EERC Technology… Putting Research into Practice

Long-Term Demonstration of Sorbent Enhancement Additive Technology for Mercury Control

EUEC

Tucson, Arizona

January 22-24, 2007

Jason Laumb
Brandon Pavlish
Energy & Environmental Research Center

Presentation Outline

- Introduction
- Previous work at Hawthorn
- Current Results at Hawthorn
- Introduce Phase III Project
- Schedule
- Acknowledgements

EERC
Energy & Environmental Research Center®

Sorbent Enhancement Additive (SEA) Technology

- SEA1 (B&W/Niro, U.S. patent 5,435,980)
  - Chloride added to coal feed.
  - Hg capture can be enhanced with carbon.
- SEA2 T2
  - Alternative method of adding SEA2.
  - Reduce effects of alkaline material.
- Questions about the technology can be addressed by B&W.

EERC
Energy & Environmental Research Center®

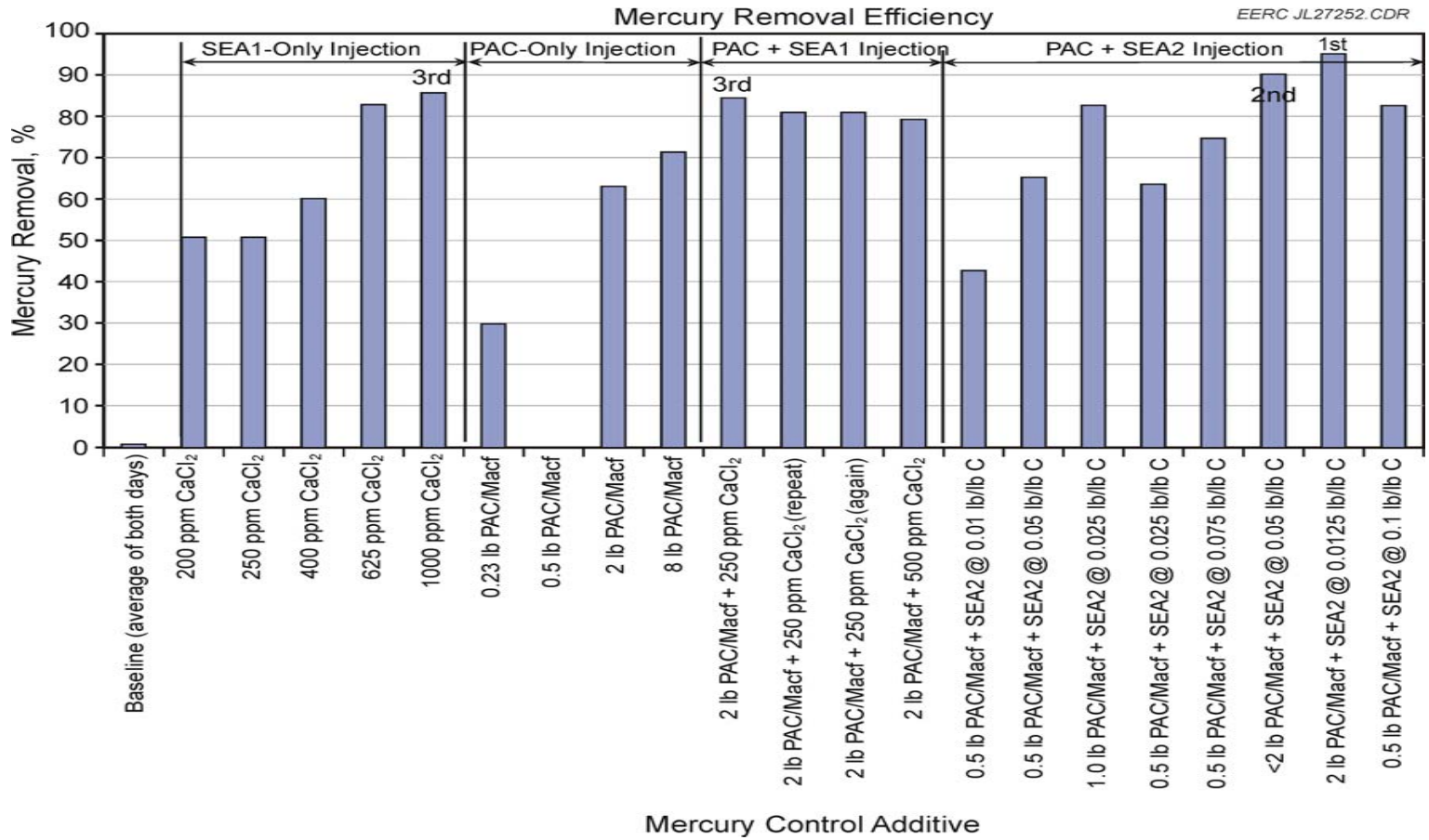
Hawthorn Unit 5

Plant	Utility Owner	Coal	Boiler Type	Boiler Size, MW	Particulate Control	SO_2 Control	NO_x Control
HAW5	KCP&L	PRB	Wall-fired	550	FF	SDA	LNB[1], OFA[2], SCR

[1] Low-NO_x burners.
[2] Overfire air.

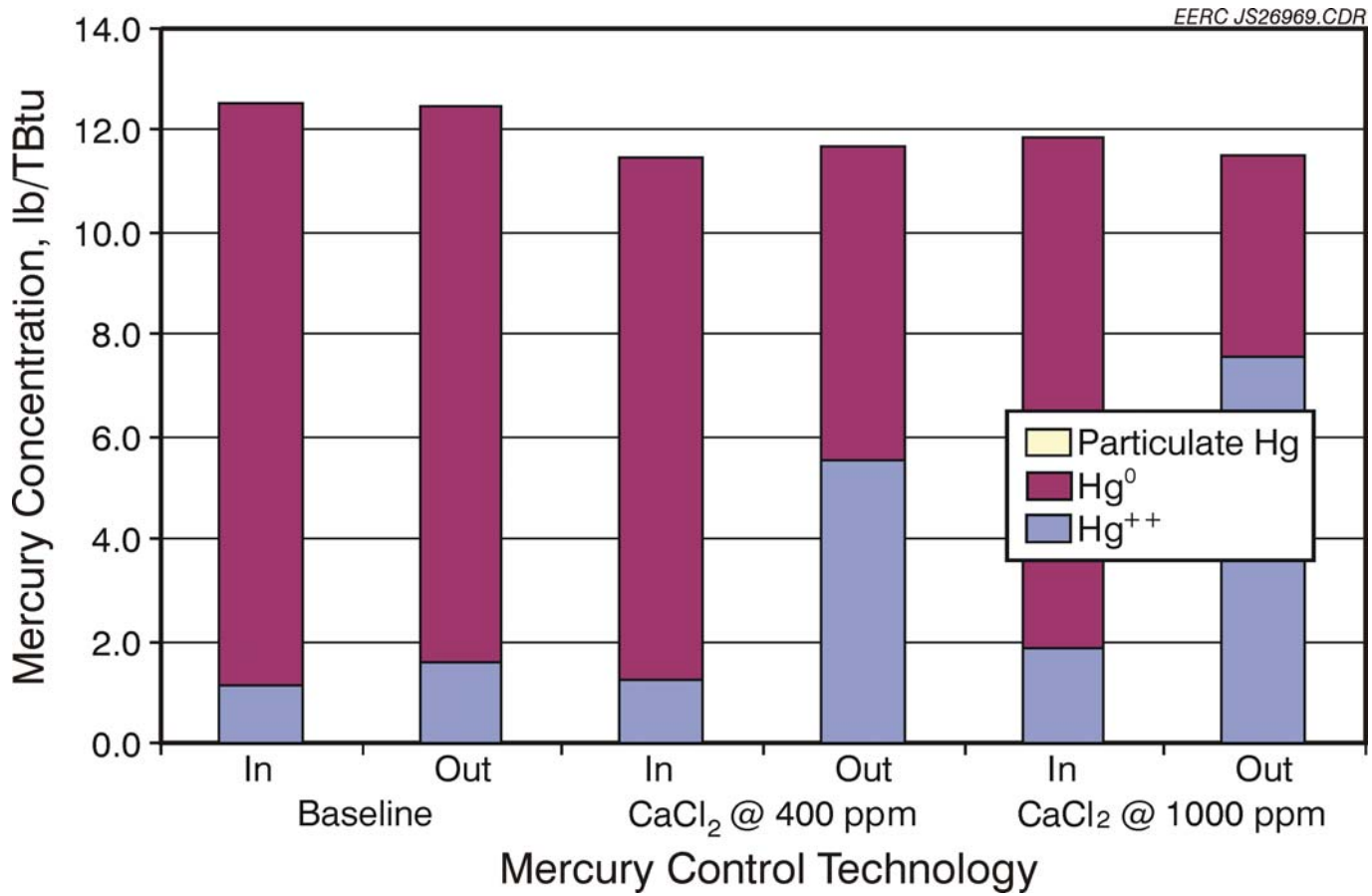
EERC
Energy & Environmental Research Center®

