentrations.

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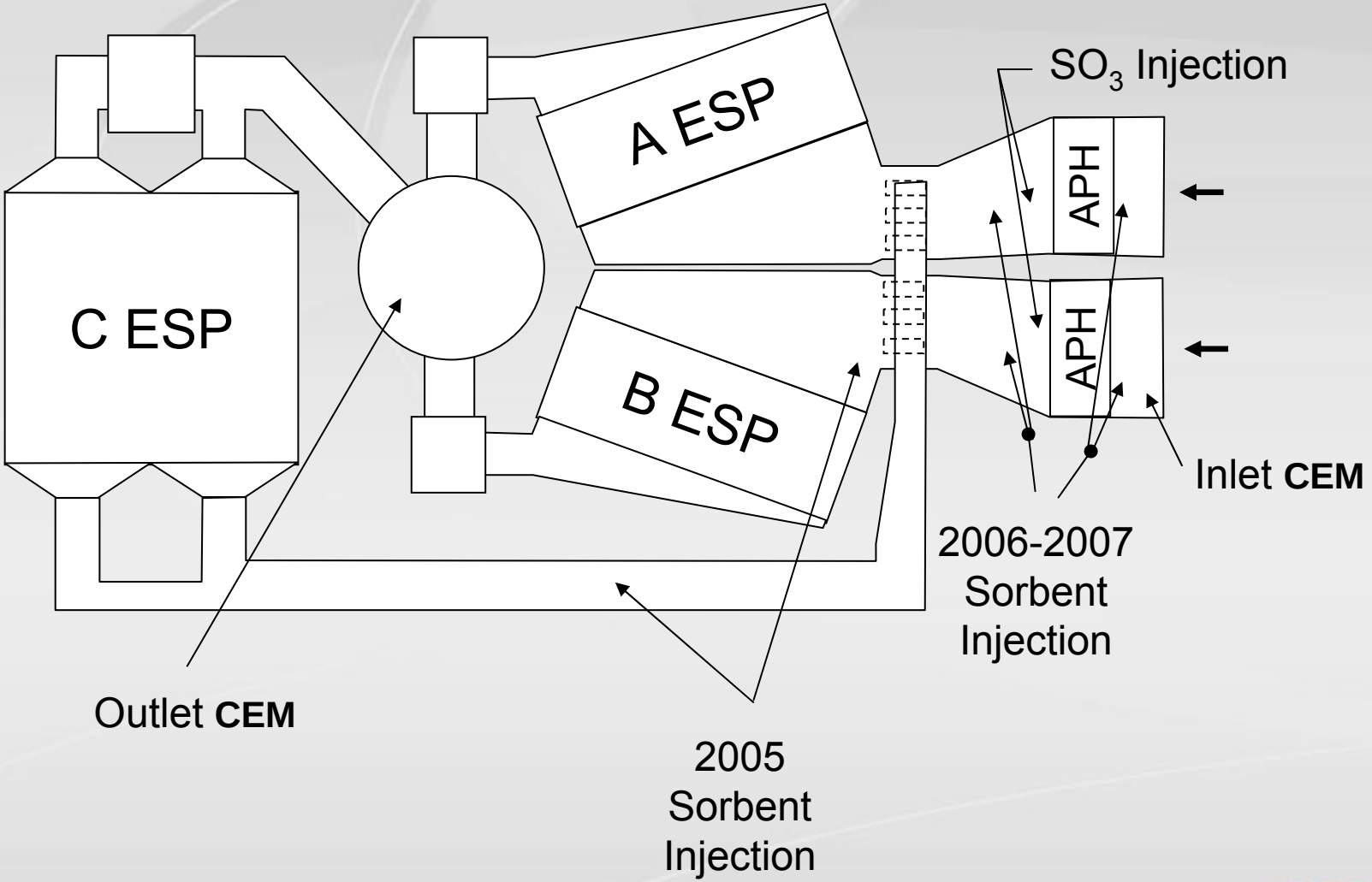
Labadie Unit 2 General Arrangement



