



**EERC**

Energy & Environmental Research Center

EERC Technology – Putting Research into Practice

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

**Pittsburgh, PA**

**July 14–15, 2004**

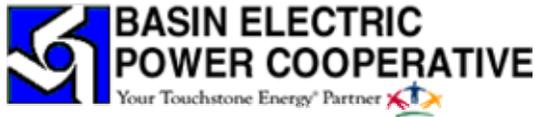
**Acknowledgment: DOE NETL and Lignite Consortium**



# Members of the Lignite-Based Consortium



North Dakota Industrial Commission



# Background

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- Regulations on mercury emissions from coal fired power plants are pending.
- Limited control technologies are available for coal fired utilities, especially for lignite applications.
- The DOE Round II Award creates a consortium to evaluate technologies for low-rank coals.
- Low cost control options are needed for primary configurations (ESP alone, wet FGD, and SDA's).
- Program provides large-scale testing of control options for periods over a month in duration.

# Technologies and Test Sites

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- Sorbent injection and enhancement additives
  - **Leland Olds Station Unit 1 (ESP)**
  - Antelope Valley Station Unit 1 (SDA)
- Injection of impregnated and advanced sorbents
  - Stanton Station Unit 1 (ESP)
  - **Stanton Station Unit 10 (SDA)**
- Mercury oxidation
  - Milton R. Young Unit 2 (Wet Scrubber)
  - TXU Monticello Unit 3 (Wet Scrubber)

# 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 (220)	FF	Spray dryer
SS1	Freedom	Wall fired	140 (70)	ESP SCA=470	None
MRY Unit 2	Kinneman Creek and Hagel	Cyclone	450	ESP SCA=375	Wet FGD
Monticello Unit 3	Texas/Upper and Lower Wilcox	Pulverized coal wall-fired	750	ESP SCA=900	Wet FGD

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 afm

5 Fabric filter.

# Leland Olds – Unit 1

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- Unit 1 (1 mile south, 3.5 miles east of Stanton, ND)
  - 210 MW (rated capacity)
  - Operational in 1966
  - Capacity factor, 80%
  - Lignite coal from the Freedom mine, occasional blending with 30% PRB (Dry Fork Mine, WY)
- Boiler
  - Subcritical, pc wall-fired, fed by 10 feeders, 10 pulverizers
  - Low-NO<sub>x</sub> burners with overfire air
  - NO<sub>x</sub> limit of 0.5 lb/MMBtu, actual emissions 0.3 lb/MMBtu
- ESPs
  - Two parallel ESPs, four rows with eight hoppers per row
  - SCA 320 ft<sup>2</sup>/1000 cfm
- Scrubbers (none)
  - SO<sub>2</sub> limit of 2.7 lb/MMBtu, actual emissions 1.9 lb/MMBtu

# Specific Objectives – LOS Unit 1

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- Conduct testing to determine if enhanced sorbent technology can be applied at Leland Olds Station Unit 1 to achieve a mercury reduction of greater than 55%.
  - Establish values for baseline Hg speciation and removal
  - Determine effectiveness of injecting PAC
  - Determine effectiveness of using sorbent enhancement additive (SEA)
  - Determine effectiveness of using PAC and SEA for 100% lignite and a blend of 30% PRB
- Quantify Hg emissions variability over 1-month period.
- Determine capital and operating costs and assess balance of plant impacts.
  - Determine the impact of PAC and SEA on corrosion, ash deposition, ash resistivity, etc.

