

Full-Scale Evaluation of Carbon Injection for Mercury Control at a Unit Firing High Sulfur Coal



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*DOE NETL
Mercury Control Technology
Conference
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Project Focus Areas

- Evaluate effectiveness of sorbent injection for mercury control in unproven environments
 - Low halogen flue gas (PRB, SDA)
 - Mid-sized ESPs
 - High sulfur flue gas

Goal: Reduce the uncontrolled mercury emissions by 50 to 70% at a cost 25 to 50% lower than DOE basis (\$60,000/lb Hg removed)

*DOE Cooperative Agreement DE-FC26-03NT41986
DOE/NETL Project Manager: Andrew O’Palko*



Five Sites Included in DOE Program

<u>Test Site</u>	<u>Coal</u>	<u>Pollution Control</u>
DTE Energy Monroe	PRB/Bit Blend	SCR Cold Side ESP
Sunflower Electric Holcomb	PRB <i>PRB/Bit Blend</i>	SDA + FF
Ameren UE Meramec	PRB	Cold Side ESP
Missouri Basin PP Laramie River	PRB <i>PRB/Bit Blend</i>	SDA + ESP
AEP Conesville	Bituminous	Cold Side ESP WFGD

Small ESP and High Sulfur Co-funders

AmerenUE*

American Electric Power*

DTE Energy*

Dynegy Generation

MidAmerican

Ontario Power Generation

Southern Company

TVA

ADA-ES

ALSTOM

Arch Coal

EPCOR

EPRI

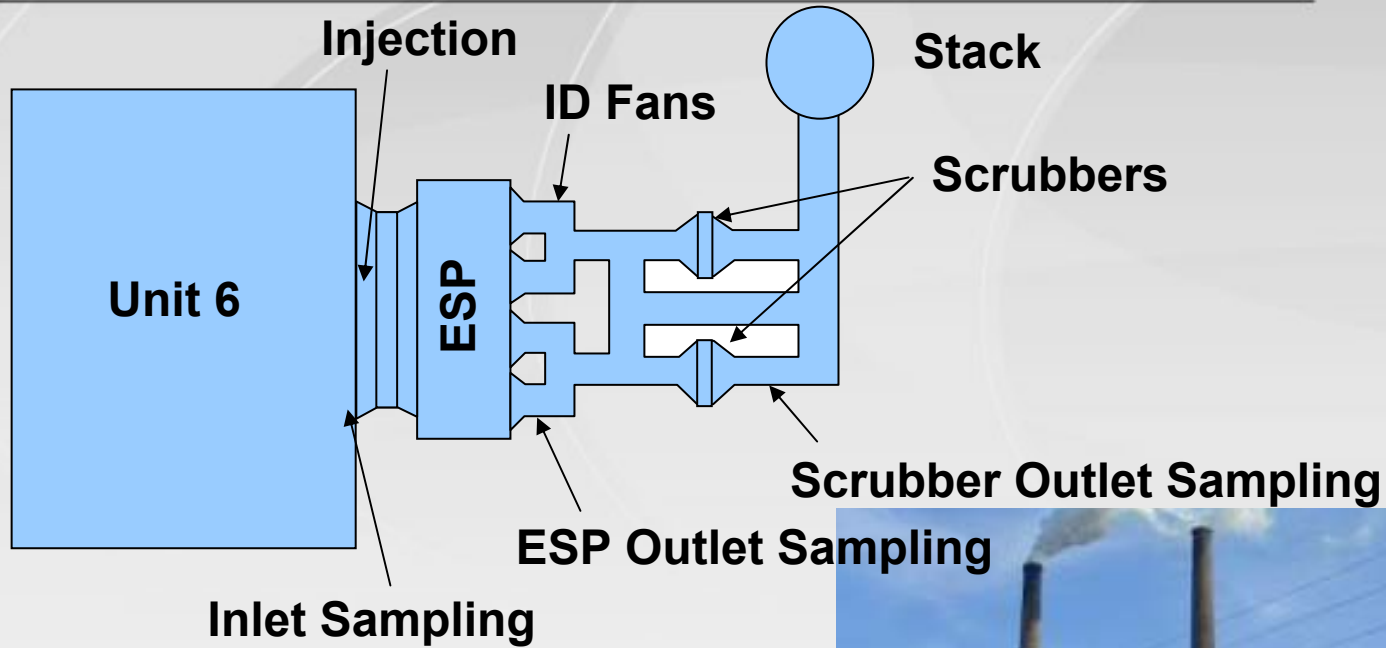
Babcock & Wilcox

NORIT Americas

*** Host Sites**



AEP Conesville Unit 6

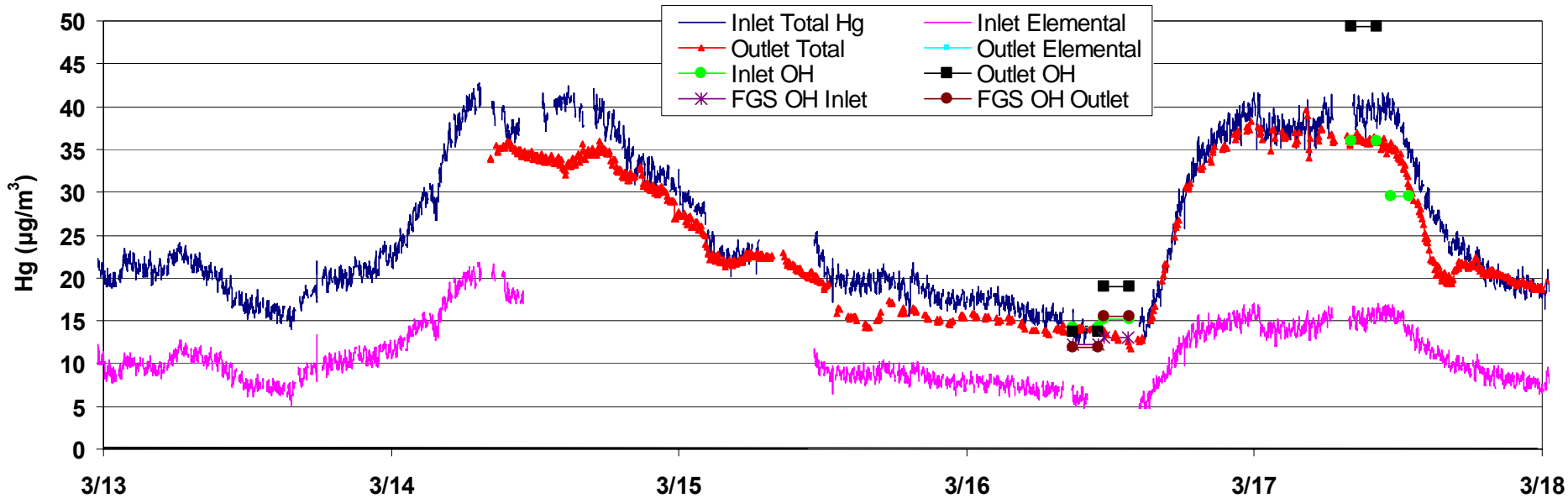


Testing March – Aug 2006

Conesville Power Plant Unit 6

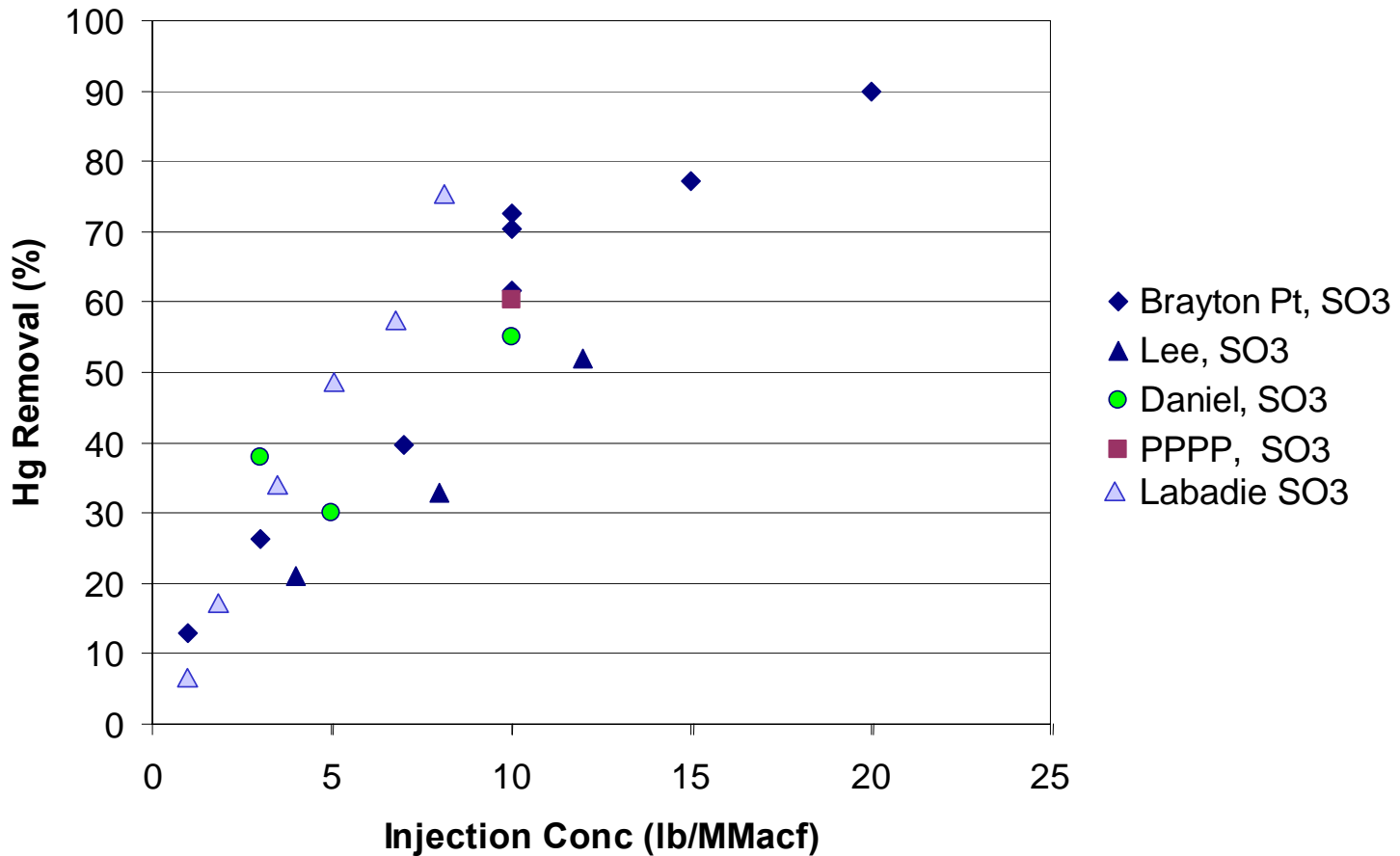
- 400 MW T-Fired boiler, ESP, WFGD
- Fires high sulfur (3 to 4%) coal
 - **Low native removal in ESP**
 - **Challenging flue gas for sorbents**
 - *Previous fixed bed testing indicated adsorption capacity for standard activated carbon reduced by 60% as a result of SO₃ FGC at PRB site (SO₃ much lower than at Conesville)*
- Moderate (~ 700 - 1200 ppm) chlorine in coal
 - **Fraction of oxidized mercury ~ 50 to 70%**

