Demonstration of Mer-Cure™ Technology for Enhanced Mercury Control

(DOE Cooperative Agreement DE-FC26-07NT42776)

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and
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DOE/NETL

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Outline

- Background
- ALSTOM Mer-Cure™ Technology
- Project Objectives and Plan
  - Budget Period 1 – LCRA short-term demo
  - Budget Period 2 – LCRA long-term, Reliant Energy demo
- Budget Period 1 Test Results from LCRA
  - Baseline measurements
  - Parametric testing
  - Ash evaluation
  - Balance of plant impact
- Summary
- Acknowledgements

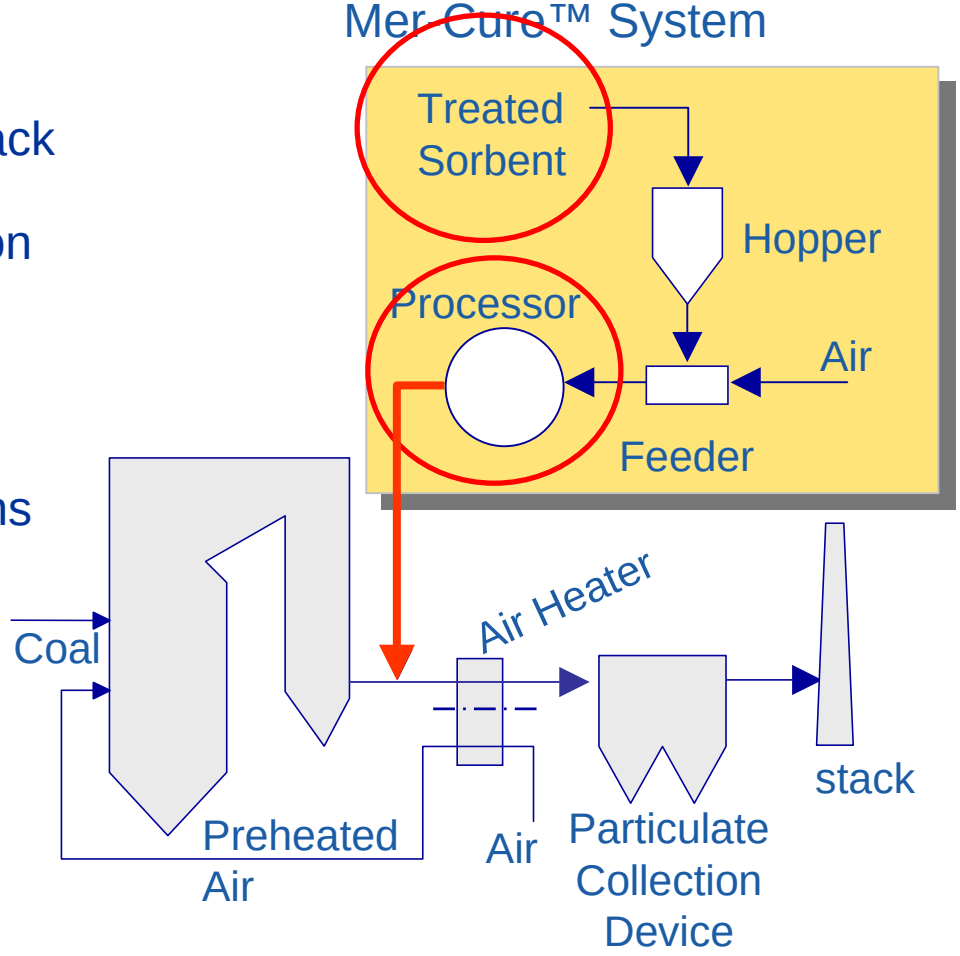
Background

- No “one-size-fits-all” solution for mercury control
  - Each plant has its own unique opportunities/challenges
  - Fuel type, boiler operation, and backend configuration
  - System-wide control strategy
    - CAMR vs. state regulations
- ALSTOM has developed diverse mercury control options in order to meet unique challenges of customers
  - Coal additives for co-benefits
  - Activated Carbon Injection (ACI) + Baghouse installation
  - “Enhanced” sorbent injection – Mer-Cure™
- ALSTOM Mer-Cure™ technology development target
  - Easy retrofit solution for boilers (mainly with ESP only)
  - Low capital investment
  - Low operating cost
  - Removal efficiency greater than 90%

Mer-Cure™ System Architecture

1. Proprietary sorbent design
   - Accelerated oxidation/capture
   - Mitigate SO_3 impact/improved stack opacity
   - Prepared for high-temp application
2. On-line processing of sorbent
   - Uniform dispersion
   - Maximum surface area
   - Removed mass transfer limitations
3. Injection upstream air heaters
   - High temperature
   - Longer residence time
   - Above acid dew point
   - More internal duct area

Patent pending



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Project Team

Department of Energy/NETL

Alstom Power Inc.

Lower Colorado River Authority

Reliant Energy

Envergex, LLC

UND EERC

Project Goals:

DOE Phase III:

- Full-scale demonstration of a mercury control technology capable of
  - 90% capture above baseline, i.e., uncontrolled mercury emissions;
  - At 50% or less of the baseline cost ($50,000/lb Hg removed)
  - Various plant configurations
- Longer-term demonstration

LCRA:

- Allow continued ash utilization
  - Reduced consumption of sorbent due to co-benefit from FGD
  - New sorbent formulations

Reliant Energy:

- Reduce sorbent consumption under high SO_3 environment
  - SO_3-tolerant sorbent formulations

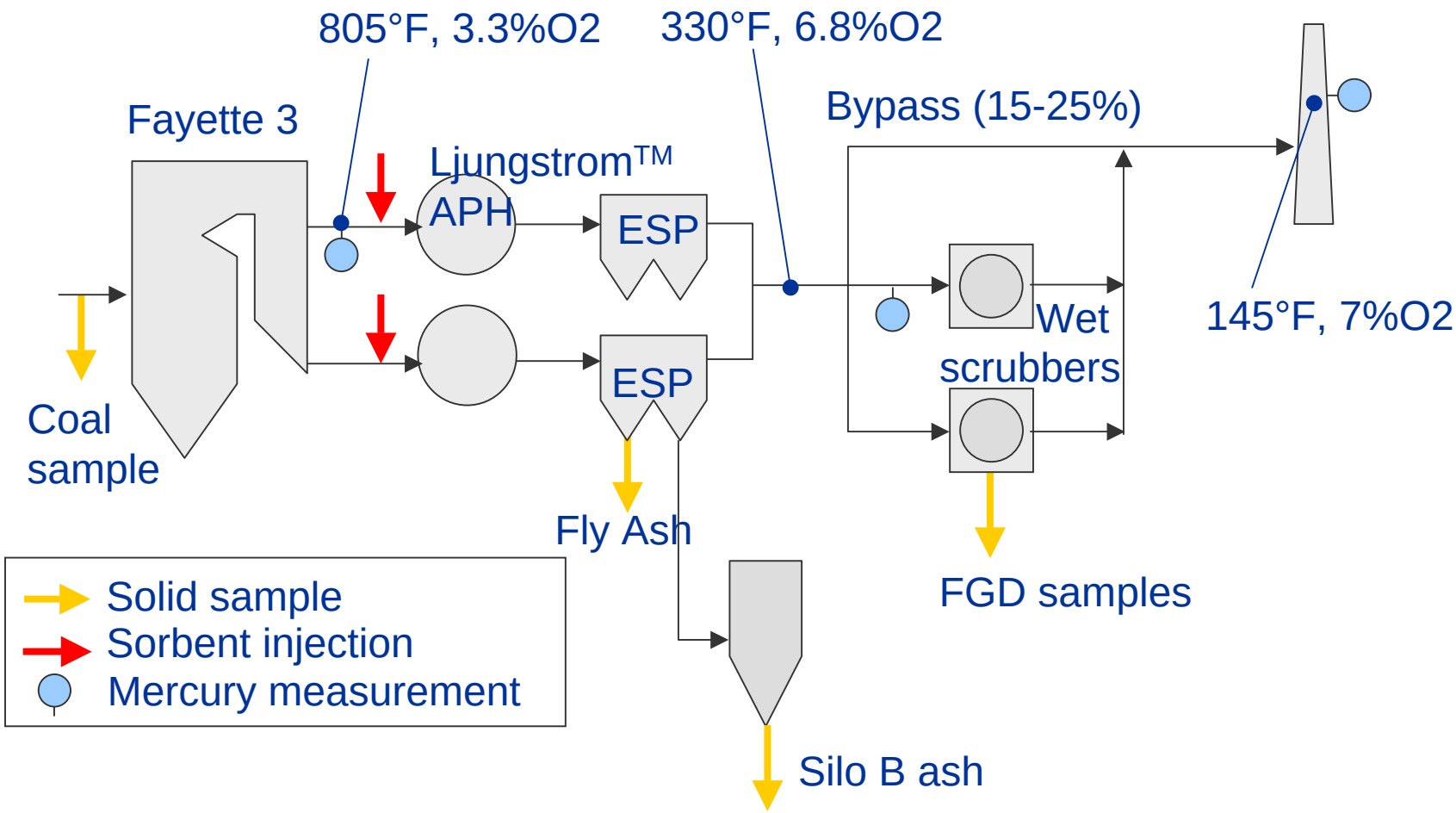
LCRA Fayette Unit 3

Utility	LCRA
Host site	Fayette Unit 3
Size (MW gross)	480
Location	La Grange, TX
Fuel %S %ash ppm Cl ppm Hg	PRB blends 0.6 7.6 49 0.09+/-0.02
Air heaters	Ljungstrom™
Particulate control	CS-ESP
SOx control	Wet FGD

