



**EERC**

*EERC Technology... Putting Research into Practice*

# **Mercury Control Technologies for Electric Utilities Burning Lignite Coal Phase II Field Testing of Slipstream Technology**

**DOE/NETL's Mercury Control Technology R&D Program Review  
Project Manager: Lynn Brickett  
Pittsburgh Hilton Hotel  
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Energy & Environmental Research Center  
Grand Forks, ND**

# Project Participants

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North Dakota  
Industrial Commission



# ***Project Goals***

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## **Develop, Test, and Demonstrate Sorbent-Based Technologies for Electric Utilities Burning Lignite Coal**

- **Increase the scientific understanding of mercury–flue gas interactions leading to more effective design of sorbents.**
- **Test a range of sorbent-based technology options.**
- **Determine and demonstrate optimum conditions for Hg capture using sorbents.**
- **Field-demonstrate sorbent-based technology to prove and quantify effectiveness, performance, and cost.**

# *Approach*

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## *Phase I – Bench- and Pilot-Scale Testing (Done)*

- Lignite flue gas characterization
- Bench-scale sorbent-screening tests
- Pilot-scale control technology-screening tests
- By-product analyses

## *Phase II – Field Testing of Slipstream Technology*

- Field demonstration
  - Select sorbent and technology option.
  - Prepare site and install technology hardware.
  - Evaluate sorbent effectiveness and impacts.
  - Evaluate impact of design and process variables.
  - Analyze by-products.
  - Quantify effectiveness and cost.

# *Phase II – Field Testing of Slipstream Technology*

## Test Site – SaskPower Poplar River Power Station

- Two units, the first commissioned in 1981 and the second in 1983
- Unit 1 = 298 MW; Unit 2 = 294 MW
- ESPs for particulate control



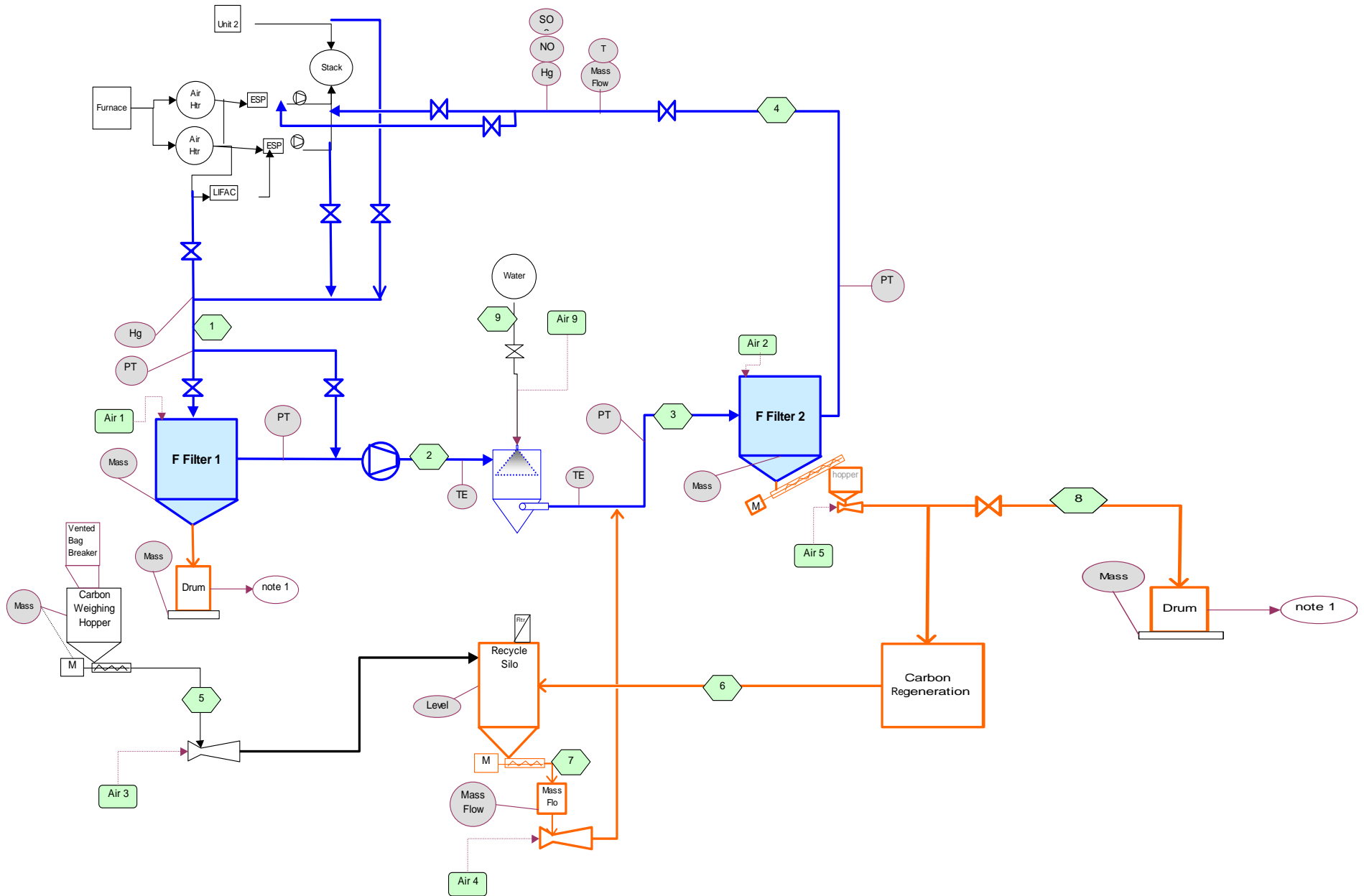
- ### Poplar River Power Station
- South-central Saskatchewan
  - 10 km SE of Coronach
  - 1- to 10-MWe slipstream (varies with air-to-cloth ratio)

# ***Phase II Field Testing Progress***

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- **System design completed.**
- **Construction completed.**
- **Shakedown testing completed.**
- **Minor modifications to unit completed.**
- **Screening tests completed for nine sorbents.**
- **Parametric testing near completion.**
- **Midterm (1- to 3-day) tests under way.**
- **Long-term (several-month) tests in planning.**

# Emission Control Research Facility (ECRF)



# ***ECRF Building***

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# *Installation of Technology – Sorbent Feed System*

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# ***ECRF Equipment***



# *Mercury Measurement – Two Dry-Based Mercury Monitors*



# ***Test Plan for Slipstream Field Testing at SaskPower's ECRF***

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# *Typical Poplar River Coal Analysis*

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- **As-received, wt%**

– Moisture	<b>36.10</b>
– Volatile matter	<b>27.76</b>
– Fixed carbon	<b>21.81</b>
– Ash	<b>14.33</b>

