EERC Technology… Putting Research into Practice

Mercury Control Technology R&D Program Review

Enhancing Carbon Reactivity for Mercury Control in Coal-Fired Power Plants: Results from Lewis and Clark, and Stanton Stations

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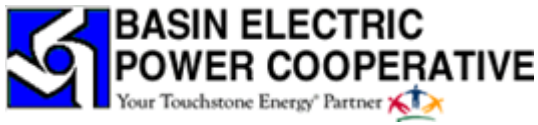
Members of the Lignite-Based Consortium

North Dakota Industrial Commission



Westmoreland Coal

Program Objectives

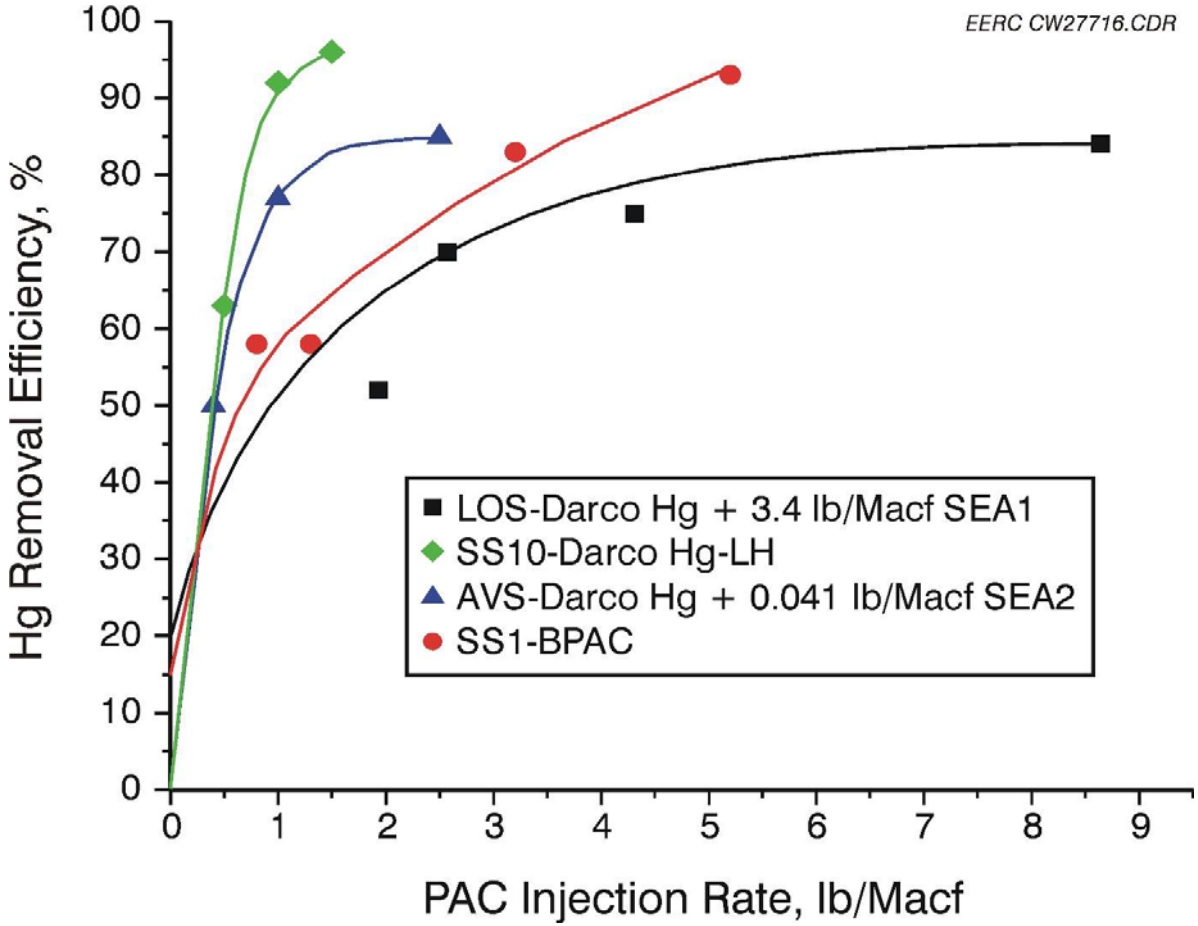
- To demonstrate two enhanced sorbent injection technologies (treated carbons and SEA with carbon) to obtain greater than 55% Hg removal.
  - Evaluate balance-of-plant impacts
  - Conduct economic analysis of options

General Site Information

Plant	Coal	Boiler Type	Boiler Size[1], MW	Particulate Control	SO_2 Control
LOS1[2]	Lignite–PRB Blend	Wall fired	220 (110)	ESP[3] SCA[4]=320	None
SS10	Freedom	Tang. fired	60	FF[5]	Spray dryer
AVS1	Freedom	Tang. fired	440	FF	Spray dryer
SS1	PRB[6]	Wall fired	140 (70)	ESP SCA=470	None
Lewis & Clark	Savage lignite	Tang. fired	60	Mech. collector	Wet FGD

1 Total size of the boiler with the value in parenthesises 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^2/1000 acfm.
5 Fabric filter.
6 Stanton Station switched from lignite to PRB coal in 2005.

Parametric Test Results – All Sites



Outline

- Testing at the Lewis and Clark Station
  - Baseline testing
  - Parametric testing
  - Longer-term testing
- Extended-duration testing at Stanton Station

Goal

- The goal of the testing at the Lewis and Clark Station was to evaluate enhanced PAC injection for Hg control of ≥75%.

- Lewis and Clarks Goals
  - Demonstrate >90% Reduction
    - Montana's proposed regulations

Lewis and Clark Plant Configuration

- Year built:1958
- Output: 60 MW_g
- Coal type: Savage lignite
- Particulate control: mechanical cyclone separator
- Additional particulate and sulfur control: wet flue gas desulfurization (WFGD)

