# Evaluation of Sorbent Injection for Mercury Control


NETL
NATIONAL ENERGY TECHNOLOGY LABORATORY

Public Service of New Hampshire
The Northeast Utilities System

**DOE/NETL Mercury Control Technology Conference**

**December 12, 2007**

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

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# Test Participants

- DOE/ NETL – Andrew O'Palko
- Public Service Of New Hampshire (PSNH) - Merrimack Station (MK2)
- ADA-ES
- Reaction Engineering
  - CFD modeling
  - Co-Benefits analysis
- O'Brien & Gere

# Merrimack Unit 2

**MK2:** 335 MW

**Coal:** Long Term Test Blend - Eastern Bit and Venezuelan Blend
~50/50 split
1.0 – 1.3% sulfur
(1.2% S is targeted)

**Cyclone Boiler**
**SCR**
**Cold Side ESP**


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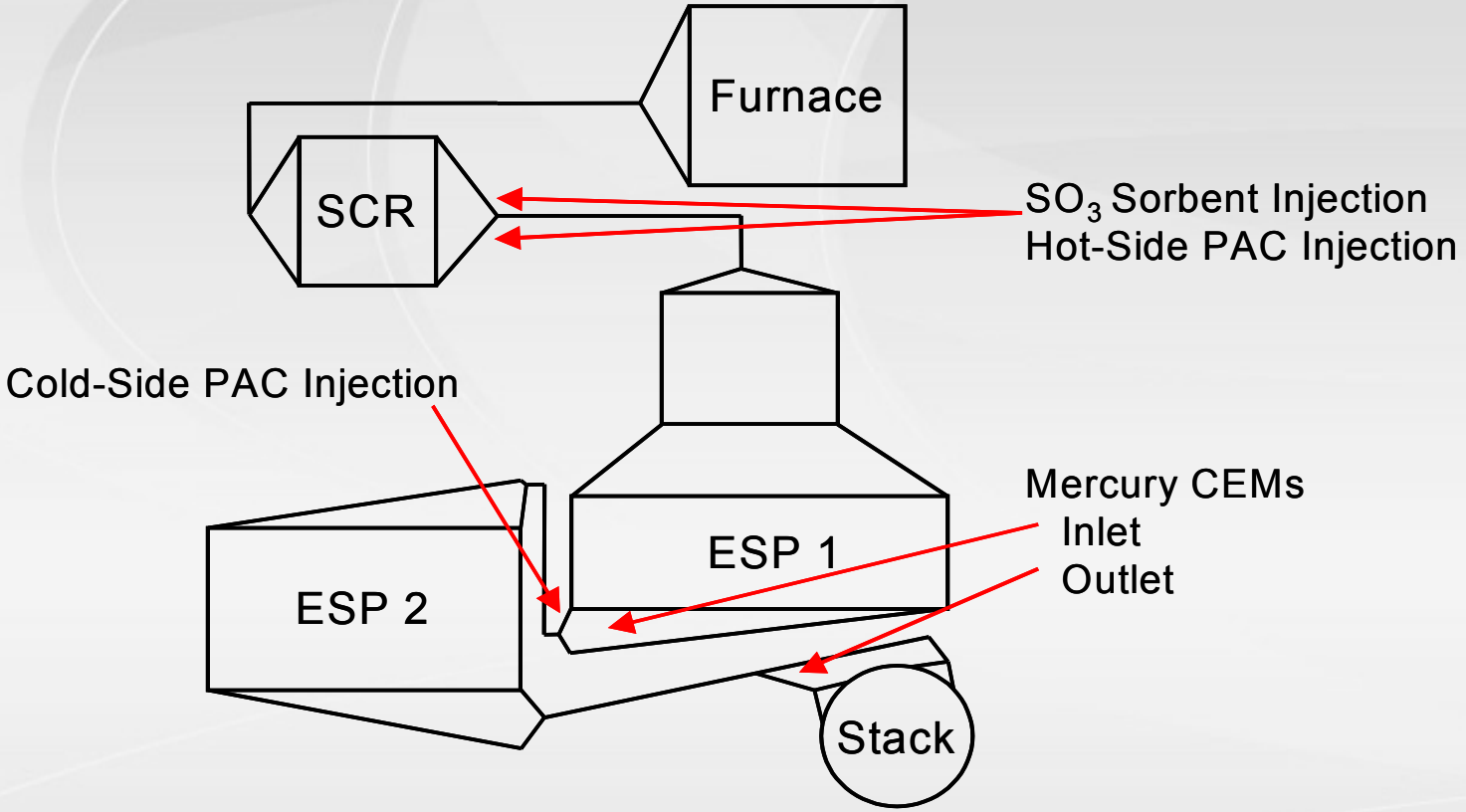
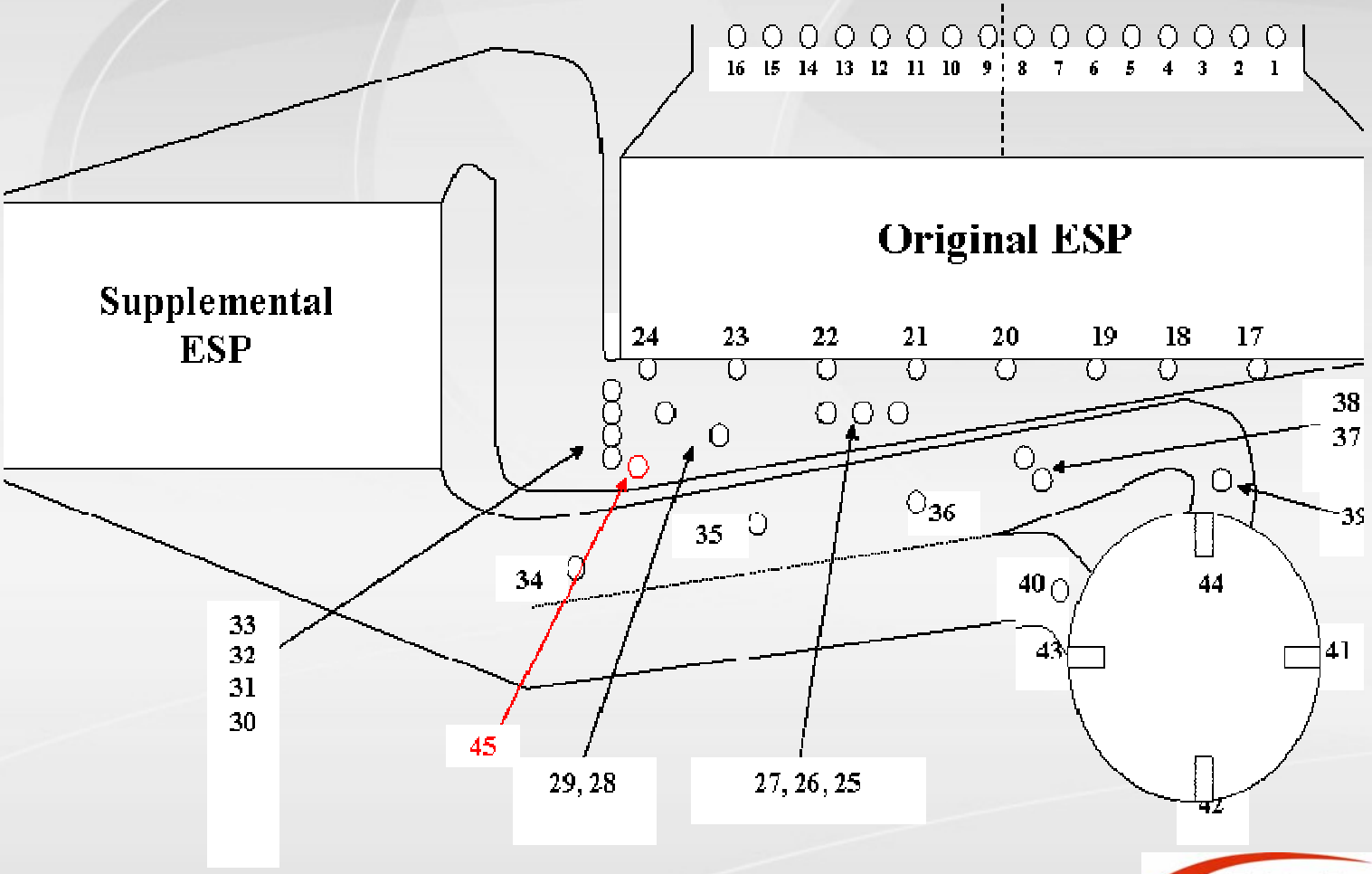
# Merrimack Unit 2 Layout



# Merrimack Unit 2



# Project Goals

- Evaluate the capability of $SO_3$ tolerant sorbents to achieve 50 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 of 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