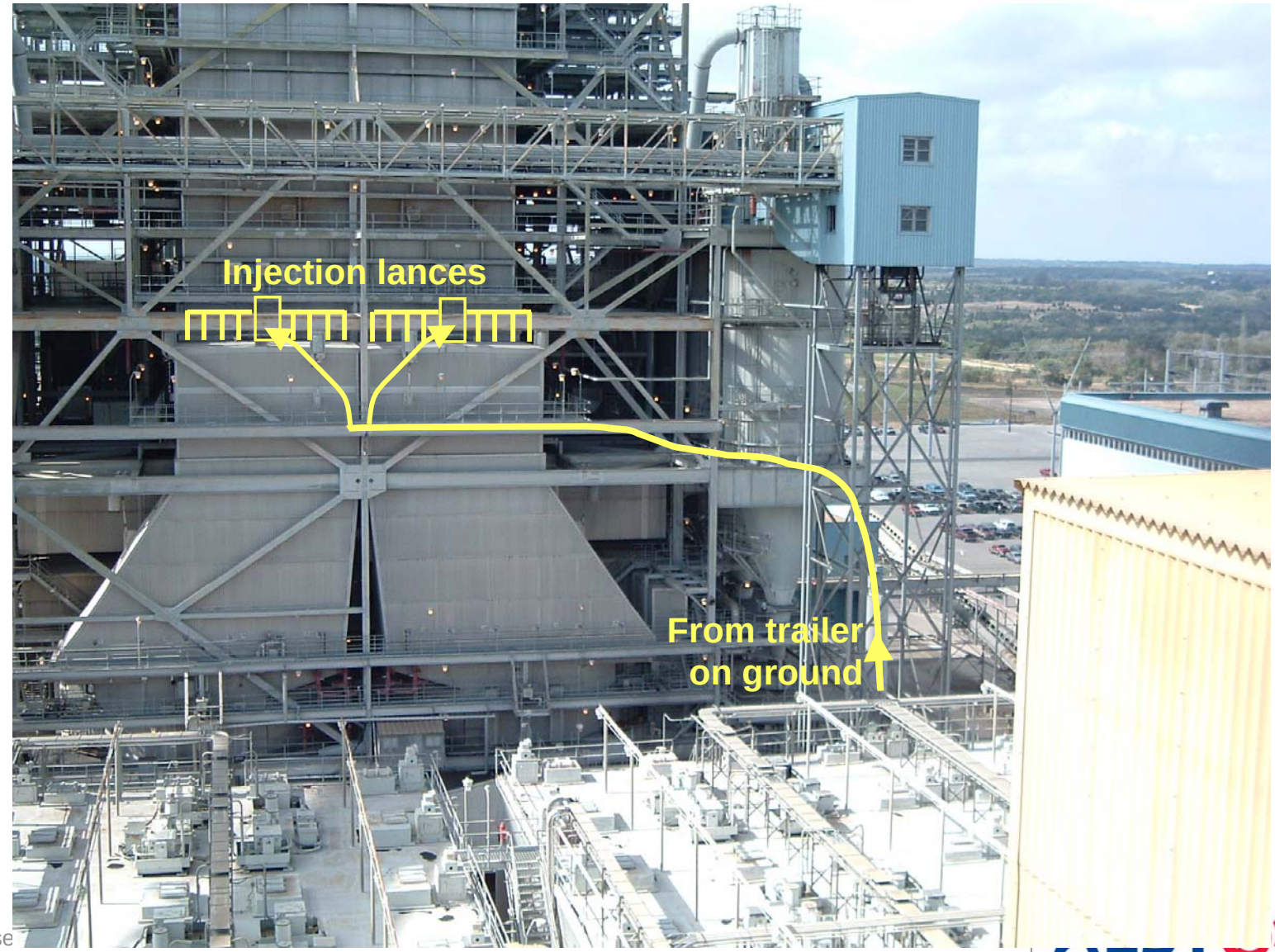
Test Plan (3/5/07 through 4/8/07)

Sun	Mon	Tue	Wed	Thu	Fri	Sat
2/25	2/26	2/27	2/28	3/1	3/2	3/3
3/4	3/5 **Baseline mercury measurement (no injection of sorbents)** **Mer-Cure installation week**	3/6	3/7	3/8	3/9 **Kick-off Meeting**	3/10
3/11	3/12 **Parametric testing (injection of various sorbents at several injection rates)**	3/13	3/14	3/15	3/16	3/17
3/18	3/19 **Ash evaluation starts (continuous injection of sorbents at a fixed lb/MMacf for sampling of representative bulk ash)** day 1 MerClean	3/20 day 2 MerClean	3/21 day 3 MerClean	3/22 day 4 MerClean	3/23 day 5 MerClean	3/24 day 6 MerClean
3/25 day 7 MerClean recovery, PM	3/26 day 1 eSorb 11	3/27 day 2 eSorb 11	3/28 day 3 eSorb 11	3/29 day 4 eSorb 11	3/30 day 5 eSorb 11	3/31 day 6 eSorb 11
4/1 forced outage	4/2	4/3	4/4	4/5	4/6	4/7
4/8	4/9 Demobilize mobile u	4/10 Demobilize	4/11 Demobilize scheduled outage starts	4/12 Demobilize	4/13 Demobilize	4/14