Previous Hawthorn Test Results



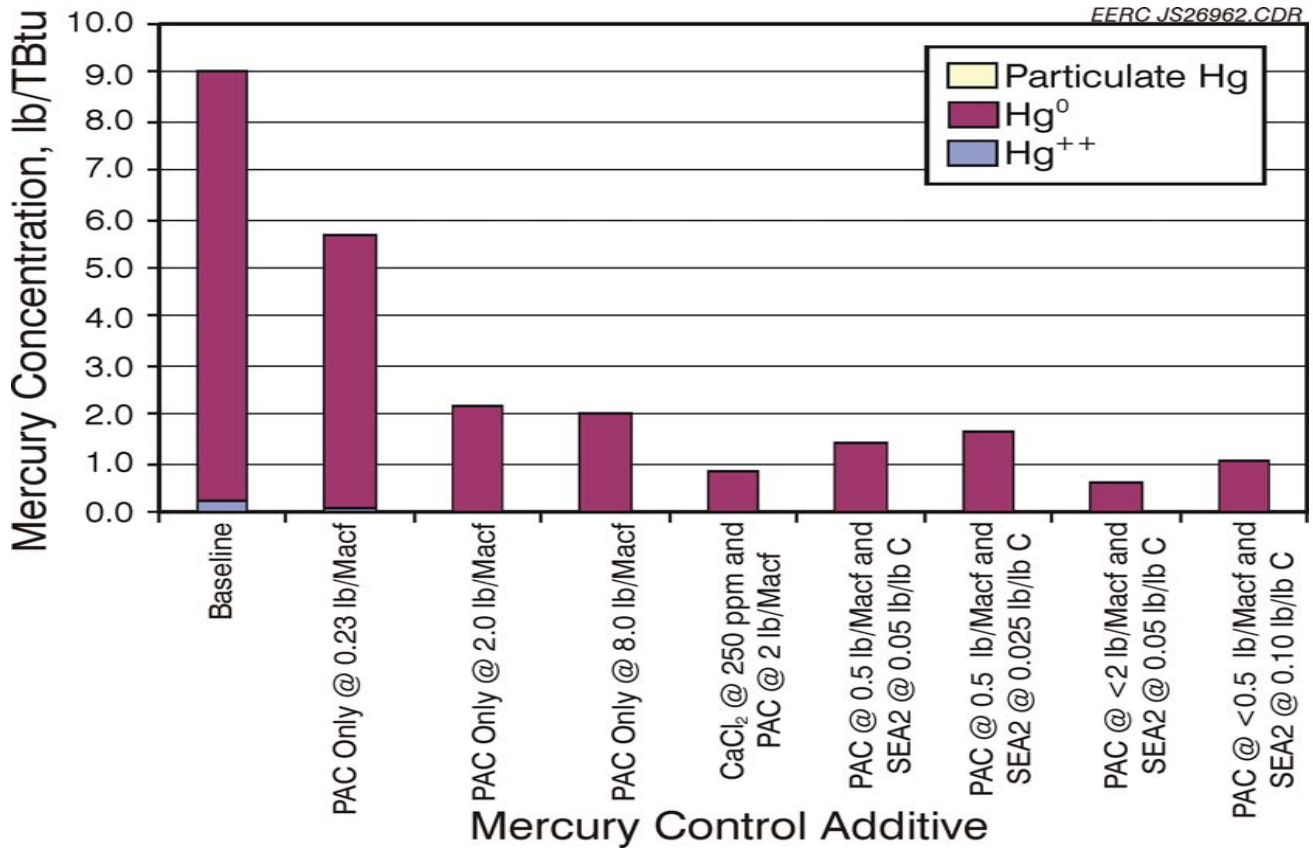
EERC
Energy & Environmental Research Center®

Previous Hg Speciation at SCR Outlet



EERC
Energy & Environmental Research Center®

Previous Hg Speciation at Stack



EERC
Energy & Environmental Research Center®

Conclusions

- 1000 ppm Cl addition (no PAC) at Hawthorn provided an 80%+ Hg capture for 6 hours.
- >90% Hg capture was possible (for short periods of time) using SEA2 and PAC.
- >90% REDUCTION is possible with SEA2 T2.

