EERC Technology… Putting Research into Practice

Mercury Control Technology R&D Program Review

Large-Scale Mercury Control Technology Testing for Lignite-Fired Utilities – Oxidation Systems for Wet FGD

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Partnership Team

North Dakota Industrial Commission

a McDermott company

THE NORTH AMERICAN COAL CORPORATION

Westmoreland Coal

Goal

- Evaluate cost-effective approaches for capturing the Hg in lignite derived combustion flue gases using a cold-side electrostatic precipitator (ESP) and/or wet flue gas desulfurization (FGD) system using oxidation methods.
- ESP–wet FGD Hg removal efficiency of ≥55% on a consistent basis.

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Introduction

- Two host sites for field testing
  - Minnkota Power Cooperative Milton R. Young (MRY) Station Unit 2 near Center, North Dakota
  - TXU Monticello Steam Electric Station Unit 3 near Mt. Pleasant, Texas

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MRY Unit 2

- B&W Carolina-type radiant boiler
  - Cyclone-fired, balanced-draft, pump-assisted circulation boiler
  - Began commercial operation in May 1977
  - Base-loaded at 450 MW gross
  - Lignite from Center Mine
- Pollution controls
  - Cold-side ESP (specific collection area of 375 ft^2/kacfm)
  - Spray tower FGD (alkaline ash and lime)

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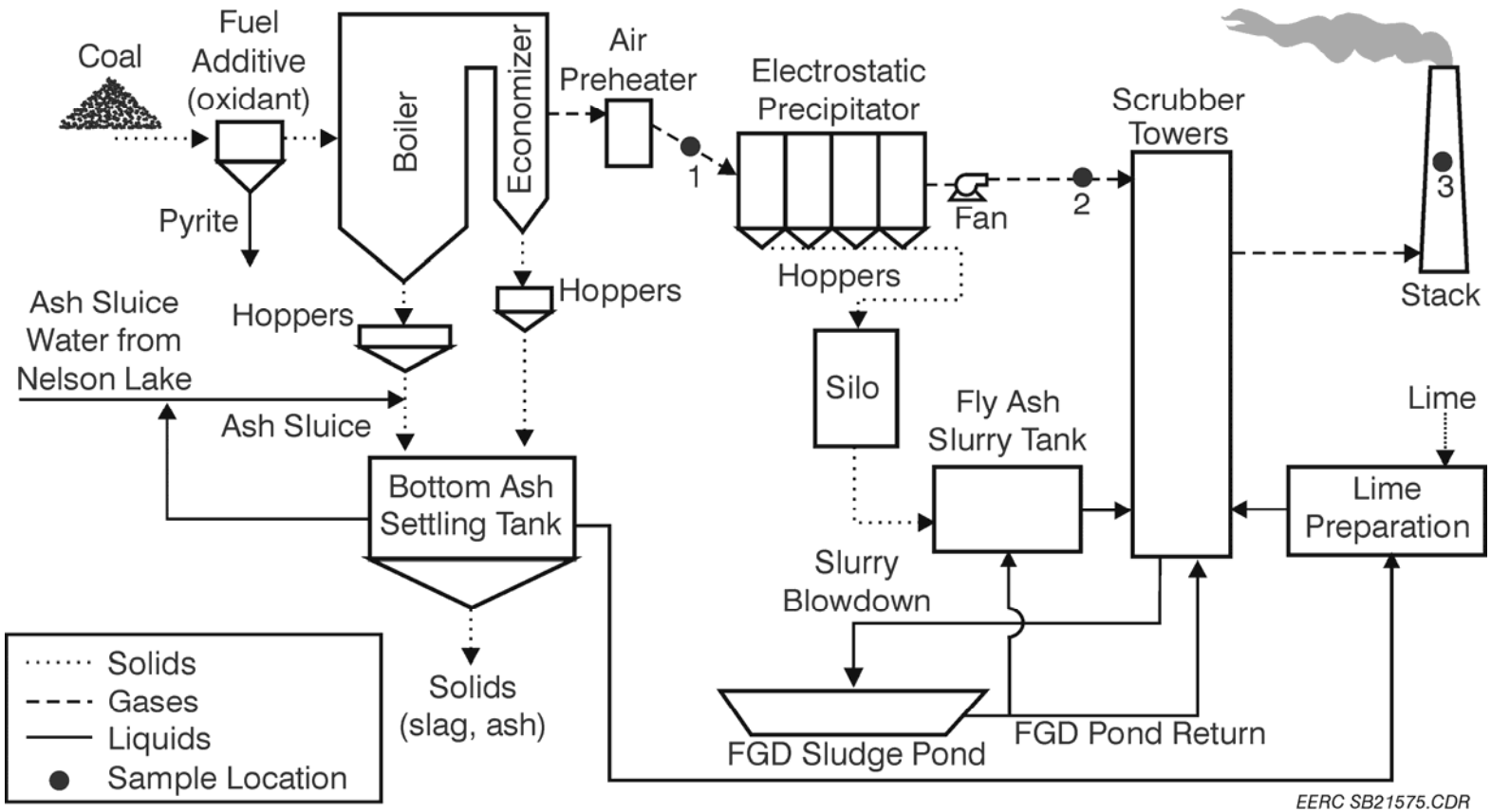
Schematic of MRY Unit 2



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Potential Mercury Control Technologies

- Hg^0 oxidizing agents
  - $CaCl_2$
  - $MgCl_2$
- Sorbent enhancement agent
  - SEA2
- PAC injection
  - NORIT Americas Inc. DARCO® Hg

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Pumping and Metering Skid

EERC SB25011.JPG

- 0.1–2.2 gal/min = ≤500 ppm (as-fired coal basis)

