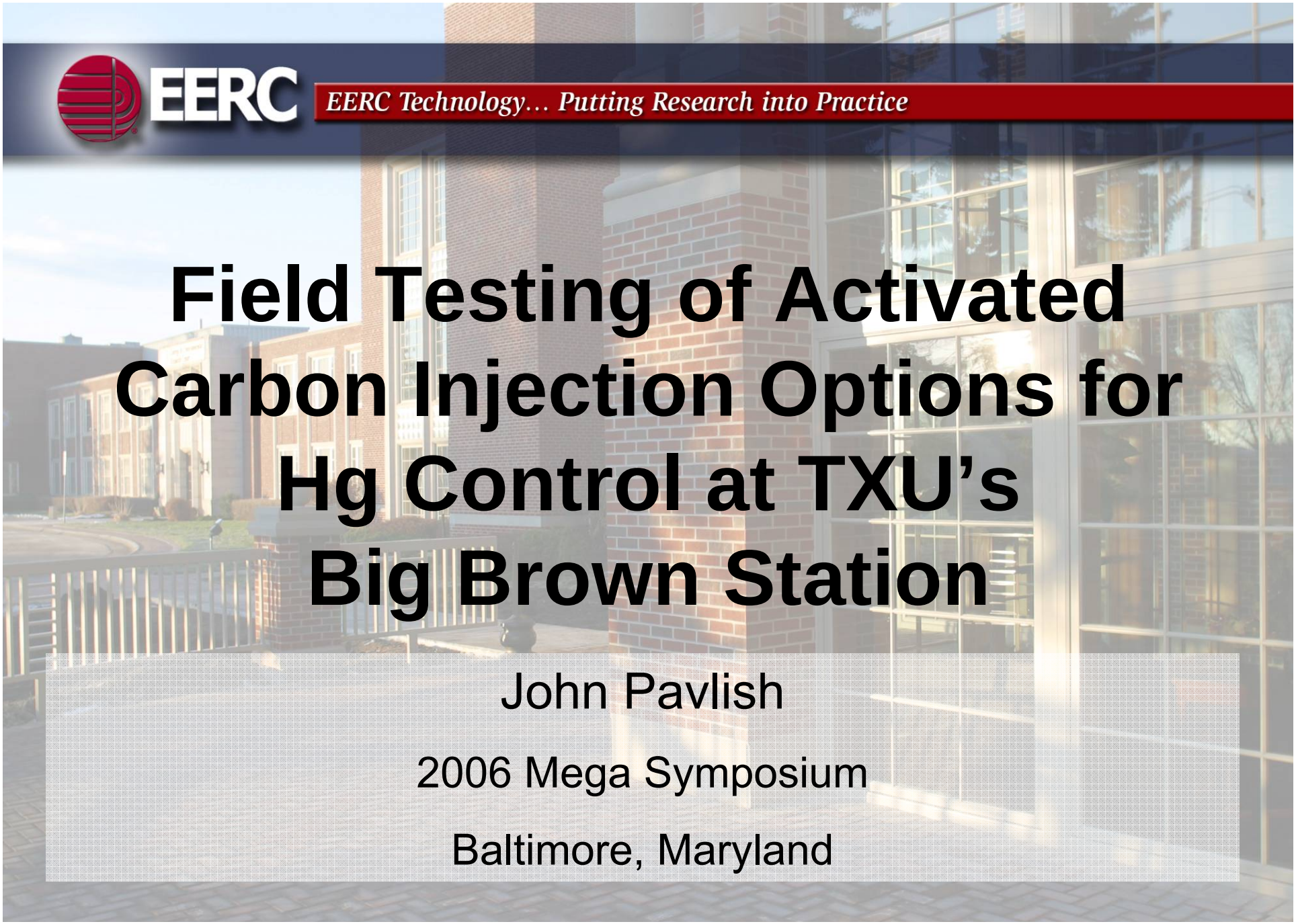


Field Testing of Activated Carbon Injection Options for Hg Control at TXU's Big Brown Station

John Pavlish

2006 Mega Symposium

Baltimore, Maryland

Acknowledgments

- Energy & Environmental Research Center
- U.S. Department of Energy National Energy Technology Laboratory (NETL)
- TXU Power
- ADA-ES, Inc.
- Babcock & Wilcox Company
- Electric Power Research Institute
- Acid Gas Solutions

Texas Lignite – Mercury Challenge

- Texas lignite is among the U.S. coals with the highest Hg content.
- Texas lignite has relatively low Cl concentrations and can, therefore, emit relatively high levels of elemental Hg—up to 80% Hg^0—making control of Hg in plants burning Texas lignite much more challenging.
- Monthlong monitoring in 2004 by the EERC showed an unusually high degree of variability in mercury concentrations.
- Texas lignite is relatively higher in Fe and Se concentrations.

Big Brown Unit Information

Big Brown Station, Freestone County, near Fairfield, Texas

- Plant capacity: Approximately 1200-MW total capacity with two 600-MW units
- Test unit: Tested one-quarter of BB Unit 2, Baghouse module 2-4 (FF 2-4)
- Boiler type: Tangentially fired with eight coal feeders per unit
- Typical fuel: 70% Texas lignite–30% PRB blend

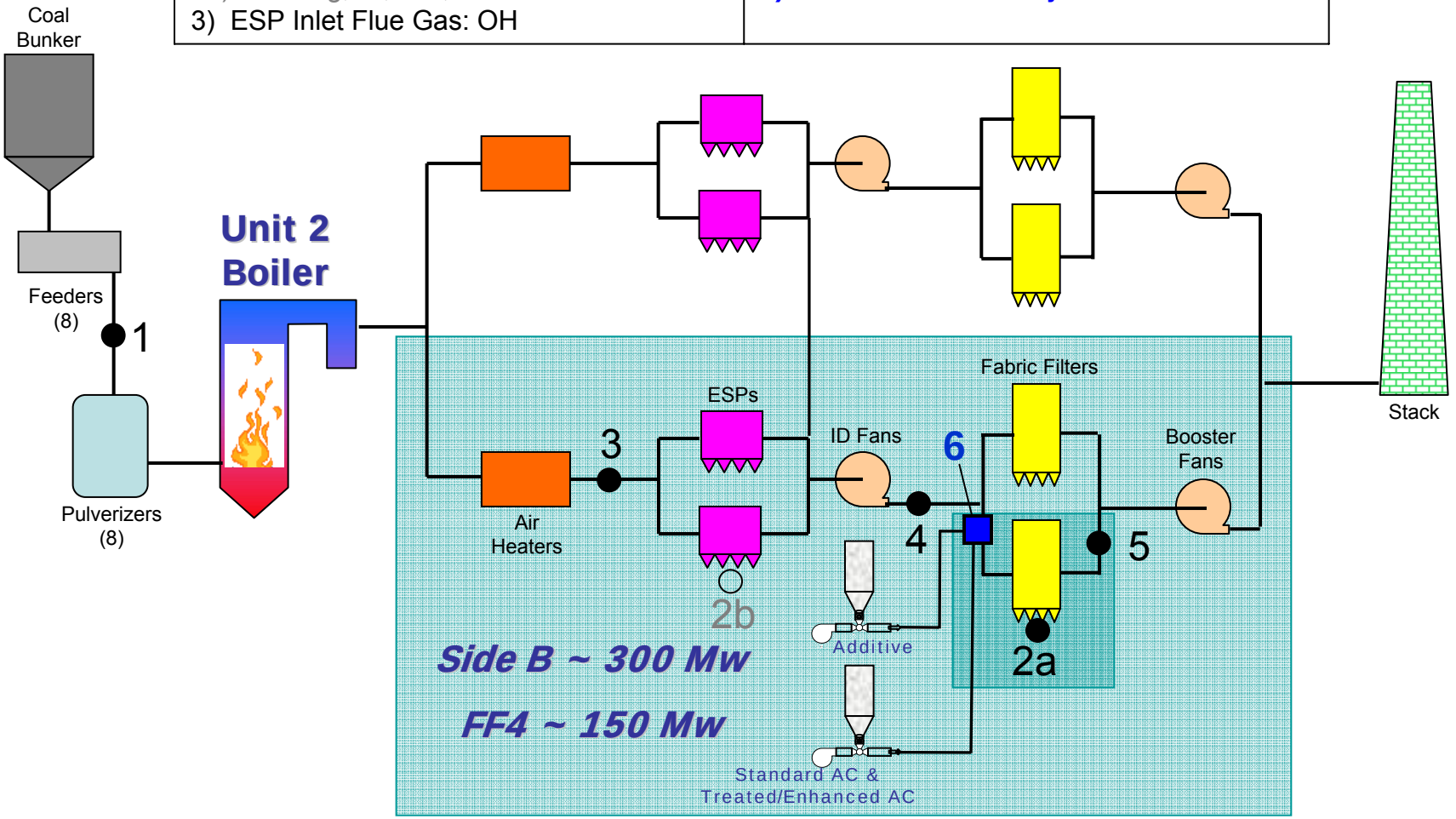
- SO_2 control: None
- NO_x control: Low-NO_x burners
- Particulate control: COHPAC™ configuration

Big Brown TOXECON™ Overview

- Each unit has four parallel ESPs followed by four baghouses operated in parallel.
- Air-to-cloth (A/C) ratio of ≥12:1 is normal.
- Each ESP has two fields, two rows, and a total of eight hoppers (two hoppers per box).
- SO_3 and NH_3 injection are used.
- Each baghouse has eight hoppers.
- High-perm bags are used at Big Brown.

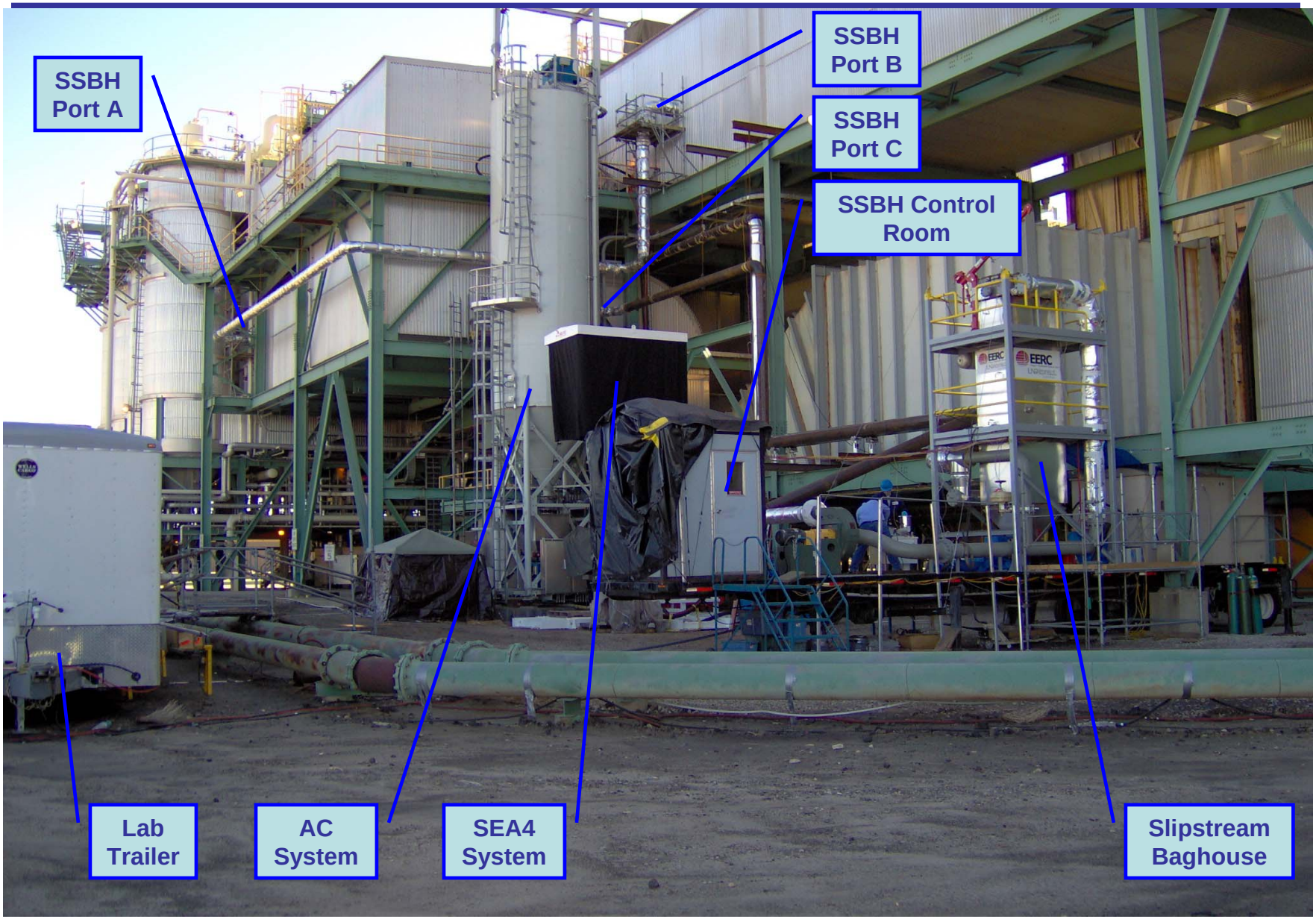
Mercury Control Options for TXU Big Brown Configuration

TXU's Big Brown Unit – Sampling Locations	
1) Coal: Hg, Cl, Prox./Ult., Heating Value	4) Baghouse Inlet Flue Gas: OH, Hg CEM
2a) Ash: Hg, Cl, LOI, C	5) Baghouse Outlet Flue Gas: OH, Hg CEM
2b) Ash: Hg, Cl, LOI, C	**6) ACI and Additive Injection**
3) ESP Inlet Flue Gas: OH	



Big Brown Power Station, Fairfield, Texas

Test Equipment



Field Testing Objectives

70% Lignite–30% PRB

- Establish baseline Hg concentrations and speciation across FF 2-4.
- Screen control technologies with short-duration parametric tests, including ACI-only, enhanced ACI, and ACI plus SEA4.
- Perform a monthlong test with the most promising technology and evaluate long-term Hg capture and balance-of-plant (BOP) issues.

