REINHOLD ENVIRONMENTAL Ltd.

2017 APC & Wastewater Round Table & Expo Presentation

July 17 & 18, 2017 in Charlotte, NC / Hosted by Duke Energy

All presentations posted on this website are copyrighted by Reinhold Environmental, Ltd (RE). Any unauthorized downloading, attempts to modify or to incorporate into other presentations, link to other websites, or obtain copies for any other uses than the training of attendees to RE's Conferences is expressively prohibited, unless approved in writing by RE or the original presenter. RE does not assume any liability for the accuracy or contents of any materials contained in this library which were presented and/or created by persons who were not employees of RE.

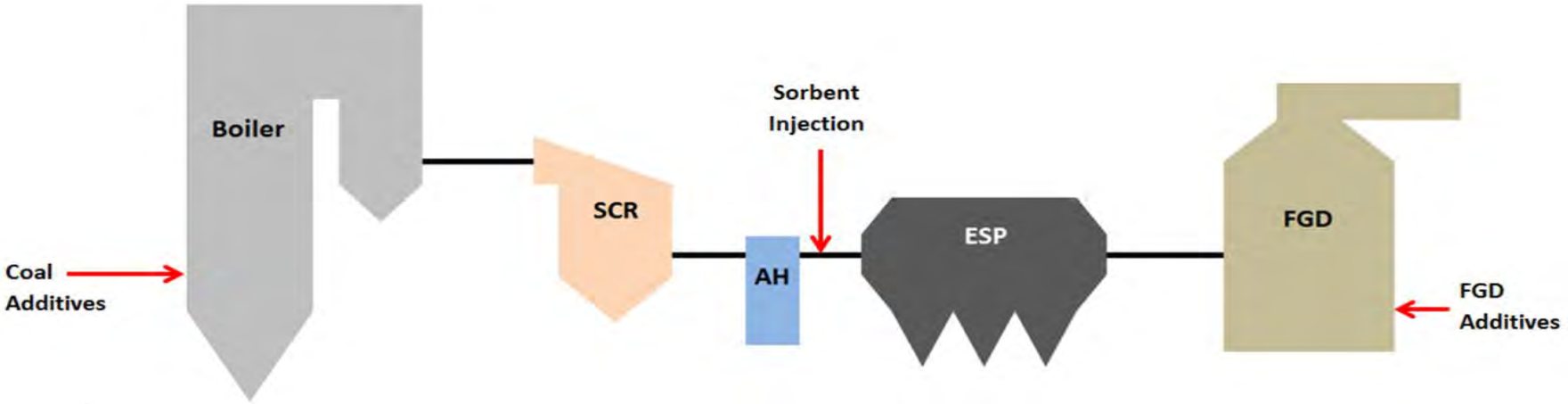
Mercury and Air Toxics Standard Mercury Controls Update

Reinhold Environmental 2017 APC & Wastewater/ PCUG Conference

Stephen Potter, Duke Energy
Lead Engineer / Mercury SME

Environmental Control Devices for Mercury Removal on EGU's Burning Eastern Bituminous Coal

- Mercury oxidation and removal from existing emission control devices:
  - SCR: for Hg Oxidation
  - ESP/BH: for PAC /Hg Removal
  - FGD: for Soluble Hg Removal
- Supplemental technologies needed for additional mercury removal:
  - Coal additives: Nalco 7895 for Increased Hg Oxidation
  - Sorbent injection: Powdered Activated Carbon (PAC)
  - FGD additives: Nalco 8034 Plus for Hg Re-emissions



Mercury Control Technologies Equipment Installations

Nalco 8034 Plus Hg Re-emissions Control:

- Thirteen Units

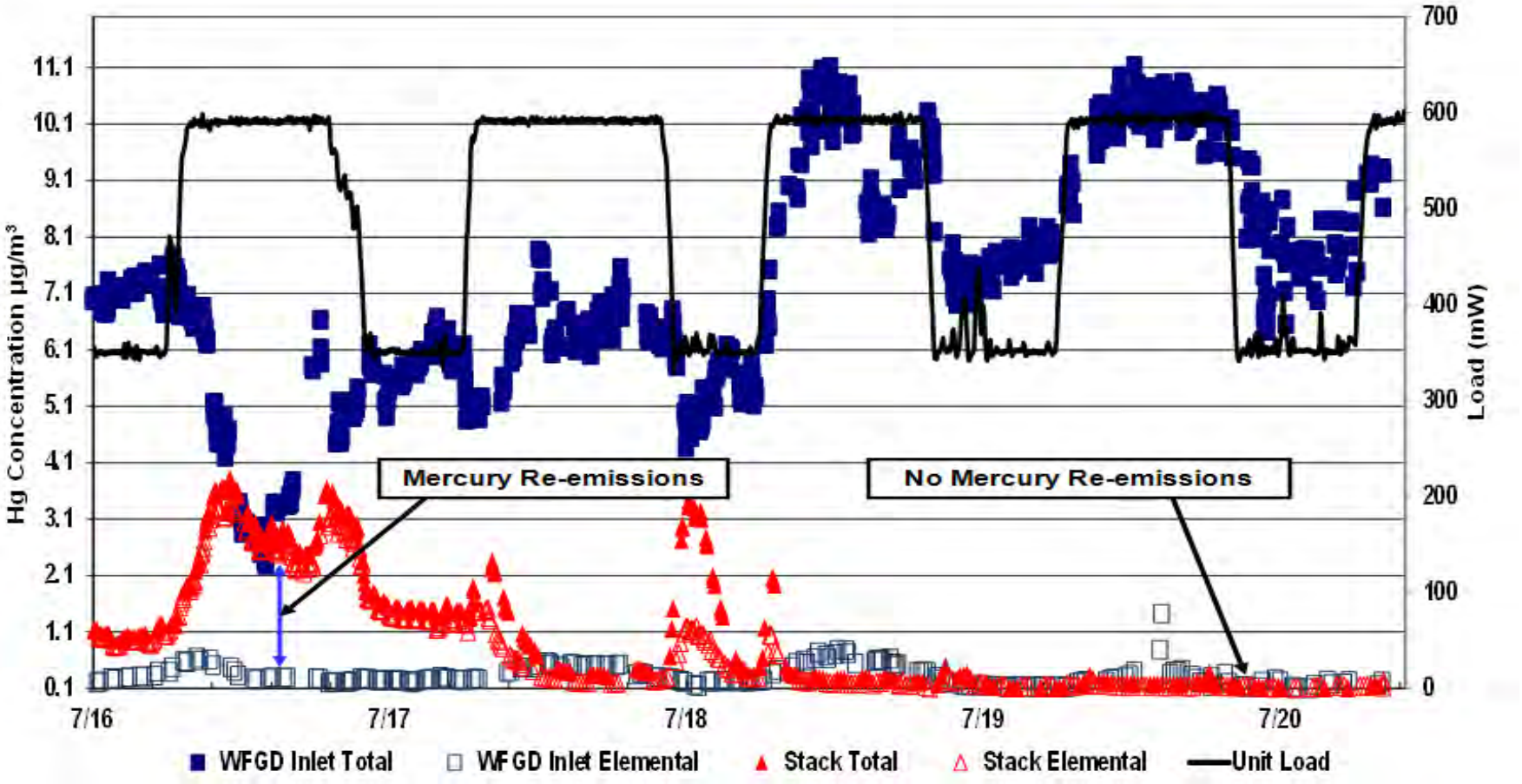
Nalco 7895 Mercury Oxidation Enhancement

- Seven Units

Powdered Activated Carbon (PAC)