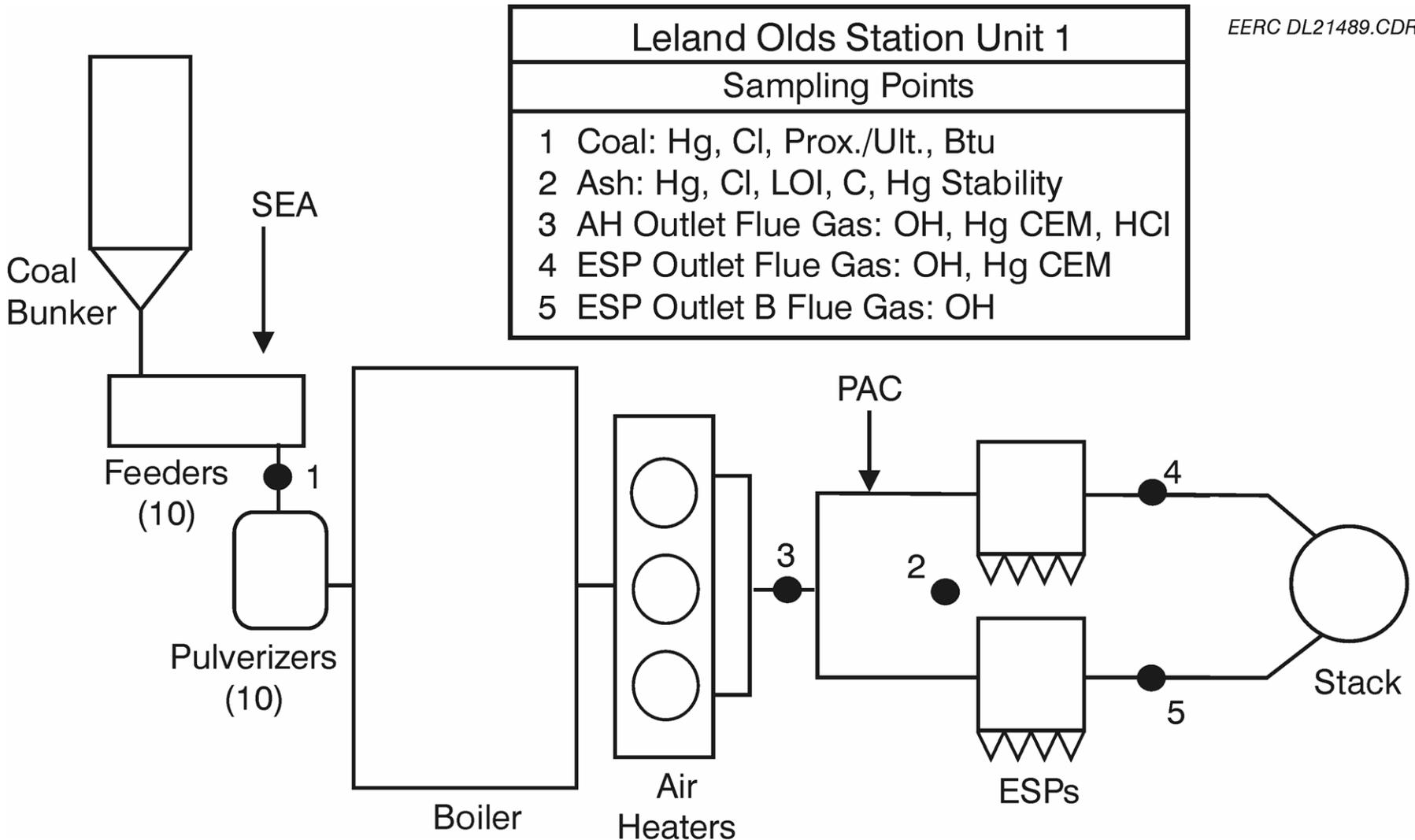
# Leland Olds Station

One mile south, 3.5 miles east of Stanton, ND



# Test Schematic for LOS – Unit 1

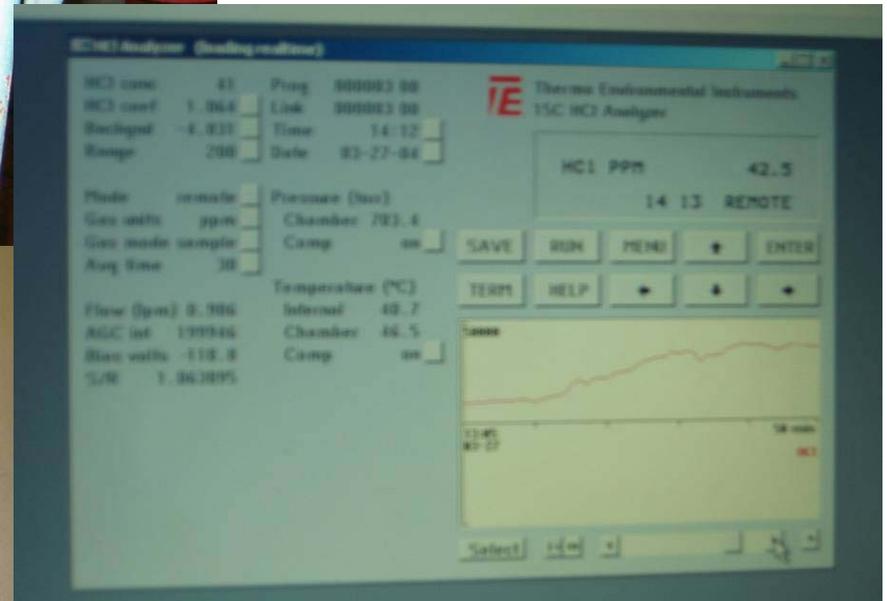
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# SEA Injection Skid



# SEA Injection Nozzle



# PAC Storage Silo and Control Panel

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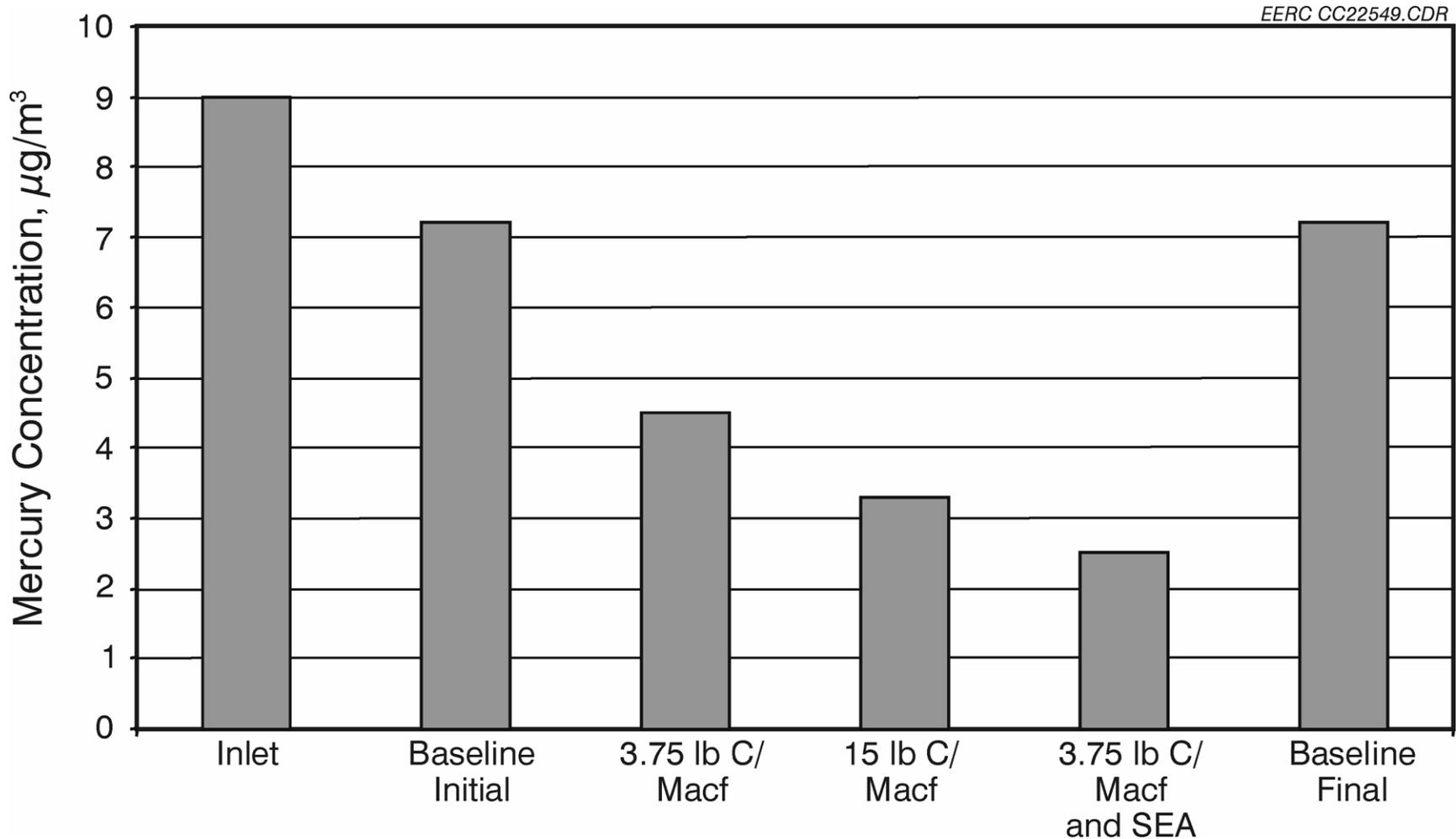


