EERC Technology… Putting Research into Practice

Phase III – Mercury Control Technologies for Utilities Burning Lignite Coal

DOE NETL Mercury Control Technology Conference

Pittsburgh, Pennsylvania
December 11–13, 2007

John H. Pavlish

Energy & Environmental Research Center
Grand Forks, North Dakota

Final Report for Phase II Work

Pavlish, J.H.; Thompson, J.S.; Almlie, J.C.; Hamre, L.L.; Musich, M.A.; Heebink, L.V.; Crocker, C.R.; Olson, E.S.; Buckley, T.D. *Mercury Control Technologies for Electric Utilities Burning Lignite Coal – Phase II;* Final Report for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-98FT40321; EERC Publication 2007-EERC-03-02; Energy & Environmental Research Center: Grand Forks, ND, May 2007.

Phase III Project Participants

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SaskPower

North Dakota
Industrial Commission

Testing Objectives

Phase III of this project is focused on evaluating long-term balance-of-plant (BOP) effects when using activated carbon injection (ACI) upstream of an electrostatic precipitator (ESP) for mercury control on a full-scale unit. Specific project objectives are as follows:

- Evaluate impact of ACI on ESP operation (increased sparking, buildup on plates, rapping frequency and effectiveness, outlet emission opacity, etc.).
- Evaluate the impact of ACI on downstream ductwork, fans, and stack.
- Evaluate the impact of ACI on ESP hoppers.
- Evaluate the impact of ACI on ash-handling equipment and disposal practices.
- Evaluate the long-term operability of the ACI system and equipment.

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Testing Objectives (cont.)

- Evaluate long-term mercury removal using ACI upstream of an ESP-only configuration.
- Determine mercury capture and the fate of mercury across the unit using a mercury continuous emission monitor (CEM), the Ontario Hydro (OH) wet-chemistry method, and analyses of coal and ash.
- Obtain mercury removal and economic data for ACI upstream of a full-scale ESP, which can be compared to previously generated data on the Emission Control Research Facility (ECRF) for ACI upstream of a fabric filter (FF).
- Perform a preliminary economic evaluation of using ACI upstream of an ESP for mercury control including observed BOP impacts.
- Perform sampling to evaluate the impact of ACI on trace metal emissions.
- Obtain particulate matter emission data sufficient to evaluate the effect of ACI.

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Poplar River Unit 2 Specifications

Component	Specifications/Notes
Plant Location	Near Coronach, Saskatchewan, Canada
Coal Combusted	Fort Union lignite (Saskatchewan lignite), Poplar River Mine; same as previous pilot-scale ECRF testing under Phase II
Boiler	Babcock & Wilcox opposed-fired wall-fired boiler
Load	310 MW
Mills	6 mills
ESP Specifications	
Manufacturer	American Air Filter
Specific Collection Area (SCA)	• Approximately 400 ft^2/1000 acfm
Controller	• EPIC III controllers
Casings	• Double casings, two parallel bus sections across the width; 10 bus sections in each casing (total of 20 bus sections)
Fields	• Five fields in the direction of gas flow
Rappers	• Tumbling hammer collecting rappers
Ash Handling	• Slurried (mixed with water) and disposed of in lagoon
Ash Sales	• None; excessive transportation to reach suitable market