Fayette 3 Plant and Sampling Layout

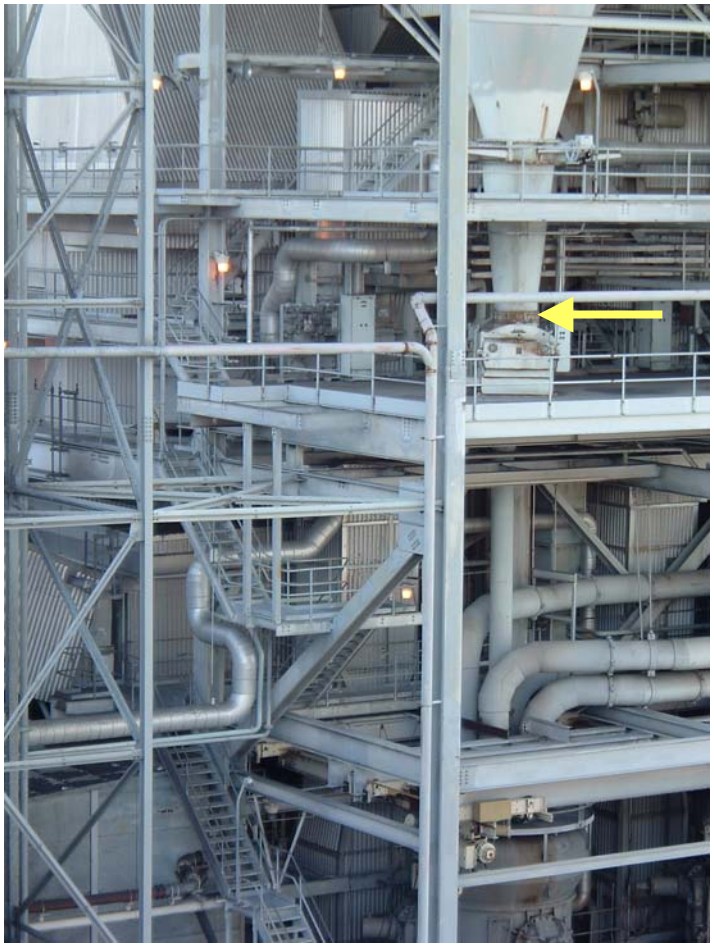


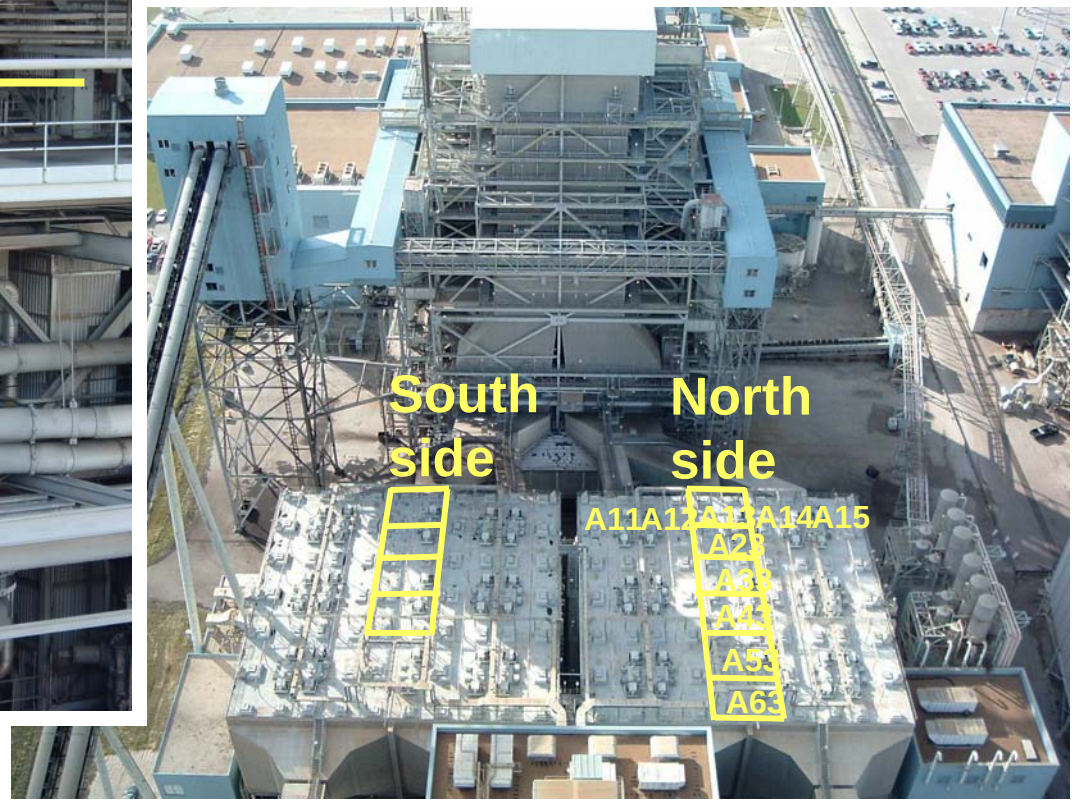
Mer-Cure™ Equipment Layout in Fayette 3



Injection Deck

Solids Sampling Locations





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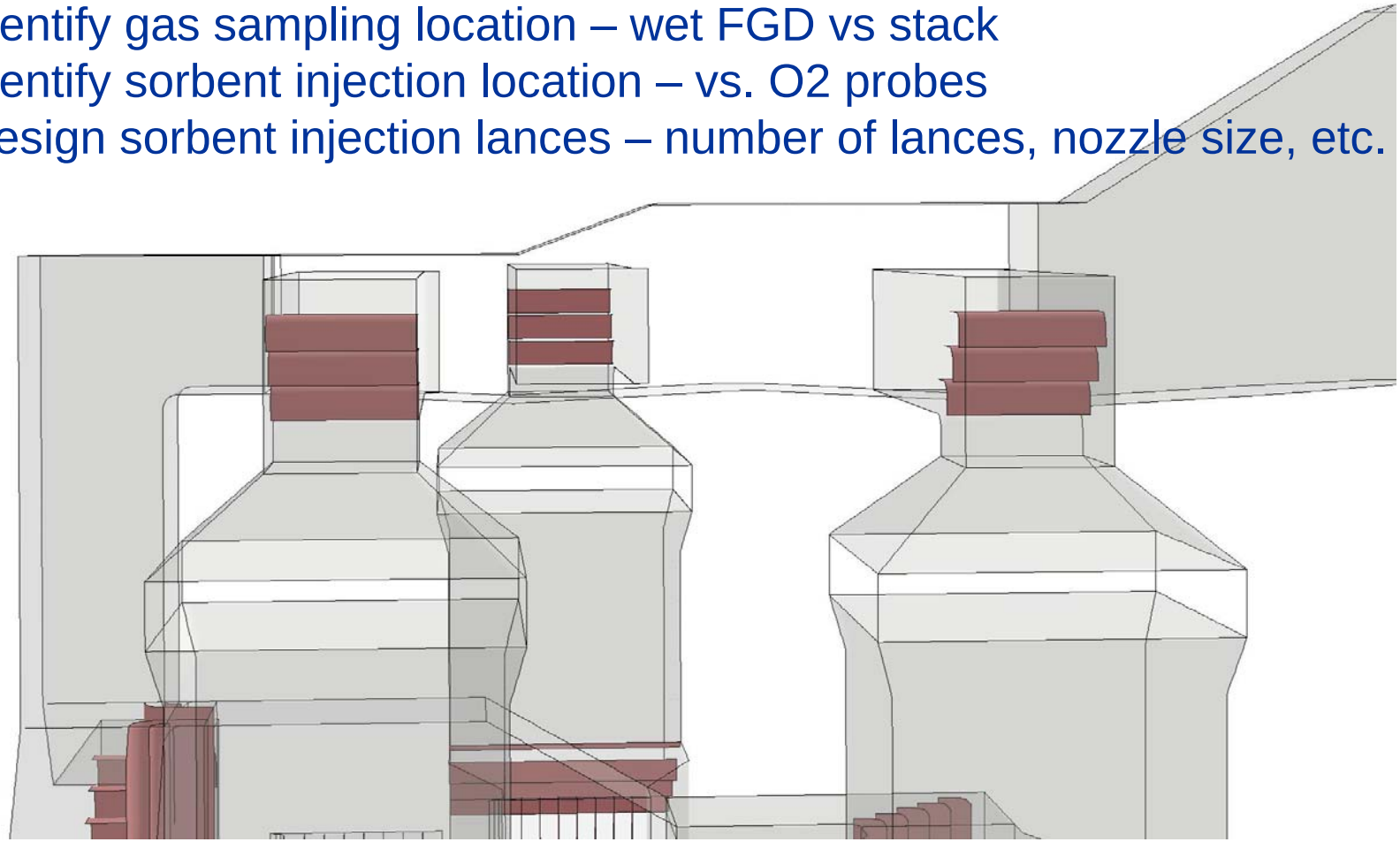
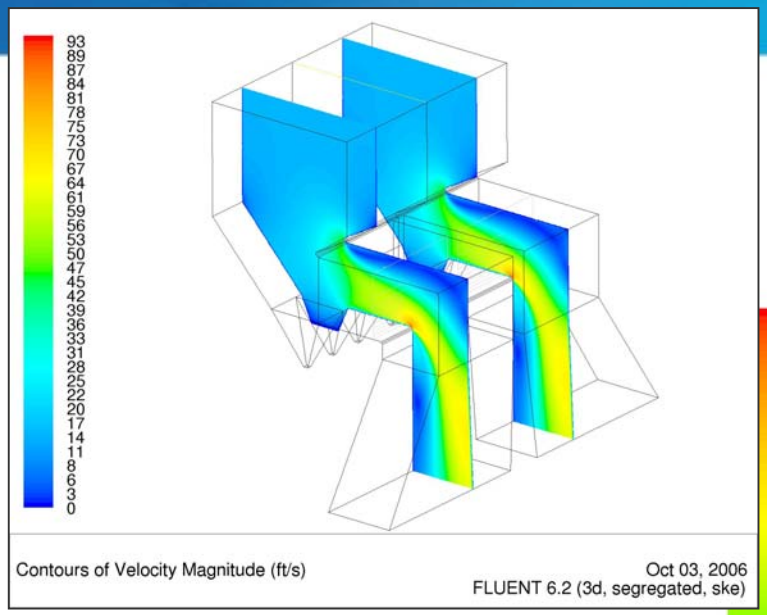
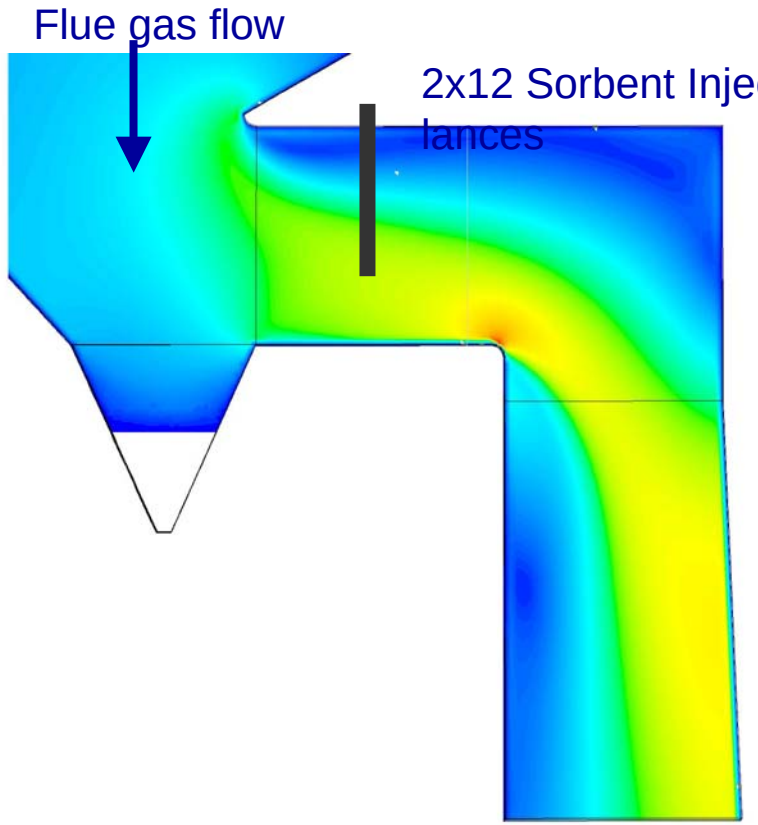
Computational Fluid Dynamics (CFD) Modeling

- Identify gas sampling location – wet FGD vs stack
- Identify sorbent injection location – vs. O2 probes
- Design sorbent injection lances – number of lances, nozzle size, etc.



FPP3 Backpass CFD Study for Lance Design





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Contours of Velocity Magnitude (ft/s)

Oct 03, 2006
FLUENT 6.2 (3d, segregated, ske)