# PAC Injection Equipment

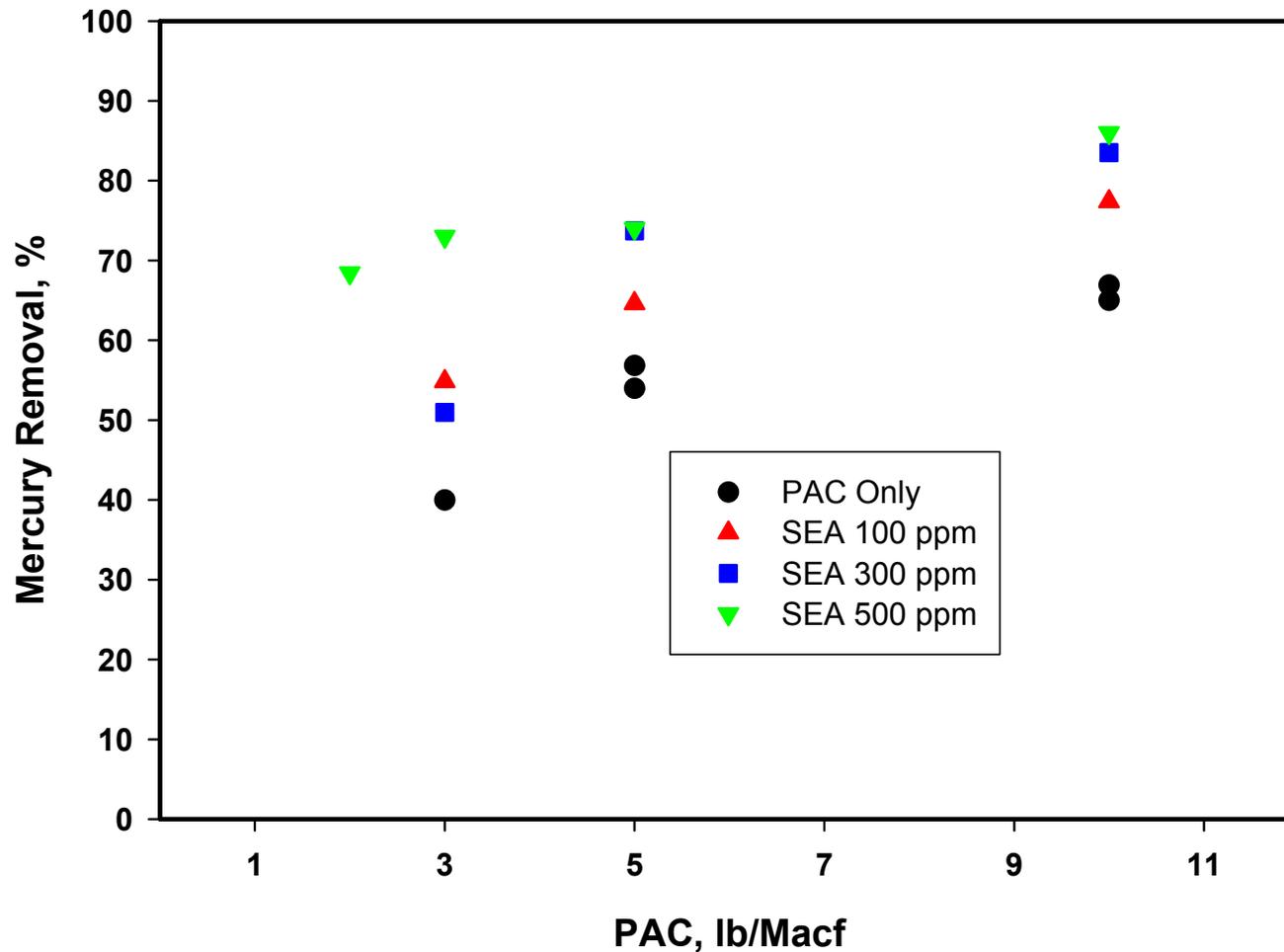
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# ESP Mercury Concentrations as a Function of Sorbent and Additive, Pilot Results

