REINHOLD ENVIRONMENTAL Ltd.

2014 APC Round Table & Expo Presentation

July 14-15, 2014, in Louisville, KY / Hosted by LG&E/KU

Alternatives to Activated Carbon Injection

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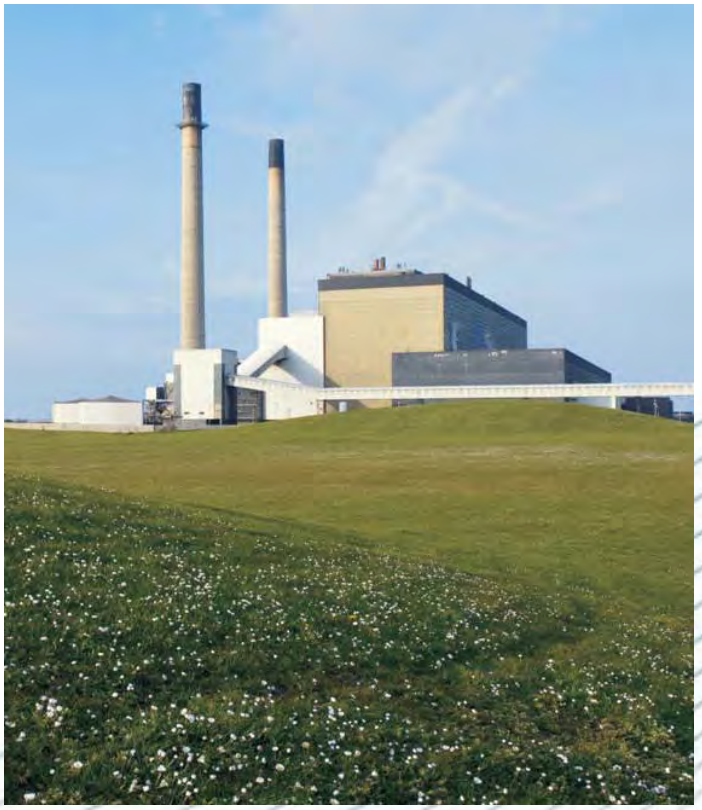

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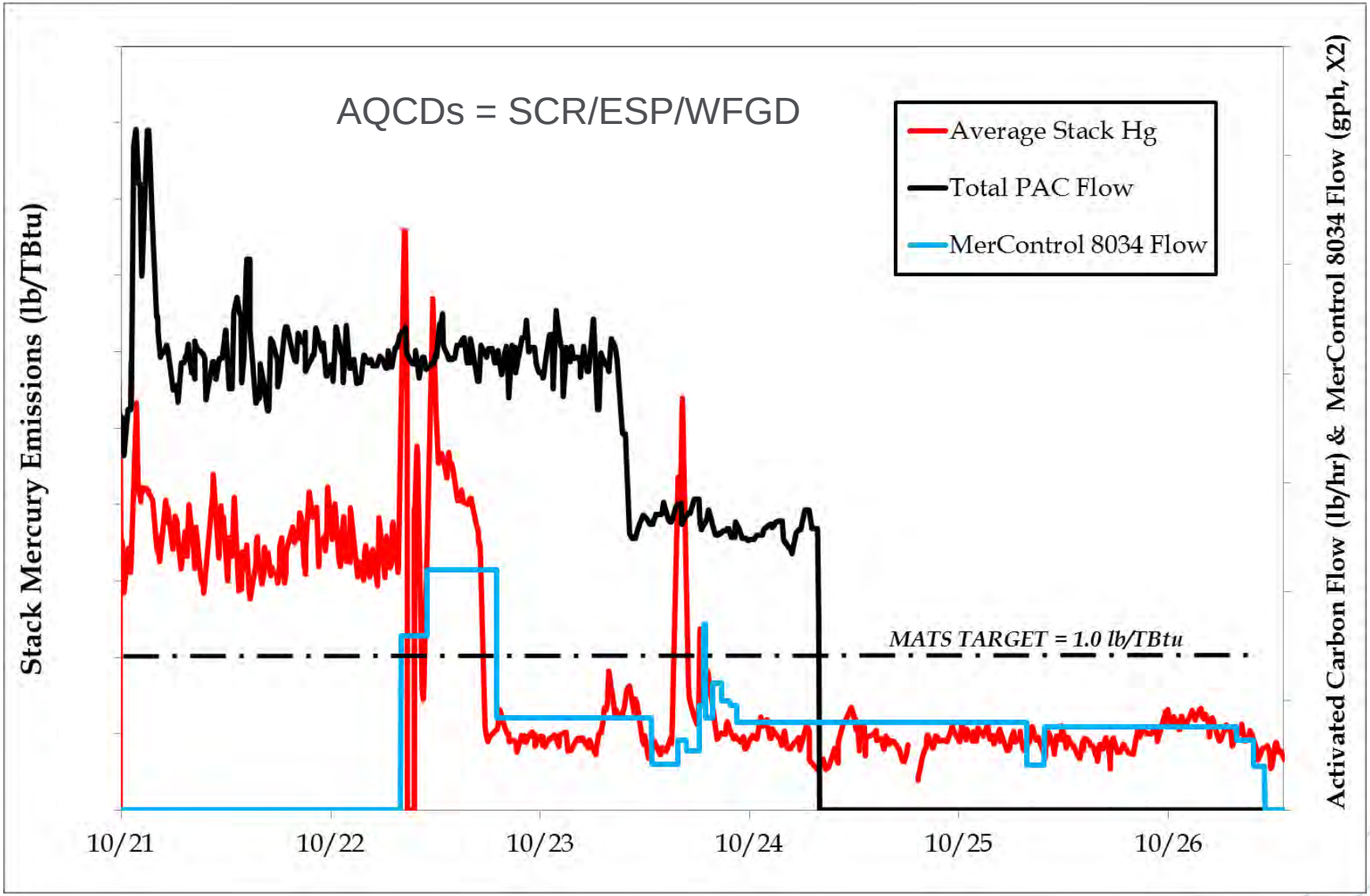
Nalco Air Protection Technologies Portfolio

Goals:

- Reduce Hg Emission below Compliance Levels
- Minimize Capital Requirements
- Minimize Client Operating Costs

……Provides Our Clients With Cost Effective, Sustainable Results

MerControl 8034 *versus* ACI Pre-ESP



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Hg Capture via SDA and FF

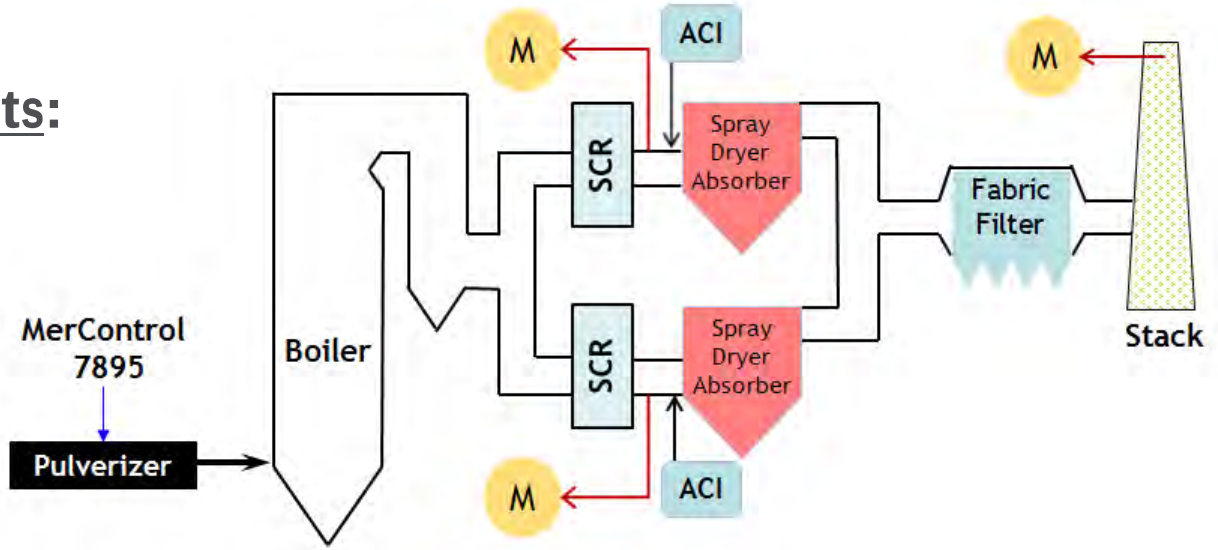
Site Description:

- Chlorine* = 24 ± 14 ppm
- Mercury* = 0.115 ± 0.020 ppm
- Full Load = 580-MWg
- Boiler Type = supercritical PC boiler
- Fuel = Low-sulfur PRB coal
- AQCDs = low-NO_x burners, SCR, SDA, FF

Goal: Mercury emissions less than 1.0 lb /TBtu at minimal cost.

Hg Measurements:

CMM, OHM and carbon traps at locations indicated at right by M



[1]Air Heater Inlet to Stack

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MerControl 7895 Technology

MerControl 7895 = Boiler Additive or BA

- Meter addition to coal pulverizers.
- Simple application equipment.
- Low capital cost.

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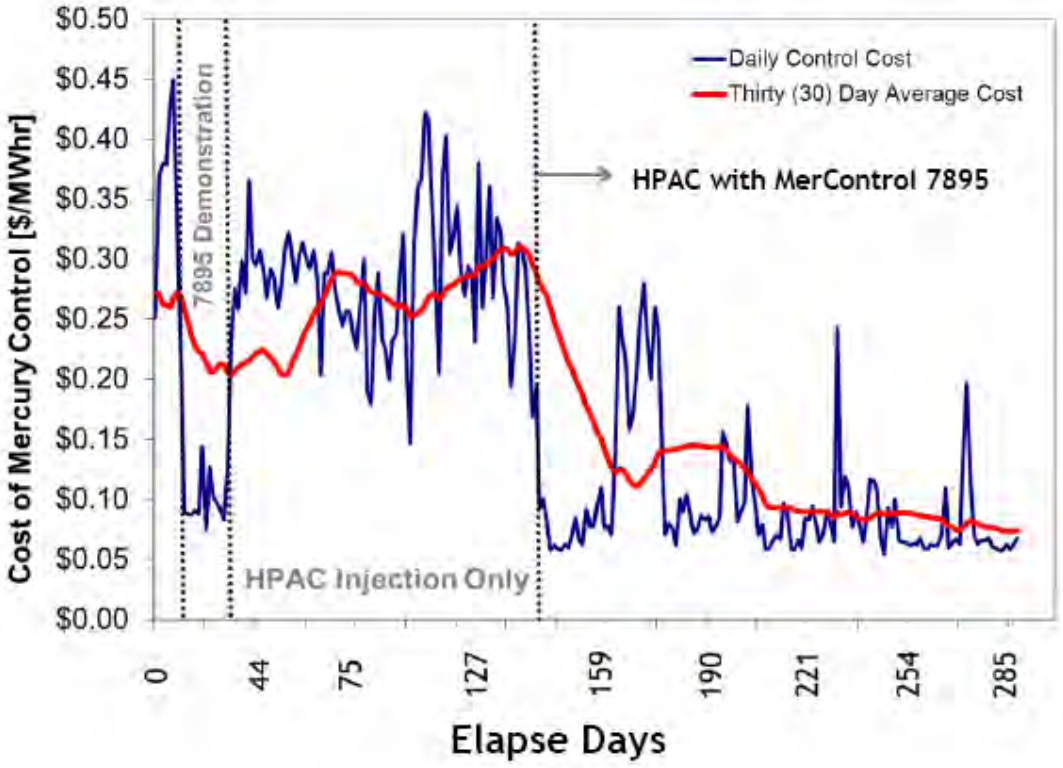
Optimized Cost of Hg Emission Control



Condition	HPAC (lb/MMacf)	BA (ppmw)	$/yr
HPAC only	1.65		$1.45MM
HPAC+BA	0.25	28	$0.36MM
Savings			**$1.09MM**

(based on annualized used & 83% Hg capture.)

HPAC alone Hg control was about $0.30/MWhr.

Optimized strategy for Hg control approached $0.07/MWhr.

- **Cost reduction of >75% with Hg emission compliance.**
- **Annual saving of $1.0-1.7MM realized.**

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Mercury Emission Control Technologies

- MerControl® 7895
- MerControl® 8034
- MerControl® 8034 Plus

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Mercury Emission Control for WFGD

MerControl 8034 and MerControl 8034 Plus

What is re-emission?

- Oxidized mercury (Hg) is soluble in water (4.8g/L at 68°F) and therefore can be removed from flue gas by a WFGD
- However, oxidized Hg can be reduced to elemental Hg within the WFGD. Elemental Hg is only slightly solubility in water (0.056 mg/L at 68°F). The result is lower Hg capture efficiency.

MerControl 8034 & 8034 Plus

- Reduces mercury re-emission up to 100%
- Consistently outperforms competitive technologies
- Reduces stack emissions without compromising gypsum quality
- Patented technology

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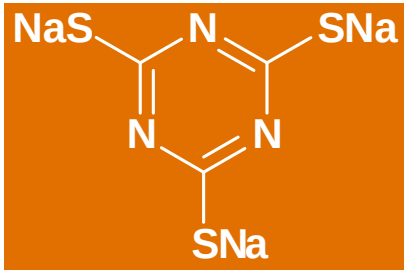
Structure of Some Mercury Chelants

Dimethyl dithiocarbamate

(DTC)

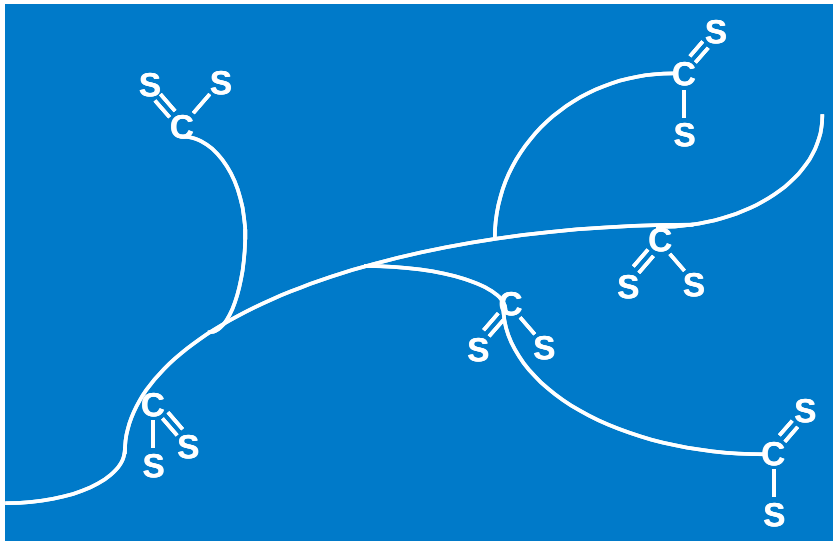
NaHS

Sodium Hydrosulfide



1,3,5-triazine-2,4,6(1H,3H,5H)-trithione

Trimercaptotriazine (TMT)



MerControl 8034 Technology

(poly-dithiocarbamate)

Patented Technology

Reduces scrubber liquor soluble mercury to less than 500 ppt.