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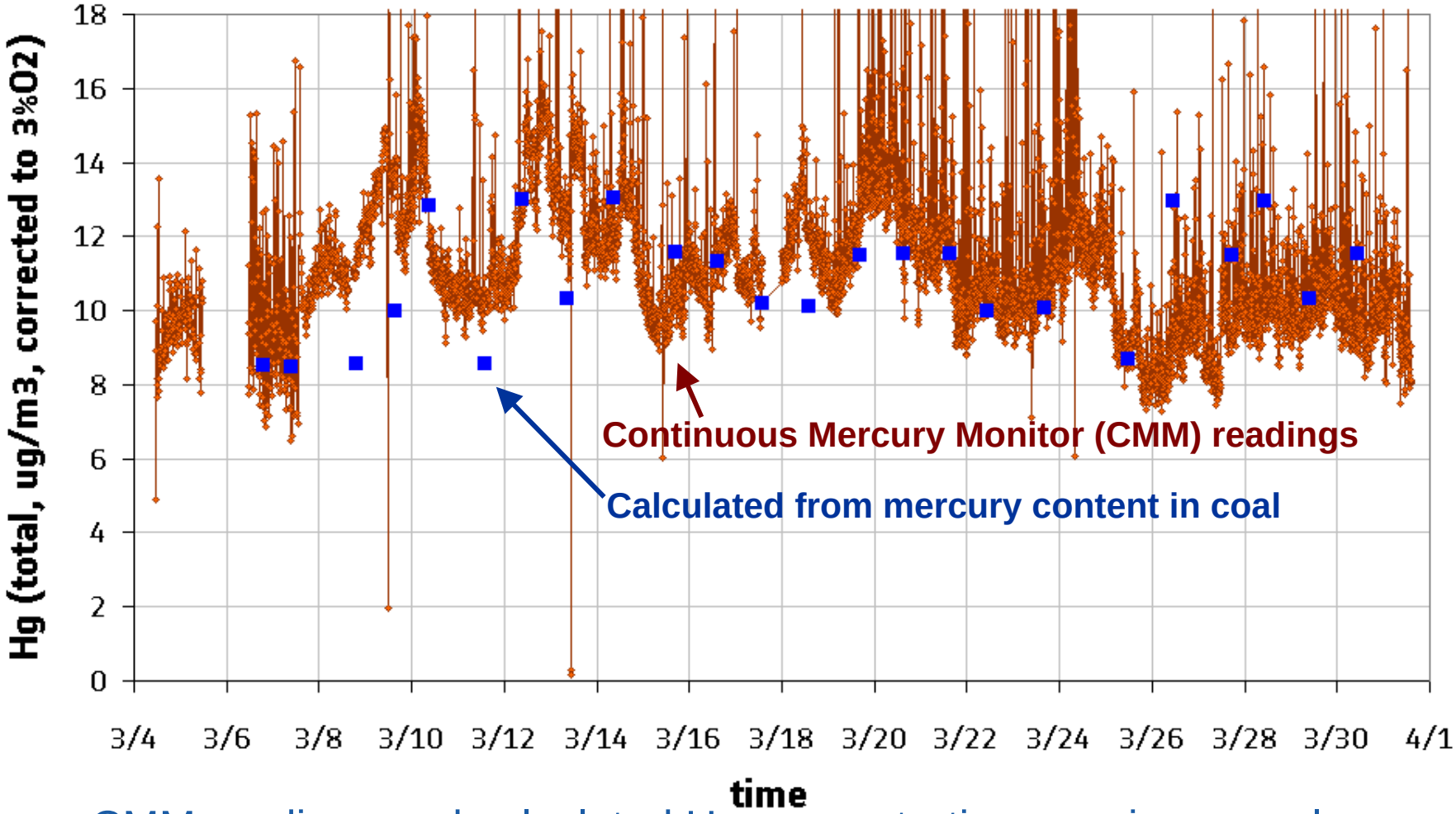
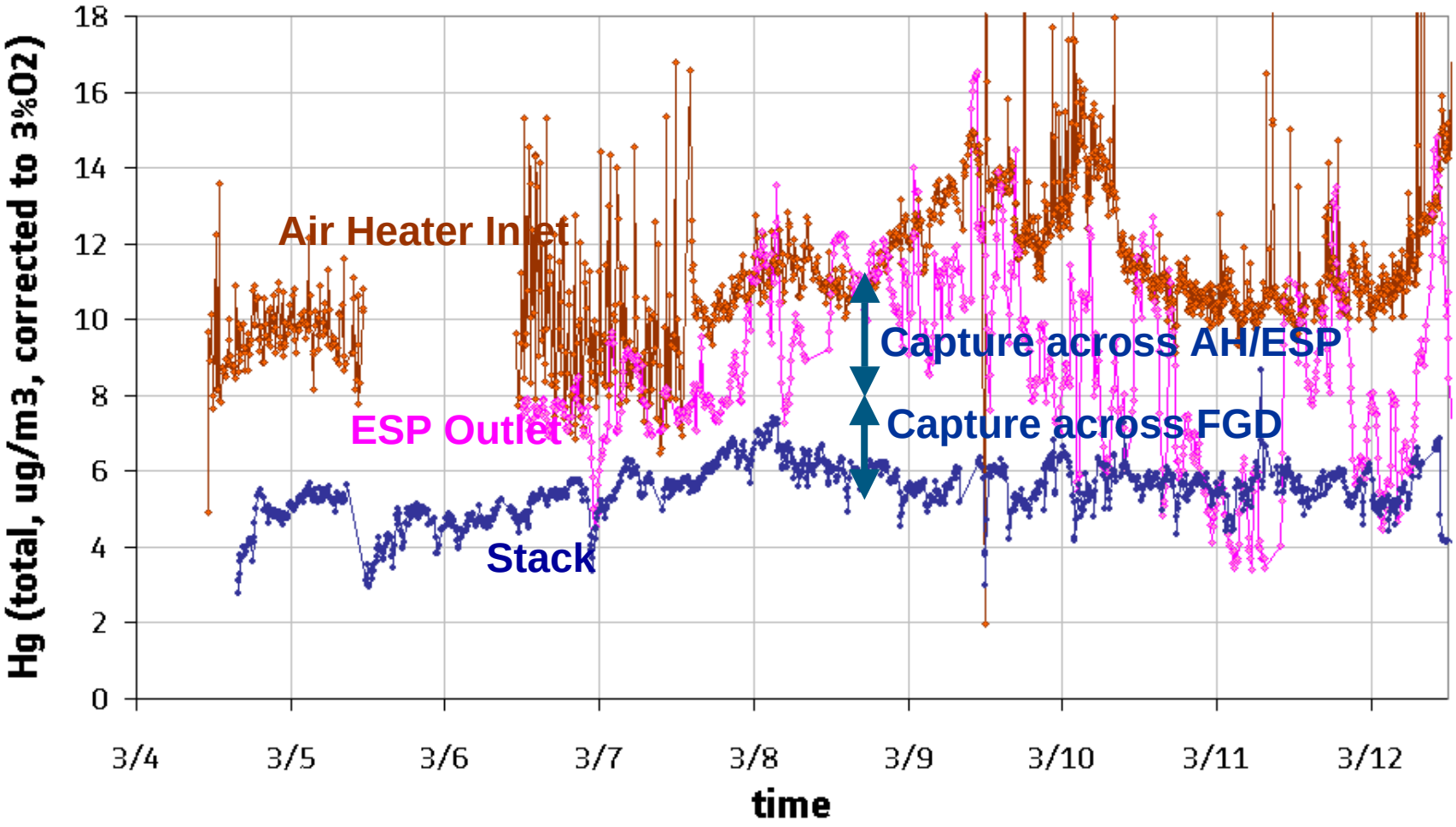
AH inlet CMM vs Hg from coal analysis

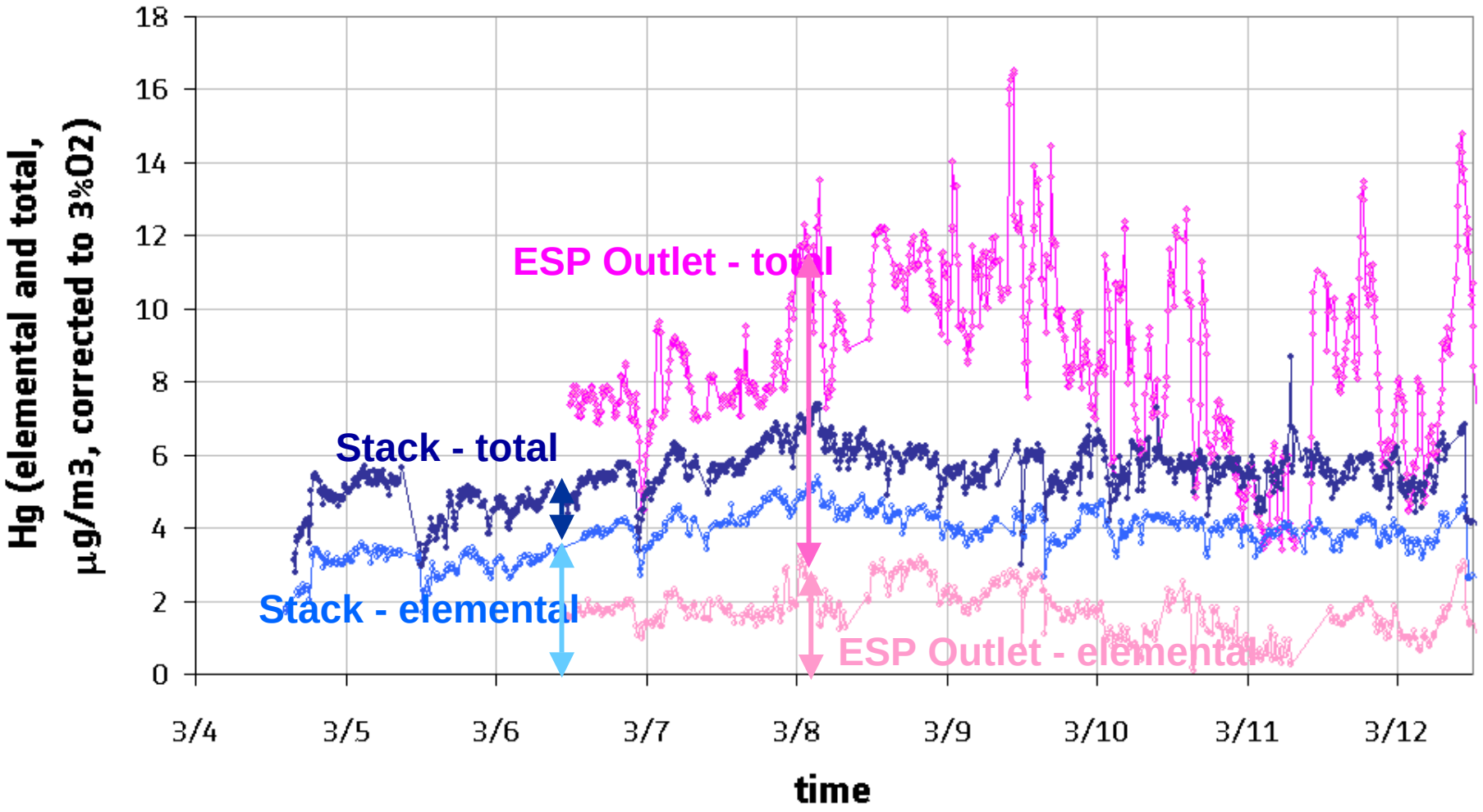


- CMM readings and calculated Hg concentrations are in general agreement

Baseline Measurements – all three locations



Baseline Measurements - Speciation



Baseline Measurements - Summary

(at 3% O2)

