EERC Technology… Putting Research into Practice

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

DOE/NETL's

Mercury Control Technology R&D Program Review

Presented by:

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Members of the Lignite-Based Consortium

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A Division of MDU Resources Group, Inc.

THE NORTH AMERICAN COAL CORPORATION

TXU

Apogee Scientific

Minnkota Power
MPC COOPERATIVE, INC.

Westmoreland Coal

OTTER TAIL POWER COMPANY

BNI COAL

SaskPower

Overview

- Project Goals and Objectives
- Site Descriptions
- Mercury Speciation – oxidation additives
- Preliminary Results – ND Lignite fired Milton R. Young Plant
  - Baseline Testing
  - Parametric Testing
  - Month Long Testing
- Conclusions

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Goals and Objectives

- Overall project goal
  - Test a mercury oxidation technology for controlling mercury emissions at two lignite-fired power plants equipped with wet FGD systems.
- Objectives
  - Determine effectiveness of mercury oxidation and removal for different boiler and lignite types.
  - Examine mercury removal efficiencies, economics, and balance of plant impacts.

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Specific Objectives

- Determine the impact of chemical addition on mercury speciation and overall mercury removal from flue gas using the combination of an electrostatic precipitator and a wet scrubber.
- Test the mercury removal technology
  - North Dakota lignite-fired unit at Minnkota Power's Milton R. Young Unit 2.
  - Texas lignite-fired unit at TXU Energy's Monticello Unit 3.
- Measure baseline mercury speciation and removal.
- Measure mercury speciation and removal with the control technology.
- Evaluate the variability of mercury removal and emissions.
- Determine the balance-of-plant effects.
- Perform a preliminary economic evaluation.

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General Site Information

Plant	Coal	Boiler Type	Boiler Size, MW	Particulate Control	SO_2 Control
MRY Unit 2	Kinneman Creek and Hagel	Cyclone	450	ESP[1] SCA[2]=375	Wet FGD[3]
Monticello Unit 3	Texas/Upper and Lower Wilcox	Pulverized coal wall-fired	750	ESP SCA=900	Wet FGD

1 Electrostatic precipitator.
2 Specific collection area, ft^2/1000 acfm.
3 Flue gas desulfurization

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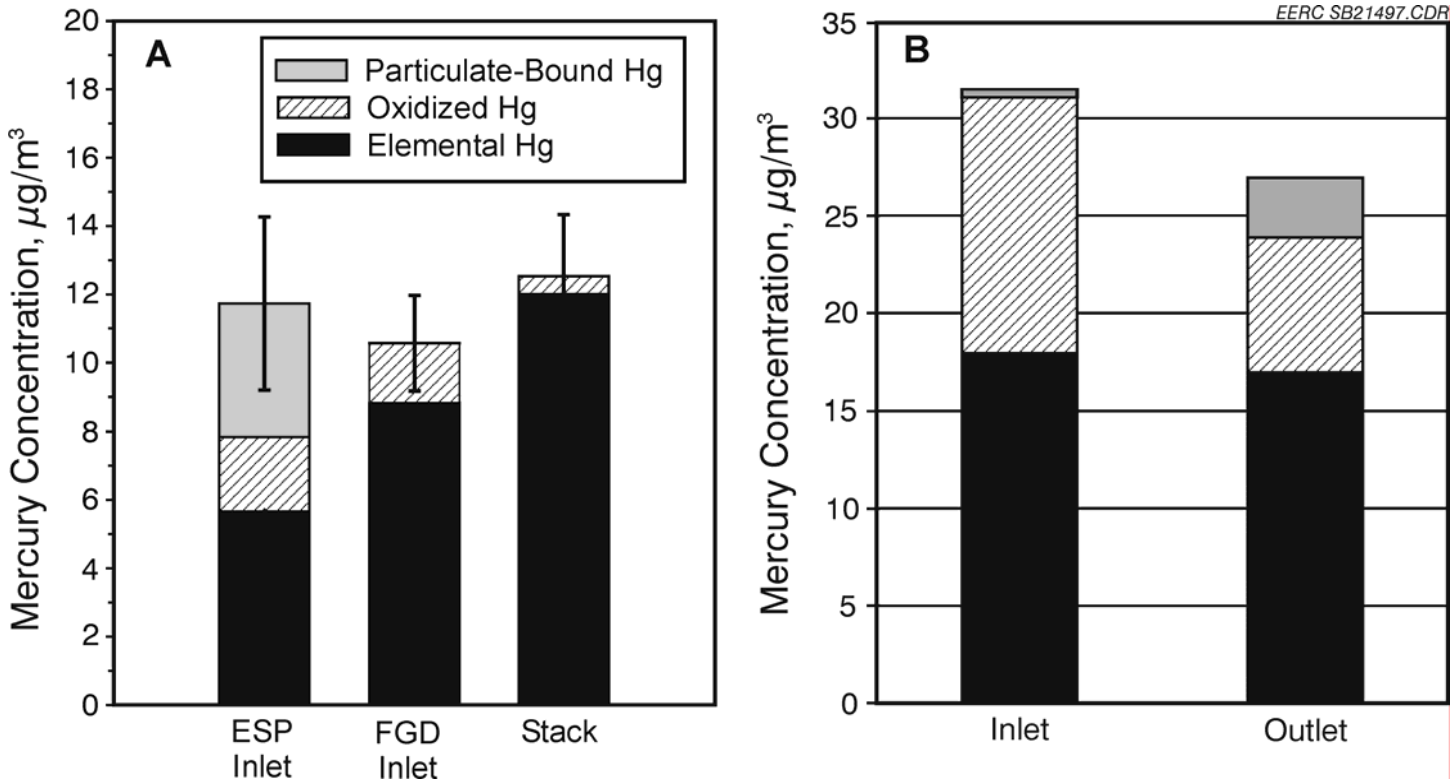
Mercury Speciation

(a) Milton R. Young and (b) Monticello



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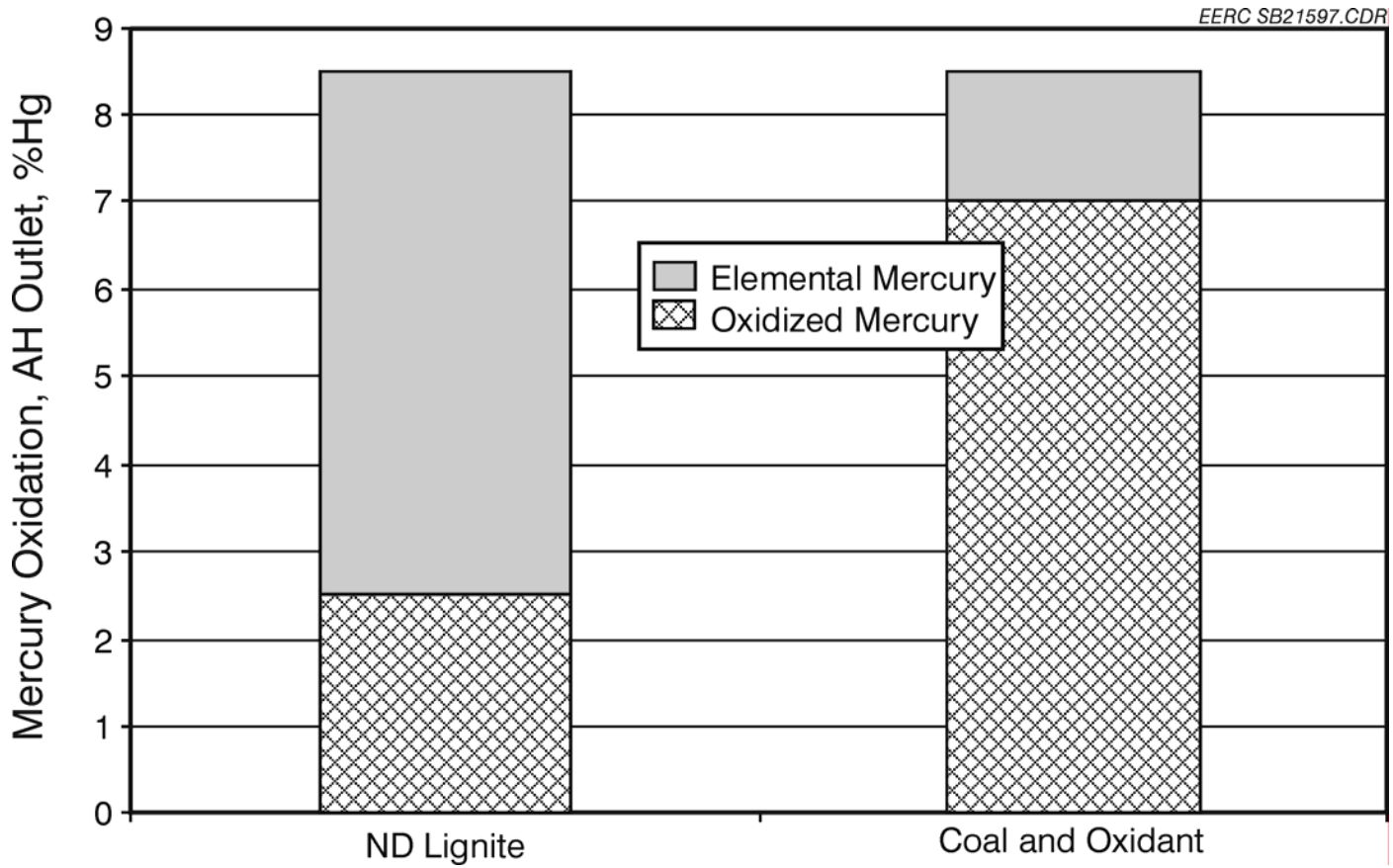
Hg Speciation with Chlorine Additives



Oxidation of mercury through the addition of chlorine-containing additive to coal in EERC pilot-scale testing.