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Injection Lances

- Injected into four coal feed pipes of the twelve Unit 2 cyclones

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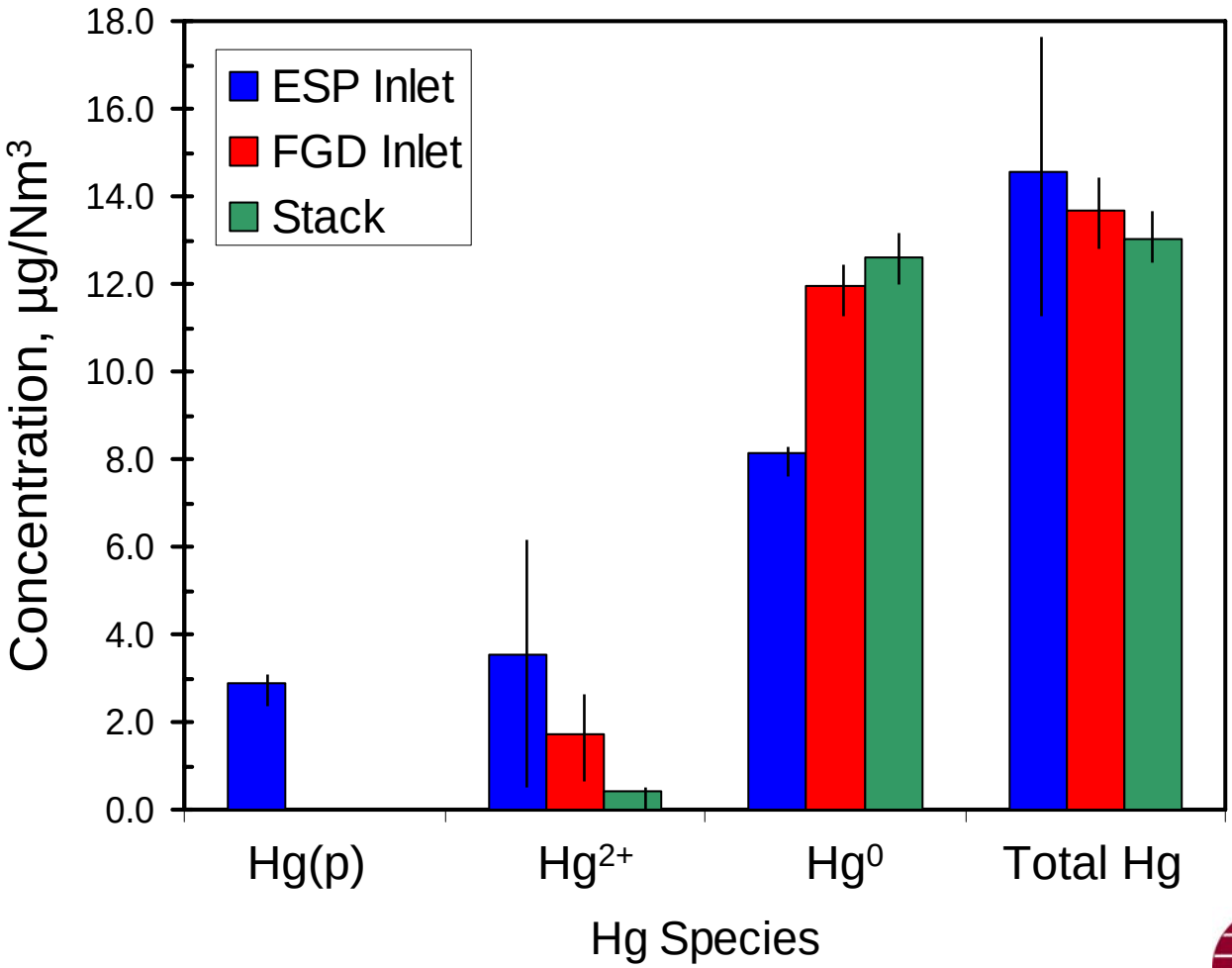
PAC Injection System

- Apogee Portapac metering skid, blower, connecting lines, and injection lances
- PAC injected at 16 locations into the ductwork upstream of the ESP

Experimental

- Flue gas Hg measurements
  - ASTM International Method D6784-02 (Ontario Hydro [OH] method)
  - Continuous mercury monitoring (CMM)
    - Tekran Model 2537A atomic fluorescence-based Hg vapor analyzer combined with a PS Analytical S235C400 wet-chemistry conversion unit

Baseline MRY Unit 2 Hg Measurements (March 16–18, 2005)



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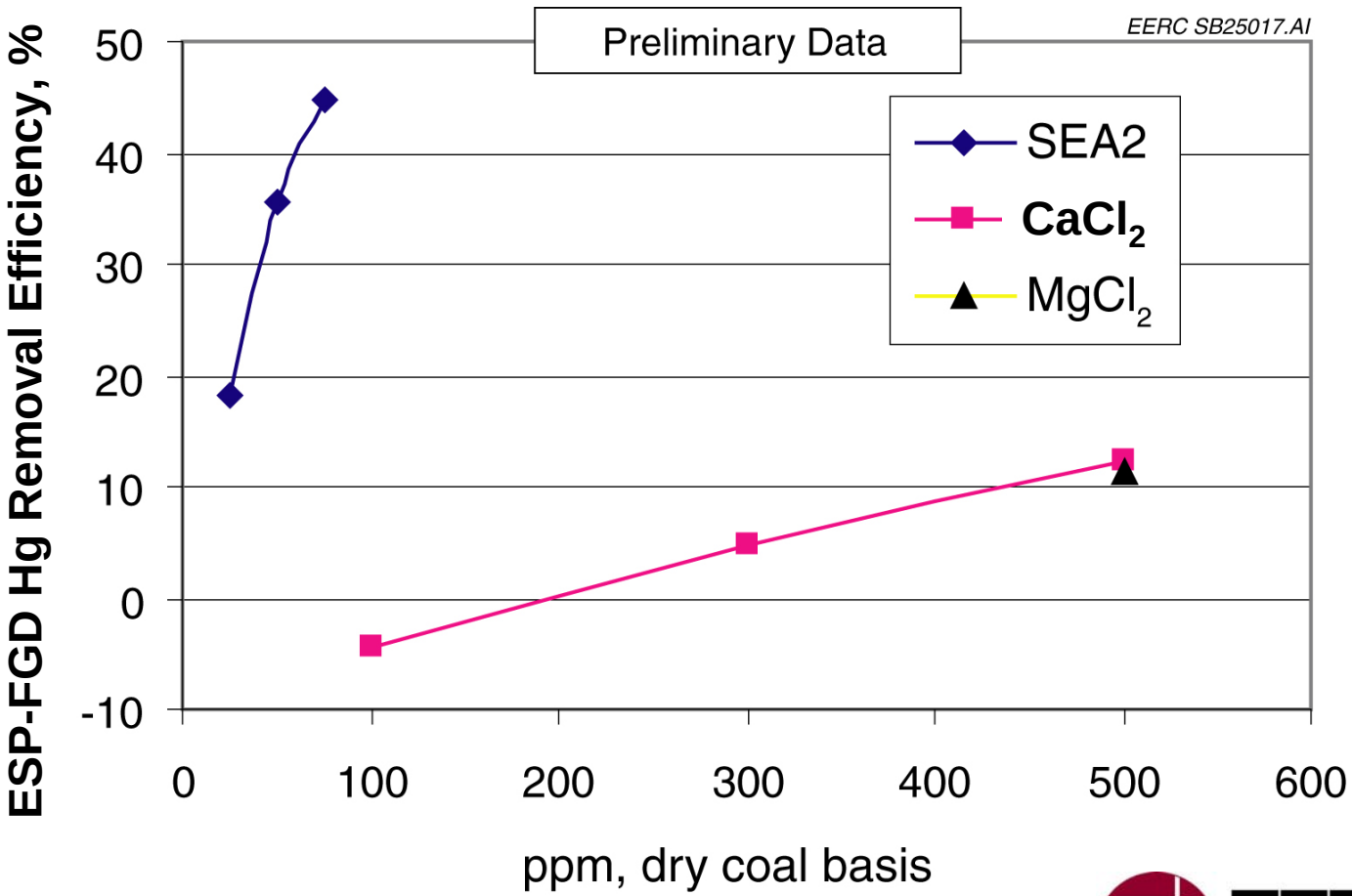
Chemical Addition Effects on Hg Capture