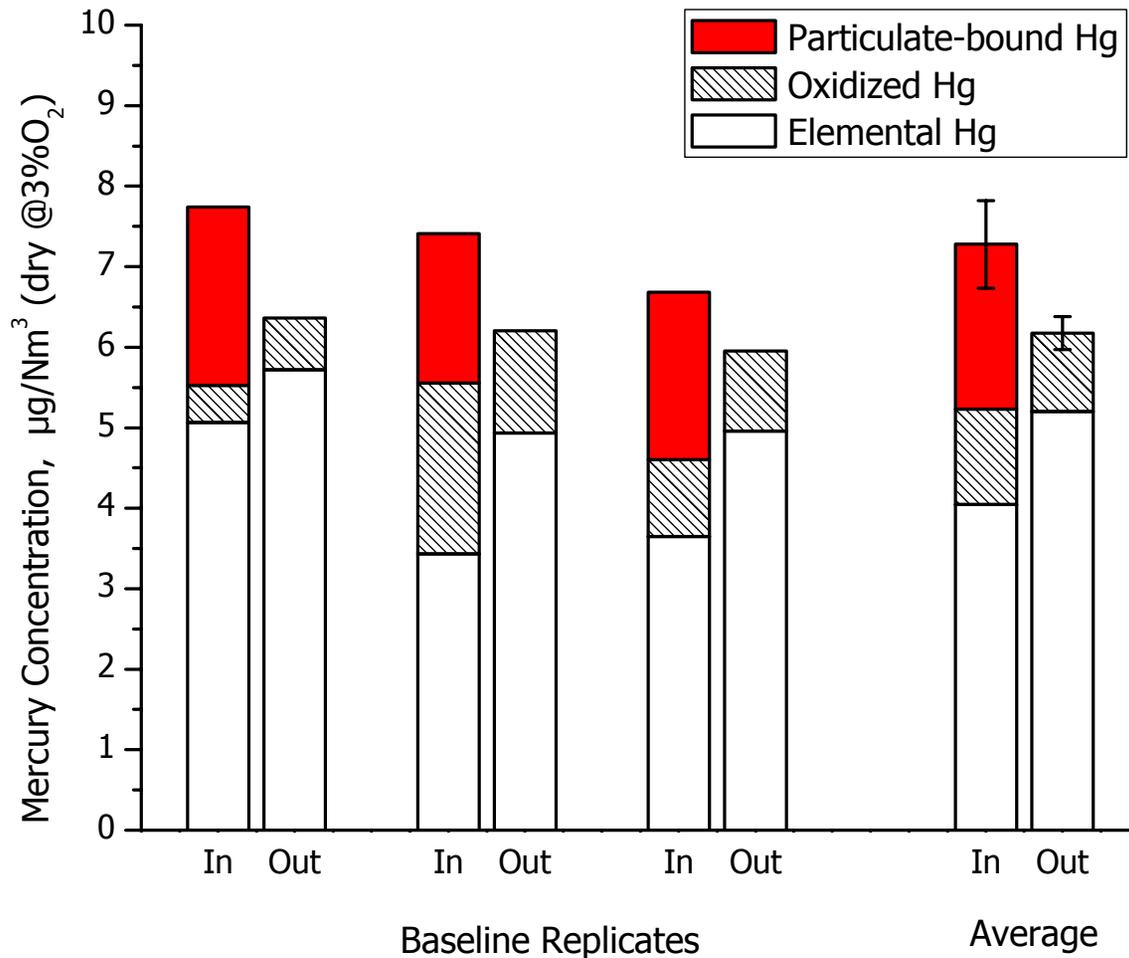


# Parametric Test Results from LOS 1



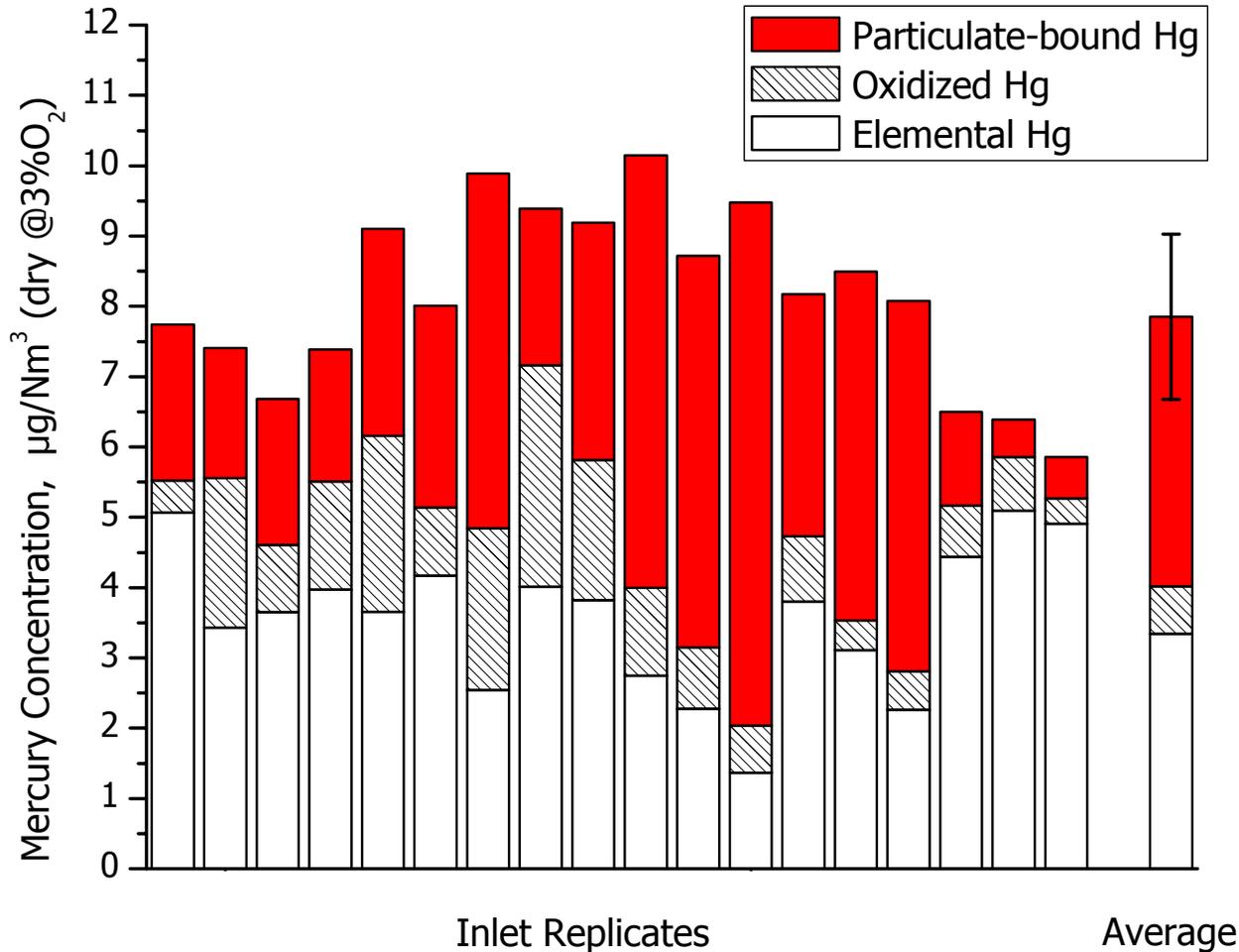
Preliminary Data –  
Do Not Cite or Quote