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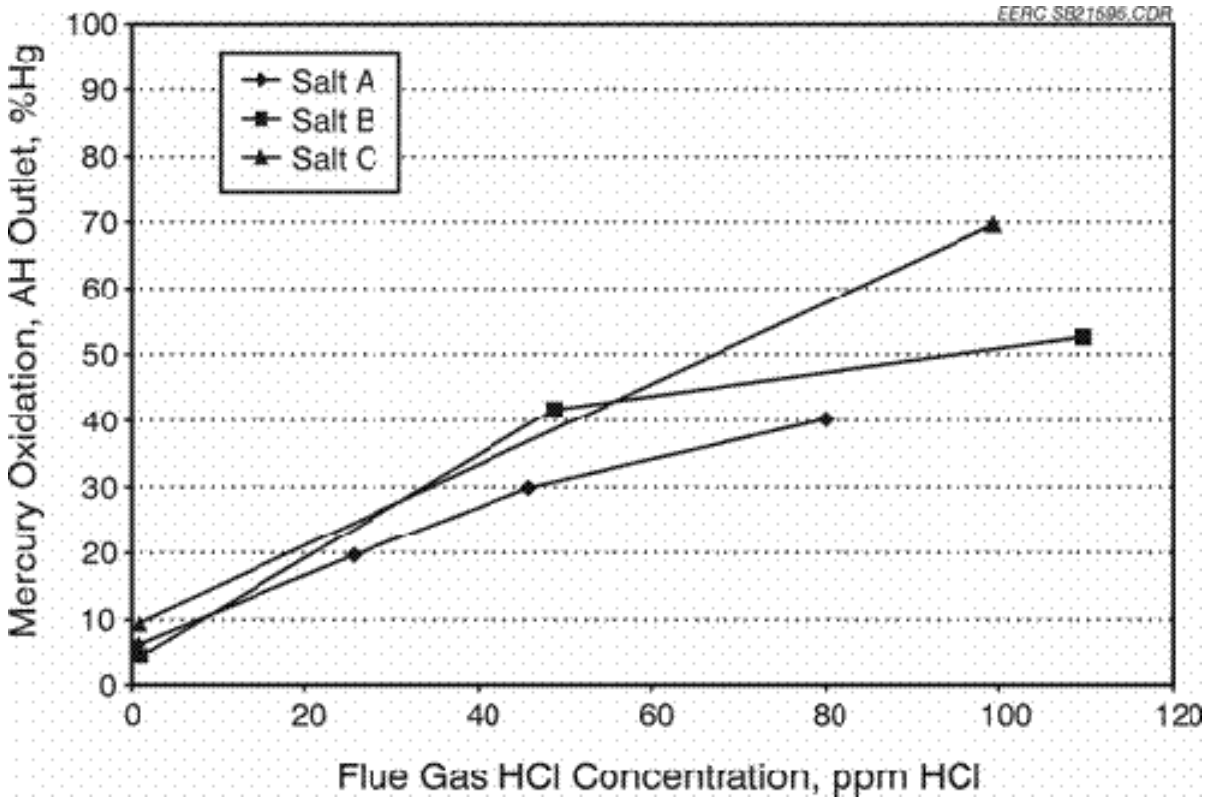
Mercury oxidation and HCl flue gas content for a range of salt injections at a ND lignite-fired power plant



Chang, R.; Strohfus, M. *The Evaluation of Chemical Additives for Mercury Emission Control at Great River Energy*; Final Report for the North Dakota Industrial Commission; Jan 2003.

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M.R. Young Test Plan

- Target mercury removal is 55% or more from baseline conditions (from 12.2 to 5.5 lb/TBtu).
- Parametric testing
  - SEA1 ($CaCl_2$)
  - $CaCl_2$ + Darco-Hg (AC)
  - $MgCl_2$
  - SEA2 (proprietary)
  - SEA2 + AC
- Month-long testing
  - SEA2
  - SEA2 + AC

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Additive Injection and Measurements

- Additive injection
  - Chemical additives injected into coal pipes feeding 4 of 12 cyclones
  - AC injected at ESP inlet
- Mercury measurements
  - CMMs at the FGD inlet and stack (after FGD)
  - Ontario Hydro sampling at the ESP inlet, FGD inlet, and stack
  - Method 26 sampling at the ESP inlet
- Other measurements and samples
  - Multicyclone sampling at the ESP inlet
  - Corrosion probes installed at the economizer inlet, APH inlet, and ESP inlet
  - Daily samples of coal, fly ash, and scrubber blowdown

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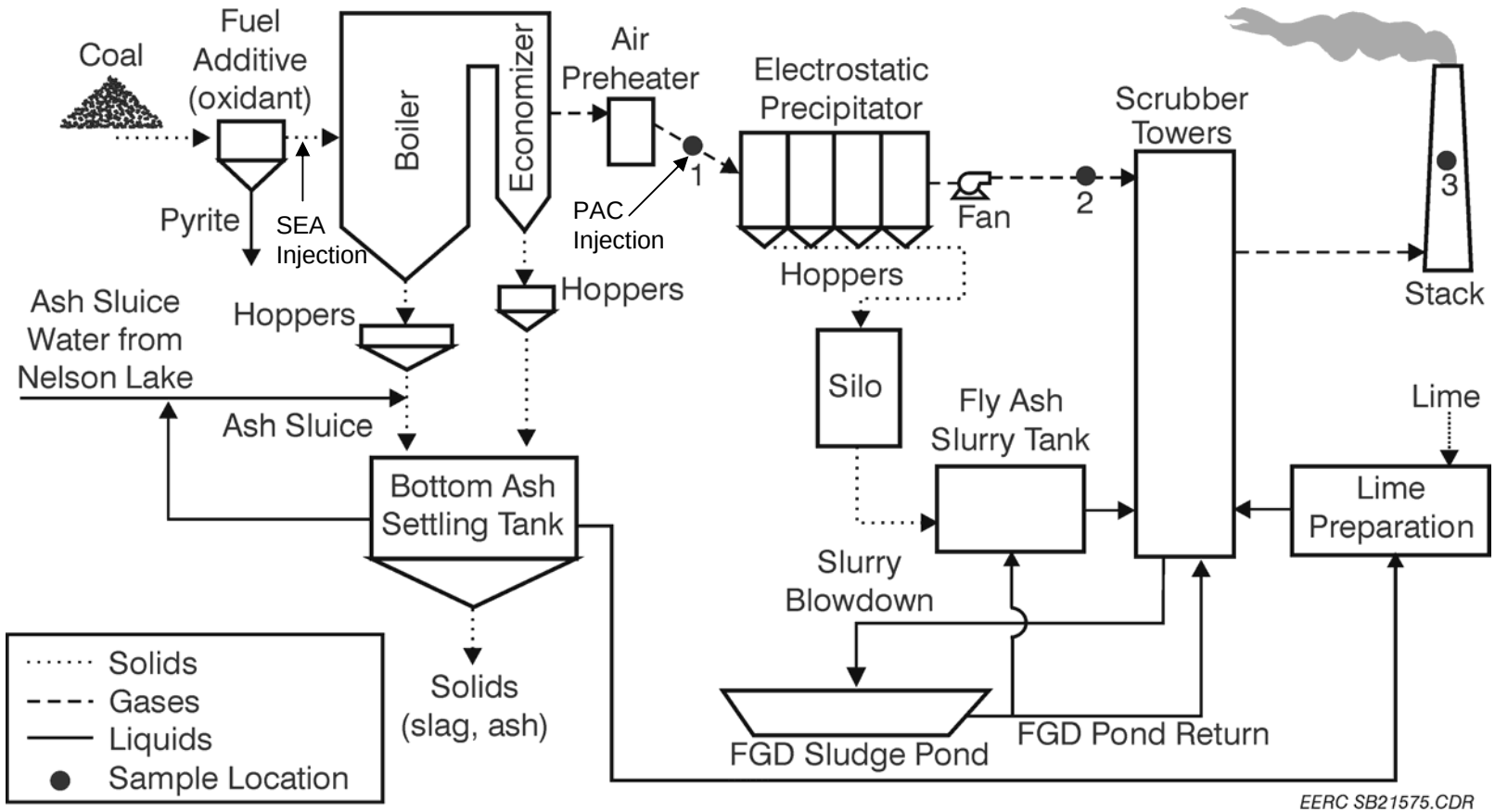
Schematic for M.R. Young Station – Unit 2



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Baseline/Parametric Tests

- Results presented today are based primarily on stack CMM measurements.
  - Removal referenced to stack CMM baseline.
  - No baseline available during injections of SEA or AC.
- OH measurements used to verify CMM measurements.
- Baseline changes over course of tests.