Baseline Mercury Trends: ESP

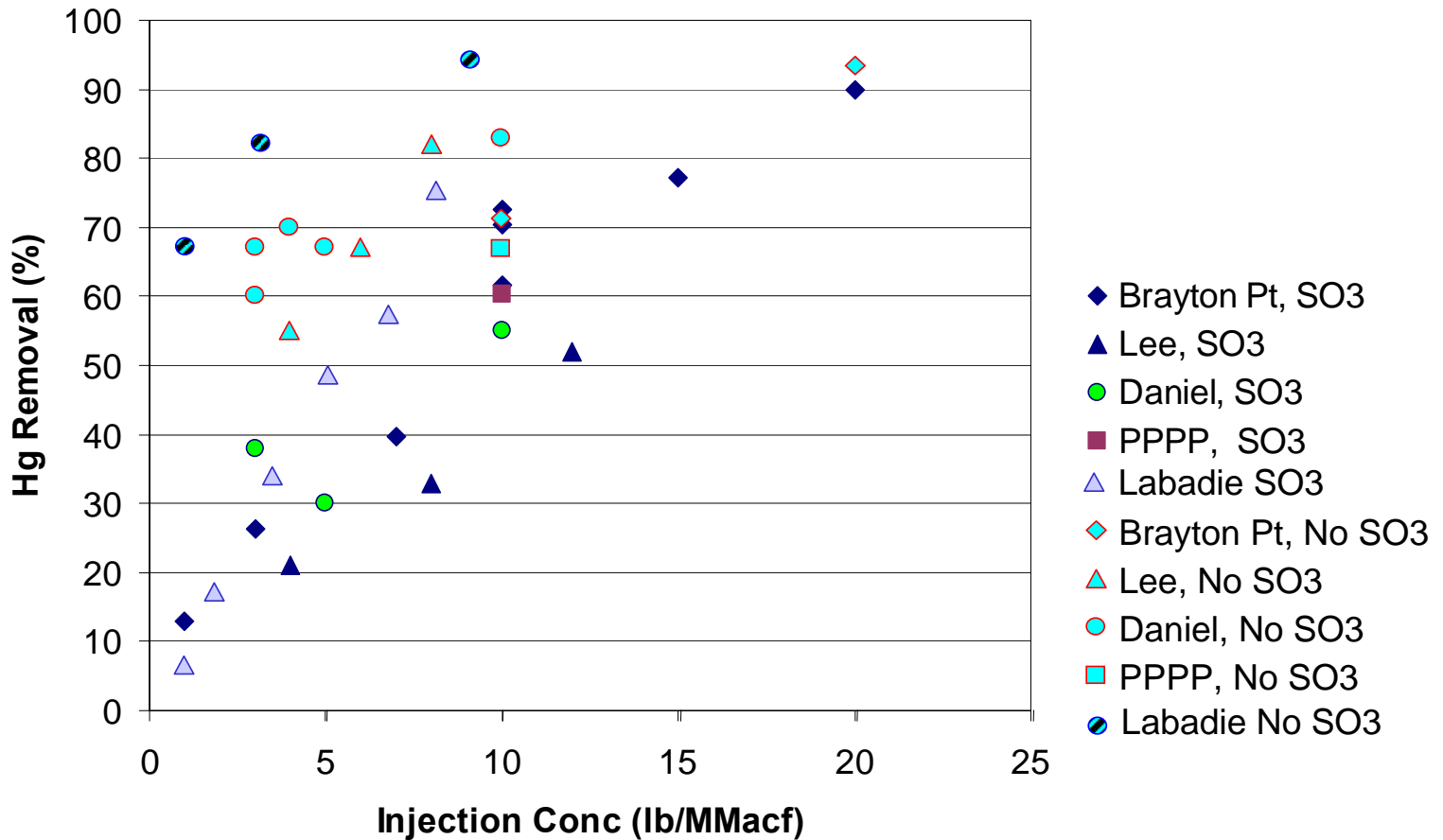


Mercury CEMS: Thermo Mercury Freedom System™

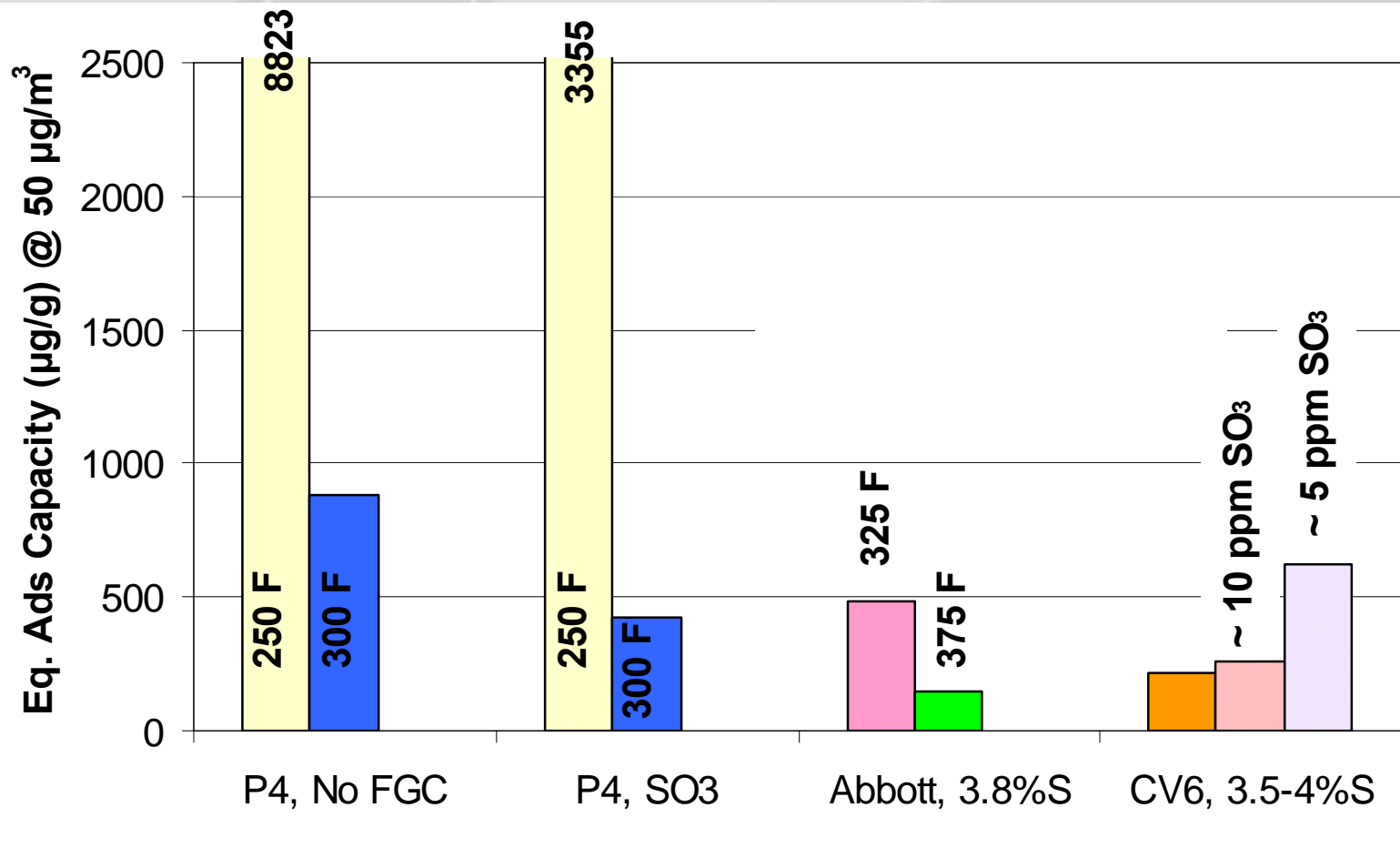
Impact of SO₃ Injection on Hg Removal



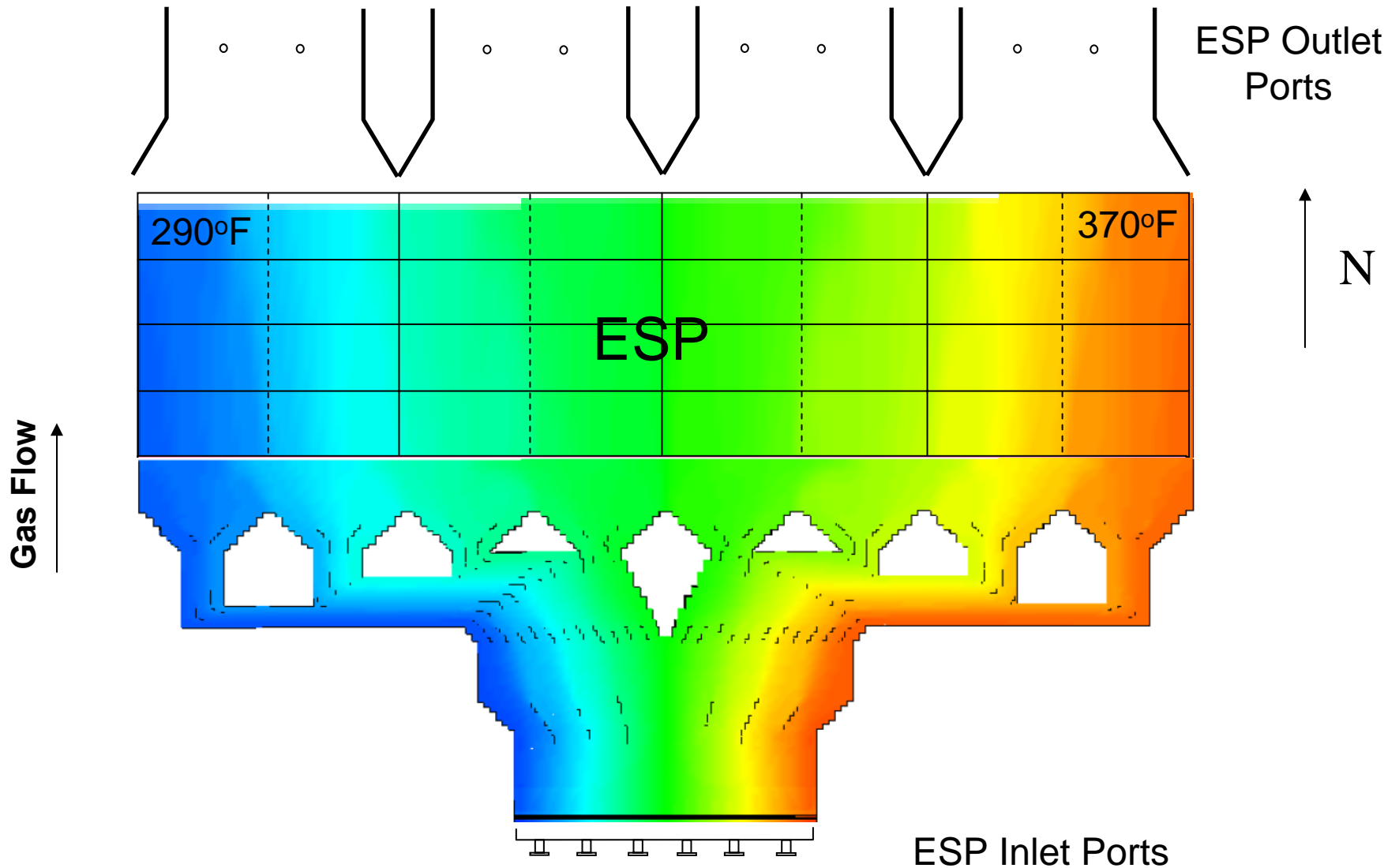
Impact of SO₃ Injection on Hg Removal



Effect of SO₃ on Sorbent Capacity: Fixed-bed results



Conesville ESP: Temperature Stratification