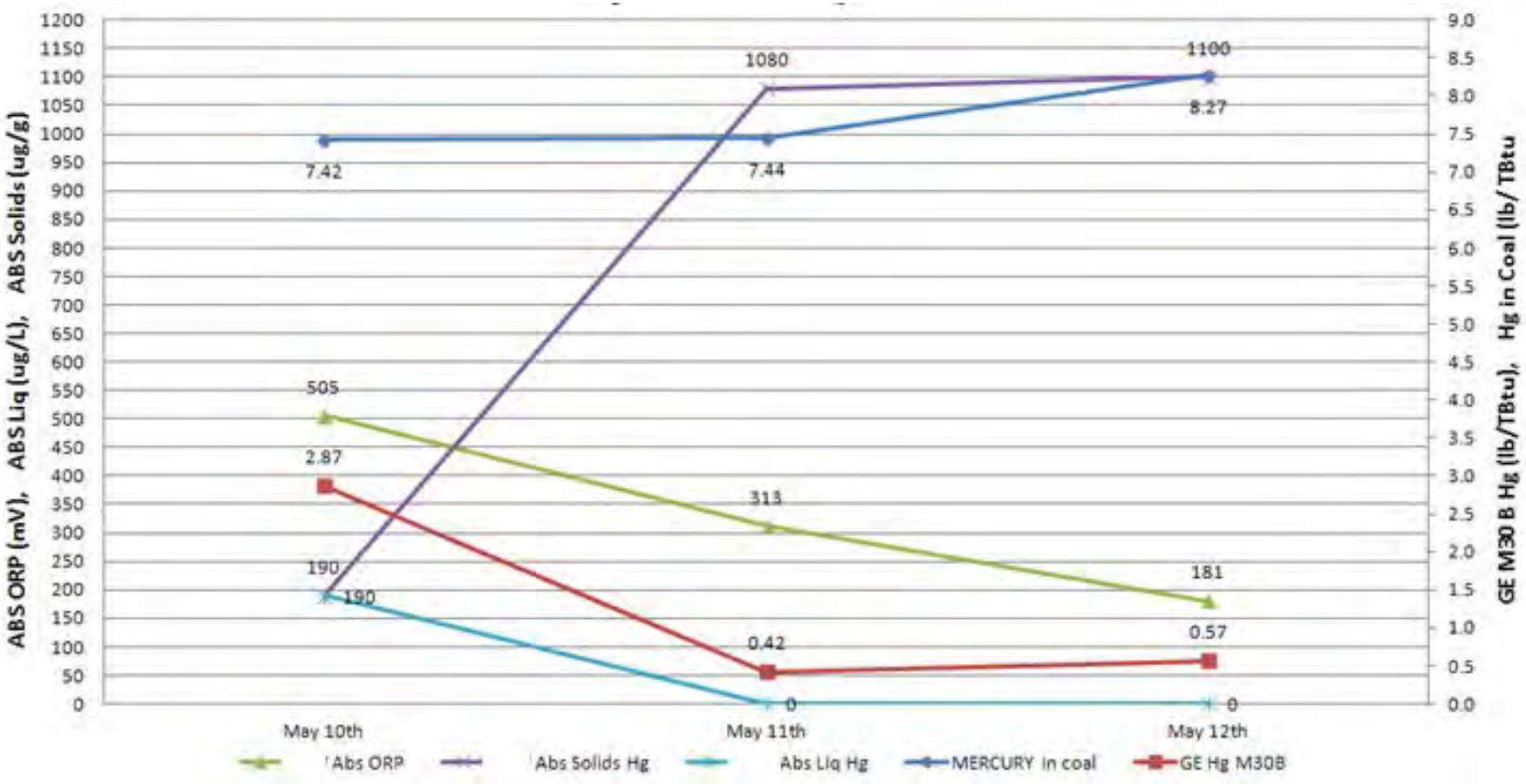
- Five Units

WFGD Mercury Re-emissions



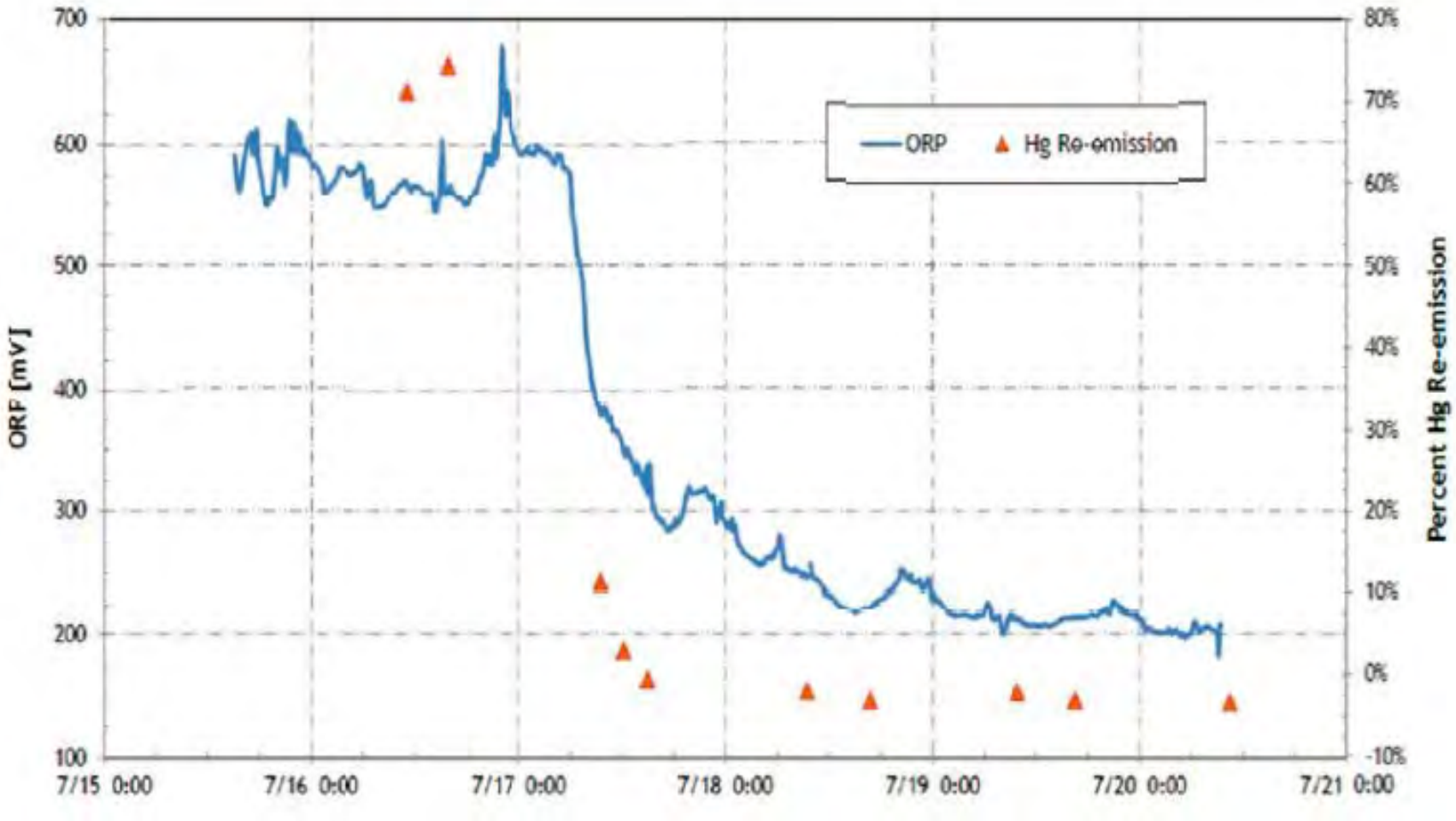
Stack Elemental Hg > WFGD Inlet Elemental Hg: Oxidized Hg is reducing back to Elemental Hg in the WFGD.

Mercury Re-emissions Can Change Overnight

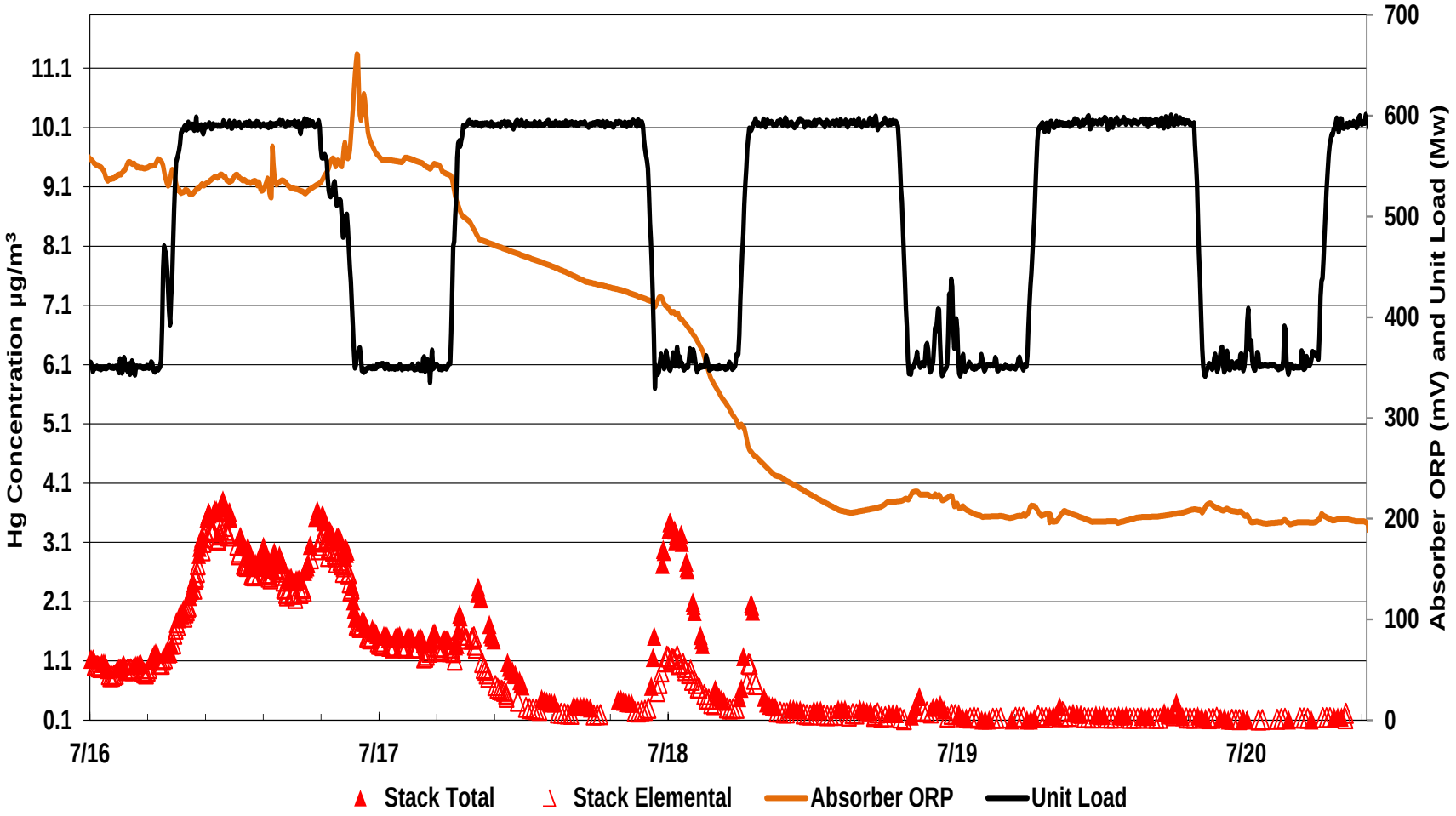


WFGD absorber chemistry changed driving ORP down moving mercury from liquor to the solids… stack Hg dropped accordingly.