## **Mercury and chlorine, dry basis**

– Hg	<b>0.124 µg/g</b>
– Cl	<b>19.4 µg/g</b>

# *Screening Test Parameters*

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## *Sorbents*

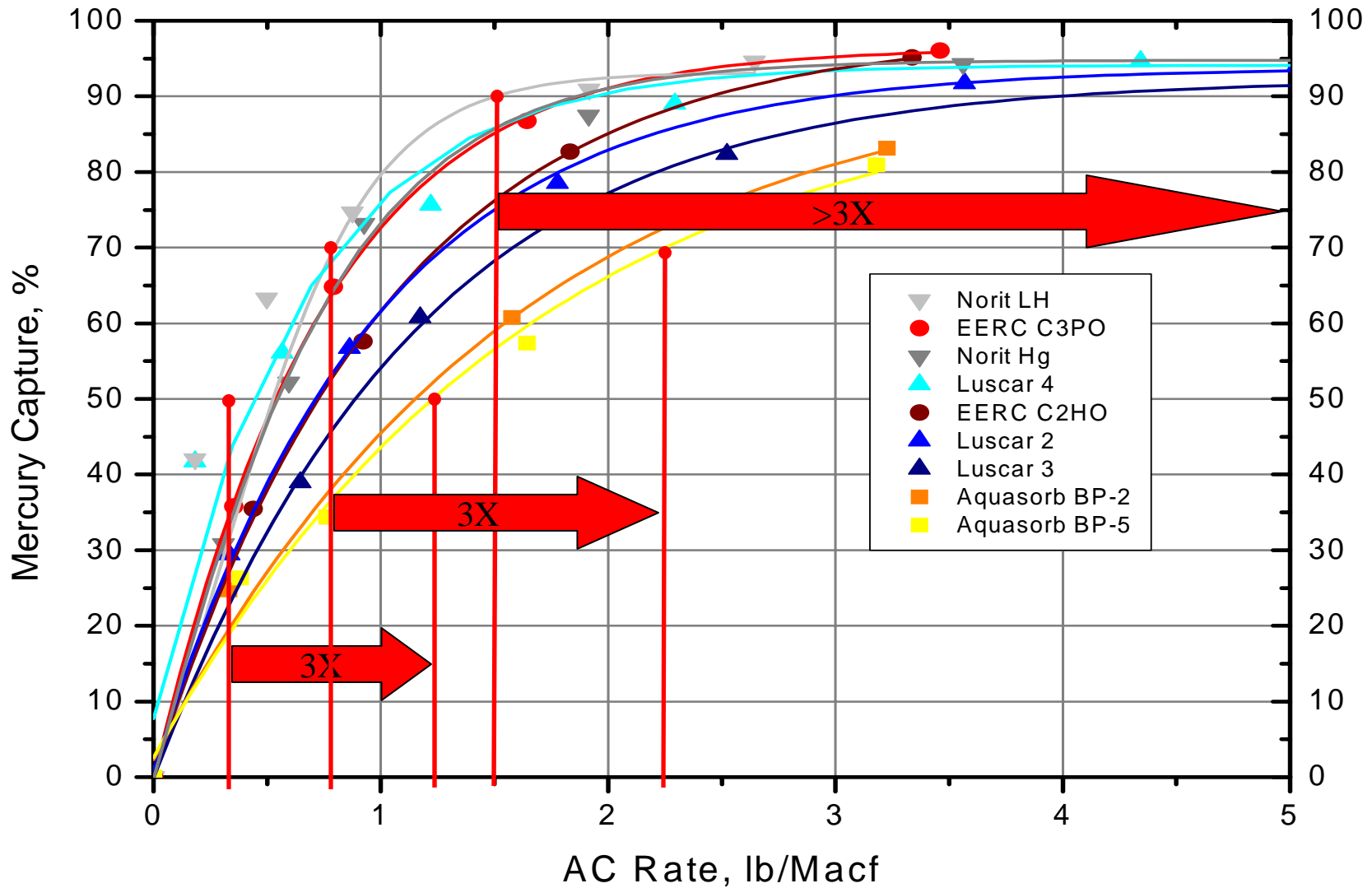
- **Commercially available AC (NORIT Hg\*, etc.)**
- **Luscar-prepared AC**
- **Treated carbons**
- **Recycled/regenerated sorbents**

\* Formerly called NORIT FGD

## *Test Parameters*

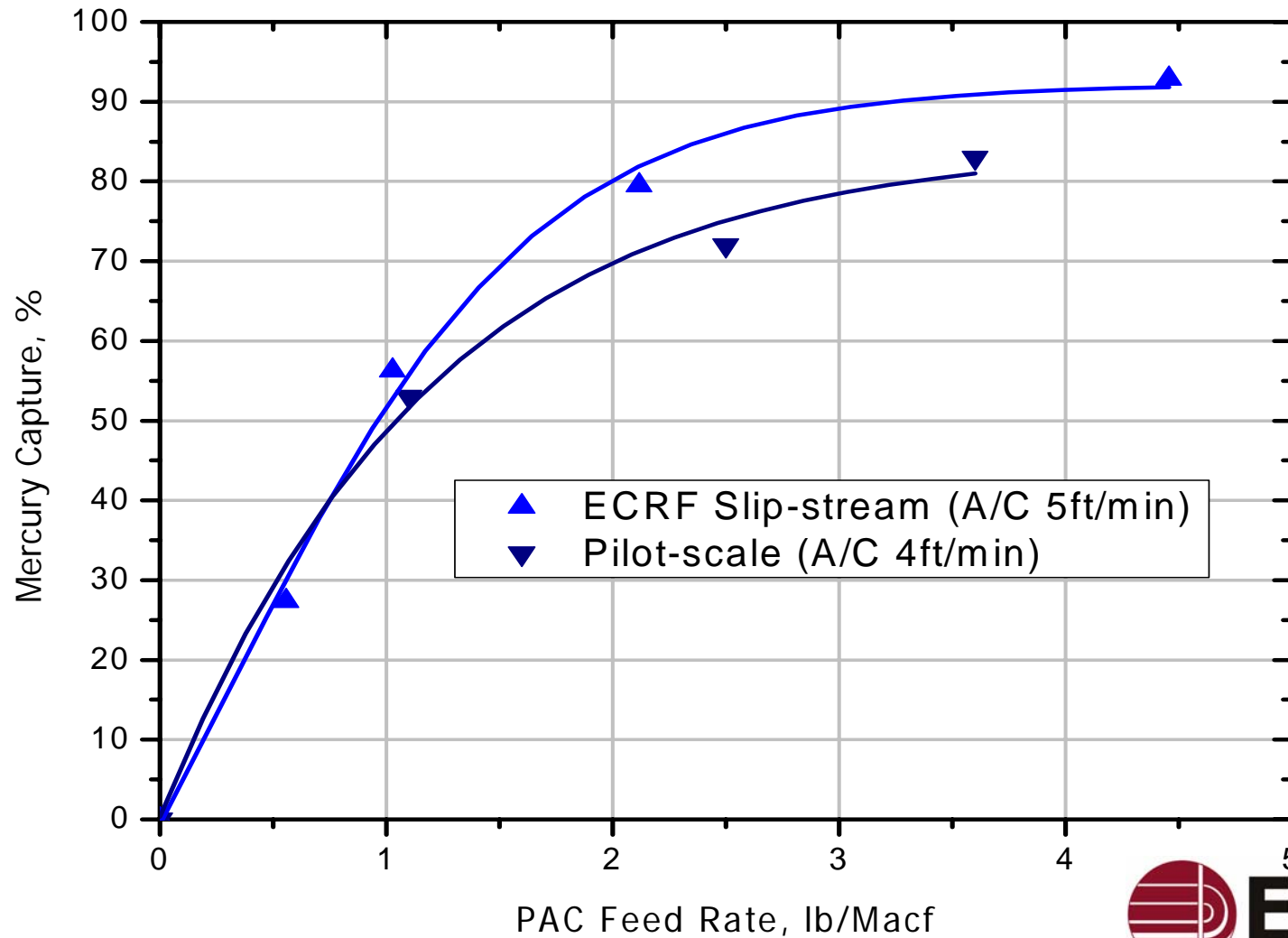
- **Injection rate, 0.25–10 lb/Macf**
- **Continuous injection**
- **Gas temperature, 300 °F**
- **Gas flow (A/C of 5)**
- **Bag cleaning cycle, 30 min**
- **Low/high dust loading**