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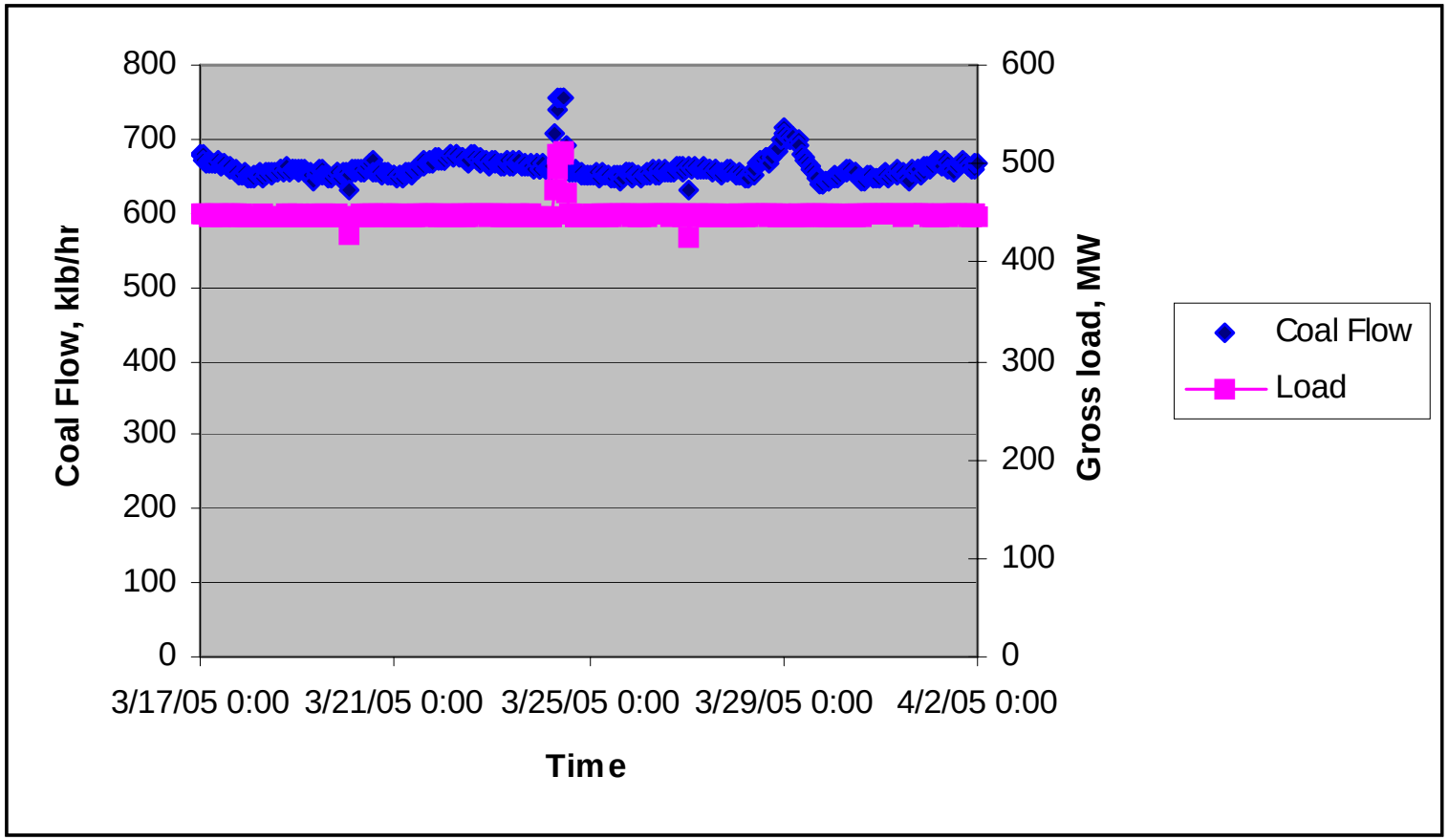
Plant Conditions



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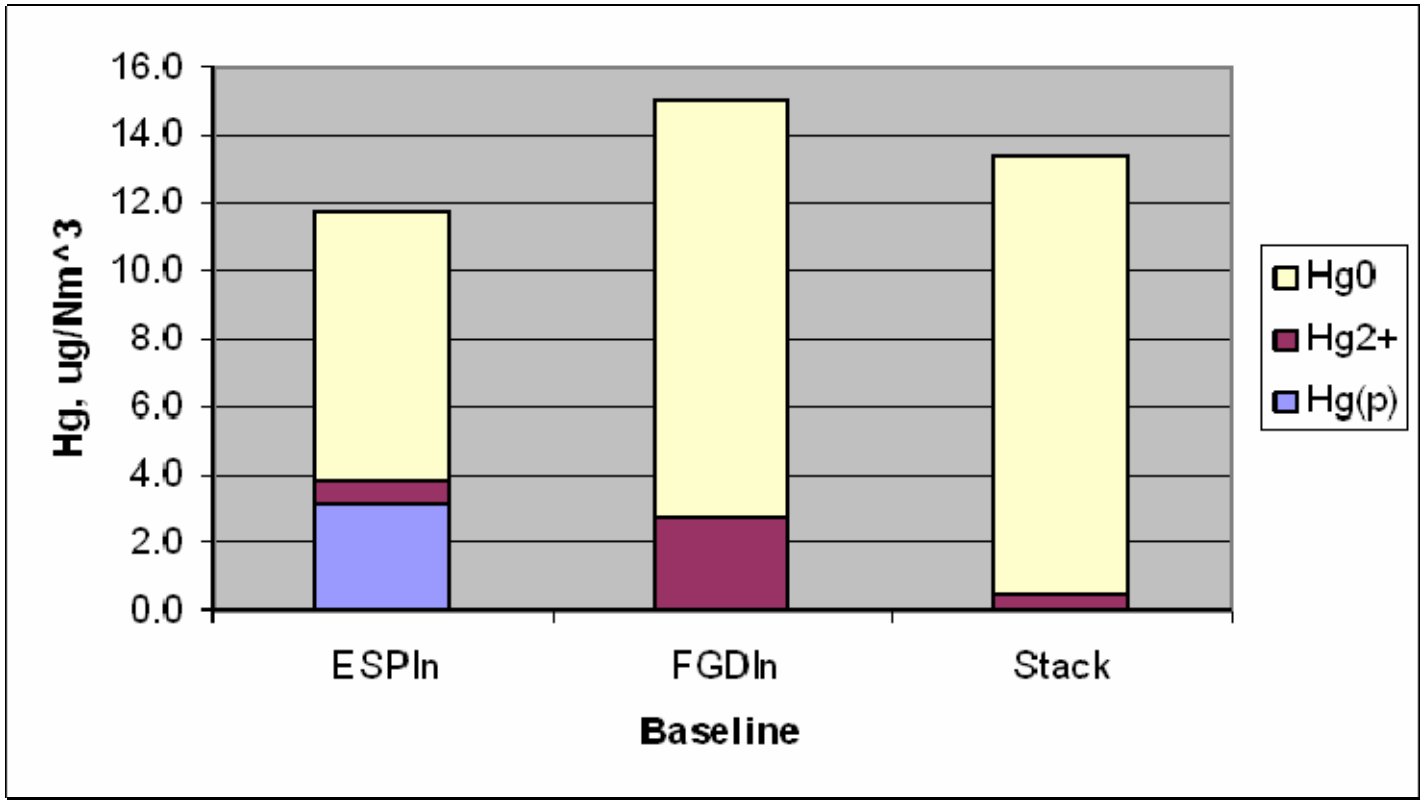
Hg Speciation (OH)
Baseline