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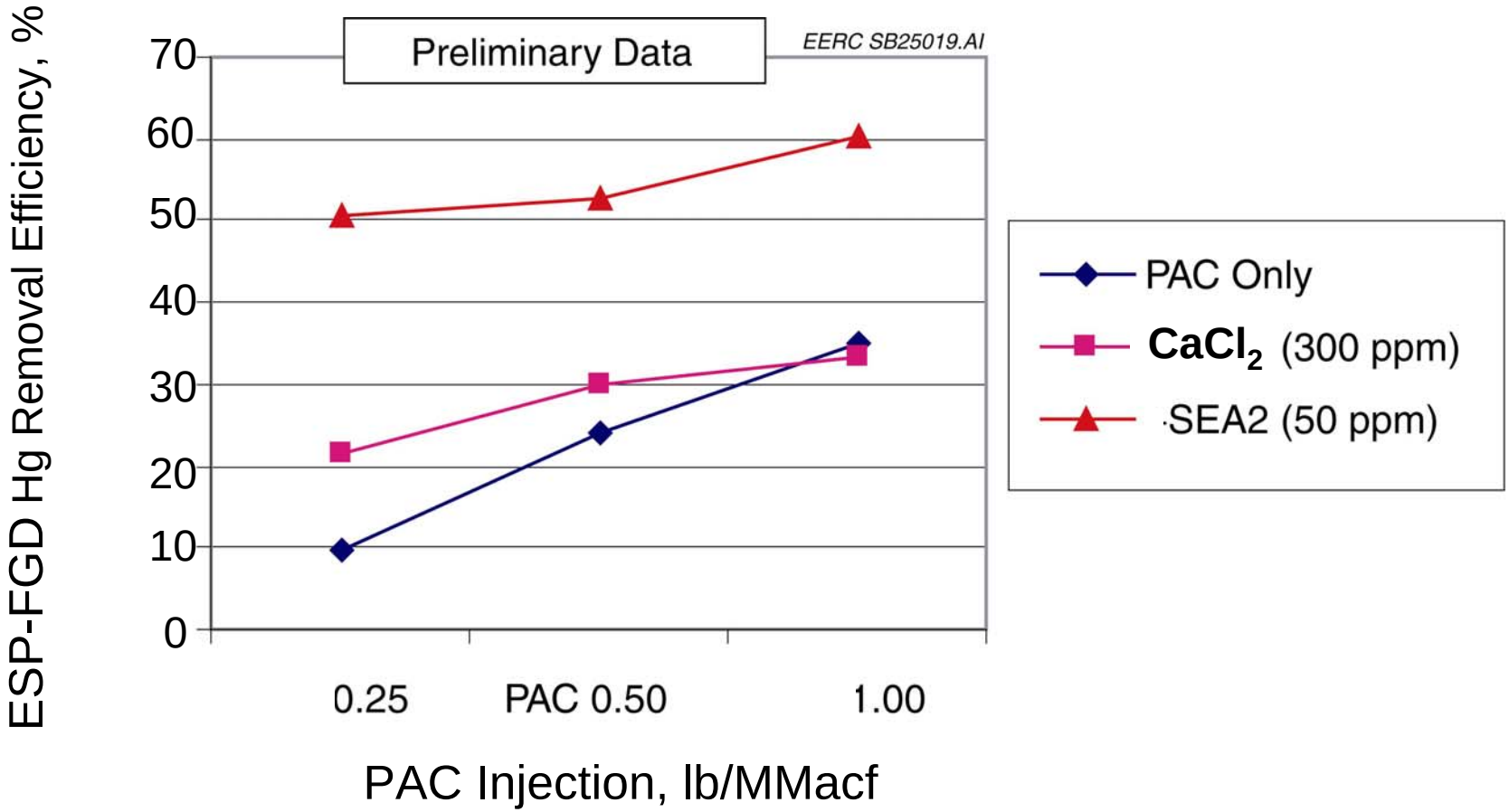
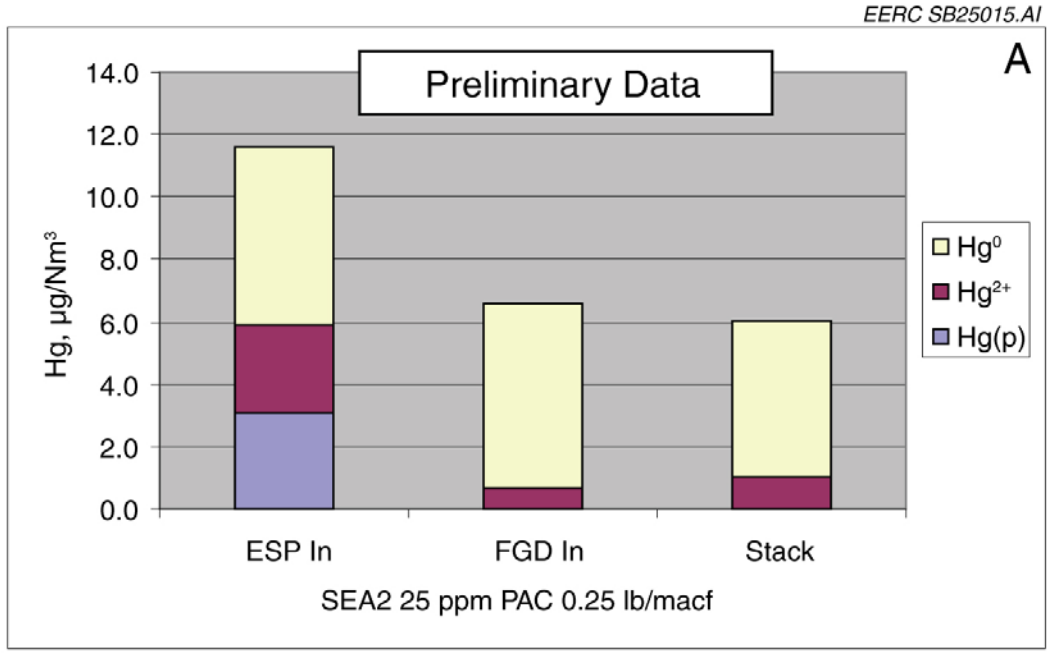
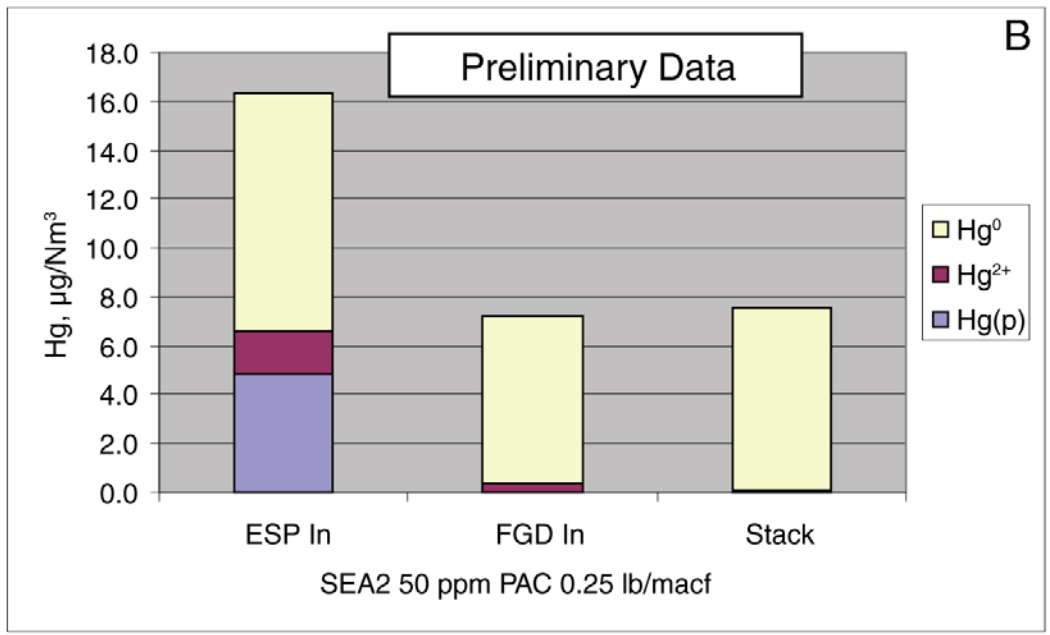
Effects of PAC and Chemical Injections on Hg Capture