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# Budget/Milestone Schedule Summary

| Milestones | Target Date | Status |
|---|---|---|
| 1. Design, Procure and Install Equipment | October 2006 | October 2006 |
| 2. Complete Baseline Tests | November 2006 | October 2006 |
| 3. Complete Parametric Tests | February 2007 | February 2007 |
| 4. Complete Long Term Testing | November 2007 | February 2008 |
| 5. Submit Final Report | Within 90 days of completion of project | |

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# Baseline Results

- Hg varies (range was 5 to 10 μg/$m^3$ from Aug 06 through Jan 07)
- Low native 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
- >85% Oxidation of Mercury

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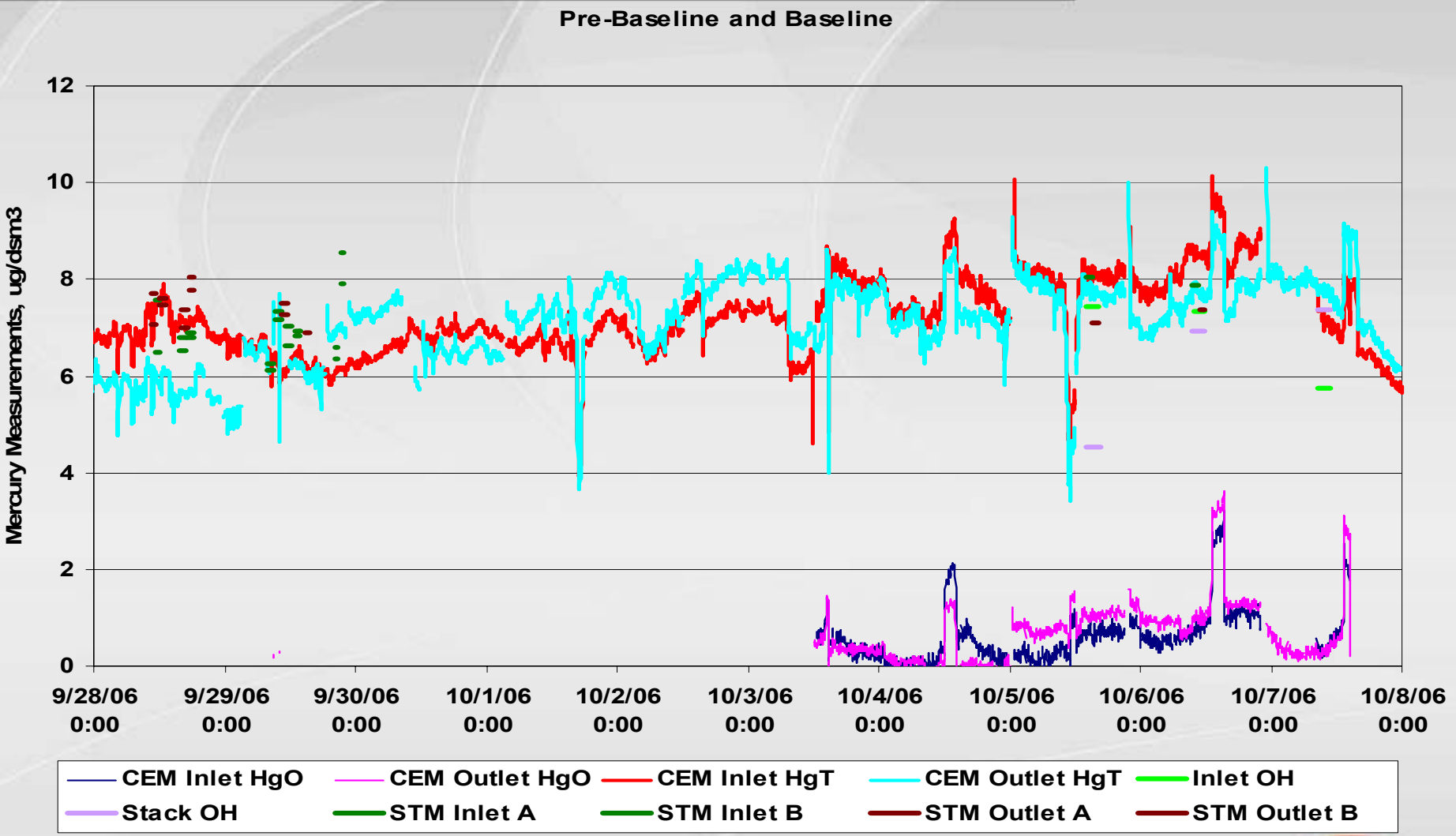
# Baseline Results