100% PRB (under separate project)

- Establish baseline Hg concentrations and speciation across FF 2-4.
- Parametric tests, including ACI-only and enhanced ACI.

Slipstream Baghouse Study

- The EERC slipstream baghouse (SSBH) was also on-site for a separate but related project and was testing parallel to the large-scale project.
- As part of this project, a switch in fuel from the 70–30 blend to 100% PRB was conducted. The alternate fuel was evaluated on both the SSBH and the large scale.
- Large-scale 100% PRB results are discussed here, while all results for the SSBH itself will be presented elsewhere.

Baseline Coal Comparison
70–30 Blend and 100% PRB Averages

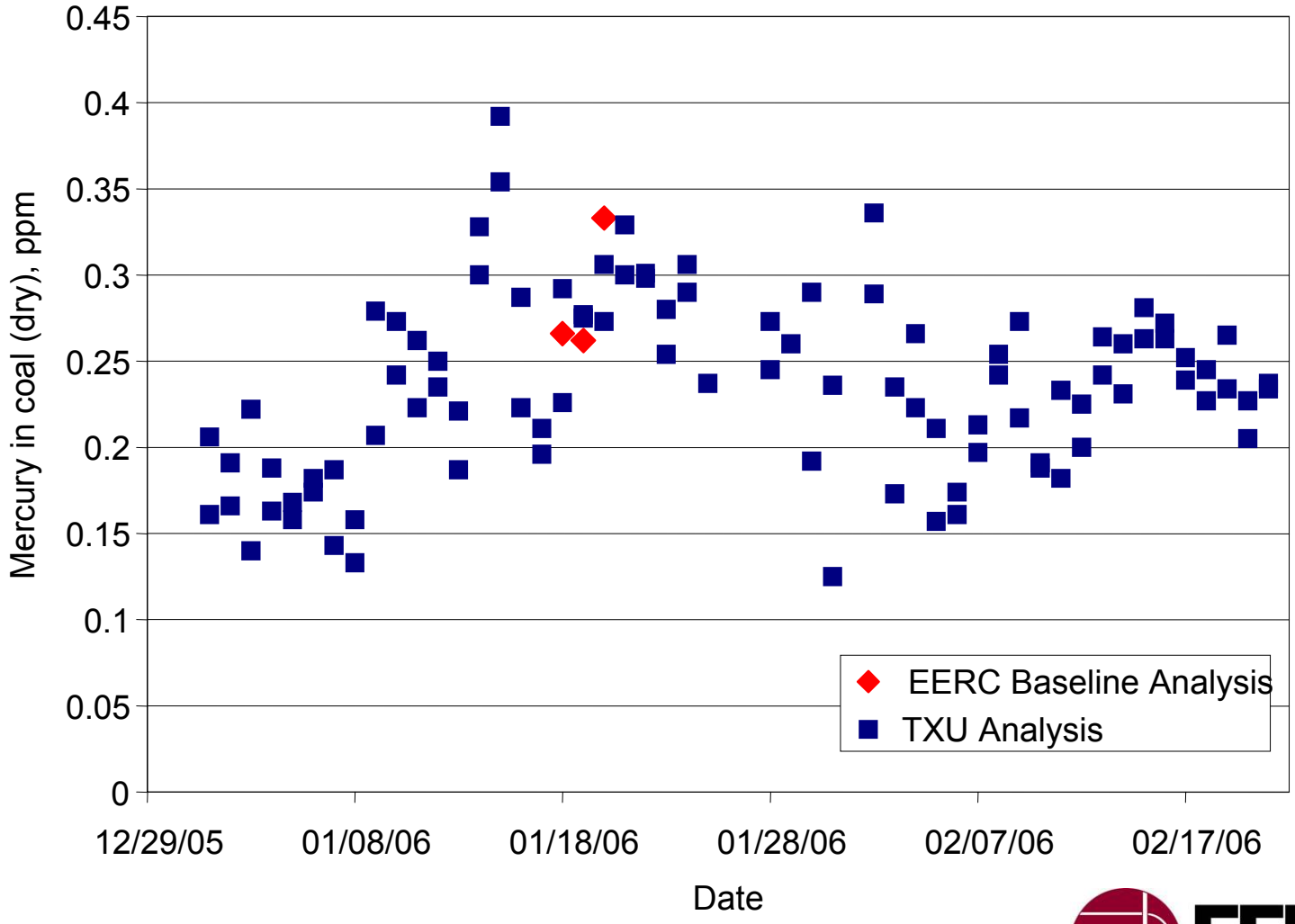
	Nominal 70–30 Blend *	100% PRB *
Hg, ppm (dry)	0.287	0.102
Cl, ppm (dry)	17**	8**
Short Proximate		
Moisture, %	31.17	31.17
Ash, %	9.91	4.94
Sulfur, %	0.68	0.39
Heating Value, Btu/lb	7531	8101
Fd, dscf/10^6 Btu	9729	9294
Hg, μg/dNm^3, 3% O_2	37.01	12.80

All values on an as-received basis unless otherwise noted

* Assumed ratio based on plant information

** Single value

Coal Mercury Values
70% Lignite–30% PRB



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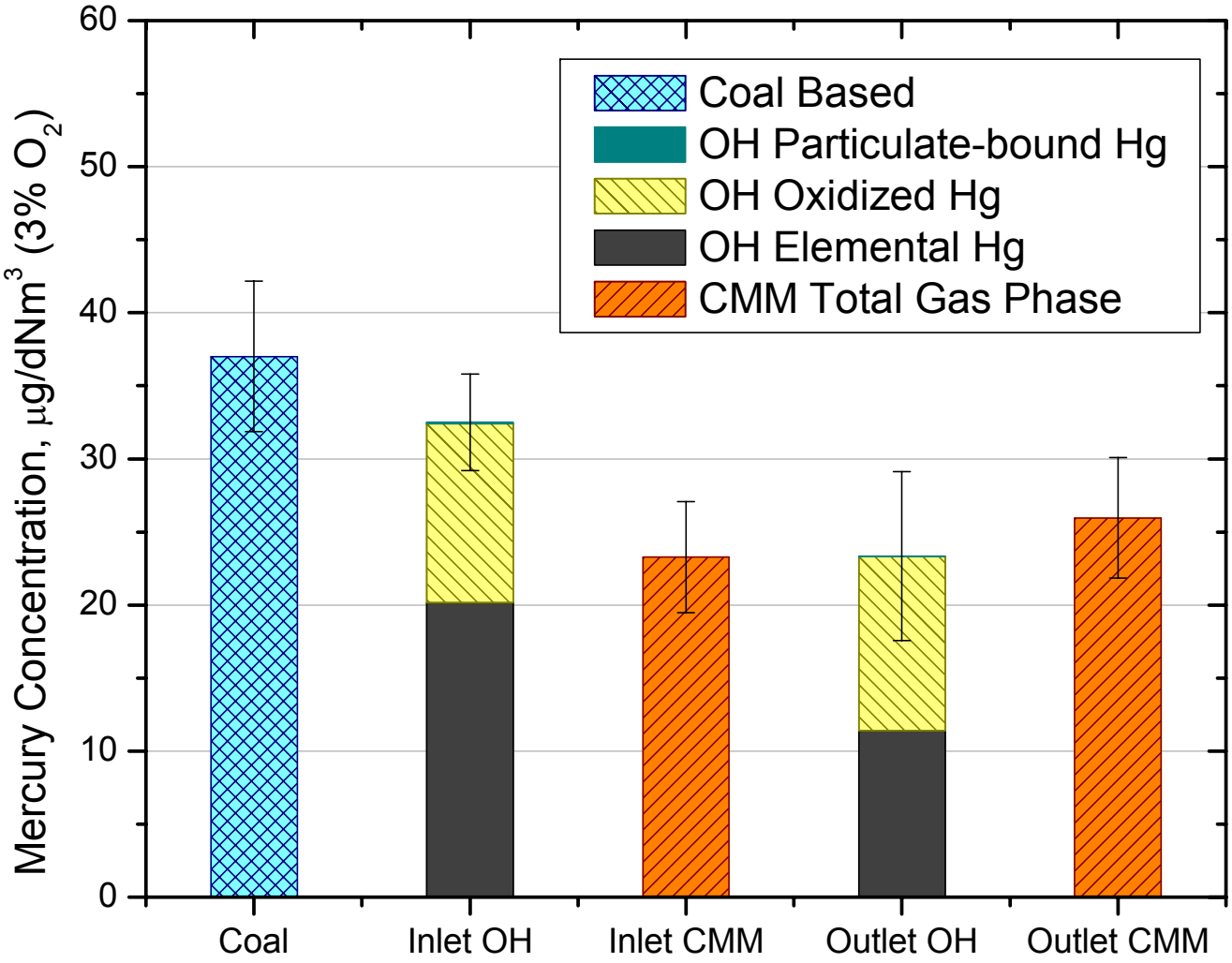
Baseline* Hg Speciation for 70–30 Blend

