

REINHOLD ENVIRONMENTAL Ltd.



2016 APC-Wastewater Round Table & Expo Presentation

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Optimization and Troubleshooting of MATS Compliance

Sheila Glesmann & Joe Wong
ADA Carbon Solutions

David Bonner
Southern Company

Reinhold APC Conference – Dearborn, MI
July 18, 2016

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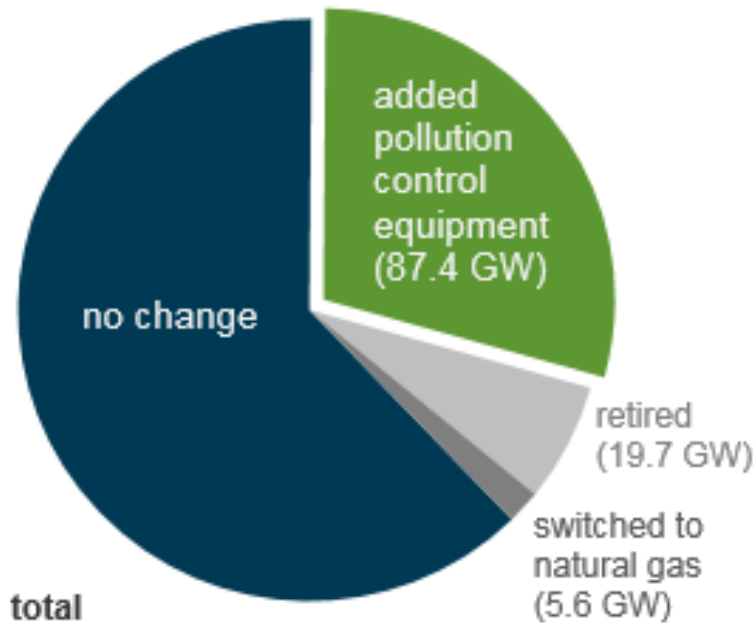
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MATS Implementation

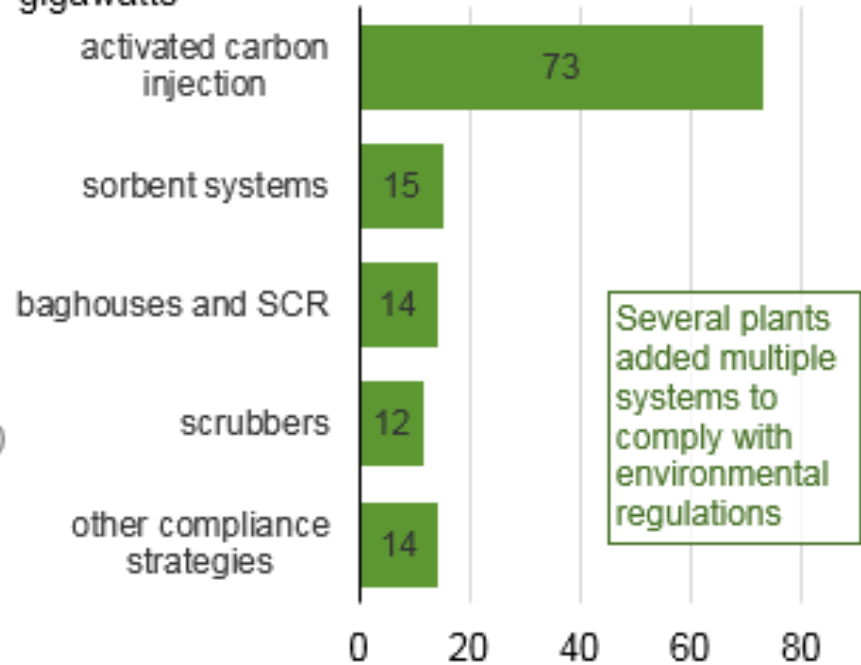
Sheila Glesmann

Coal Capacity and MATS

Changes in U.S. coal capacity, December 2014 to April 2016
gigawatts (GW)



pollution control equipment added in 2015 or 2016
gigawatts



Source: EIA, [Annual Electric Generator Data \(EIA-860\) Early Release](#) and [Preliminary Monthly Electric Generator Inventory \(EIA-860M\)](#)

<http://www.eia.gov/todayinenergy/detail.cfm?id=26972>

- The CAMD now includes unit-by-unit data on technology selected and compliance under MATS
- Plant configurations are shown along with compliance date (2015 / 2016)
- 216 units (of 804 coal units) reporting Hg control of some type as of June 2016
- 206 of these show PAC as part of strategy
- Other control strategies listed include:
 - Additives used to enhance Hg capture – 78 units
 - Catalyst used to oxidize Hg (w/WFGD) – 3 units
 - Sodium Based – 4 units
 - Non-PAC sorbent – 5 units, 2 of which also list PAC
 - Regenerative activated coke – 1 unit
- Hourly emissions data
- Does not show coal type
- <https://ampd.epa.gov/ampd/>

Institute of Clean Air Companies survey that covered 181 GW of coal-fired power generation revealed:

	Number of Generating Units Covered in Survey	Size of Generating Units, GW (% of those in survey)
ACI	310	137 (76%)
Boiler Oxidant	49	26 (14%)
Non-carbon Sorbents	3	1.6 (1%)
Wet FGD Additives	36	16.5 (9%)
Totals	398	181 (100%)