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# Co-Benefit Results

| Test Condition | $SO_3$ Measurements (ppm) | |
|---|---|---|
| | Breen | Manual Measurements |
| Baseline | 10–20 | 15–20 |
| MgO Injection | 5–12 | |
| Trona Injection | 7–10 | 7–10 |

Tested Sorbents

- MgO
- Trona

MgO previously tested on site

Trona selected per REI recommendation

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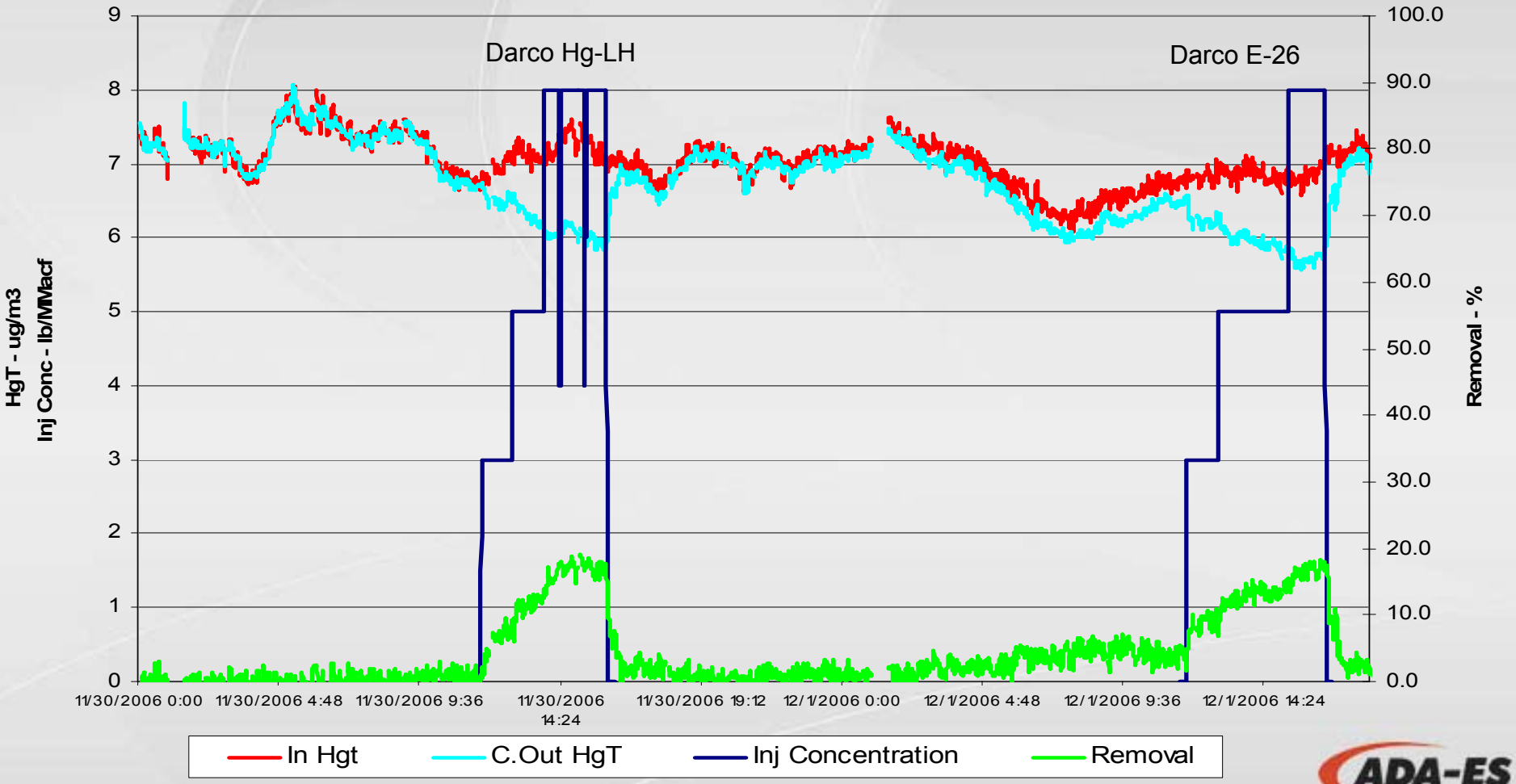
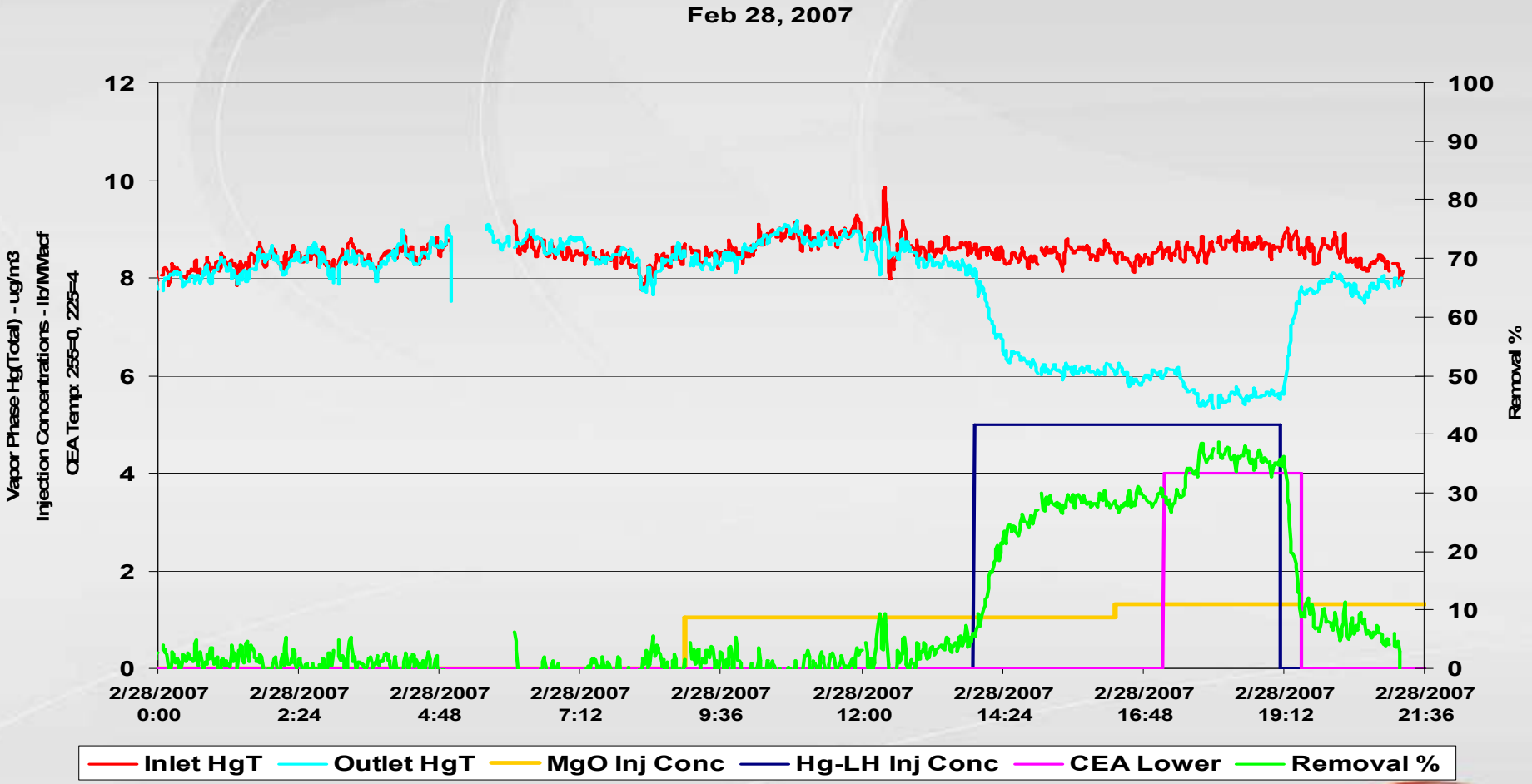
# December 2006 Parametric Testing

