Evaluation of Sorbent Injection for Mercury Control

Public Service of New Hampshire

The Northeast Utilities System

EUEC 2007

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DOE Cooperative Agreement DE-FC26-06NT42780
DOE/NETL Project Manager: Andrew O'Palko

Test Team

- DOE/NETL
- PSNH
- ADA-ES
- Reaction Engineering International
- Other Support
  - Breen Technology – Dew point monitors
  - E.ON Engineering – SO_3 Measurements
  - Air Sampling Associates – Manual Measurements
  - Lab analysis, etc.

DOE Project Focus Areas

- Evaluate effectiveness of sorbent injection for mercury control in unproven environments
  - Cyclone Boiler
  - SCR on a medium sulfur flue gas – 1.2% coal blend
  - Mid-sized ESPs, Injection between ESPs
  - High SCR generated SO_3 flue gas
  - Co-control for SO_3 and Hg
  - Temperature effects on ACI in the 300 – 350°F range

Project Goals

Reduce the uncontrolled mercury emissions by 50 to 70% at a cost 25 to 50% lower than DOE basis ($60,000/lb Hg removed)

- Determine process/equipment costs for various levels of mercury removal
- Quantify balance-of-plant impacts
- Evaluate the capability of SO_3 tolerant sorbents to achieve 70 to 90% mercury removal
- Evaluate the effect of co-benefits from SO_3 mitigation on mercury control, and the balance of plant benefits from lowered flue gas temperatures including increased plant efficiency and overall reduced emissions
- Evaluate the impact of sorbent injection on ash disposal
- Support the education and transfer of information and results to local and state interests groups

ADA-ES

PSNH Merrimack Station

Unit Capacity
- 335 MW

Test Portion
- 335 MW

Coal
- Bituminous/Venezuelan 1/1 Blend for 1.2% S
- Hg Content:
  - 0.04 – 0.1 ppm-dry
- Cl Content:
  - ~750 ppm-dry

SO_2 Control – Low sulfur coal blends

APH – Tubular Design

Particulate Control – 2 ESPs in series (120, 230 SCA)