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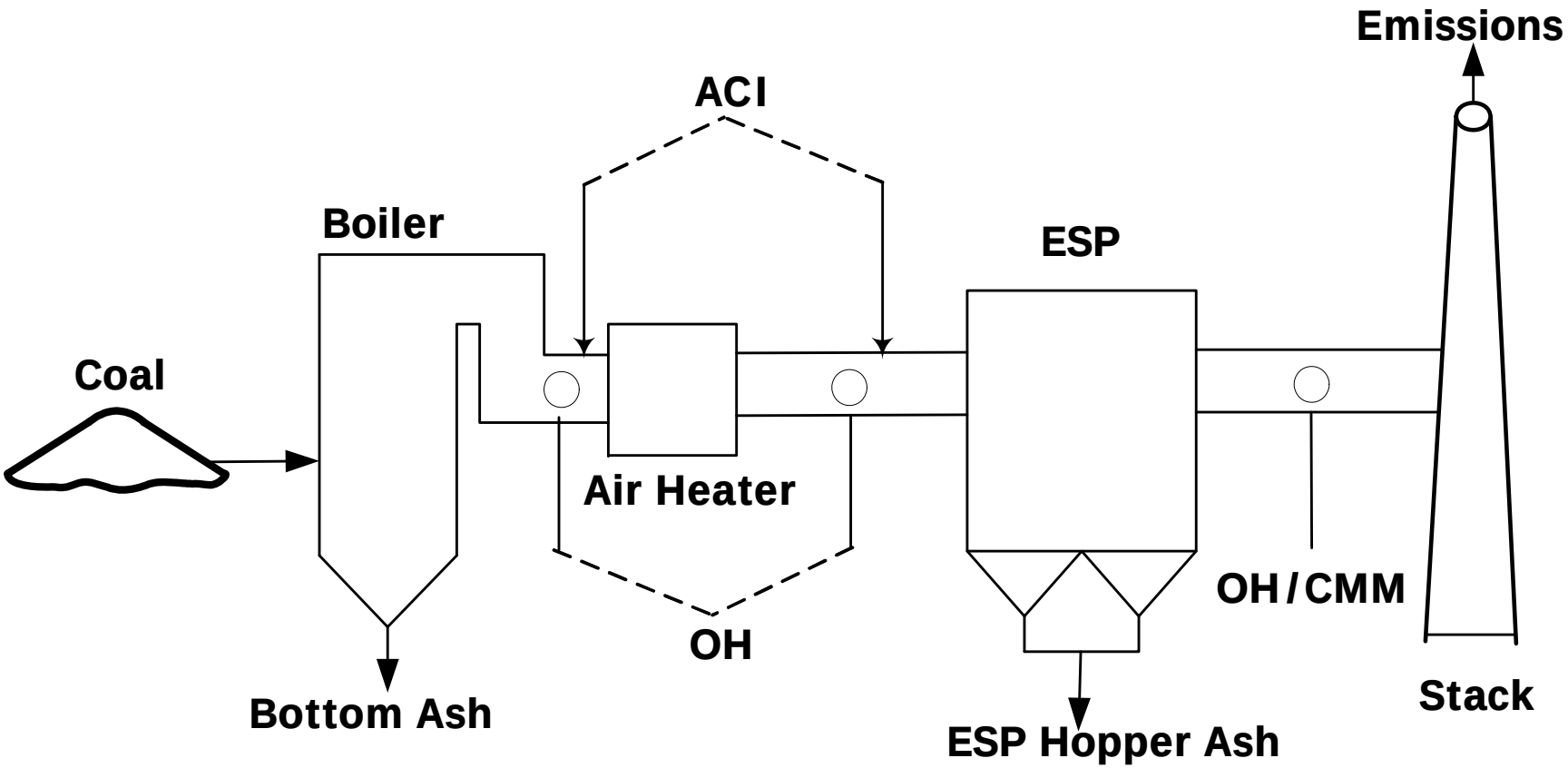
Poplar River Unit 2 Schematic



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Activated Carbon Injection System

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Delivery of Activated Carbon

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Equipment at Poplar River

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Silo and Injection Skid

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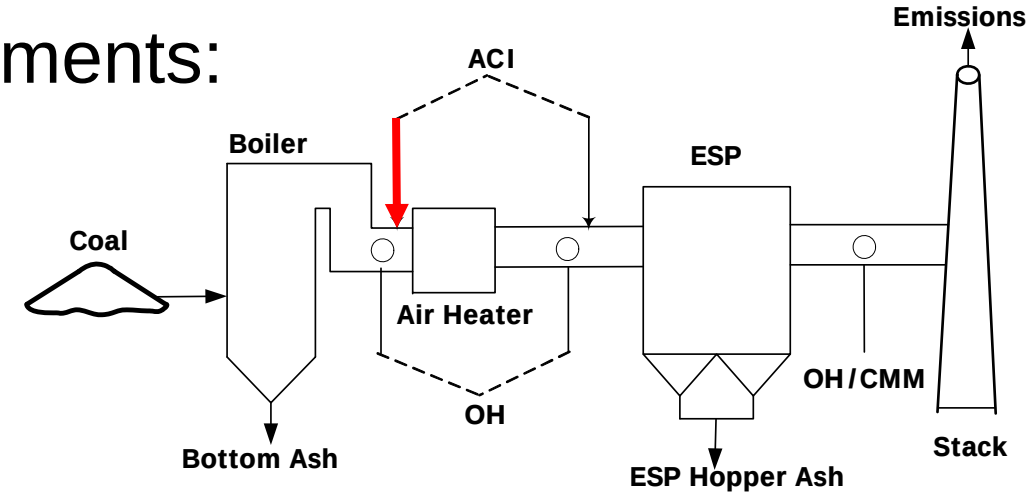
Injection Grid at AH Inlet

- Duct at air heater (AH) inlet is approximately 26 x 15 ft in an expanding duct.
- 400 feet from AC silo.
- Six injection ports across the 26-ft width.
- Traverse measurements:
  - Pitot
  - Temperature