EERC
Energy & Environmental Research Center®

Phase III Project

EERC
Energy & Environmental Research Center®

Project Overview

- Goals & Objectives
  - To demonstrate 90% REDUCTION in mercury emissions at Hawthorn Unit 5 and Mill Creek Unit 4.

EERC
Energy & Environmental Research Center®

Sites

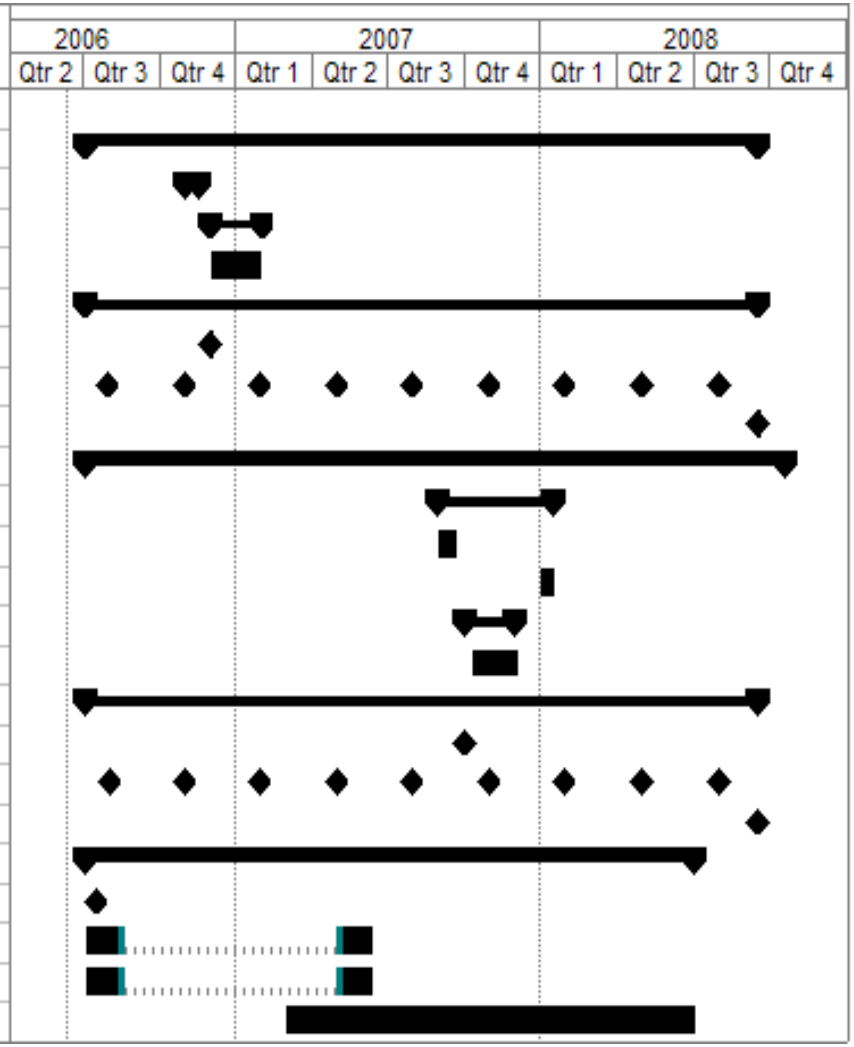
Plant	Utility Owner	Coal	Boiler Type	Boiler Size, MW	Particulate Control	SO_2 Control	NO_x Control
HAW5	KCP&L	PRB	Wall-fired	550	FF	SDA	LNB[1], OFA[2], SCR
MC4	LG&E	Eastern bituminous	Wall-fired	530	ESP/SCA= 232	Wet FGD	LNB, SCR

[1] Low-NO_x burners.
[2] Overfire air.