ADA-ES Mobile Powdered Activated Carbon (PAC) Silo System

Super-Sacs

OR

PAC Storage Trailer

Portable CEM/ IRM (Method 30A)

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Mercury CEMs Quality Assurance Program

- Prior to shipment
  - All systems are undergo a comprehensive check-out prior to shipment to a project in accordance with ADA-ES established QA/QC program
- Arrival on site
  - Setup and checked out in accordance with ADA-ES established QA/QC program
  - Includes initial 2-point calibration check and linearity check
- During Operation
  - Daily zero/span check more strict than CAMR
    - CAMR “Critical” at Calibration Error > 5% (CE = |R-A|/S) or |R-A| = $\pm$ 1 µg/m^3 for < 5 µg/m^3
    - ADA-ES QA:
      2.5 % ($\pm$ 0.5 µg/m^3) = high maintenance
      1% ($\pm$ 0.2 µg/m^3) = low maintenance
  - CEMS monitored remotely by a separate in house ADA-ES team
  - Relative Accuracy with either 30A, 30B or OH

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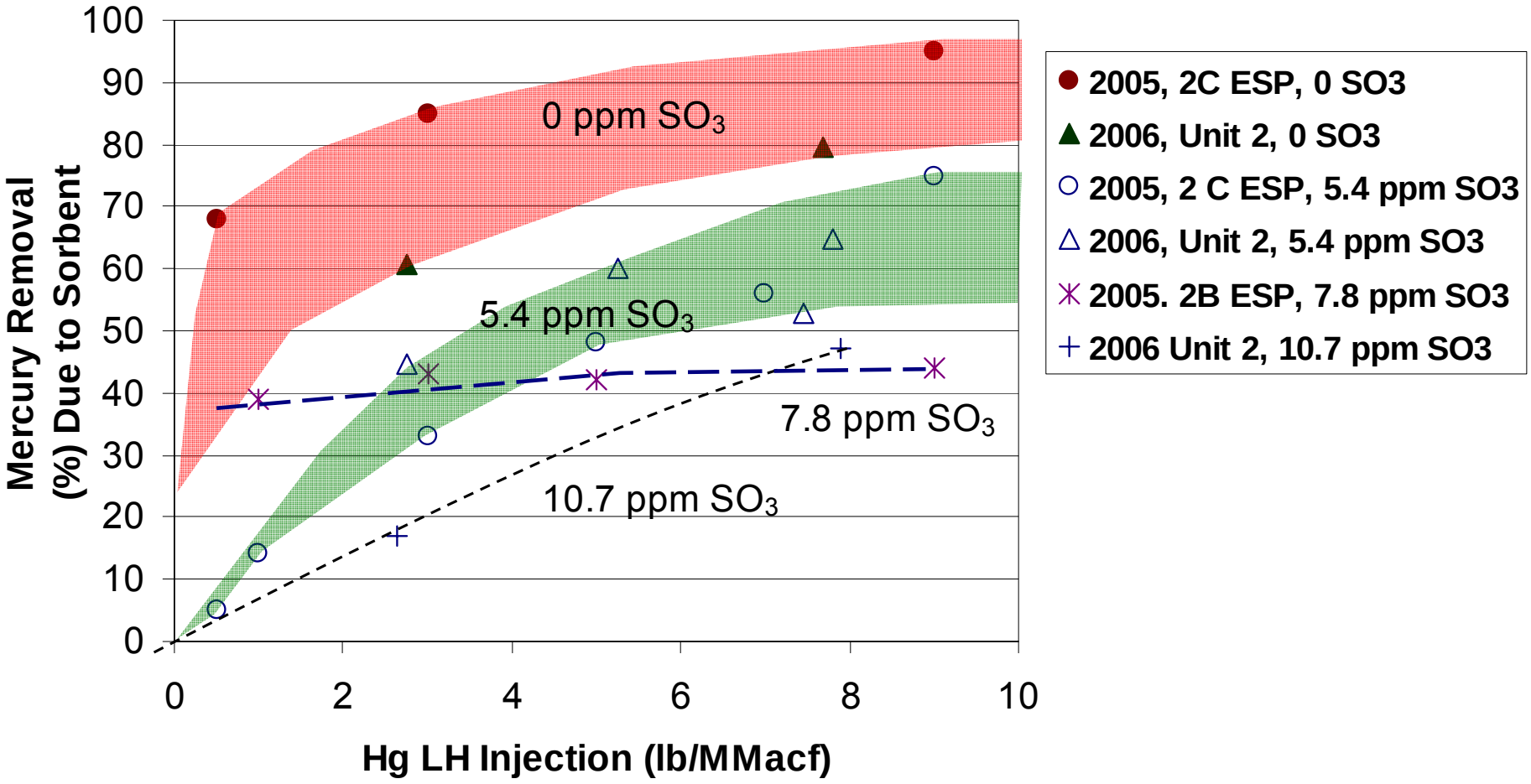
Parameters Evaluated at Labadie