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



# February 2007 Parametric Testing

## PAC Injection between ESPs, MgO $SO_3$ Mitigation, CEA Temp Change

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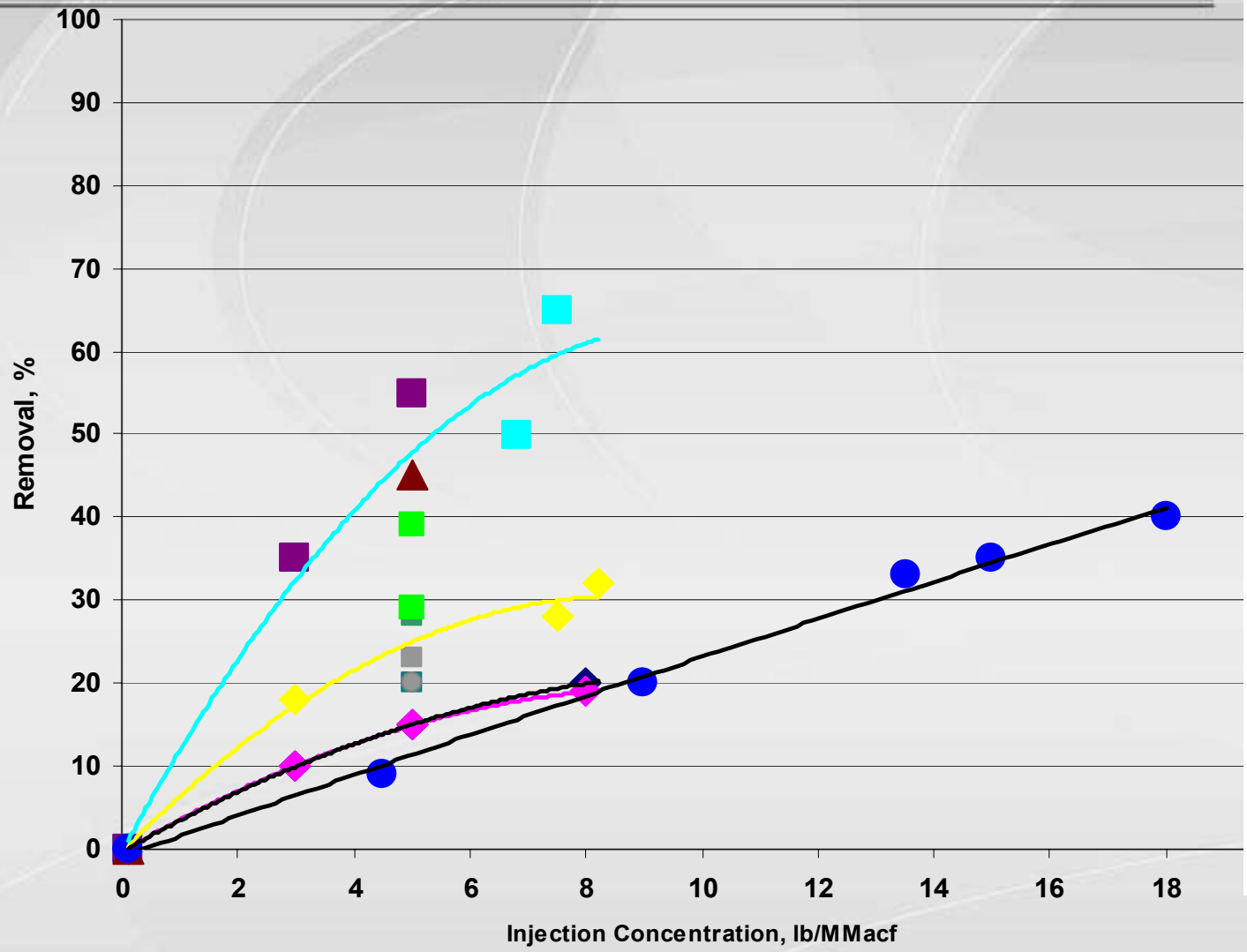
# Parametric Test Results




- Hg-LH only
- E-26(1) only
- E-26(2) low CEA
- Hg, Trona, low CEA
- Hg-LH, Trona, low CEA
- Hg-LH, Trona, norm CEA
- Hg-LH, APH Inlet
- Hg-LH, MgO-30
- Hg-LH, MgO-90
- MC+, MgO-30
- MC+, MgO-90
- Hg-LH, MgO-150
- Hg-LH, MgO-150, low CEA

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# Why Continue Testing Both MgO and Trona

- Trona better performer for aiding Hg removal
- MgO Benefit
  - Can be recycled back to the furnace
  - No land fill issues
- Trona
  - Cannot be recycled back to the furnace
  - Na% can prevent beneficial uses (concrete additive)