Average of Jan. 18, 19, and 20, 2006



* Measurement taken at inlet and outlet of FF2-4

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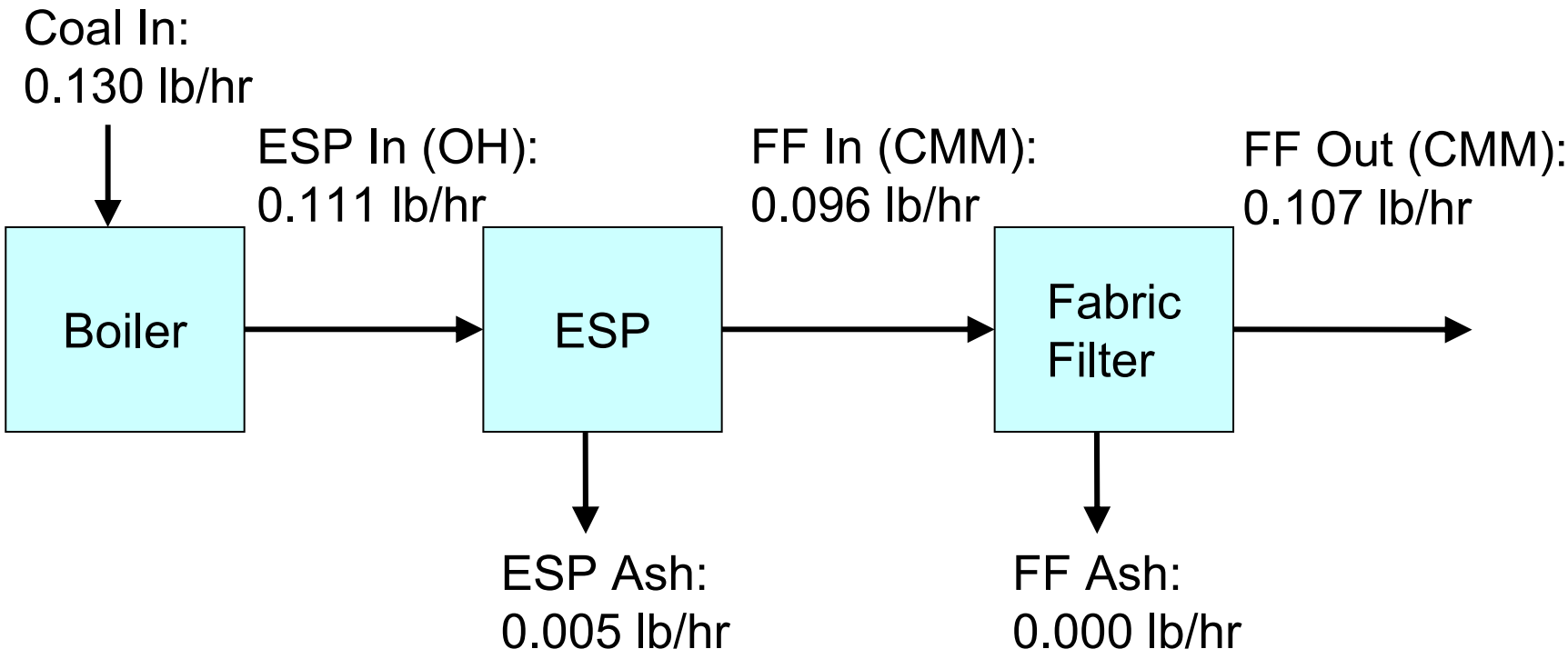
Baseline Unit 2 Hg Balance for 70–30 Blend

Based on FF 2-4 Measurements



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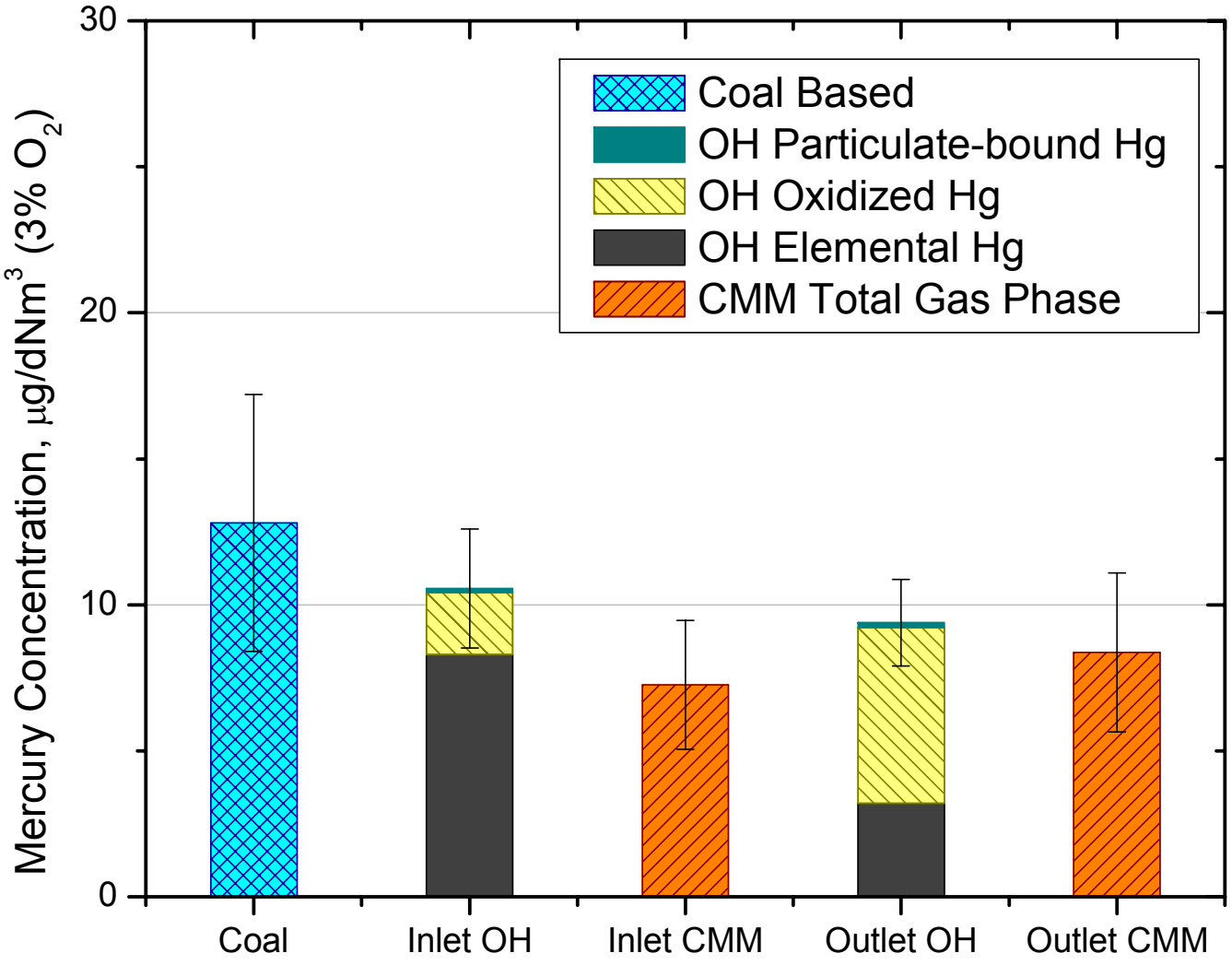
Baseline* Hg Speciation for 100% PRB

Average of 3/30/06, 3/31/06, and 4/1/06



* Measurement taken at inlet and outlet of FF2-4

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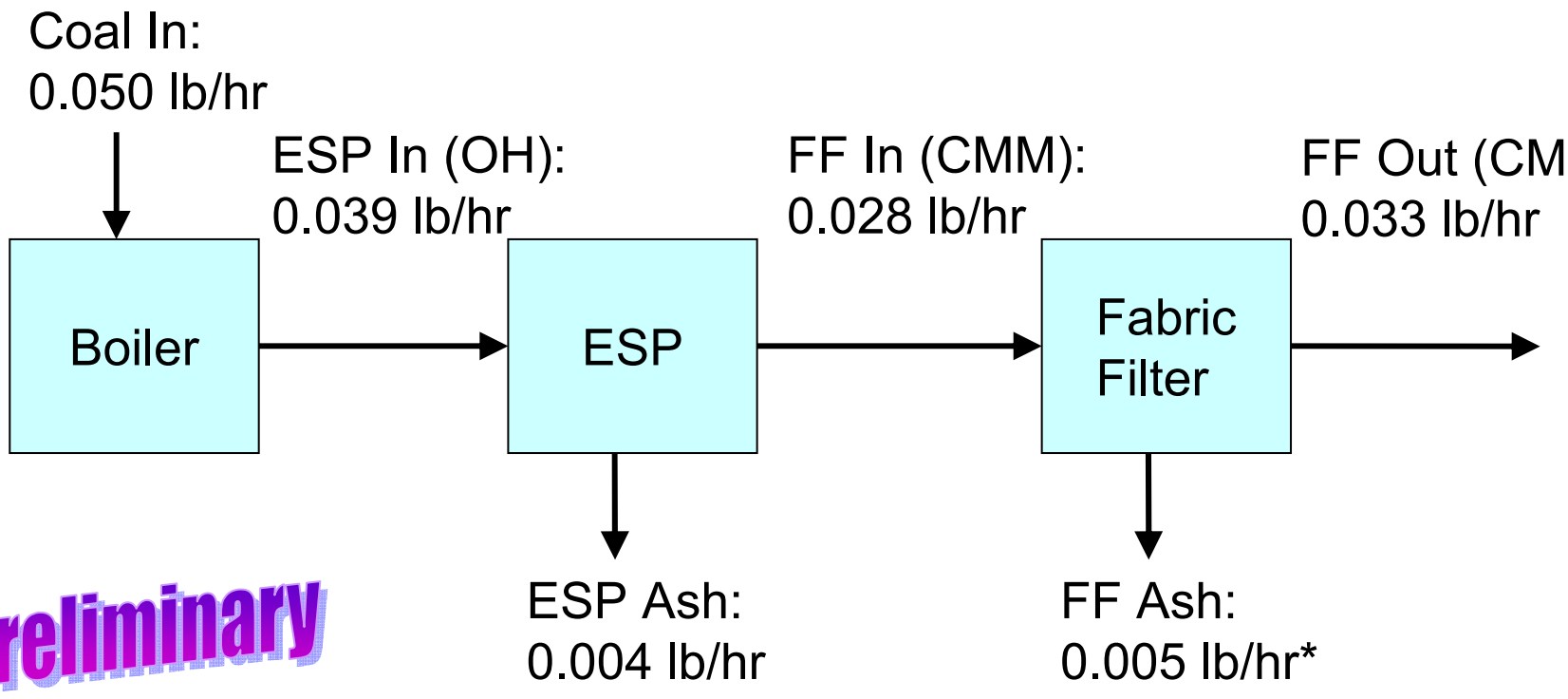
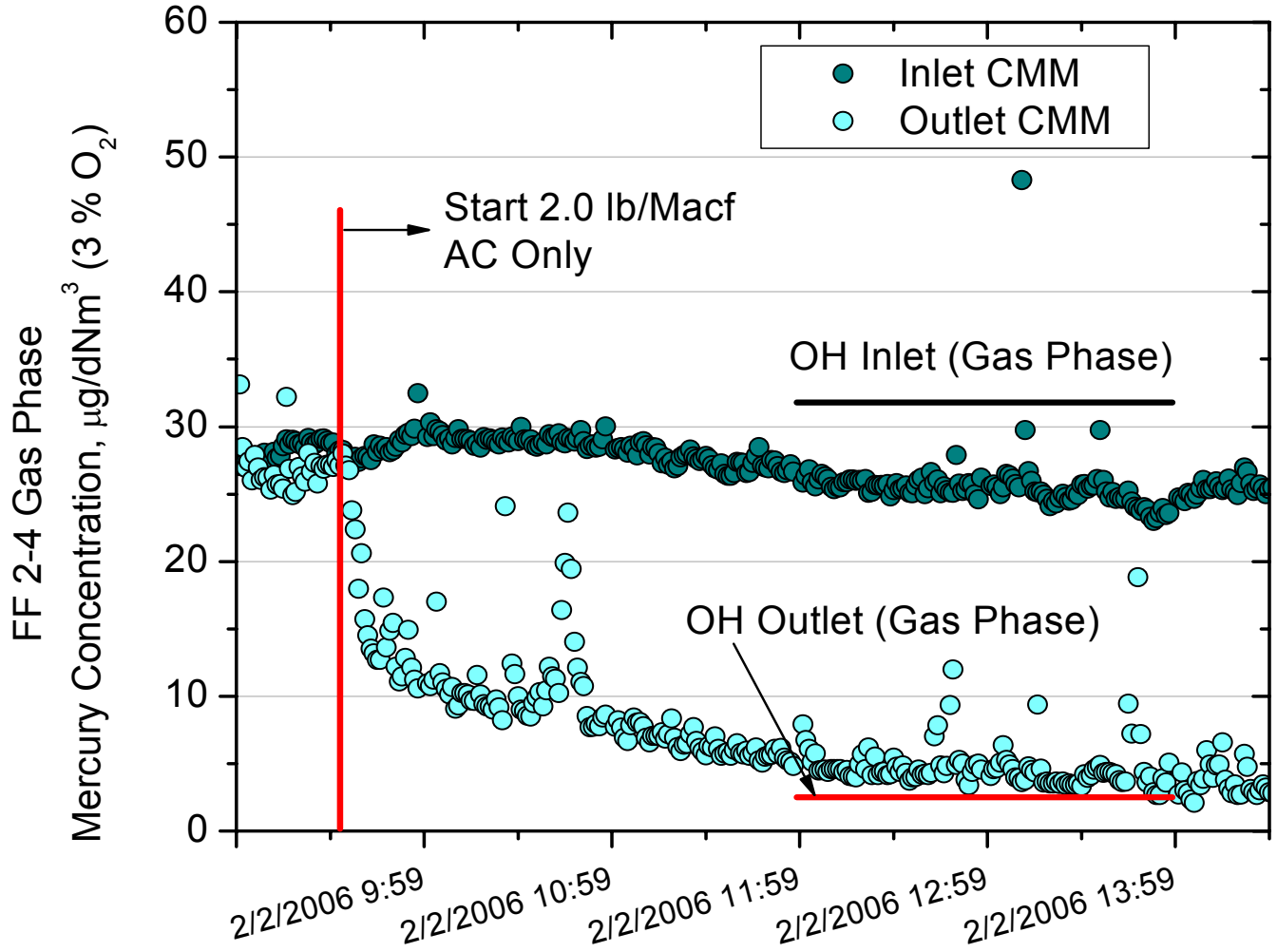
Baseline Unit 2 Hg Balance for 100% PRB
Based on FF 2-4 Measurements



*The indicated removal of Hg in the FF ash is likely an artifact from the prior monthlong testing since the ash carbon content (1.73%) was higher than expected.