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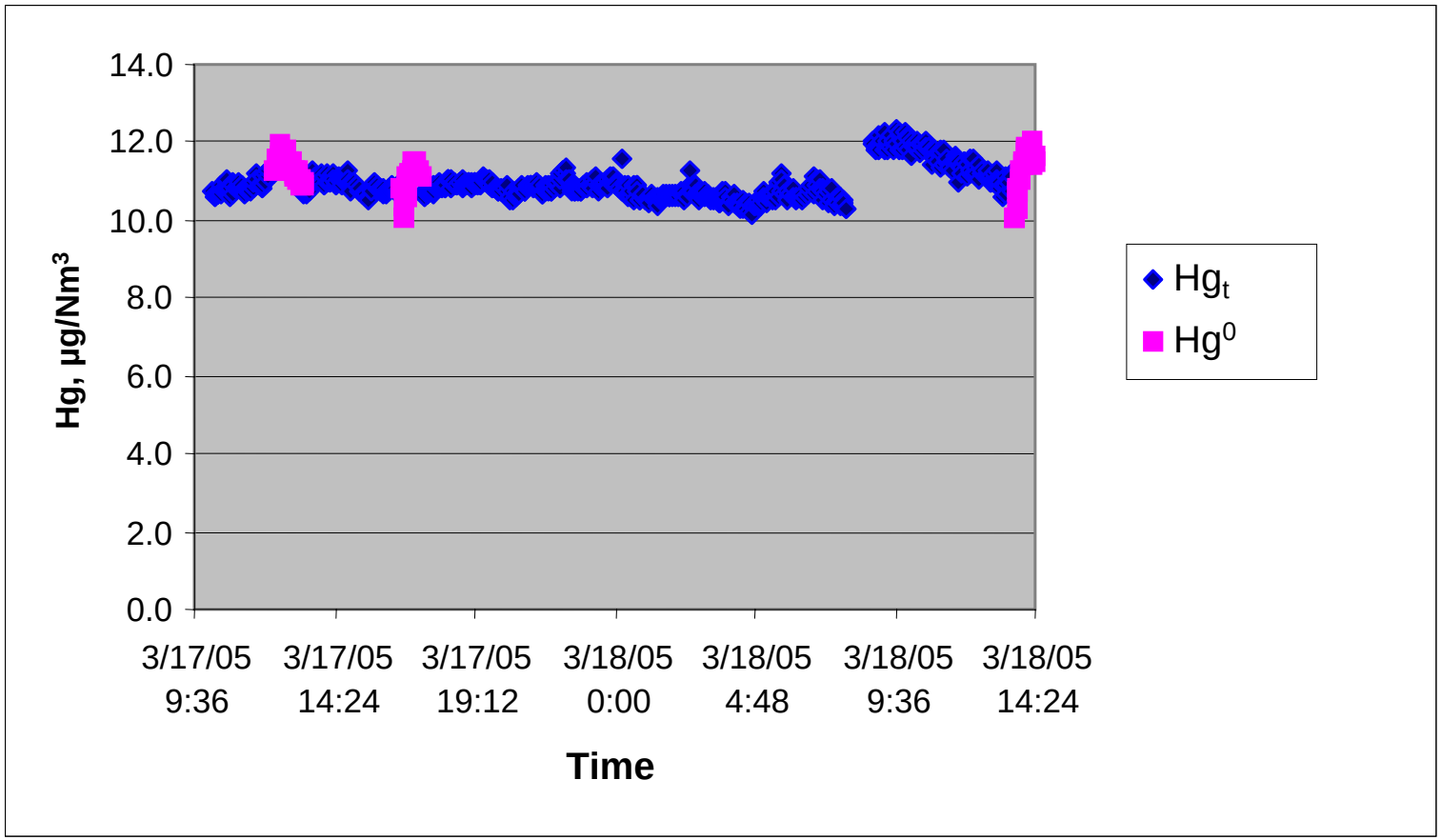
Baseline (Stack CMM)



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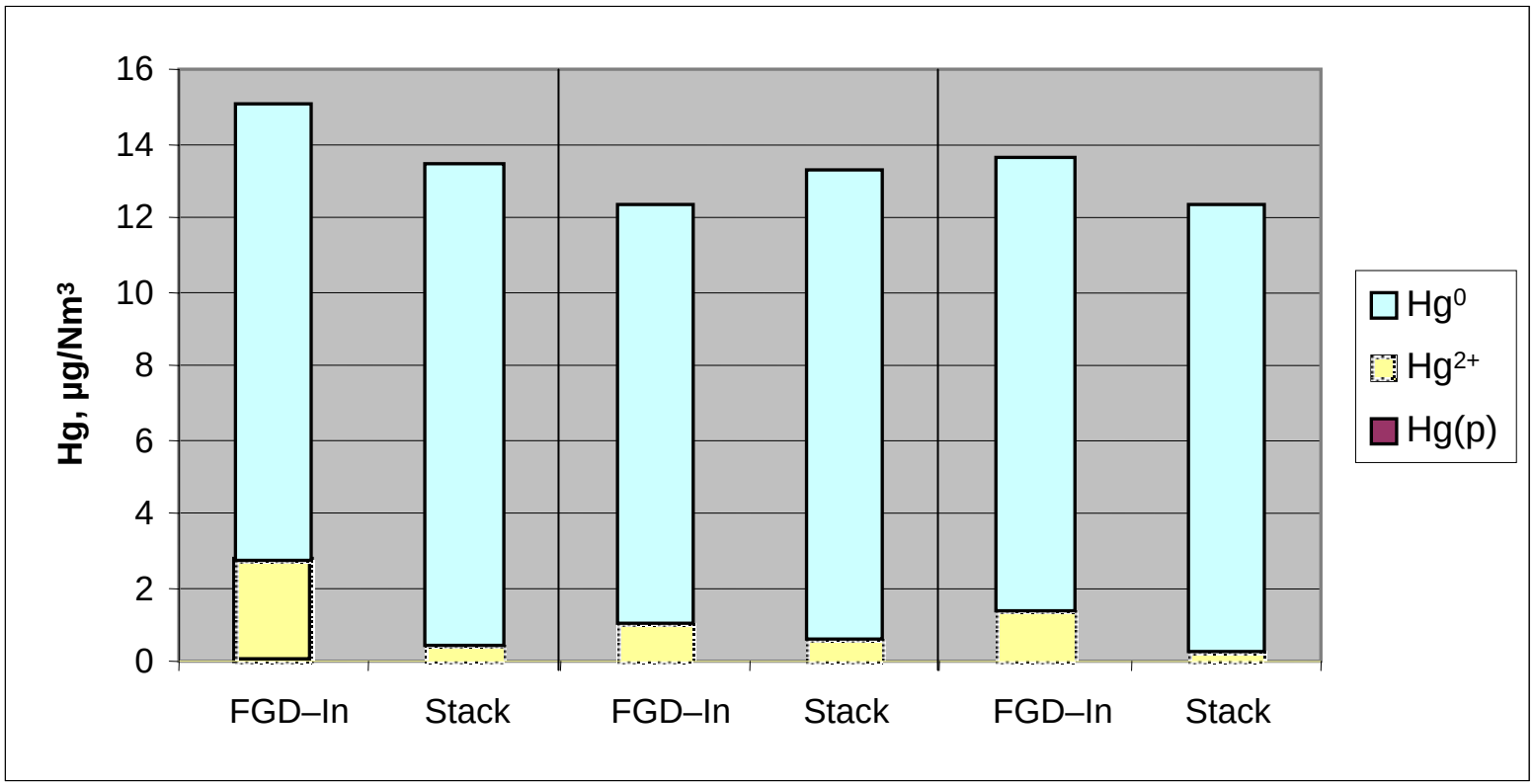
Baseline Mercury Speciation (OH)



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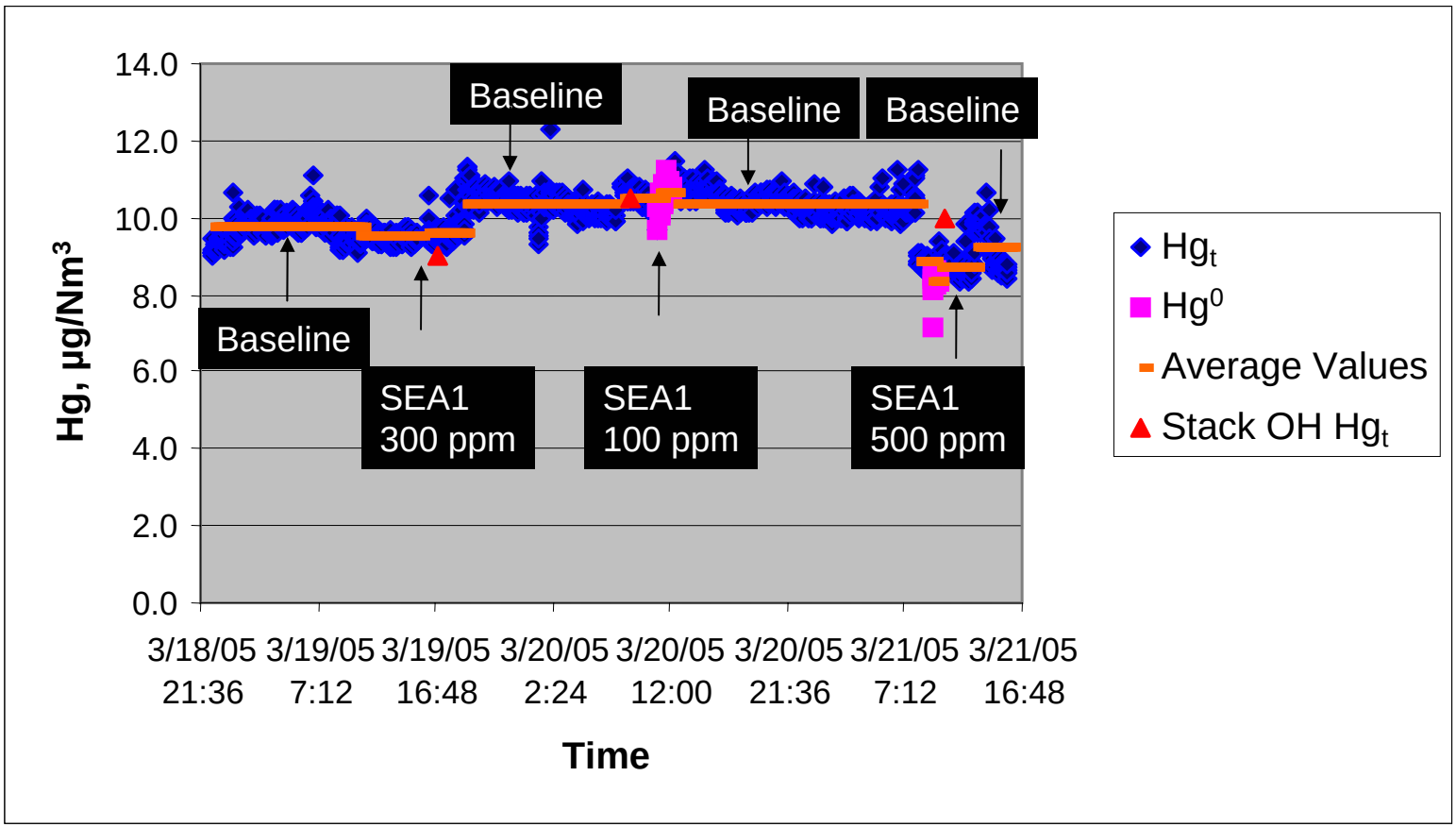
SEA1 ($CaCl_2$) Stack CMM Results