Model Results (10 lb/MMacf)

Predicted Hg Removal

DARCO Hg (n=1)	22.3
Lower Reactivity (n=0.5)	9.1
Smaller Particle Size	35.8

Actual Results:

DARCO Hg: 8.1% removal at 9.5 lb/MMacf

Fine PAC: 11% removal at 8 lb/MMacf

Model uses Freundlich Isotherm

$$W^* = [1/K](C^*)^{1/n}$$

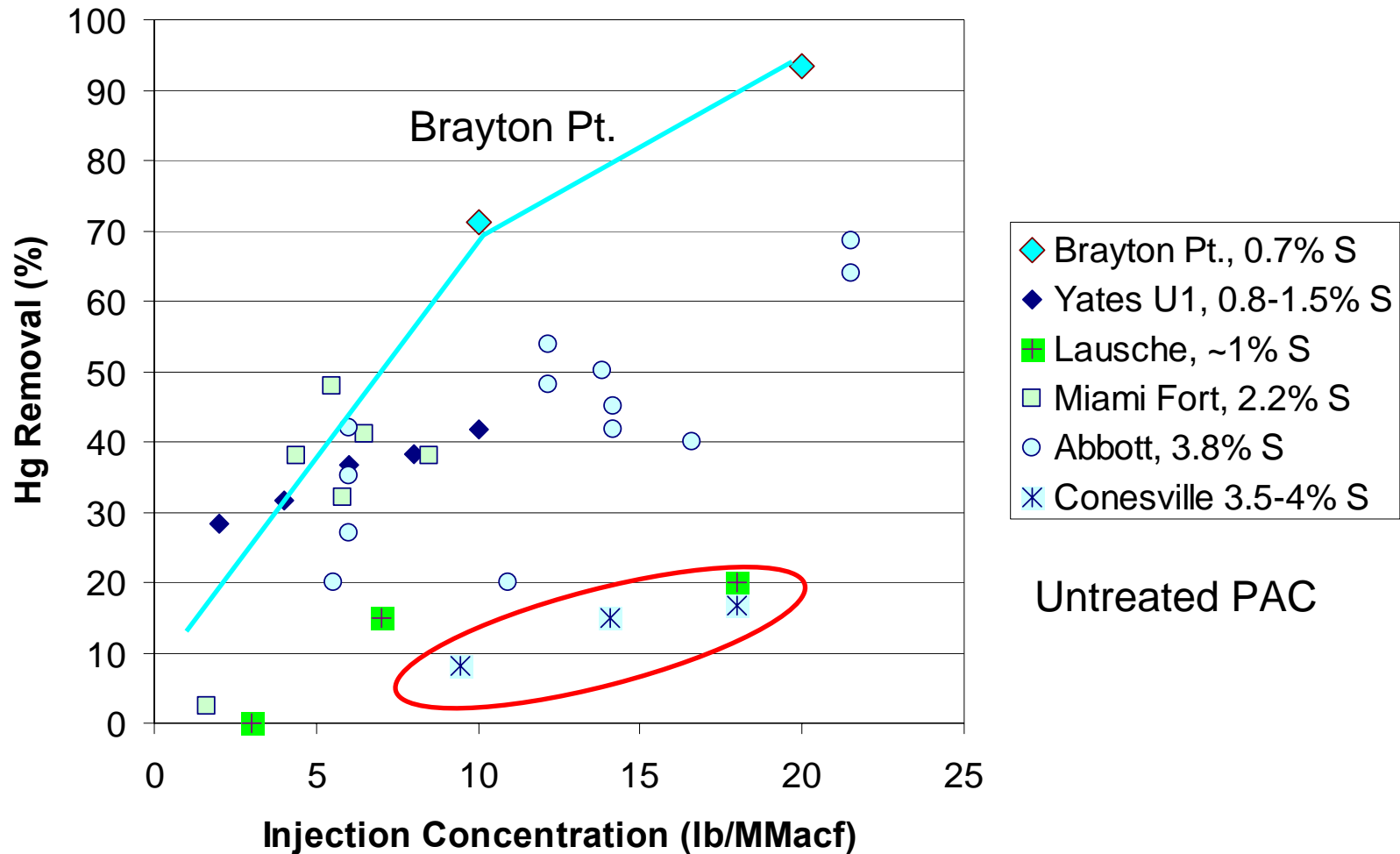
Finding the Right Sorbent for Conesville