# AC Screening Results



# Comparison to Pilot-Scale Data

Luscar 2





# *Parametric Test Parameters*

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## *Sorbents*

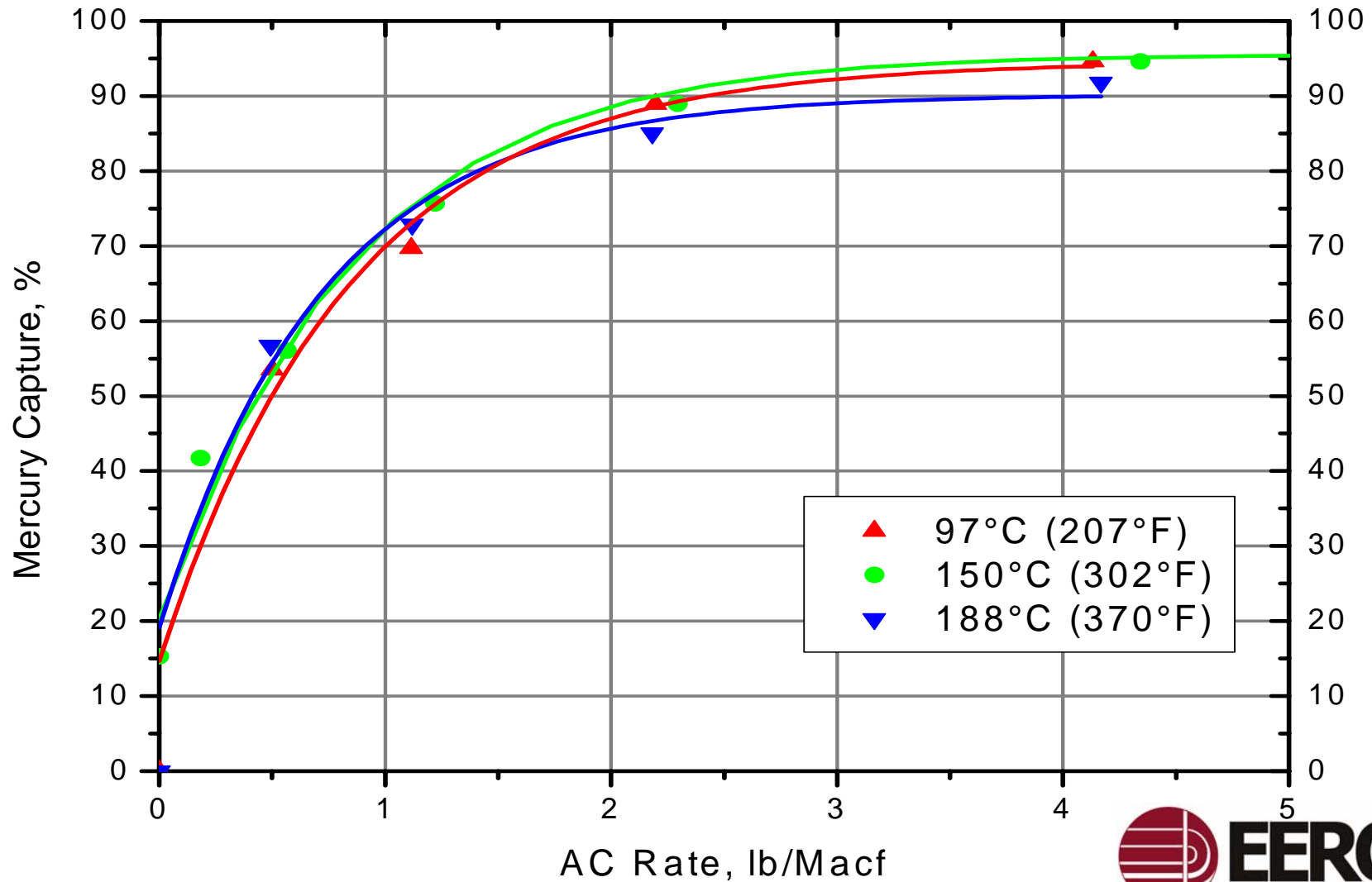
- **Commercially available AC (NORIT Hg\*, etc.)**
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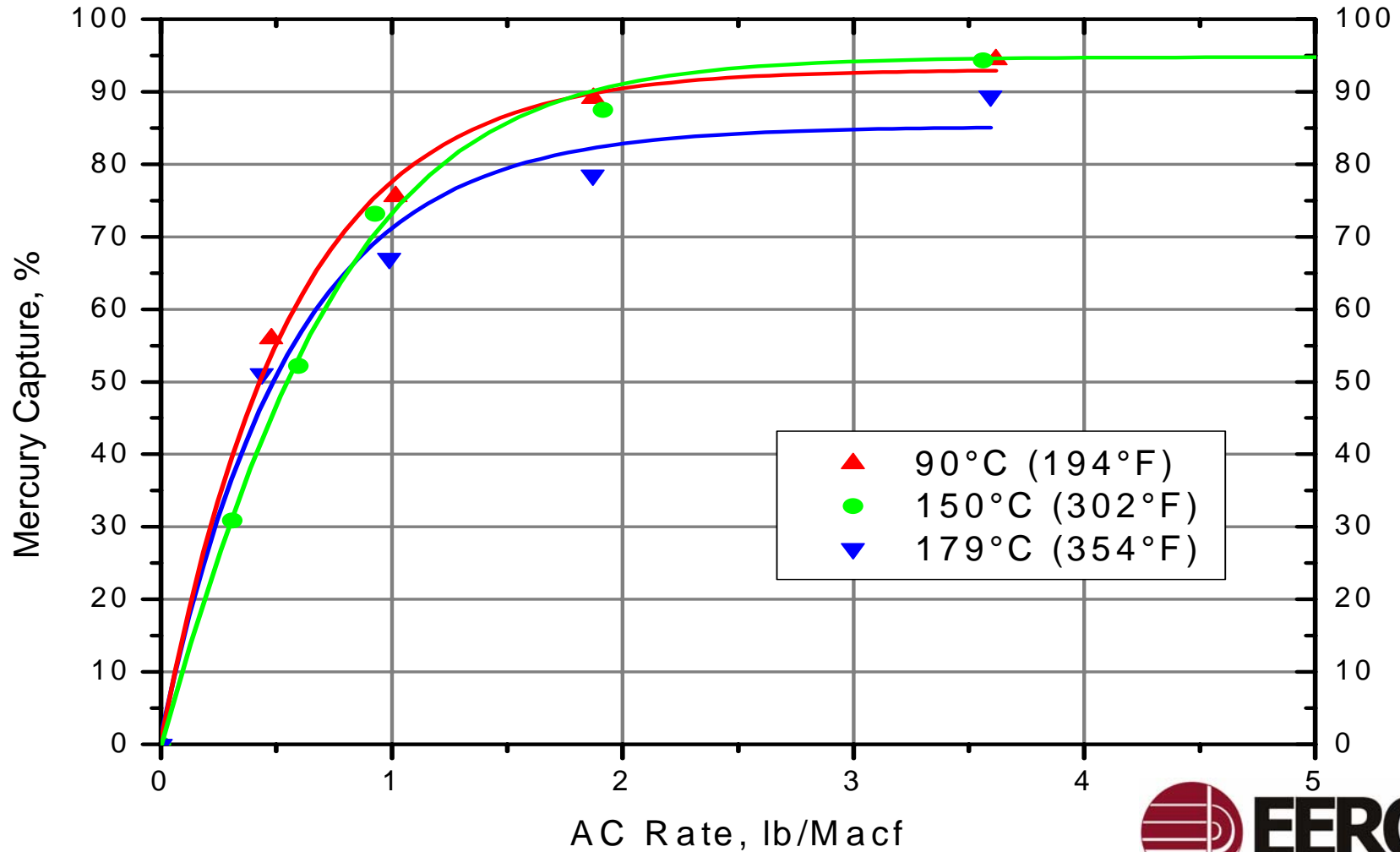
## *Test Parameters*

- **Injection rate**
- **Batch/continuous injection**
- **Gas temperature**
- **Gas flow (A/C of 2-8)**
- **Bag cleaning cycles**
- **Ash loading**
  - **Low, ~ 60-80 mg/m<sup>3</sup>**
  - **High, ~600-800 mg/m<sup>3</sup>**