SEA2 and PAC Injection





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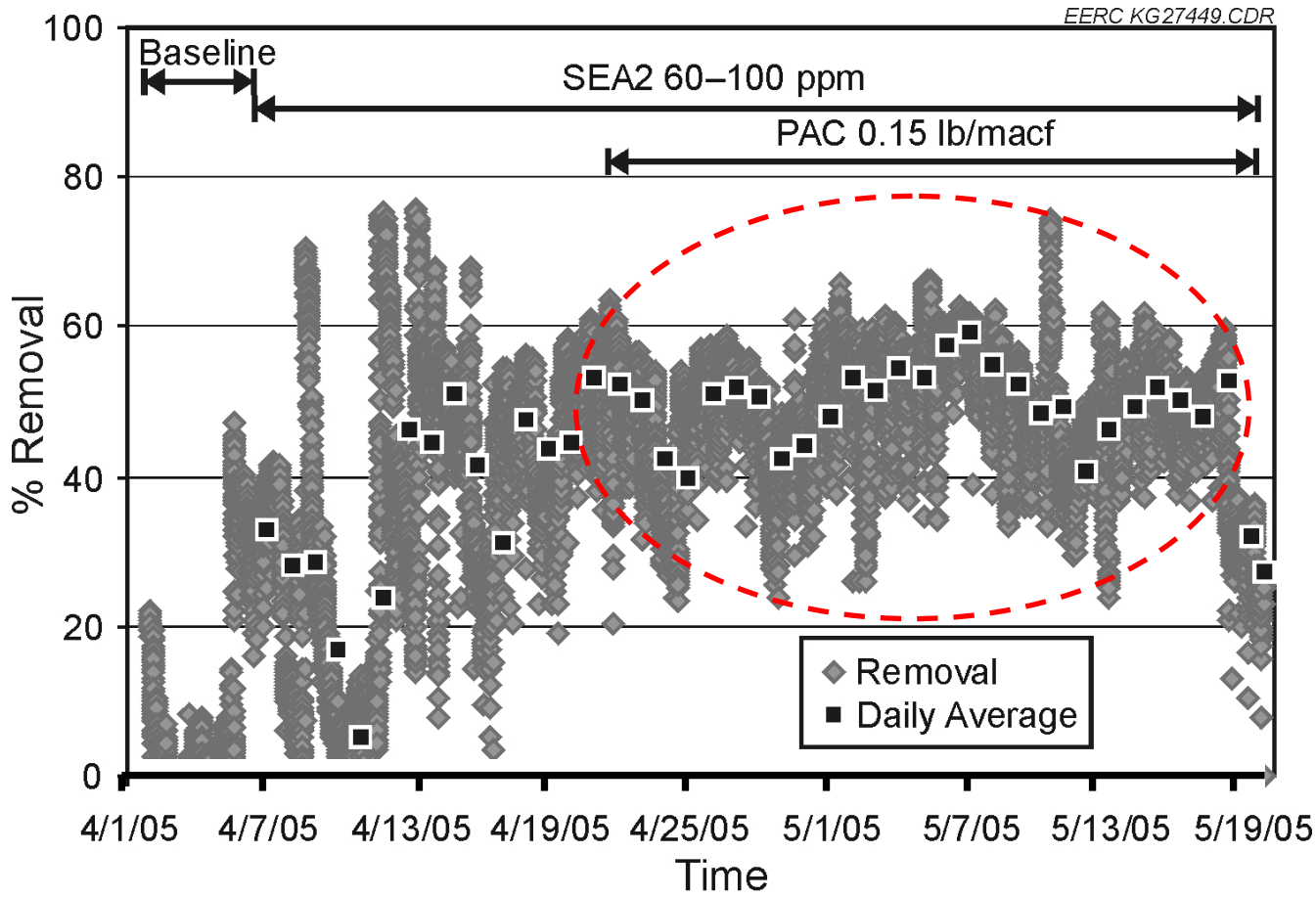
Long-Term Hg Control Test Results



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Conclusions

- Lignite combustion flue gas at MRY Unit 2 contained primarily Hg^0 (>70%).
- SEA2 was more effective in enhancing ESP– FGD Hg removal relative to $CaCl_2$ and $MgCl_2$.
- ESP–FGD Hg removals of ≥55% were maintained by injecting 50 ppm SEA2 and 0.15 lb/MMacf.
- The Hg in baseline and SEA2- and PAC-containing fly ashes was insoluble.
- The Hg in SEA2- and PAC-containing fly ash was thermally more stable relative to baseline fly ash

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Monticello Unit 3

- 793 MW
- Fires a blend of Texas lignite and PRB coals
- Equipped with cold-side ESP
- Equipped with wet FGD scrubber
    - Limestone forced oxidation
    - Spray tower