- Evaluate various sorbents
 - Fixed-bed screening
 - >50 sorbents from 15 suppliers
 - Activated Carbon
 - Enhanced Activated Carbon
 - Mineral
 - Alkaline
 - Full-scale injection tests
 - 20 sorbents from 5 suppliers

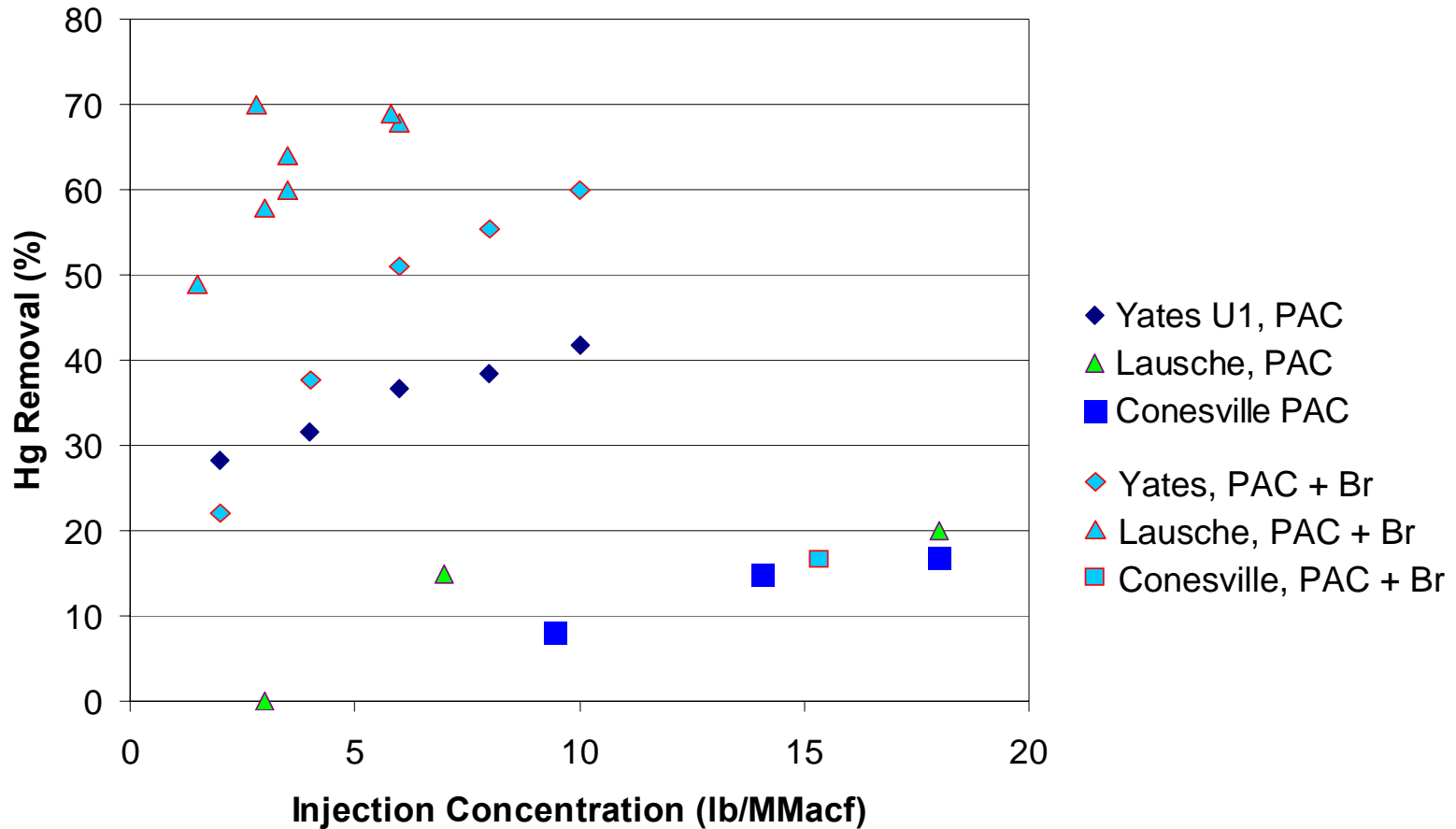
Sorbent Suppliers Included in Screening Tests

- ADA-ES
- Advanced Fuel Research
- AEP
- Calgon
- California Earth Minerals
- Donau
- EERC
- Engelhard
- Frontier Geosciences
- NEST
- Norit
- Sorbtech
- TDA Research
- Zinkan