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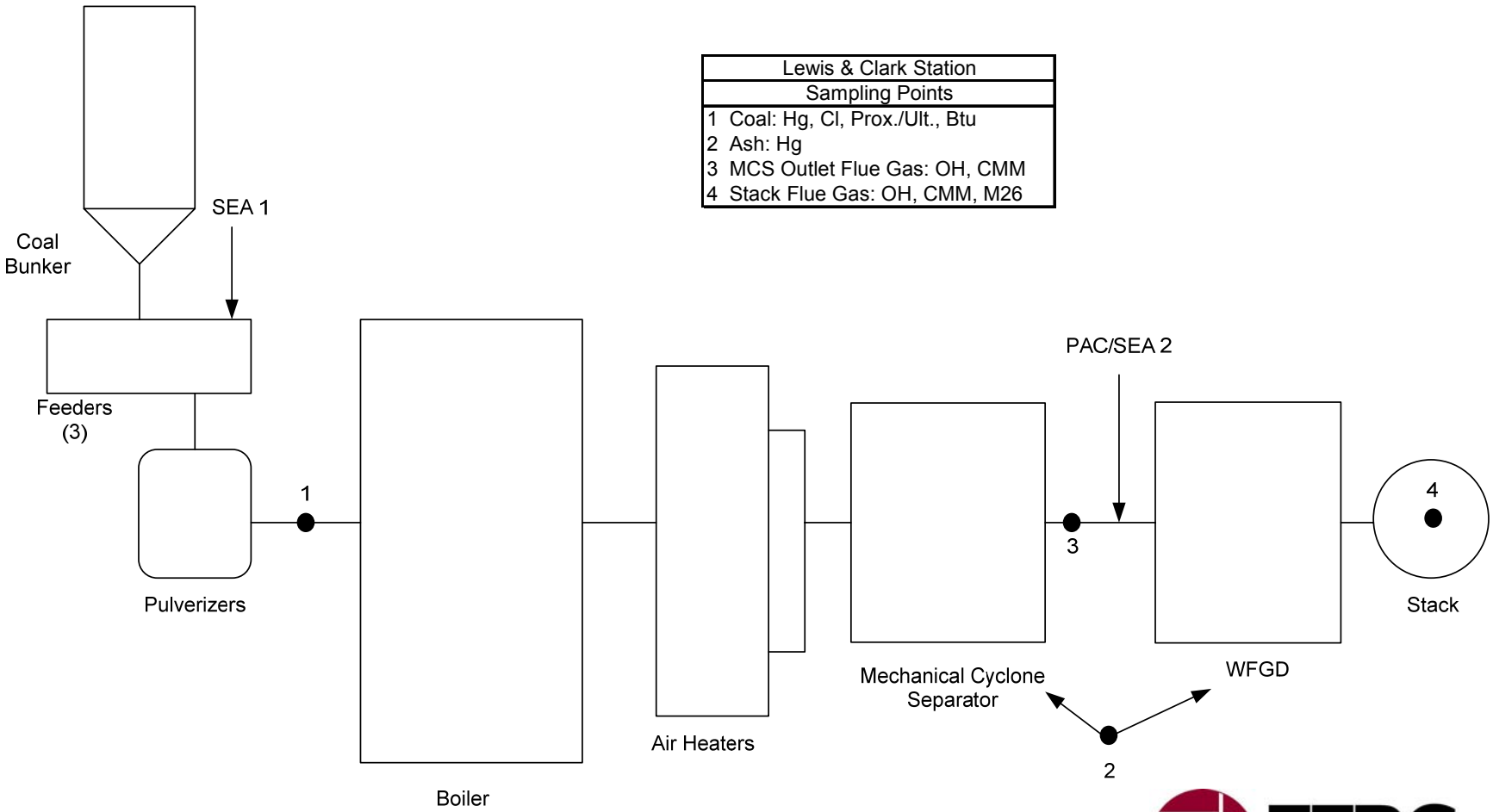
Injection and Measurement Locations



EERC Slipstream Baghouse

- Twelve 6-inch FFs.
- Bag lengths up to 12 feet.
- Approximately 226 ft^2 of filtration area.
- Variable-speed fan is used to draw between 450 and 2700 acfm of flue gas.
- 2700 acfm ~1 % of Lewis and Clarks total flow.

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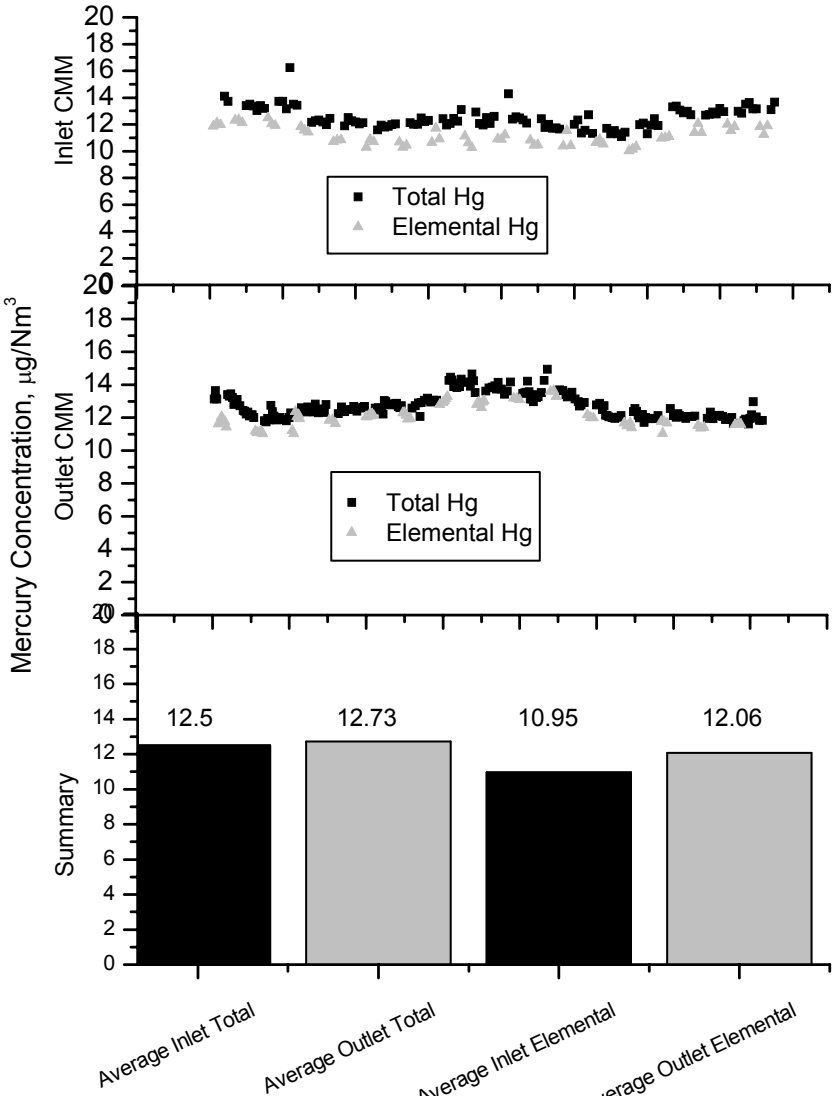
Baseline Testing Results