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MerControl Product Comparison

	8034 Plus	8034
Stability- Appearance	Extended (> 1 yr)	Short (< 6 mo.)
Composition	No chlorides	Contains chlorides
Hazard Class/Packing Group	Non-hazardous	8/III
Aquatic Toxicity (EPA)	Practically Nontoxic	Slightly Toxic
Toxicity - German WGK	1	3
National Fire Protection Act (H/F/R)	1 1 0	2 1 0
Toxicity - Rainbow Trout - LC_{50}	211 mg/L	74 mg/L
Toxicity – Daphnia magna - LC_{50}	165 mg/L	73 mg/L
Freezing point	14 F (-10C)	-5F (-15C)

The higher the LC_{50} number, the less toxic the chemical;

MerControl 8034 Plus is designed with performance and environmental impact in mind.

EPA Toxicity Categories for Aquatic Organisms:	
LC50 (ppm)	**Toxicity Category**
< 0.1	Very highly toxic
> 0.1 - 1	Highly Toxic
> 1 - 10	Moderately toxic
> 10 - 100	Slightly toxic
> 100	Practically nontoxic

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MerControl 8034 Plus: Very Low Toxicity

Mammalian Testing

- Significantly less toxic and lower environmental impact than competitive technologies
- MSDS NFPA Rating = 1 1 0
- Non-irritating to skin
- Non-mutagenic

Substance/Structure	Acute Oral	Eye Skin Corrosion/ Irritation	Mutagenicity
Nalco's New Technology 8034 Plus	> 2,000 mg/kg	Skin- Non-irritating Eye- Non-irritating	Negative Ames
TMT	>2,000 mg/kg	Skin-Slightly Irritating Eye- Irritating	Negative Ames
Na_2S	LD_{50}- 254 mg/kg	Skin- Corrosive Eye- Corrosive	Negative Ames
DMDTC	LD_{50}- > 2,000 mg/kg	Skin-Severely irritating Eye-Severely Irritating	Positive Ames

Colors represent EPA defined toxicity categories

- Red = highly toxic
- Yellow = moderate to slightly toxic
- Green = practically non-toxic

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MerControl 8034 Technology

Simple Application Equipment, Low Capital Cost

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Injection and Sampling Points

Basin Injection

Recirculation Line Injection

Sampling Stream

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Application Control Strategy

Nalco Monitor and Control Skid

- Temporary installation in minutes.
- 24/7 monitoring and control
- Data logging and retrieval
- Plant specific design control
- Minimally intrusive to plant operations
- Auto alarms and secure remote access
- Automated control of application rate

Already successfully used at several full-scale demonstrations. Facilitates feed back mercury re-emission control. Patent pending.

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Nalco APT Controller

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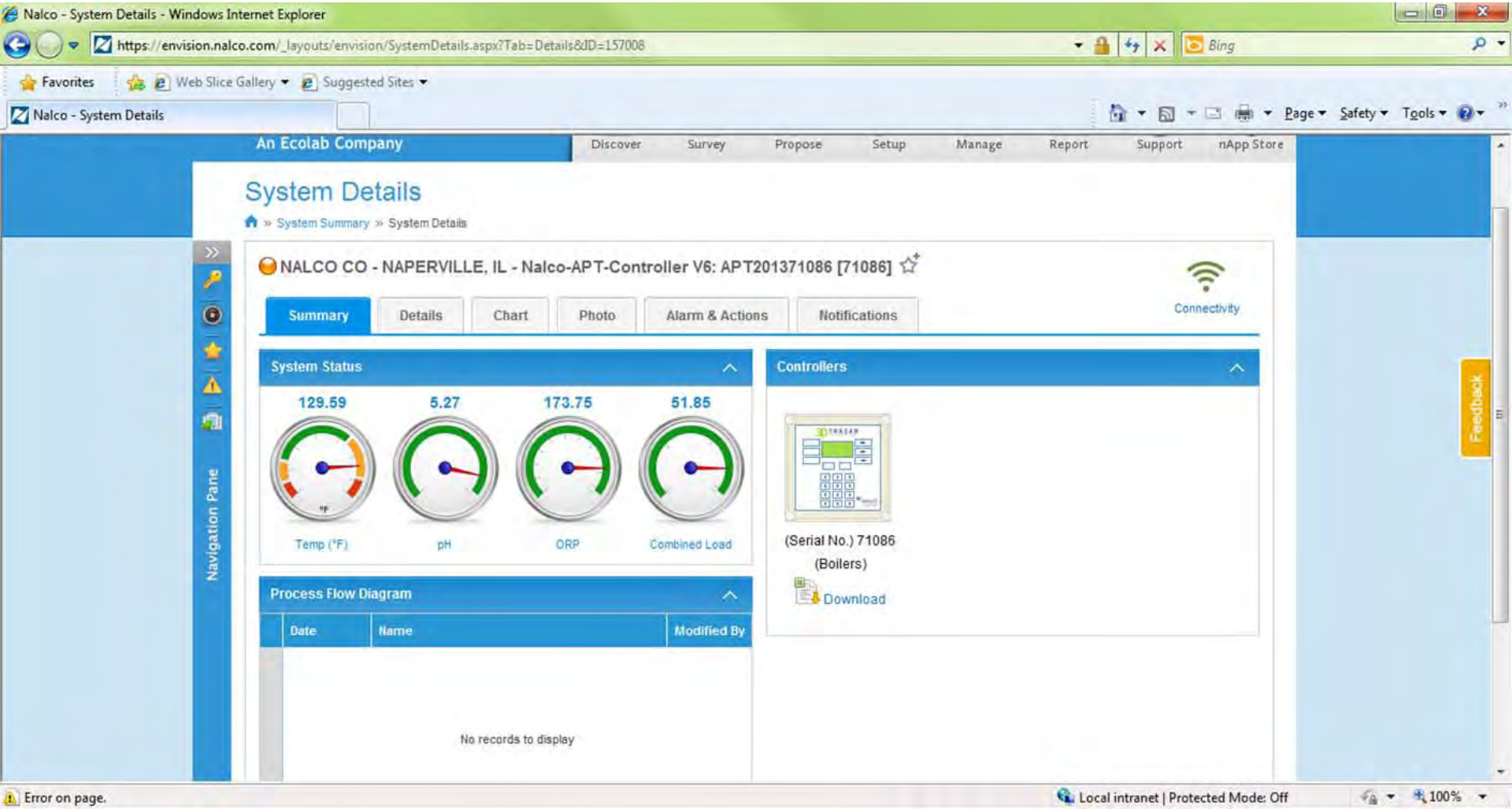
Data Download from enVision