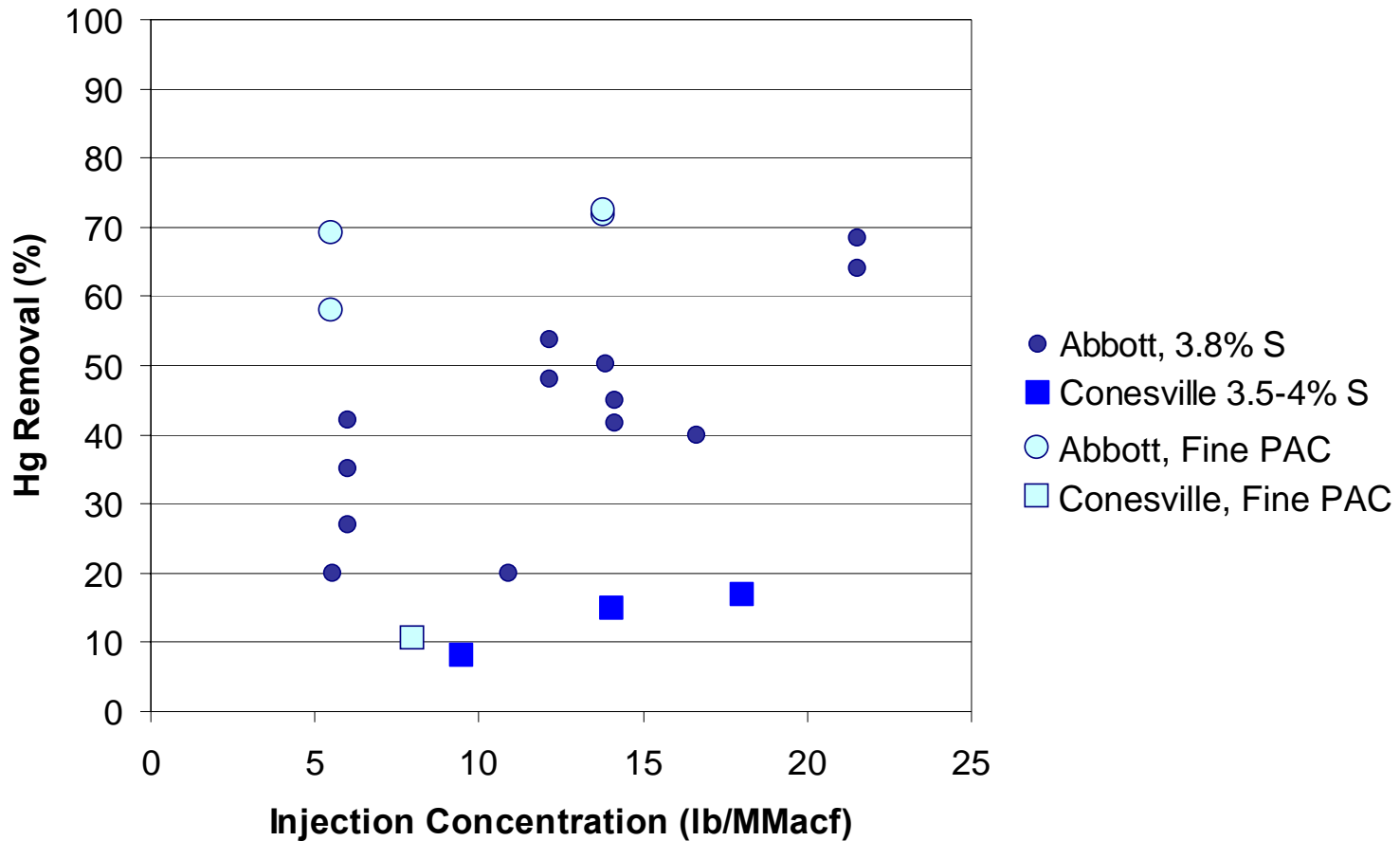
Mercury Removal Comparison



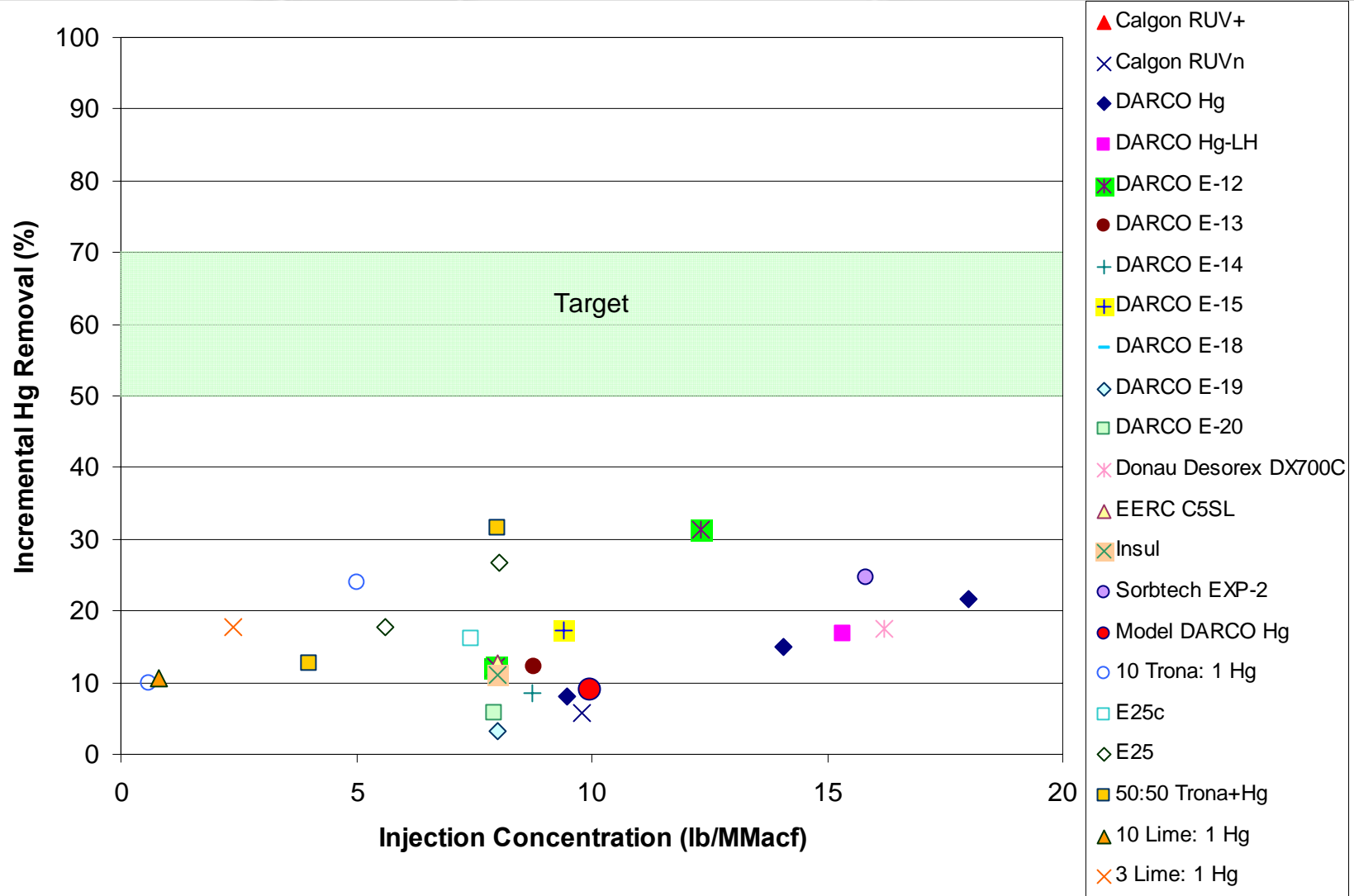
Enhancements with Treated PAC



Enhancements with Fine PAC



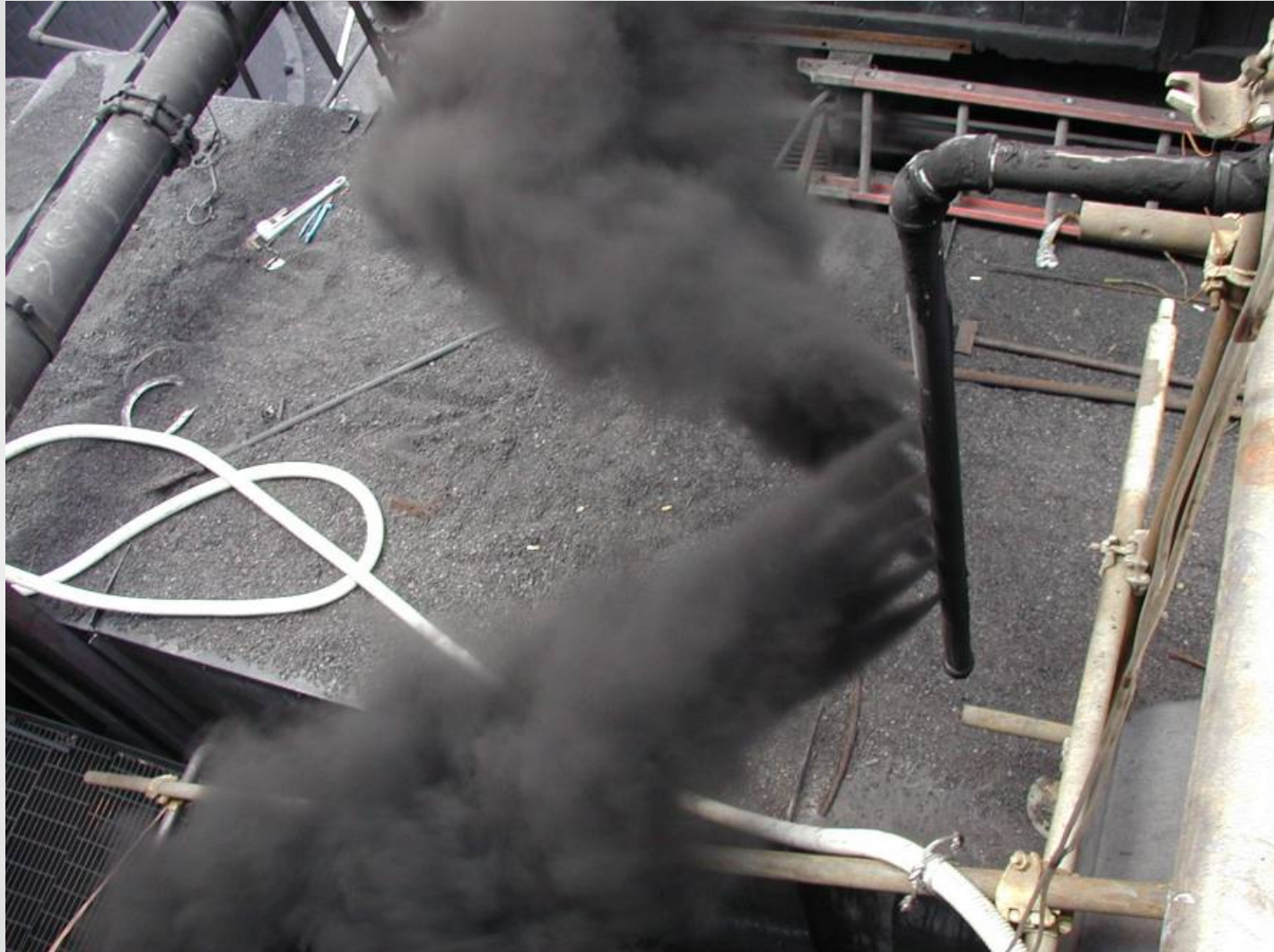
Full-Scale Parametric Results (~ 2 hr)