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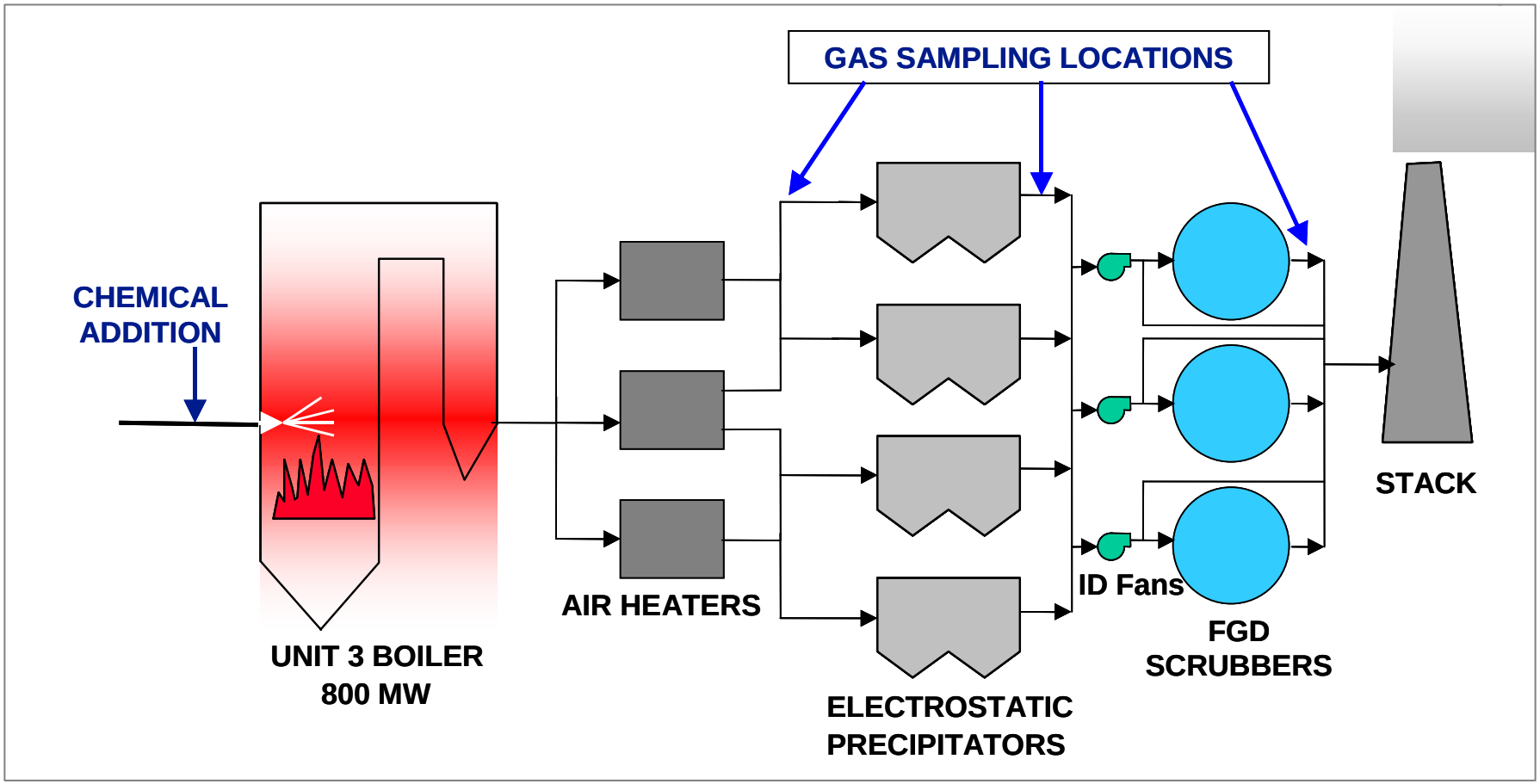
Monticello Unit 3



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Method of Salt Addition

- Add liquid salt to the coal
  - **Spray on belt upstream of pulverizer**

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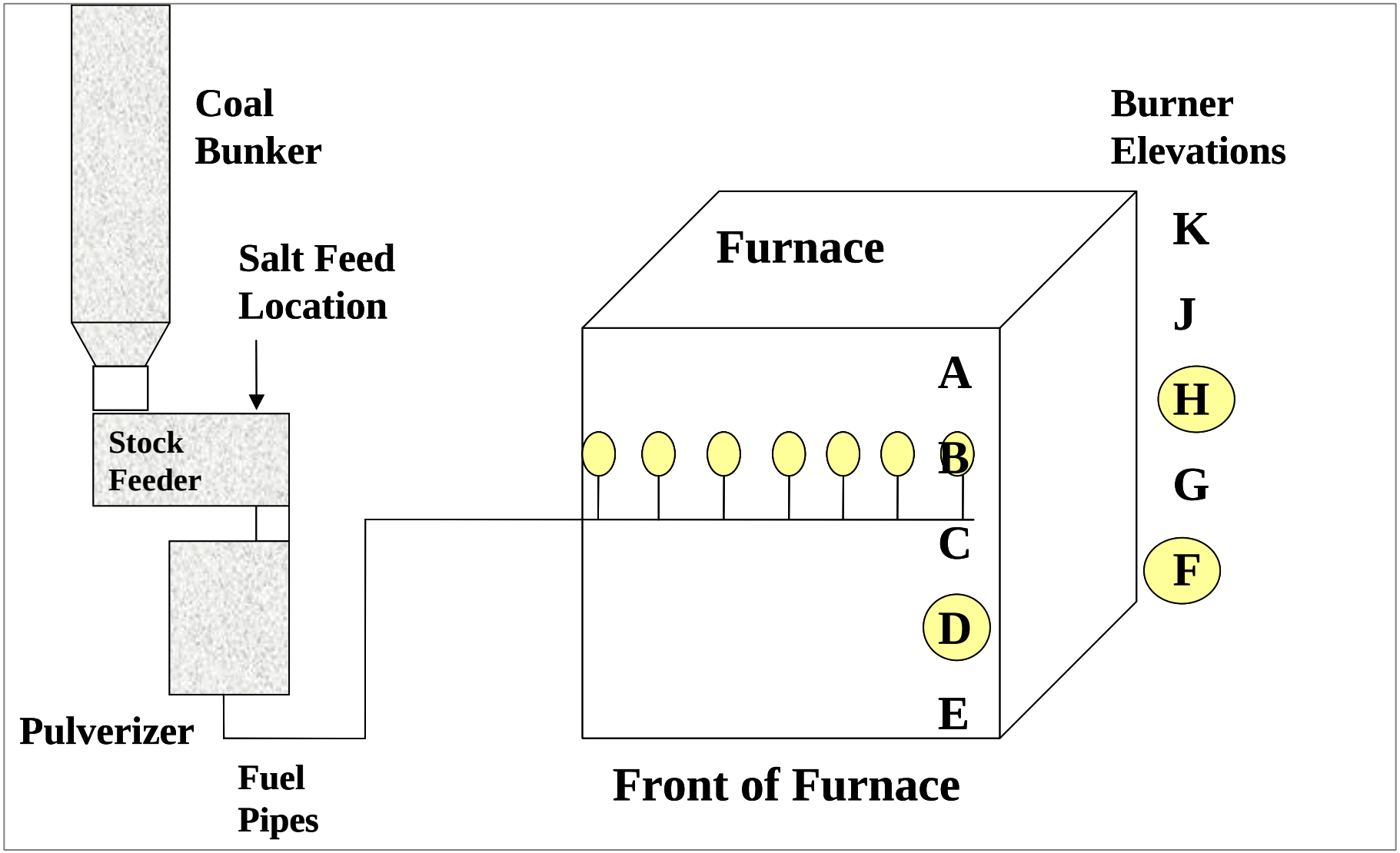
Method of Salt Addition



Baseline Hg Concentrations

- Coal Hg concentrations
  - PRB: 0.05 – 0.10 ppm, dry
  - TxL: 0.15 – 0.35 ppm, dry
- ESP Inlet Hg
  - 10–30 µg/dNm^3
  - 10%–40% oxidation
- Less than 20% Hg removal by fly ash
- FGD outlet Hg
  - 10–18 µg/dNm^3
- Removal across ESP/FGD: 10%–40%

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Parametric Test Plan

- Compare performance of two salts
- Measure Hg oxidation vs. injection rate
- $CaCl_2$
  - Cost is $ 0.31/lb Cl
  - Tested at rates of 400, 600, 800 ppm Cl in the coal
- $CaBr_2$
  - Cost is $ 1.76/ lb Br
  - Br more reactive with Hg
  - Tested at rates of 12, 50, 100, 200 ppm Br in the coal