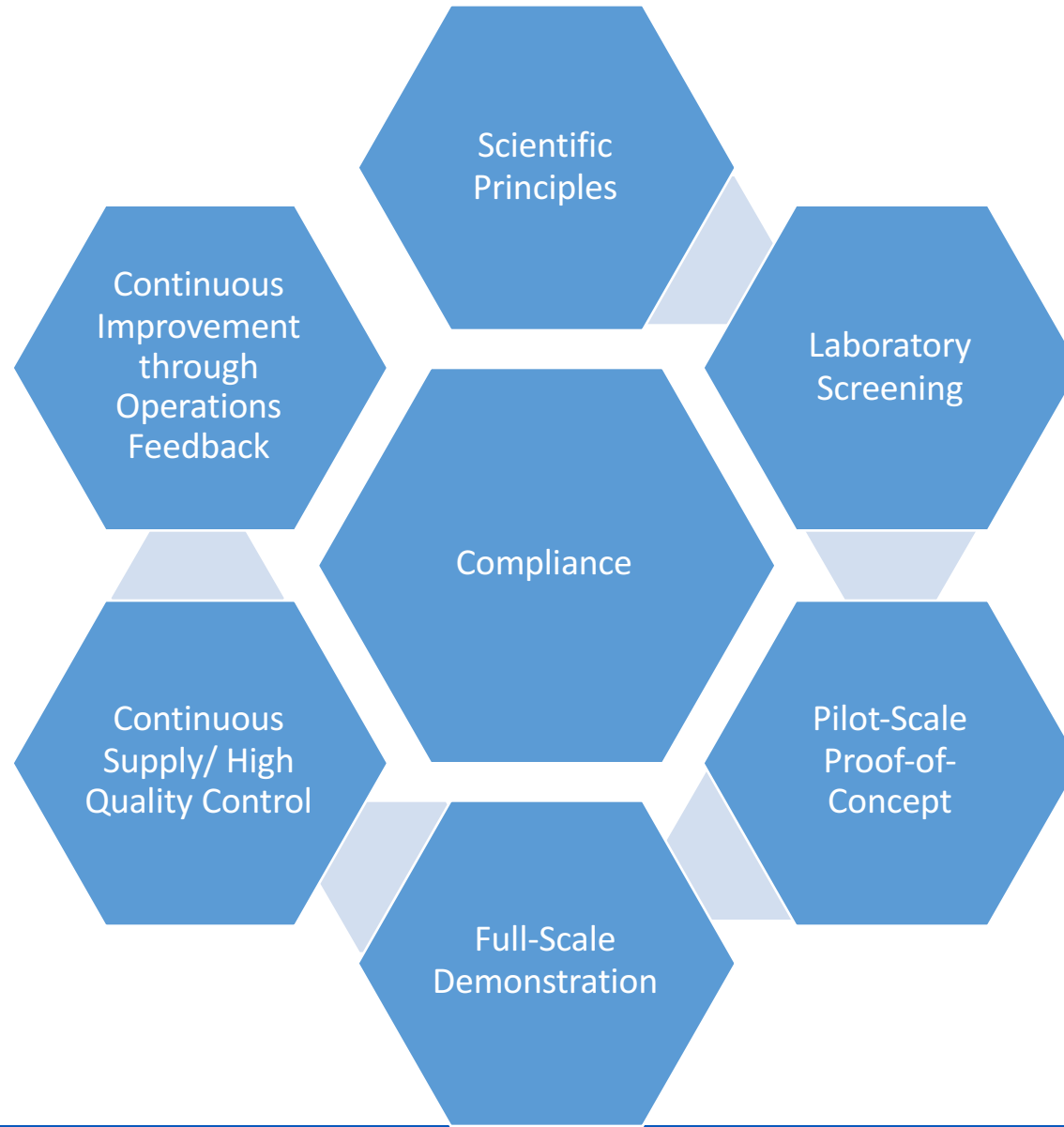
<http://www.powermag.com/the-state-of-u-s-mercury-control-in-response-to-mats/>

Activated Carbon Injection is considered as Best Available Control Technology and Maximum Achievable Control Technology

- ✓ Achieves emission targets
 1. Maximizes the value of native control
 2. Consistently meets all emissions limits under varying conditions (load, coal type)
 3. No surprises
- ✓ Minimizes all sorbent / reagent usage
 1. The combination of all emissions control reagents / sorbents is optimized
 2. Each sorbent works synergistically with other additives and technologies
 3. Balance-of-plant adverse impacts are managed and minimized

- ✓ Mercury is captured securely
 1. Short-term monitoring may not reveal true fate of mercury
 2. Adsorption into PAC avoids re-emissions that can occur from ash alone or from scrubber liquor over time
 3. TCLP testing has shown that PAC is an effective capture medium
- ✓ Maximizes the value of the byproducts
 1. Maintains the maximum value of the byproducts for beneficial use
 2. Avoids leaching issues if temporary storage is necessary
 3. The technology selected for mercury control and the plant operations both impact byproduct utilization
 4. Many ways to crack this one – collaboration is key

- Create better mechanistic understanding of plant emission system leading to:
 - Clearer definition of active process control levers
 - Rigorous R&D technology roadmaps for tailored PAC properties
- Enable rapid PAC prototyping from lab to field to advance promising PAC technologies for your commercial use.
 - Reduce risk of change
 - Create “fail-safe” testing scenarios
- Create culture of interactive and reciprocal technical rapport and support, leading to rapid technical problem solving



- High SO₃ ?
- Mercury control at higher-temperature, continuous or seasonal operation?
- Fuel flexibility?
- Corrosion?
- Fly Ash Impacts / Beneficial Use?
- Reduce reagent use / Optimize what you have in place?
 - Br impacts on Se, water?
- ELG concerns over fate of mercury?

Advancing PAC Development

Joe Wong

Three Critical Mechanisms

Contact

of mercury, which is in very dilute concentrations in the flue gas, with the capture media

Conversion

of elemental mercury (Hg^0) to an oxidized state (Hg^+ or Hg^{++}) to enhance mercury's receptivity to the capture media

Capture

of the mercury in the capture media's structure for removal from the system

All three mechanisms must occur in seconds or less to achieve compliance.

But, there are practical operating constraints...