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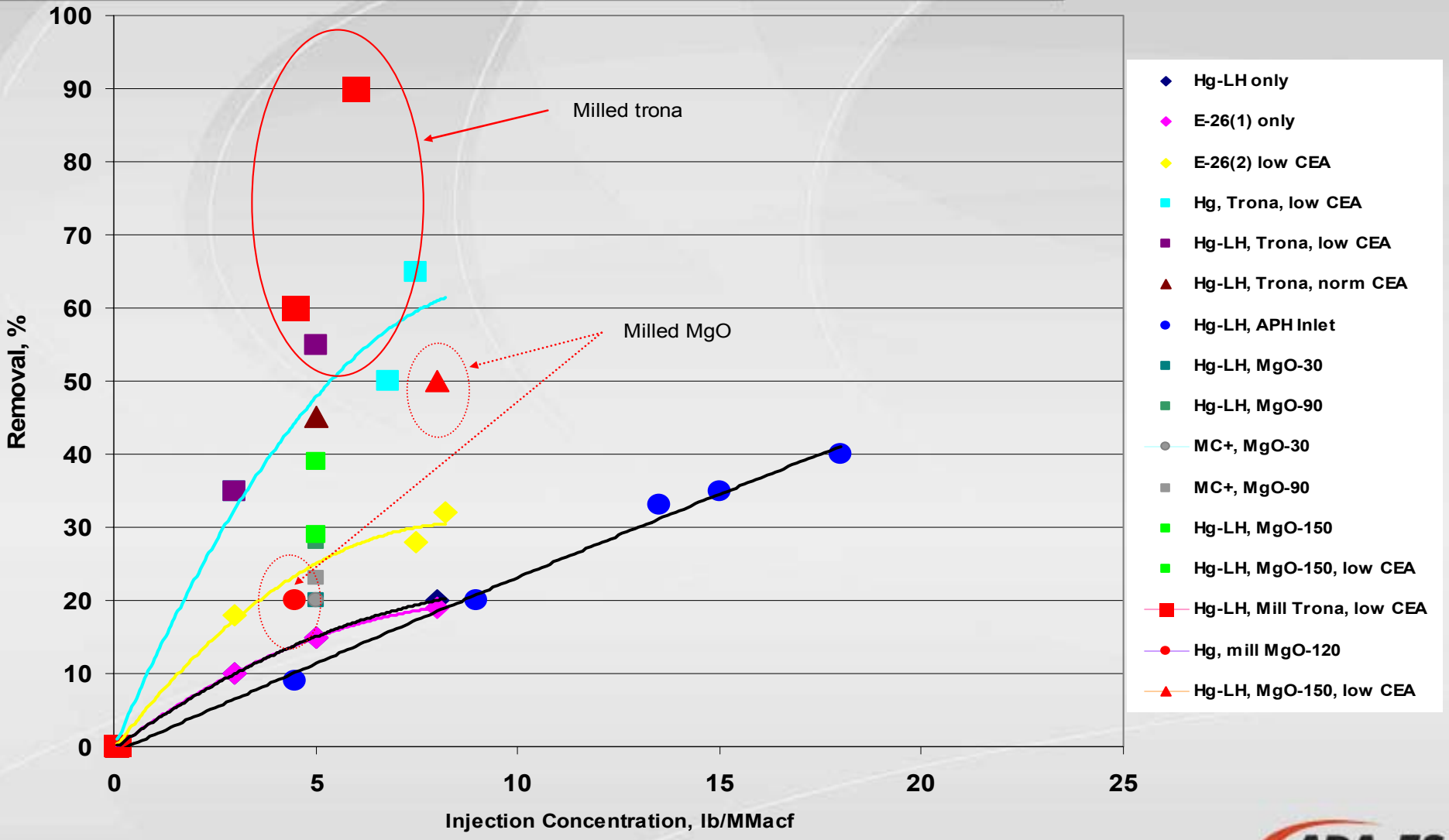
# Balance of Plant Test Results

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# Long Term Testing at Merrimack Unit 2

- Long Term Test Sequence
  - LT Test : Scheduled Start June 2007, Delayed until November 2007
    - Trona Injection: 400 - 500lb/hr
      - Option 1: On-site milling
    - PAC Injection: 5lb/MMacf
      - Brominated PAC – Norit DARCO Hg-LH
  - Commercial equipment installation complete June 25
    - Equipment testing June 25 – 27
    - First PAC shipment June 27
  - O'Brien&Gere Trona injection equipment complete June 27
    - Transition from trailer injection to silo injection July 2007

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# Long Term Schedule at Merrimack Unit 2

- Long Term Schedule
  - Three challenges prior to start of long term testing – June 2007
    - Planned LT test evolutions affected by the commitment of DOE to fund the project
    - Opacity problems
    - Ash utilization
  - Long Term Test
    - Started November 2007
    - Completion currently scheduled in February 2008
  - Final Report issued May 2008