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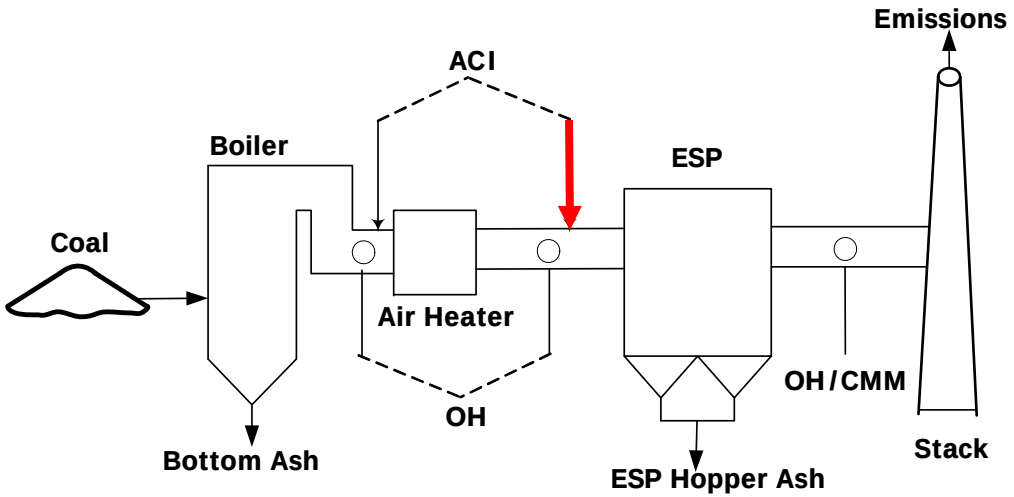
Injection Grid at ESP Inlet

- Duct at ESP inlet is approximately 26 x 8 ft.
- 350 feet from AC silo.
- 12 injection ports.
- Traverse measurements:
  - Pitot
  - Temperature
- Flow is condensed near the bottom of the duct.



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AC Splitter

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Distribution Hoses

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Injection Ports at ESP Inlet

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Mercury Sampling

- Baseline sampling for mercury in the flue gas prior to ACI
- Mass balance (Monitoring Protocol in Support of the CWS…)
  - Coal
  - ESP hopper ash
  - OH method
- Hg CEM at the west ESP outlet

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Coal and Ash Sampling

- Coal
  - Daily sampling
  - Analysis of 3 samples bi-weekly
- ESP hopper ash
  - Initially, biweekly sampling and analysis of all hoppers to determine mercury-ash distribution
  - Long term sample from one hopper from row 1 and row 2 daily

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Flue Gas Sampling

- Hg CEM (gas-phase mercury)
  - ESP outlet
- OH (speciated mercury)
  - ESP outlet
  - Upstream of injection location
- Method 29 (trace metals)
  - As, Cd, Cr, Pb, Se, Sb
- Particulate matter
  - ESP outlet

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BOP Data

- Pretest and posttest inspection reports
  - Documentation of AH, ESP components, ductwork
- Corrosion probes
- Documentation of ESP operations
  - TR sets
  - Rapping frequency
- Documentation of plant operations (load, temperature, SOx, NOx, etc.)

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Baseline Inspection Report

- Inspections completed May 20 – June 6, 2007
- PAH and SAH
  - Partially plugged with fly ash
  - Both sides were washed and blown clean
- Ductwork
  - Very little corrosion noted
  - Minor leakage at expansion joints
- ESPs
  - No corrosion
  - Some errosion
  - Some buildup of ash, samples collected
  - Plates and electrodes cleaned

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Corrosion/Deposition Coupons

- Preweighed
- Duct metal
- Cut and welded
- Locations
  - Upstream of ACI
  - Upstream of ESP (downstream of ACI)
  - Downstream of ESP
- Duration
  - 12 probes, 24 coupons for timed sampling