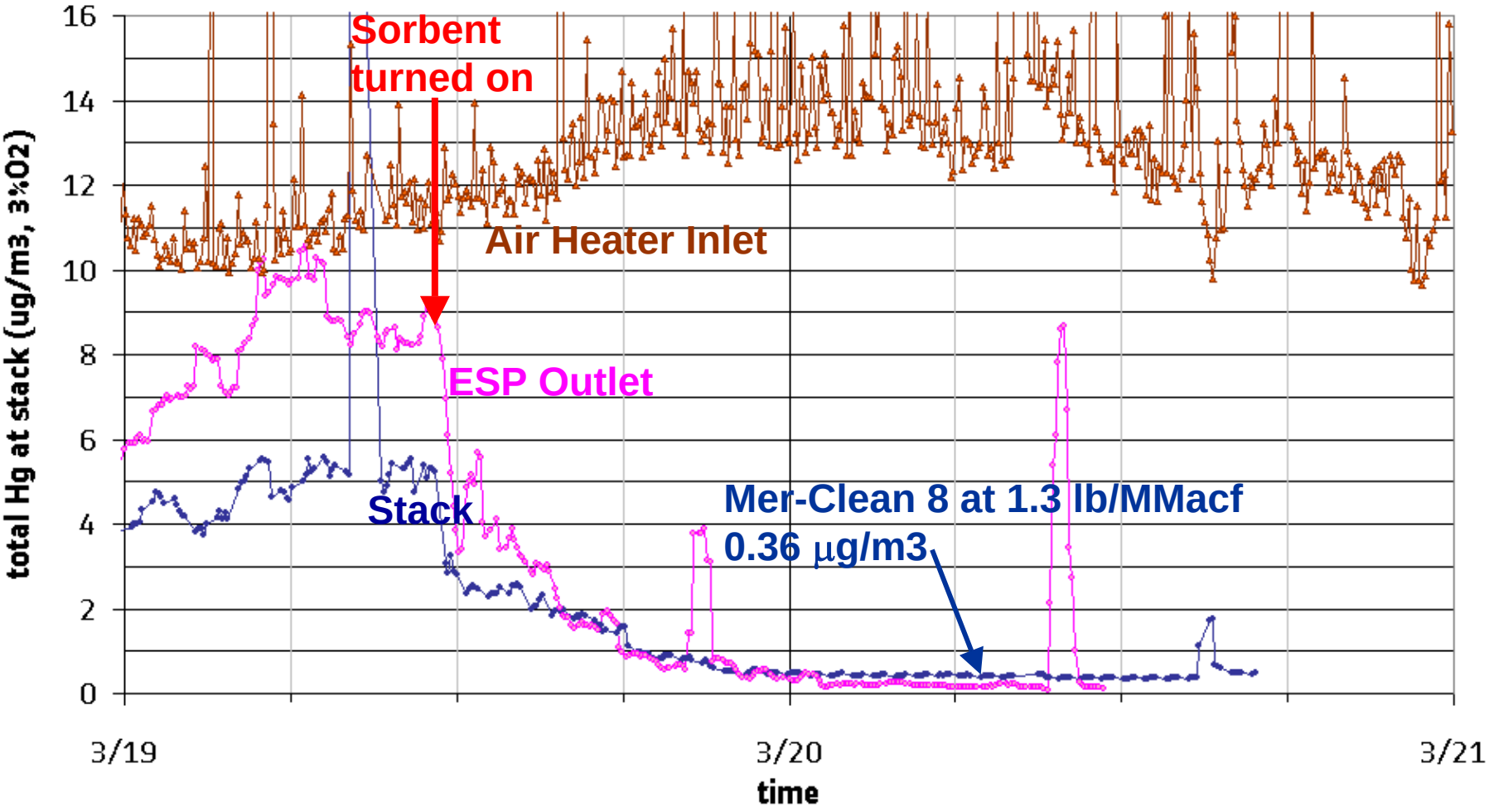
Measurement location	total	elemental	oxidized	% oxidized
Air Heater inlet	11.7	N/A	N/A	
ESP outlet	8.5	1.7	6.8	80% oxidized
Stack	5.9	4.2	1.7	28% oxidized

- About 50% of AH inlet mercury inherently captured by boiler:
  - 27% across AH and ESP
  - 23% across FGD modules
- Not all of oxidized mercury was captured across FGD!!
- A significant amount of oxidized mercury was reduced to elemental mercury in FGD

Parametric Testing

- Tested four (4) sorbents for mercury reduction:
  - ALSTOM's Mer-Clean™ 8, Envergex's eSorb™ 11, 13 and 18
  - Constructed performance curve: injection rate vs. % removal
- Constructed foam index chart with simulated ash-sorbent mixture:
  - Mixed LCRA ash with a small amount of sorbent at various proportions
  - Foam index-tested ash-sorbent mixtures
  - % carbon (sorbent) in ash vs. drops (foam index value)

Parametric Testing – Typical Run



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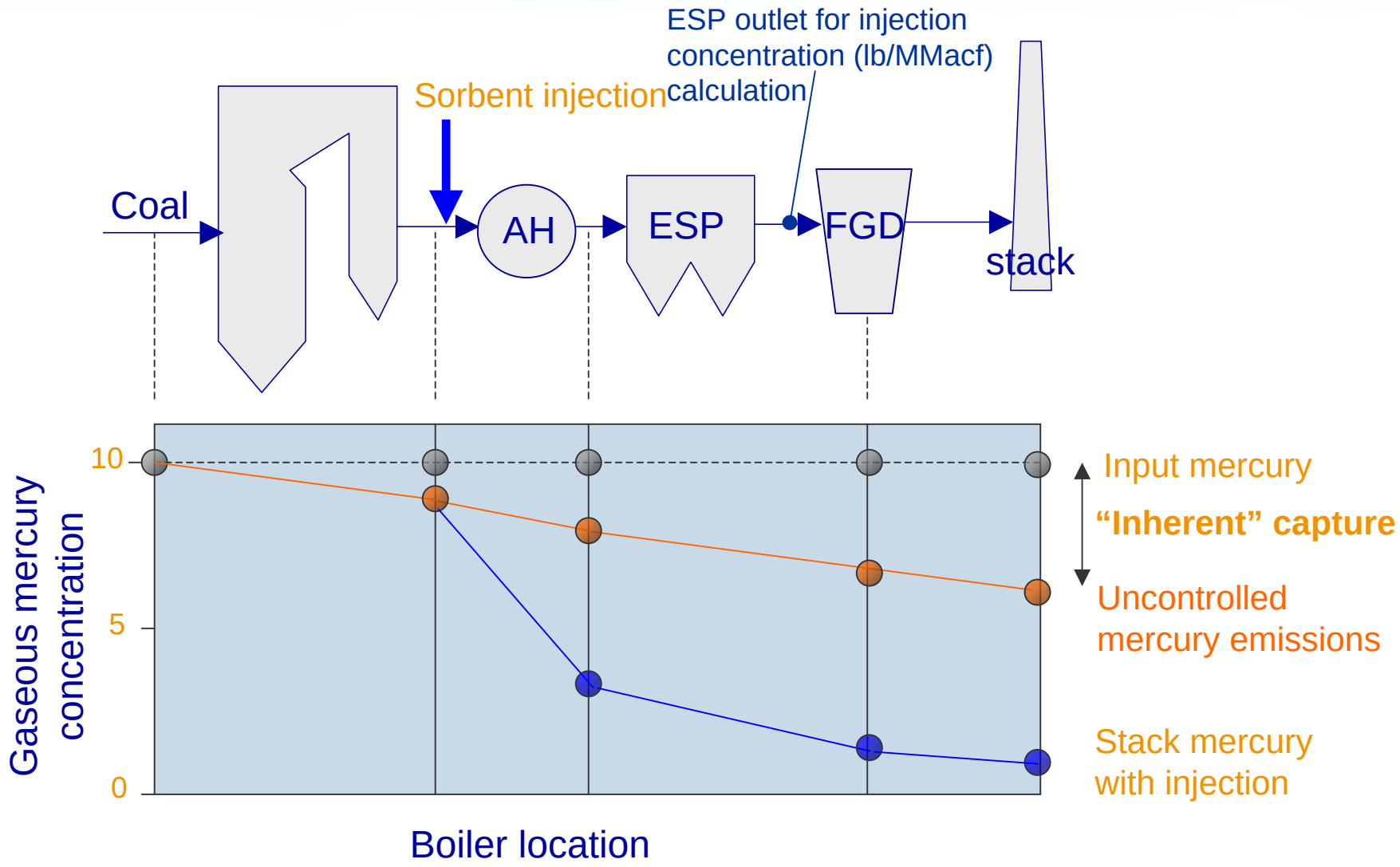
Definitions of Mercury Capture Efficiencies