Testing Began September 2006

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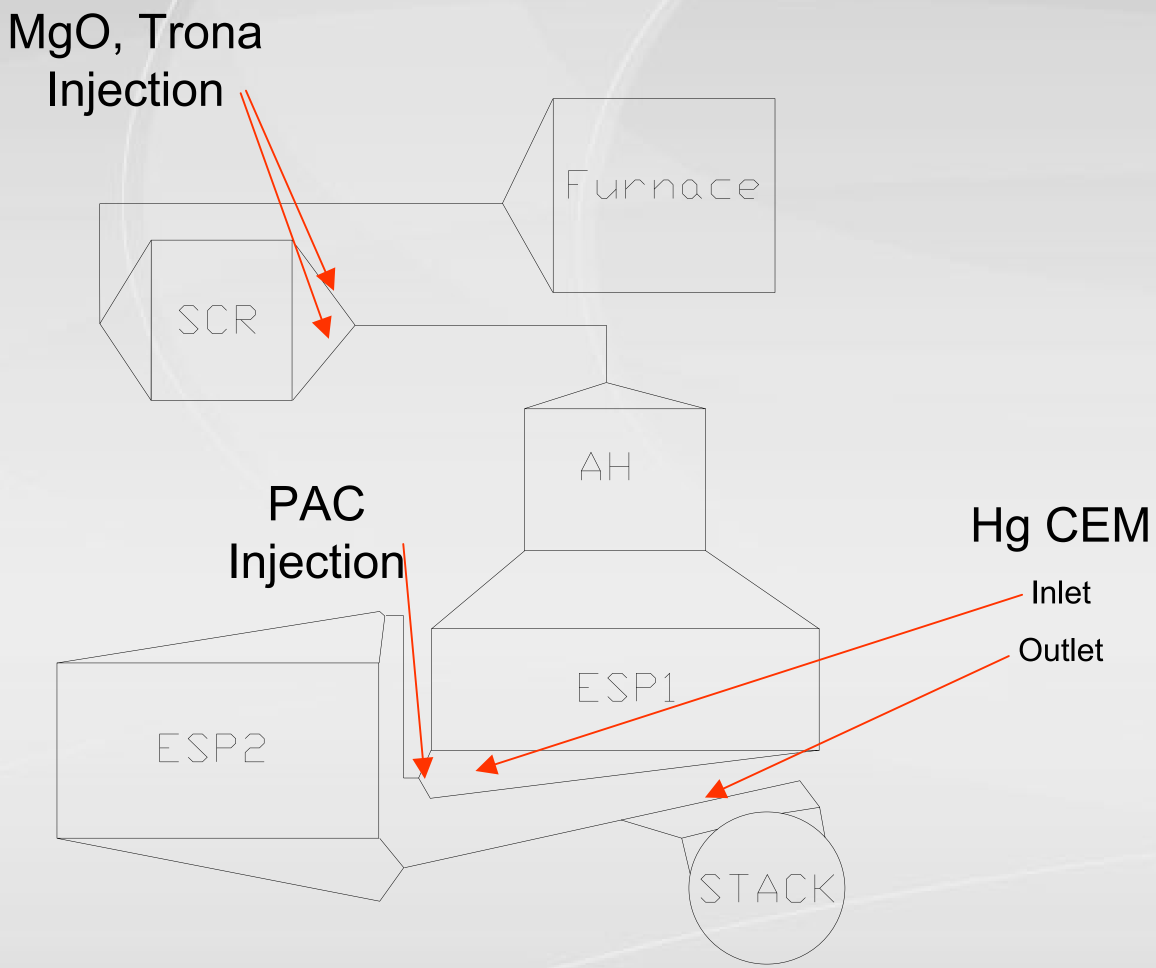
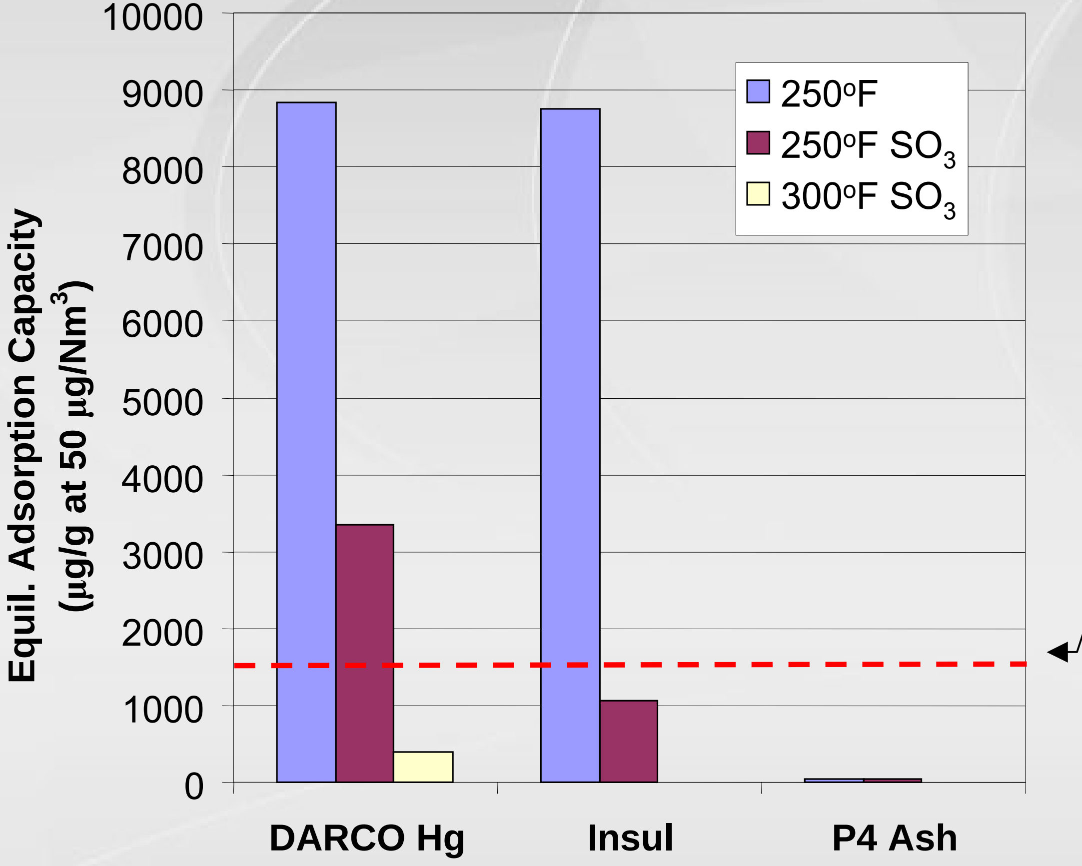
Merrimack Unit 2 Overall Layout