Using variable fuel sources and blends	No SCR to oxidize Hg	Concerned about BOP impacts from halogen on coal	No DSI system
PM control from under-sized ESP	Compatibility with Flue Gas Conditioning additive	Fly ash sales	wFGD operation and acid gas removal efficiency
Gypsum quality and sales	Water effluent quality, e.g fate of Selenium, Br	Equipment materials of construction compatibility	Technology licensing / Freedom to Practice
Capital or O&M Costs	System Reliability	Operating Ease	Load Following Effectiveness

Creating Activated Carbon Features to Maximize Contact, Conversion & Capture

Surfaces

- Host for chemical reactants, catalysts and chemical functionalities

Pores

- “Holes” of varying sizes to “transport” and “capture” target molecules to be removed

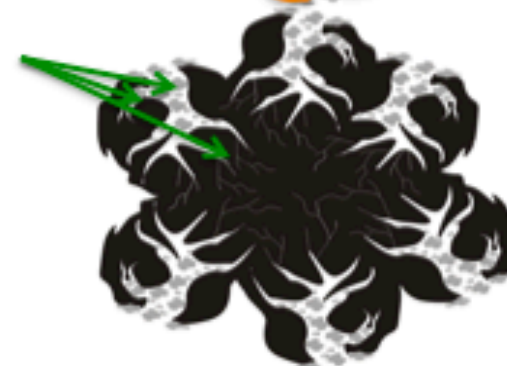
Particles

- Transportation medium to deliver desired properties to the right location at the right time

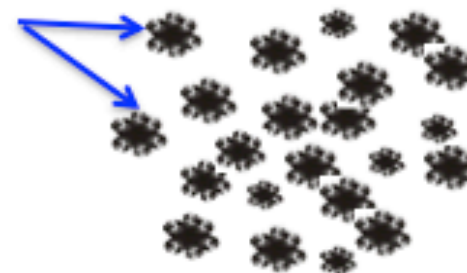
Surface



Pores

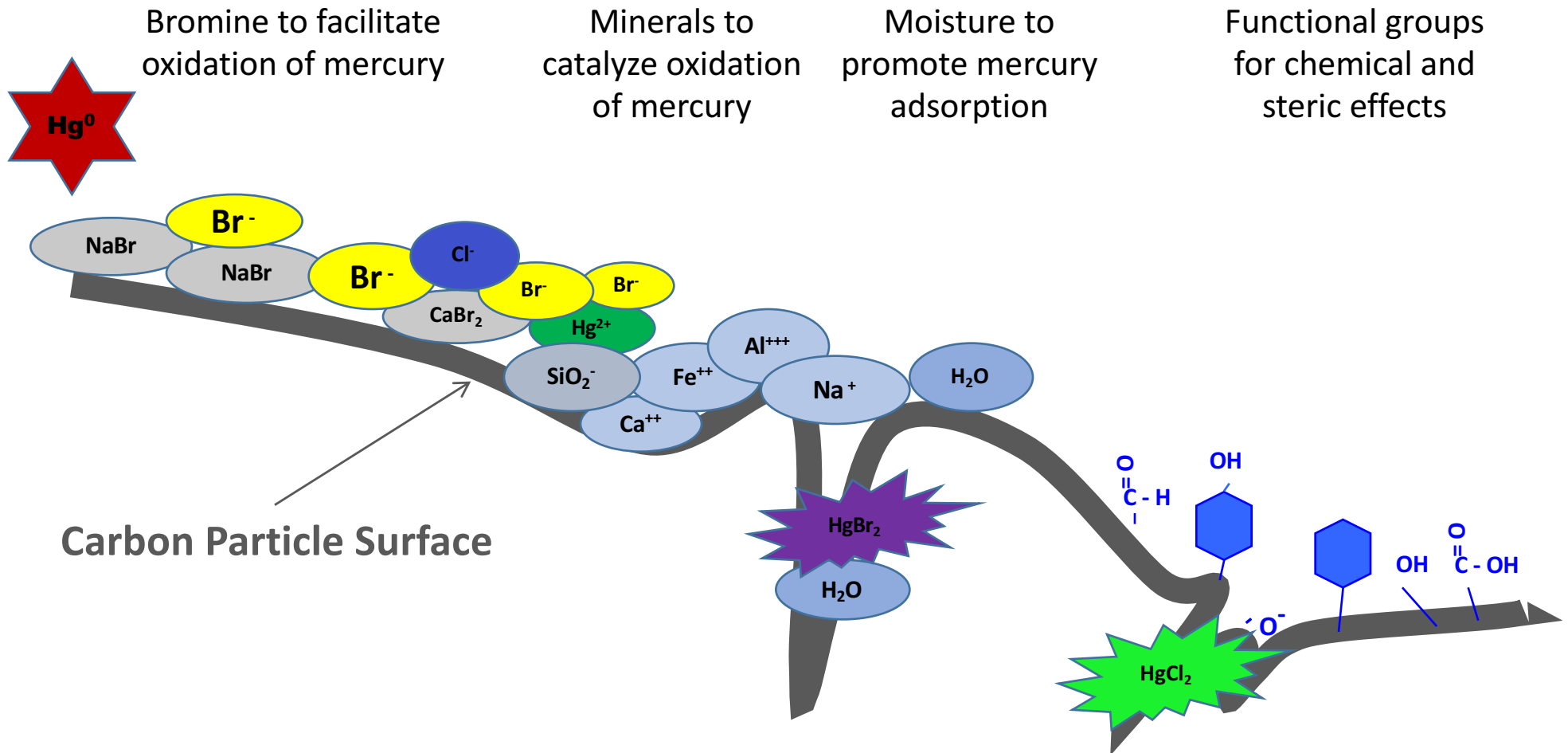


Particles



Tuning carbon surfaces, pores and particles improves Hg control properties

Tuning the Activated Carbon Surface is One Key Approach



The activated carbon surface can be modified in different ways to maximize Hg capture