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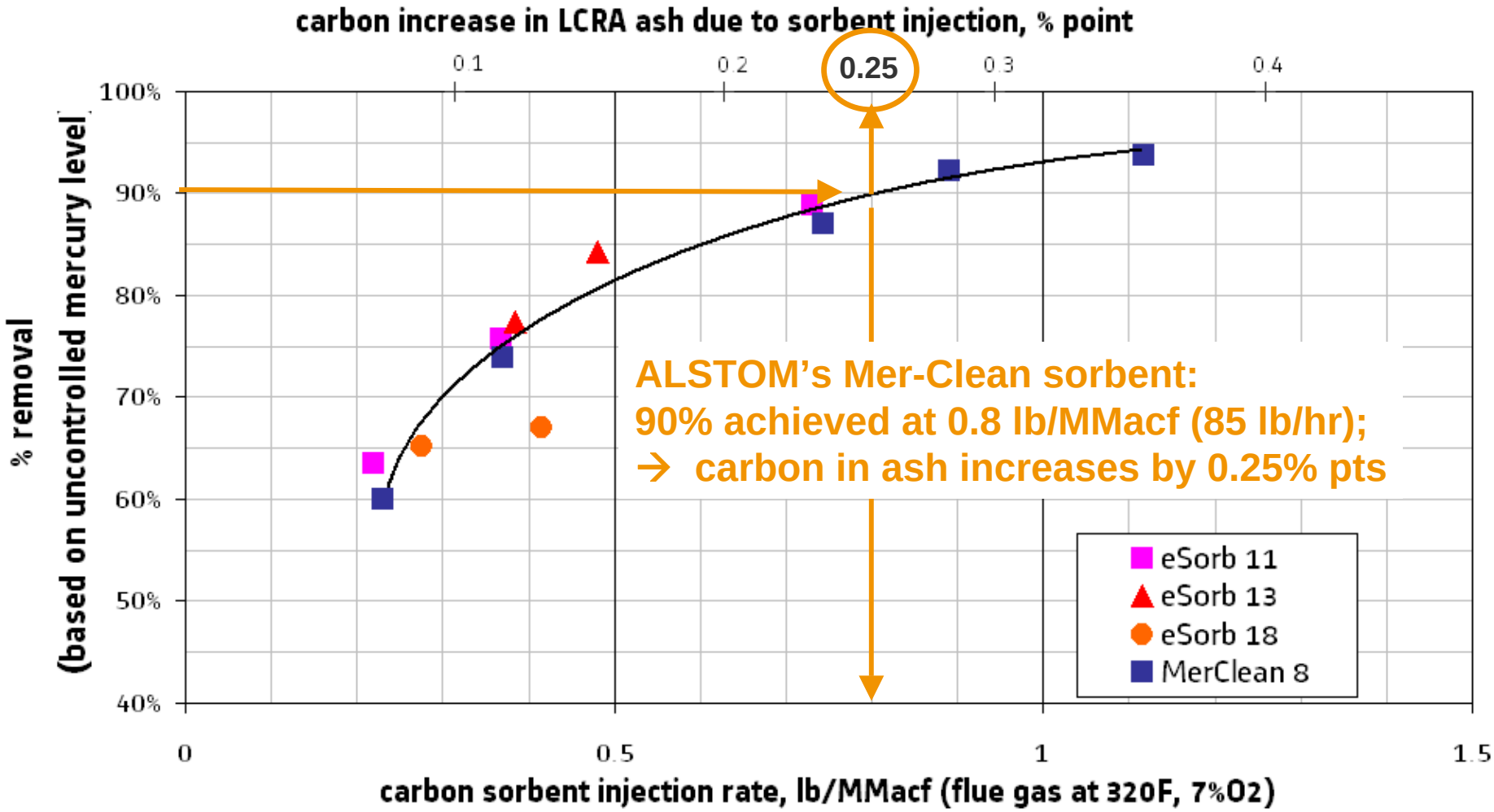
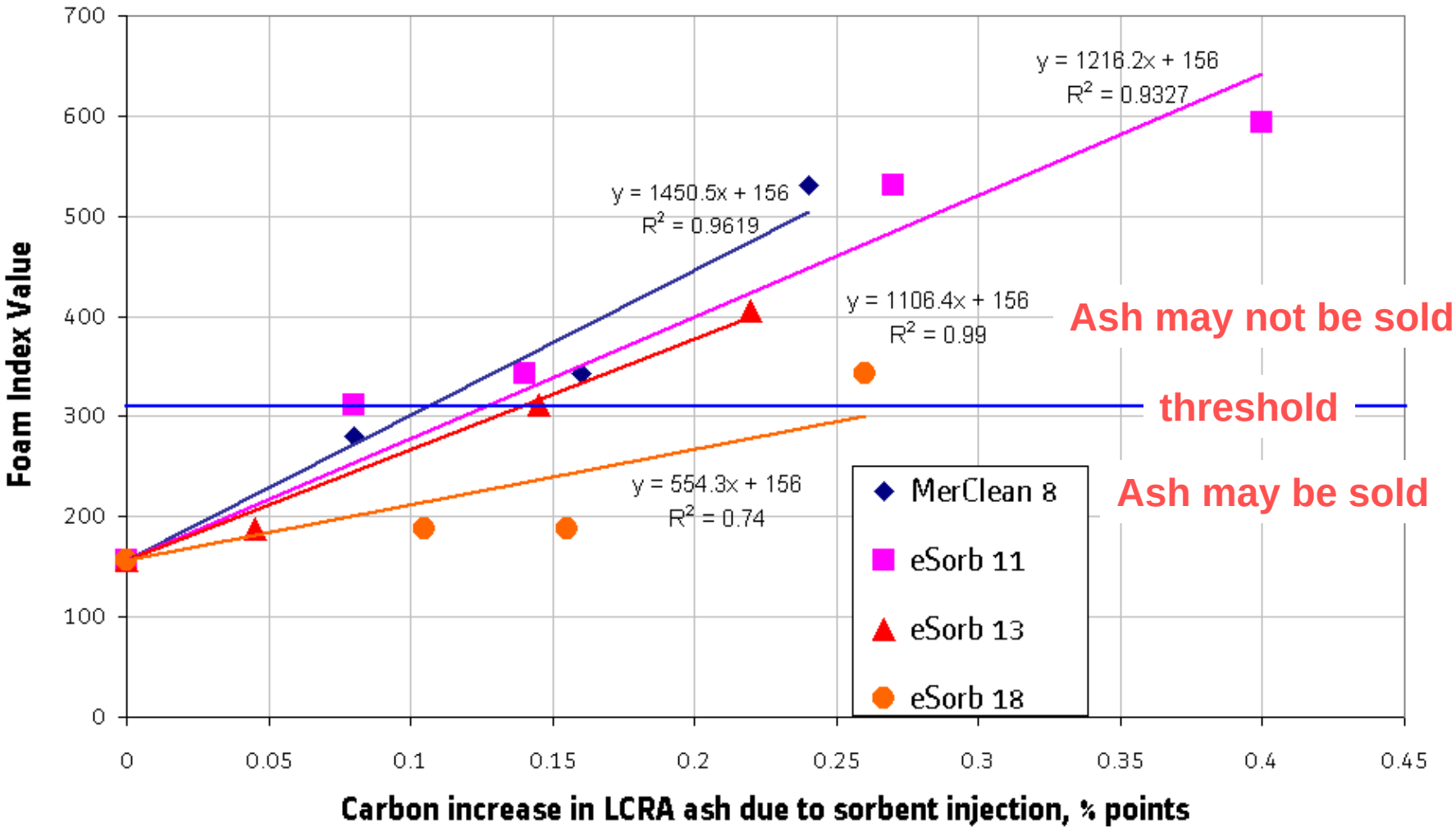
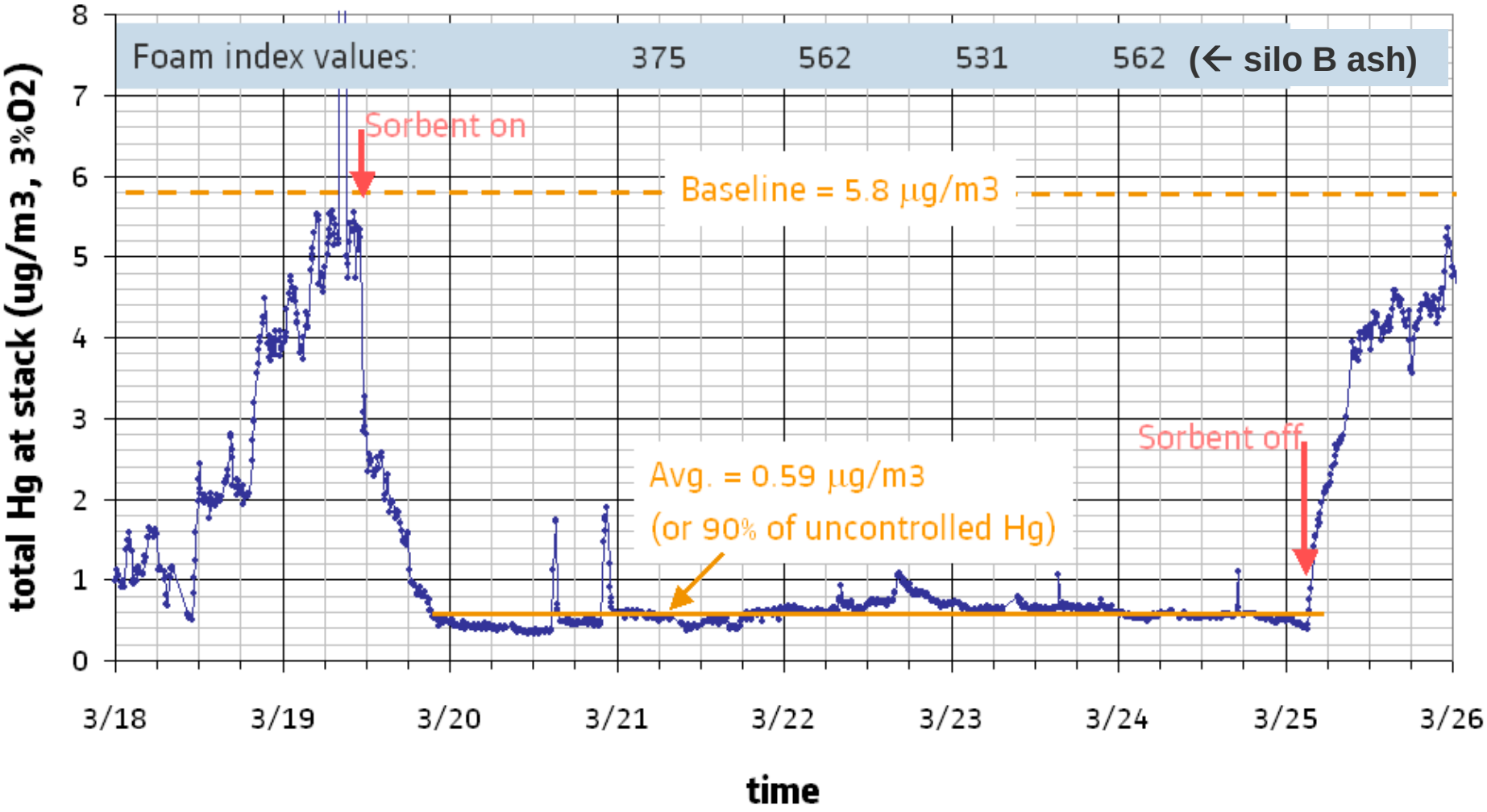
Parametric Testing – Hg capture performance