Co-Benefit Testing

Effect of SO_3 on Sorbent Capacity: Fixed-bed Results



REI Model suggests capacity > 1500 to 2000 µg/g is needed for good Hg capture in an ESP

***Not Tested at Merrimack**

Equilibrium Adsorption Capacities Upstream and Downstream of SO_3 Injection for FGC

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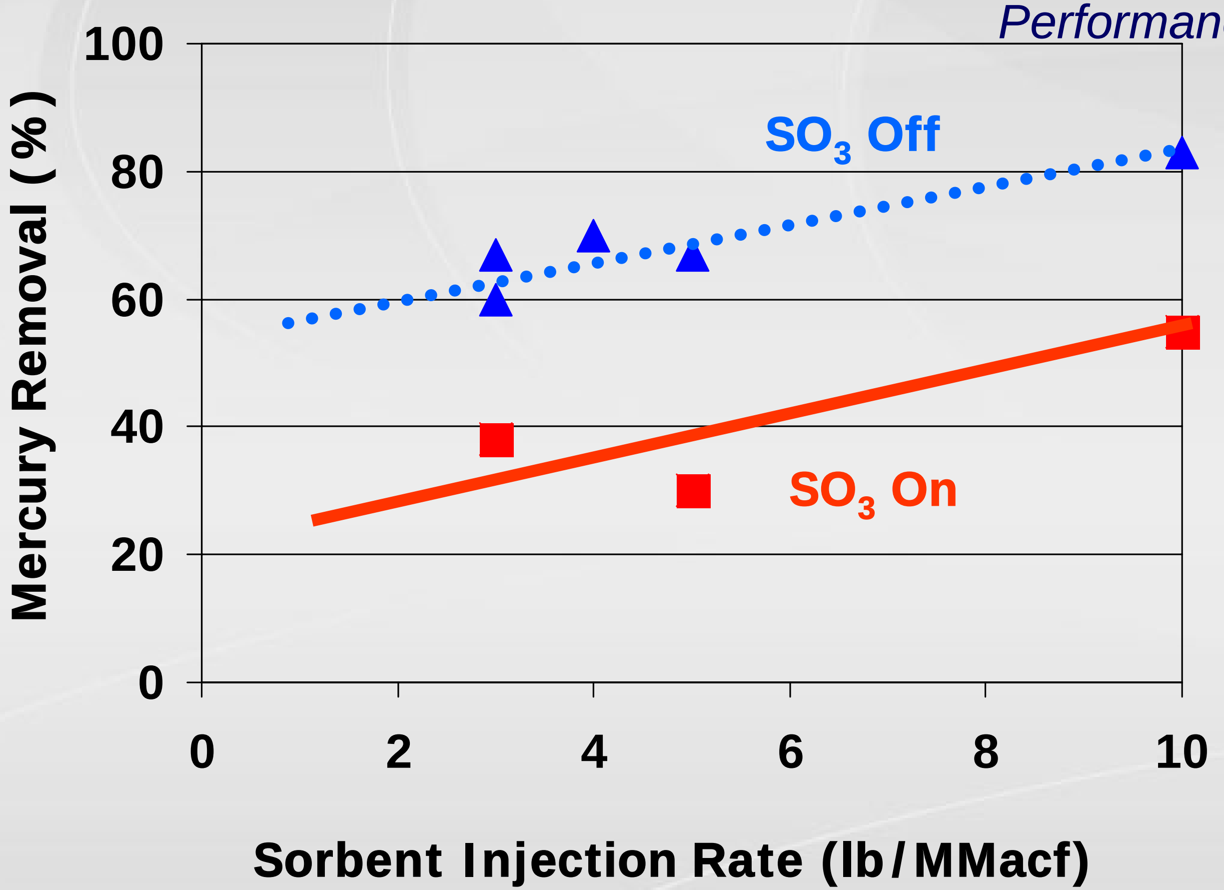
Effect of SO_3 – Plant Daniel