Advancing the View on PAC Mercury Capture Performance



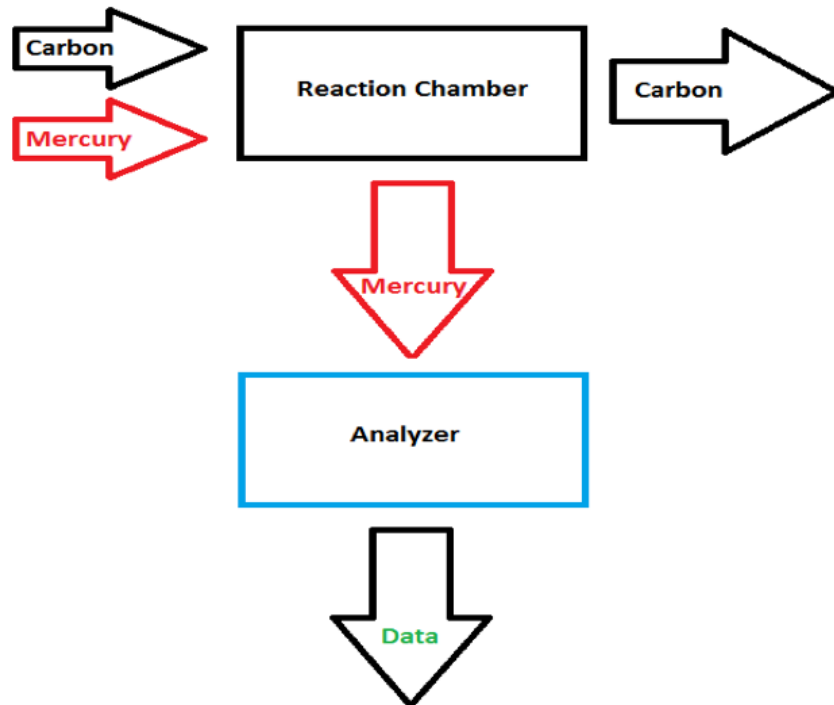
Activated Carbon Properties	Applications Performance “Surrogate Tests”	Applications Performance “Direct Tests”
<ul style="list-style-type: none"> • Surface Area • Pore Volume • Moisture • Bulk Density • Particle Size • Abrasion Number • Extractables pH 	<ul style="list-style-type: none"> • Ignition Temperature • Total Sulfur • Halide Content • Iodine Number • Molasses Number • Decolorizing Index • Bromophenol Blue Capacity • Butane Activity 	<ul style="list-style-type: none"> • Packed Bed Hg Breakthrough

EGU Applications Specific Simulation

Applications Performance “Simulation Tests”

- Dynamic Mercury Test

The Dynamic Mercury Test more closely simulates Hg capture in utility emission equipment.



Inputs

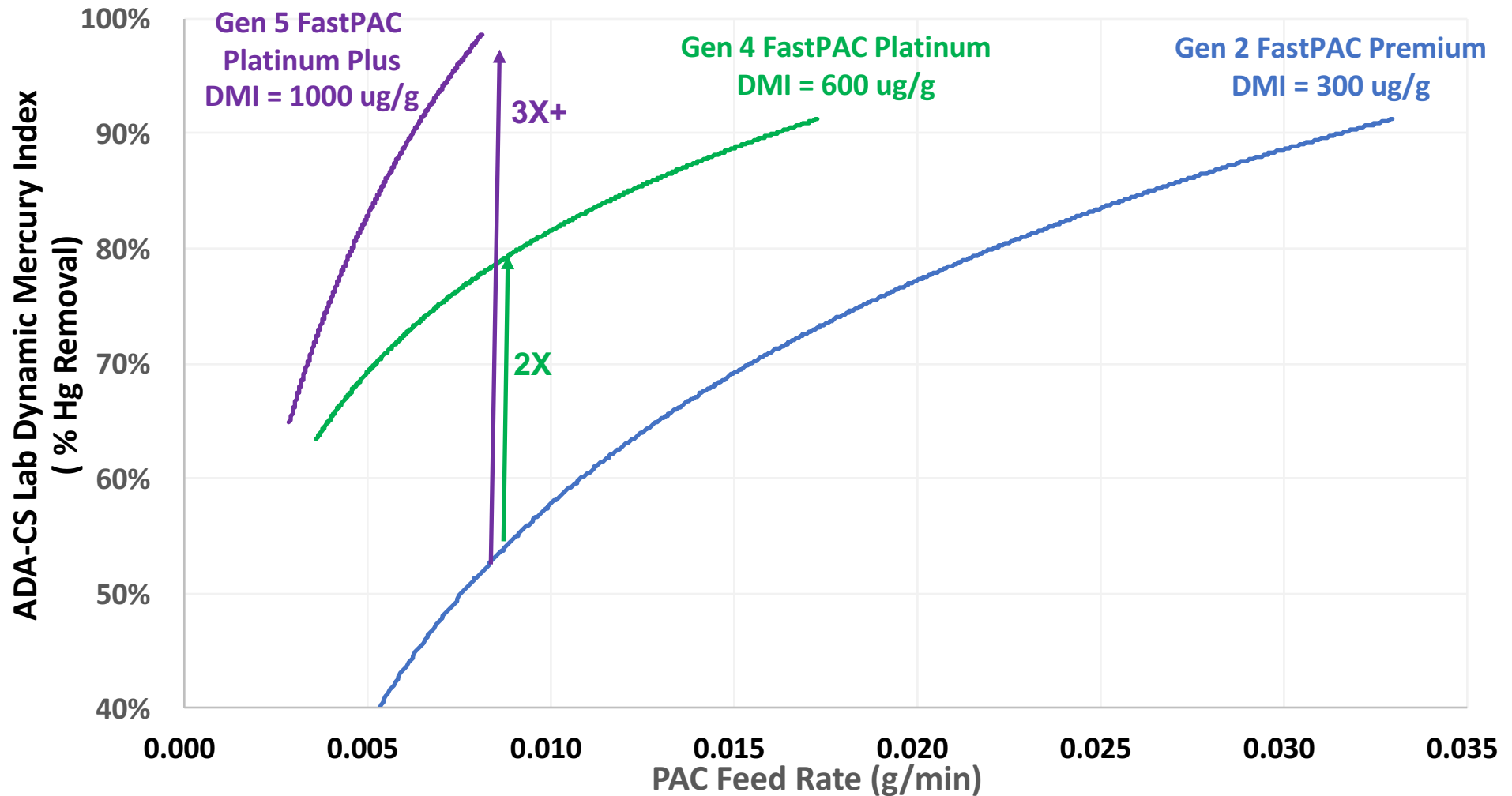
- Temperature: 325°F
- Gas: Air
- Target simulated injection rate: 1 to 5+ lb/MMacf
- Residence time: ~1 second
- Mercury concentration: 10 $\mu\text{g}/\text{m}^3$