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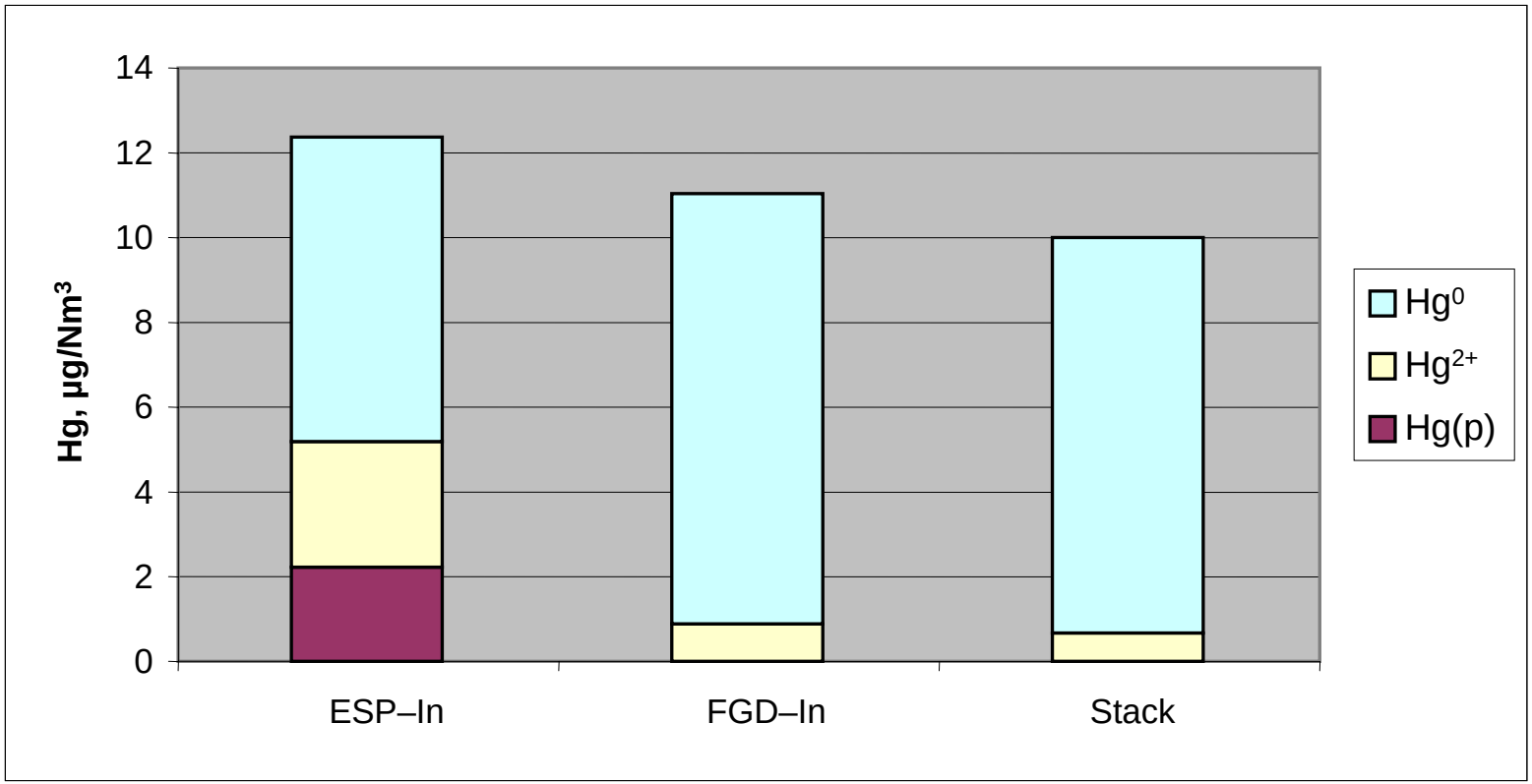
Mercury Speciation (OH)
SEA1 – 500 ppm



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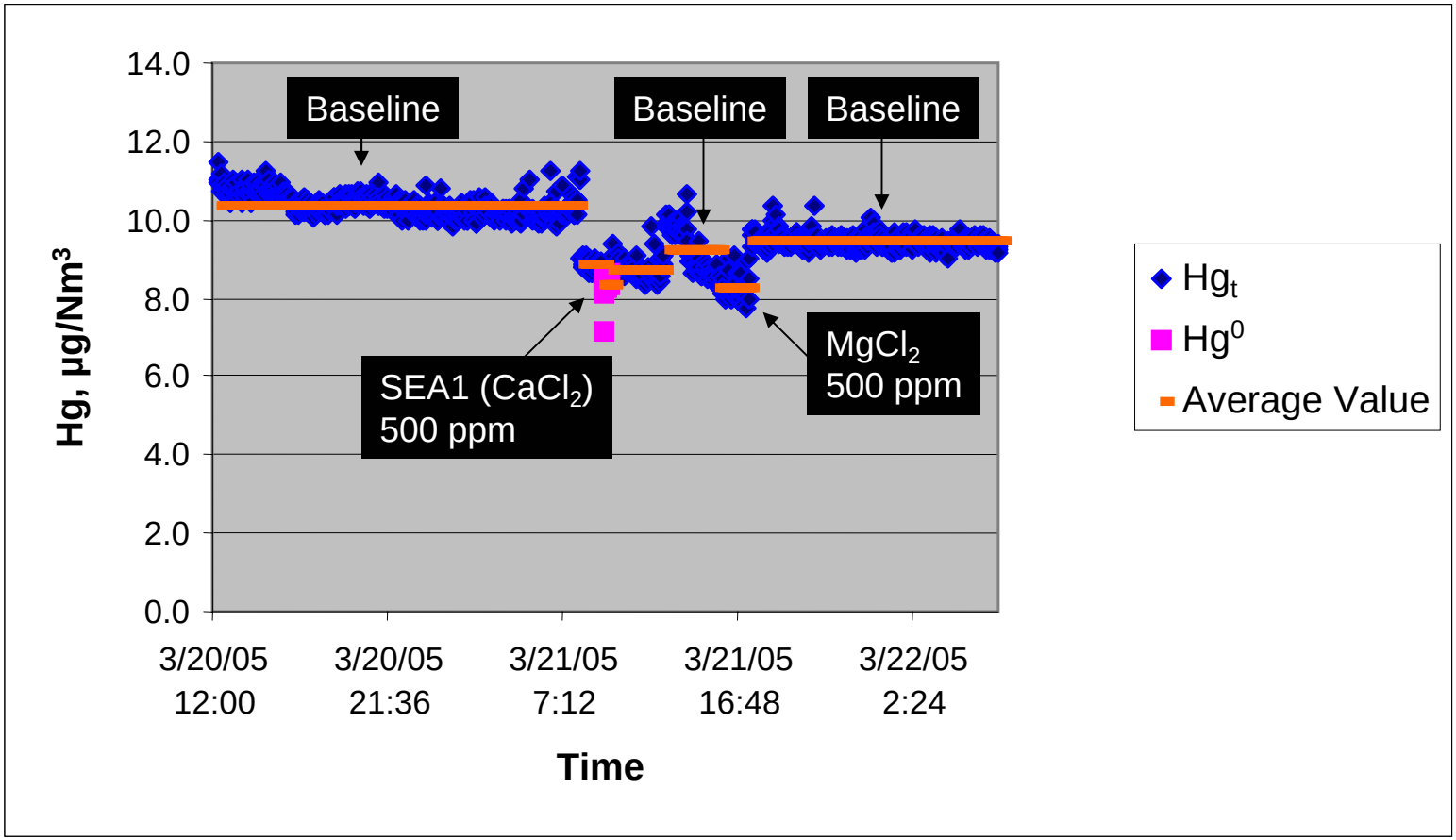
$MgCl_2$ Stack CMM Results