- Sorbent type and treatment
- SO_3 injection concentration
- Injection location (upstream and downstream of air preheater (APH) and SO_3)

APH Outlet Injection of Hg-LH



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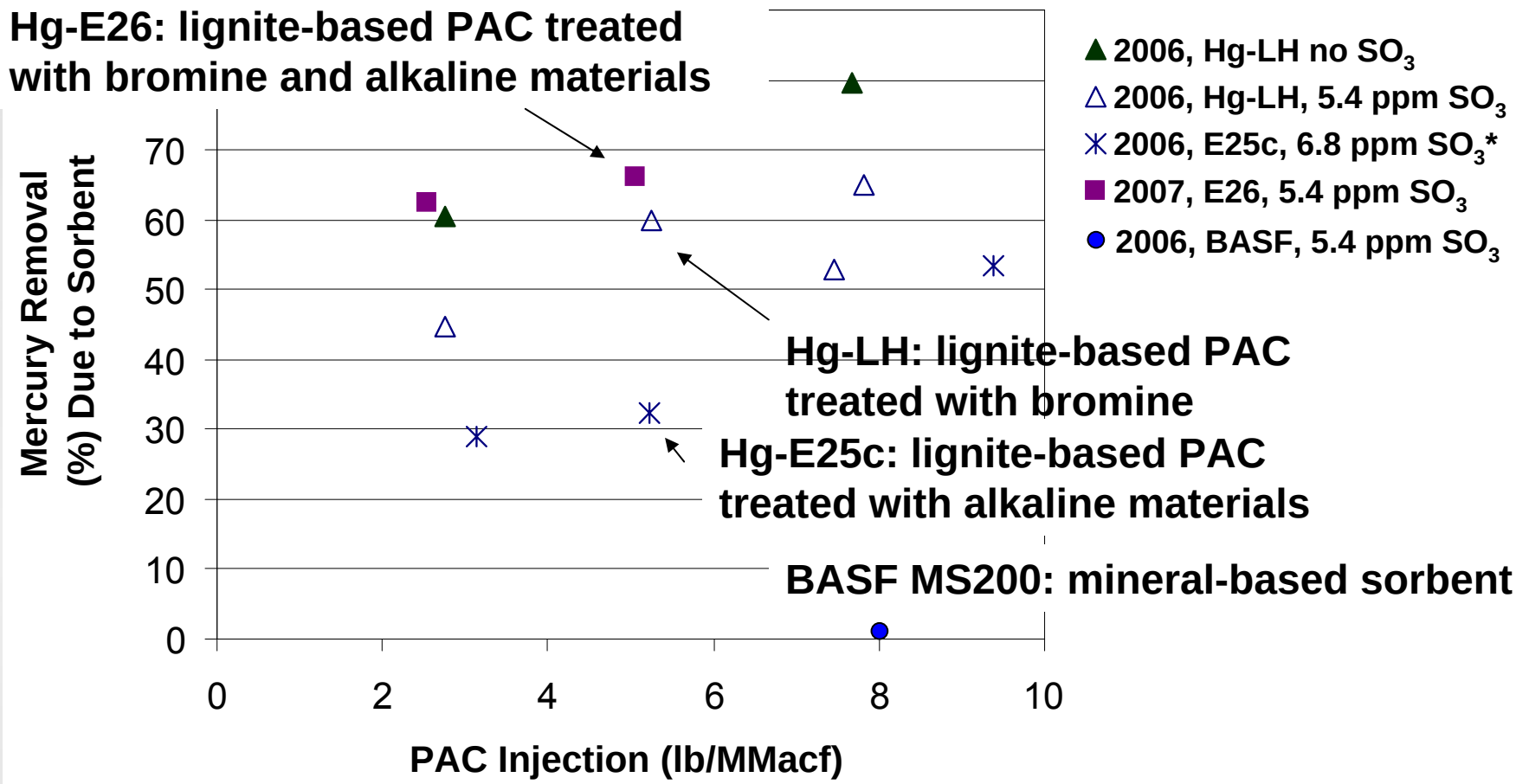
APH Outlet Injection