Outputs

- Hg Concentration: μg Hg captured/g PAC

Inputs are standardized to simulate plant operating conditions, but simplified to provide easy lab-scale comparisons.

Rapid Prototyping with Our Lab DMI Leads To Quantitatively Enhancing PAC Mercury Removal

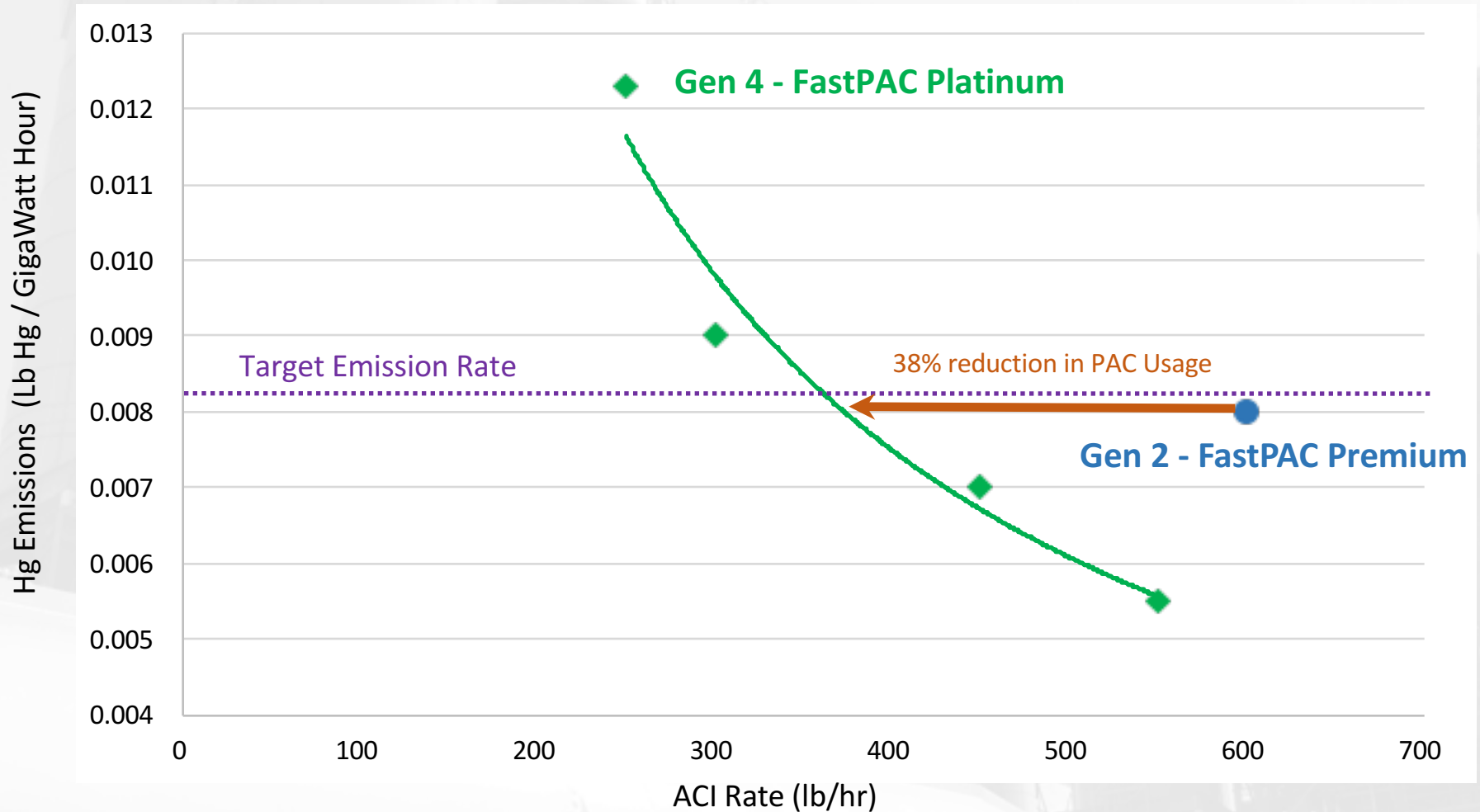


In lab DMI tests, our patent-pending Gen 4 and Gen 5 PACs have 2 to 3+ times mercury removal capability compared to our industry standard Gen 2 FastPAC Premium.