Lewis and Clark Baseline Testing*



*Gas Phase Hg Only

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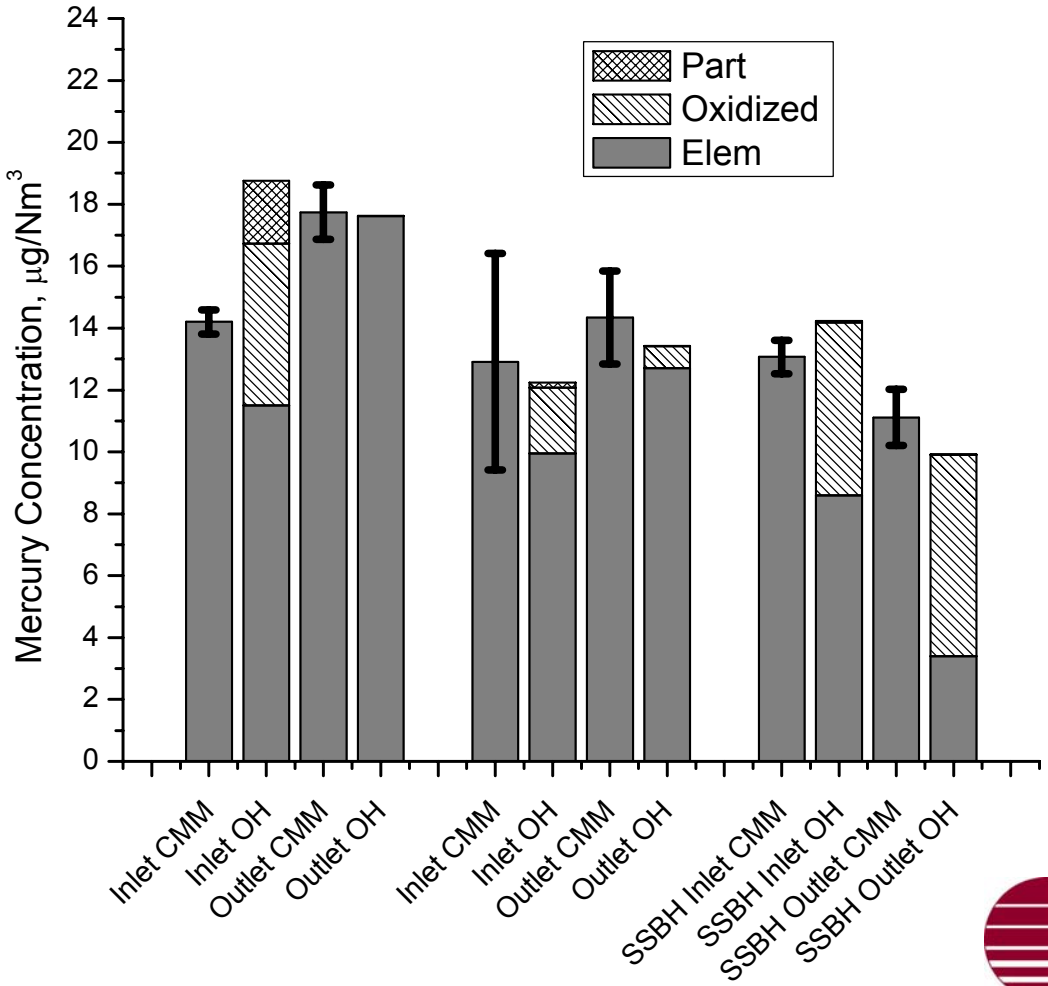
Baseline OH Results



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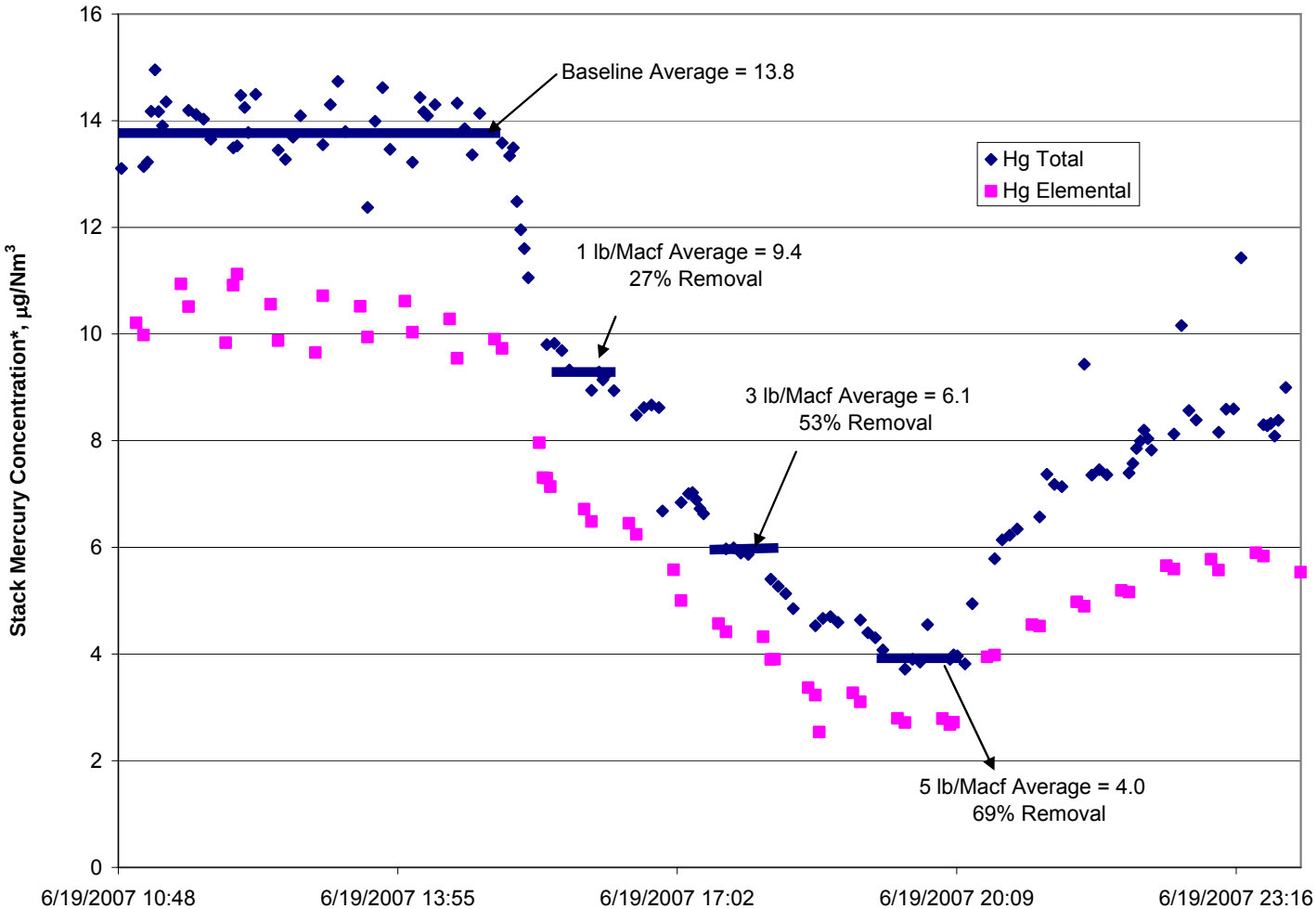
Parametric Testing Results

PAC (Darco Hg) Injection



*Represents gas phase Hg only.