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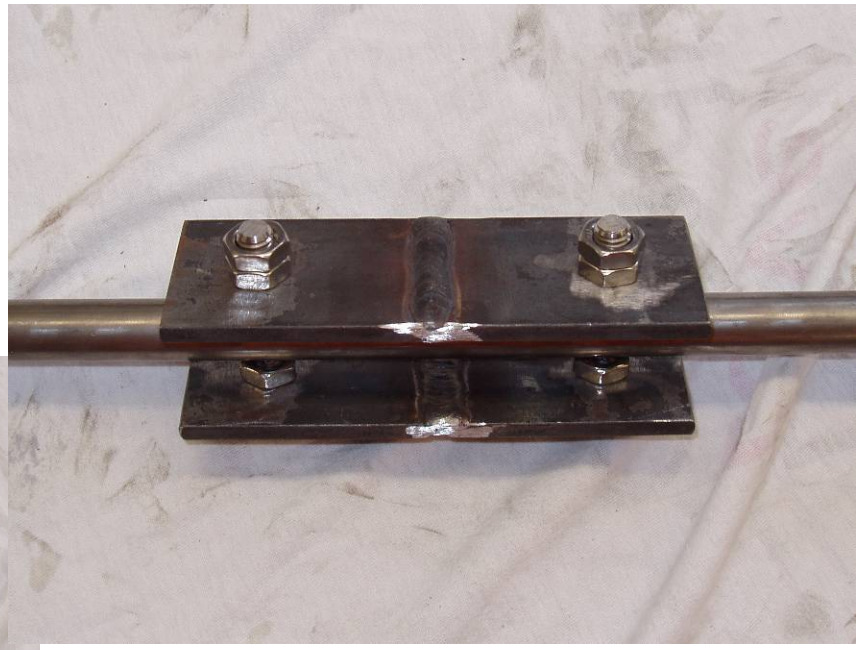
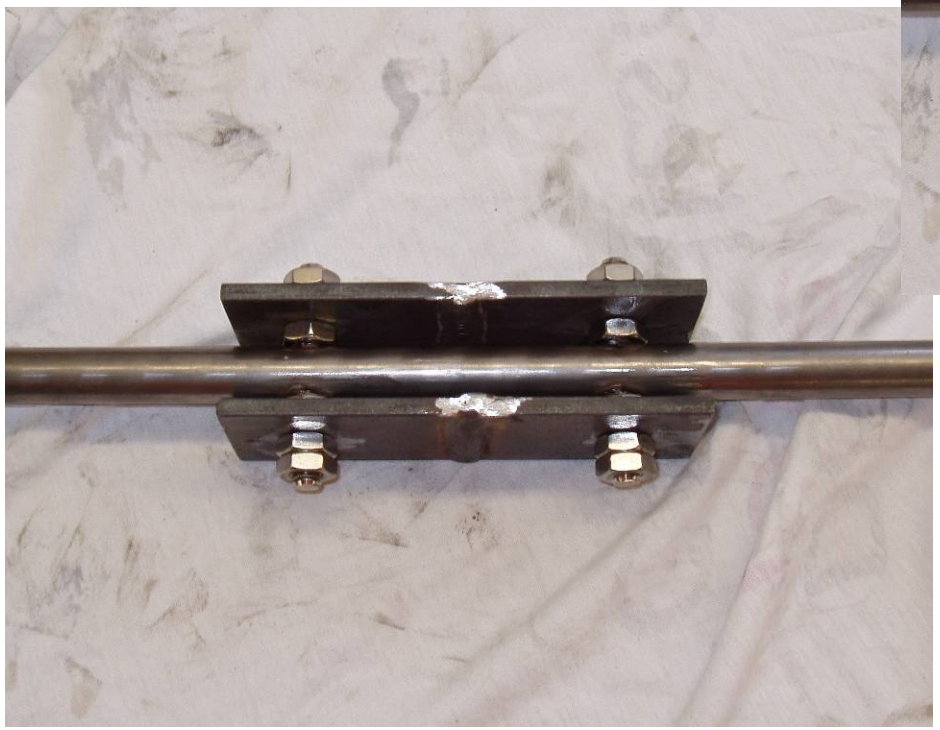
Corrosion Probes





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Parametric Test Matrix

- Commercially available ACs (three)
- Injection location
  - AH Inlet
  - ESP Inlet (AH outlet)
  - ESP inlet plenum
- Injection grid/lance design
  - Measurement of flow/temperature/O_2 profiles
- Injection rates/mercury removal

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Preliminary Data

- Parametric testing has indicated mercury capture of approximately 60%–80% while injecting a treated AC at 2–2.5 lb/Macf (at 300°F).

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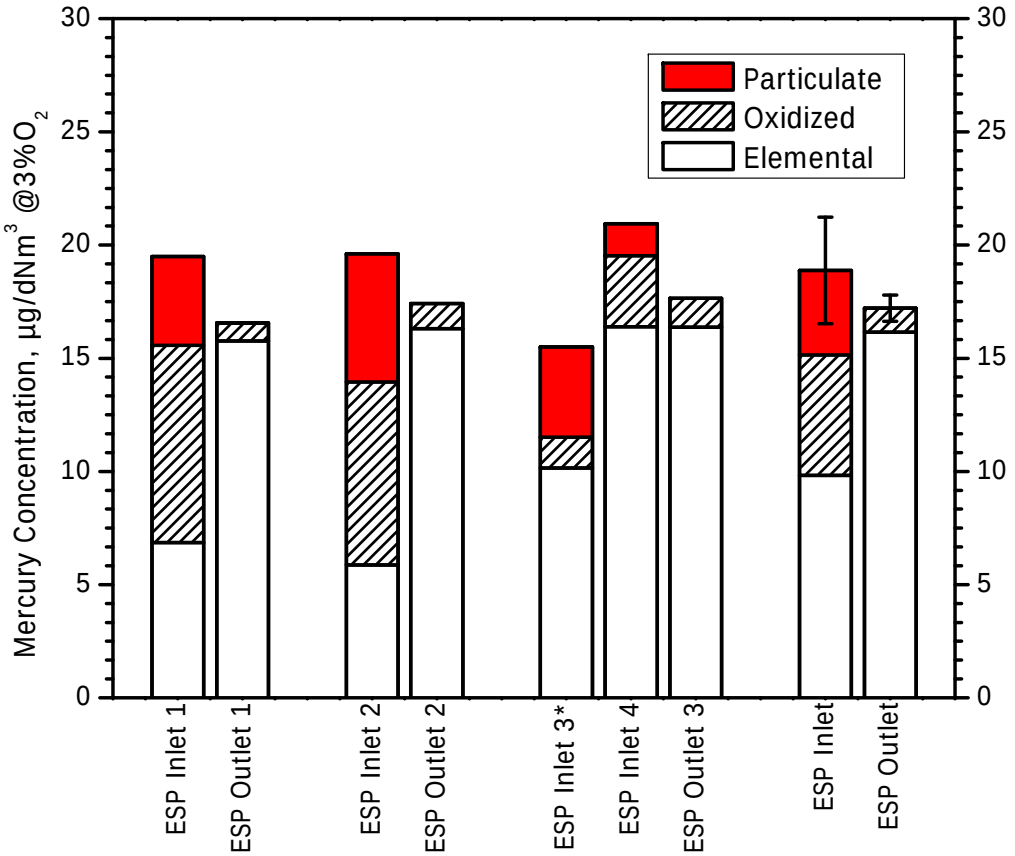
OH Baseline Sampling