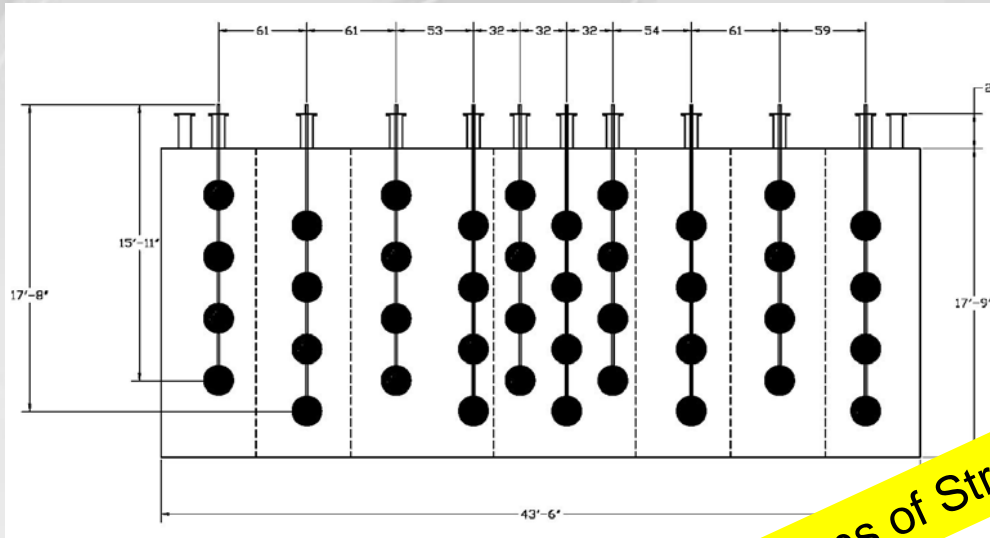


***Lance Design and
Sorbent Distribution***

Powdered Activated Carbon Injection



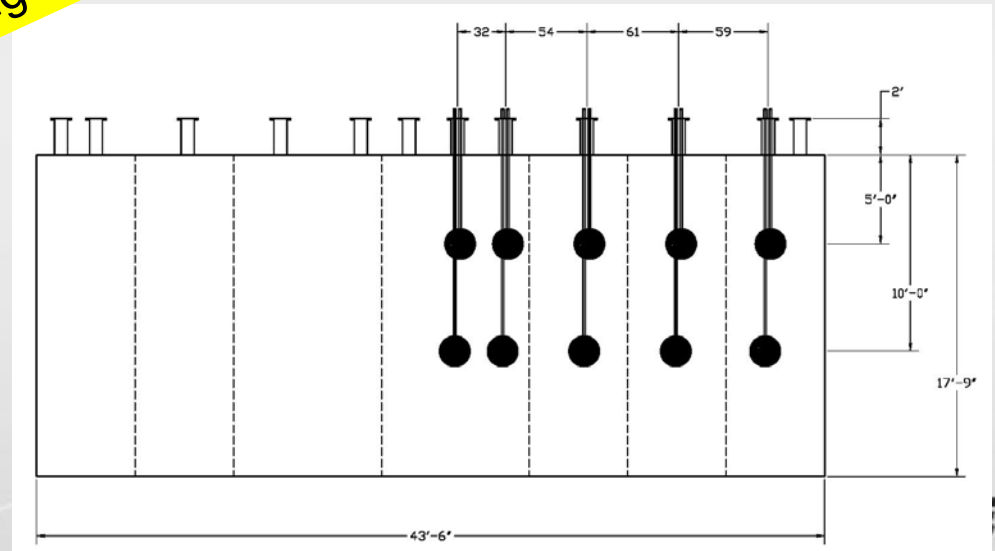
Conesville Lance Design



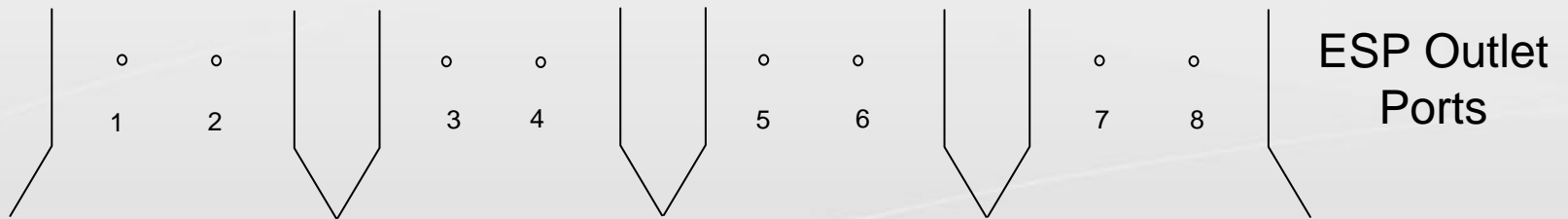
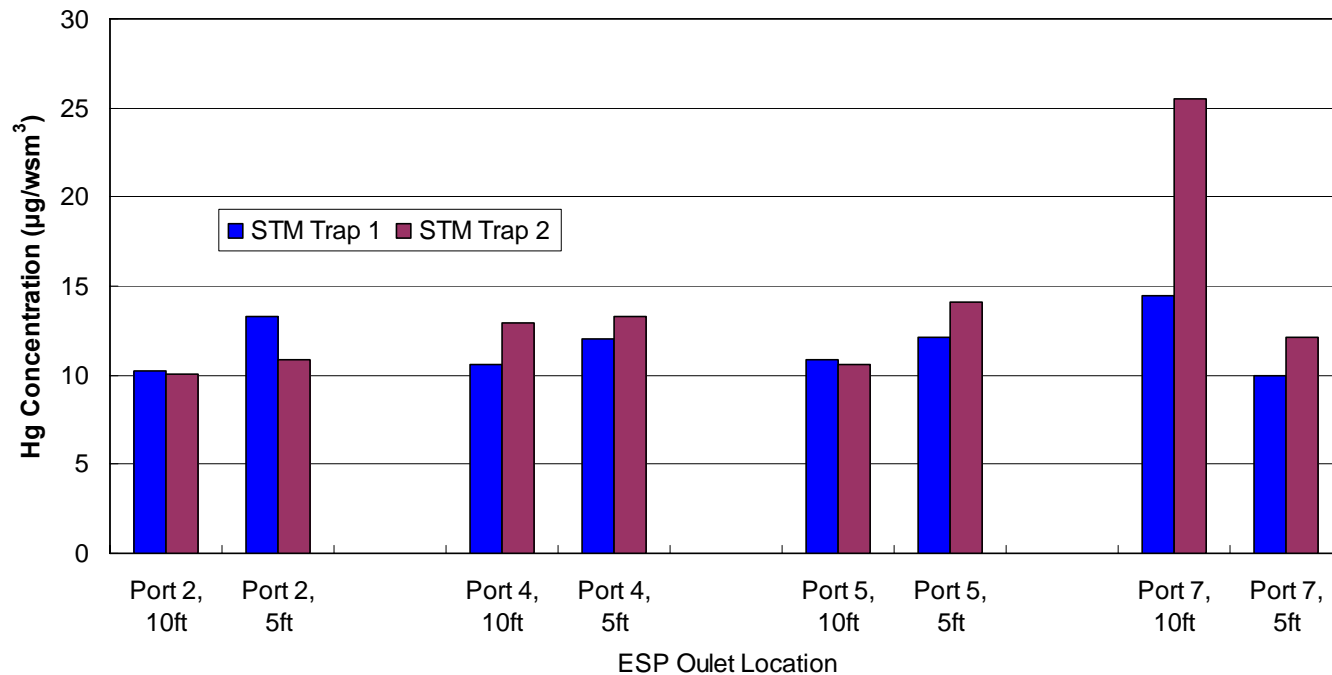
10 Lances, 8 nozzles per lance
400 MW (Entire Unit 6)