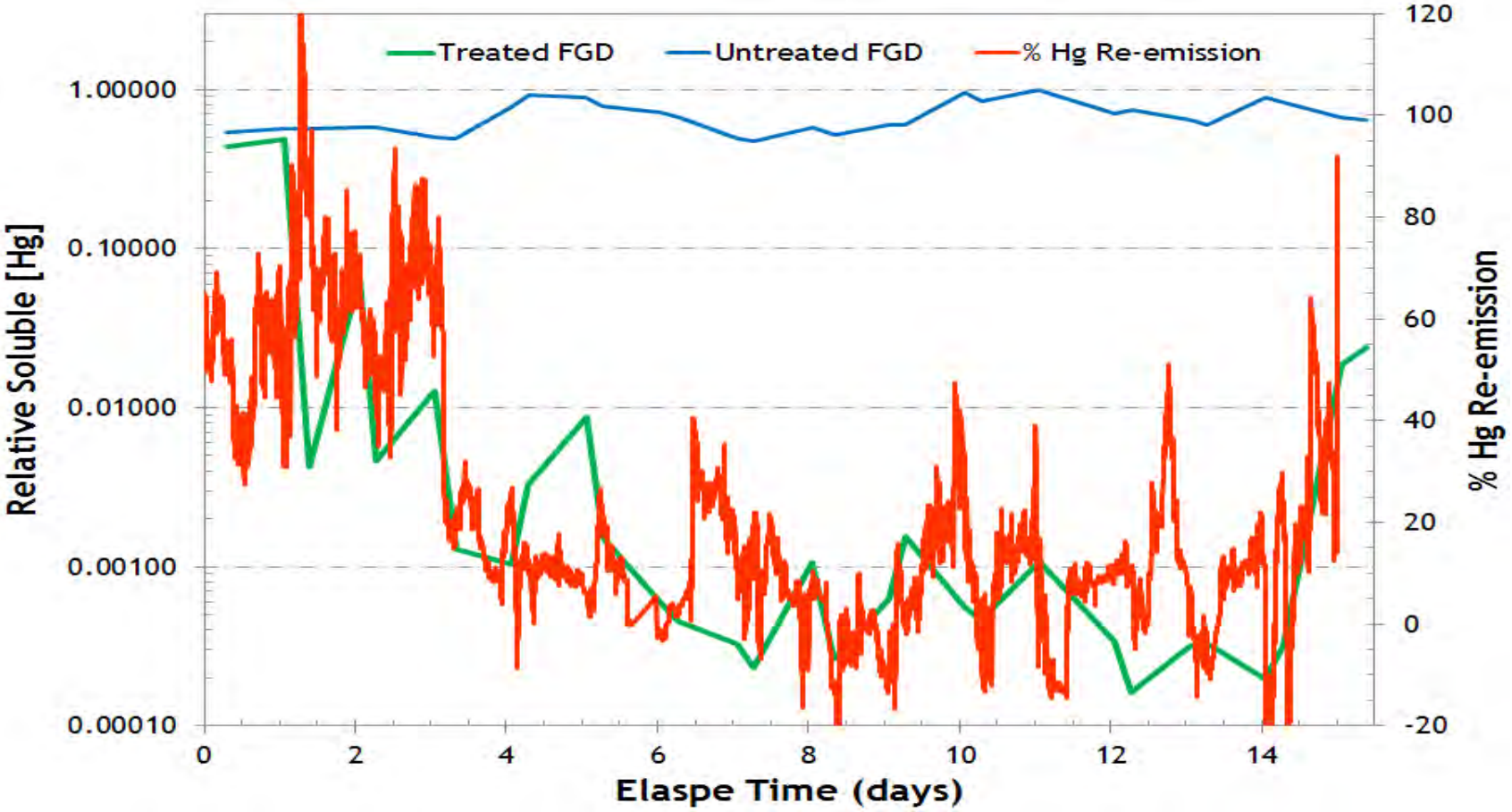
Absorber ORP vs Mercury % Re-emissions



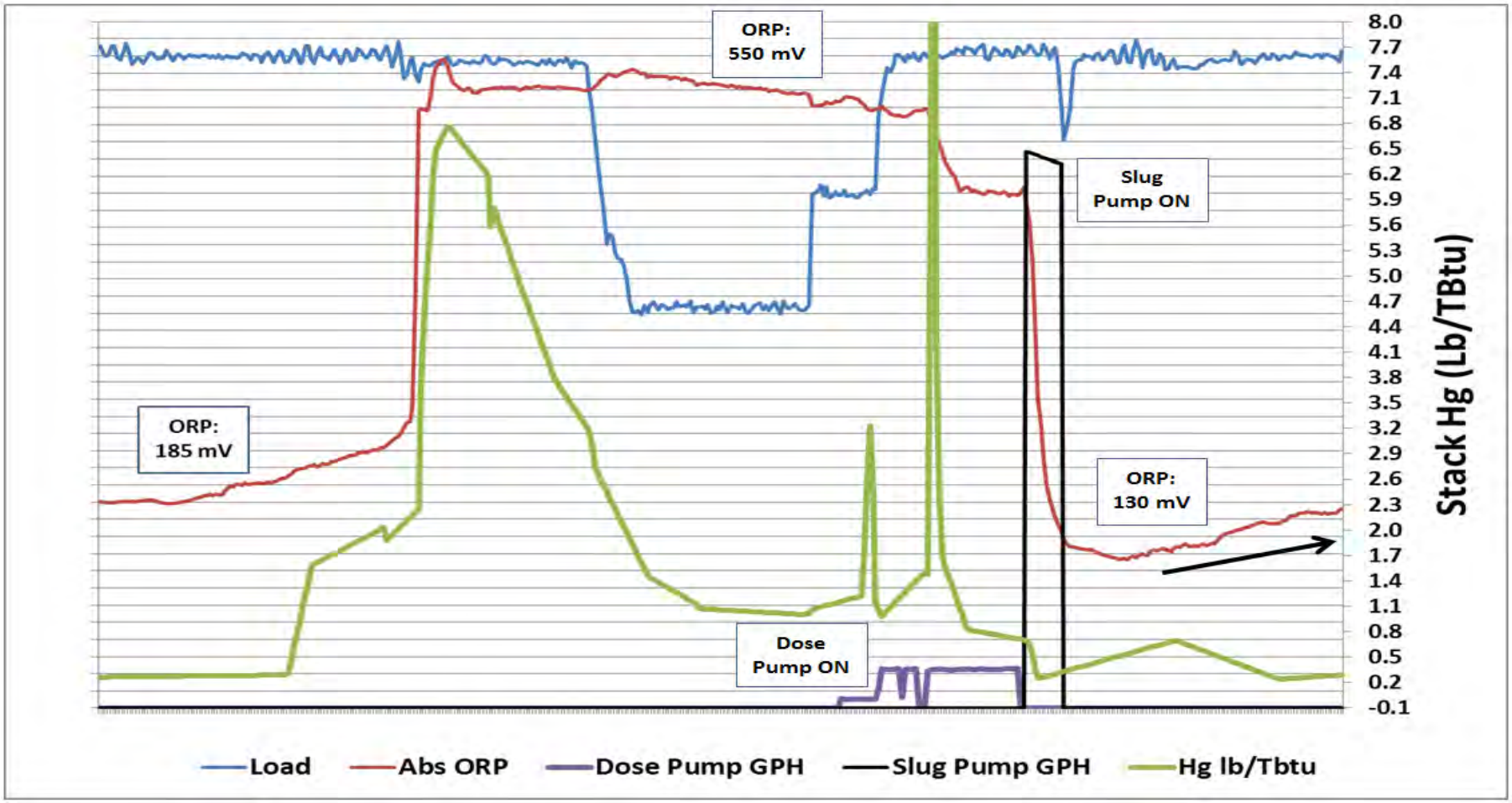
Stack Mercury vs Absorber ORP



Hg Re-emissions and Absorber Soluble Hg While Injecting Nalco 8034

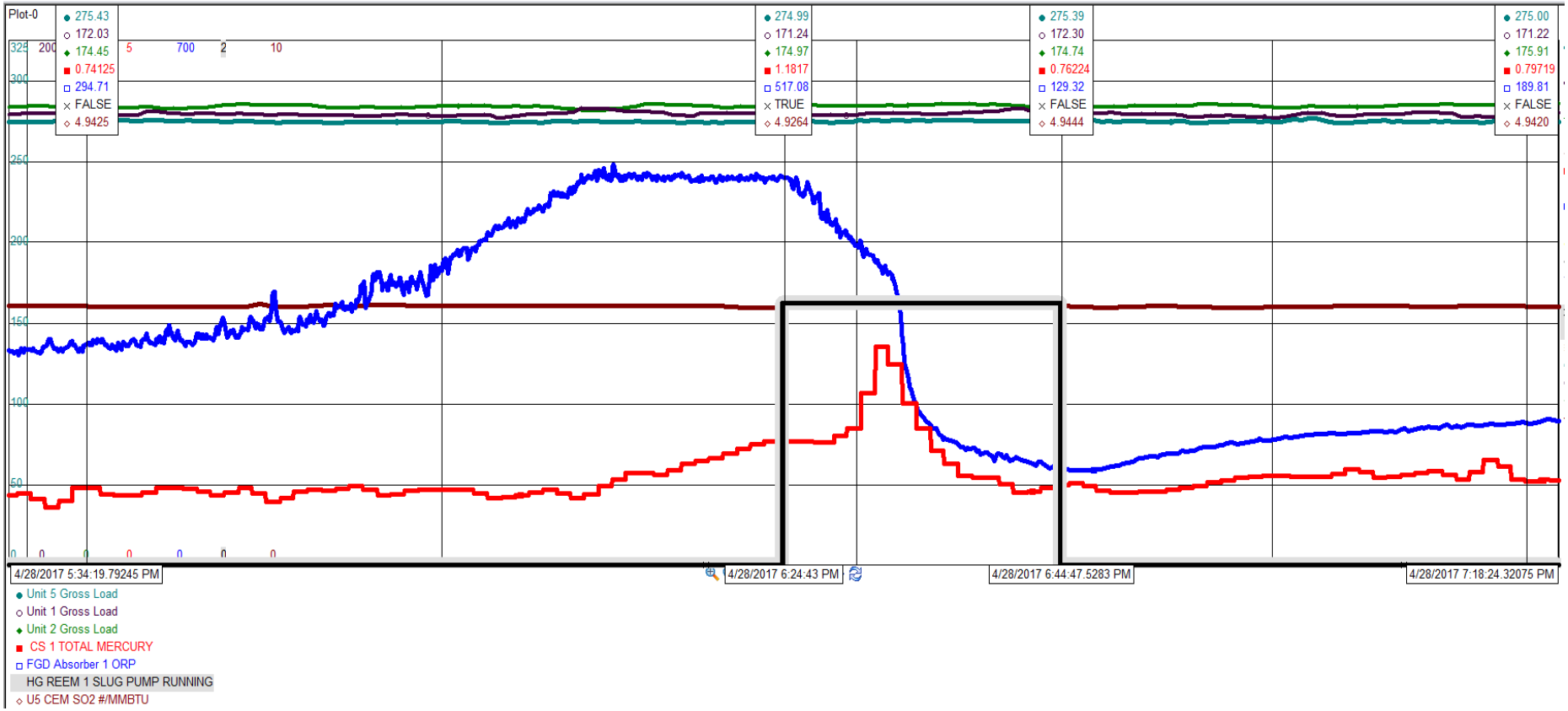


Nalco 8034 Plus Systems, Mercury Re-emissions Control



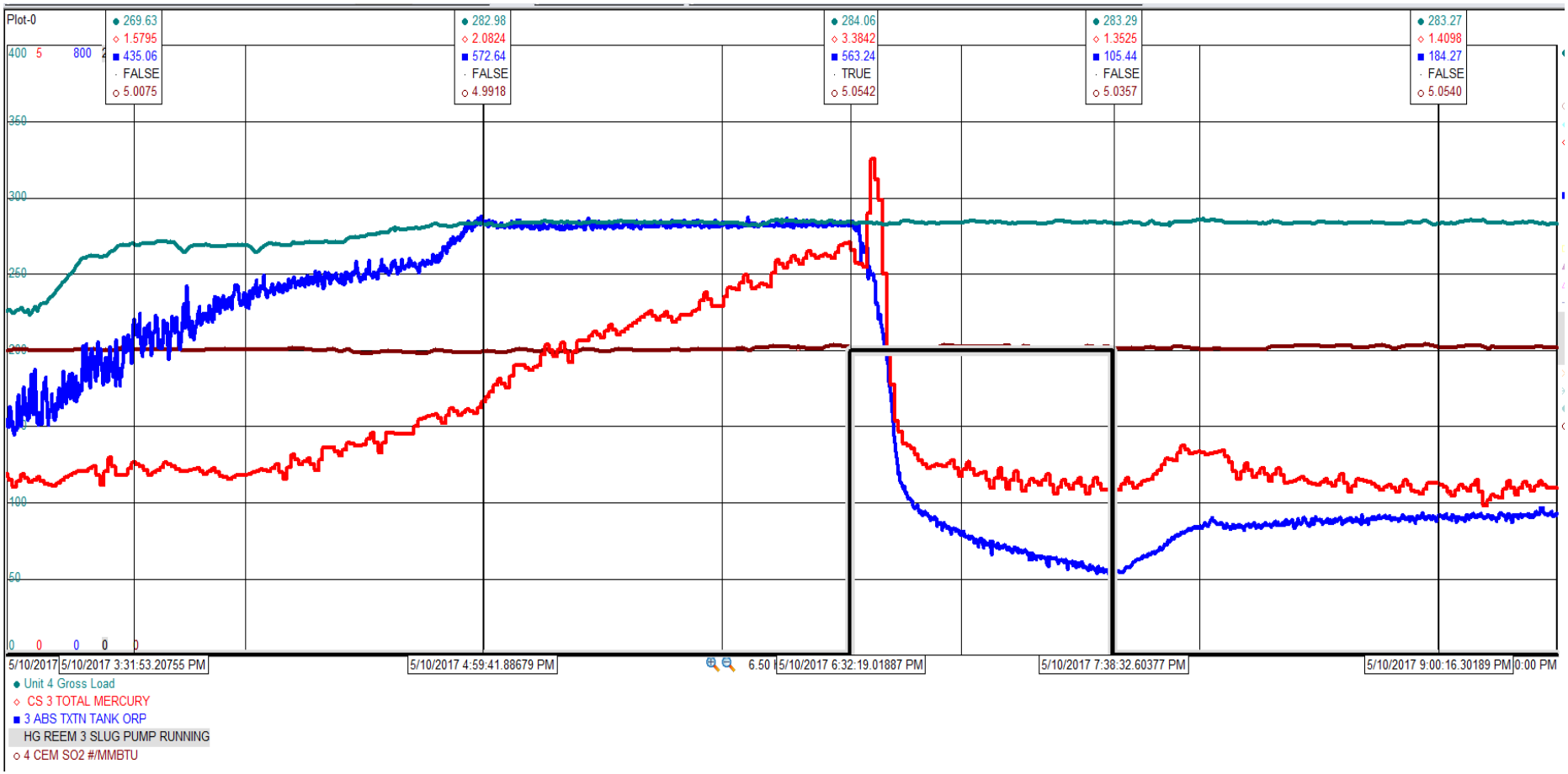
➢ ***ORP and Stack Hg Increasing from 0.2, peaks at 6.8, settles ~1.0 lb/TBtu. Nalco Dose Pumps ON, Reduces ORP and Hg, Slug Pump ON quickly reduces ORP and Stack Hg back to ~ 0.2 lb/TBtu. Chemical pumps OFF: ORP and eventually Stack Hg begin increasing again… until Nalco pumps are turned back ON.***

Nalco 8034 Plus Systems, Mercury Re-emissions Control



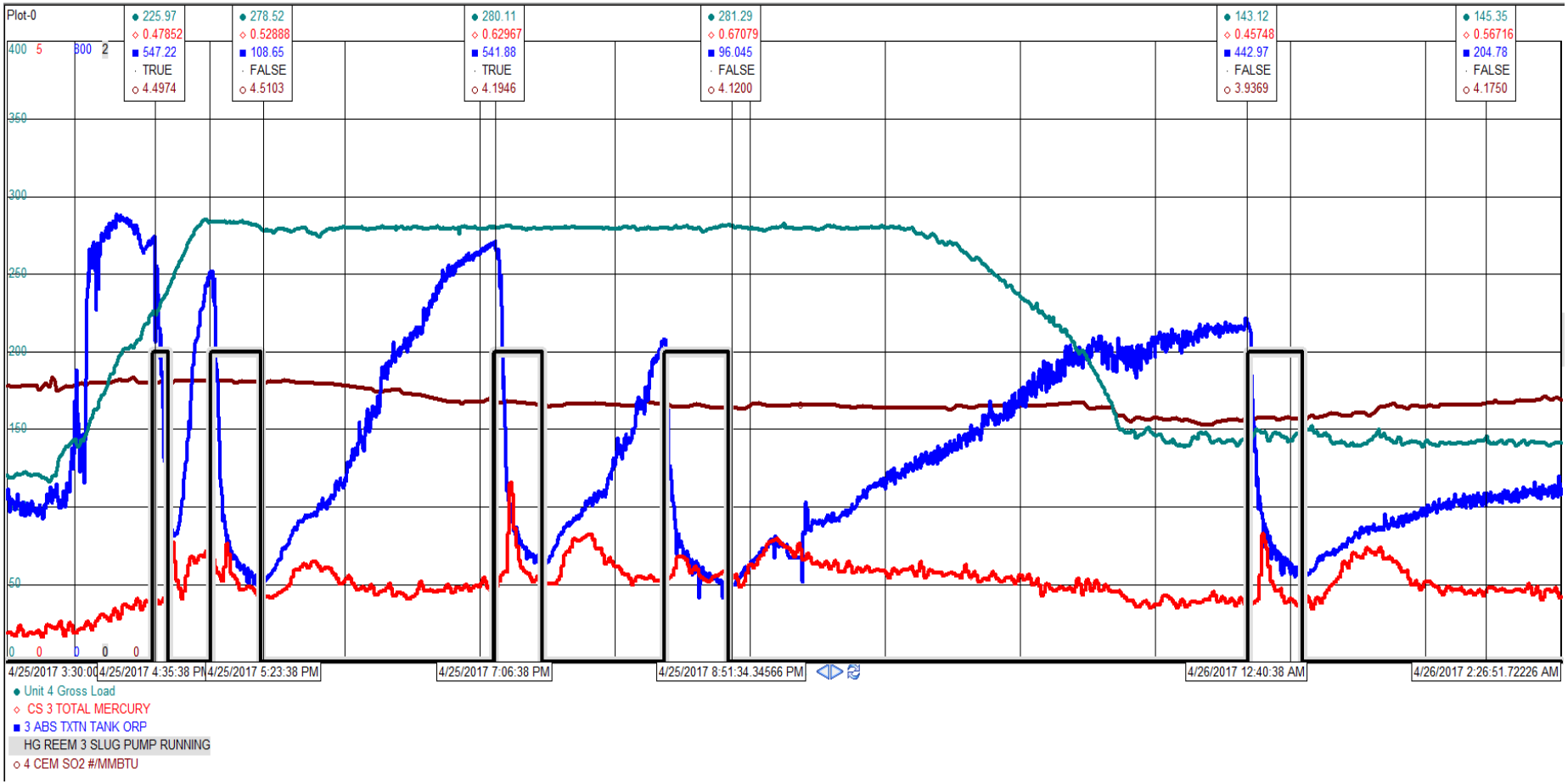
- ***With Unit Load and Coal SO2 constant, ORP increases up to ~516 mV with Stack Hg increasing. Stack Hg peaks at 1.18 ug/CM when Nalco 8034 Plus Slug Pump is turned "ON". With Slug Pump ON for 20 minutes the ORP and Stack Hg decrease and settle out to 189 mV and 0.79 ug/CM***

Mercury Re-emissions Mitigation with Nalco 8034 Plus