Parametric Testing – foam index test performance



Ash Evaluation Testing – Mer-Clean™ Sorbent



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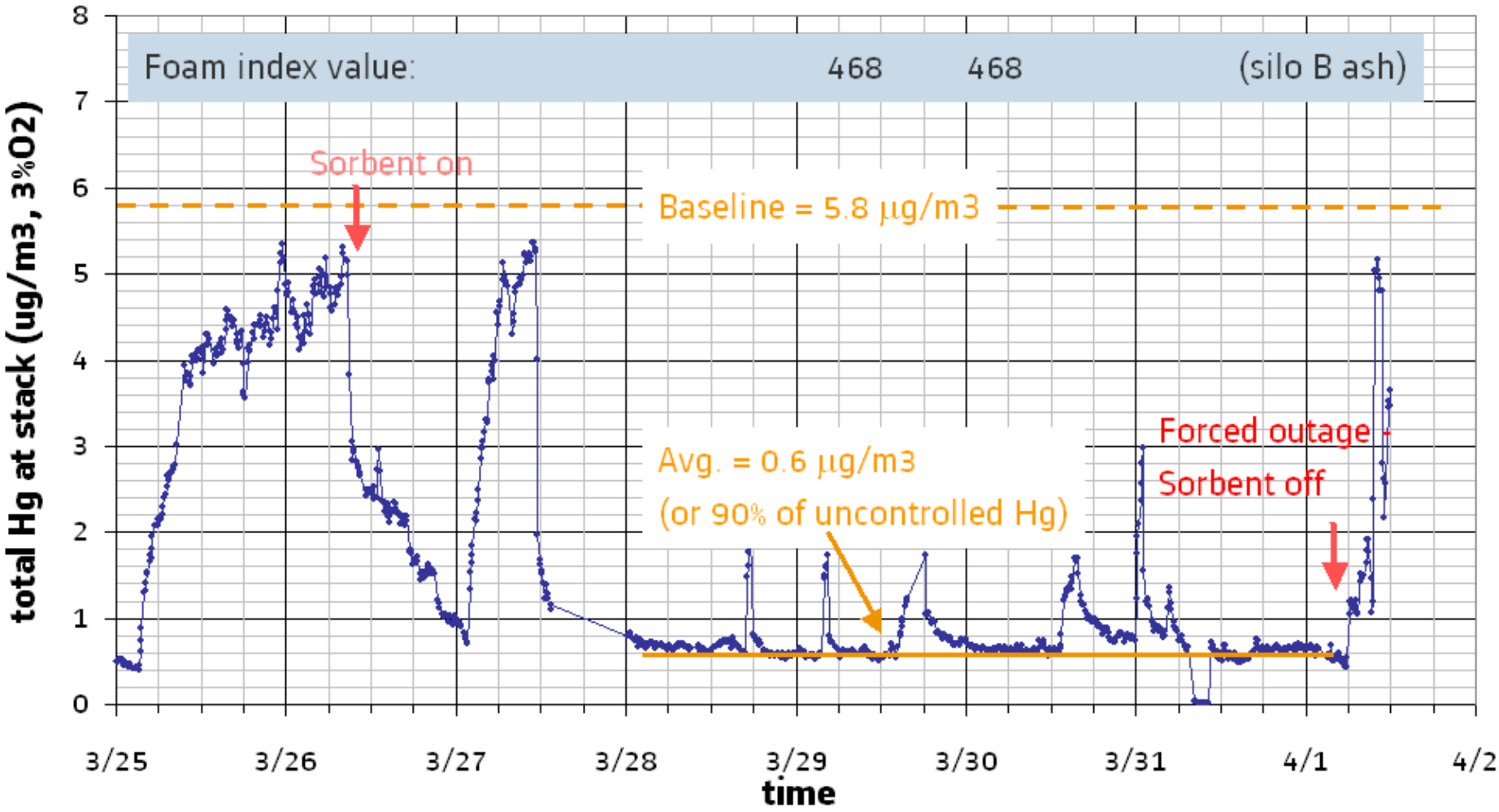
Ash Evaluation Testing – eSorb™ 11 Sorbent



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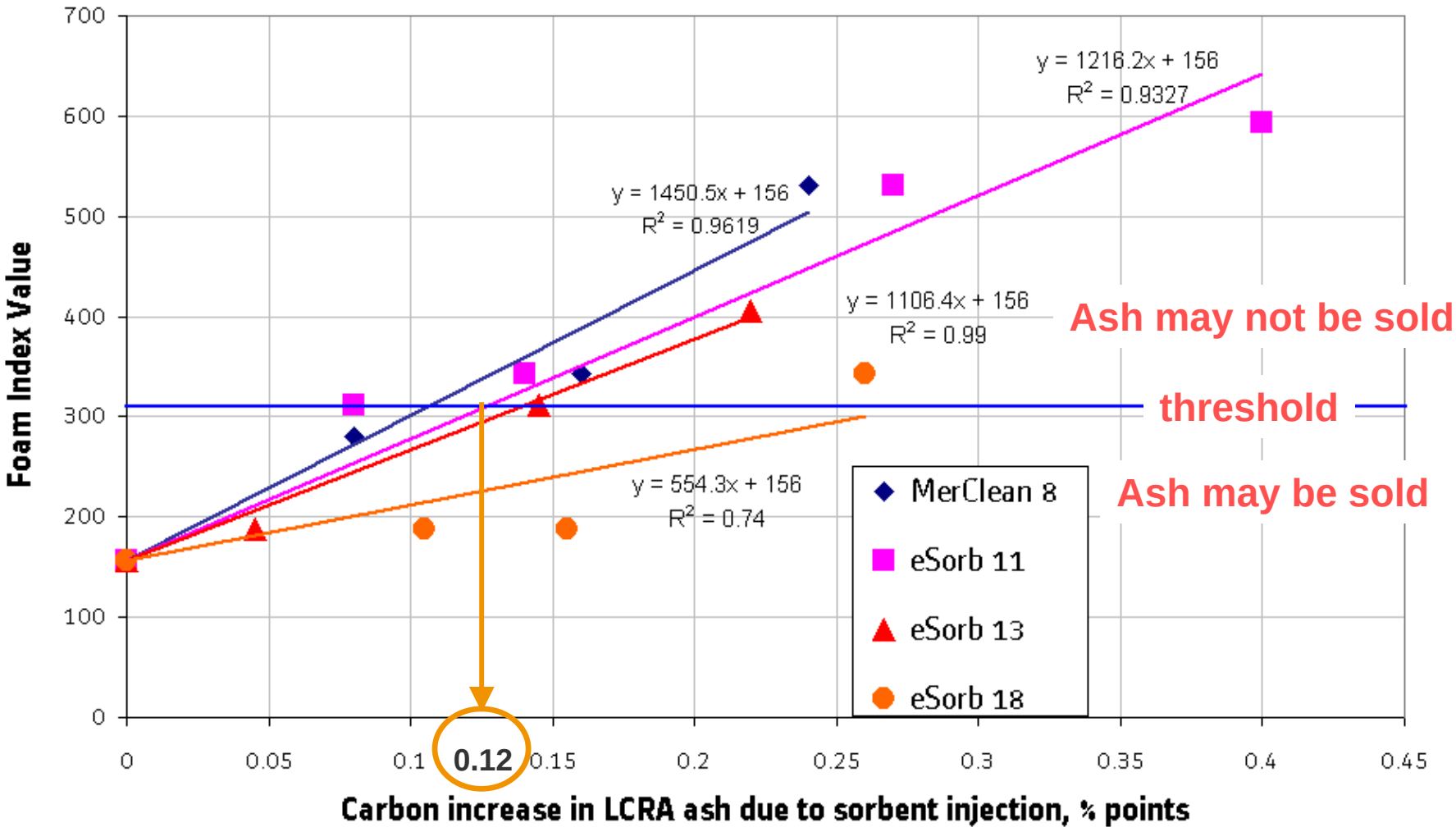
Ash Evaluation Testing – foam index test performance