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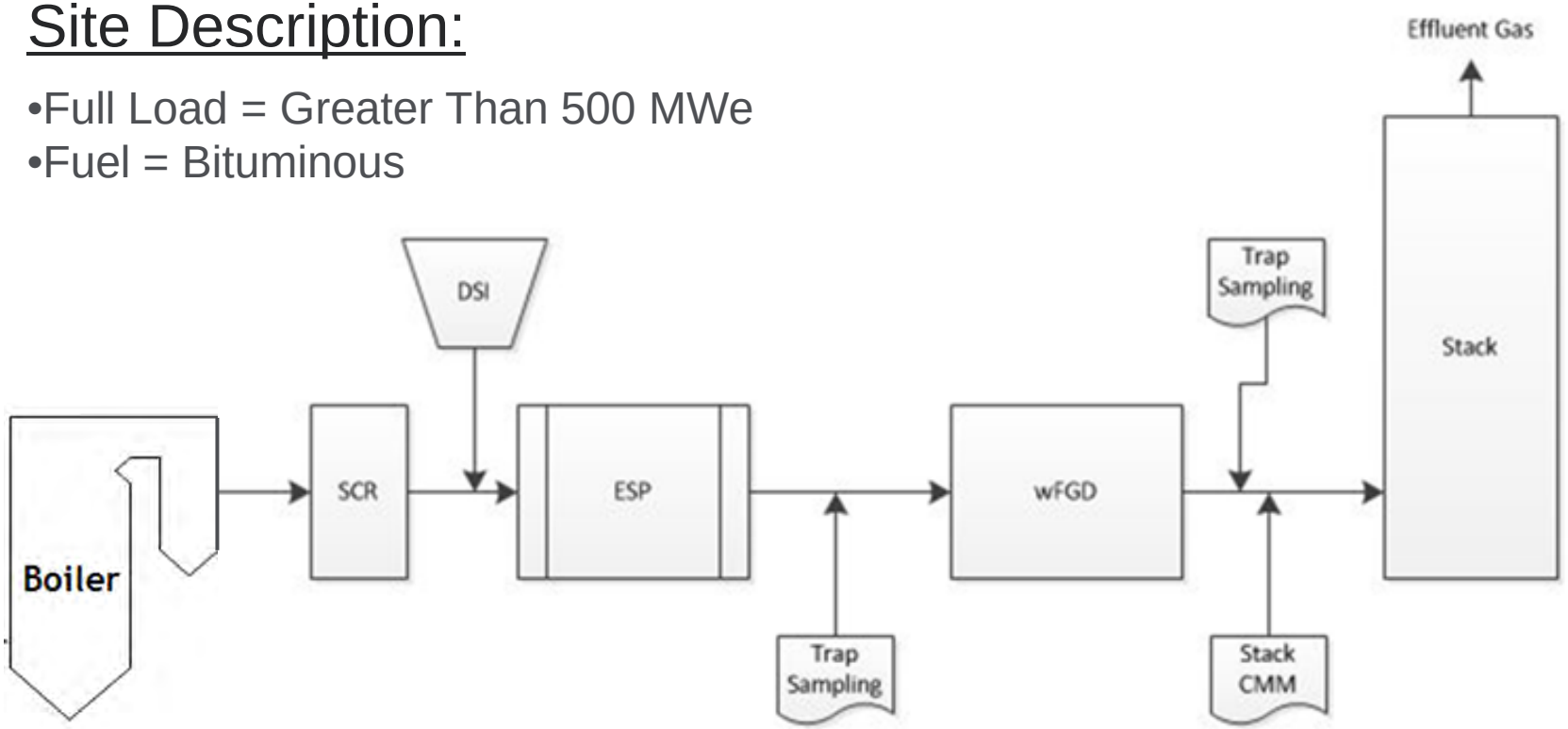
Hg Capture via SCR and WFGD

Site Description:

- Full Load = Greater Than 500 MWe
- Fuel = Bituminous



Goal: **Reduce Hg re-emissions to meet MATS limit.**

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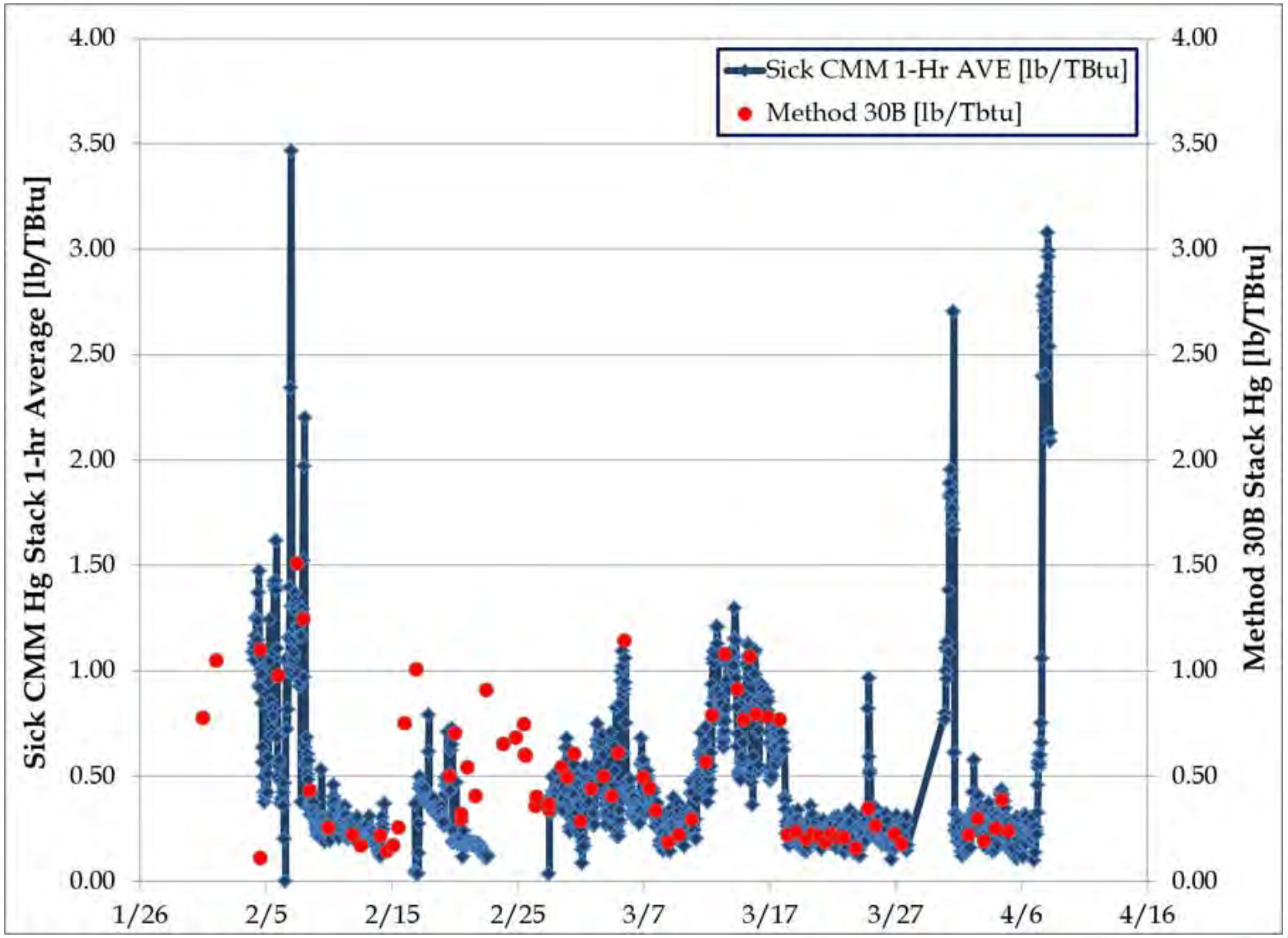
Hg Measurement Validity