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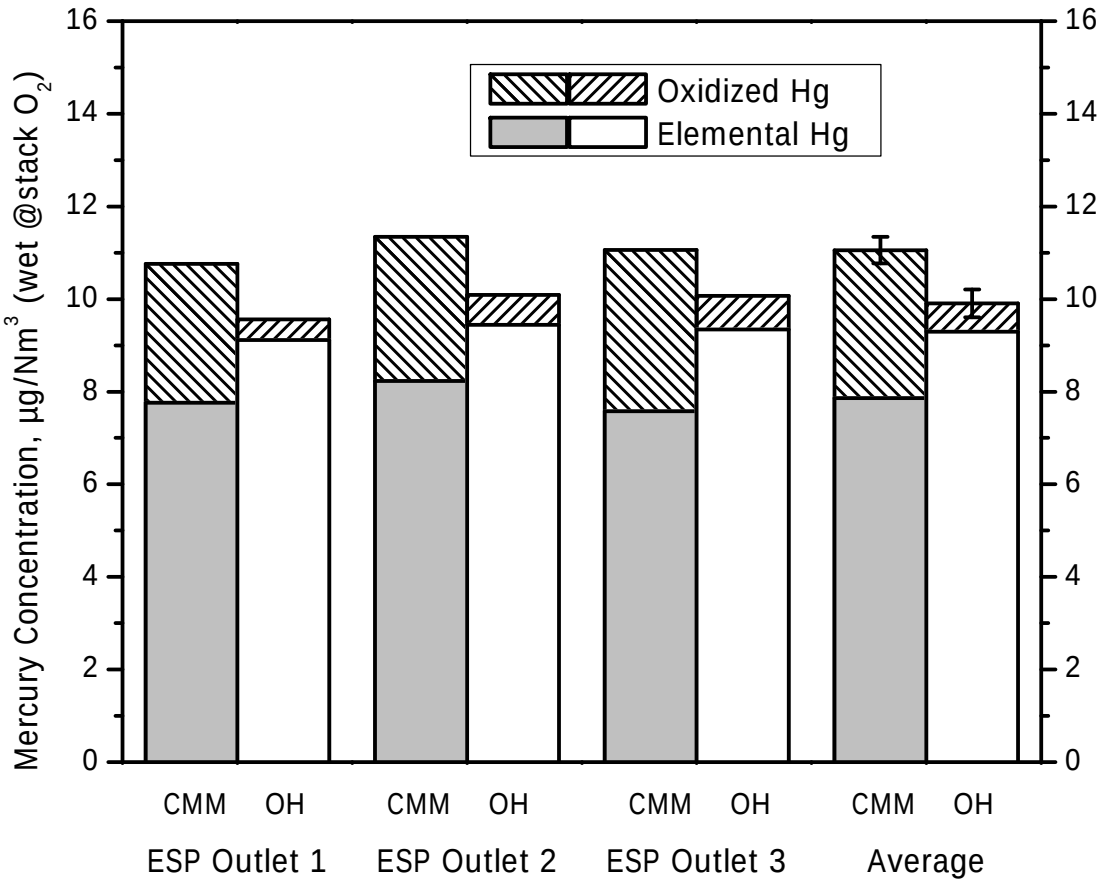
Hg CEM vs. OH



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Baseline Solids

- Coal Hg (dry basis)
  - 0.125 µg/g-coal
  - Approximately 600 µg/kg-ash (estimated)
- ESP hopper ash Hg, µg/kg

Field	A	B	C	D	Field Average
1	51	55	78	36	55
2	152	93	92	60	99
3	54	97	120	67	84
4	48	91	87	59	71
5			40	39	39