Parametric Screening

ACI Only, 2.0 lb/Macf (70–30 blend)



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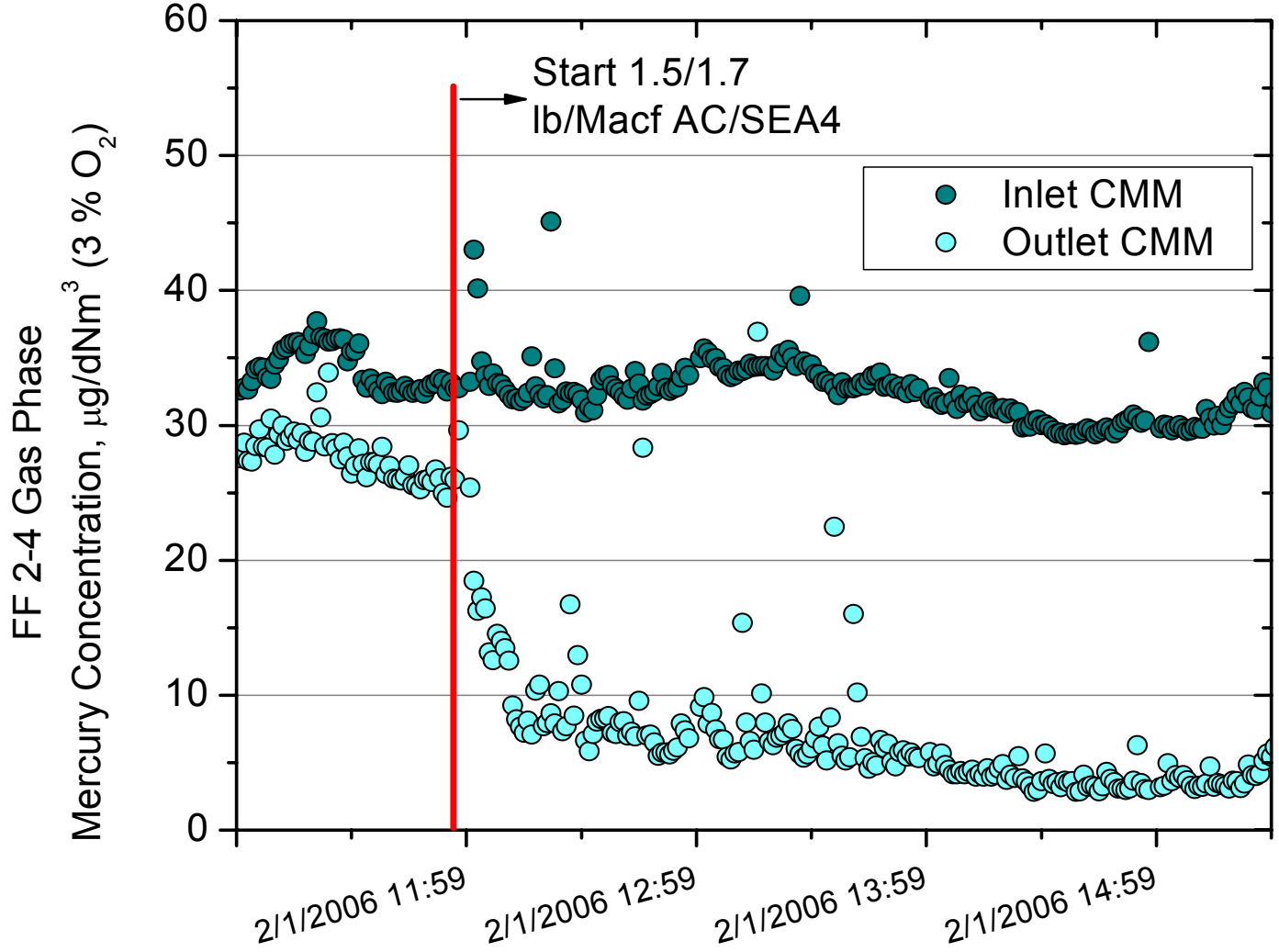
Parametric Screening

ACI and SEA4, 1.5/1.7 lb/Macf (70–30 blend)



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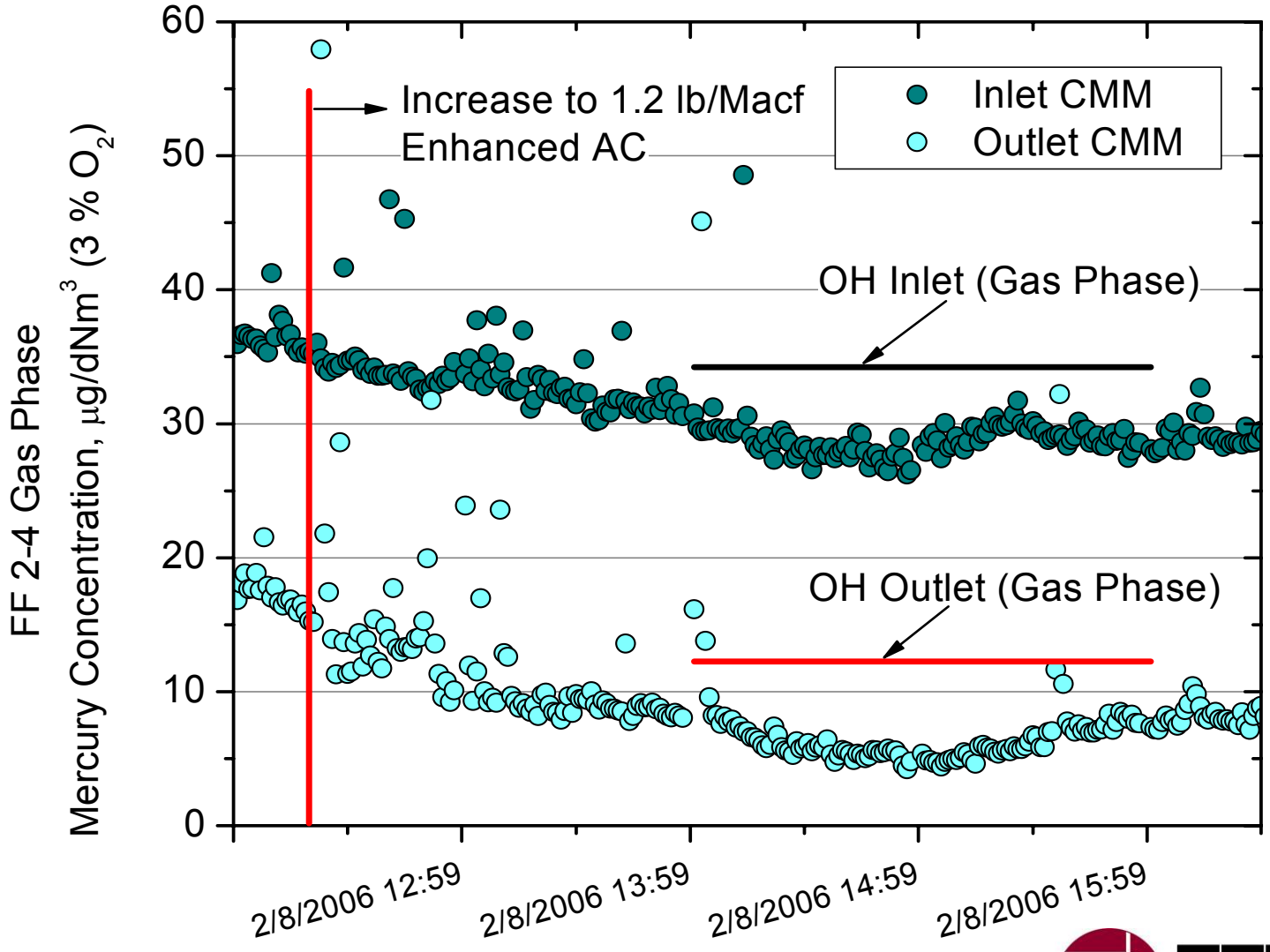
Parametric Screening

Enhanced ACI, 1.2 lb/Macf (70–30 blend)



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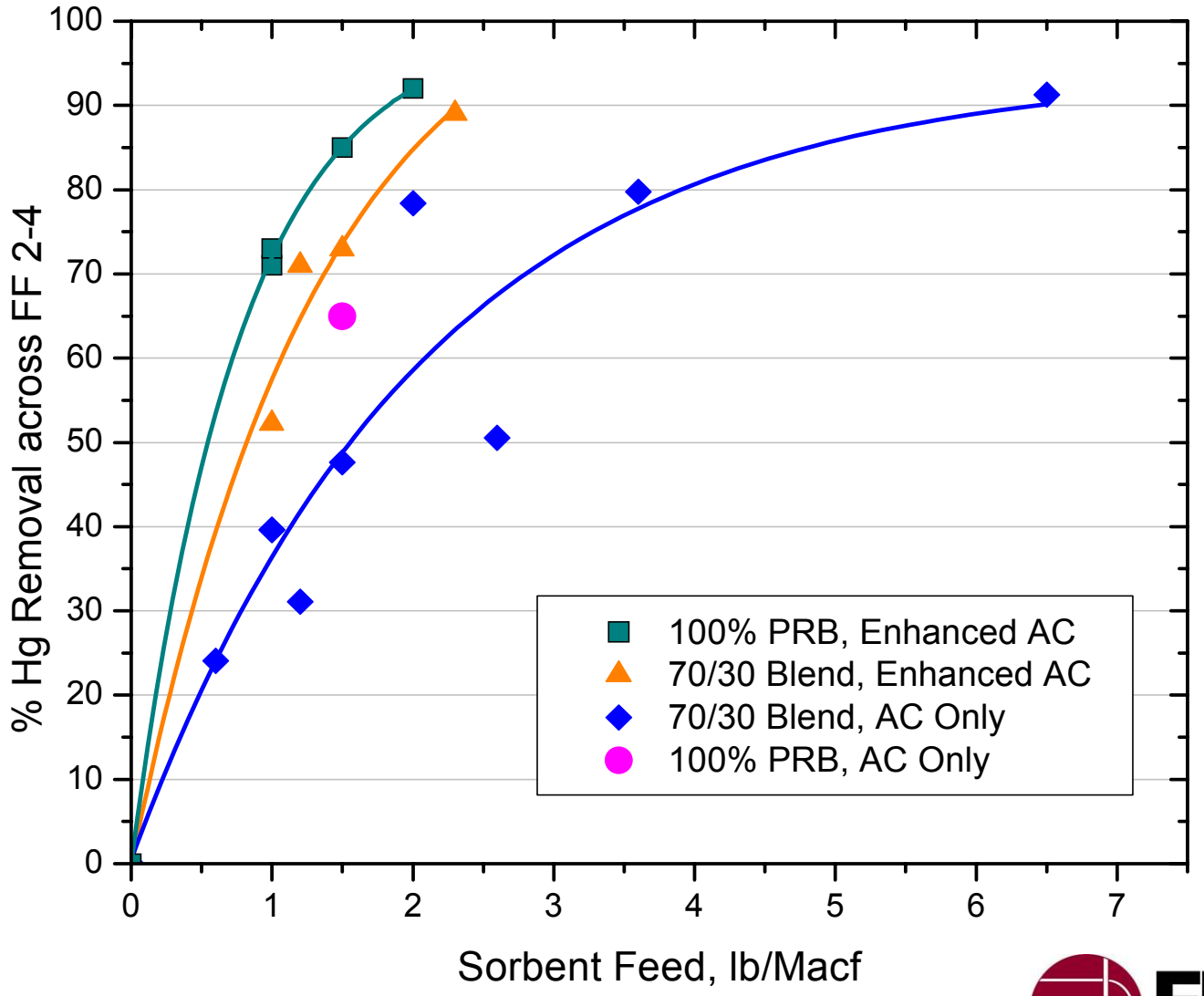
Comparison of Parametric Testing 70–30 Blend and 100% PRB