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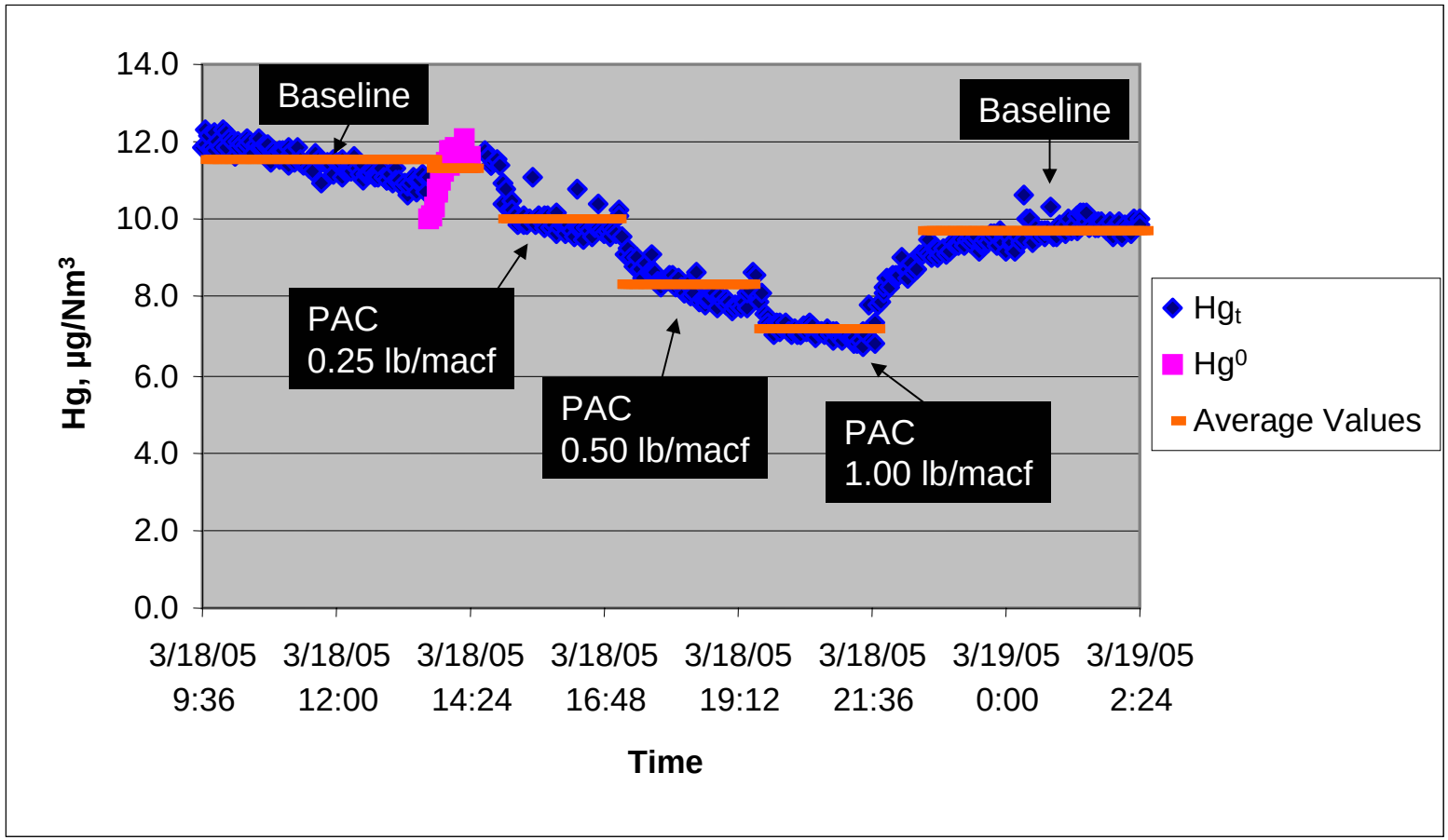
PAC Stack CMM Results



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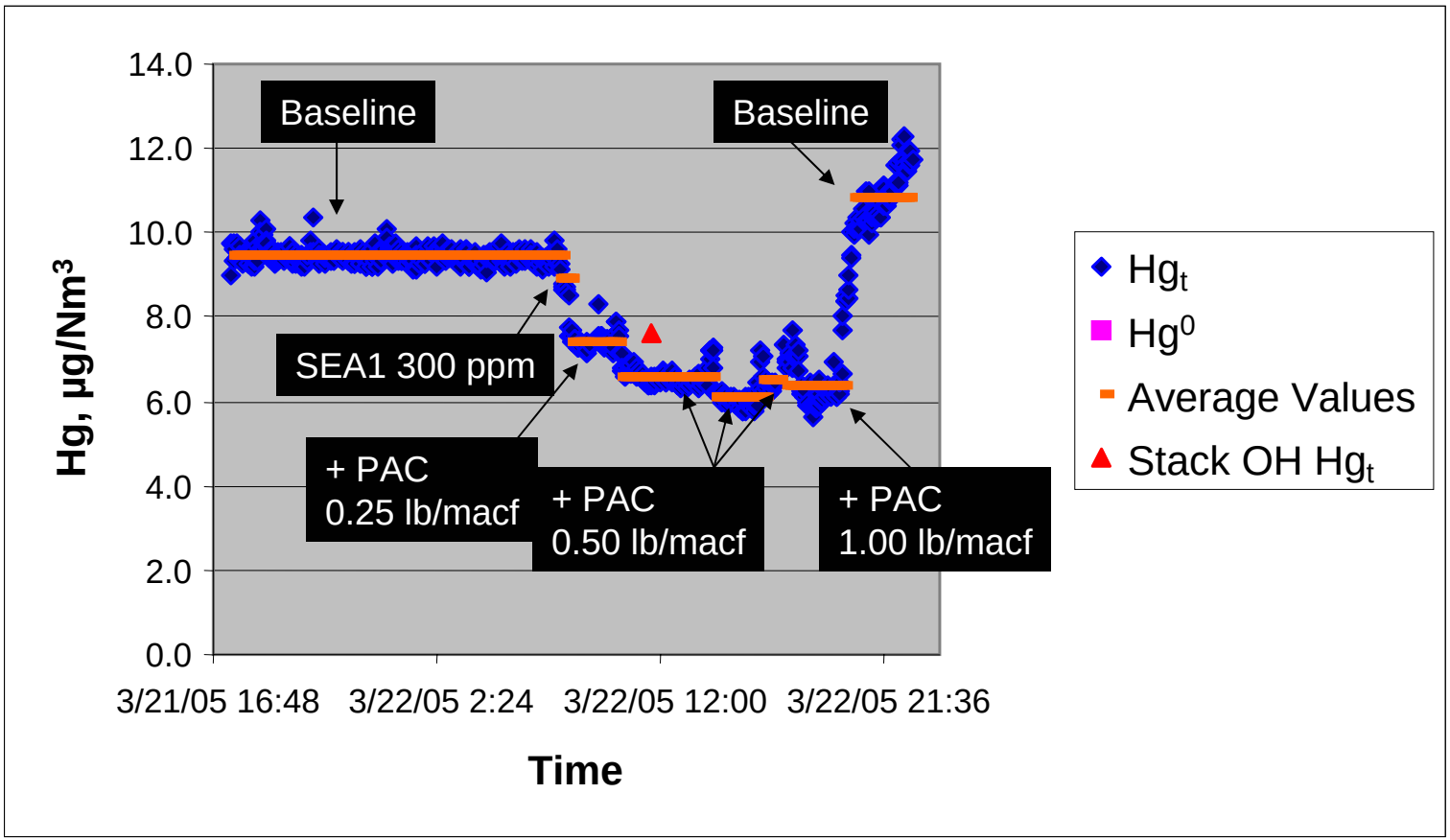
SEA1 + PAC Stack CMM Results



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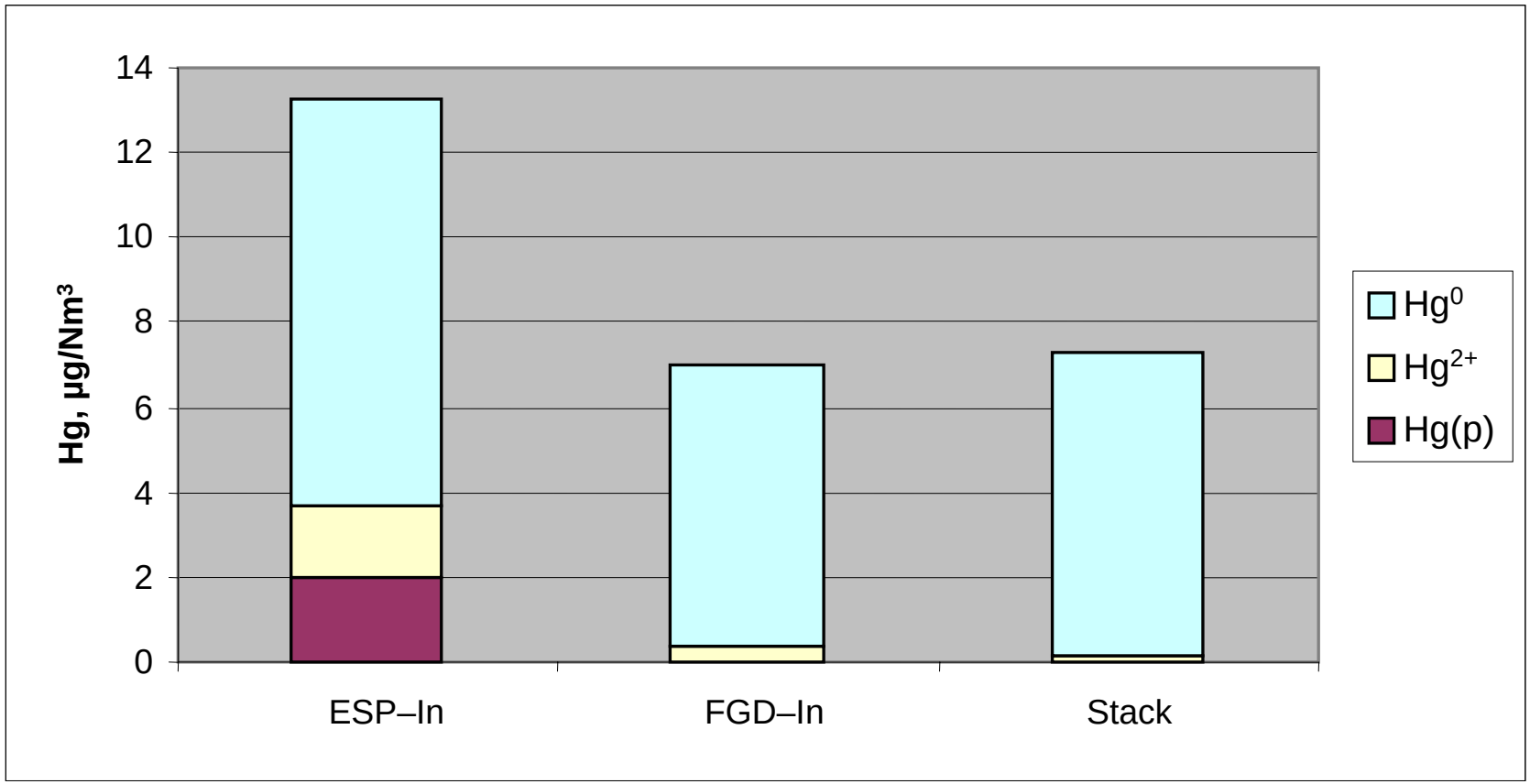
Mercury Speciation (OH)
SEA1 300 ppm + PAC 0.50 lb/macf