Full-Scale Testing of Advanced Gen 4 FastPAC Platinum

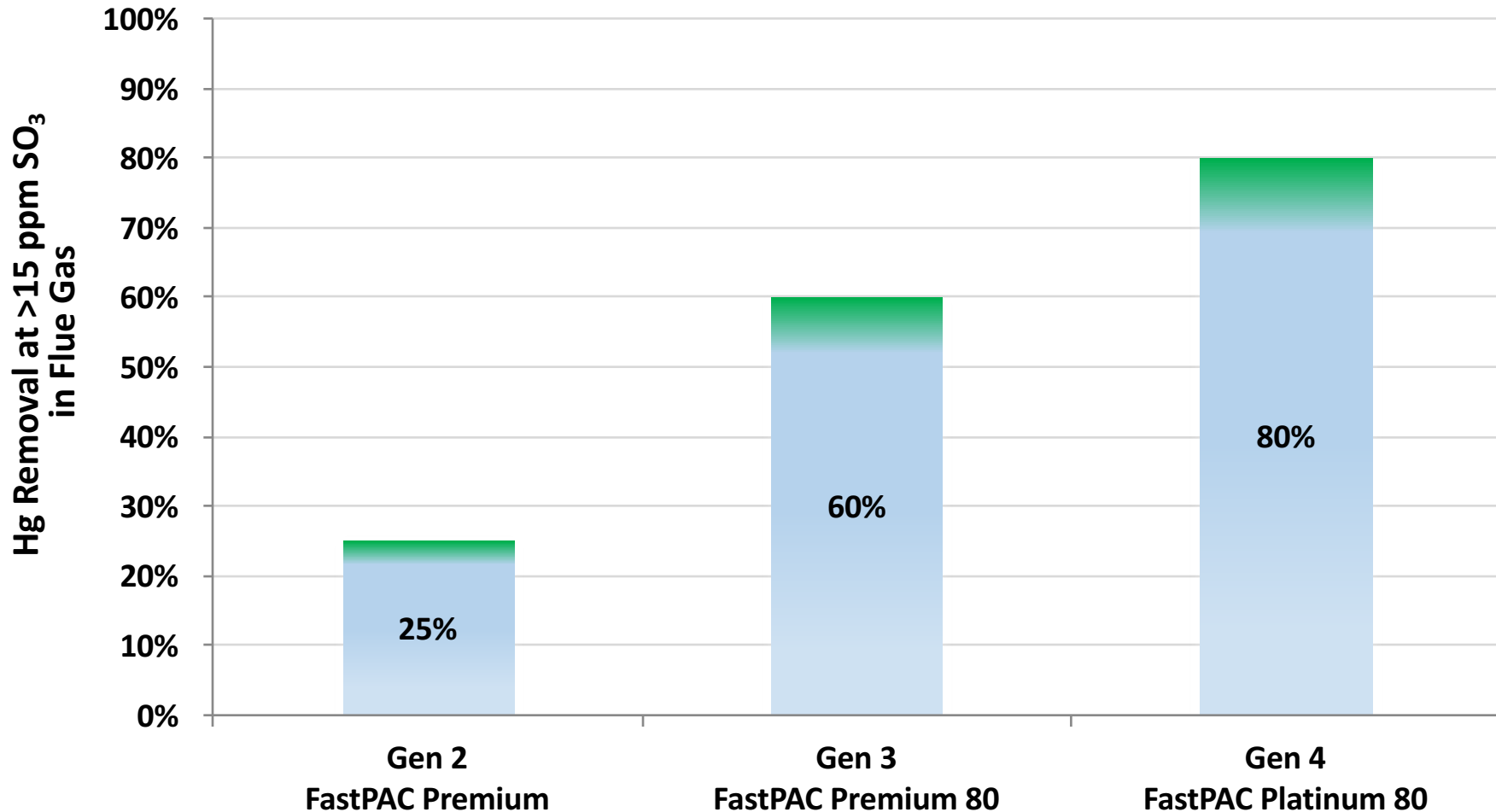


PRB Fired - 660 MW: Econ-SCR-DSI-APH-ACI-ESP-Stack



Our Gen 4 FastPAC Platinum reduced PAC usage by 38% compared to our Gen 2 FastPAC Premium in a sodium DSI system.