No Obvious Signs of Stratification

10 Lances, 1 nozzle per lance
200 MW (1/2 Unit 6)

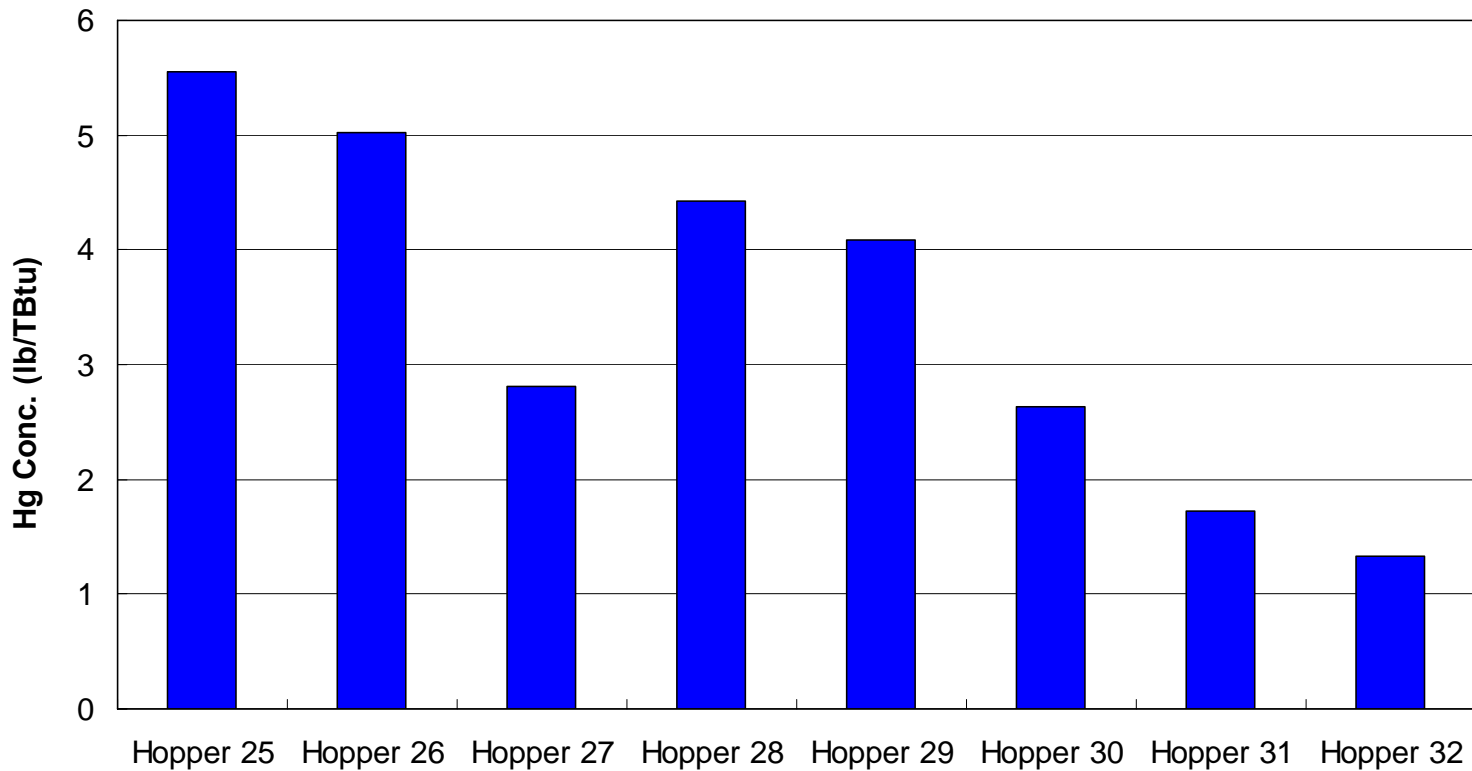
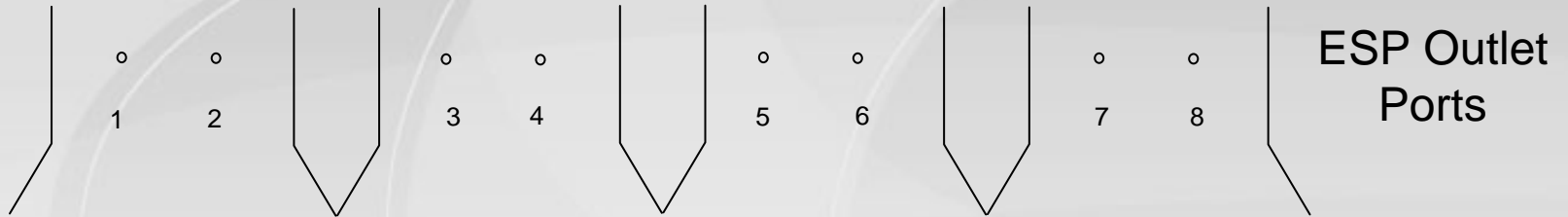


Mercury Stratification Measurements



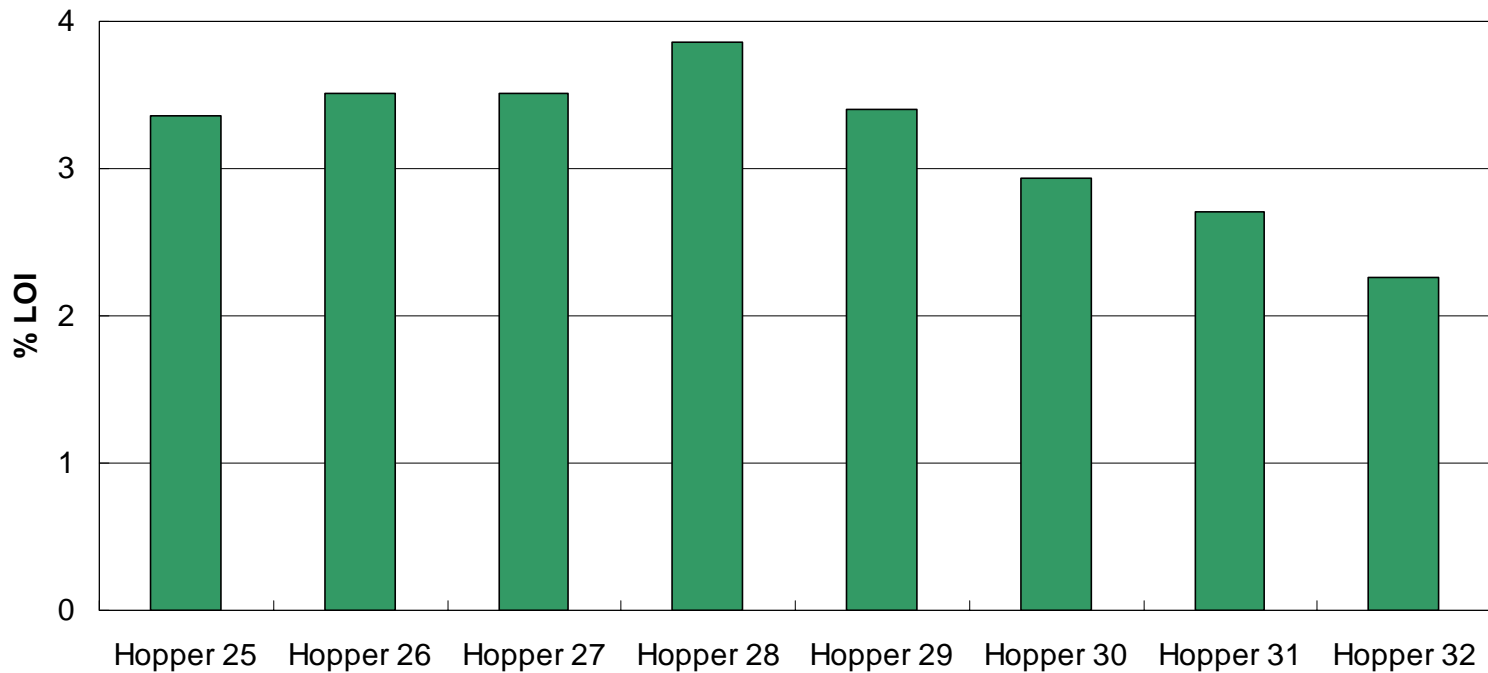
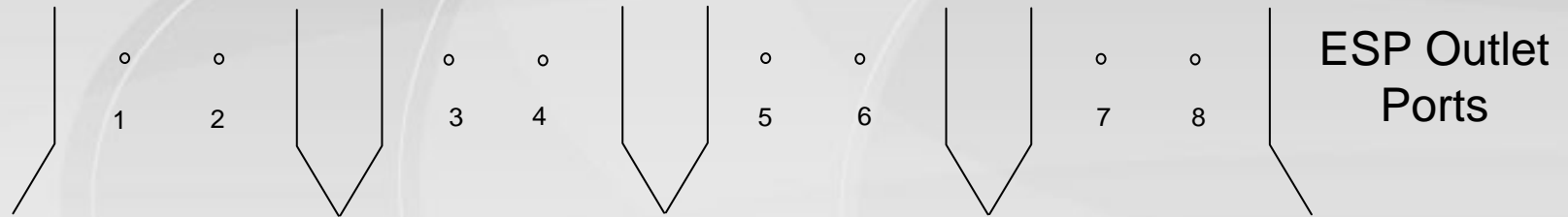
Multi-Nozzle Lances