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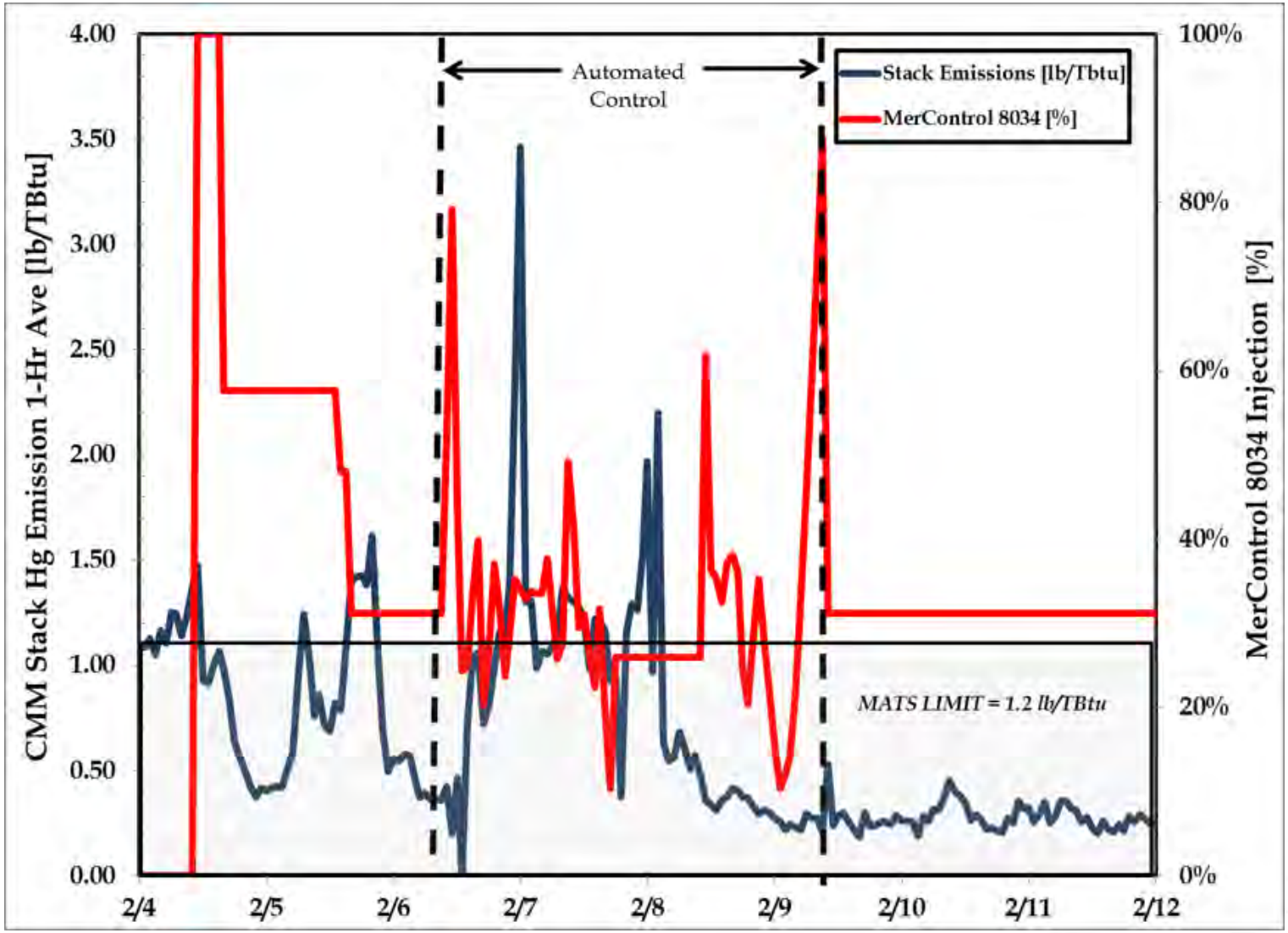
Initial MerControl 8034 Dosing



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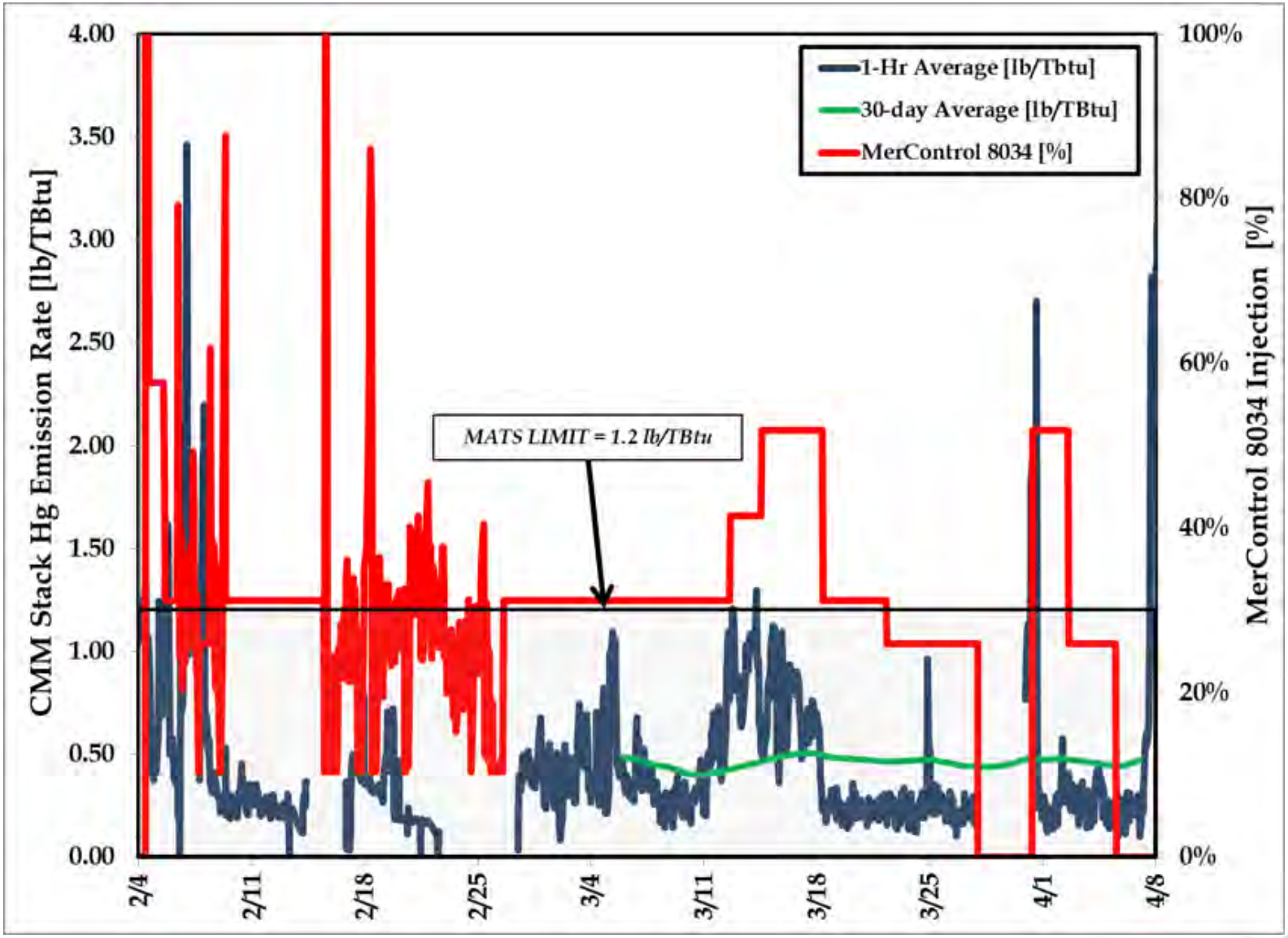
Demonstration Data