- ***ORP slowly increasing settles ~ 563 mV with Stack Mercury increasing to ~3.38 ug/cm. The Nalco 8034 Plus Slug Pump is turned "ON" for about an hour. The chemical reacts very quickly reducing ORP as low as 106 mV and stack mercury to 1.36 ug/cm.***

Mercury Re-emissions "Whack a Mole" Control



- ***Shortly after Unit startup ORP spikes to ~ 547 mV with Stack Hg increasing. The Nalco 8034 Plus Slug Pump is turned "ON" for a short period of time. It is not long enough as ORP climbs back four other times until it finally settles out around 218 mV.***

Nalco 8034 Plus Systems, Mercury Re-emissions Control Systems

- ***Duke installed Nalco 8034 Plus systems on 13 units.***
- ***Depending on the site, some systems are Automated, some systems are Manual.***
- ***Basic Control consists of:***
  - ✓ ***Turn "On" Nalco 8034 Plus higher feed rate Slug Pump when ORP and Stack Hg is increasing.***
  - ✓ ***Run the Slug Pump into the absorber until the ORP and Stack Hg decrease.***
  - ✓ ***Then either run the lower feed rate Dose Pumps in AUTO ..***
  - ✓ ***OR..***
  - ✓ ***Turn Off Nalco chemical and wait for next ORP excursion.***