Mississippi Power Plant Daniel
Low sulfur Bituminous Coal with
PRB, SO_3 Injection for ESP
Performance Improvement



SO_3 Measurements

- Manual Measurements
  - Baseline Test Period
    - Downstream of the APH: 10 – 16ppm
  - Trona Injection (Measured Inter-ESP)
    - Pre-Injection (Inter-ESP): 13 – 17ppm
    - Trona at 500lb/hr: 5 - 10ppm
    - Post-Injection (Inter-ESP): 20ppm
- Breen Energy Solutions In-Situ Monitor
  - Trona Injection
    - Indicate <10ppm SO_3 Levels

Comparison of SO_3 Sorbents

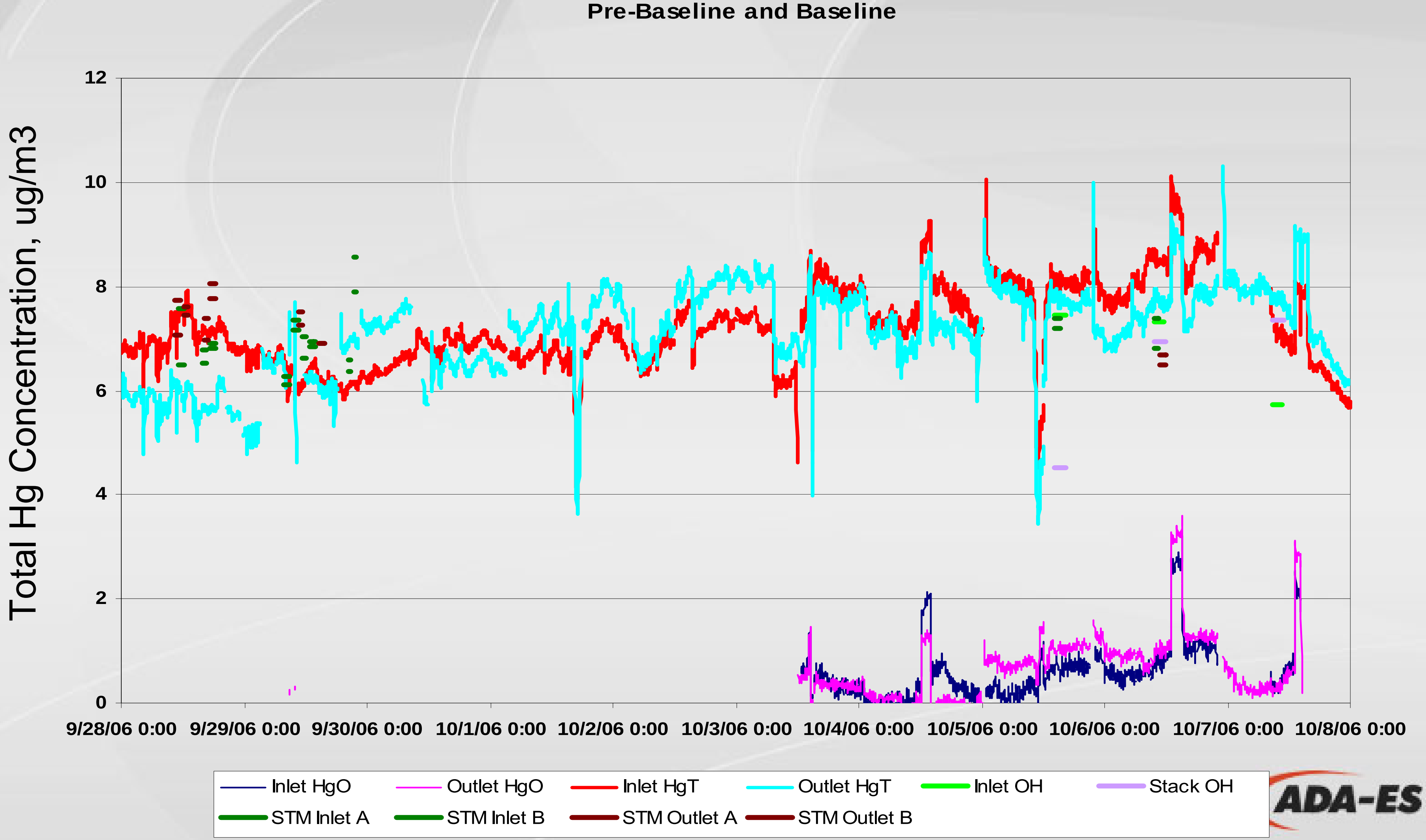
- Cost comparison of MgO vs Trona
  - Trona –
    - $85/ton – Wyoming
    - Injection rate of 500 – 625lb/hr
  - MgO –
    - $780/ton
    - Injection rate of 180lb/hr
- Comparison of effects on ESP performance
  - MgO –
    - Power levels in Original ESP drop from average of 12 to 5kW
    - Opacity at 180lb/hr increased to above 15% from 10%
  - Trona –
    - Power levels unaffected
    - Opacity increase of 2%