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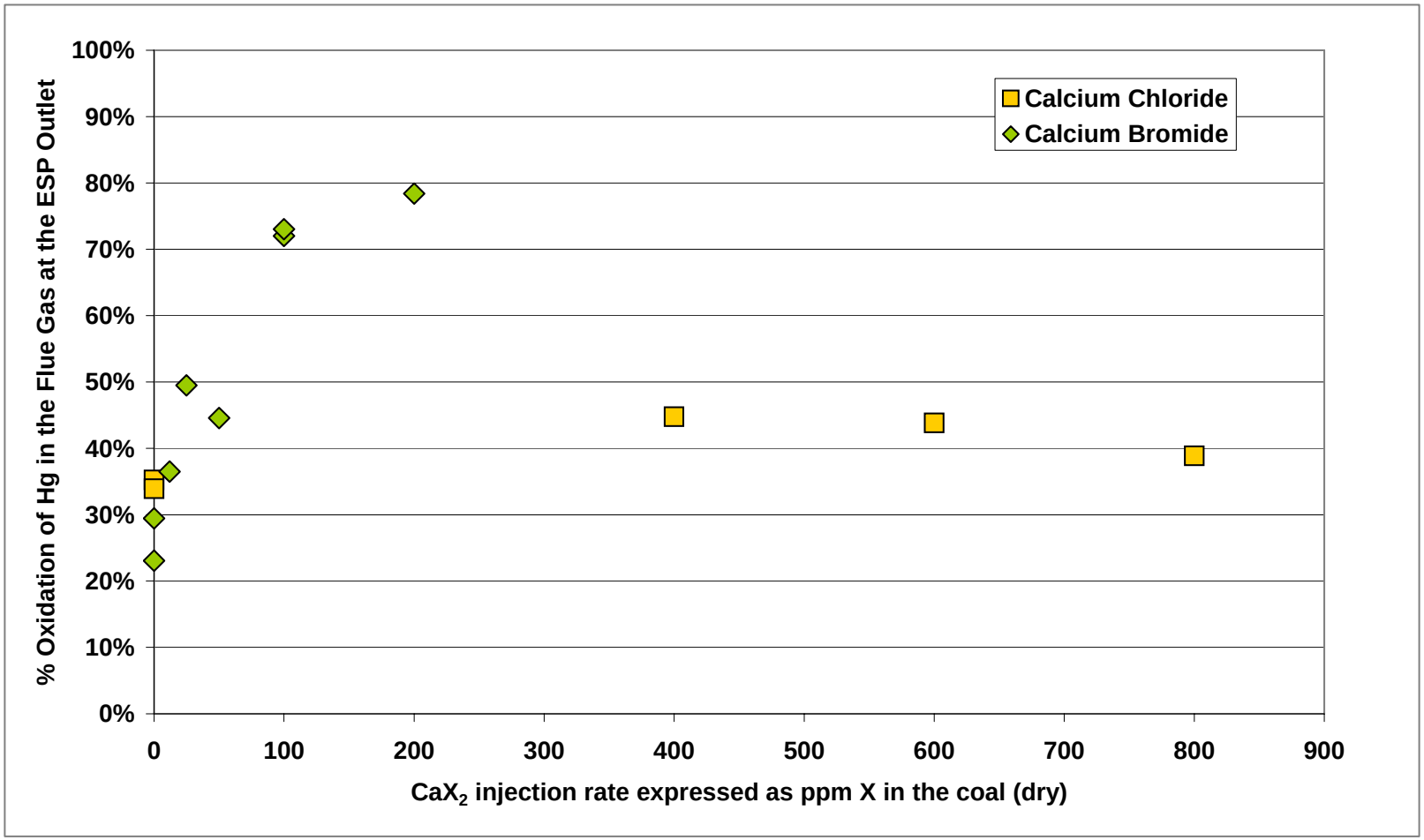
Parametric Test Results
Hg Oxidation vs. Injection Rate



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Long-Term Test Plan

- Evaluate salt's ability to maintain high level of Hg oxidation
- Evaluate balance-of-plant impacts
- First 2-week test of $CaBr_2$ at 55 ppm Br in coal
- Second 2-week test of $CaBr_2$ at 113 ppm Br in the coal

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% Hg Oxidation: 55 ppm Br in the Coal

- Compare average coal inlet Hg to average SCEM Hg^0 at FGD inlet
- 67% oxidation of mercury at 55 ppm Br in coal

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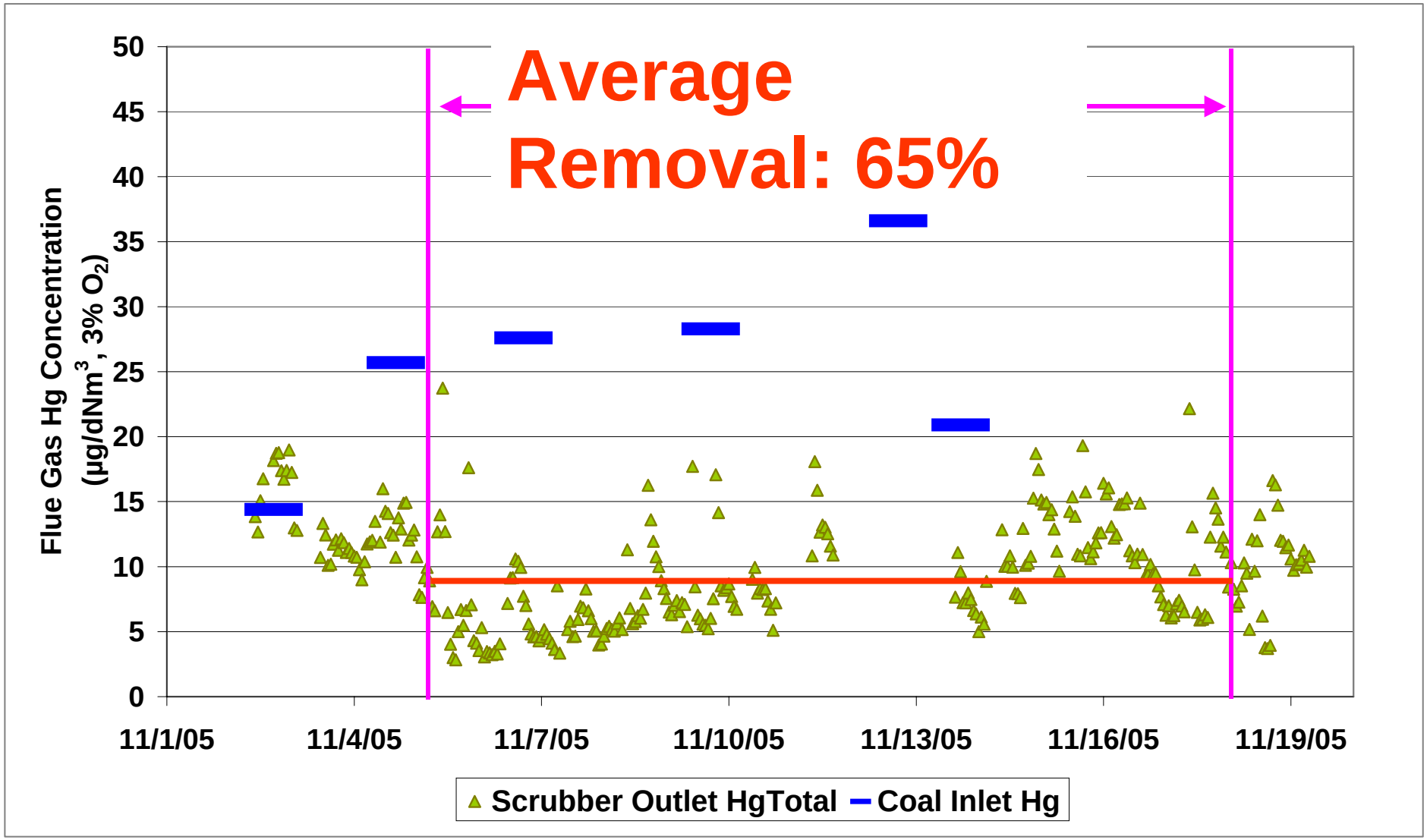
Coal Inlet vs. FGD Outlet: 55 ppm Br in the Coal