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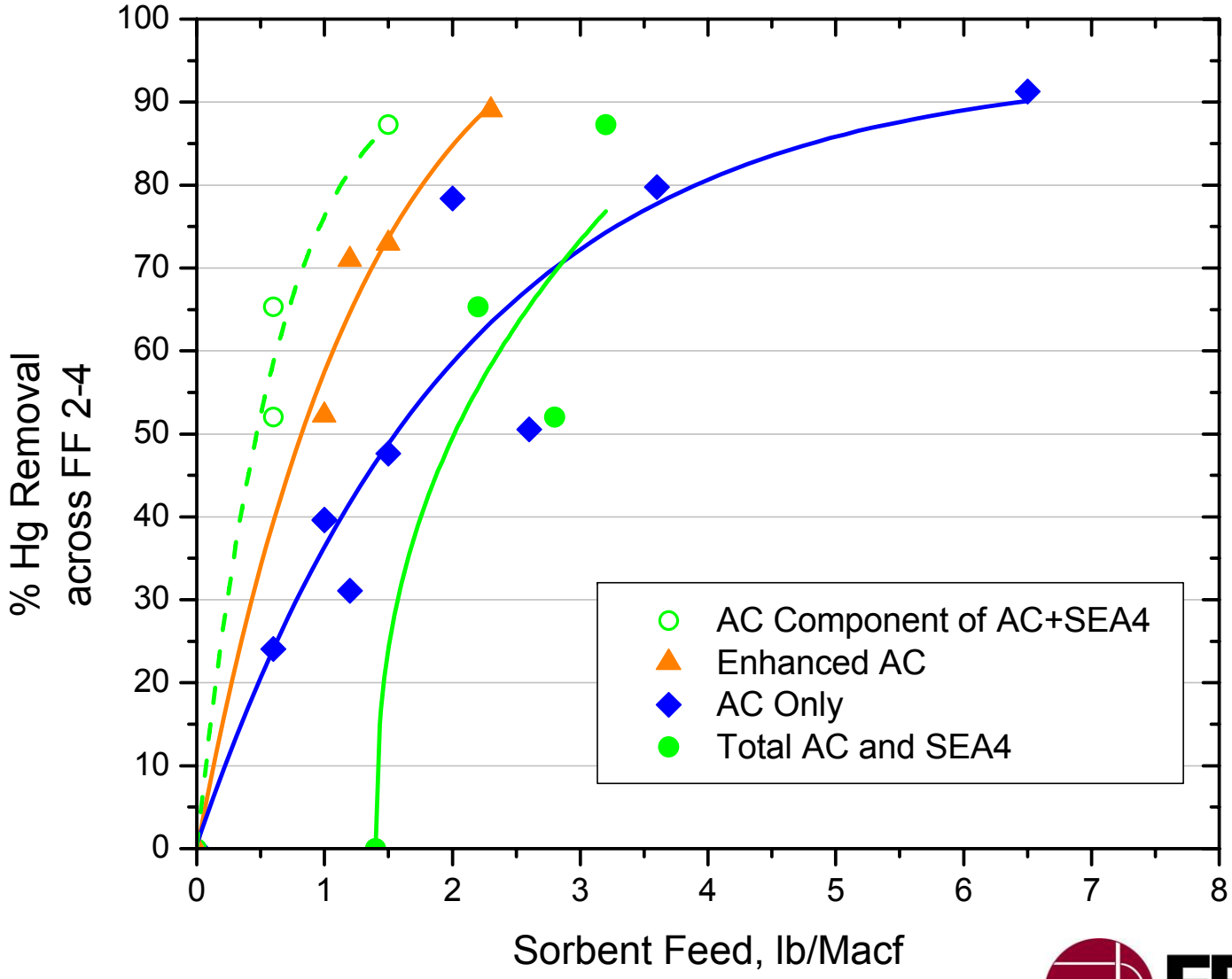
Parametric Results Summary
70–30 Blend



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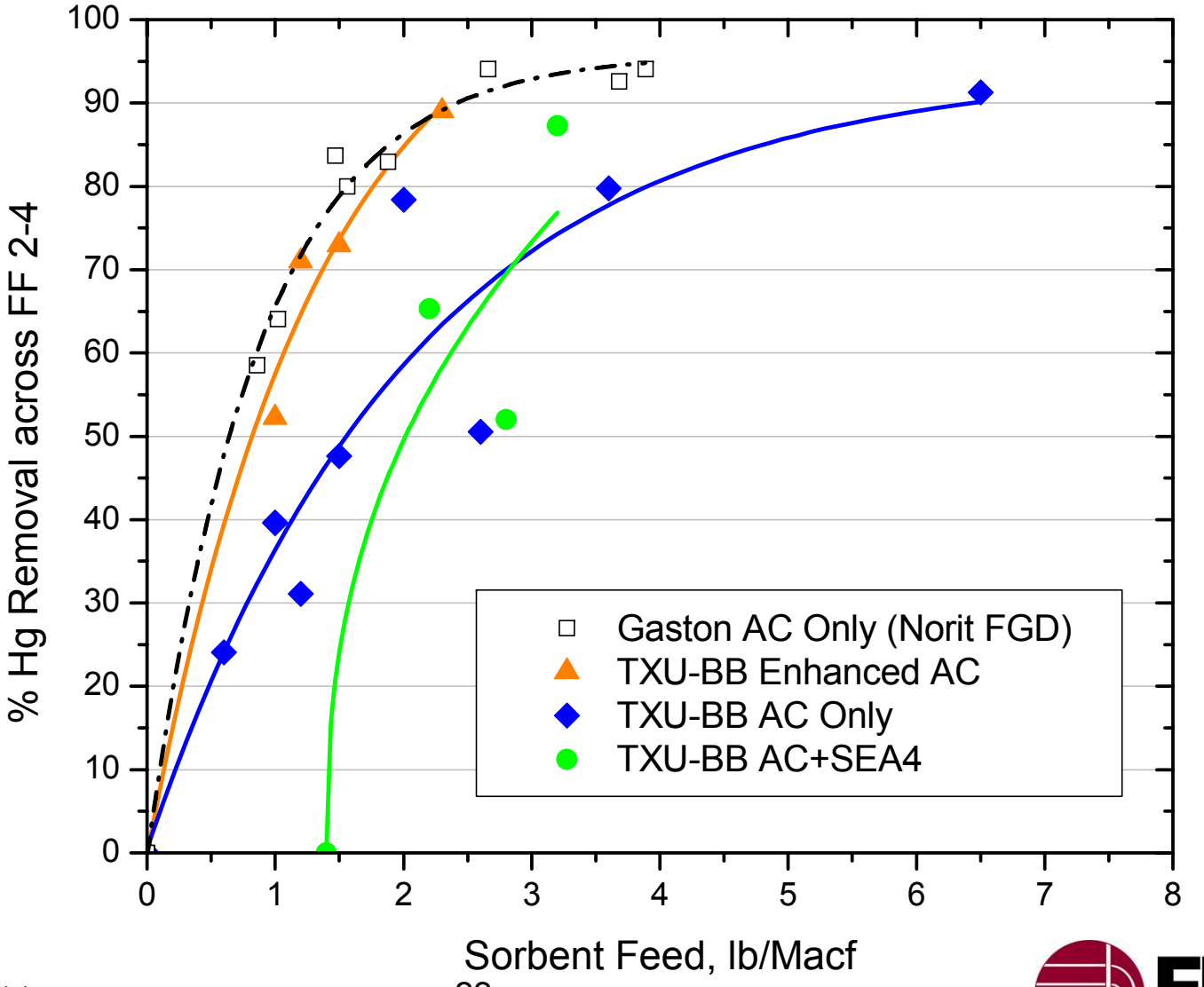
Comparison of Parametric Data to Gaston Results



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Comparison of Blend and PRB Hg Emissions

(based on CMM data)

	FF 2-4 Inlet μg/dNm^3, 3% O_2	FF 2-4 Outlet μg/dNm^3, 3% O_2	FF 2-4 Removal, %	FF 2-4 Outlet Emission, lb/TBtu
Blend Baseline	23.3	26.0	0	18.4
PRB Baseline	7.2	8.4	0	5.7
Blend with Enhanced AC*	18.1	5.1	75	3.2
PRB with Enhanced AC*	8.5	1.6	81	0.9

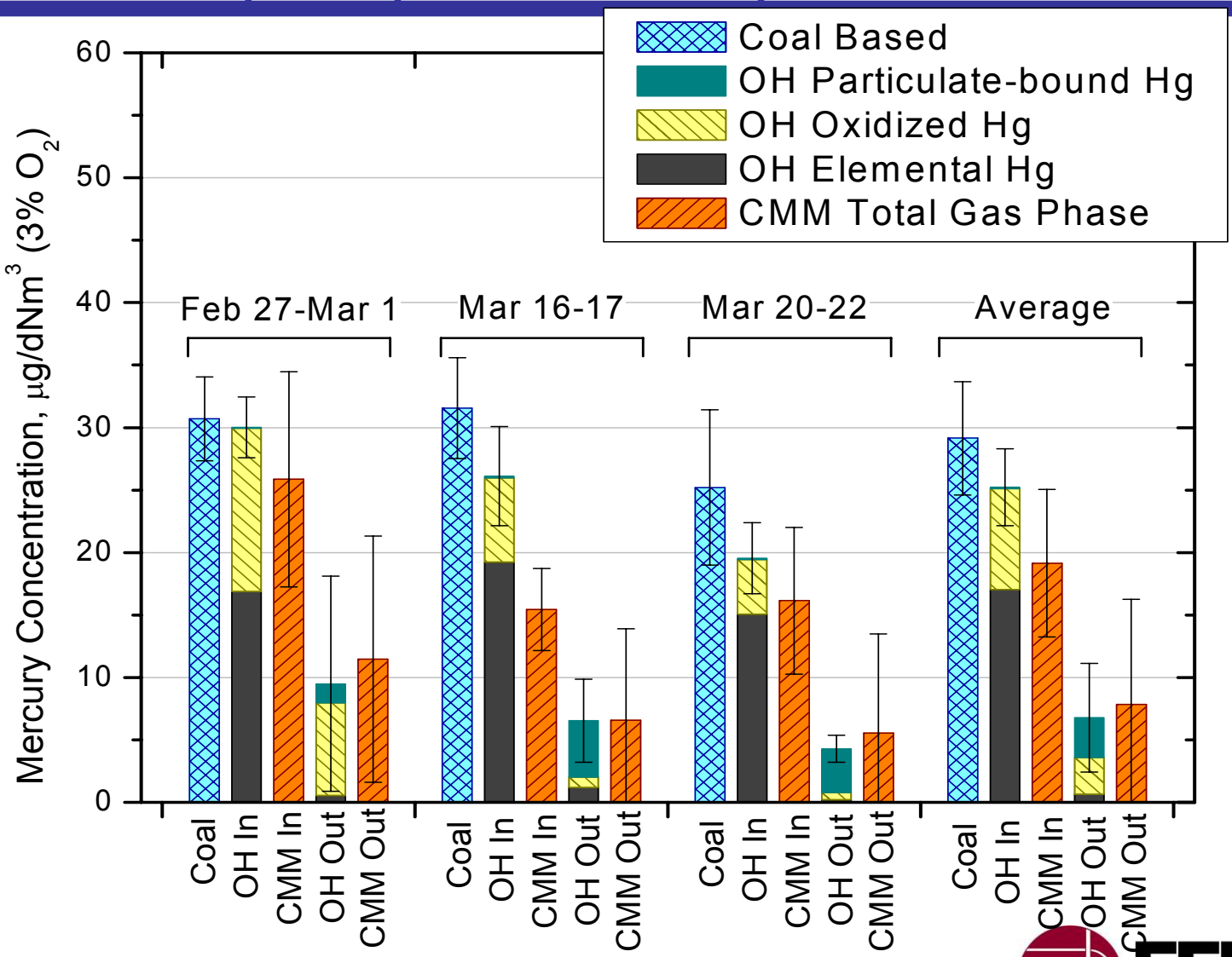
* Enhanced AC rate was 1.5 lb/Macf

Monthlong Test Rationale

Enhanced ACI at a rate of 1.5 lb/Macf (load-following) was selected for the monthlong testing because it had a favorable balance among the following factors:

- Hg removal goals, parametric testing indicated >55% capture was possible.
- Preliminary economics based on sorbent consumption and equipment needs.
- Reducing plant impacts by minimizing the quantity of injected sorbent.