35-40 % removal

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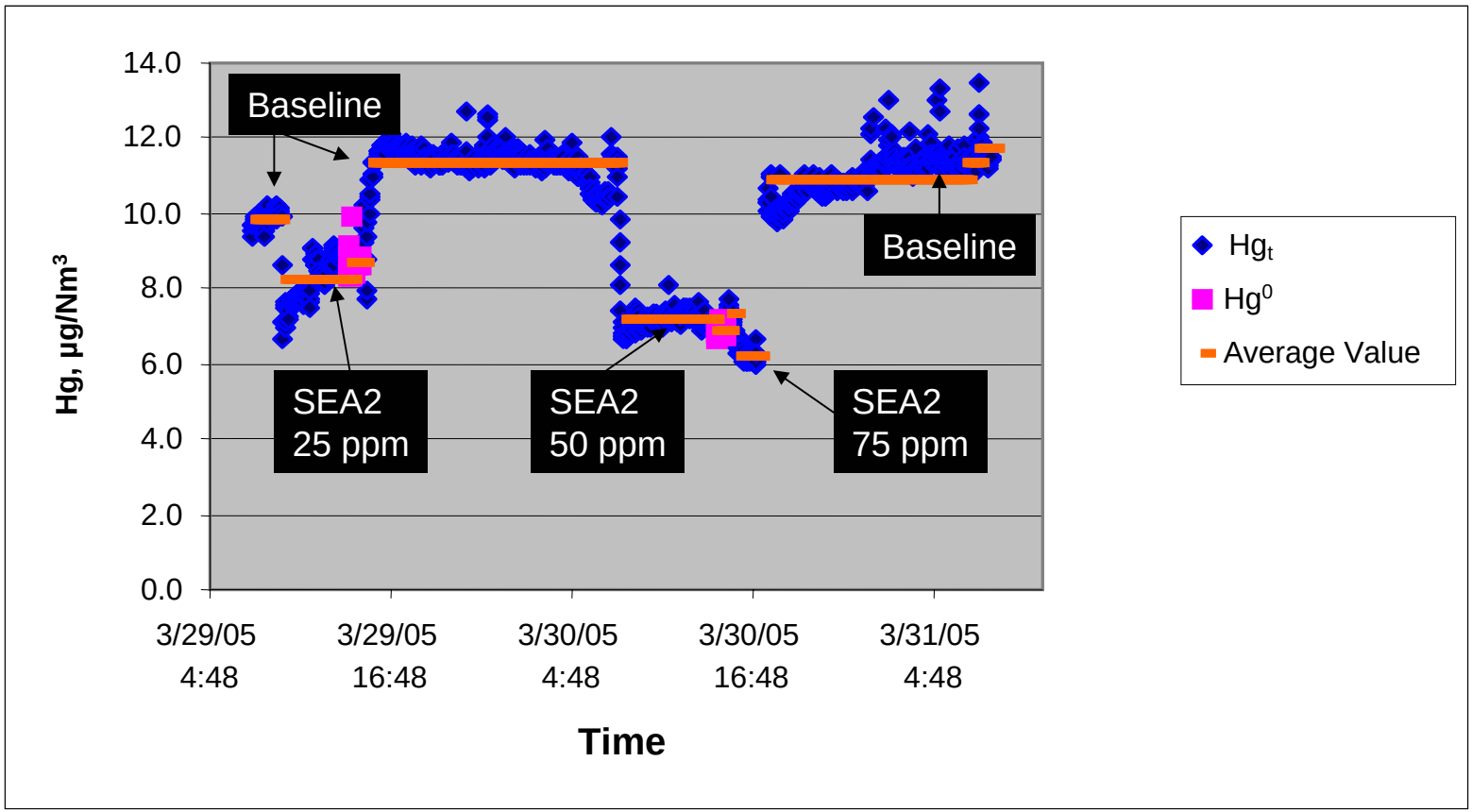
SEA2 Stack CMM Measurements



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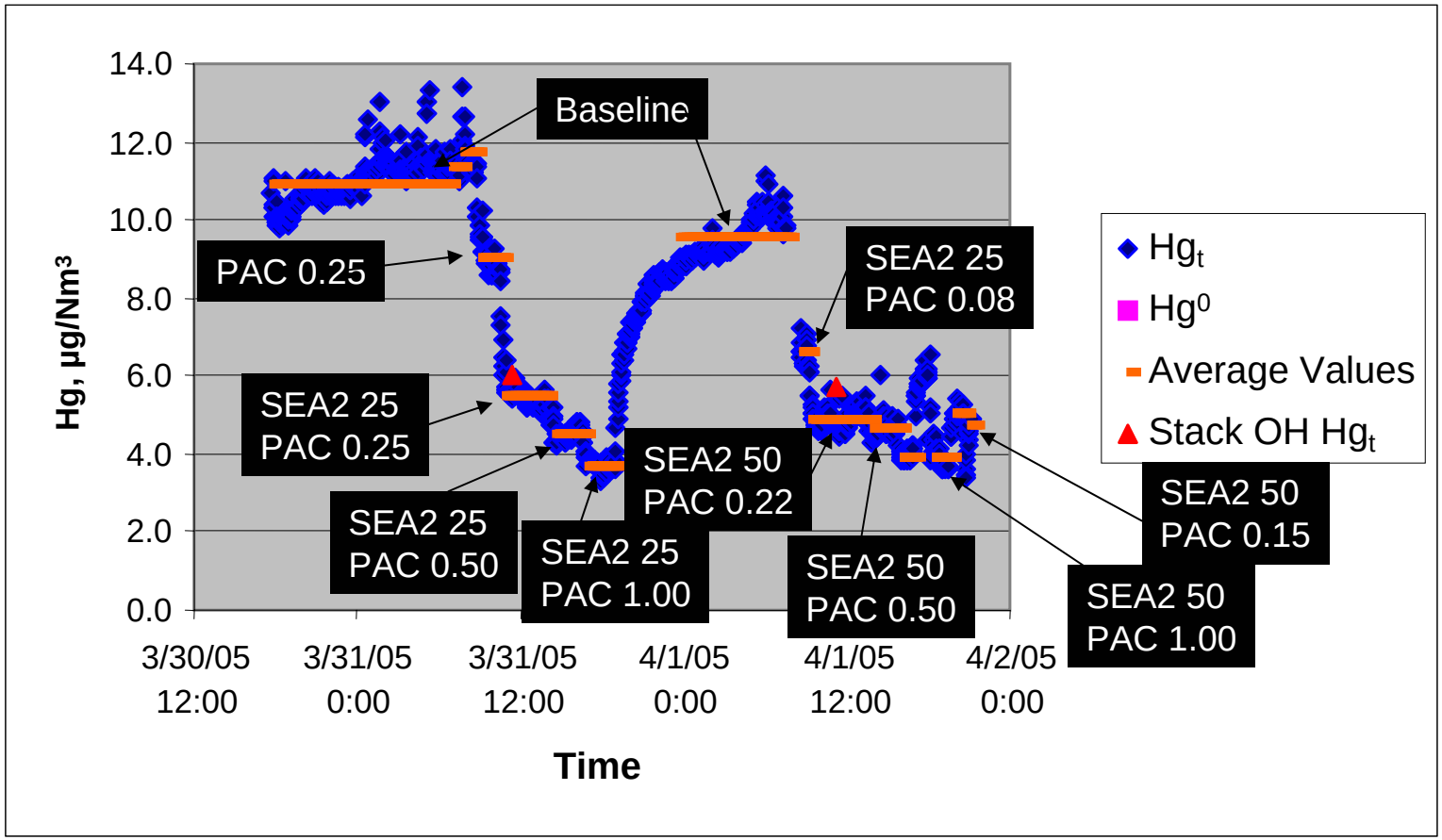
SEA2 + PAC Stack CMM Measurements (SEA- ppm, PAC- lb/macf)