EERC
Energy & Environmental Research Center®

Task Structure/Schedule

Task Name
Task Name
Task 1. Hawthorn Unit 5 (HAW5)
1.1 Parametric Tests
1.2 Longer-Term Tests
Ontario Hydro Sampling (Three 1-week occurances during a 2-month period)
1.3 Management and Reporting
Site Report - Go/No Go
Quarterly Reports
Project Final Report
Task 2. Mill Creek Station Unit 4 (MC4)
2.1 Parametric Tests
Parametric/Baseline SCR On
Parametric/Baseline SCR Off
2.2 Longer-Term Tests
Ontario Hydro Sampling (Three 1-week occurances during a 2-month period)
2.3 Management and Reporting
Site Report - Go/No Go
Quarterly Reports
Project Final Report
Task 3. Project Planning
Kick-off Meeting
Test Plan Development
QA/QC Plan Development
Data Reduction/Analysis



Test Plan for Hawthorn

- Based on previous work the test plan for Hawthorn will concentrate on the following technologies:
  - SEA 1 Only
  - SEA 1 + PAC
  - SEA 2 T2

EERC
Energy & Environmental Research Center®

Previous Data-Mill Creek Unit 4

Sample Location	SCR Inlet, µg/Nm^3	SCR Outlet, µg/Nm^3	wet-FGD inlet, µg/Nm^3	Stack, µg/Nm^3	Removal %
With the SCR in Service					
Hg^p	0.02	0.03	0.00	0.00	
Hg^0	8.32	2.83	0.33	3.97	
Hg^{2+}	0.94	5.05	7.60	0.54	
Hg_{total}	9.27	7.90	7.93	4.50	**43.3**
With the SCR Bypassed					
Hg^p			0.07	0.05	
Hg^0			2.44	2.63	
Hg^{2+}			6.79	0.55	
Hg_{total}			9.30	3.23	**65.3**

EERC
Energy & Environmental Research Center®

Mill Creek Unit 4 Cont.

- Mill Creek offers challenges with the SCR in service!
  - Possibly due to reactions with sulfur species.
  - Lower halogen levels in scrubber?
- SEA2 T2 will be primary technology tested at Mill Creek.
- B&W Re-emission additive will also be added to scrubber, if necessary.

EERC
Energy & Environmental Research Center®

Mill Creek Test Plan

- Parametric study with SCR in and out of service.
- Two Month demonstration with the SCR in service.
- Plan to be developed upon completion of negotiations with plant.