Nalco 8034 Plus Systems, Mercury Re-emissions Control Installations

➢ ***Storage Tanks: Double Wall and Single Wall with Containment.***

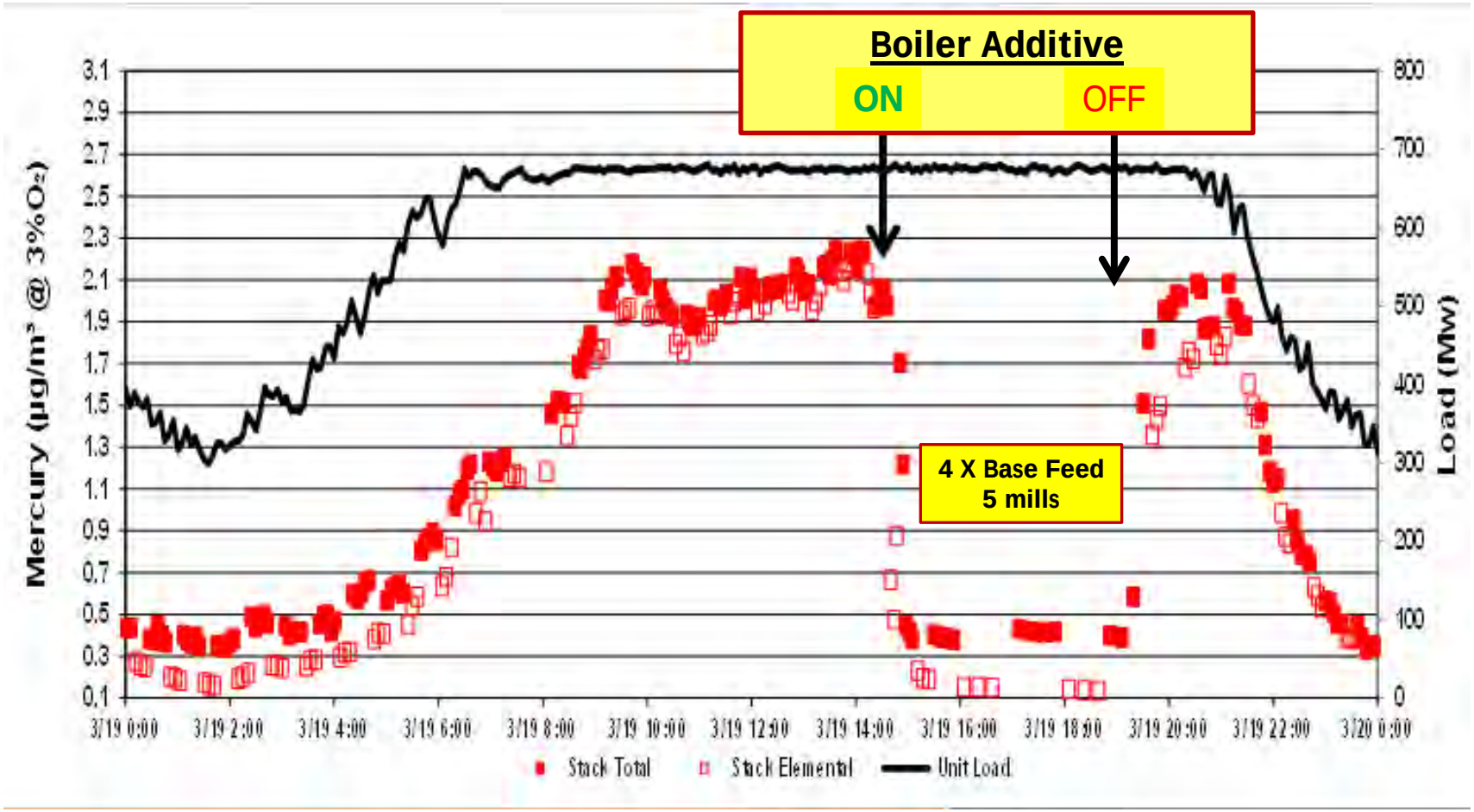
Nalco 8034 Plus Systems, Mercury Re-emissions Control Installations

- ***Pump Skid: Two Dose Pumps and One Air Operated Slug Pump Or Motor Driven Slug Pump***

Enhancing Mercury Oxidation: Coal Additive: Nalco 7895

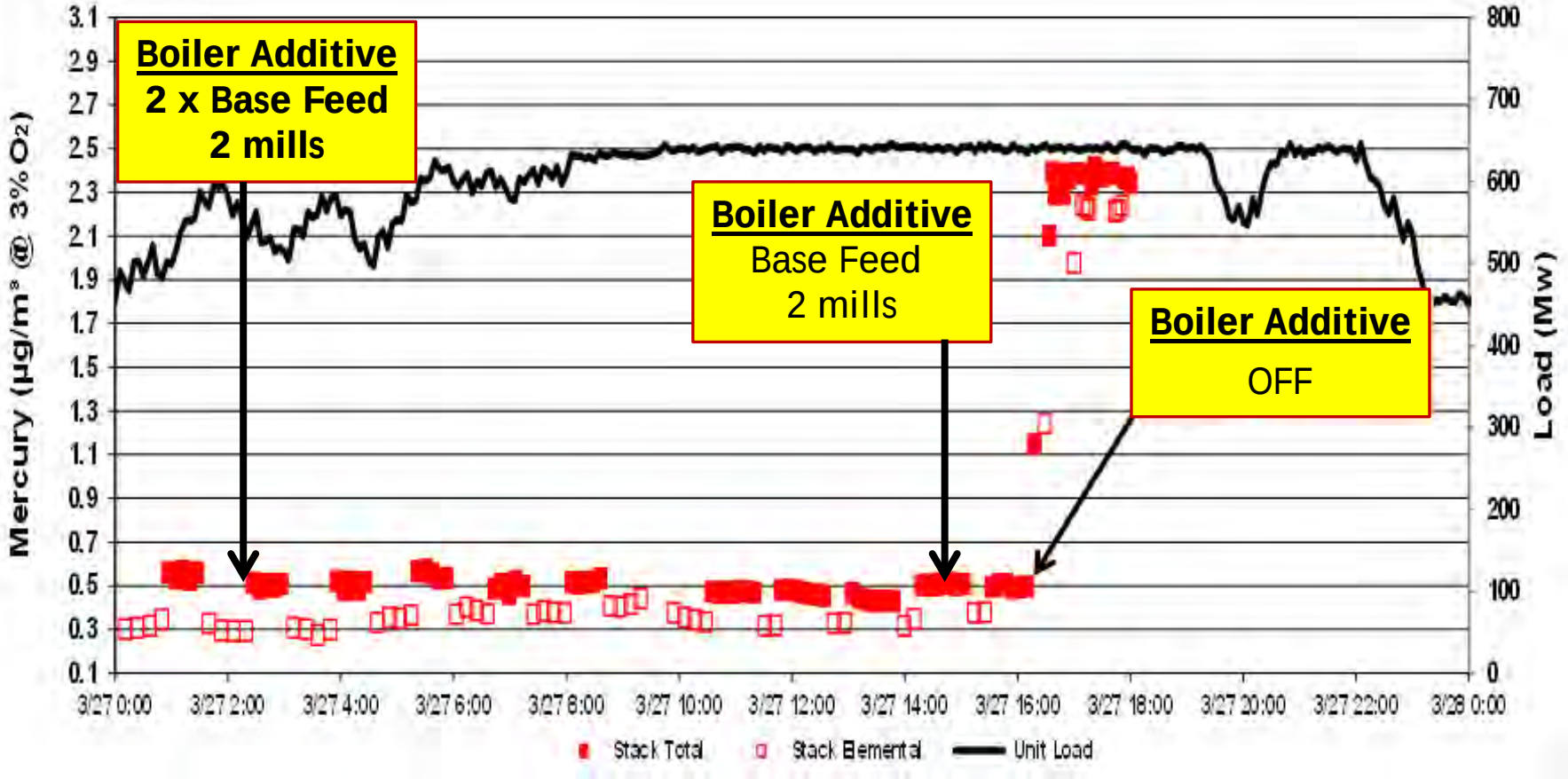
- ***Units are equipped with SCR for NOx control but limited on mercury oxidation due to:***
  - ***High flue gas temperatures and / or***
  - ***NH3 injection for NOx control.***
- ***Nalco Mercontrol 7895 is injected into the mill feeders, drips directly onto coal.***
- ***Elemental mercury (Hg^0) with the addition of a strong oxidizing agent will convert to oxidized mercury (Hg^{2+}).***
- ***Increasing oxidized mercury allows for more removal across the wet scrubber.***

Nalco Mercontrol 7895
Five Mill Injection Test



- ***Improved mercury speciation decreased mercury emission.***
- ***Rapid stack total mercury emission response.***

Nalco 7895
Two Mill Injection



- ***Mercury oxidation results independent of number of mills.***
- ***Low application rate yields targeted emission decrease.***