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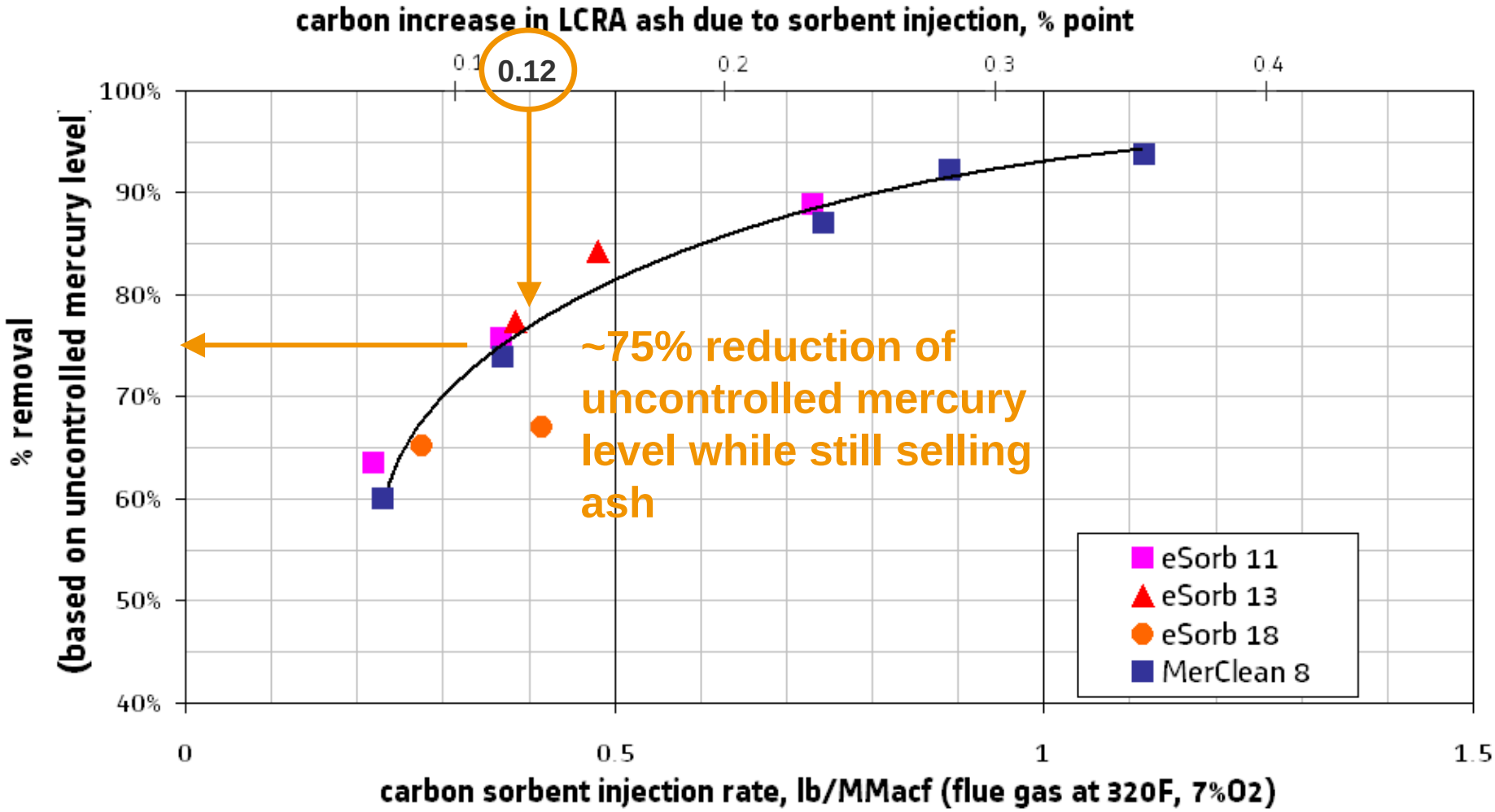
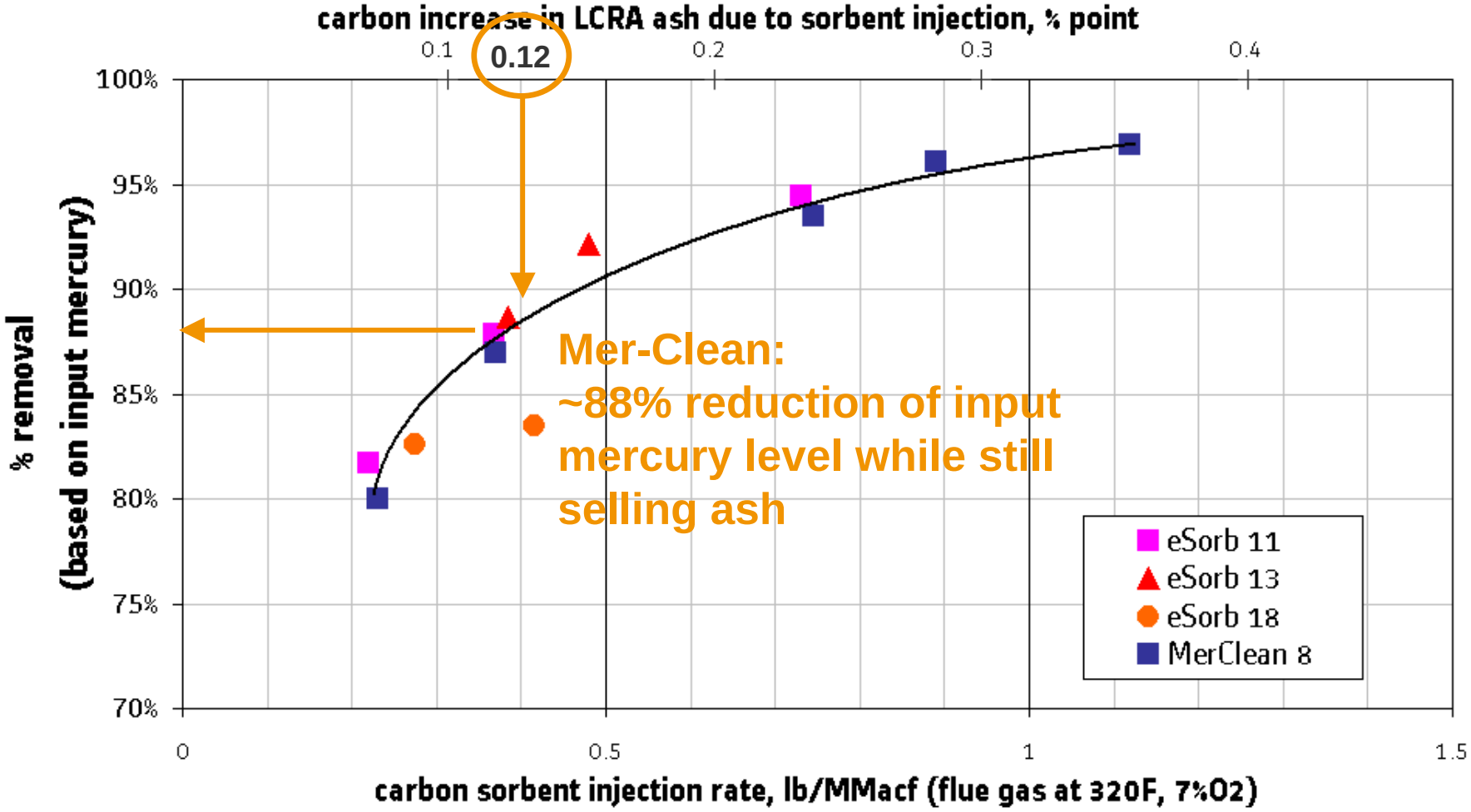
Ash Evaluation Testing – Hg capture performance



On Input Mercury Basis…

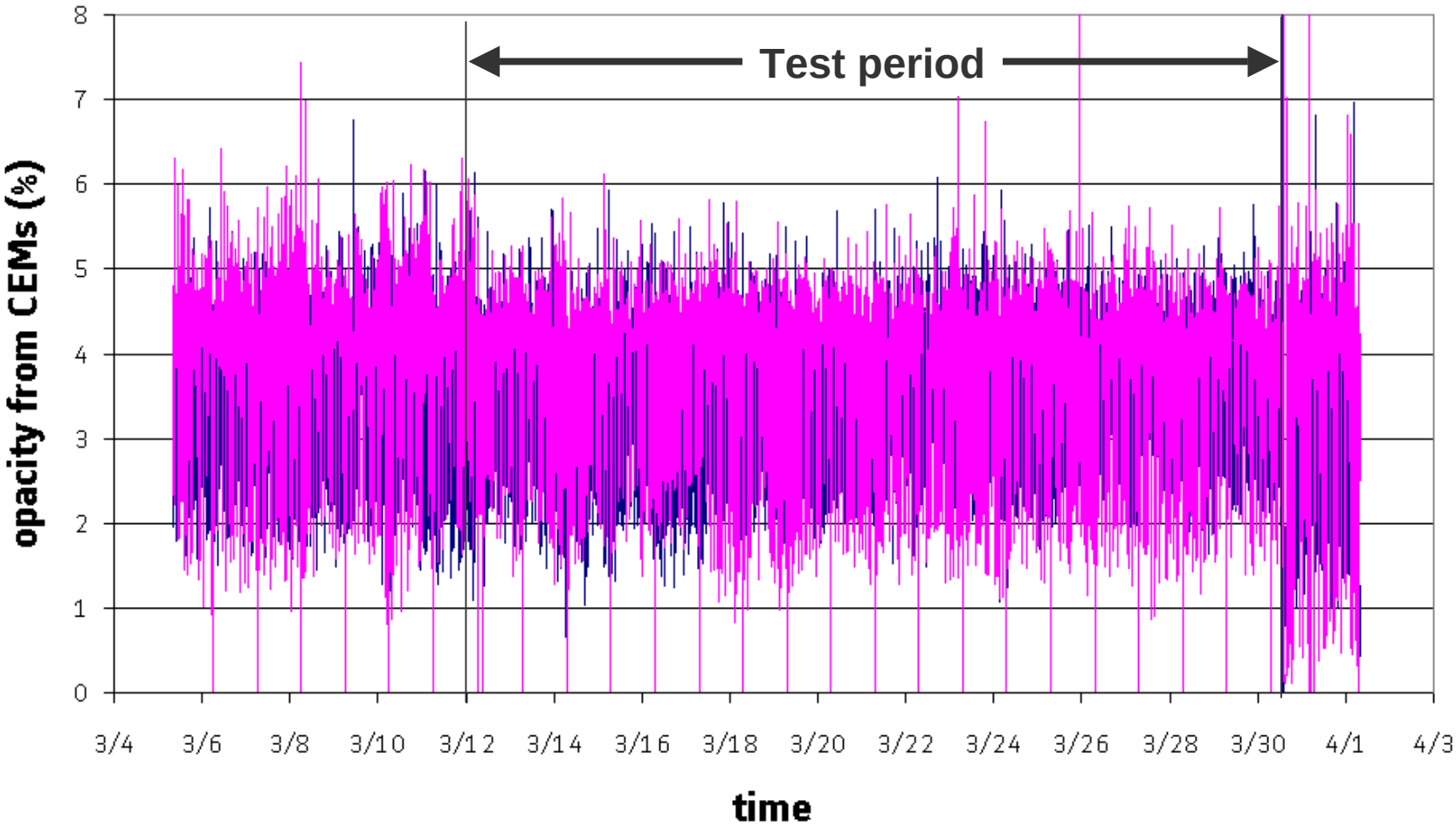


Ash Leaching Test Results – No Detectable Leaching

PPL#	Sample location	Date	Time	mg Hg/l	TCLP Extraction (mg/liter)							
					As	Ba	Cd	Cr	Pb	Hg	Se	Ag
7-2676-M	Reclaim Pond	3/12	8:57	<0.2								
7-2677-M	LS slurry tank	3/12	8:28	<5								
7-2586-A	Silo ash	3/13			<1	3.5	<0.1	0.3	<0.5	<.001	<0.5	<0.1
7-2587-A	Silo 3B-01	3/23	17:15		<1	3.3	<0.1	0.29	<0.5	<.001	<0.5	<0.1
7-2588-A	Silo 3B-02	3/23	17:15		<1	2.9	<0.1	0.28	<0.5	<.001	<0.5	<0.1
7-2589-A	Silo 3B-01	3/30	16:15		<1	4.3	<0.1	0.32	<0.5	<.001	<0.5	<0.1
7-2590-A	Silo 3B-02	3/30	16:15		<1	3.6	<0.1	0.28	<0.5	<.001	<0.5	<0.1
7-2616-A	Silo B	3/28	15:05		<1	3.7	<0.1	0.31	<0.5	<.001	<0.5	<0.1
7-2617-A	Silo B	3/29	11:35		<1	3.6	<0.1	0.32	<0.5	<.001	<0.5	<0.1
7-2618-A	Silo B	3/30	9:00		<1	3.6	<0.1	0.32	<0.5	<.001	<0.5	<0.1

Analysis conducted by Alpha Analytical

ESP Performance - Opacity



No change in stack opacity during sorbent injection

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Summary

- Baseline measurements
  - Native capture is 50% - 27% by AH/ESP and 23% by FGD
  - Not all of oxidized mercury was captured by FGD
  - A large amount of oxidized mercury was reduced to elemental in FGD
- Parametric testing during sorbent injection
  - 90% of uncontrolled mercury emission was captured at 0.8 lb/MMacf
  - 90% of input mercury was captured at 0.5 lb/MMacf
  - No capture was observed by FGD
- Balance-of-plant impact
  - No stack opacity increase during injection
  - No leaching of mercury from flyash
- Continued ash sales/utilization
  - 75% of uncontrolled mercury can be removed before ash sales loss
  - 88% of input mercury may be removed before ash sales loss

Acknowledgements

Department of Energy/NETL – financial support

Lower Colorado River Authority – host site

Envergex, LLC – specialized sorbents

UND EERC – measurement services

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