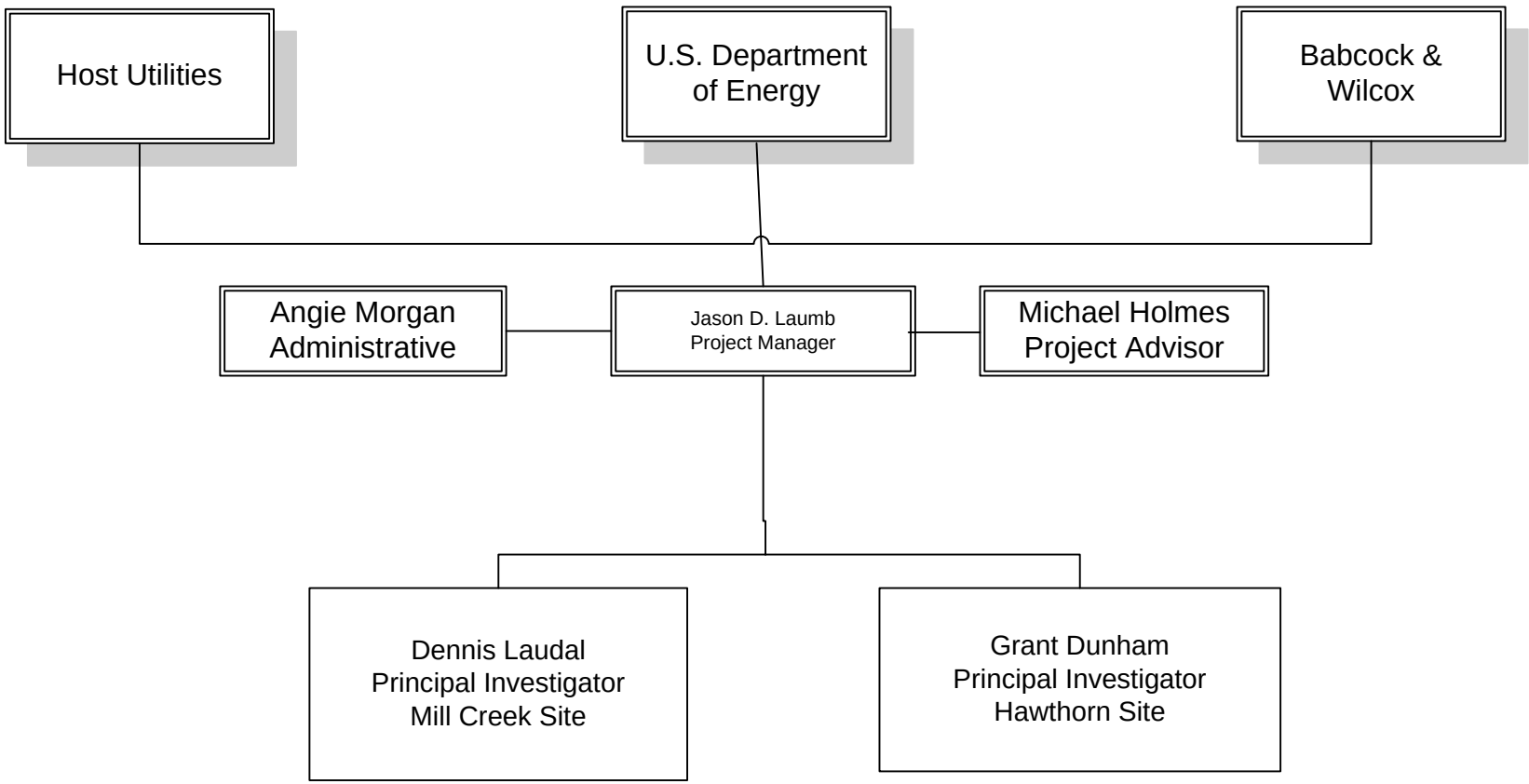
EERC
Energy & Environmental Research Center®

Sampling Locations (Both Sites)

- Continuous Mercury Monitors – PCD inlet and stack for parametric tests. Stack only for long-term.
- Ontario Hydro – PCD inlet and stack for parametric tests and long term.
- Solid Samples – Daily coal, ash, slurry samples during parametric. Three per week during long term.
- EPA Method 5 – PCD inlet & stack?

EERC
Energy & Environmental Research Center®

Personnel



EERC
Energy & Environmental Research Center®

Hawthorn Coal Results

Parameters, Unit	9/18/2006	9/19/2006	9/20/2006	Average	Standard Deviation
Mercury, ppm (dry)	0.114	0.106	0.105	**0.108**	0.005
Proximate					
Moisture, wt%	19.1	20.6	20.9	20.20	0.964
Volatile Matter, wt%	34.86	34.22	34.14	34.41	0.395
Fixed Carbon, wt%	40.66	40	39.75	40.14	0.470
Ash, wt%	5.38	5.18	5.21	5.26	0.108
Ultimate Analysis					
Hydrogen, wt%	6.12	6.1	6.1	6.11	0.012
Carbon, wt%	55.17	54.06	53.6	54.28	0.807
Nitrogen, wt%	1.05	0.97	0.96	0.99	0.049
Sulfur, wt%	0.45	0.38	0.5	0.44	0.060
Oxygen, wt%	31.83	33.32	33.62	32.92	0.959
Heating Value, Btu/lb	9613	10942	9365	9973	848
Calculated Parameters					
$F_{d,}$ dscf/10^6Btu	9636	8238	9542	9139	782
Sulfur, wt% (dry)	0.56	0.48	0.63	0.56	0.077
Heating Value, Btu/lb (dry)	11883	13781	11839	12501	1109
Hg, µg/Nm3 (flue gas basis)	13.67	12.82	12.76	**13.08**	0.509
Hg, lb/Tbtu (flue gas basis)	9.59	7.69	8.87	8.72	0.960

EERC
Energy & Environmental Research Center®

Hawthorn Baseline Results

- **Baseline Hg measurements indicate a native Hg capture average of 17.8 %***
- **Coal and OH inlet measurements are consistent.**
- **CMM inlet and outlet measurements tend to be low for the baseline period when compared to OH and Coal results, but agree well during Hg control technology testing**