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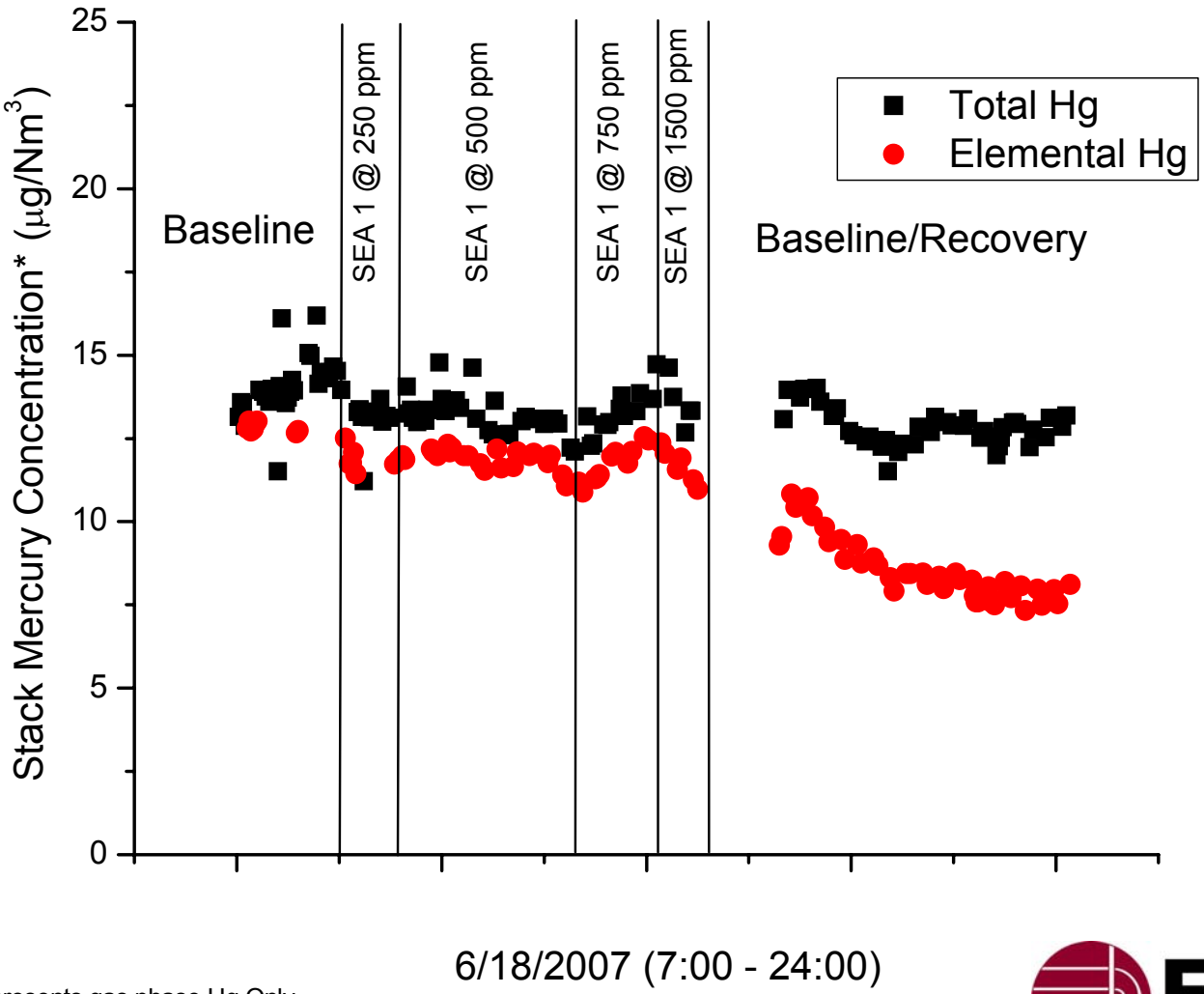
SEA1 Injection*



*Represents gas phase Hg Only

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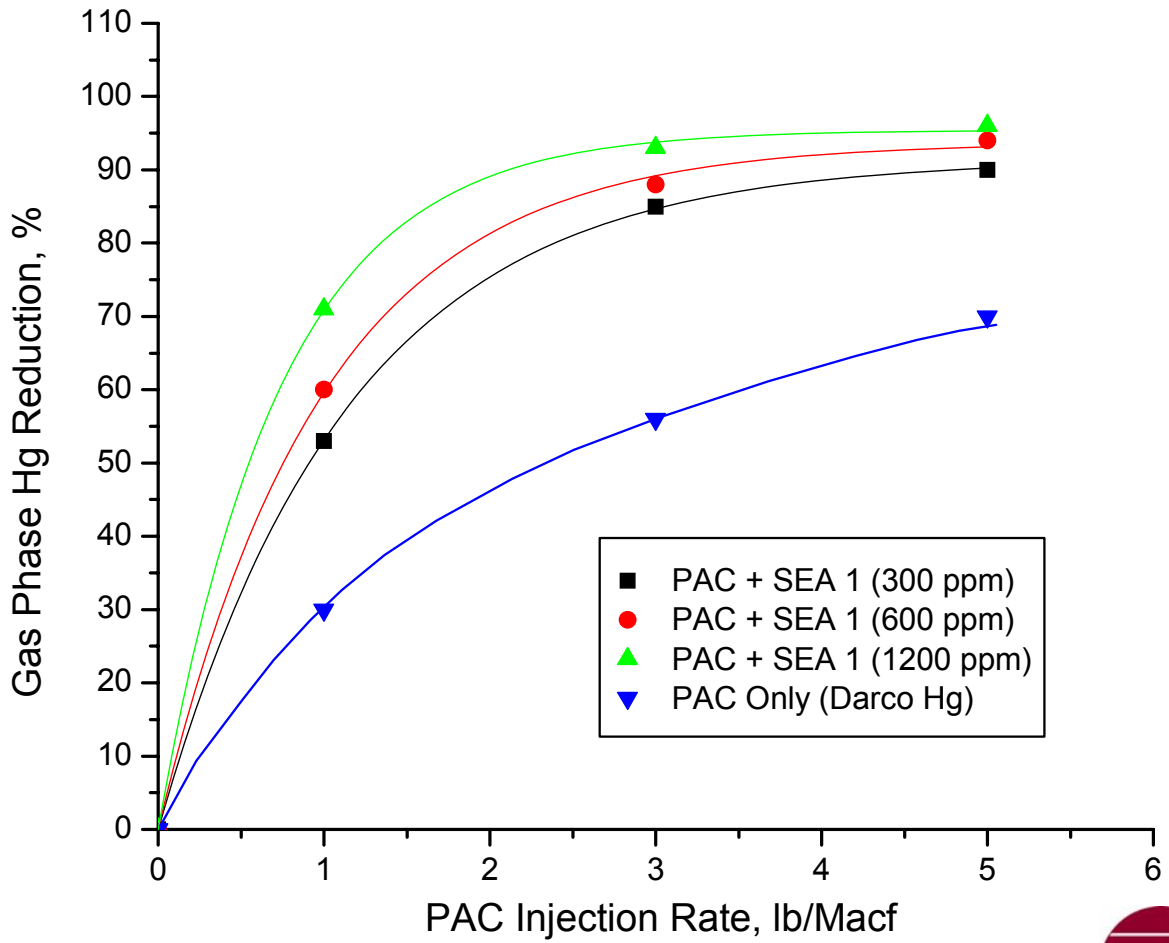
SEA1 + PAC Injection