# Baseline Ontario Hydro Results



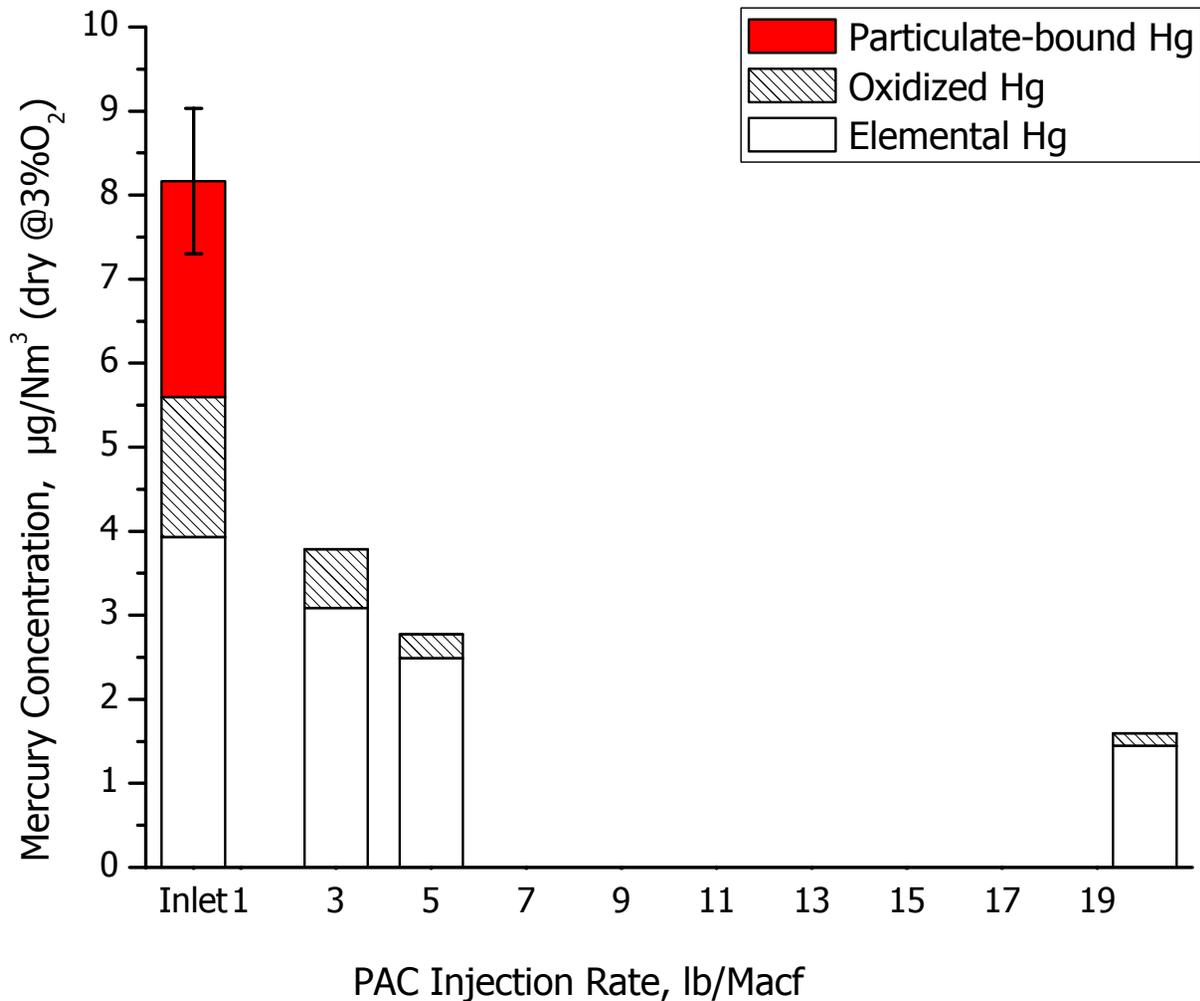
Preliminary Data –  
Do Not Cite or Quote

# Inlet Ontario Hydro Results



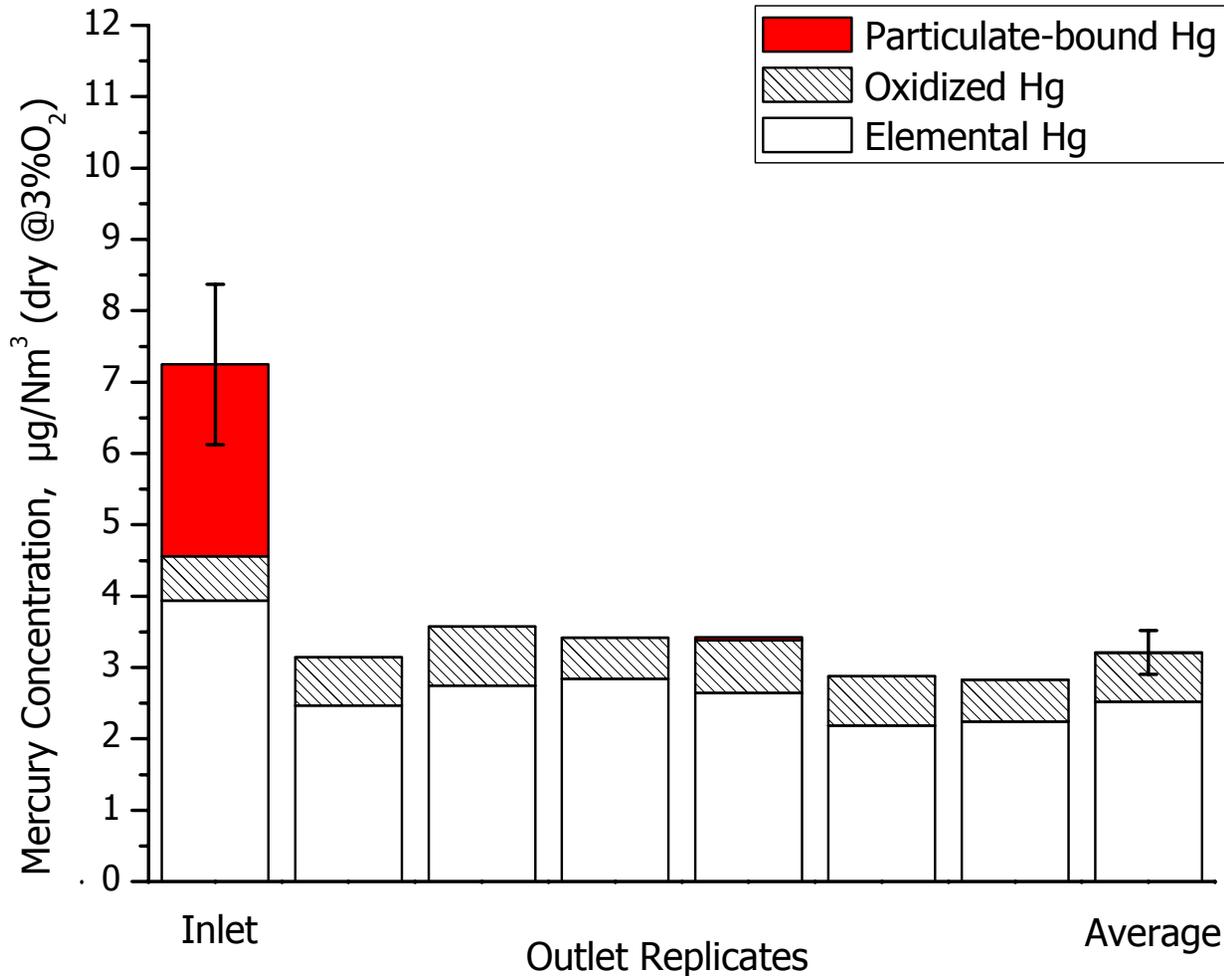
Preliminary Data –  
Do Not Cite or Quote