Date	Test Description	Coal (Inlet) μg/Nm^3	CMM Inlet μg/Nm^3	OH Inlet μg/Nm^3	CMM Outlet μg/Nm^3	OH Outlet μg/Nm^3	Coal-to-Stack Hg Removal, %	
							OH	CMM
9/18/2006	Baseline	13.67	7.23	14.28	8.7	11.37	16.9	36.4
9/18/2006	Baseline	13.67	7.52	13.61	8.64	10.86	20.5	36.8
9/19/2006	Baseline	12.82	6.24	11.27	8.28	10.54	17.8	35.4
9/19/2006	Baseline	12.82	6.93	12.67	8.64	10.78	15.9	32.6

*Coal inlet to OH outlet basis

EERC Energy & Environmental Research Center®

Hawthorn SEA1 Results

- **Testing of SEA1 occurred during 9/20/06-9/22/06**
- **Results indicate a positive effect on Hg capture when compared to baseline removals.**
- **Hg removal efficiencies appear to only slightly increase with increasing SEA1 rate.**

Date	Test Description	Coal (Inlet) μg/Nm^3	CMM Inlet μg/Nm^3	OH Inlet μg/Nm^3	CMM Outlet μg/Nm^3	OH Outlet μg/Nm^3	Coal-to-Stack Hg Removal, %	
							OH	CMM
9/18/2006	Baseline	13.67	7.23	14.28	8.7	11.37	16.9	36.4
9/18/2006	Baseline	13.67	7.52	13.61	8.64	10.86	20.5	36.8
9/19/2006	Baseline	12.82	6.24	11.27	8.28	10.54	17.8	35.4
9/19/2006	Baseline	12.82	6.93	12.67	8.64	10.78	15.9	32.6
9/20/2006	SEA1 Only (600 ppm)	12.76	11.54	12.46	3.72	4.67	63.4	70.8
9/21/2006	SEA1 Only (800 ppm)	13.08	12.93	12.15	4.12	4.53	65.4	68.5

EERC
Energy & Environmental Research Center®

Hawthorn SEA 1 + PAC Results

Additive Rate	CMM IN:OUT	CMM Coal to Stack	OH Coal to Stack
PAC 3.3 lb/Macf SEA1 800 PPM	59.5%	69.6%	
PAC 3.3 lb/Macf SEA1 1000 PPM	64.3%	73.9%	85.0
PAC 3.9 lb/Macf SEA1 1000 PPM	73.3%	80.5%	
PAC 3.6 lb/Macf SEA1 1200 PPM	80.3%	82.5%	
PAC 3.9 lb/Macf SEA1 1200 PPM	89.7%	88.3%	96.0
PAC Hg LH 3 lb/Macf SEA1 1200 PPM	90.2%	91.1%	94.0

EERC
Energy & Environmental Research Center®

Hawthorn SEA2 T2 Results

Additive Rate	CMM IN:OUT	CMM Coal to Stack	OH Coal to Stack
PAC 3 lb/Macf SEA2 0.07 lb/lb PAC	78.7%	79.1%	
PAC 2.8 lb/Macf SEA2 0.14 lb/lb PAC	83.6%	83.5%	85.0

EERC
Energy & Environmental Research Center®

Conclusions

- Baseline removals at Hawthorn are considerably more variable than previous work.
  - Different coal?
- Preliminary results with $CaCl_2$ are also different (lower) from previous work.
  - Catalyst age?
  - Different coal?

EERC
Energy & Environmental Research Center®

Future Work

- Address issues associated with different PRB coals at Hawthorn.
- Perform an additional set of parametric tests with SEA1 + PAC and SEA2 T2 while firing a consistent fuel.
- Hawthorn long-term monitoring.
- Mill Creek site assessment.

EERC
Energy & Environmental Research Center®

Acknowledgments

- Electric Power Research Institute, Kansas City Power & Light, Otter Tail Power Company, Dynegy, Pacificorp, Ameren UE, Southern Company, Texas Genco, The Babcock & Wilcox Company, Wisconsin Public Service, Cormetech, Norit, and the U.S. Department of Energy National Energy Technology Laboratory

EERC
Energy & Environmental Research Center®