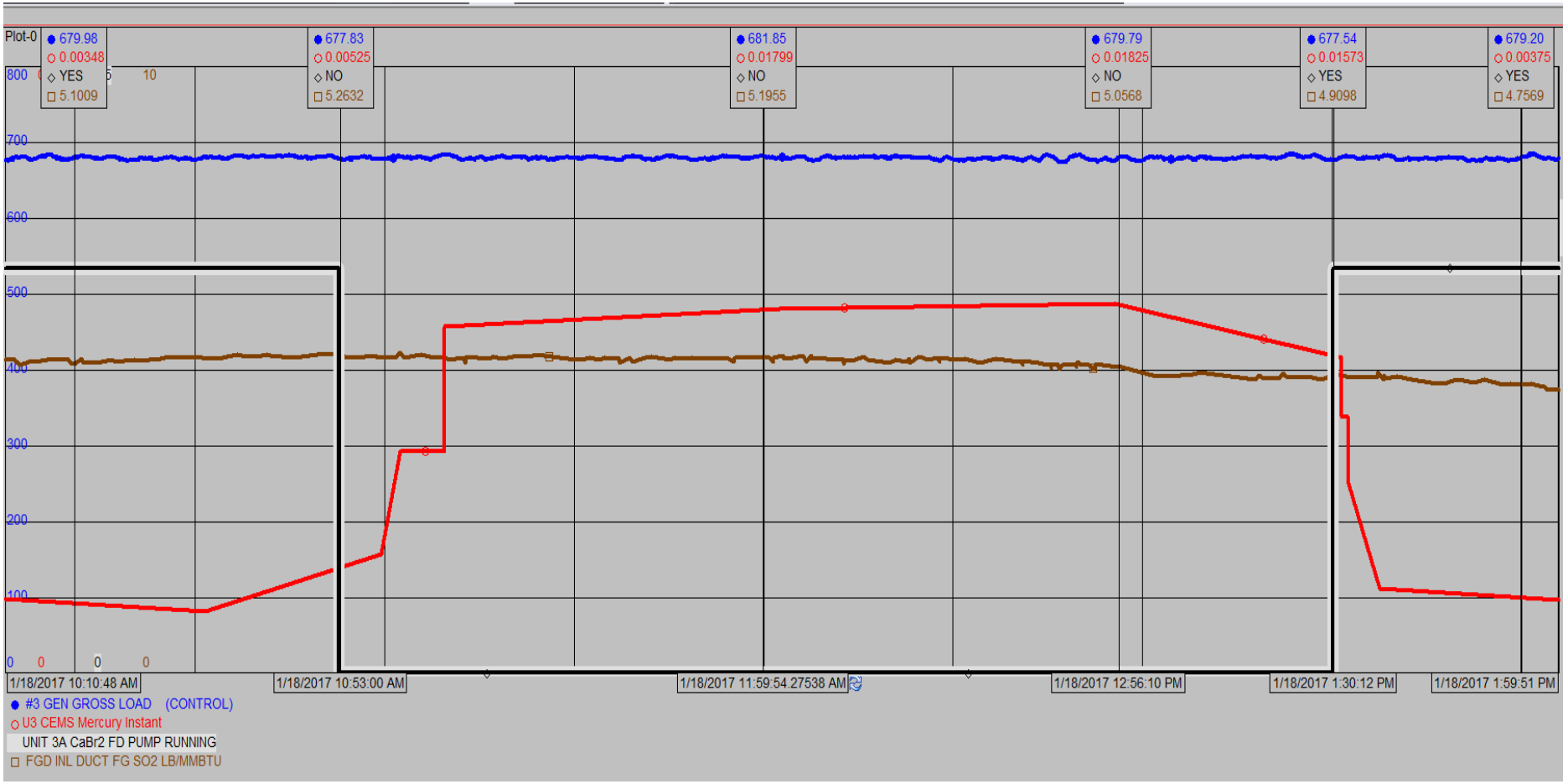
Nalco Mercontrol 7895 Equipment

- ***Two Storage Tanks and transfer pump skid supplying day tanks and chemical dose pumps at each unit.***

Nalco Mercontrol 7895 Equipment

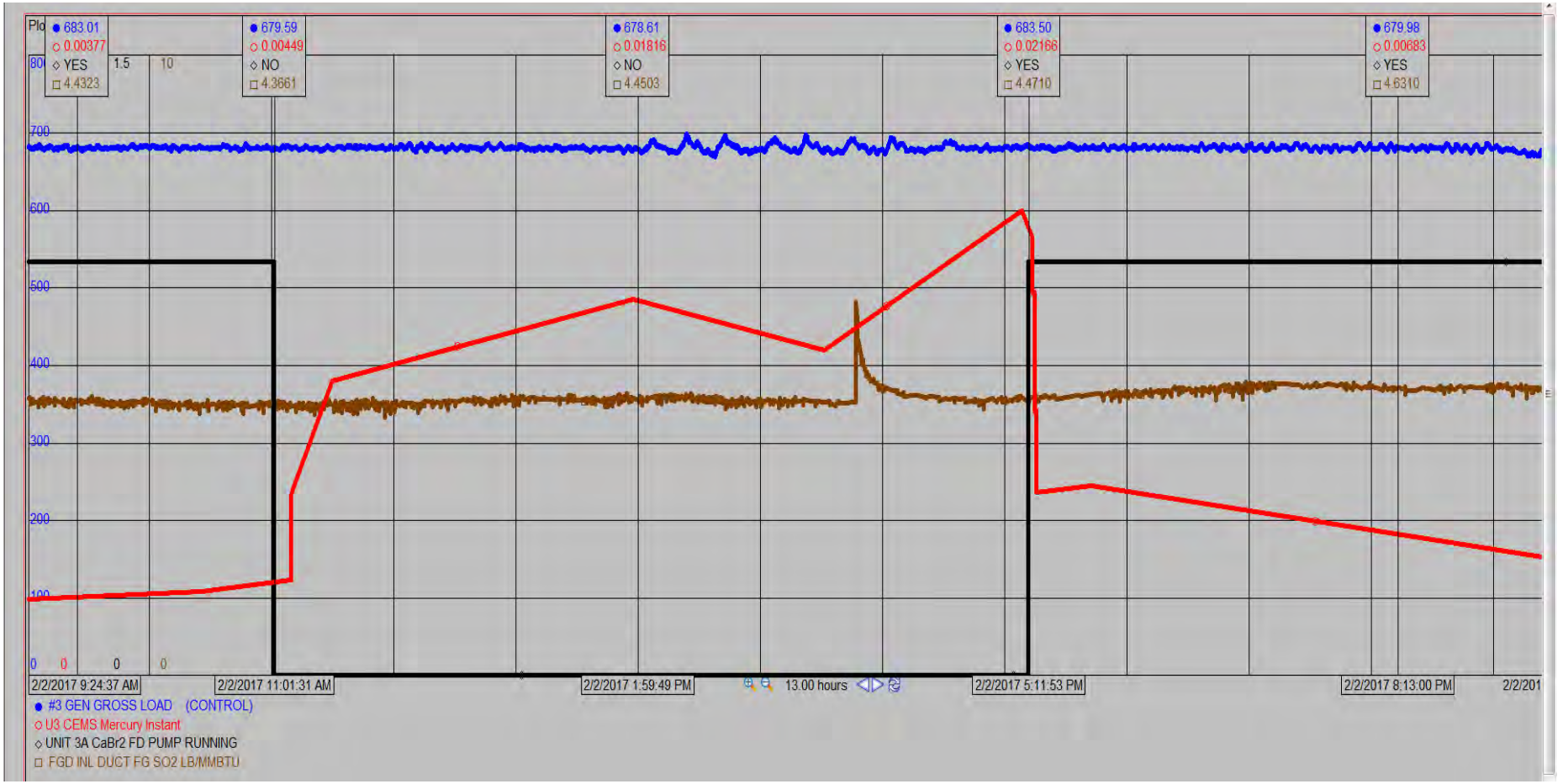
- ***Nalco 7895 chemical is fed into the coal mill feeder.***

Mercury Oxidation Enhancement with Nalco 7895



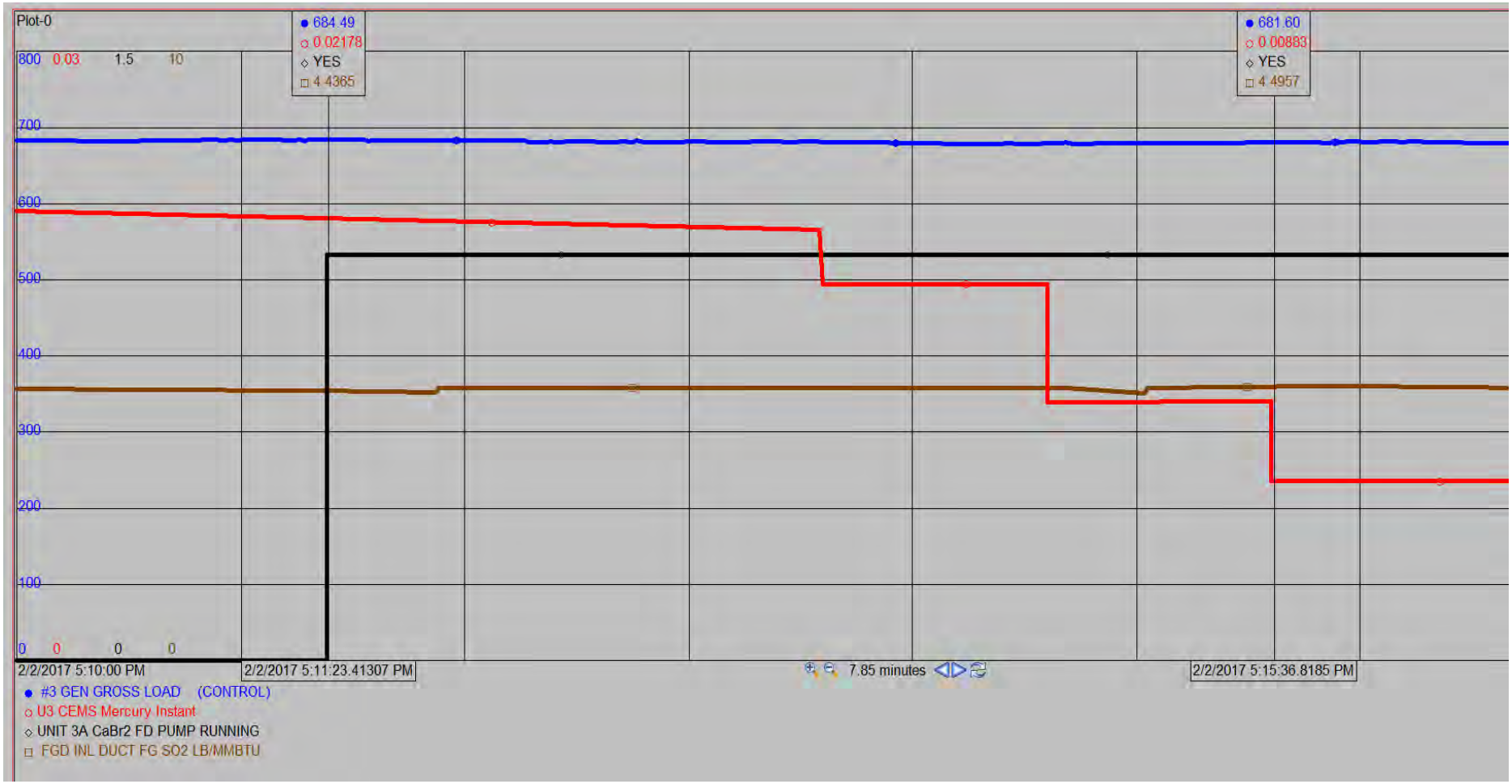
- ***Unit Load, Coal Sulfur Content Constant; Turning OFF the Nalco 7895, the Mercury Oxidation Decreases and Stack Mercury Increases from a Baseline of 0.0052 up to 0.0182 lb/GWHr. Turning ON the Nalco 7895, the Stack Mercury Returns to ~0.0037 lb/GWHr.***