Summary of APH Outlet Results

- SO_3 impacted PAC performance

  Projected removal at 5 lb/MMacf Hg-LH

SO_3 (ppm)	Hg Removal (%)
0	75 to 90+
5.4	50 to 60
10.7	33

- Alkali-treated material demonstrated SO_3 tolerance
- No impact on ESP operation or opacity as a result of PAC injection
  - *ESP power decreased and spark rate increased when SO_3 was turned off*

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Optimizing PAC Performance

- Air Preheater Inlet Injection
- On-Site Enhancement

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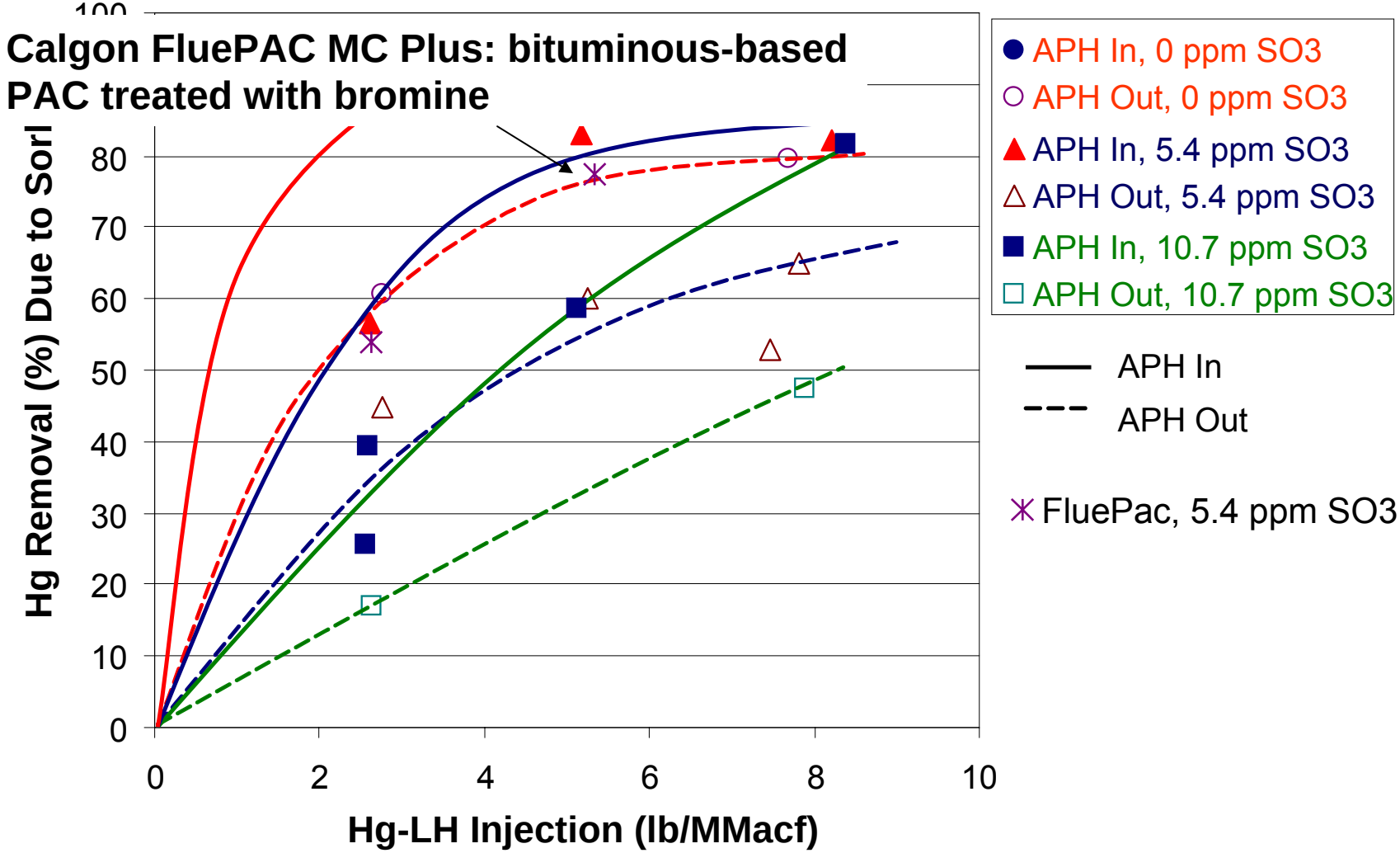
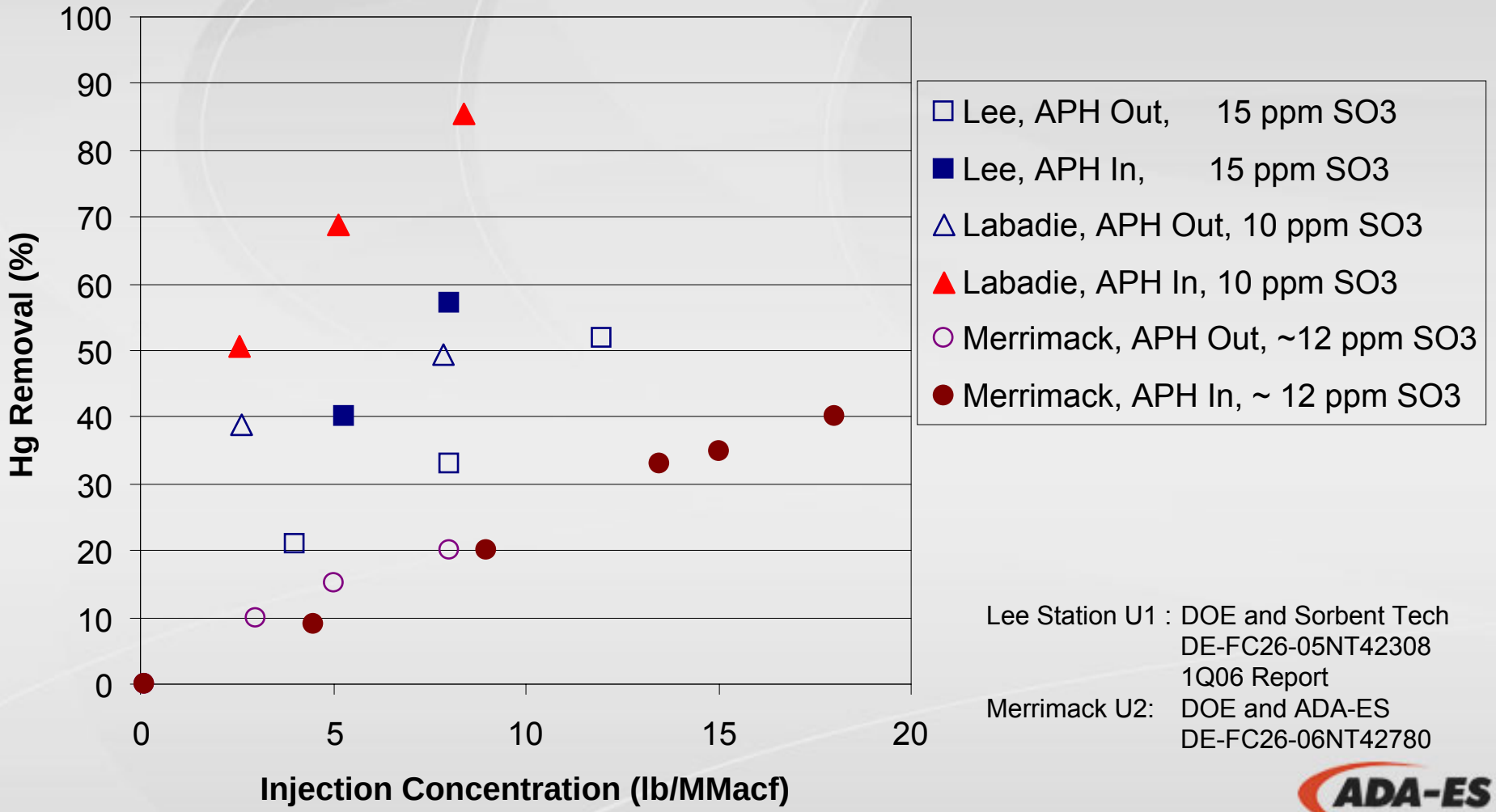
Injection Location Comparison