% Hg Oxidation: Second Long-Term Test

- Compare average coal inlet Hg to average SCEM Hg^0 at FGD inlet
  - 113 ppm Br: 85%
  - 193 ppm Br: 91%
  - 330 ppm Br: 93%

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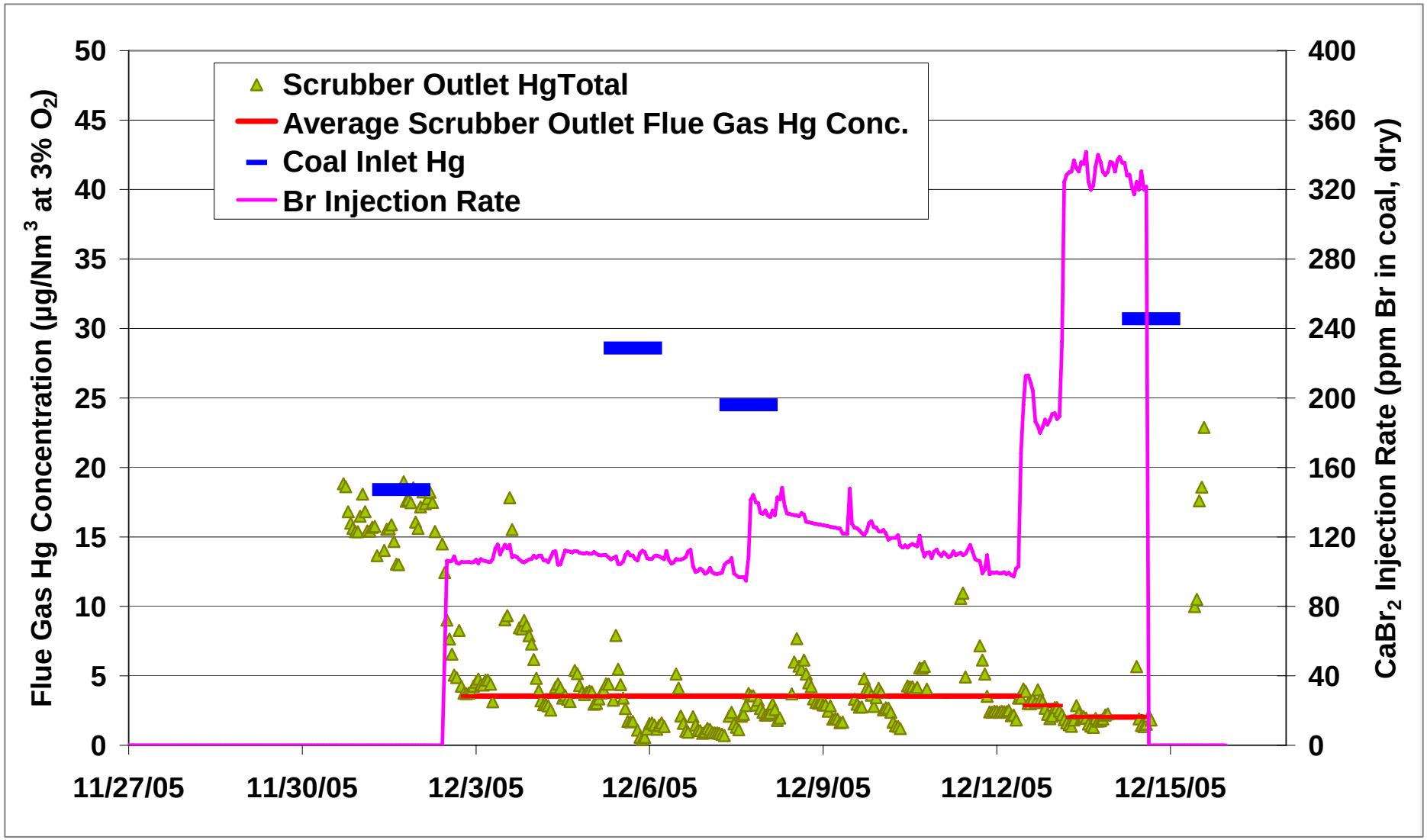
Coal Inlet vs. FGD Outlet: 113 ppm Br in the Coal



Summary

- Oxidation of flue gas mercury was increased with $CaCl_2$ and $CaBr_2$ salts.
- Removal of Hg across wet scrubber correlated well with oxidation of Hg.
- Results of long-term test (FGD outlet vs. average coal Hg)
  - Baseline: 10%–40% removal
  - 55 ppm Br in coal: 65% removal
  - 113 ppm Br in coal: 86% removal
  - 330 ppm Br in coal: 92% removal

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Further Testing Needed

- Evaluate long-term operation
- Characterization of potential balance-of-plant impacts of chemical injection
  - Corrosion
  - Air heater plugging
  - FGD performance
  - FGD materials of construction
  - Effects on by-products

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Hg Leachability from Fly Ashes

- Hg concentrations in baseline and Hg control (SEA2 and PAC) fly ash leachates from SGLP and LTLP were <0.01 µg/L.

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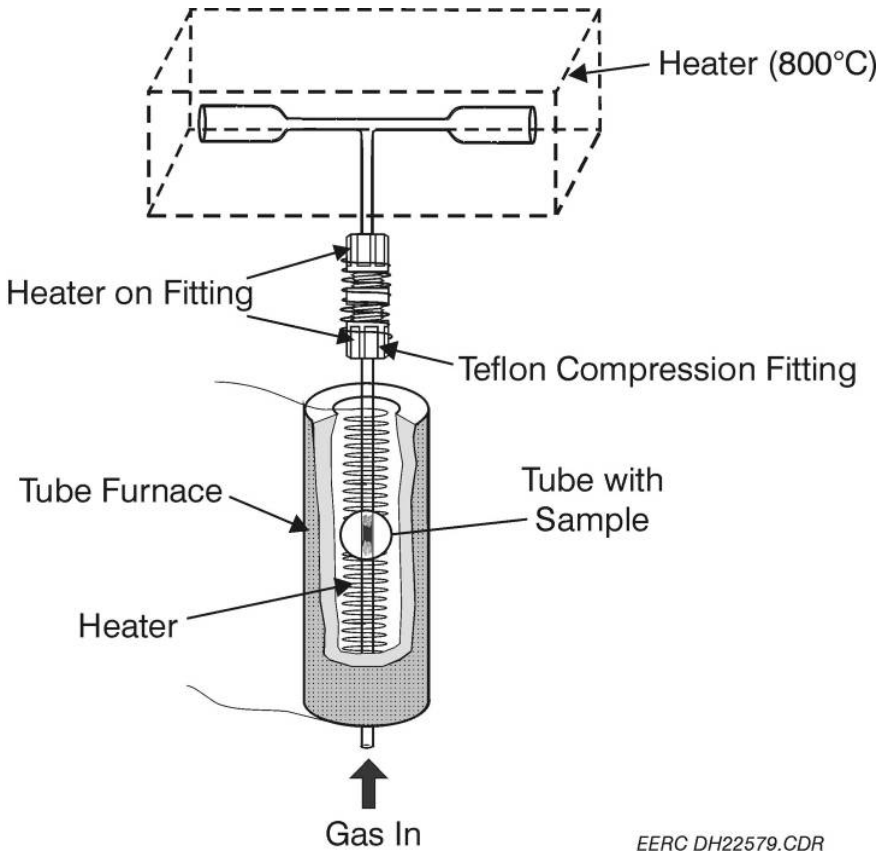
Hg Thermal Desorption Apparatus