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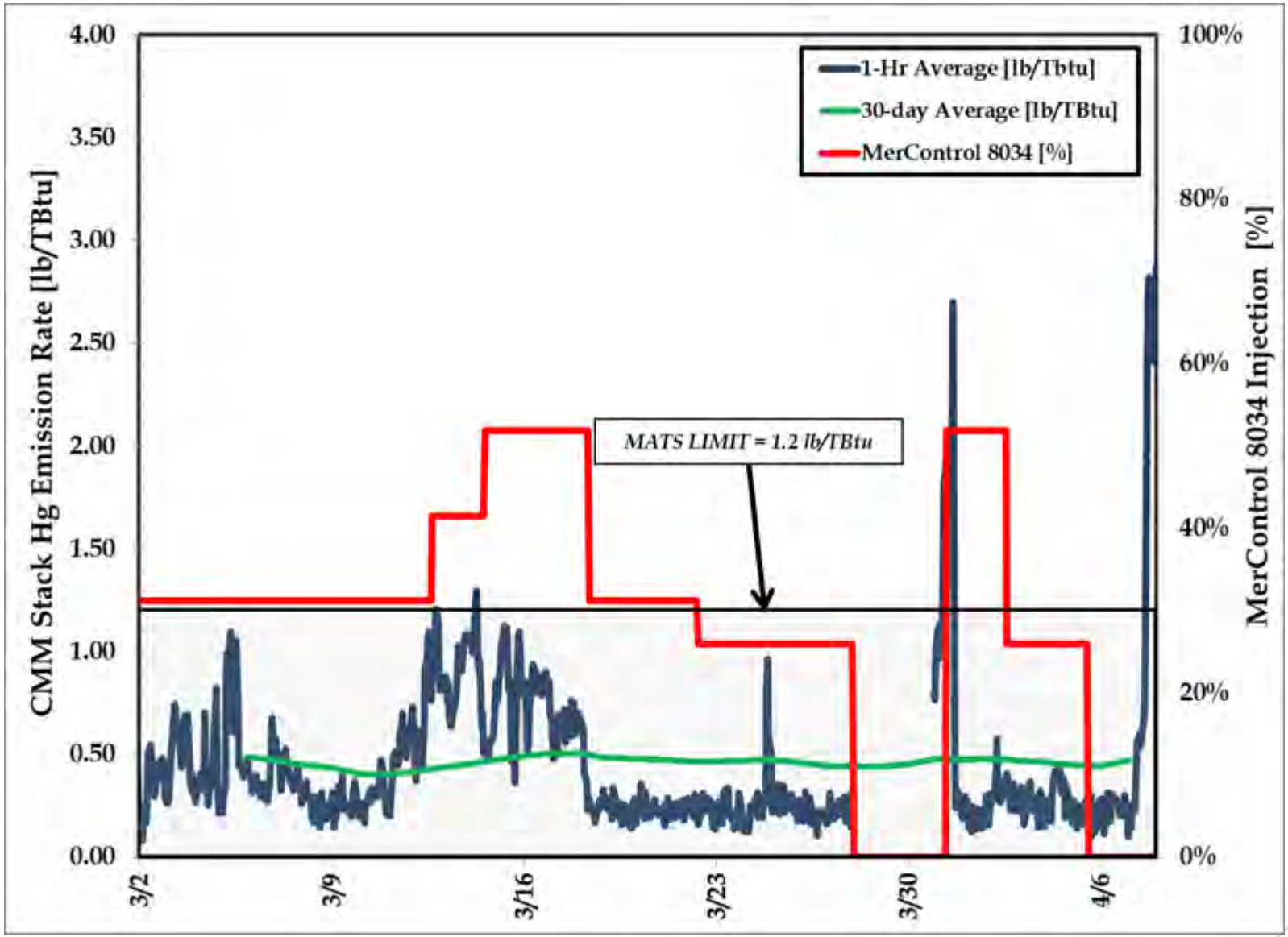
30-Day Rolling Average



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30-Day Rolling Average with 8034

30-Day Rolling Average (3/6 through 4/5)*		
Average	0.46	lb/TBtu
Max	0.50	lb/TBtu
Min	0.40	lb/TBtu
Standard Deviation	0.02	lb/TBtu

*All data with MerControl 8034 Injection

- Baseline Mercury Emission Rate = 1.20 ± 0.13 lb/TBtu
- 30-Day Rolling Average with 8034 = 0.46 ± 0.02 lb/TBtu

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MerControl 8034 Performance

- **Operational Impacts**

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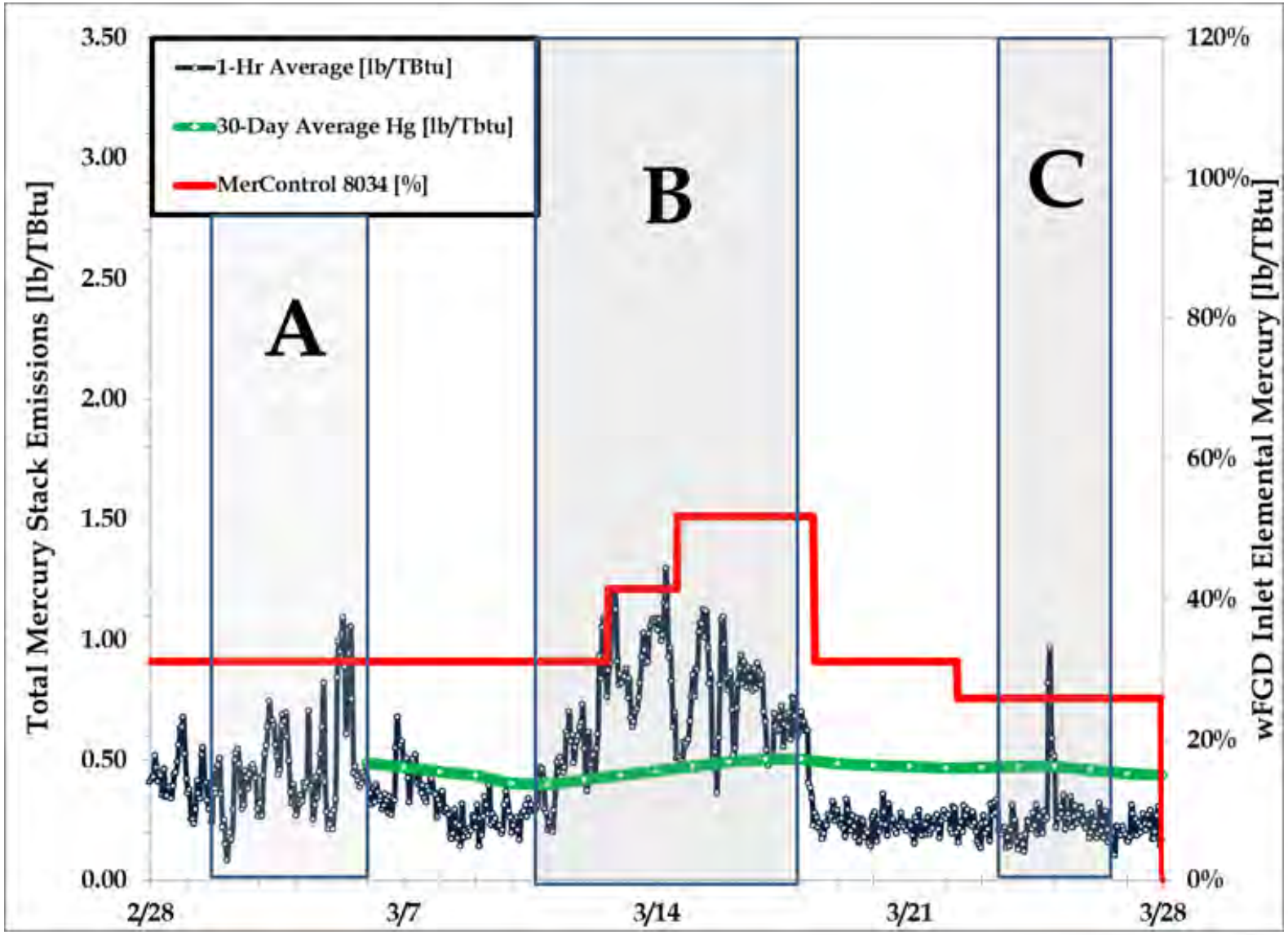
Emission Excursions