Injection Location Comparison



Lee Station U1 : DOE and Sorbent Tech
DE-FC26-05NT42308
1Q06 Report

Merrimack U2: DOE and ADA-ES
DE-FC26-06NT42780

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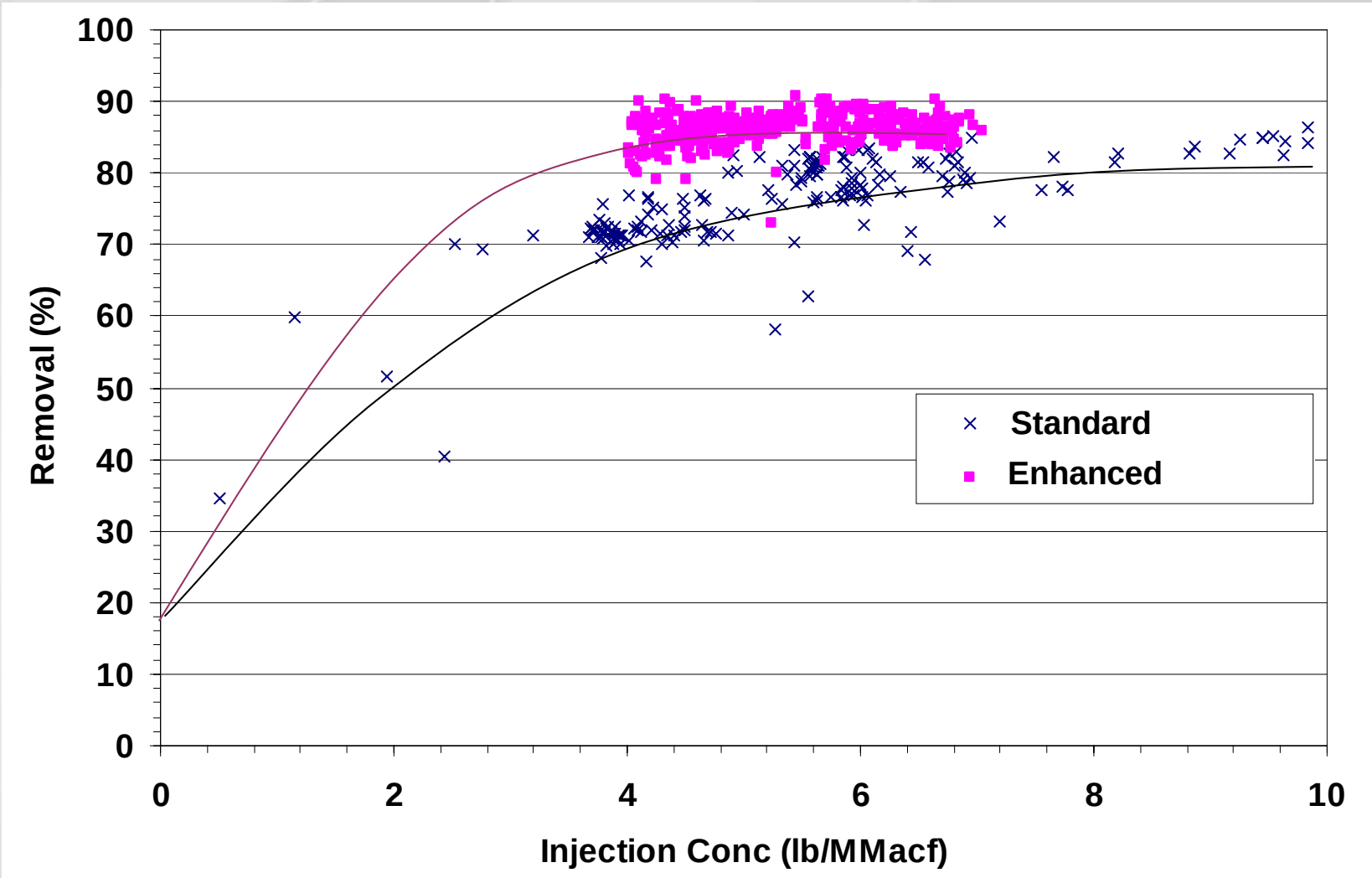
APH Inlet Injection – Questions?