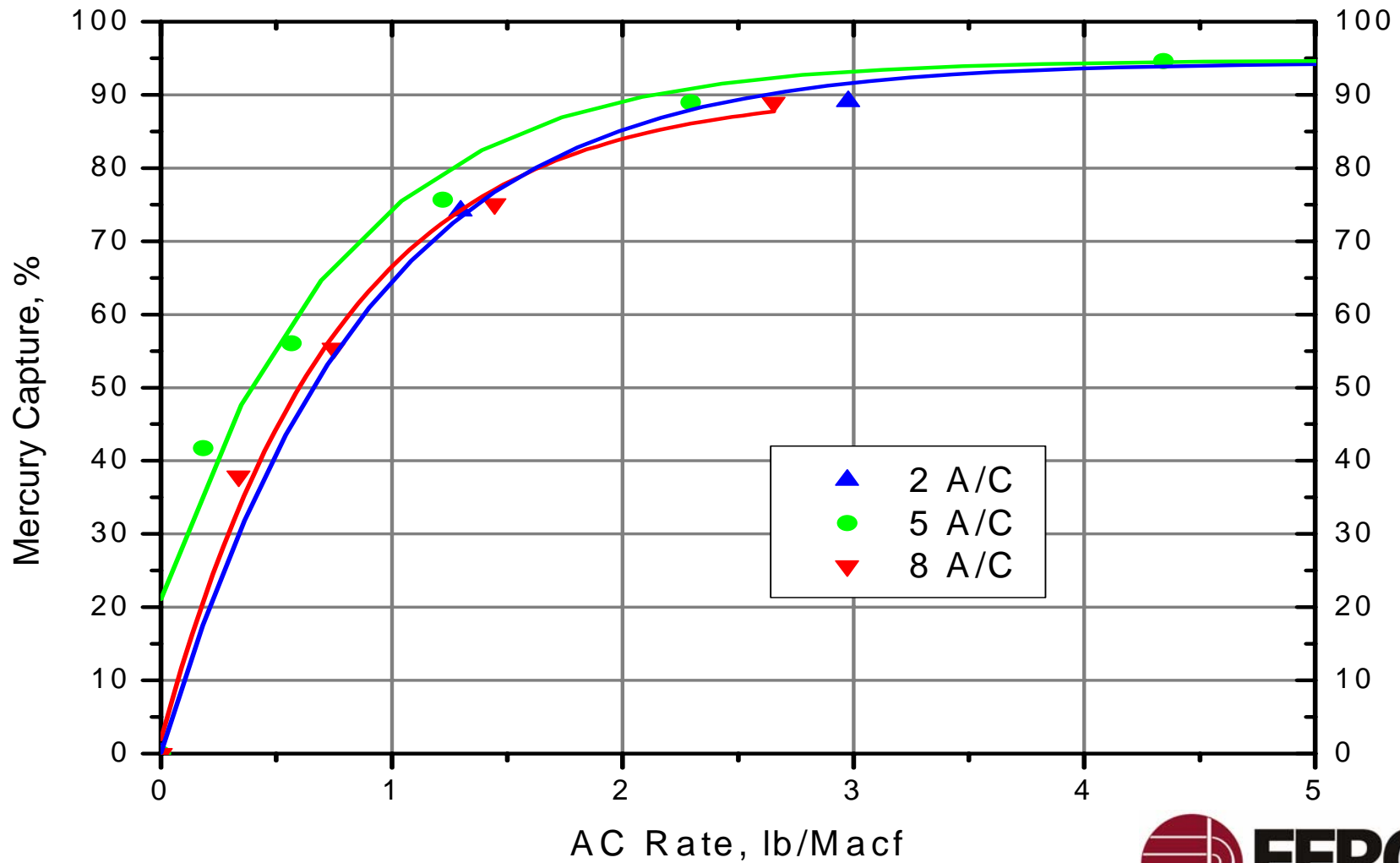
# Temperature, Luscar 4



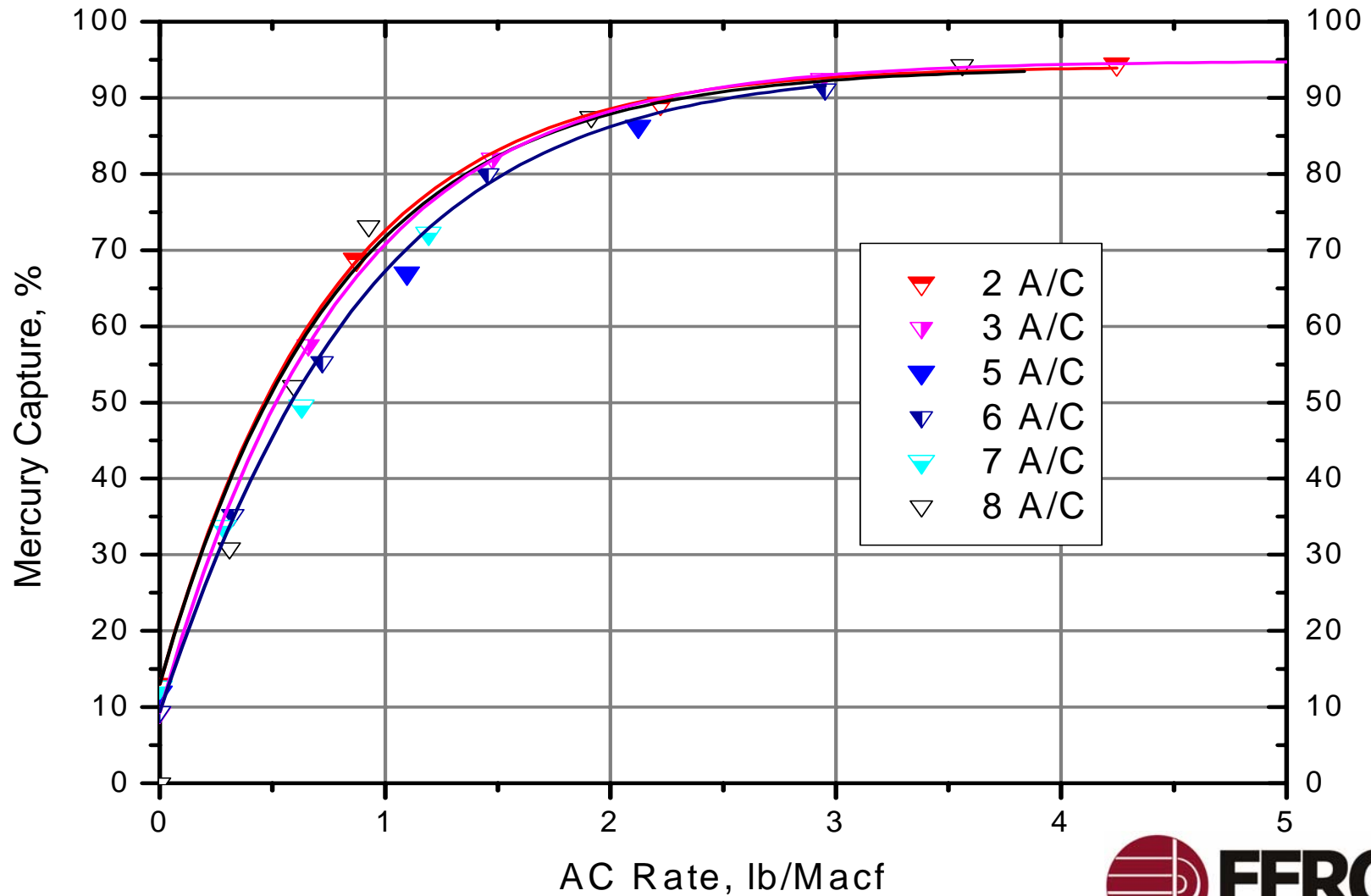
# Temperature, NORIT Hg



# *Air-to-Cloth Ratio, Luscar 4*

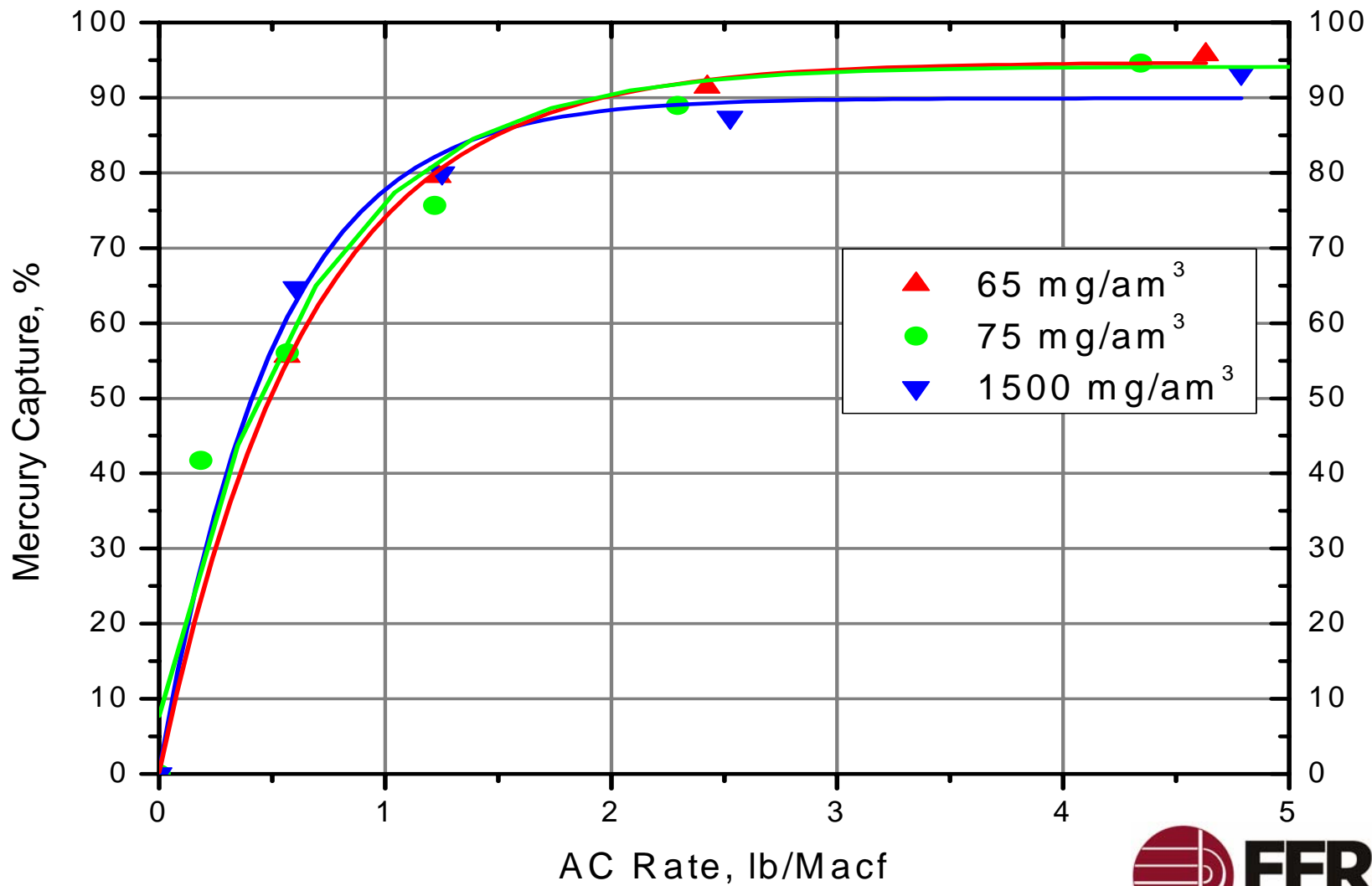


# Air-to-Cloth Ratio, NORIT Hg

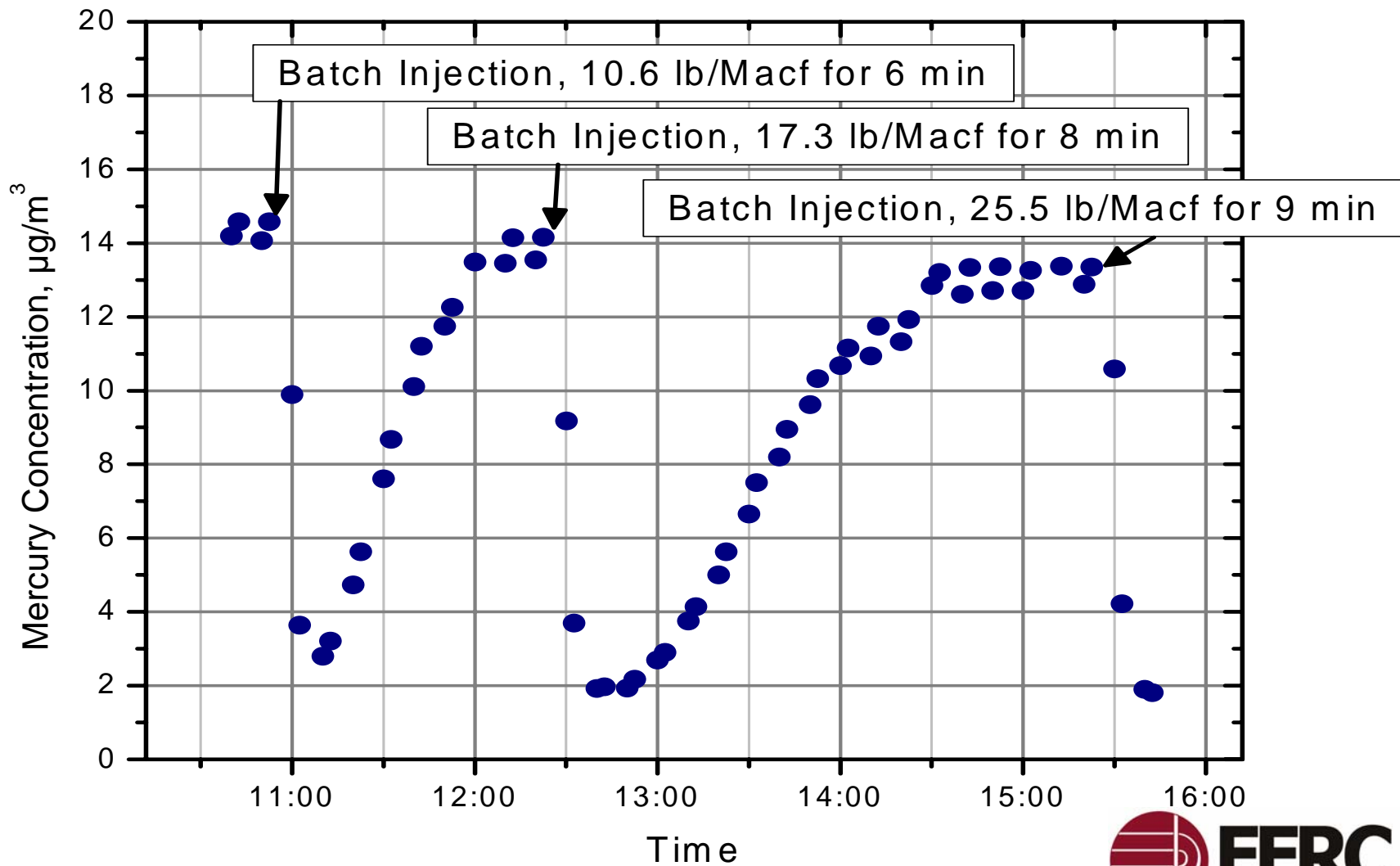


# Ash Loading, Luscar 4

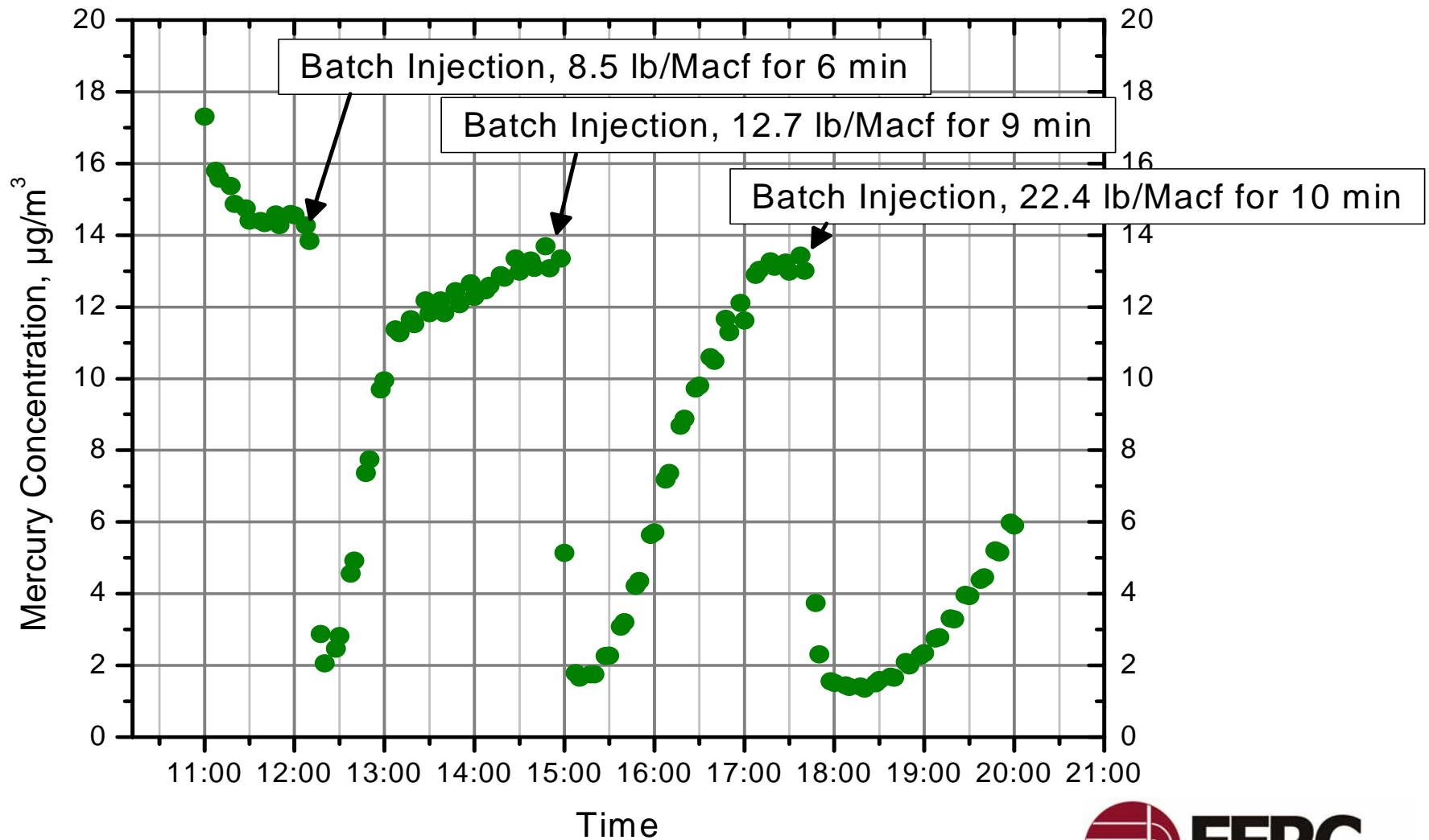
## A/C = 5



# Batch Injection, Luscar 4



# Batch Injection, NORIT Hg





# *Capacity, $\mu\text{g Hg/g AC}$*

Sorbent	Batch Tests	Continuous Tests
Luscar 2	460	413
Luscar 4	$383 \pm 21$	581
NORIT Hg	$510 \pm 70$	739

**Preliminary**

# *Limited Test with Recycled Sorbent*

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- **Recycled sorbent (Luscar 2)**
  - **Spent sorbent was injected, resulting in little mercury capture.**