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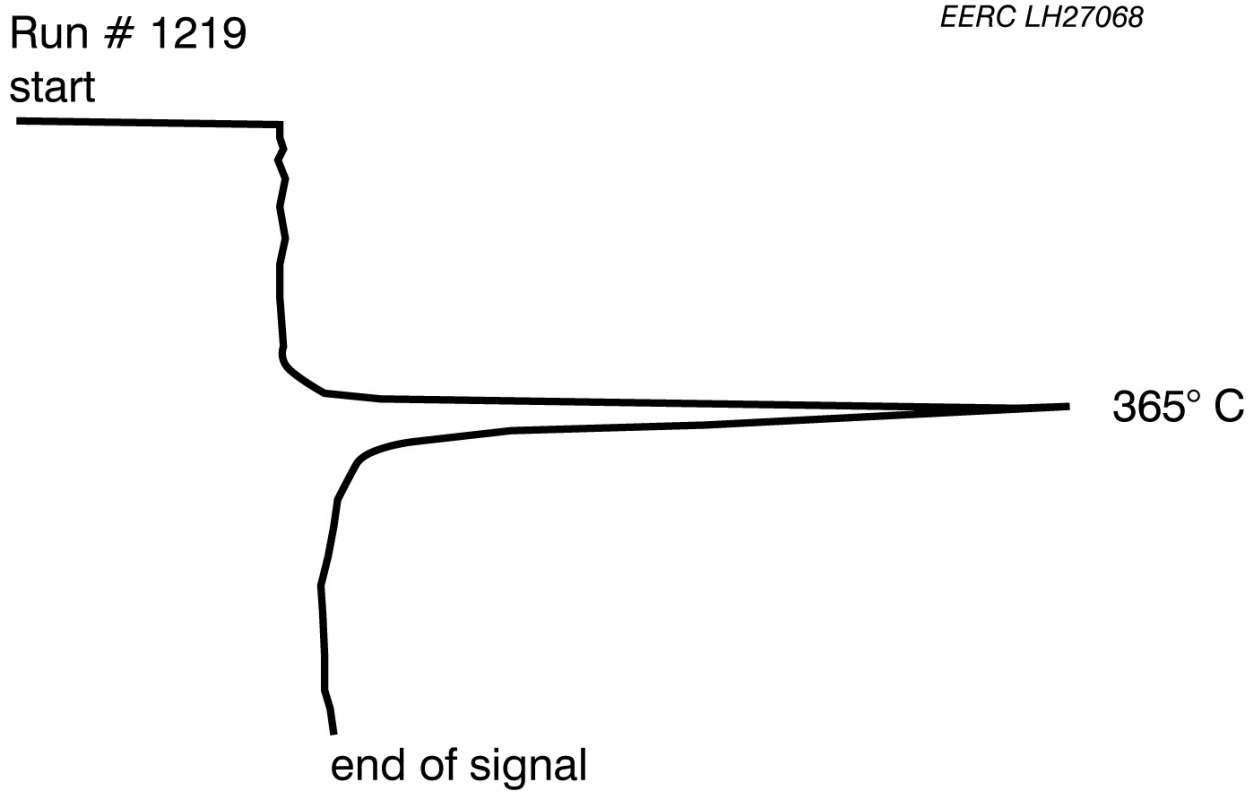
Hg Thermal Desorption from Baseline Fly Ash



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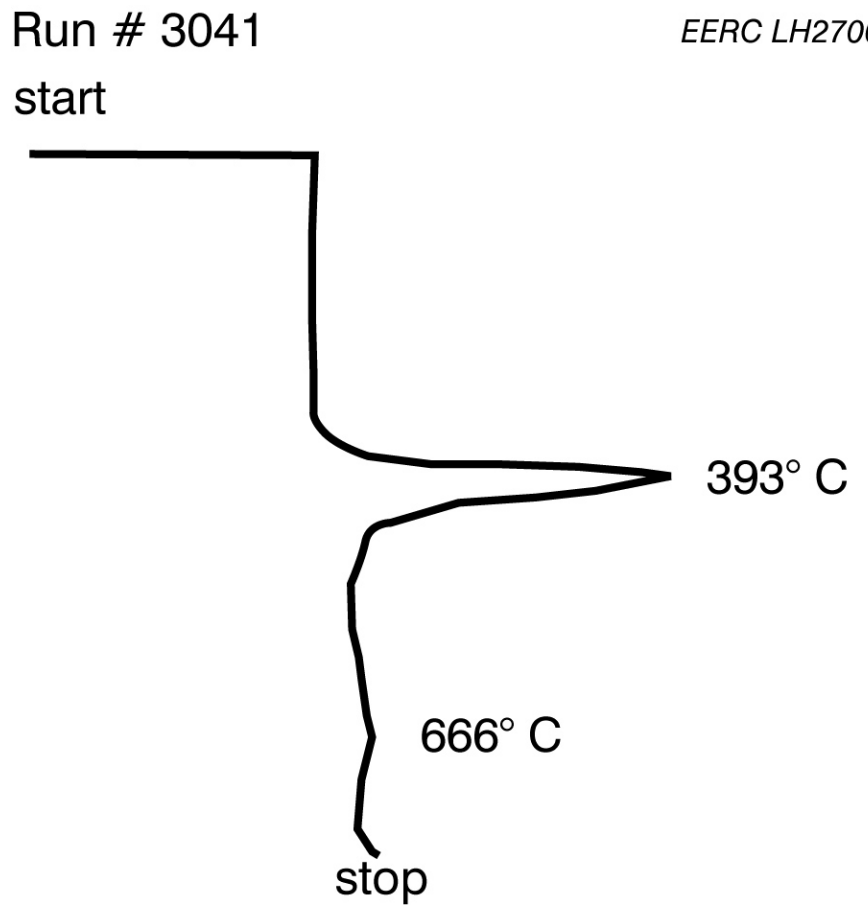
Hg Thermal Desorption from Fly Ash Sampled During SEA2 and PAC Injections



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