Mercury Oxidation Enhancement with Nalco 7895



- ***Unit Load, Coal Sulfur Content and ORP All Constant. Turning OFF the Nalco 7895, the Mercury Oxidation Decreases and Stack Mercury Increases from a Baseline of 0.0045 up to 0.022 lb/GWHr. Turning ON the Nalco 7895, the Stack Mercury Returns to ~0.007 lb/GWHr and dropping.***

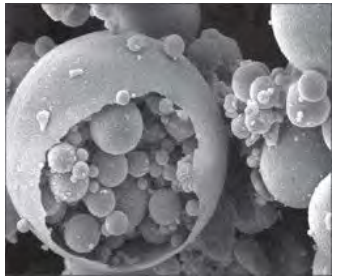
Mercury Oxidation Enhancement with Nalco 7895 Response Time

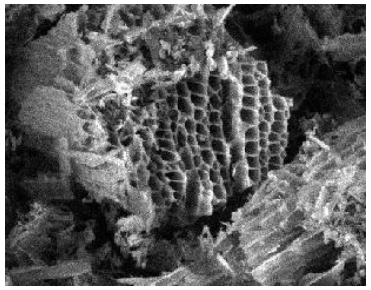


- ***The Response Time of the Nalco 7895 is very fast. Adding the Chemical to the Mill Feeder, Through the Mill, the Furnace, the SCR, the Air Pre-heater, the ESP, the WFGD and to the Stack Mercury CEMS, it takes ~ 4 Minutes Response Time.***

Sorbent Injection- Activated Carbon

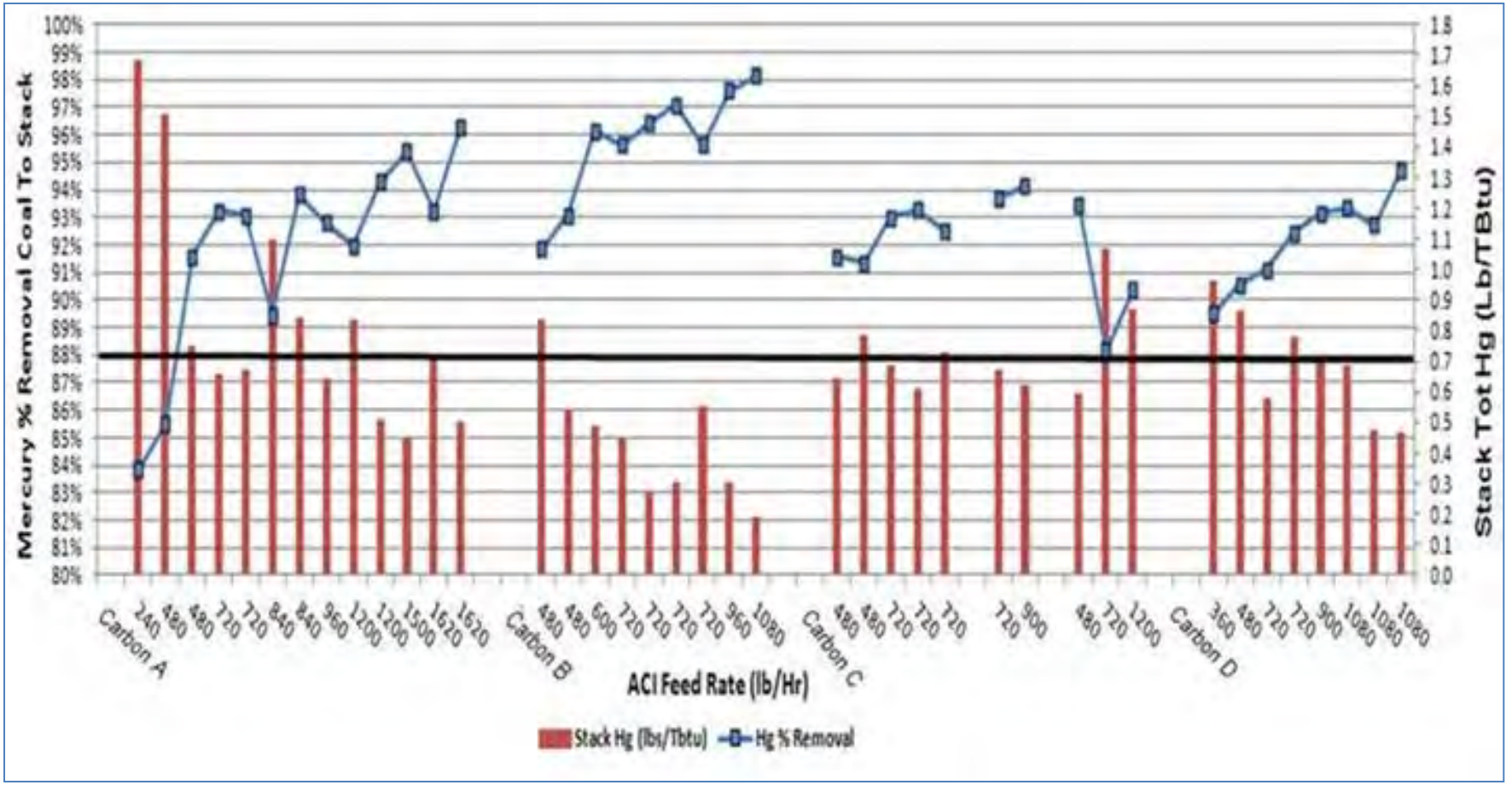
- ***Powdered activated carbon (PAC) is a very porous material with a lot of surface area.***
- ***Mercury will occupy the pores and adhere to the surface of the carbon. The particulate collection device, ESPs or bag-house will remove the carbon and hence the mercury.***
- ***Halogenated PAC increases mercury oxidation at the surface of the carbon for better adsorption and removal.***
- ***Loss On Ignition (LOI) is native carbon but is different than PAC. LOI's surface area is like a golf ball compared to PAC's surface area which is like a sponge.***



ACI Test Results

Not all PACs are the same: different activation process, different pore size and volume, different surface areas, different additive methods and concentrations.



Coal Sulfur Content Negative Impact on PAC Performance

Coal Sulfur Content Decreasing Required Less PAC for Hg Control

New ACI Silo and PAC Delivery

- *Duct Injection Header*

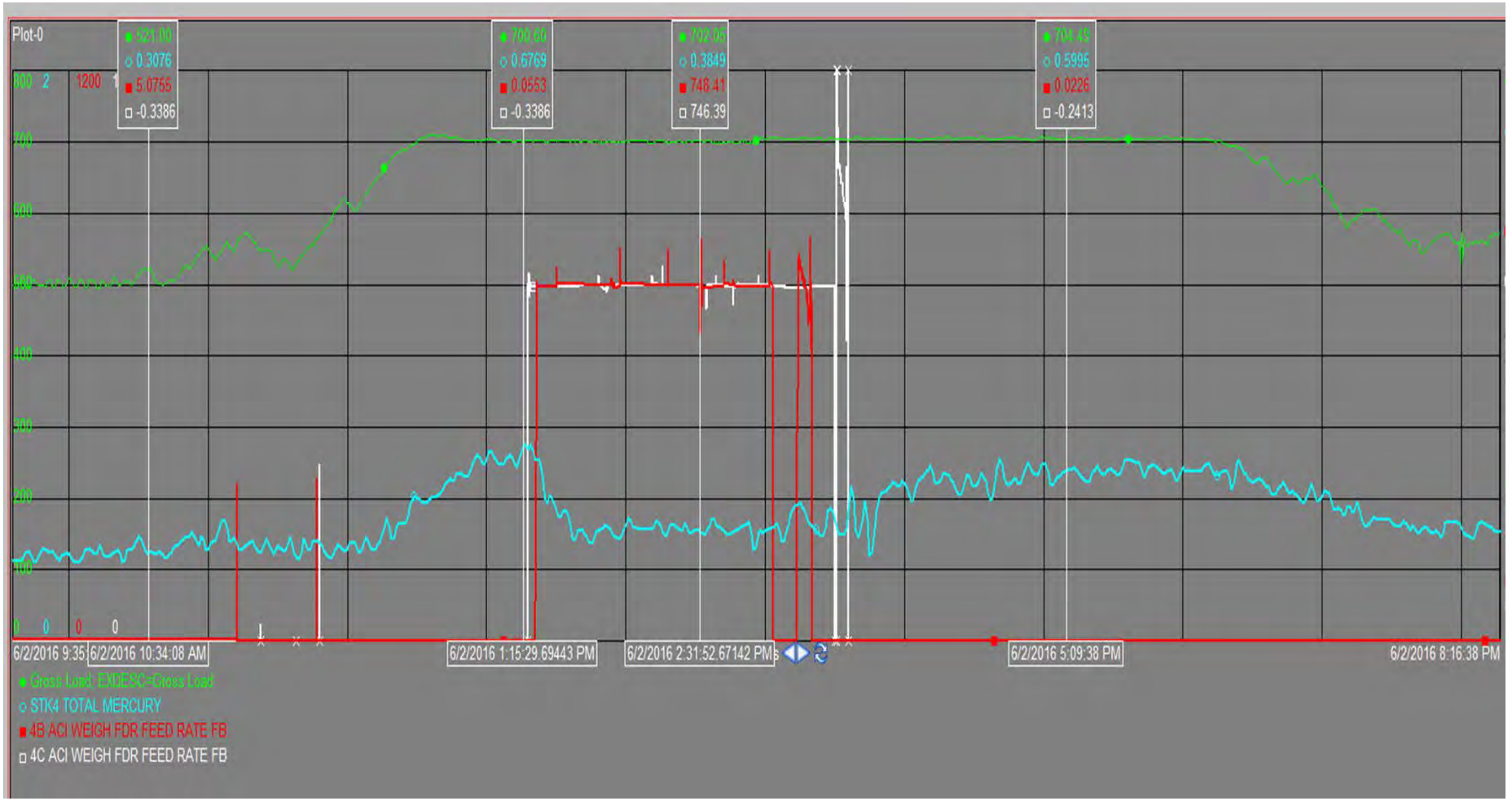
ACI System Commissioning Issues

- ***PAC Blowing Back Into Silo..***
- ***Boroscope Inspection of Feed Lines for Pluggage Issues***