# *High ACI Rates*

Sorbent	Mercury Capture, %	Injection Rate, lb/Macf
Luscar 2	97	9.4
Luscar 4	97	10.4
Luscar 4	97	16.5
NORIT Hg	96	8.3

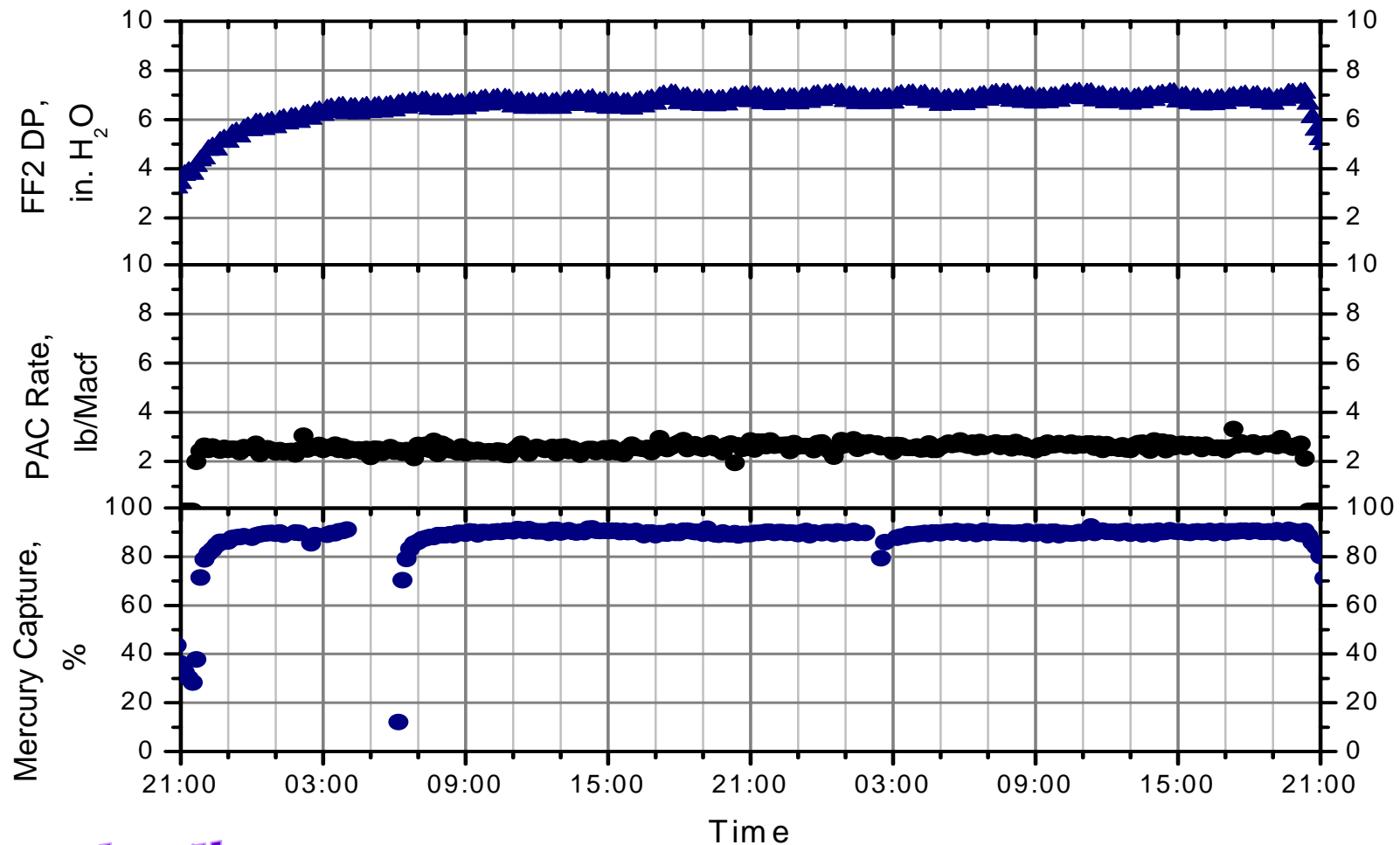
**Preliminary**

# *Midterm (multiple-day) Tests*

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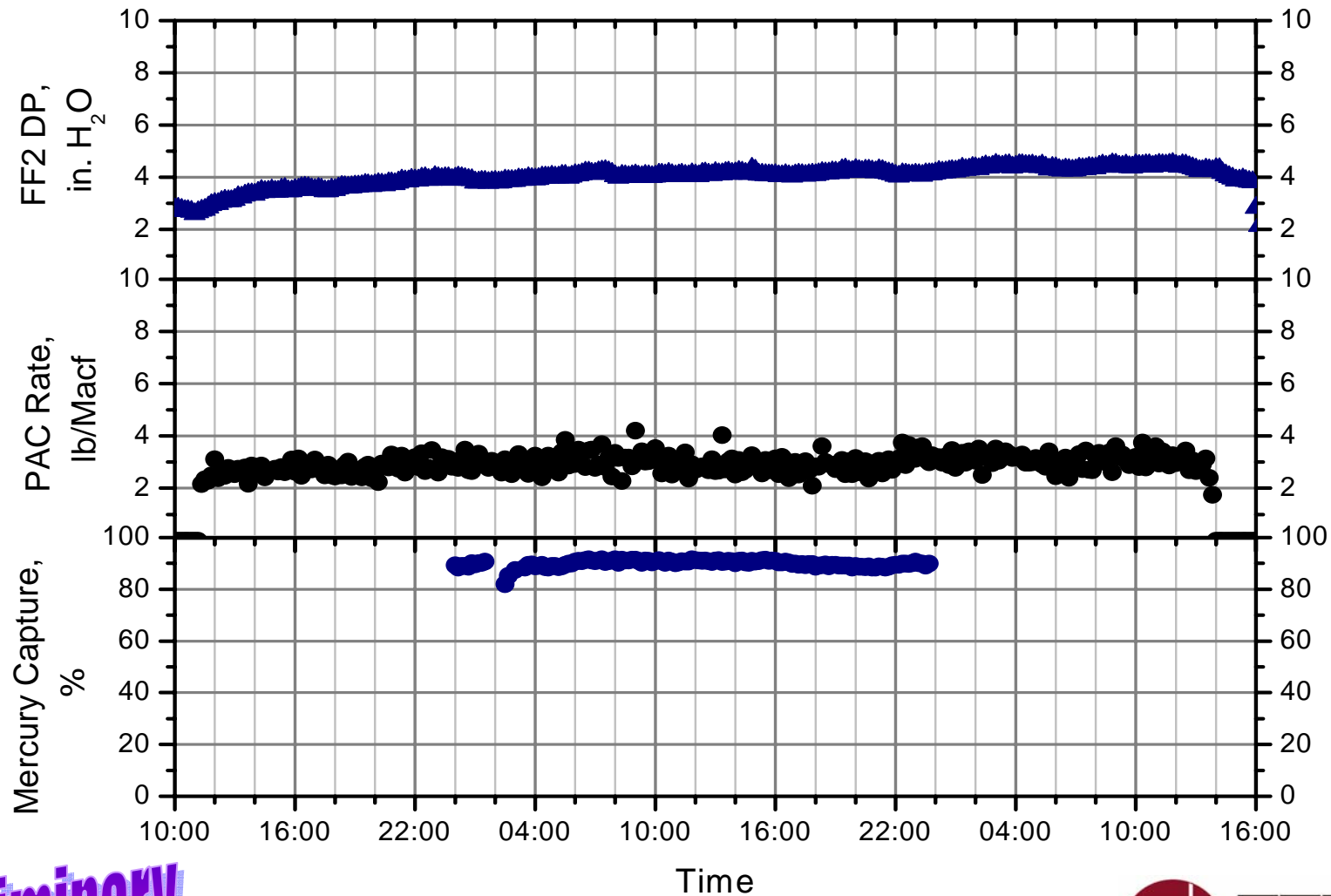
- **Several midterm (1- to 3-day) tests have been completed, and others are planned to determine the effect of cleaning (pulse) frequency on FF  $\Delta P$  and mercury capture as a function of ACI rate and ash loading.**