Baseline Results

Baseline Results

- Hg varies (range was 5 to 10 µg/m^3 from Aug 06 through Jan 07)
- No removal across the ESP
  - Based on CEM, STM
  - Low Hg levels in ash analysis (10 ppb)
- OH within 20% of Baseline CEM and STM results
- On and off site analysis of STM traps correlate well with inlet CEM
- Outlet CEM reads 0.5 – 2 ug/ m^3 higher than inlet, when manually corrected – trend together
- >80% Oxidation of Mercury

Baseline Mercury Trends



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Parametric Sorbent Injection

Finding the Right Sorbent

- Evaluate various sorbents
  - Fixed-bed screening
  - Full-scale injection tests
- Assure good sorbent distribution
  - CFD Modeling
  - Stratification measurements
    - Outlet mercury grid
    - Variations in hopper LOI and Hg
- Assure good mercury measurements
  - QA checks and RA measurements
  - Mass balance checks with coal and ash

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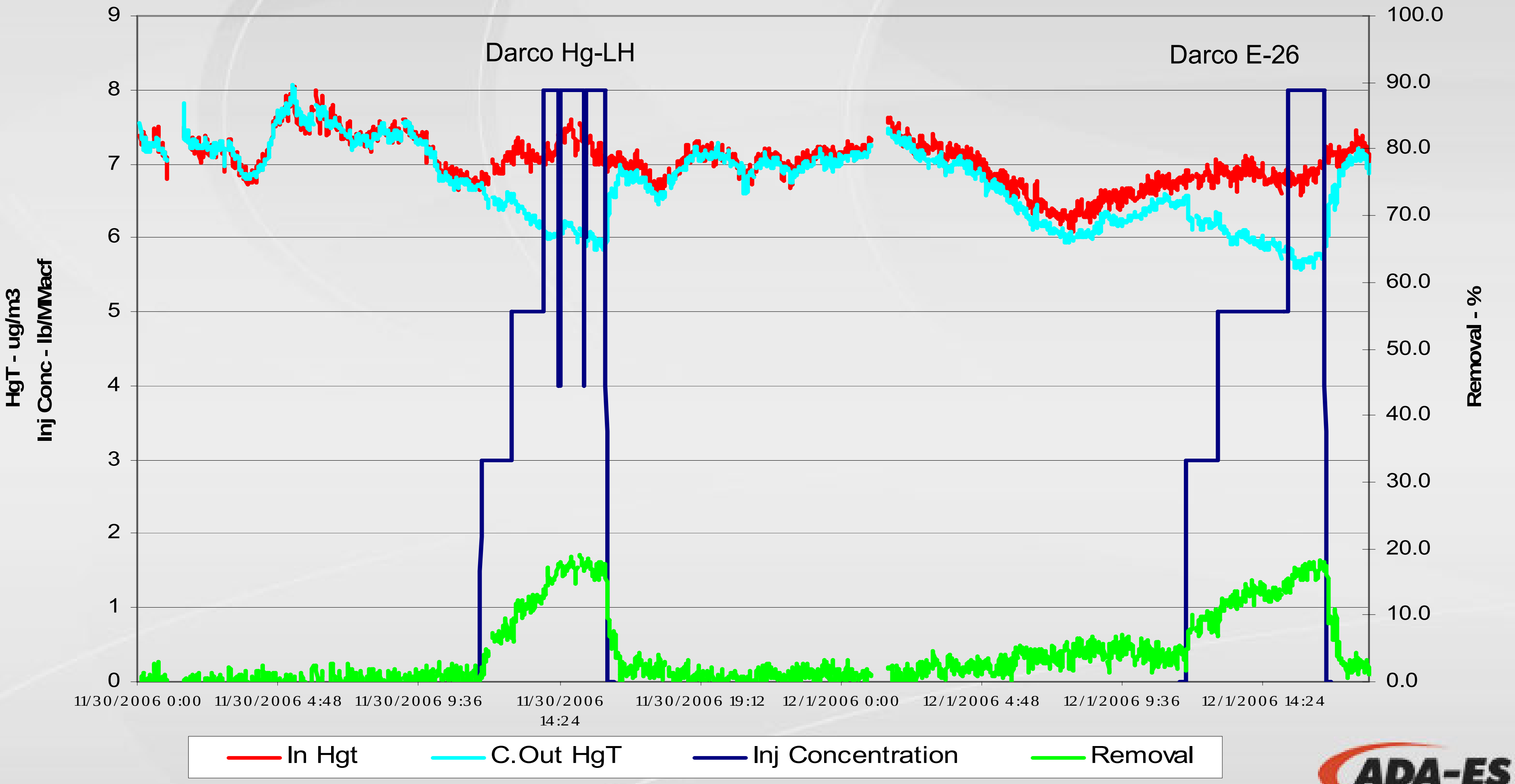
December 2006 Parametric Testing

PAC Injection between ESPs, No SO_3 Mitigation, Normal APH Outlet Temp – 330-350°F