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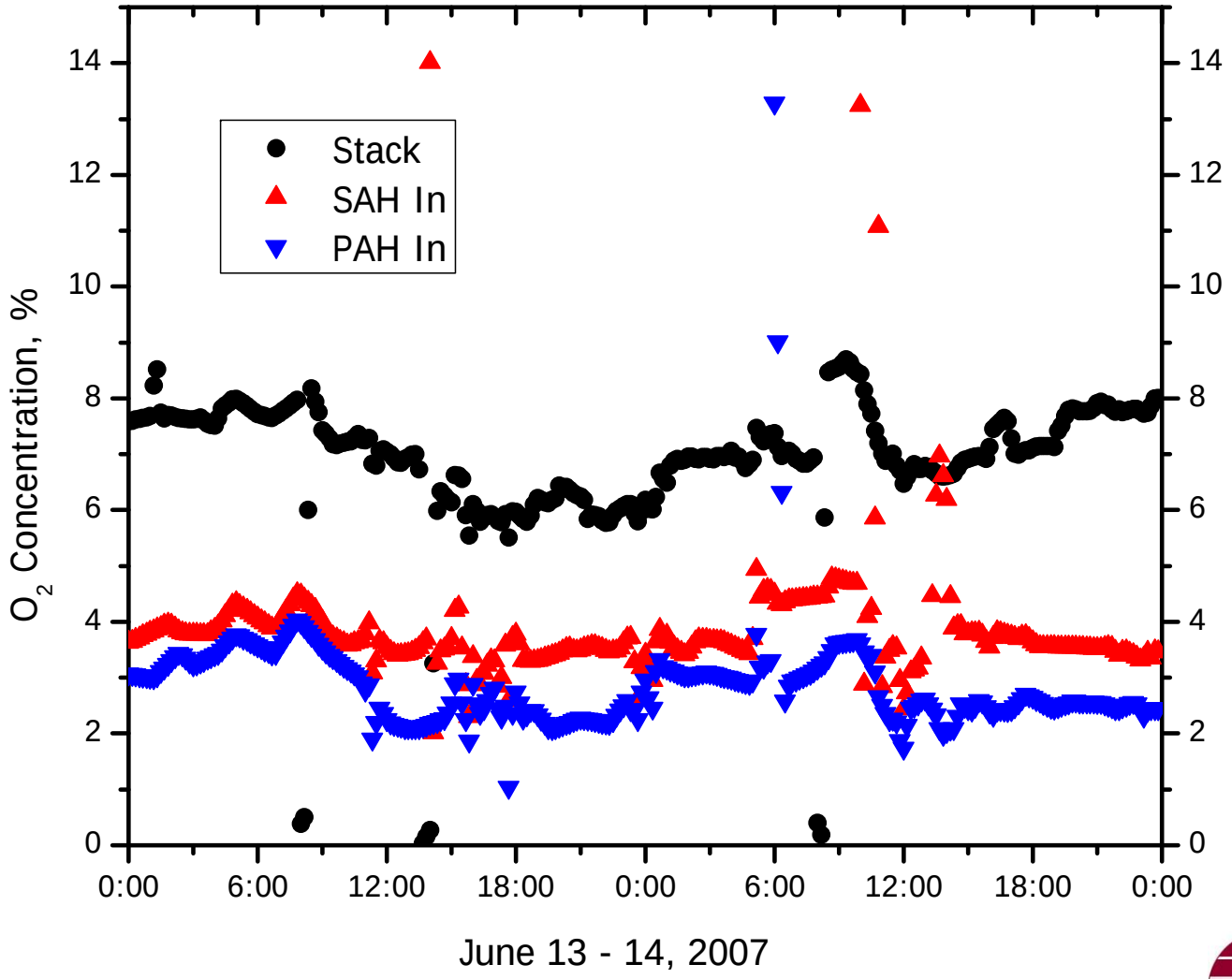
Baseline Oxygen



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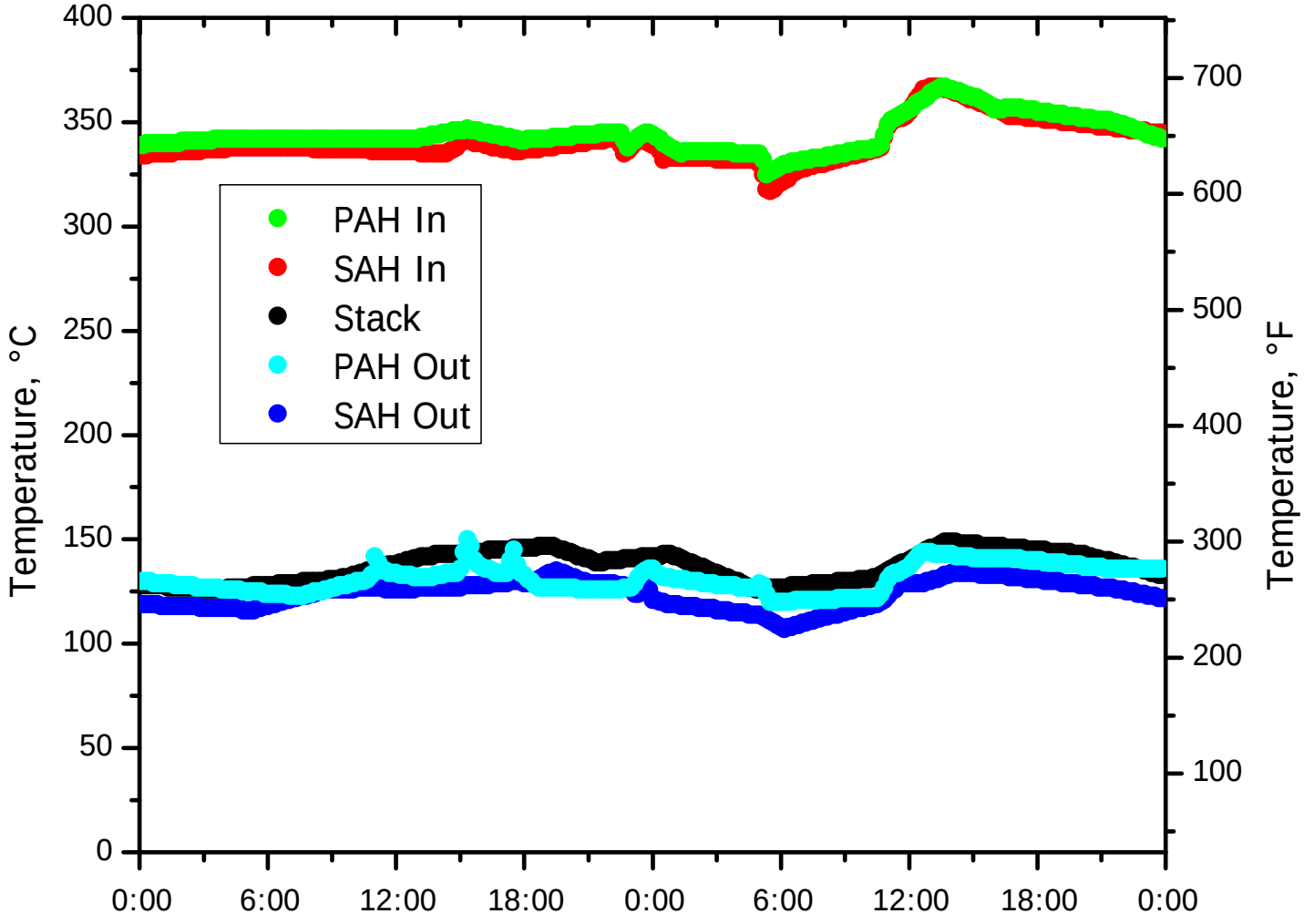
Baseline Temperatures