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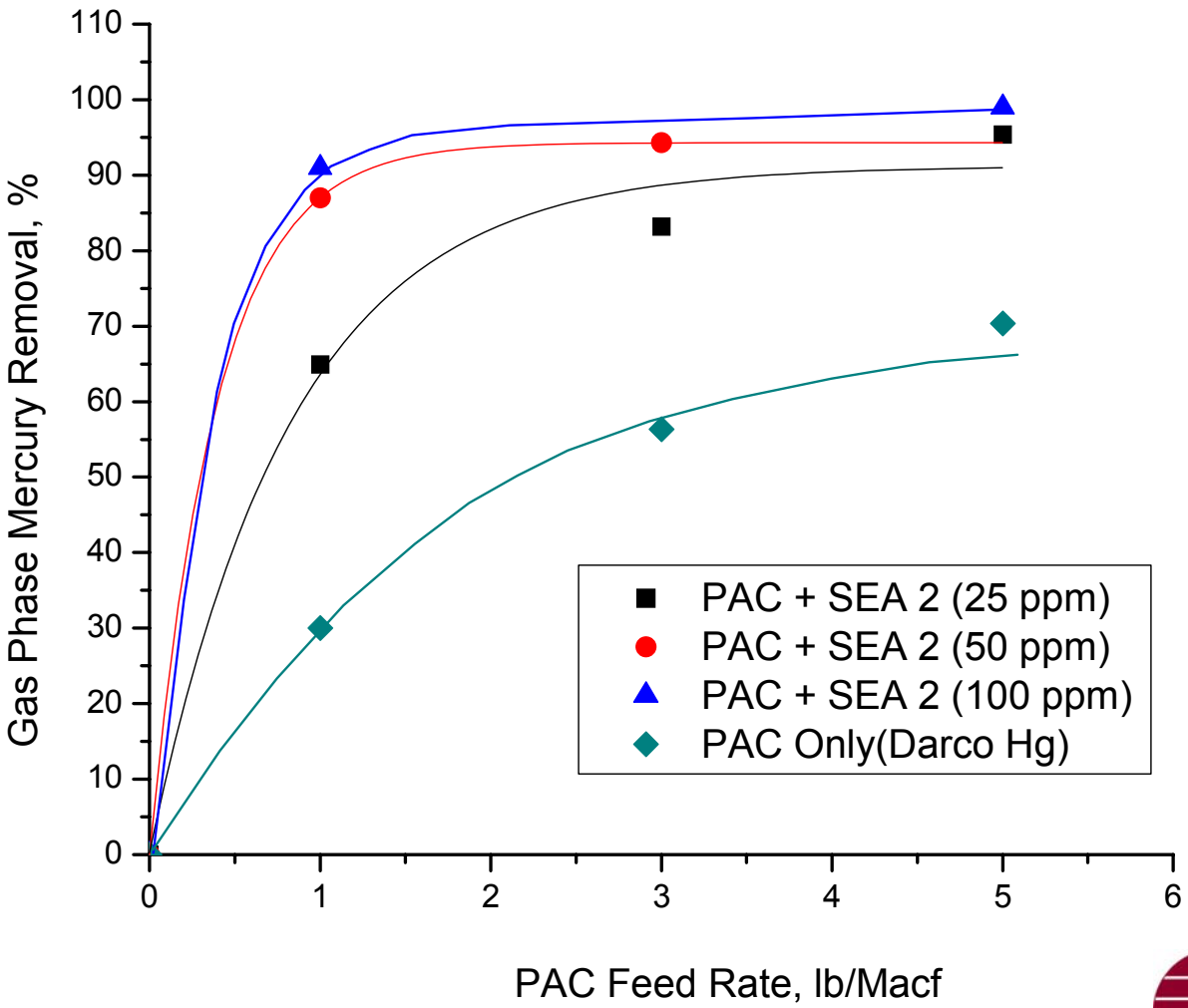
SEA2 + PAC Injection