Hg Sampling Throughout Monthlong Test Coal, OH, and CMM, 70–30 Blend



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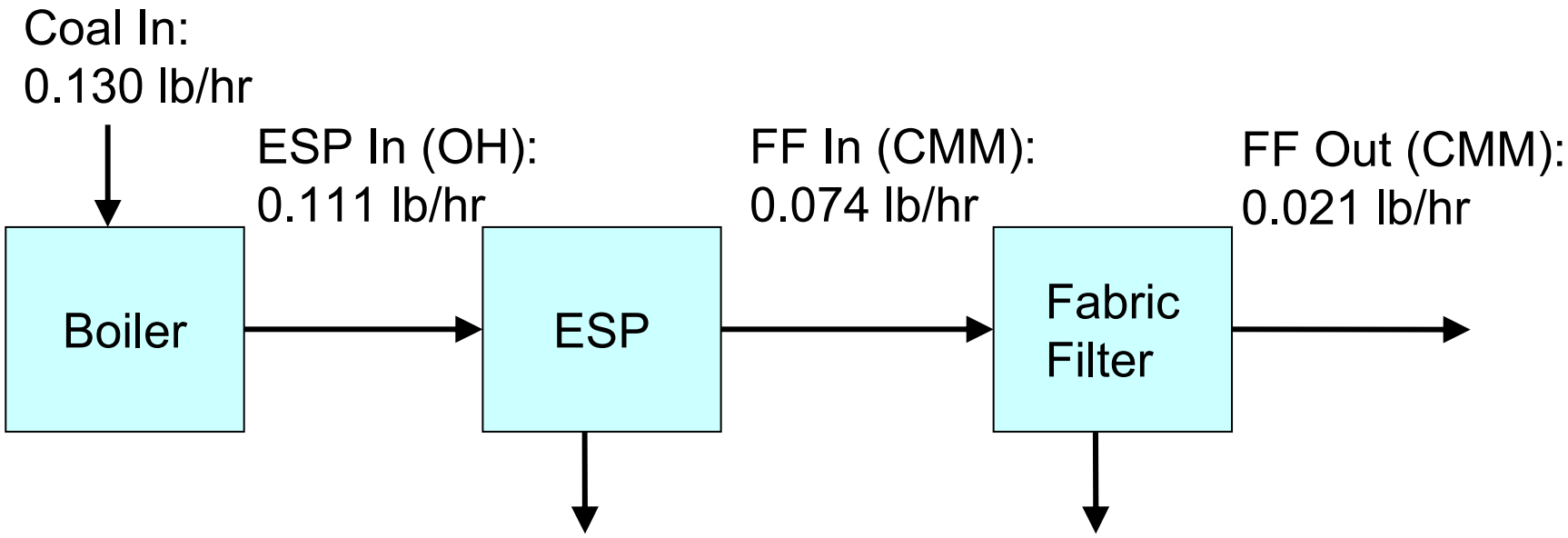
Monthlong Unit 2 Hg Balance
Based on FF 2-4 Measurements



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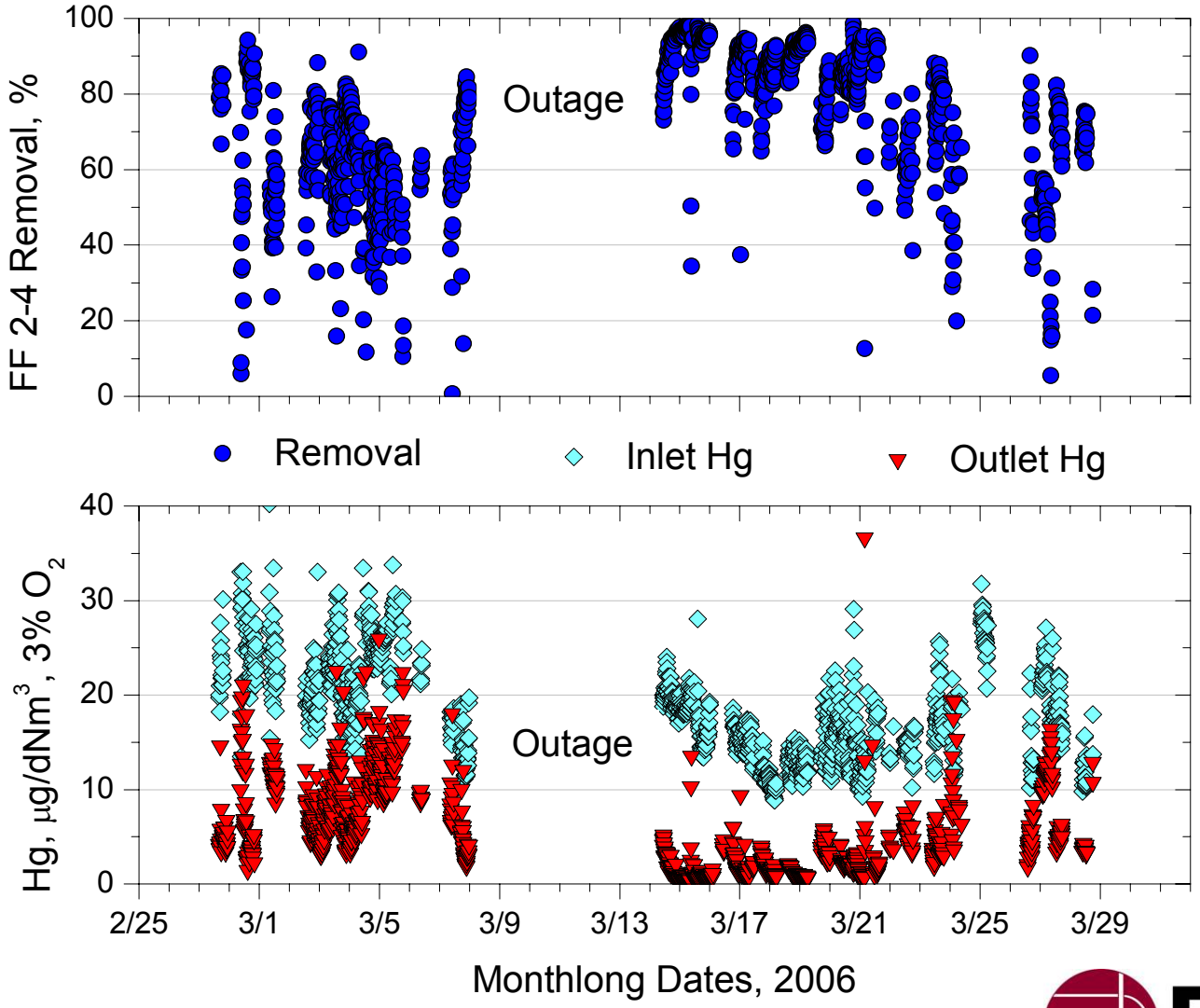
Monthlong Hg Concentration and Removal Data, 70–30 Blend



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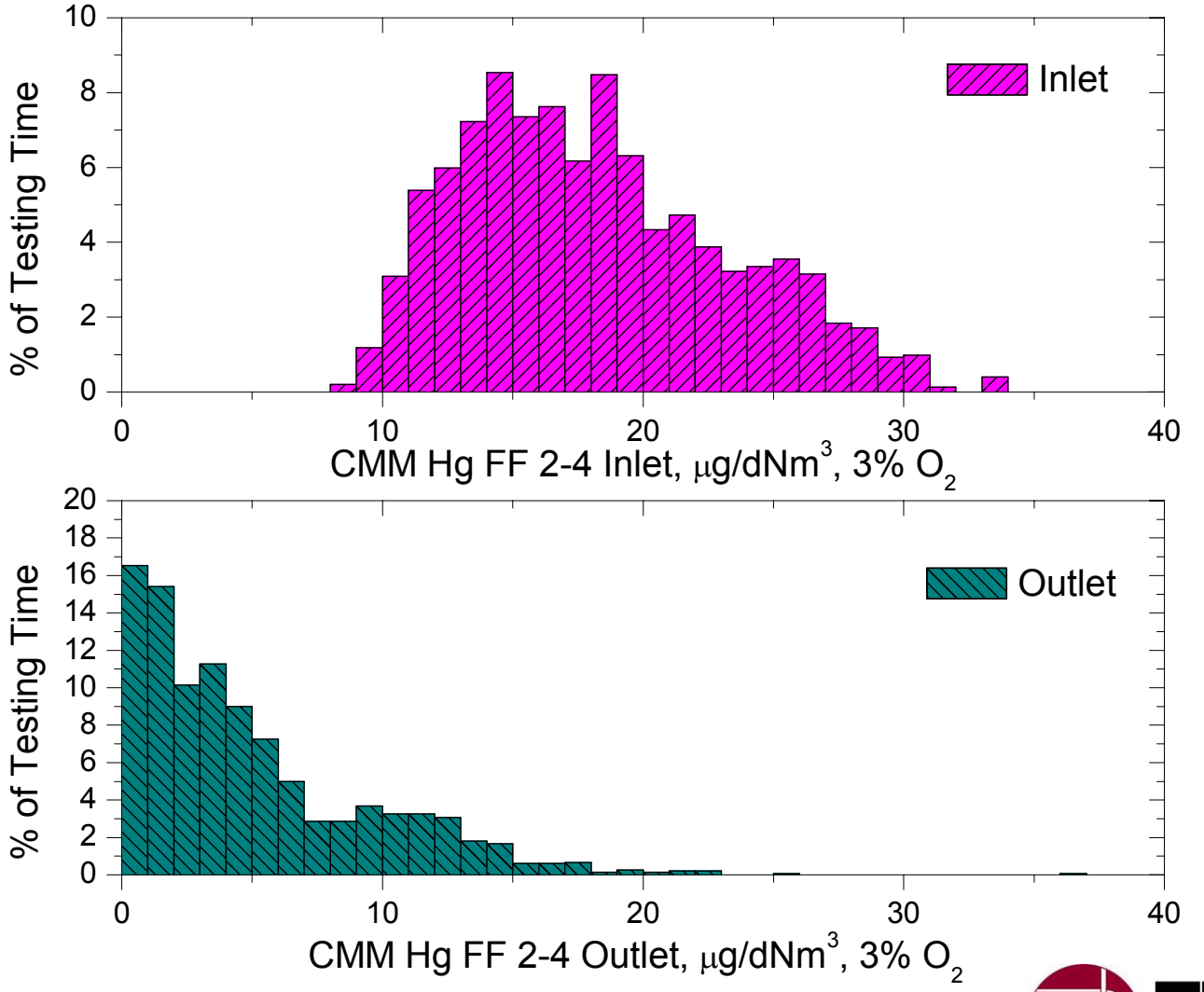
Monthlong Hg Concentration Variability