# Removal with PAC Only



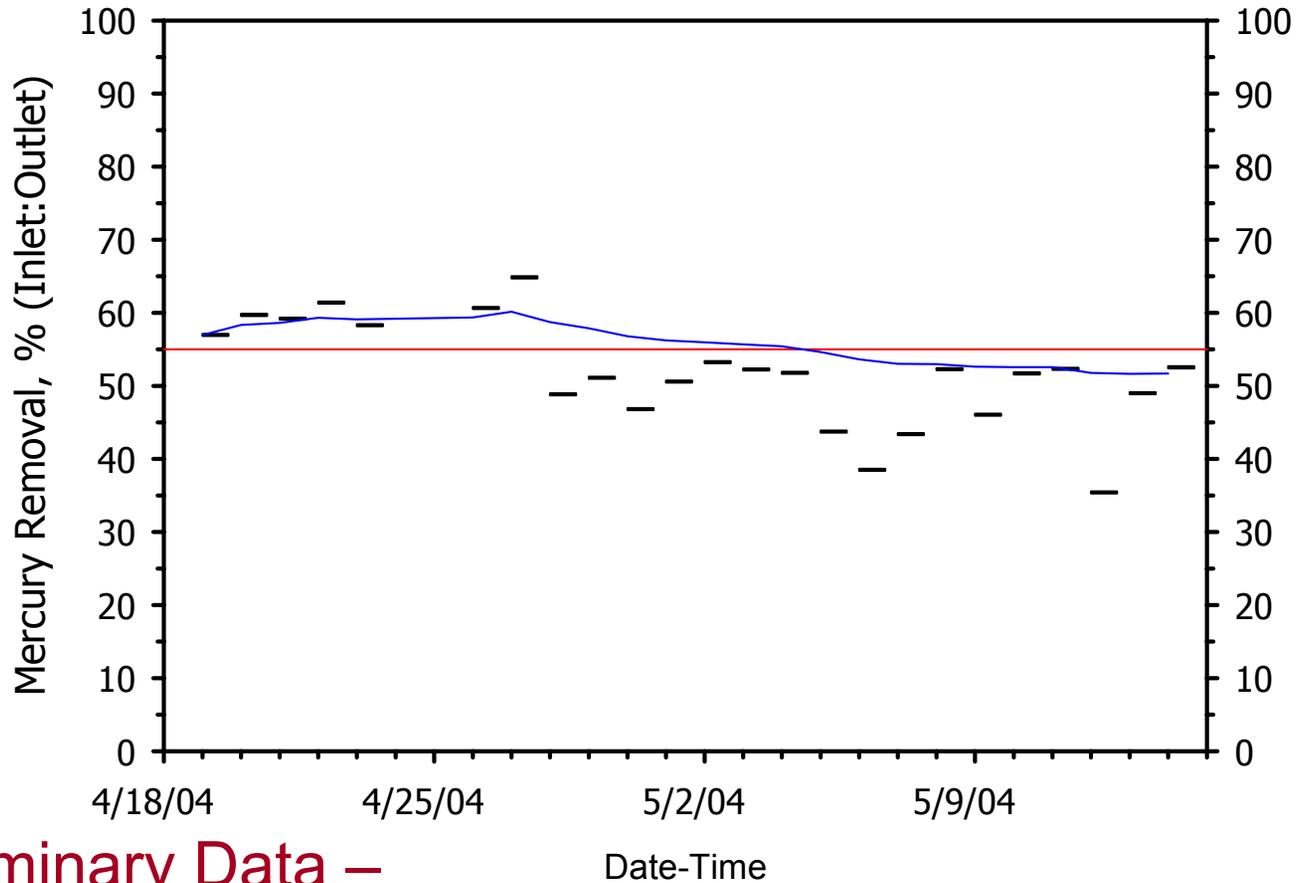
Preliminary Data –  
Do Not Cite or Quote

# Month-Long Test Condition



Preliminary Data –  
Do Not Cite or Quote

# Month-Long Test Results for LOS1



Preliminary Data –  
Do Not Cite or Quote

# Balance of Plant Impacts

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- Corrosion – Sample analyses underway.
- Opacity – No measurable changes.
- ESP Operation – No noticeable changes.
- Pressure Drop – No measurable increases.

*Data are currently under more detailed review, Much longer operation is needed to fully characterize*

# GRE Stanton Station Unit 10

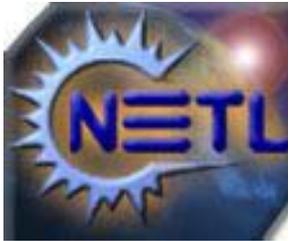
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- 60-MW CE tangential-fired boiler
- Low NO<sub>x</sub> burners
- Lime spray-dryer for SO<sub>2</sub> control
- Reverse-gas baghouse
- ND lignite (Freedom Mine) [0.74% sulfur, <60 ppm chlorine]
- >90% elemental mercury at SD inlet



# Stanton Test Team

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North Dakota Industrial Commission



# Stanton Station Unit 10

Parameter	Stanton Unit 10
<b>Boiler</b>	
Type	PC, Tangential-Fired
Manufacturer	Combustion Engineering
Equivalent MWe	60 Gross
<b>Coal</b>	
Coal Type	North Dakota Lignite
Heating Value (Btu/lb)	6635
Source (Mine)	Coteau Freedom Mine
Mercury (ppm – dry)	0.05535
Chlorine (% - dry)	<0.003
<b>Ultimate-Proximate Analysis</b>	<b>% as received</b>
Moisture	37.81
Volatile Matter	26.12
Fixed Carbon	28.69
Ash	7.38
Hydrogen	2.19
Carbon	34.51
Nitrogen	0.52
Sulfur	0.64
Oxygen	16.95
<b>NO<sub>x</sub> Control</b>	Low NO <sub>x</sub> Burners
<b>SO<sub>2</sub> Control</b>	Spray Dryer (Research Cottrell)
<b>Particulate Control</b>	Reverse-Gas Baghouse
<b>Gas Flow Rate (scfm)</b>	160,000

# Stanton Unit 10 Test Objectives

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## Evaluate Sorbent Injection for Mercury Control in Lignite Flue Gas across a SD-BH Combination