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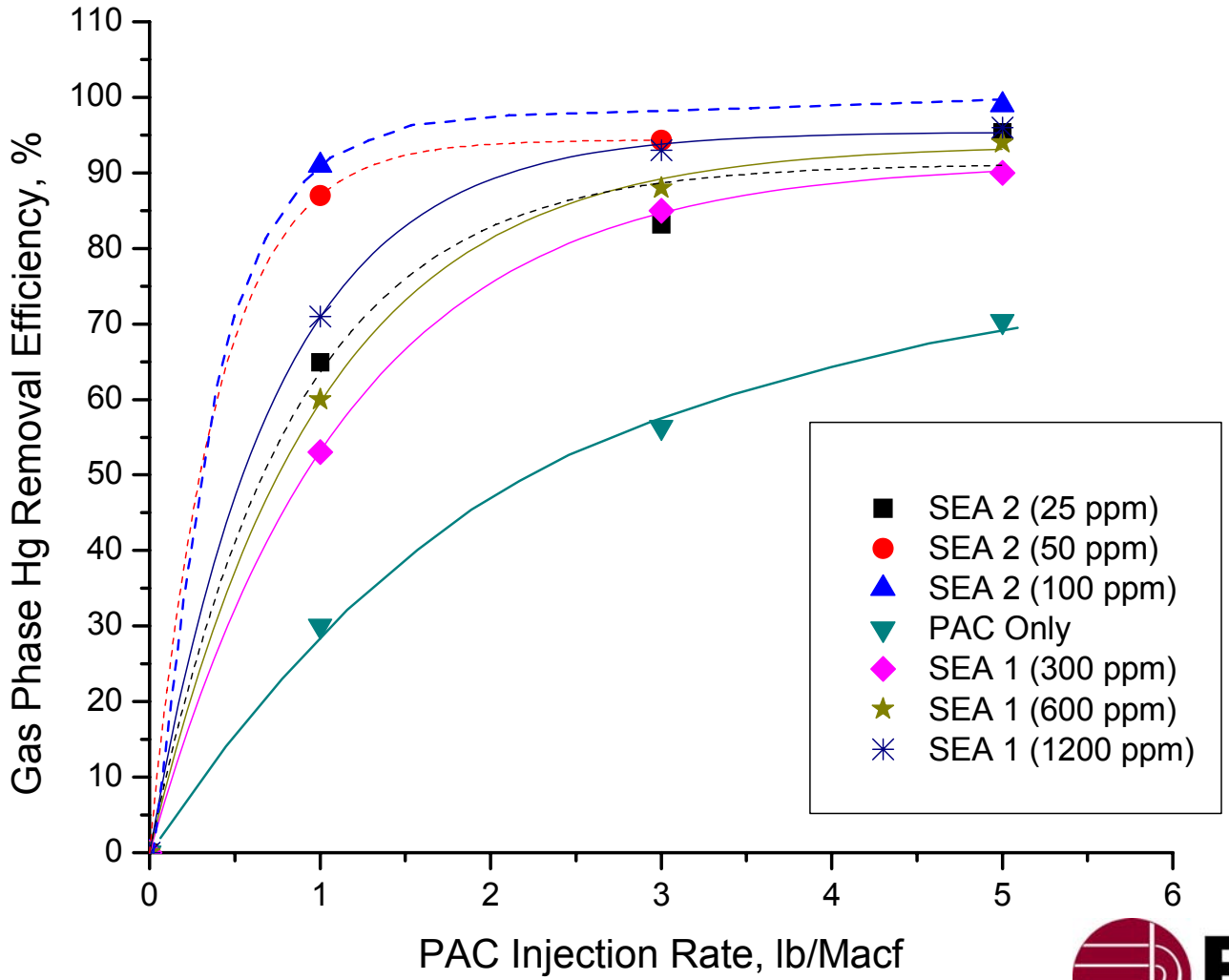
Comparison of SEA1 and SEA2



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Longer-Term Testing Results

Longer-Term Testing

Date	Condition	PAC Rate, lb/Macf	SEA 2 Rate, ppm	Hg Removal Efficiency, %
7/11/2007	Baseline	0	0	9.1
	PAC Only	1	0	19
	PAC + SEA 2	1	25	43
	PAC + SEA 2	3	38	91
7/12/2007	PAC Only	3	0	60
	PAC + SEA 2	1	50	96
	PAC + SEA 2	2	50	95
	PAC + SEA 2	1	50	87
7/13/2007	PAC + SEA 2	1	75	88
	PAC + SEA 2	1	88	68
	PAC + SEA 2	1.5	88	87
	PAC + SEA 2	2	88	92
	PAC + SEA 2	2	50	87
Phase 1 Overall				**79**
Phase 1 PAC + SEA2				**84**
7/23/2007	Baseline	0	0	-1.4
7/24/2007	Baseline	0	0	1.1
	PAC Only	3	0	34
	PAC + SEA 2	3	50	94
	PAC + SEA 2	2	50	92
	PAC + SEA 2	2.5	50	91
7/25/2007	PAC + SEA 2	3	50	93
	PAC Only	3	0	75
Phase 2 Overall				**89**
Phase 2 PAC + SEA2				**92**

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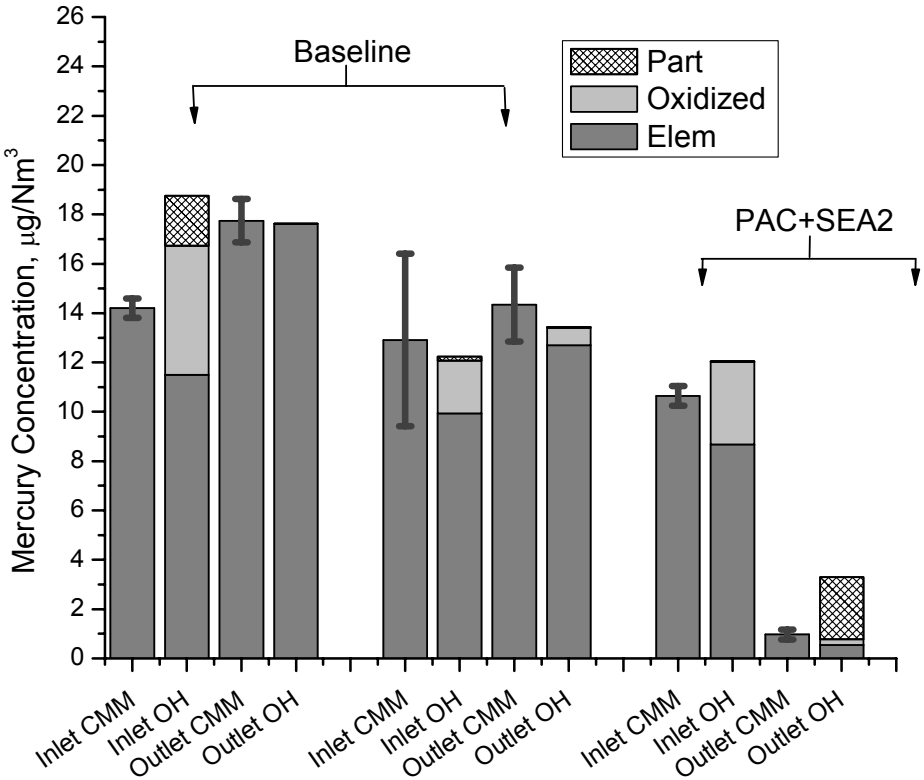
CMM/Ontario Hydro Comparison



- Gas-phase Hg concentrations agreed very well.
- Particulate-phase Hg noticed during longer term injection of PAC + SEA2.
- Ontario Hydro (OH)-based % removal = 73%