Preliminary



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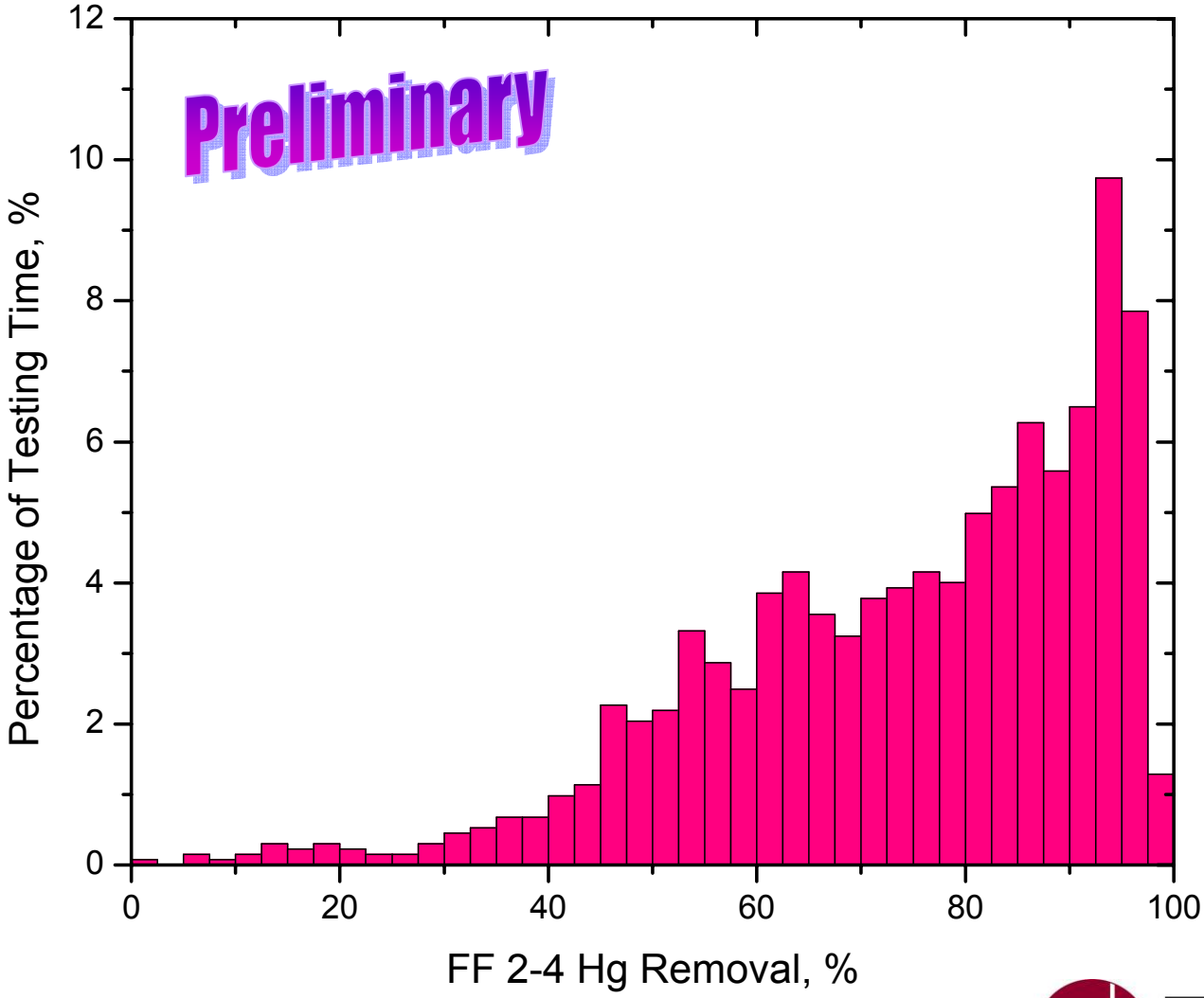
Monthlong Hg Removal Variability



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Balance-of-Plant Impacts

- The monthlong and 100% PRB tests were interrupted during an unscheduled outage of Unit 2 (approximately 6 days) and during periods of bypass opening across FF 2-4.
- A combination of increasing frequency of high-load conditions and higher drag across FF 2-4 contributed to increased bypass openings.
- While Hg control was promising, BOP issues may be the key factor for applying Hg control technology at Big Brown.

Balance-of-Plant Investigation

The BOP effects are possibly related to 1) injection of material, 2) changes in flue gas or ash chemistry due to addition of sorbent materials, 3) changes in operating conditions

- Changes in operating conditions included:
  - Flow rate variations (rebalancing of flow, increased flow)
  - Temperature fluctuations
  - Ash-conditioning systems
  - Fuel blend
  - Load variation, changes to flow and particulate loading
  - Frequent bypassing at 10” H_2O
  - Operations of ash-handling system
  - Unit outages
- Chemical and morphology analysis is ongoing.

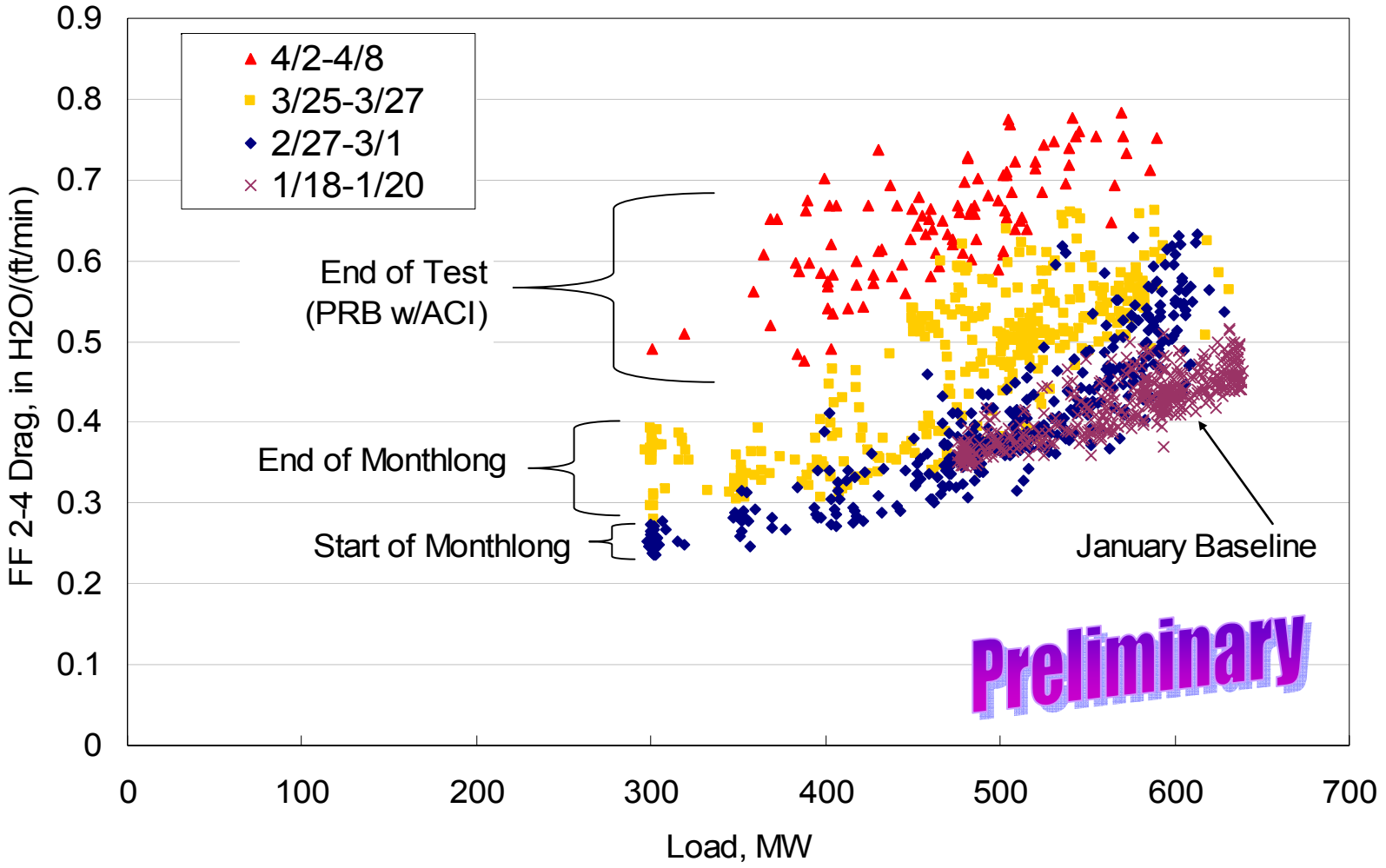
Balance-of-Plant Data Collection

While the focus of field testing was on determining effectiveness of mercury control options, additional data and information have been collected to determine the root cause of observed BOP effects.

- Plant operational data for the duration of field testing.
- Flue gas sampling data, composition, dust loading, etc.
- Daily FF ash samples and coal samples.
- Bag samples taken from compartments 2-3C and 2-4C before and after testing. Samples were sent to the EERC and an independent filtration consultant for analysis.
- Hopper samples were collected and sent to the EERC and an independent laboratory.
- Additional samples and plant operating data have been requested.

FF 2-4 Drag vs. Load at Testing Milestones

Data sorted during closed bypass



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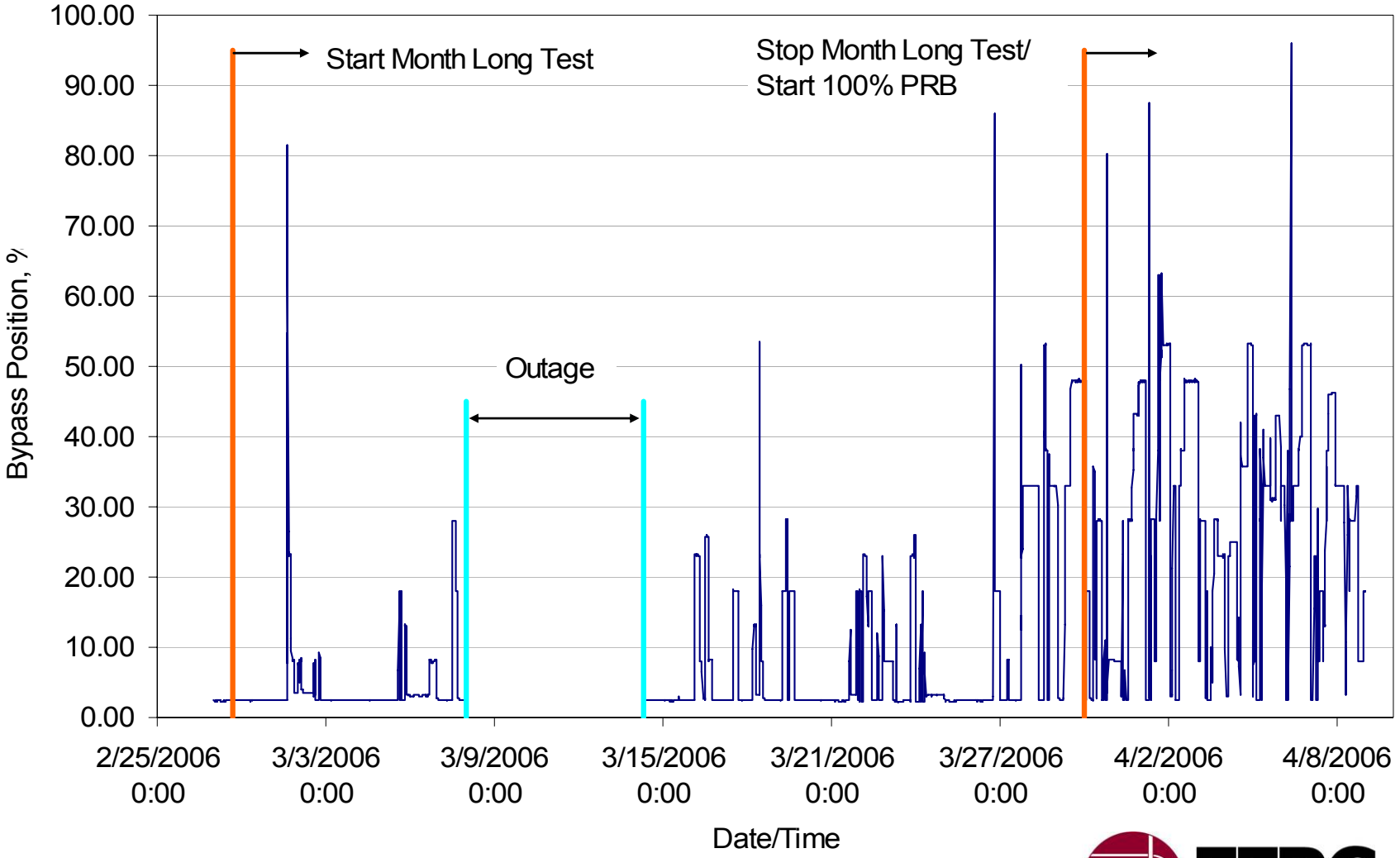
FF 2-4 Bypass Position
February 27 to April 8, 2006