- Is hotside APH injection safe?
  - Activated carbon by nature has very low or no volatile content.
  - Lab tests indicate no fire or explosion hazard exists at the typical APH inlet temperatures and expected PAC injection concentrations.
- Does material build up on the air preheater?
  - No evidence of increased APH pressure drop or balance of plant issues during short-term parametrics and a 15 day extended test.
- Are alternate lance materials required?
  - Standard stainless recommended for all installations
- What is the mercury removal performance improvement?
  - Promising results compared to APH outlet injection

On-Site Enhancement (w/ 5.4 ppm SO_3)



Balance-of Plant

- Extended Testing – Results under Review
  - APH dP
  - Opacity and PM emissions
  - ESP Operation
  - Fate of Bromine

15-Day Extended injection period at APH inlet with Calgon FluePAC MC Plus

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Summary of Optimization Results

- **APH inlet injection** more effective than APH outlet on sites with SO_3 injection
  - Relative impact of SO_3 similar at APH inlet and outlet
- **On-Site Enhancement**
  - 85% mercury removal with 5.4 ppm SO_3 achieved at 4.2 lb/MMacf enhanced PAC compared to 9.4 lb/MMacf as received PAC

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Preliminary Economics for Labadie

Mercury Removal Rate	75%*
Brominated PAC Injection rate for above removal	5 lb/Mmacf (660 lbs/hr)
Native Mercury Removal	10 – 15%
Stack Flow	2.2M acfm
Average Coal Mercury Concentration	8.2 lb/ TBtu
Mercury Removed	585 lb/ yr
Overall 20 Year Levelized Cost	$ 7.8M **
Overall 20 Year Levelized $/lb Mercury removed	$ 13.3K **

Capital Cost Estimate:$1.68/kW
O&M Cost Estimate:$1.21/MW-hr

Enhancement Option **PRELIMINARY** Estimate $9,000/lb Hg removed** for 85% removal*

* Includes baseline removal.

** Includes loss of ash sales and disposal fees.

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Questions?

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