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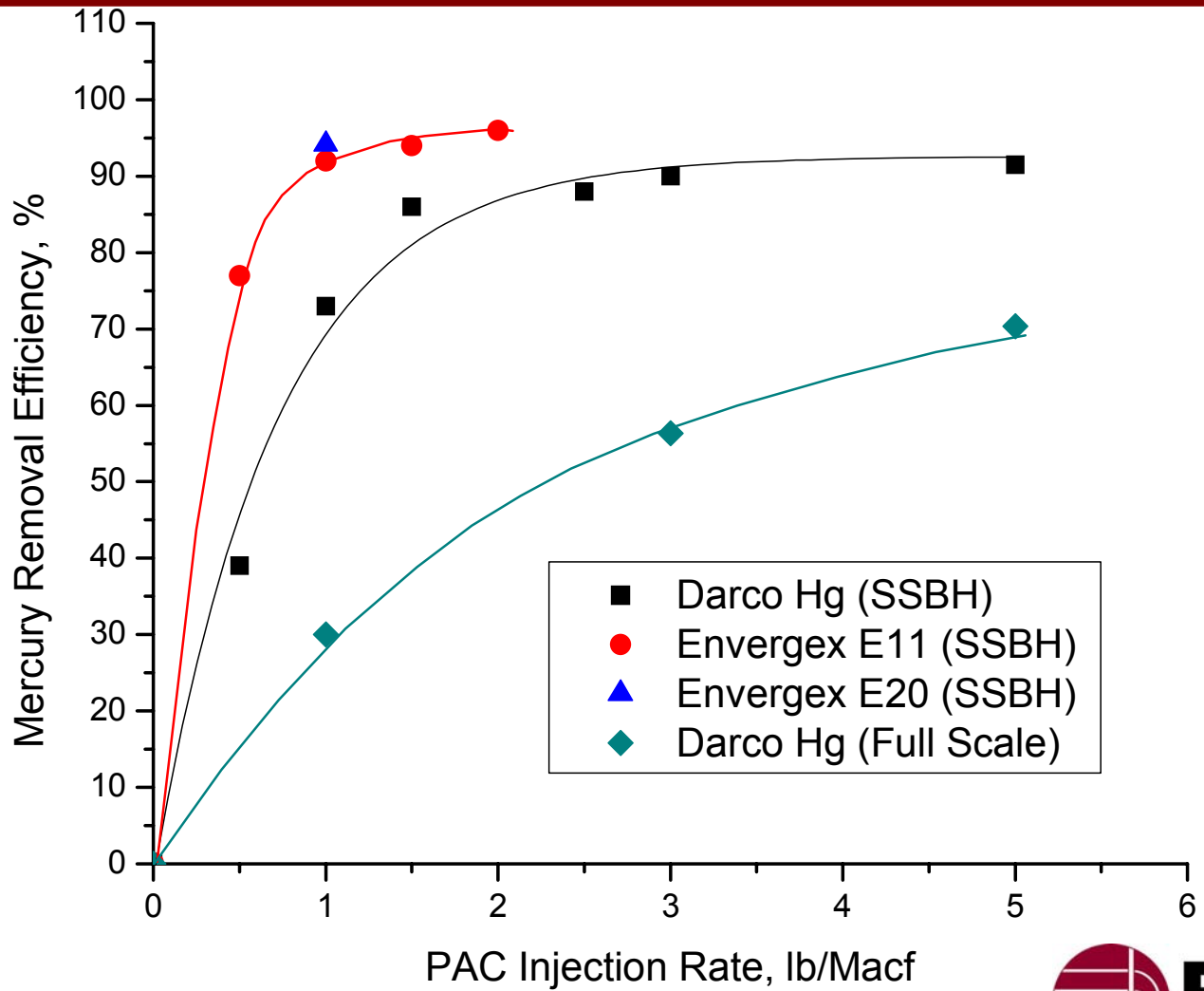
SSBH PAC-Only Results



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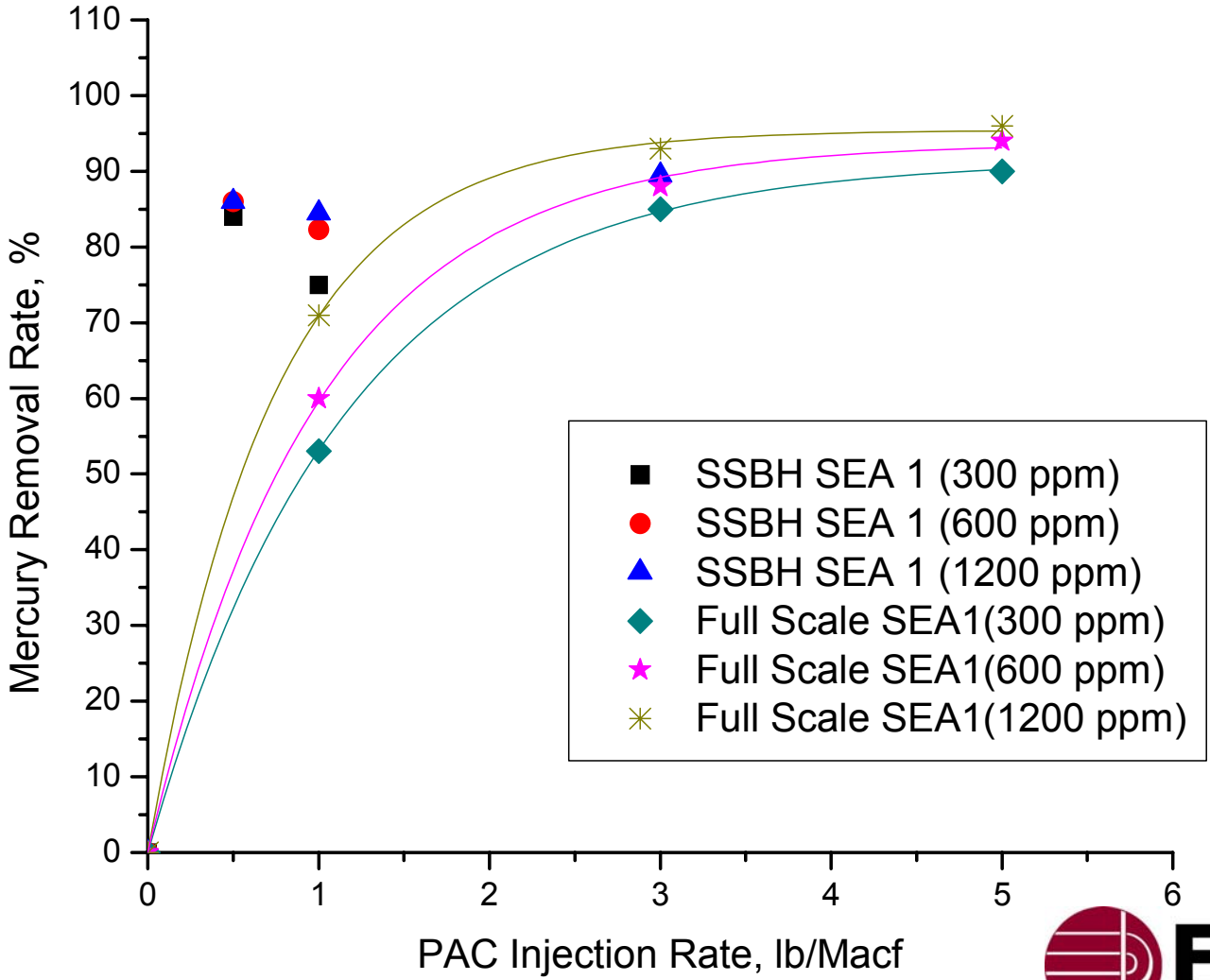
SSBH SEA1 + PAC Results