Ash Hg Stratification Measurements



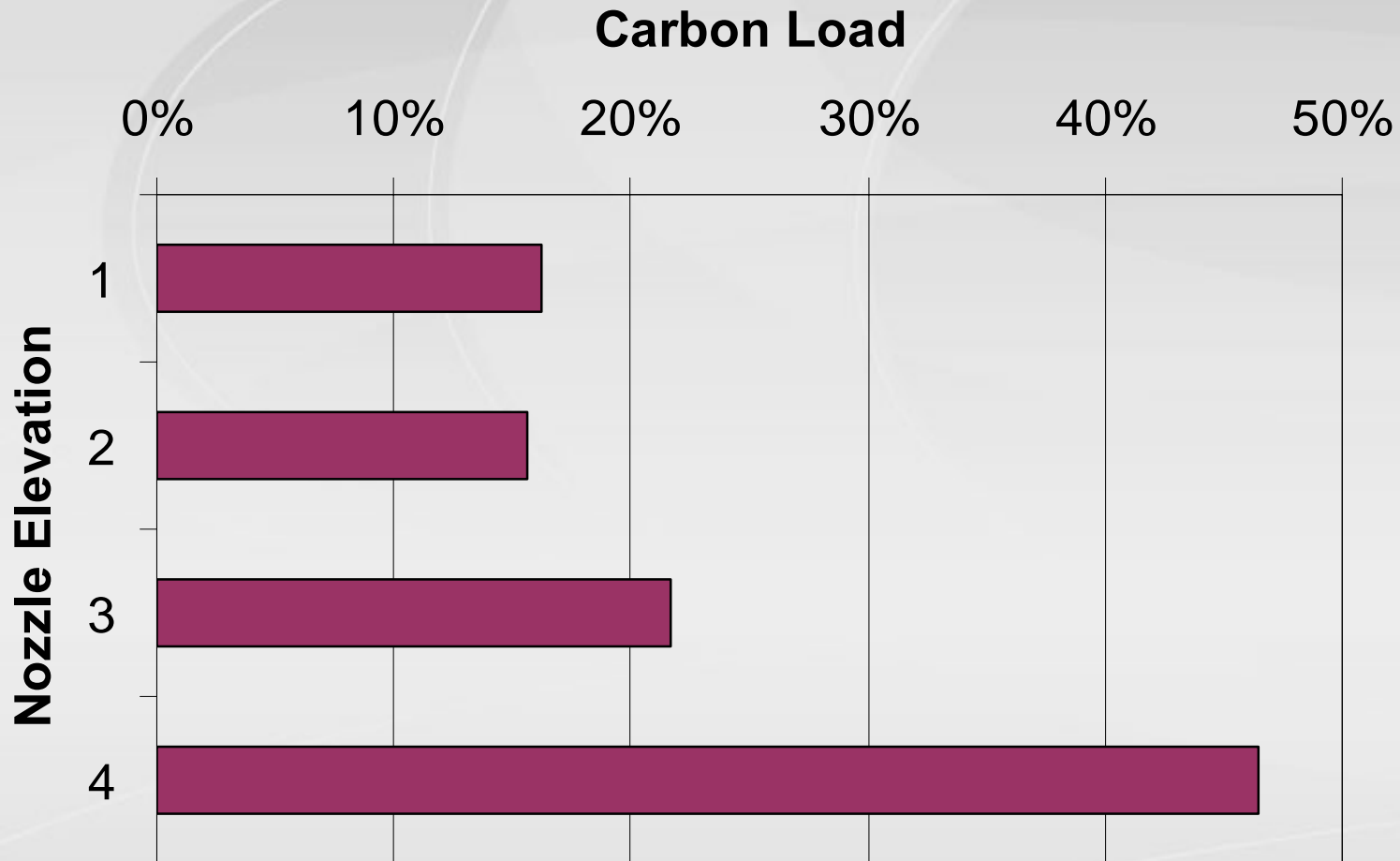
Multi-Nozzle Lances

LOI Stratification Measurements



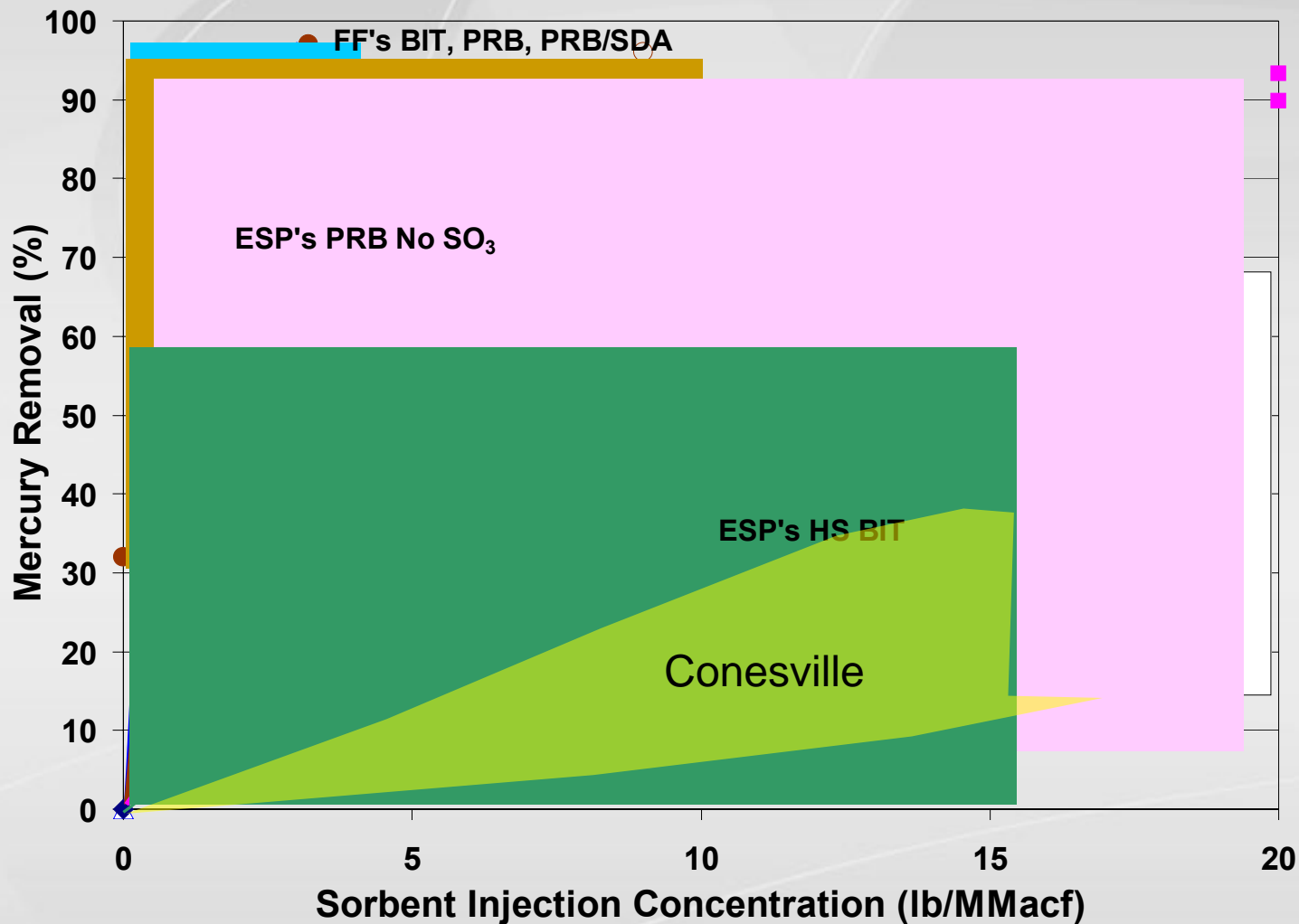
Multi-Nozzle Lances

Carbon Mass Distribution



Example only. Data not available for Conesville lance design

Mercury Reduction Trends with ACI on FF's and ESPs



Conclusions from Conesville

- No baseline removal across ESP
 - 50 to 70% Oxidized Hg at ESP inlet
 - ~ 75% Oxidized Hg removed in WFGD
- Maximum mercury removal across ESP with PAC << target of 50%
- SO₃ (and other species ??) significantly reduced effectiveness of PAC at Conesville
- No noticeable improvement using brominated carbon or fine carbon
- Some improvements achieved with alkali/PAC blends
- Hg CEMs performed well in this challenging flue gas

Ongoing Testing

- Ameren's Labadie Power Plant
 - PRB coal
 - ESP
 - SO₃ FGC
- Plans
 - Evaluate several sorbents
 - Vary SO₃ concentration
 - Inject upstream and downstream of APH

Questions?

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