SO₃ Tolerance Performance Improvements



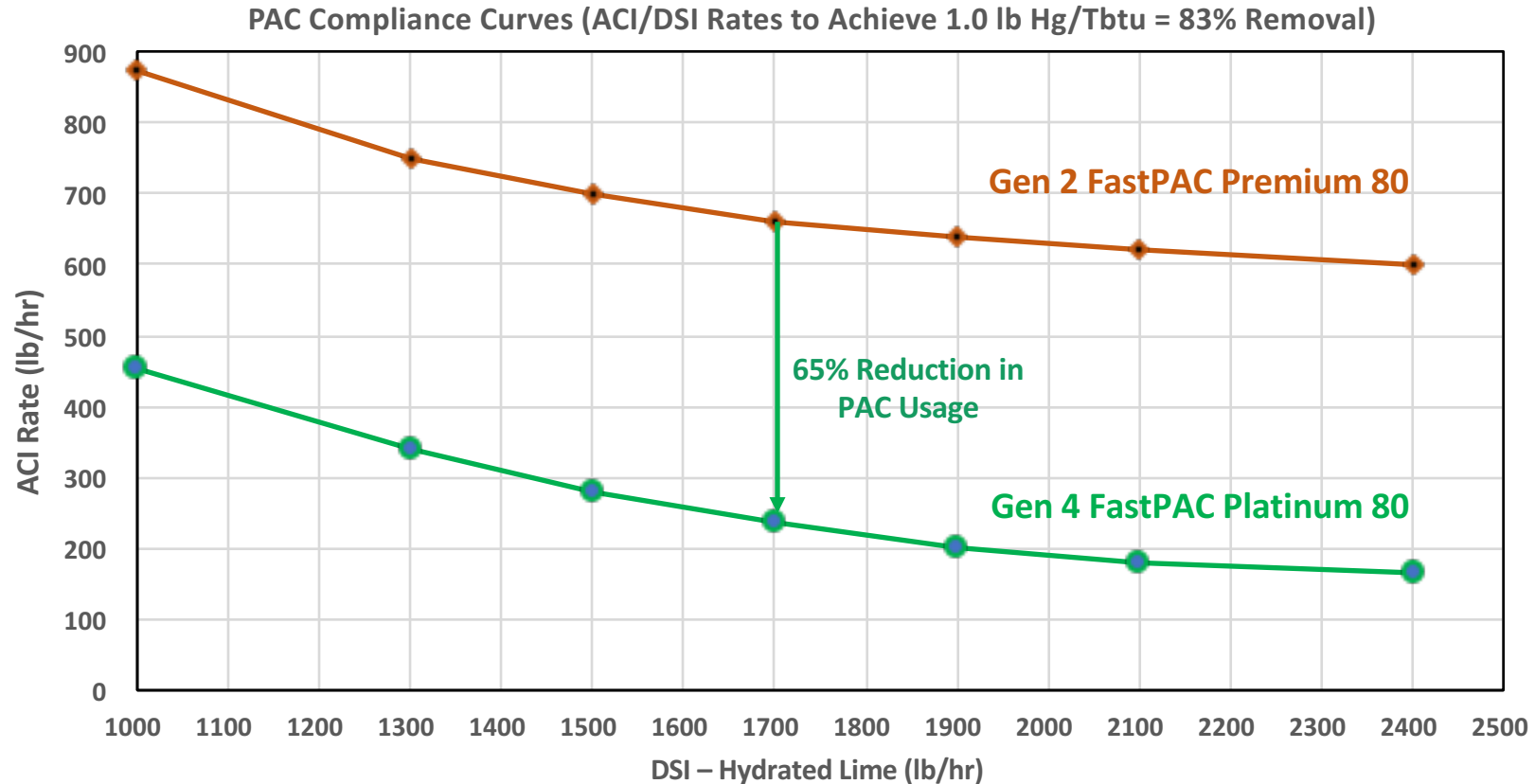
- Our advanced Series 80 PACs are designed for high SO₃ flue gas systems approaching 15-25 ppm levels, providing up to 80+% Hg removal.

SO₃ Tolerant PACs: Gen 2 FastPAC Premium 80 and Gen 4 FastPAC Platinum 80



Mid-Sulfur Bituminous Coal/Petroleum Coke Blend with >15 ppm SO₃ in flue gas.

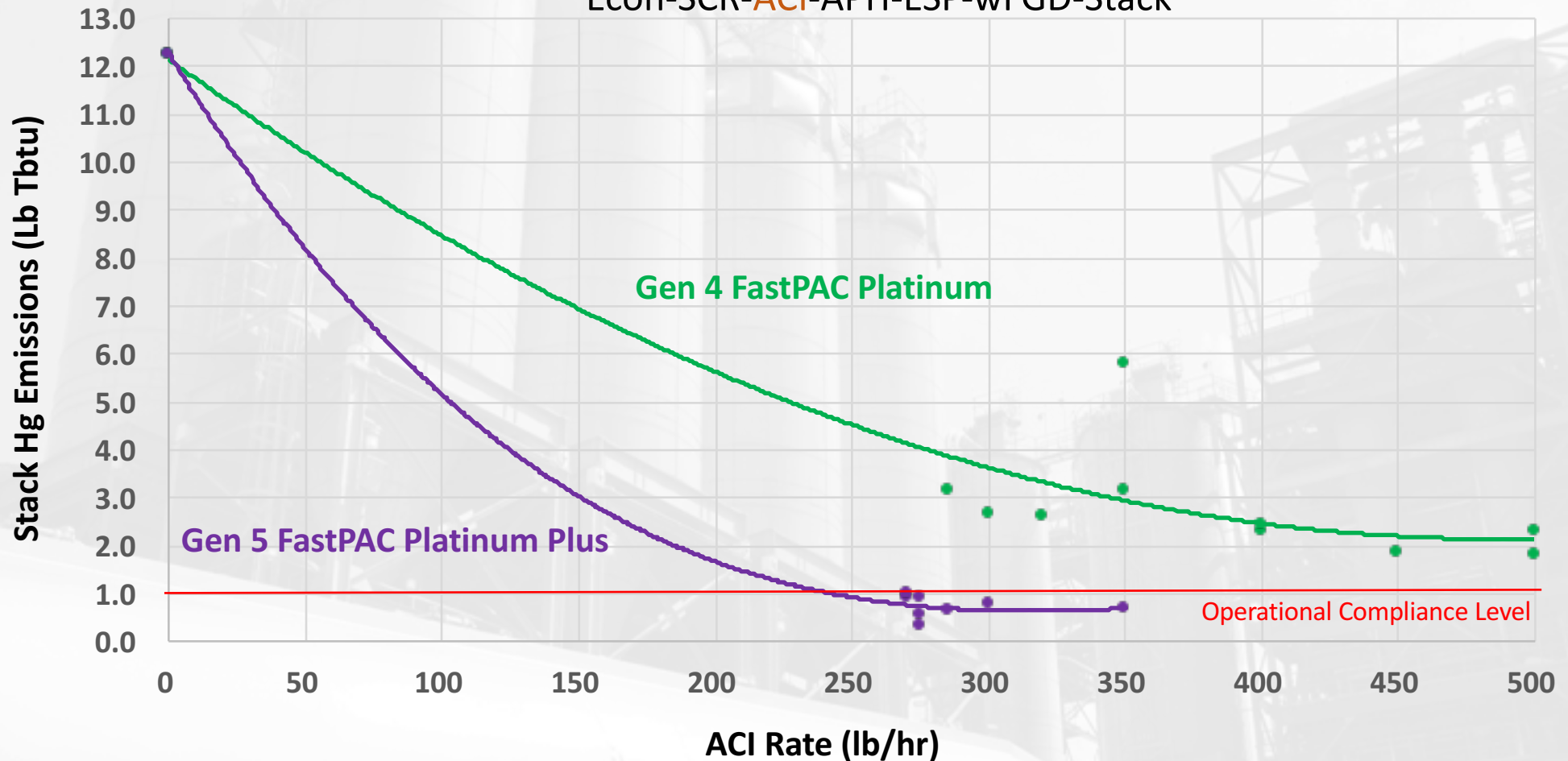
Econ – DSI – APH – ACI – ESP - wFGD



Our new advanced Gen 4 FastPAC Platinum 80 offers significantly higher Hg removal performance over our Gen 2 FastPAC Premium 80 in a SO₃ tolerant EGU system.