ACI System Performance Issues Resolved

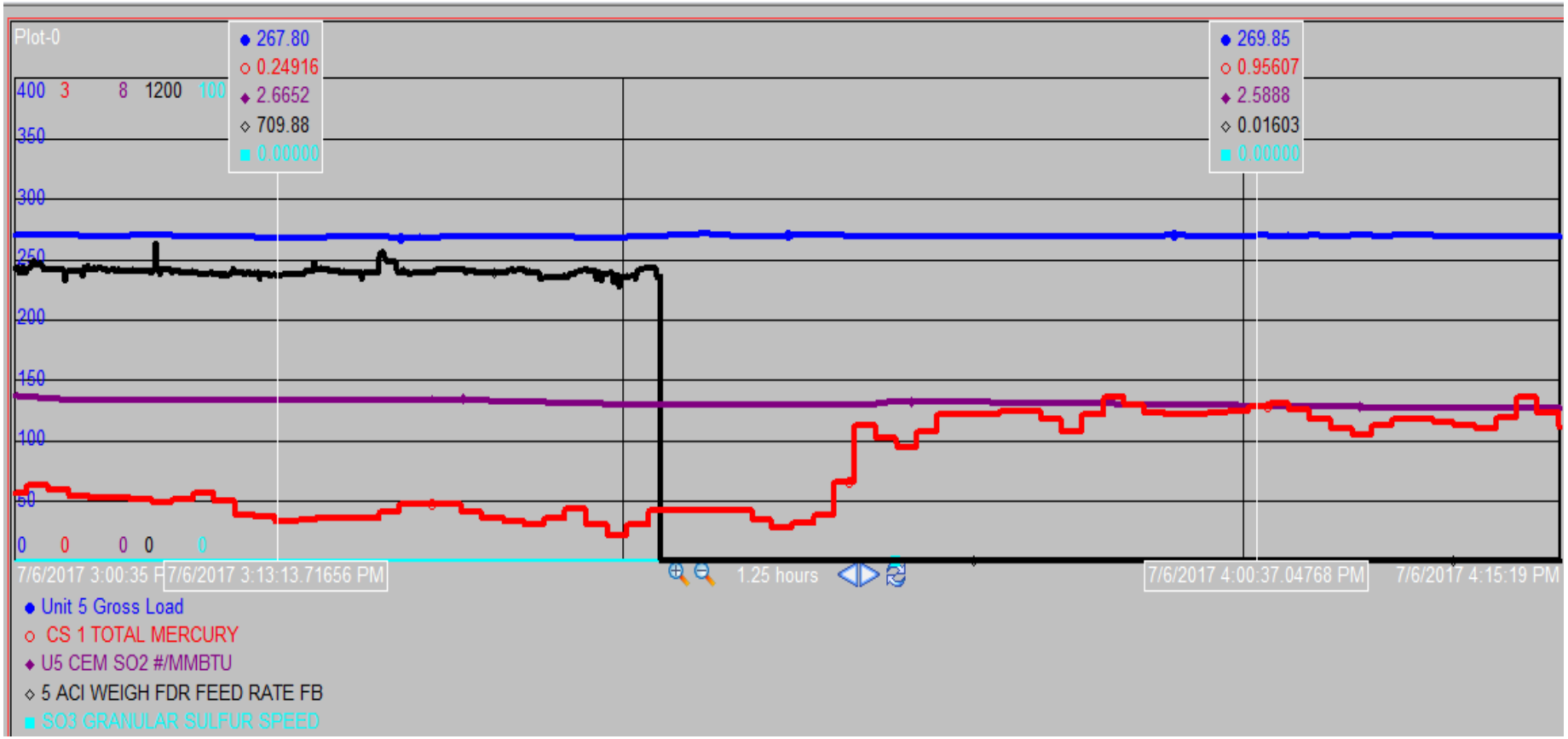
- ***From Equipment Modifications,***
- ***Now Capable of Feeding PAC ~500 Ft at 1500 lb/hr***

ACI Results During Commissioning



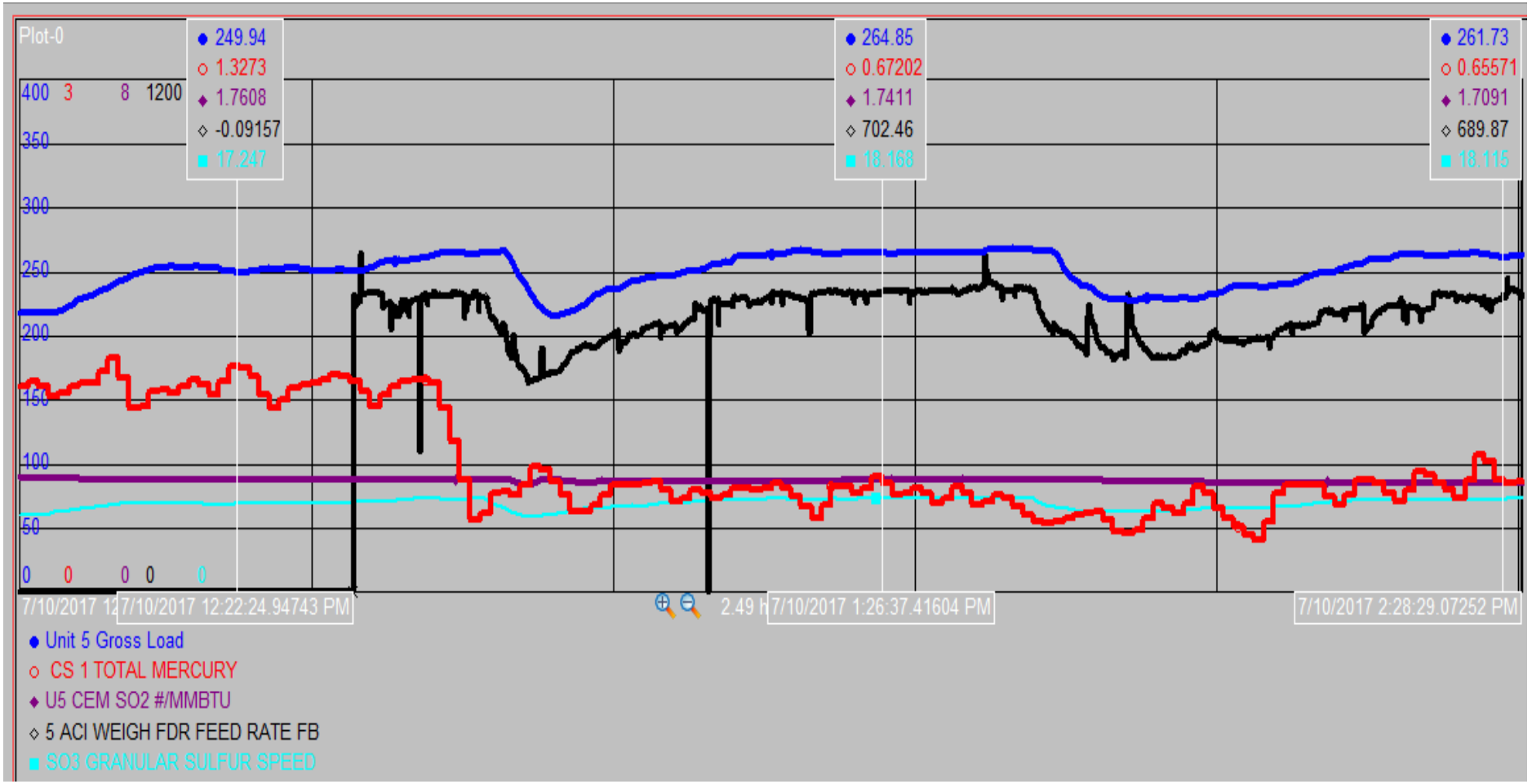
Standard Non-Halongenated PAC,
Mercury (ug/cm) Removal At ~1500 lb/hr: ~ 43%

Cabot Non-Halongenated 5th Generation PAC Results: Burning 2.6 lb/MMBtu Eastern Bit Coal



Mercury (ug/cm) Removal: ~ 74% at ~709 lb/hr.
SO3 Flue Gas Conditioning OFF.

Cabot Non-Halongenated 5th Generation PAC



Impact of SO3 Flue Gas Conditioning (~6 ppm SO3). Mercury (ug/cm) Removal: ~ 50% at ~700 lb/hr

Challenges For Mercury HAPs Compliance

Coal Quality Variability

- **Coal sulfur impact on PAC injection.**
- **Coal quality impact on mercury re-emissions. Chlorine, Sulfur, Mercury content.**

Unit Operation Impacts on Mercury Control

- **SO3 flue gas conditioning for ESP performance negative hit on Activated Carbon Injection.**
- **Flue gas temperatures: Replacing air heater baskets or economizer can change outlet duct temps impacting ACI performance and SCR mercury oxidation.**
- **PAC in long term storage. Shelf Life and Conveyance issues; may have to "warm up" ACI system: operate silo fluidizing air and blower ahead of actual injection to promote PAC feed.**

Mercury Instrumentation

- **Support and maintain the mercury CEMs to make them as reliable and believable as possible.**
- **Install and maintain ORP instrumentation for mercury re-emissions controls.**

Operation of Mercury Control Technologies

- **Train operators to recognize when to utilize the control technologies for compliance and optimization.**