- Activated and chemically impregnated carbons
- Lower cost carbons

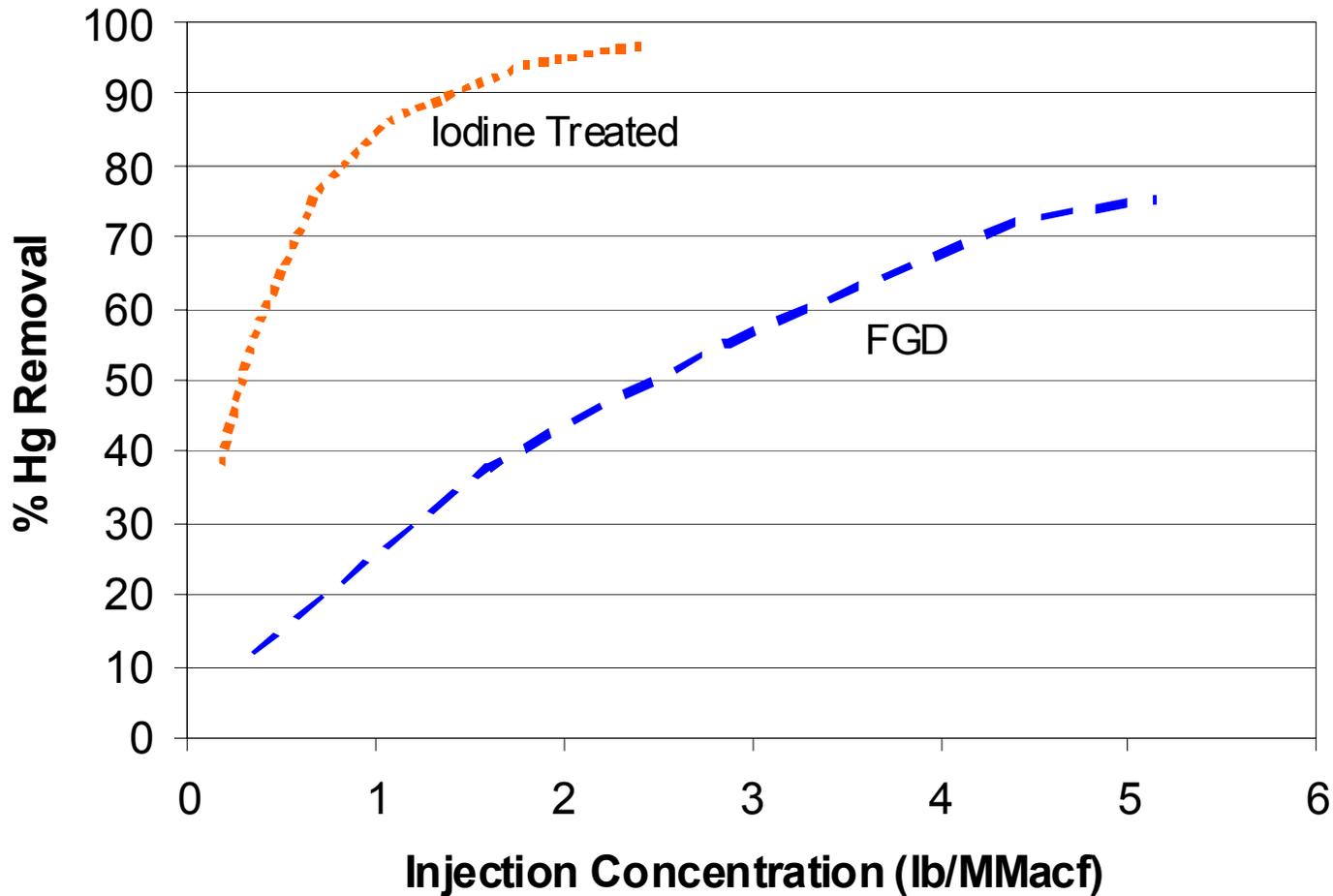
### Parametric testing

- Effect of sorbent type
- Effect of sorbent addition rate

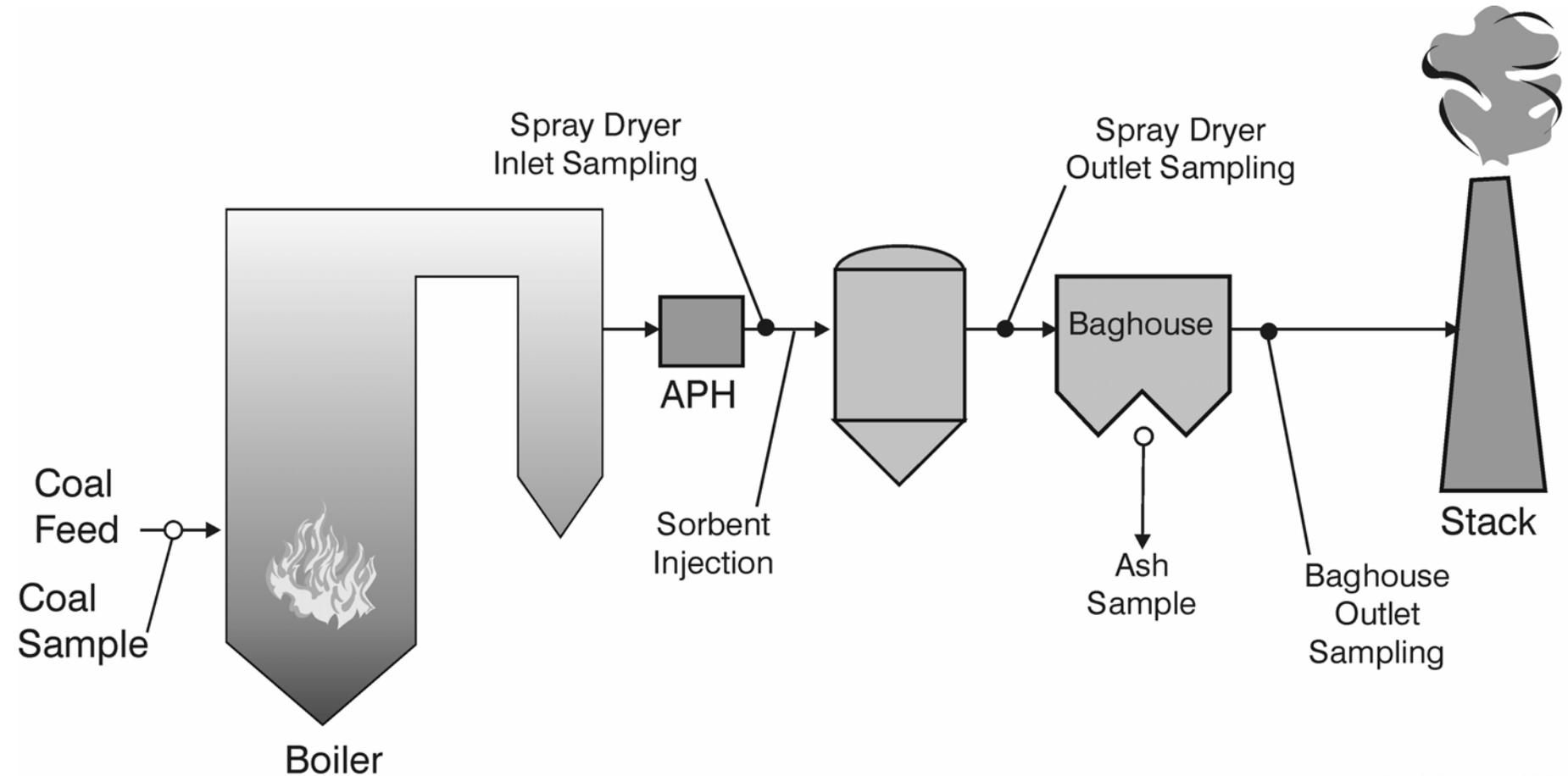
### Month-long testing

- Performance and variability over one month

# ACI Mercury Removal across SD-BH in Lignite Flue Gas



# Schematic for Stanton Station – Unit 10



EERC DL21571.CDR

# Field Activities for Stanton Station – Unit 10

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## Overview of Field Testing:

- **Measure baseline Hg speciation and removal**
- **Evaluate up to four sorbents for Hg removal**
  - **Parametric Testing**
  - **Determine the rate of sorbent needed to achieve at least 55% Hg removal**
- **Quantitate Hg removal and emissions variability over a 4-week test**
  - **Effects on SD-BH operations**
  - **Ash characteristics**
- **Evaluate economics based on results**

# Stanton Unit 10 Test Schedule

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<b>Date</b>	<b>Activities</b>	<b>Hg Sampling</b>
3/30–4/1	Setup and Baseline Sampling	SCEM; OH
4/2–4/18	Parametric Testing – Sorbent Injection Tests	SCEM; OH
6/7–7/17	One-Month Demonstration	SCEM; OH

# Stanton Unit 10

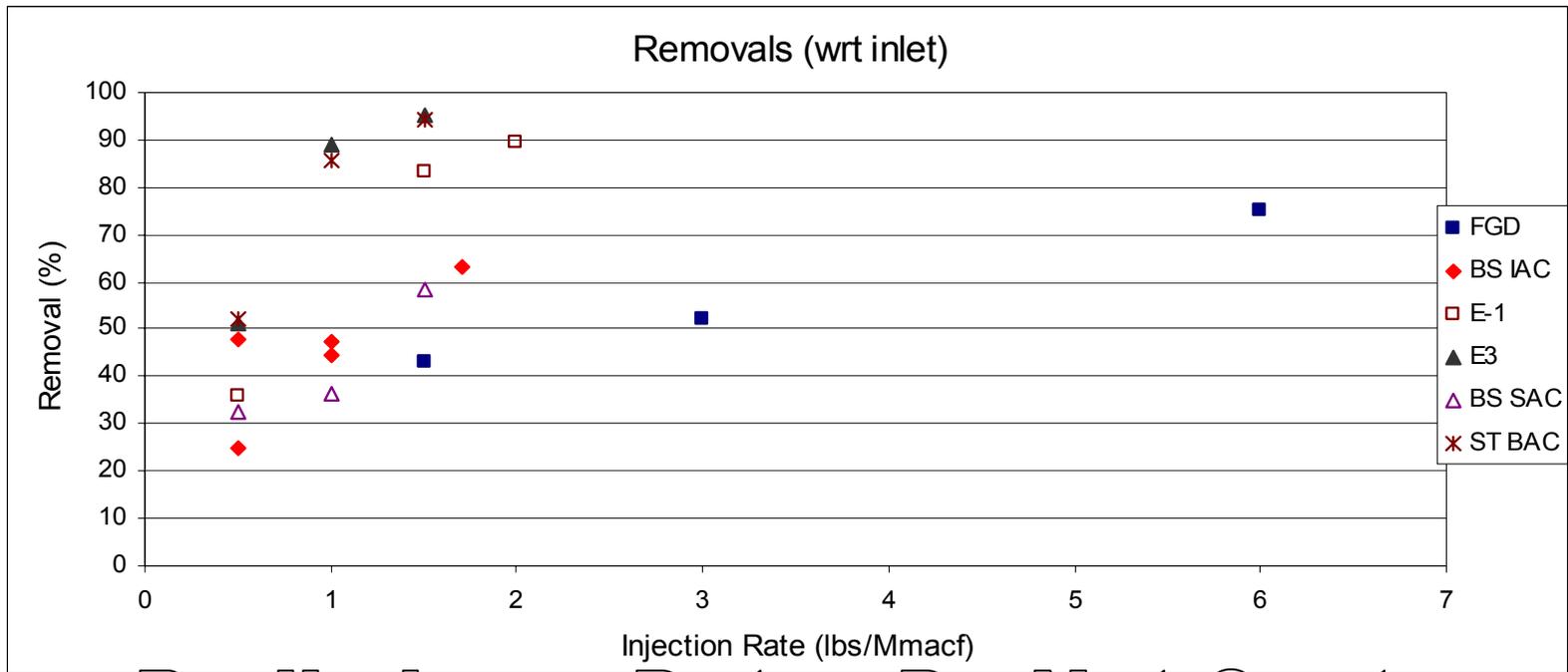
## Parametric Tests

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<b>Manufacturer</b>	<b>Name</b>	<b>Description</b>
Barnaby Sutcliff	Iodated Activated Carbon (IAC) CB200XF	Coconut shell derived, "By fines" particle size, Iodine impregnated
Barnaby Sutcliff	Super Activated Carbon	Coconut shell derived, high activation carbon
Norit	FGD	Baseline sorbent, Lignite derived
Norit	FGD-E1	Chemically treated
Norit	FGD-E3	Proprietary sorbent
Sorbent Technologies	BAC	Bromine impregnated activated carbon

# Stanton Unit 10

## Preliminary Parametric Results



Preliminary Data - Do Not Quote

# Project Schedule

Task Name	2003	2004					2005				2006				2007
		Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1
<b>OVERALL TESTING PLAN</b>															
<b>Site 1. Leland Olds Station, Unit 1 - ESP Only</b>															
1.1 Sampling Activities and Data Analysis															
1.2 Site Planning, Management, and Reporting															
a. Site Report															
<b>Site 2. Stanton Station, Unit 10 - SDA/Baghouse</b>															
1.1 Testing Activities and Data Analysis															
1.2 Site Planning, Management, and Reporting															
a. Site Report															
<b>Site 3. Antelope Valley Station, Unit 1 - SDA/Baghouse</b>															
1.1 Testing Activities and Data Analysis															
1.2 Site Planning, Management, and Reporting															
a. Site Report															
<b>Site 4. Stanton Station, Unit 1 - ESP Only</b>															
1.1 Testing Activities and Data Analysis															
1.2 Site Planning, Management, and Reporting															
a. Site Report															
<b>Site 5. Monticello Station, Unit 3 - ESP/FGD</b>															
1.1 Testing Activities and Data Analysis															
1.2 Site Planning, Management, and Reporting															
a. Site Report															
<b>Site 6. Milton R. Young Station, Unit 2 - ESP/FGD</b>															
1.1 Testing Activities and Data Analysis															
1.2 Site Planning, Management, and Reporting															
a. Site Report															
<b>Program Planning &amp; Management</b>															
Program Planning & Oversight															
Quarterly Reports & Presentations															
Annual Reviews & Final Project Report															