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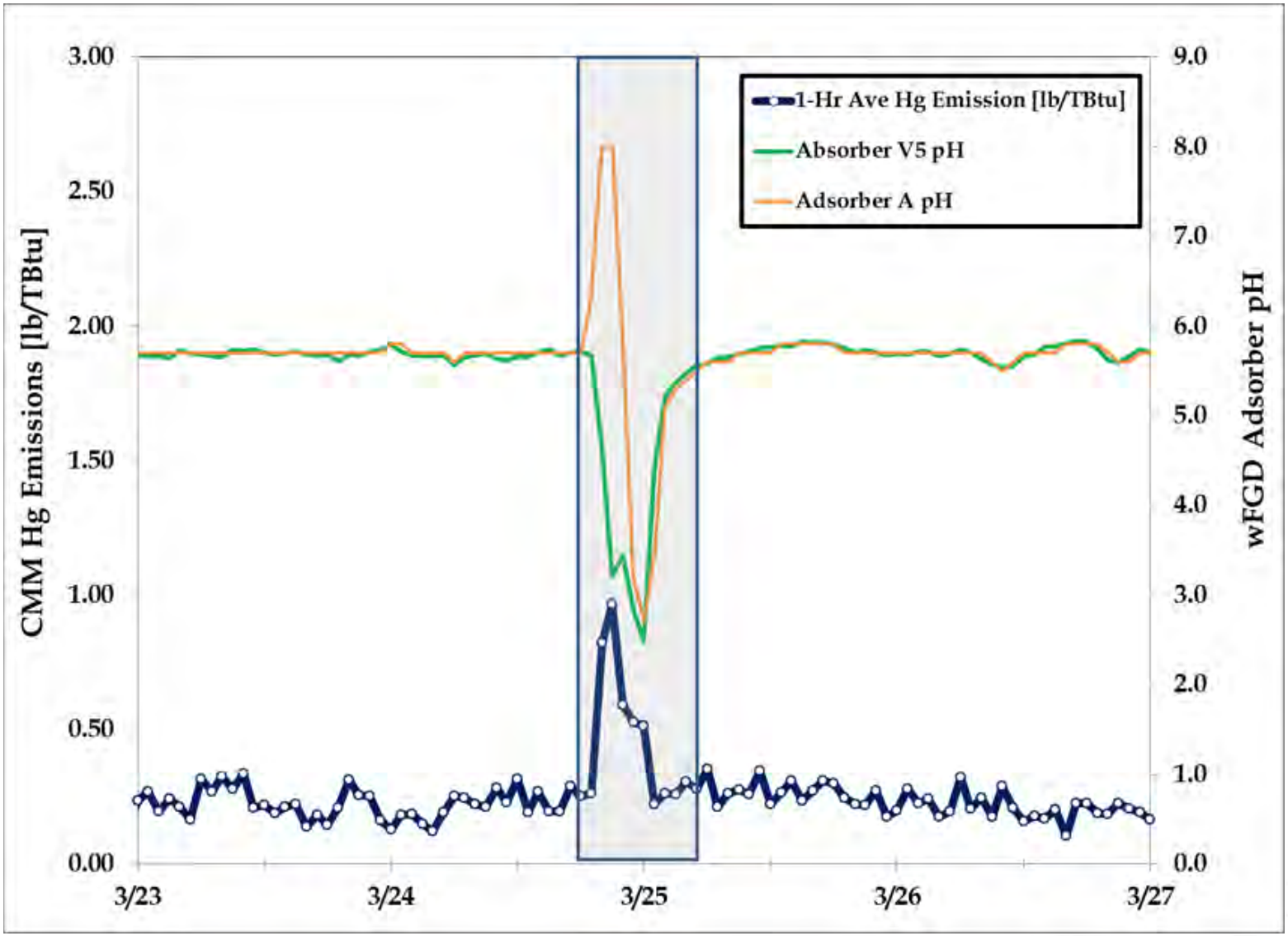
Scrubber pH



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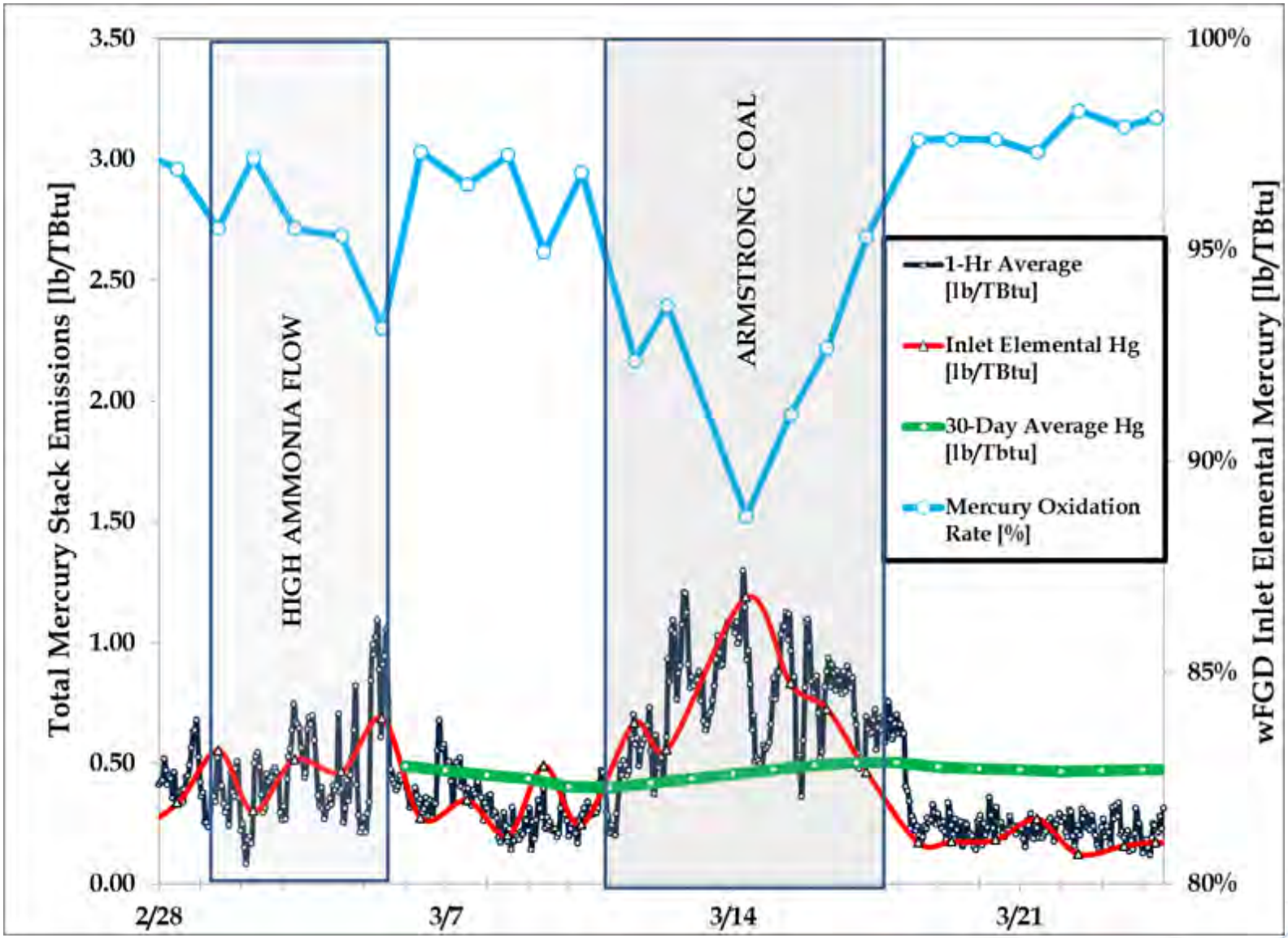
Mercury Oxidation