# *M3, 1800-sec Pulse Frequency Low Ash Loading (A/C~5)*



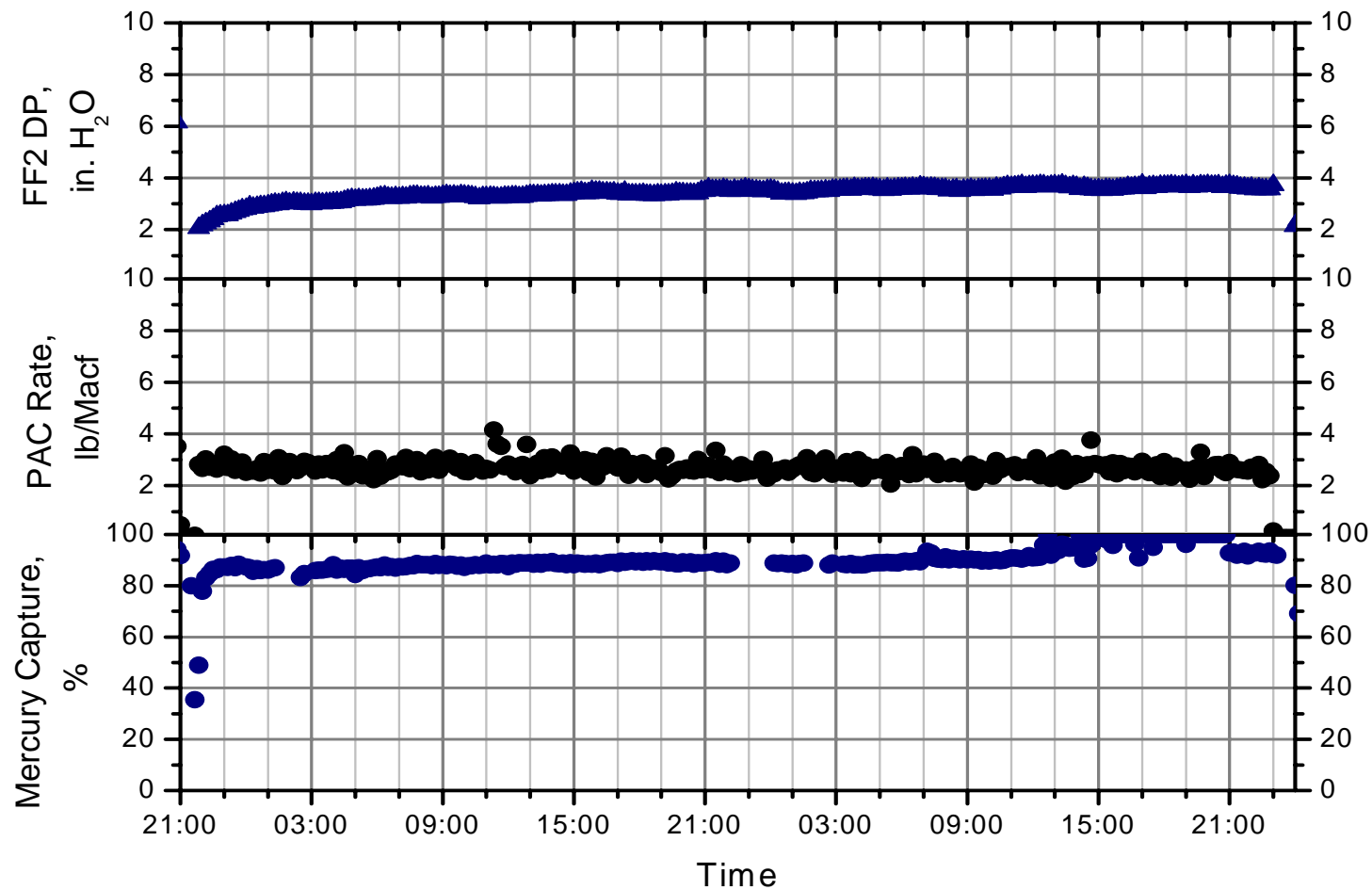
**Preliminary**

# M5, 300-sec Pulse Frequency Low Ash Loading (A/C~5)



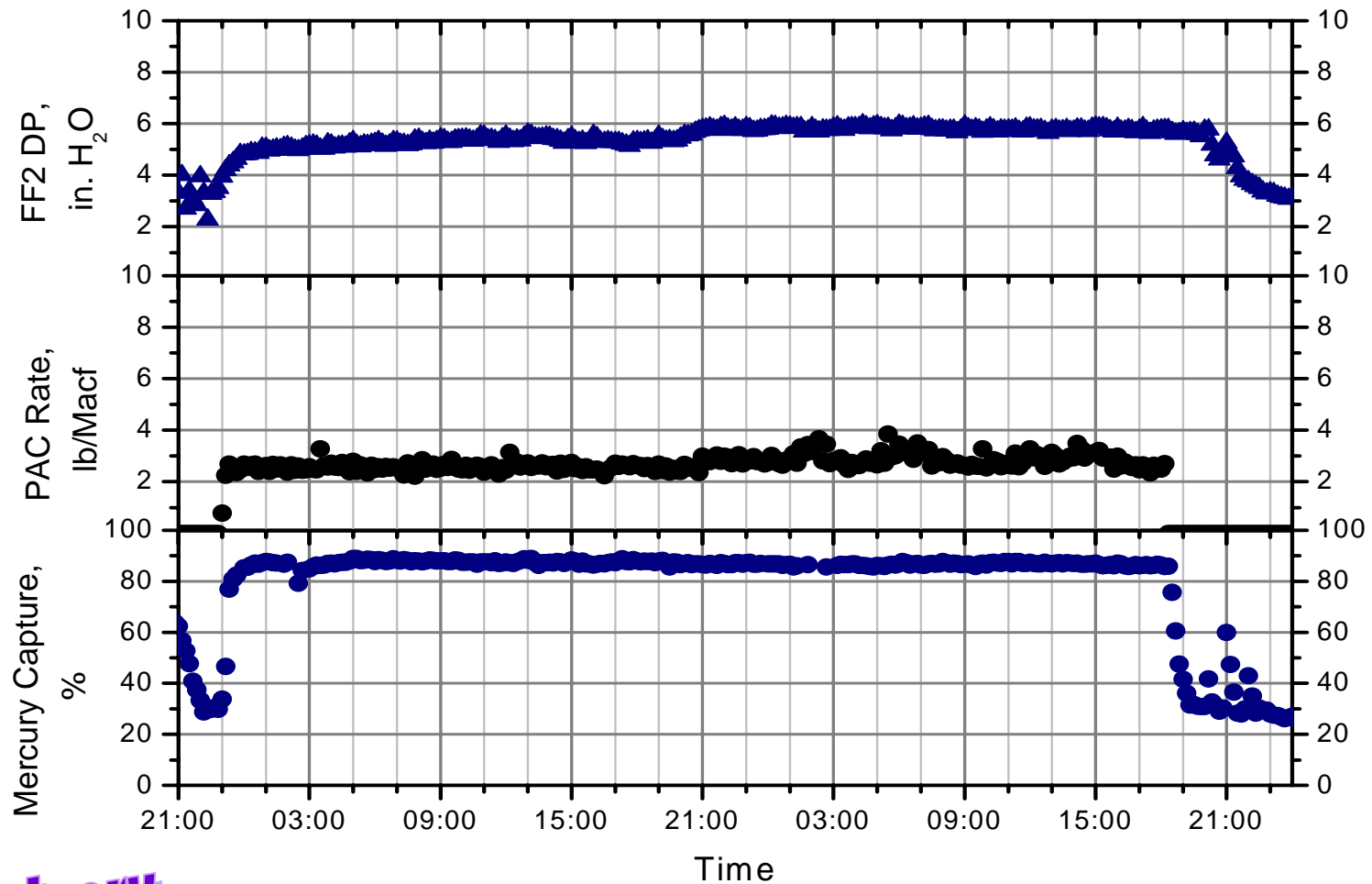
**Preliminary**

# *M6, 150-sec Pulse Frequency Low Ash Loading (A/C~5)*



**Preliminary**

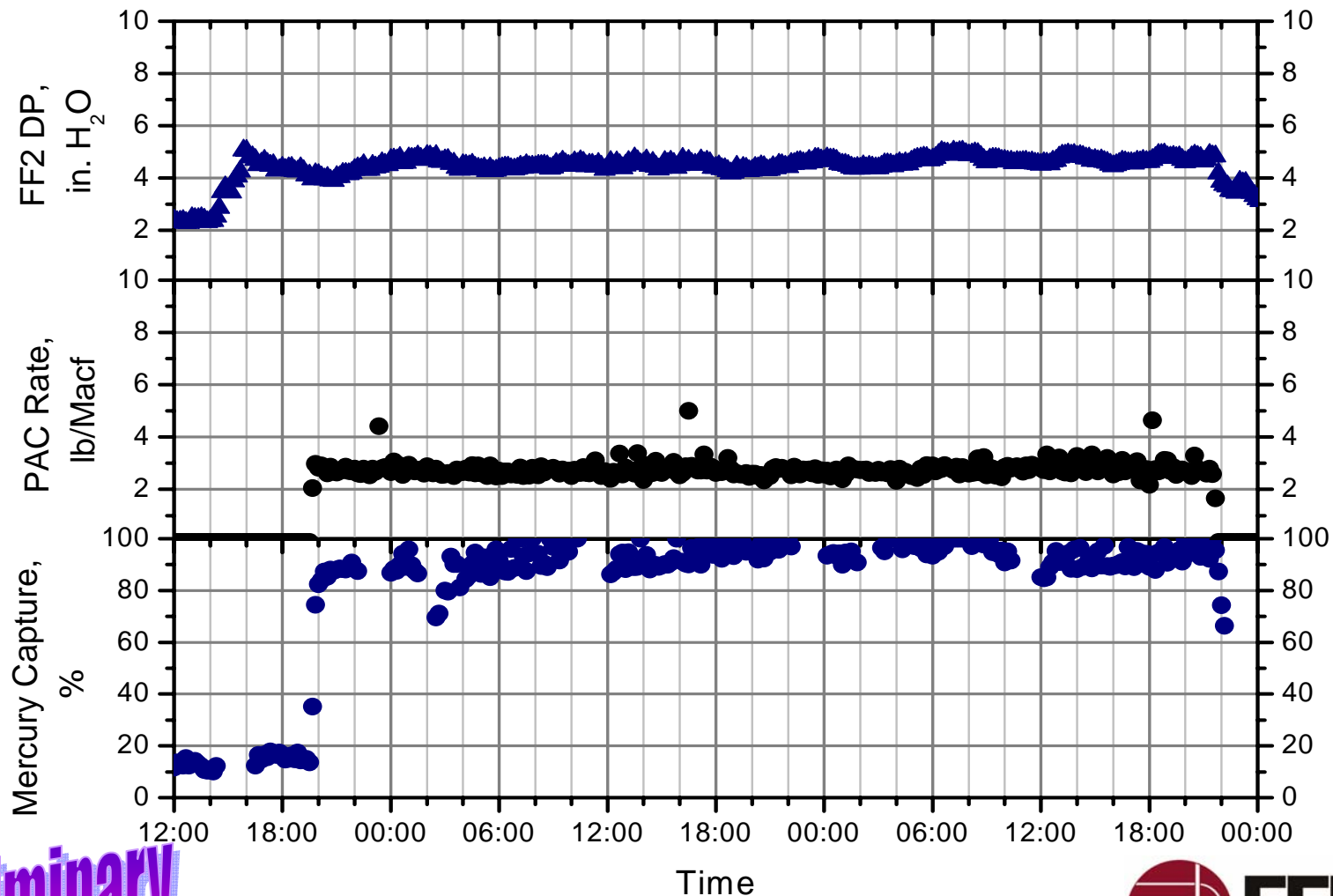
# *M4, 300-sec Pulse Frequency – High Ash Load, 600 mg/am<sup>3</sup>*



**Preliminary**

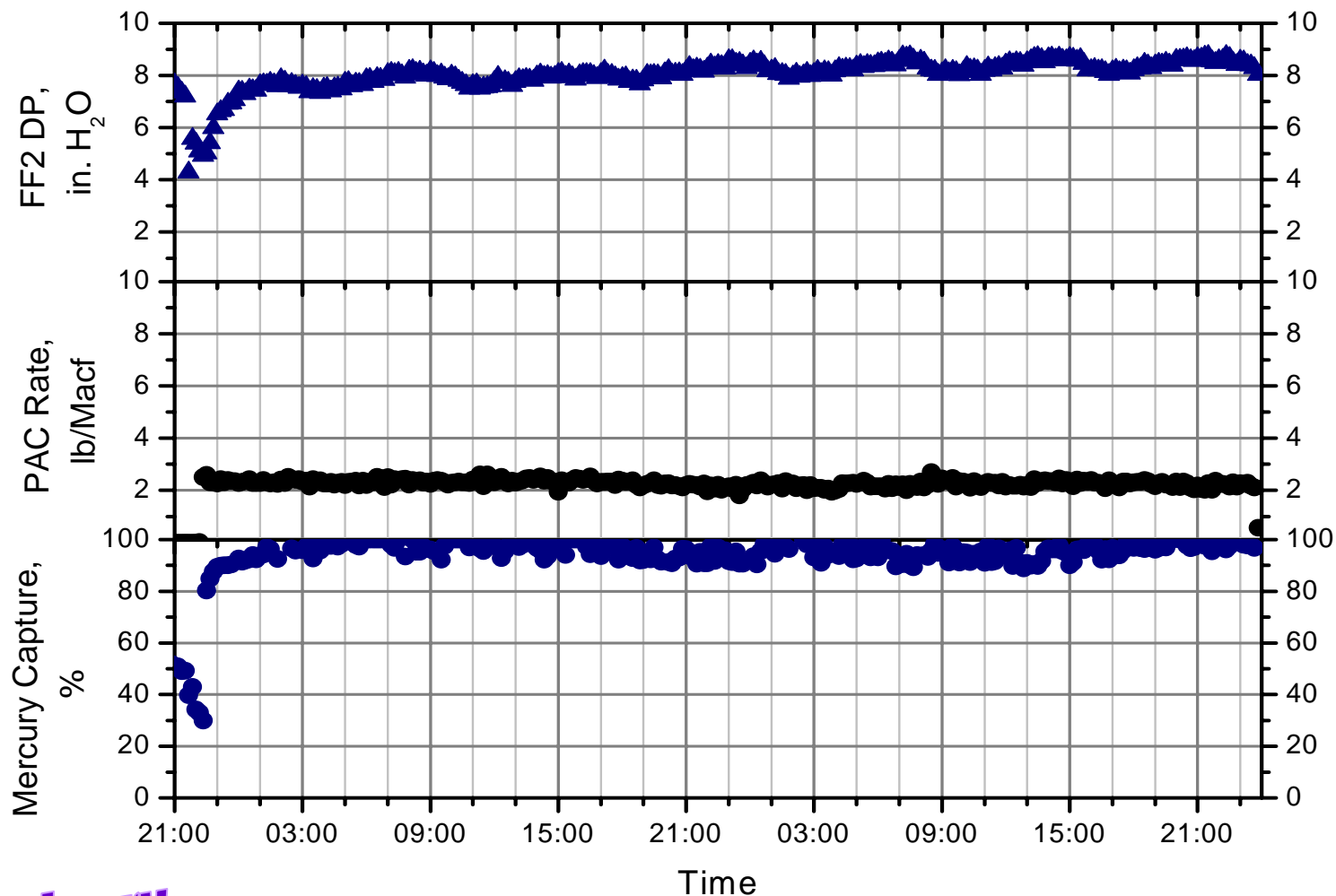


# *M7, 150-sec Pulse Frequency – High Ash Load, 600 mg/am<sup>3</sup>*



**Preliminary**

# *M8, 257-sec Pulse Frequency – High Ash Load, 600 mg/am<sup>3</sup> – A/C, 6 ft/min*



**Preliminary**

# ***Additional Testing/Sampling***

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- Repeat baseline OH.
- Particulate sampling.
  - In-flight size analysis of several ACs
- Additional sorbent screening.
  - One additional AC
  - Amended Silicates (if ADA makes available)
- Testing to evaluate shelf life.
- Additional testing at higher A/C, low ash.

# Long-Term Testing – Parameters

Description	Sorbent Description	Ash Loading, mg/m <sup>3</sup>	Temp, °F	Gas Flow, acfm	A/C, ft/min	Injection Rate, lb/Macf	Material Needed, lb	Test Duration, days	NOTES
<b>Long-Term Testing (Operational):</b>	<p>Identify long-term operational issues. Sorbent based on results from previous tests. Testing to begin November, break, then return in December.</p> <p>Evaluate budget at this time to determine if alternative tests can be performed.</p>								
Test L1 (conditions to be set based on parametric and midterm test results)	Luscar 4	~75	300	6000-8000?	6-8?	1-2?	8000	~30-45	OH tests to be conducted during each on-site period.
Test L2 (conditions to be set based on parametric and midterm test results)	Luscar 4	~600	300	5000-7000?	5-7?	1-2?	8000	~30-45	OH tests to be conducted during each on-site period.

# *Phase II Schedule*

<b>Date</b>	<b>Milestones</b>
June 1, 2003	Phase II activities start
December 2003 – June 2004	Conceptual and detailed design
January – March 2004	Construct ECRF building
May – August 2004	Construct ECRF equipment
August – September 2004	Shakedown testing of equipment and instruments
September – December 2004	Perform screening and parametric testing
January – July 2005	Perform parametric and midterm testing
July – December 2005	Perform long-term testing
August – February 2005	Evaluate ash impacts
August – May 2006	Summarize technology performance
August – May 2006	Estimate sorbent technology costs
May – June 2006	Draft report
July – August 2006	Report review, address comments, and issue final report

\*Exact schedule will be based on plant outages and other plant considerations.

# ***Contact Information***

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