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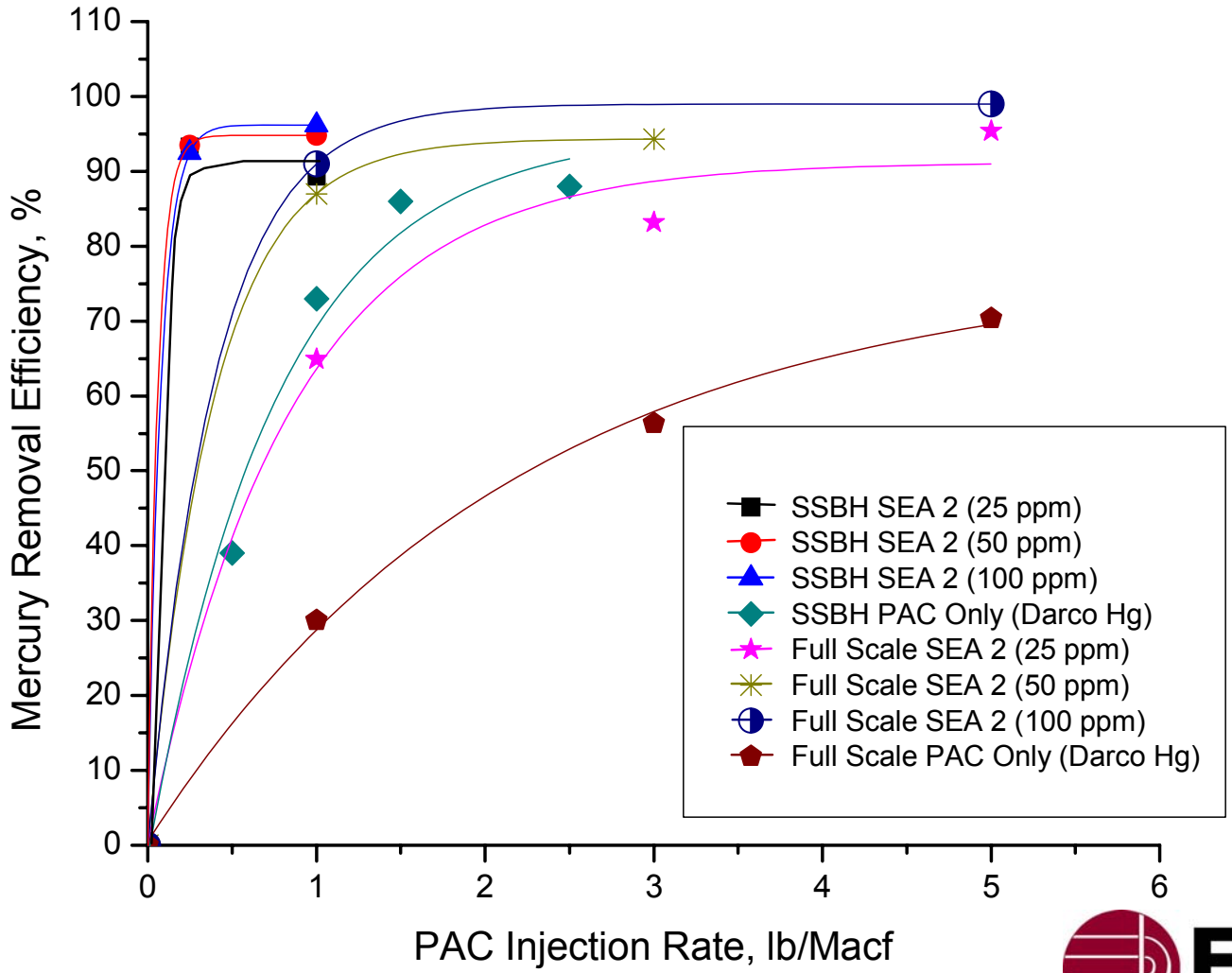
SSBH SEA2 + PAC Results



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Baseline Conclusions

- The average CMM concentration measured at the cyclone outlet (WFGD inlet) was 12.5 μg/dNm^3, which was very similar to CMM measurements at the stack averaging 12.73 μg/dNm^3.

- Based on baseline Hg measurements, it was apparent that no native or natural capture was occurring across the WFGD.

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Parametric Testing Conclusions

- Parametric testing occurred during a 1-week period from 6/17/07 to 6/21/07.

- The injection of untreated PAC (Darco Hg) alone enhanced Hg reduction from essentially 0% during baseline to 69% at a PAC injection rate of 5lb/Macf.

- SEA2 performed better than SEA1, yielding results of >90% gas-phase Hg removals at rates much lower than that of SEA1.

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SSBH Conclusions

- The SSBH outlet baseline concentrations indicated a slight natural capture across the system of ~15%.

- SSBH results indicated similar trends, but much higher Hg removal efficiencies at lower rates than the full-scale results. This was caused by the baghouse's ability to facilitate longer reaction times for the Hg–carbon reaction to occur.

- The best-performing technology tested during SSBH parametric testing was the addition of SEA2 with the injection of PAC (PAC + SEA2).

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Longer-Term Testing Conclusions

- Two longer-term test periods occurred 7/10/07–7/13/07 and 7/2307–7/25/07.
- The average gas-phase Hg removal for the first phase of longer-term testing was 79.4% overall and 84.2% for the PAC + SEA2 periods only.
- The average gas-phase Hg removal for the second phase of longer term testing was 89% overall and 92.4% for the PAC + SEA2 periods only.
- Particulate-phase Hg exiting the stack increased because of the fine PAC particles not being captured by the WFGD. Because of this, Hg removals greater than 75% were not obtained in the full-scale system when OH results including the particulate-phase Hg were used in the calculations.

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Stanton Station Testing

Stanton 2007 Long-Term ACI Program (Status)

- No baseline removal across ESP
  - Baseline inlet HgT = 4.8 µg/Nm^3, 8% oxidized
  - Baseline outlet HgT = 5.2 µg/Nm^3, 12% oxidized
- 60-day continuous injection upstream of ESP of Norit's DARCO Hg-LH at 1.9 lb/Macf
  - Inlet Hg monitored primarily by coal, with limited vapor-phase measurements
  - Outlet Hg monitored with CMM: ranged from 0.5 to 5.0 µg/Nm^3
  - Waiting on coal Hg data to calculate Hg removal across ESP
  - Twice weekly ash was collected to be analyzed for carbon and mercury content by URS Laboratories.
  - Headwaters will do chemistry via XRF, fineness via Horiba, LOI, LECO carbon analysis, C109 strength, and foam Index

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