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Hg Capture via SCR and WFGD

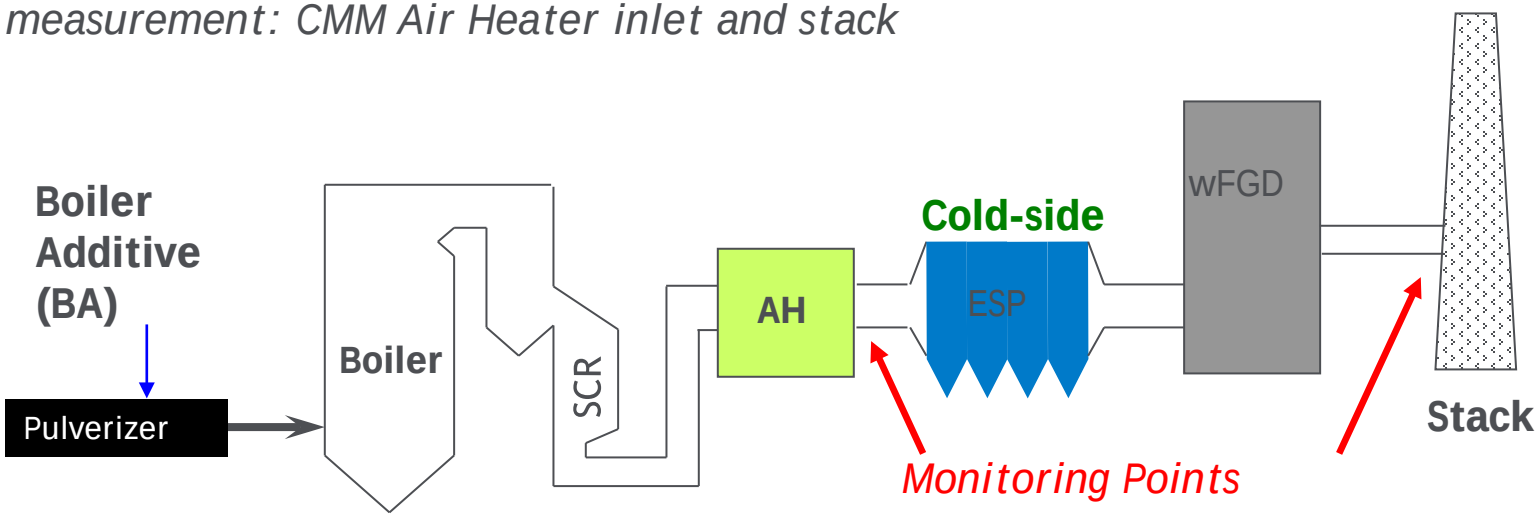
Site Description:

- Chlorine* = 1200 ppm (max = 1400)
- Mercury* = 0.05 ppm (max = 0.06)

- Full Load = 192 MWe
- Boiler Type = PC, Corner Fired
- Fuel = High Chlorine Bituminous
- AQCDs = SCR, cold-side ESP and wFGD

Goal: Achieve 90% Hg Capture[1] *and* meet mercury water discharge regulations.

Hg measurement: CMM Air Heater inlet and stack



[1]Air Heater Inlet to Stack

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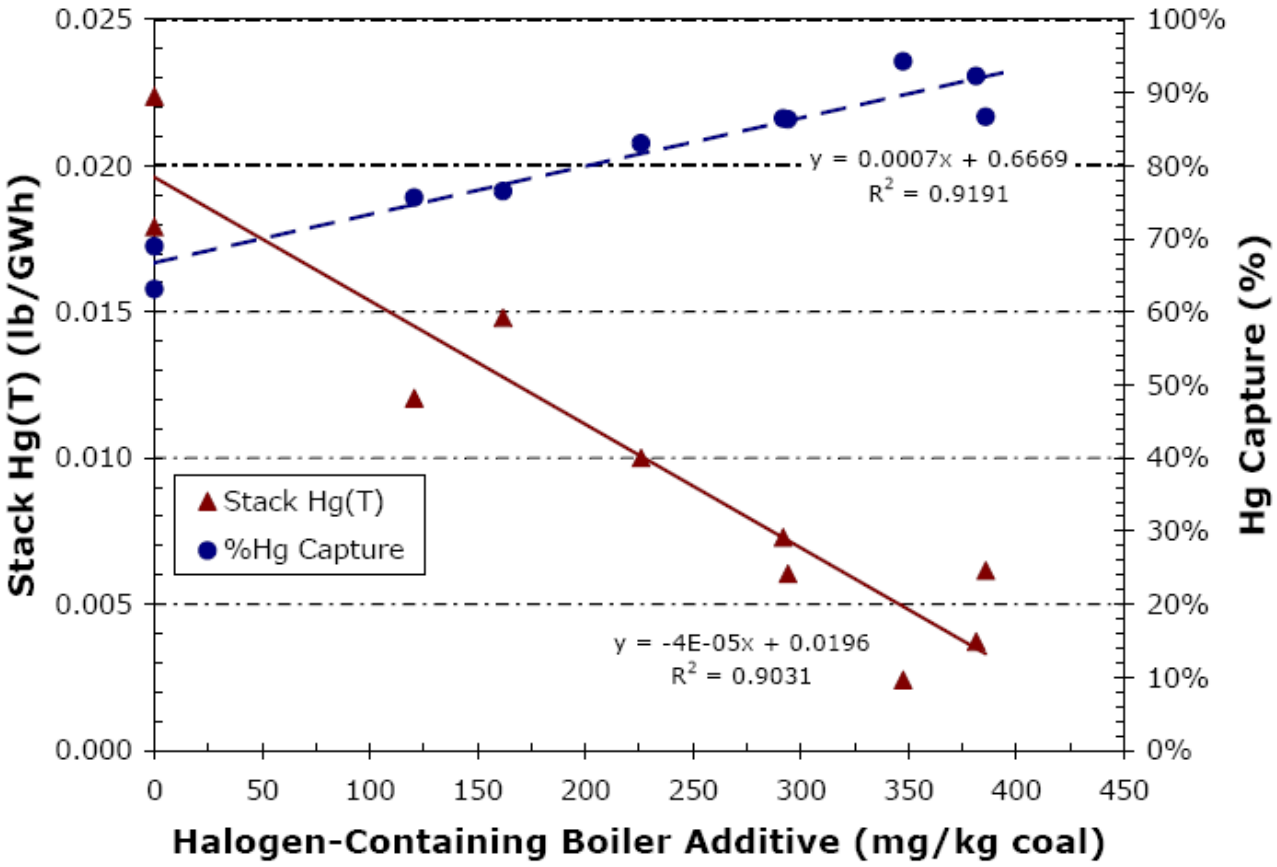
Mercury Emissions and Capture



Hg Capture %

$$\left(\frac{Hg^{T}_{\text{FGD inlet}}}{Hg^{T}_{\text{stack}}} \right) X\ 100$$

Based on OHM measurements

➢ ***Halogen-containing BA reduces Hg stack emissions.***

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MerControl 8034 Summary

- MerControl 8034 application resulted in reduction of stack mercury emissions from 1.20 to 0.46 lb/TBtu.
- Scrubber solids analyzed and pass TCLP leaching test
- No effects observed on SO_2 capture
- No effects observed on normal plant operation
- Burning Armstrong Coal resulted in reduced mercury oxidation rates, and higher mercury emissions
- Significant deviation in scrubber pH resulted in emission excursion.

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Questions

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