June 13 - 14, 2007

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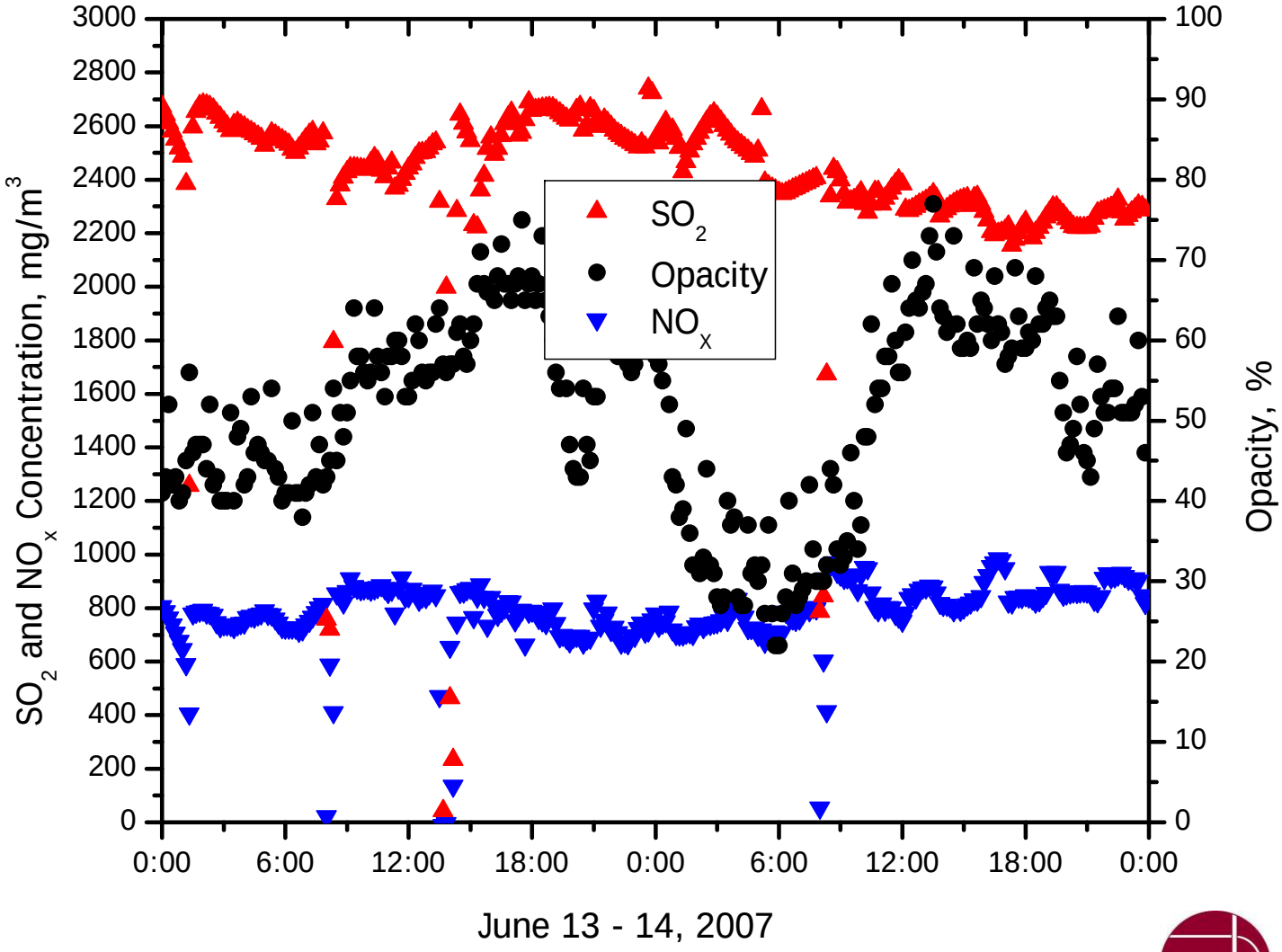
Baseline Stack CEM Data