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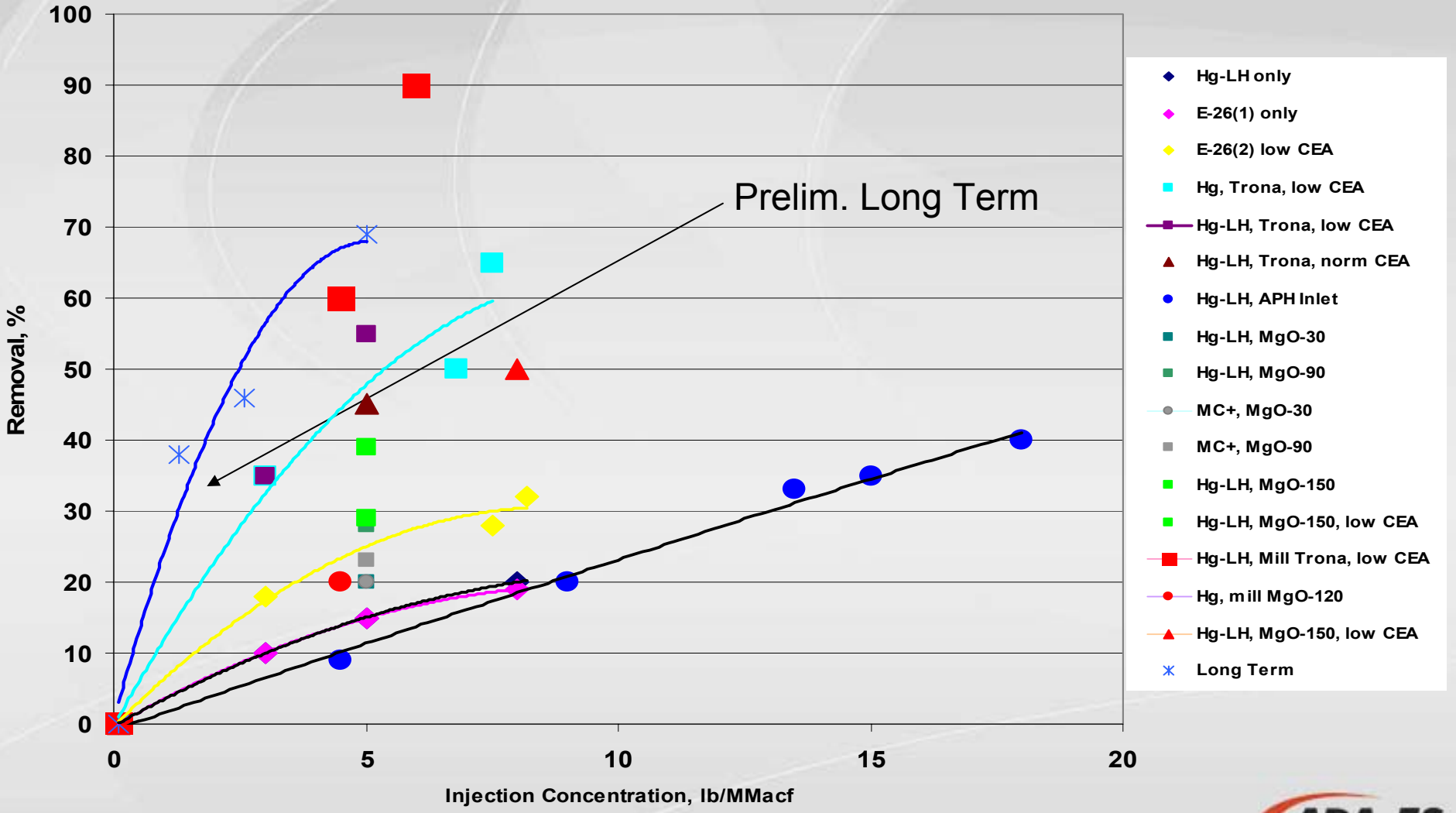
# Preliminary Long Term Results at MK2

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# Economics

| | |
|---|---|
| Mercury Removal Rate | 70%* |
| Brominated PAC Injection rate for above removal | 6 lb/MMacf<br>(400 lbs/hr) |
| Native Mercury Removal | 0 – 10% |
| Stack Flow | 790 kscfm |
| 20 Year Levelized Cost | $ 3.7M ** |
| 20 Year Levelized $/lb Mercury Removed | $ 59K ** |

* Includes native removal from long term test blend of coal.

** Includes ash disposal fees and trona costs.

**Capital Cost Estimate:$10.66/kW**
**O&M Cost Estimate: 1.62 mills/KW-hr**

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# Questions/Discussion

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