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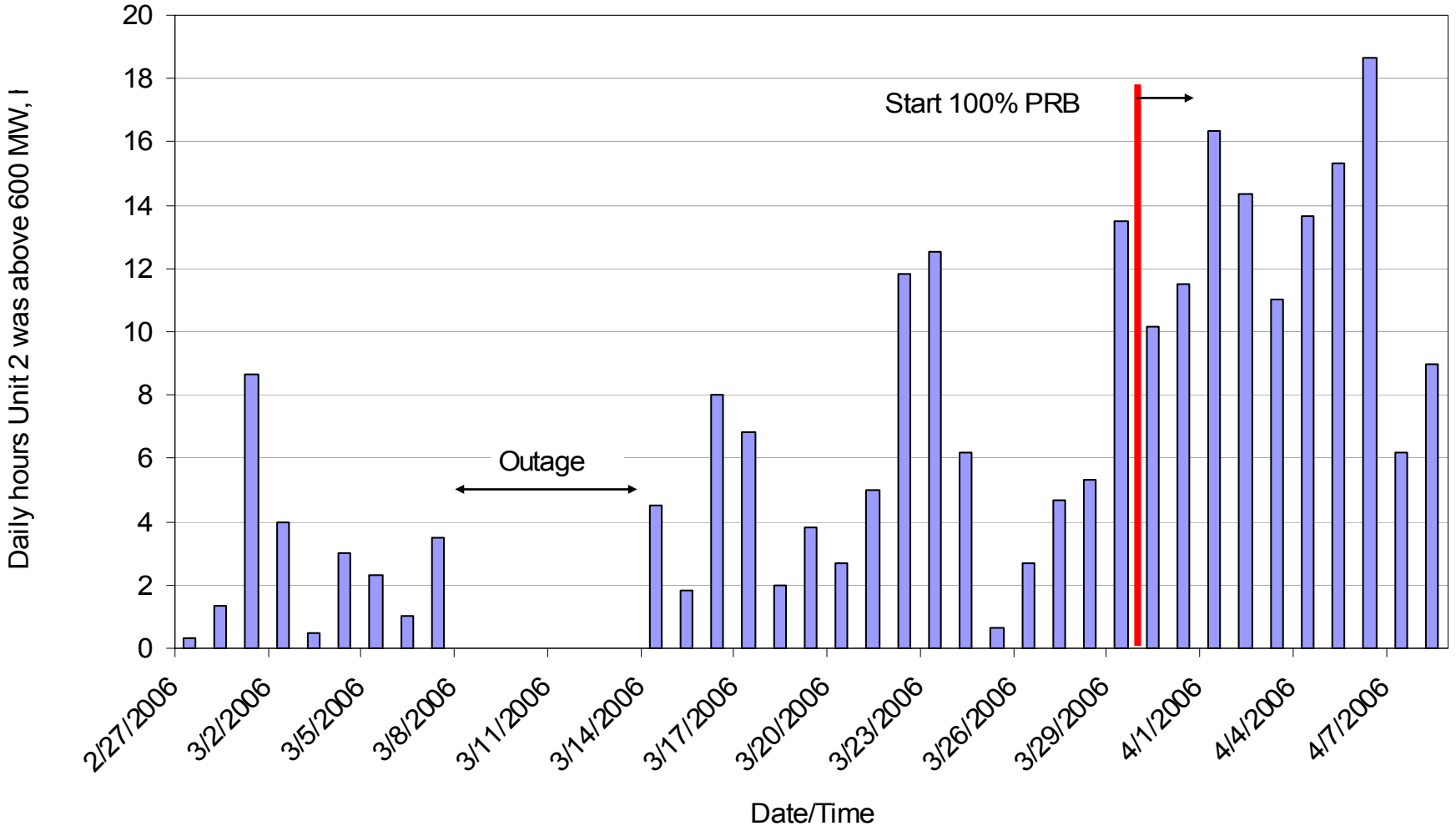
BB Unit 2, Hours Above 600 MW
February 27 to April 8, 2006



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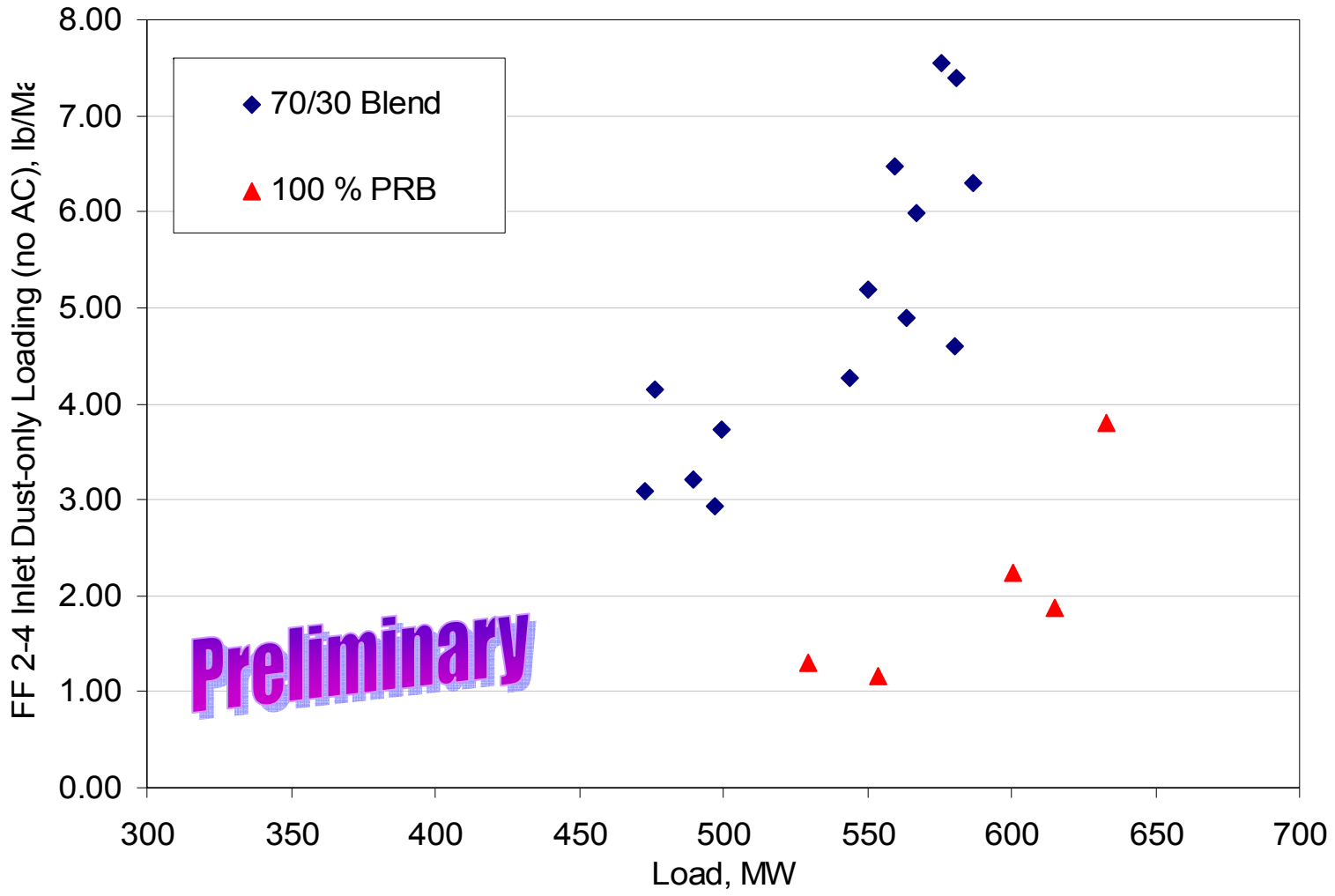
FF 2-4 Inlet Dust Loading vs. Load

Dust only, no AC



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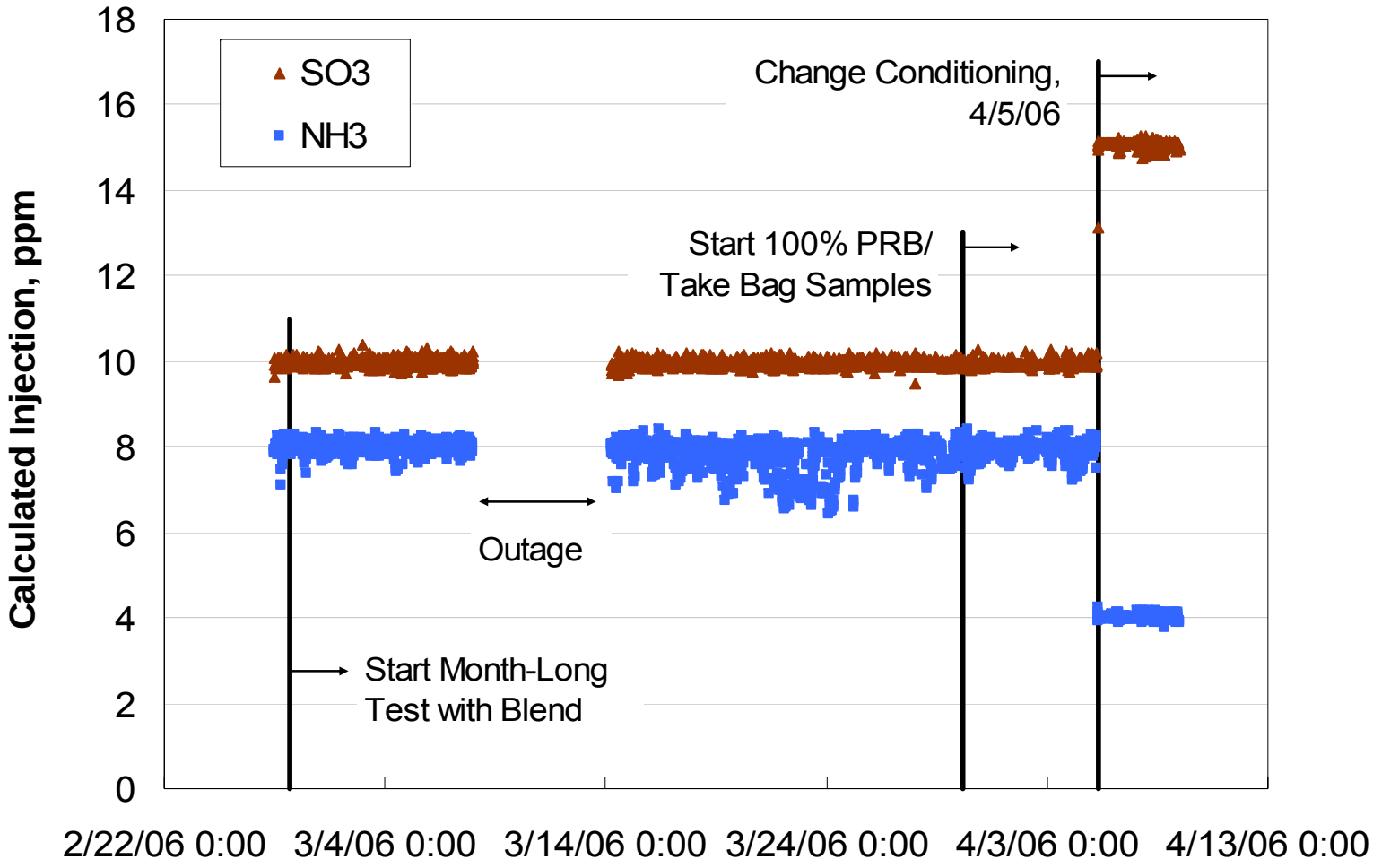
Ash Conditioning, SO_3 and NH_3 Injection
February 27 to April 8, 2006



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Conclusions

- Under baseline test conditions, mercury capture across the baghouse is effectively zero for both the 70–30 blend and 100% PRB.
- Hg removals were generally better than expected when compared to pilot-scale testing.
- Both the AC+SEA4 and enhanced AC options performed better than ACI alone. Testing showed that >70% capture could be achieved with rates lower than 2 lb/Macf.
- Parametric testing identified that injection rates >2 lb/Macf resulted in increased dP across FF 2-4.

Conclusions

- Long-term testing of 1 month showed an average removal greater than 70% at an injection rate of 1.5 lb/Macf enhanced AC (load following).
- Hg removal efficiencies were similar for the 70–30 blend and 100% PRB, but emissions were much lower with the PRB due to the lower Hg in coal content.
- BOP impacts (bag blinding, plant operations, ash handling/management, etc.) were observed – ongoing analyses are under way to quantify impacts and determine cause-and-effect relationships.
- Economics of tested control technologies are expected to be highly dependent on BOP impacts.
- While Hg control was promising, BOP issues may be the key factor for applying Hg control technology at Big Brown.