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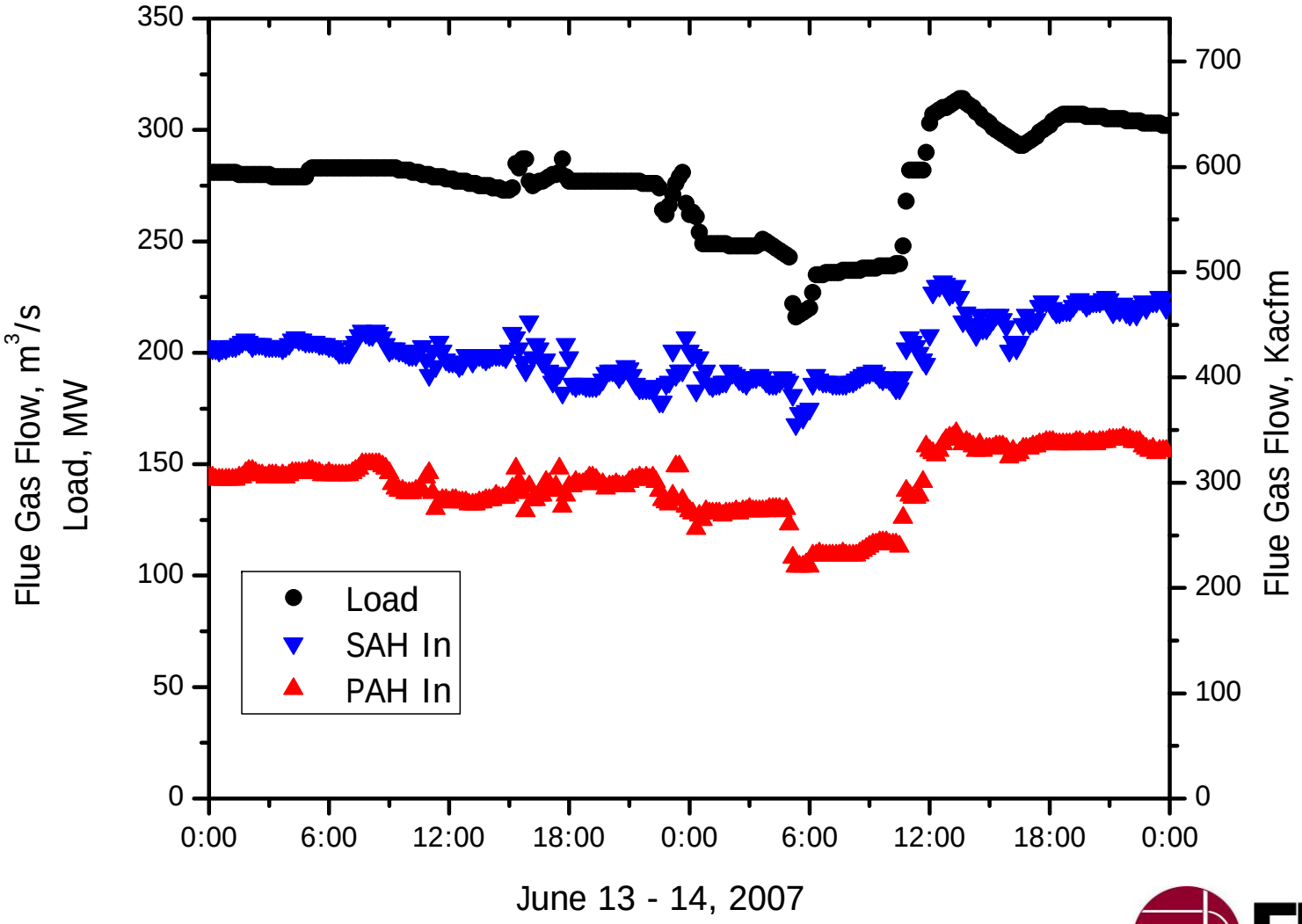
Baseline Flows and Load



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Long-term Test Status

- Started December 4
- Monitoring of mercury emissions via CMM and periodic OH sampling
- Plant data is being logged and monitored
- Weekly and monthly inspection
  - Injection equipment
  - Air heaters
  - Ductwork
  - ESPs
  - ID fans
- Results will be reported at project meetings, conferences, etc. as testing progresses

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