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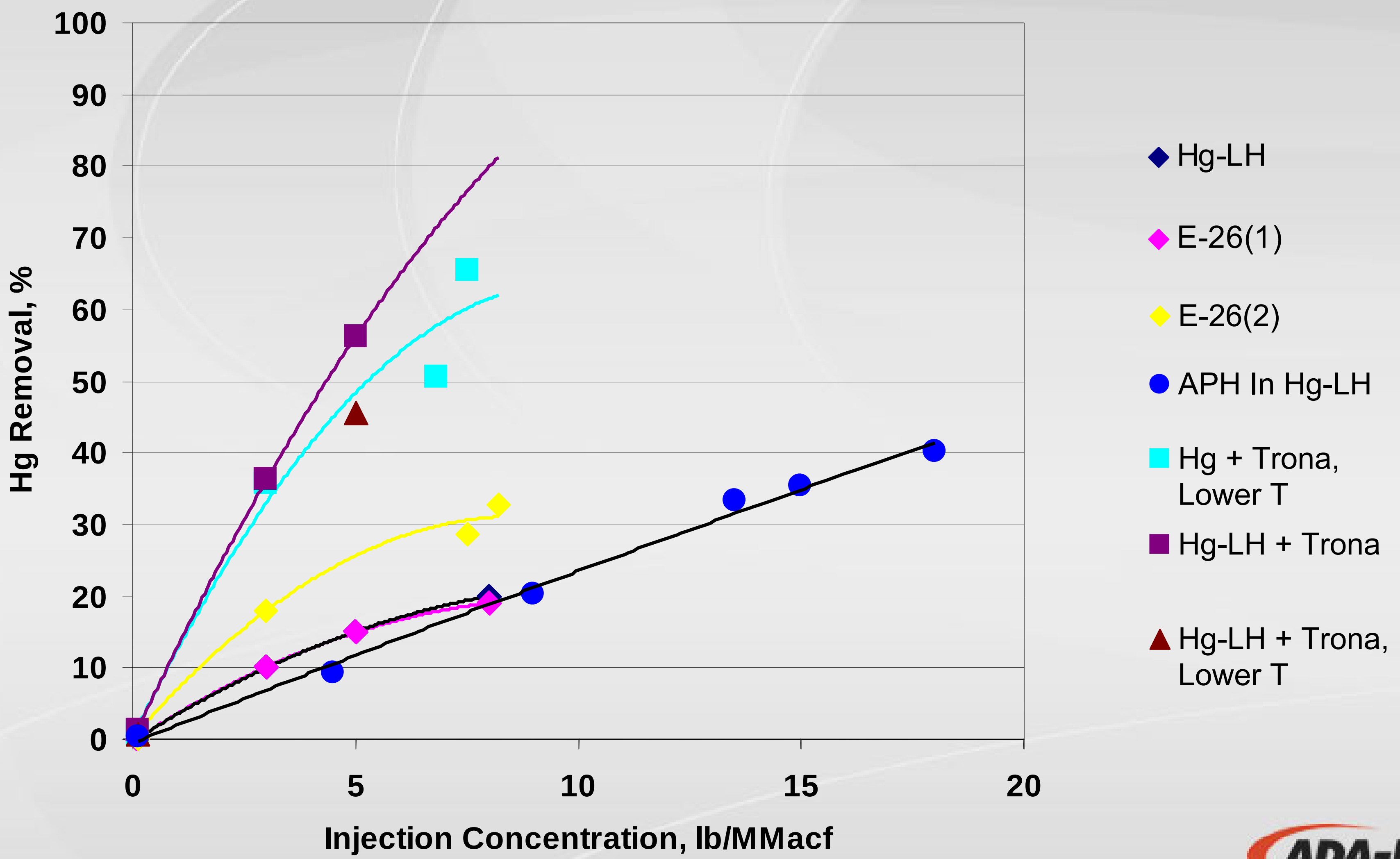
Parametric Test Results



Future Testing at Merrimack Unit 2

- Dual Injection of MgO with PAC
  - Low level injection of MgO
    - Start at 30lb/hr, increase to 60 and 90lb/hr
    - Above 90lb/hr, significant immediate impact on ESP performance
  - Without full SO_3 absorption, restricted ability to lower APH outlet temperatures
    - Impact on PAC Hg removal
    - Three potential sorbents
      - DARCO Hg
      - DARCO Hg-LH
      - DARCO E-26

Issues

CCB and Other General Issues

- The mercury captured by activated carbon, LOI carbon, and ash appears to be very stable and unlikely to leach into the environment.
- The presence of activated carbon in ash will most likely prevent sale for use in concrete.
  - Several developing technologies to address the problem
- Low level bromine leaching from ash mixed with treated carbon – *How significant is this?*
- Secondary stack emissions measured due to treated sorbent injection

Questions/Discussion

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