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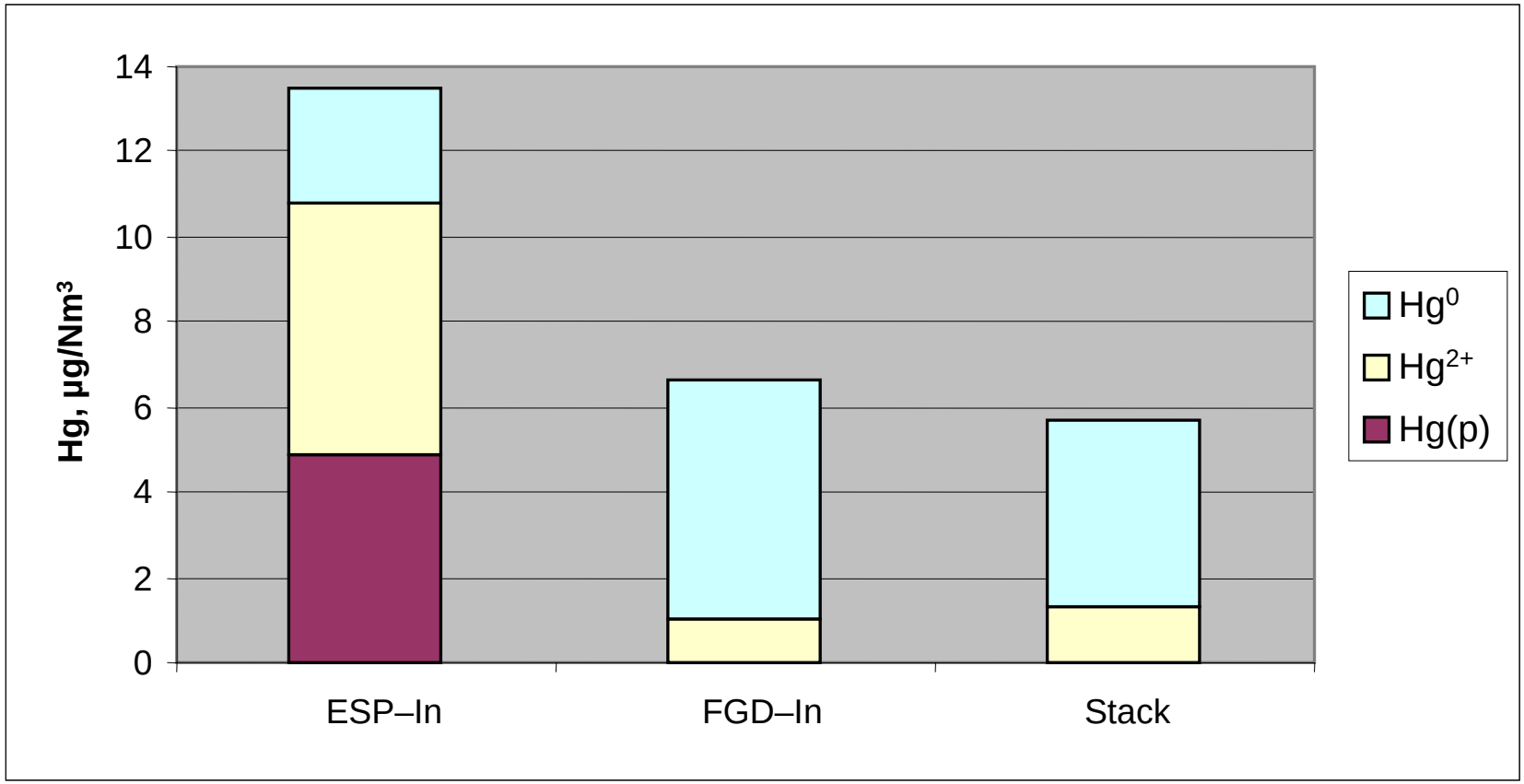
Mercury Speciation (OH)
SEA2 – 50 ppm/PAC 0.25 lb/macf



+50% removal

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M.R. Young Summary of Stack Data (total mercury)

SEA1, ppm	SEA2, ppm	$MgCl_2$, ppm	PAC, lb/macf	% Removal
			0.25	13.1
			0.27	23.3
			0.50	26.9
			1.00	37.4
			1.80	53.1
100				-1.3
300				7.7
500				16.0
		500		12.2
300			0.25	21.4
300			0.50	29.9
300			1.00	35.6

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M.R. Young Summary of Stack Data (total mercury) (cont.)

SEA1, ppm	SEA2, ppm	$MgCl_2$, ppm	PAC, lb/macf	% Removal
	25			16.3
	50			34.9
	75			44.0
	25		0.08	30.5
	25		0.27	48.7
	25		0.53	57.6
	25		1.00	65.1
	50		0.14	48.6
	50		0.22	49.8
	50		0.49	51.9
	50		1.03	59.9

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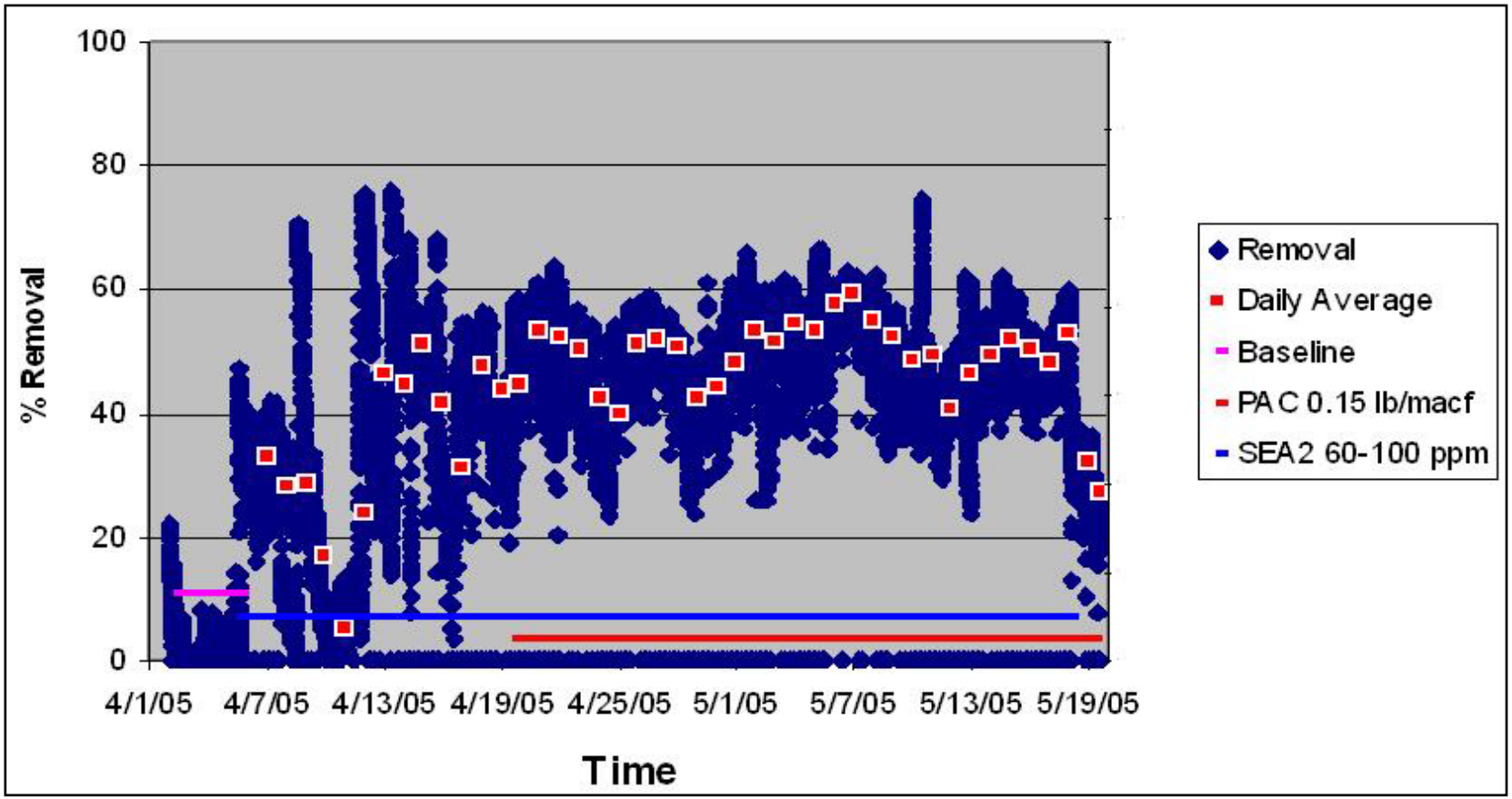
Month-Long Testing



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Conclusions

- Goal of 55% removal can be achieved.
  - SEA2 and SEA1 did not perform as well as expected.
    - High sodium coal
    - Impacts cyclone firing
  - A combination of SEA2 and PAC was required.
- Removal is primarily across the ESP.
  - Most mercury exiting the ESP is elemental.
  - FGD has small impact on removal.
- Considerations for commercial application:
  - SEA2 and water quality
  - Variability of baseline mercury level
  - CMM monitoring and control of removal

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Conclusions (cont.)

- Next project steps for MRY:
  - Complete analyses
  - Evaluate balance of plant impacts – corrosion probes
  - Preparation of report
- Cost estimate (SEA2 and PAC only):
  - SEA2 = $2200/day; PAC = $225/day
  - Average plant load = 445 MW
  - Cost = $0.23/MWh

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