Full-Scale Testing of Advanced Gen 4 & Gen 5 PACs in a Variable 4-15 ppm SO₃ Flue Gas

Mid-Sulfur Bituminous Coal - 660 MW, 4-15 ppm SO₃
Econ-SCR-ACI-APH-ESP-wFGD-Stack



Our Gen 5 FastPAC Platinum Plus achieved operational compliance target at reduced PAC usage.

- We have taken a fundamental scientific approach to examine each of pores, surfaces and particles to optimize mercury capture based on specific flue gas requirements
- Use of laboratory tools and full-scale test feedback loop to drive Contact, Conversion and Capture while tuning mercury removal to minimize reagent consumption and BOP impacts
- Some common takeaways:
 - Use a low-volatility halogen salt (e.g. Sodium Bromide – NaBr)
 - Use a halogen concentration that assures effective and efficient Hg oxidation but is not in excess to cause BOP issues
 - Design PACs so that the halogen is at the surface of the PAC particle to maximize accessibility to the gas phase Hg and to insure efficient halogen utilization and apply in a way that it is also less water extractable
 - Use advanced Gen 4 and 5 PACs that require less consumption to reduce overall halogen levels in your emission system
 - Evaluate next-generation non- or low-halogen PAC technologies

- Advancements in PACs for highly efficient Hg removal are a priority at ADA Carbon Solutions
 - Commercial introduction of Gen 4 PACs and development of Gen 5 offerings
 - Minimizing Balance of Plant impacts
 - Applying fundamental scientific understanding for durable solutions
 - Rigorous lab prototyping and pilot-scale simulations to build performance confidence
 - Collaborative full-scale testing to integrate specific site requirements
- These Gen 4 and Gen 5 PAC platforms have significantly enhanced Hg removal capabilities thus increasing the options for application at our customer EGU sites
- The SO₃ problem is better understood mechanistically allowing rigorous R&D technology roadmaps to build next-generation SO₃ Tolerant PACs
- Balance of Plant impacts have driven more/new R&D developments in other air/water/solid emission system requirements

- Insure that fundamental capture mechanisms of **Conversion-Contact-Capture** are completed as effectively as possible and ideally all at once
- Adopt true “engineering” or “**active**” **control methods**
- Capture Hg **as far forward** in your emission train as possible...downstream capture must contend with multiple phases, complex uncontrolled & competing chemistries, dilute Hg concentrations with lower capture driving force, etc.
- Always consider **balance of plant** (BOP) issues...corrosion, excess chemicals in water, re-emissions, Hg in water streams, Hg in solid wastes, ash utilization, impact on other contaminants, need for added chemicals or multiple control steps, etc.
- Collaborate for Continuous Improvement
 - Apply advanced Gen 4 and 5 PACs to capture Hg efficiently and reduce your total cost of compliance
 - Collaborate with experienced PAC supplier to optimize processes at the plant
 - Drive and keep up with new PAC developments



ACI Operational Experiences

Dave Bonner

Generation

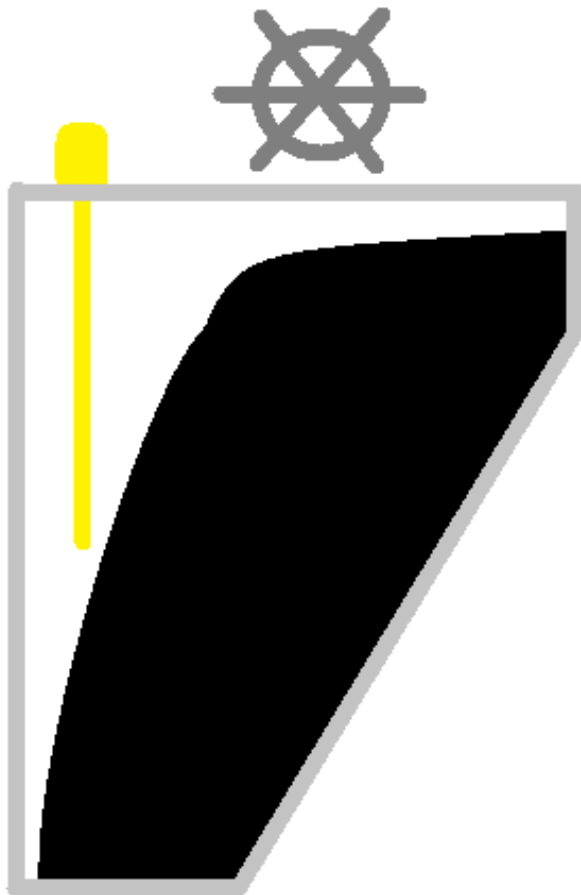
Overview

- How Did the Rest of Start-ups go?
- Optimization and Tuning
- Improving Reagent Consumption
 - Acoustic Monitoring

Start-Ups Since Last Year

- Daniel
- Red Hills
- Gorgas
- Gaston
- Bowen 3 and 4
- Barry 4

Daniel Lessons Learned



Red Hills Lessons Learned

- MFT wiring
- Leaking Bin Vent, Manway Door, and PRV
- Water intrusion into the silo internals
 - Caused rust in hopper, drop tube assembly, and eductor



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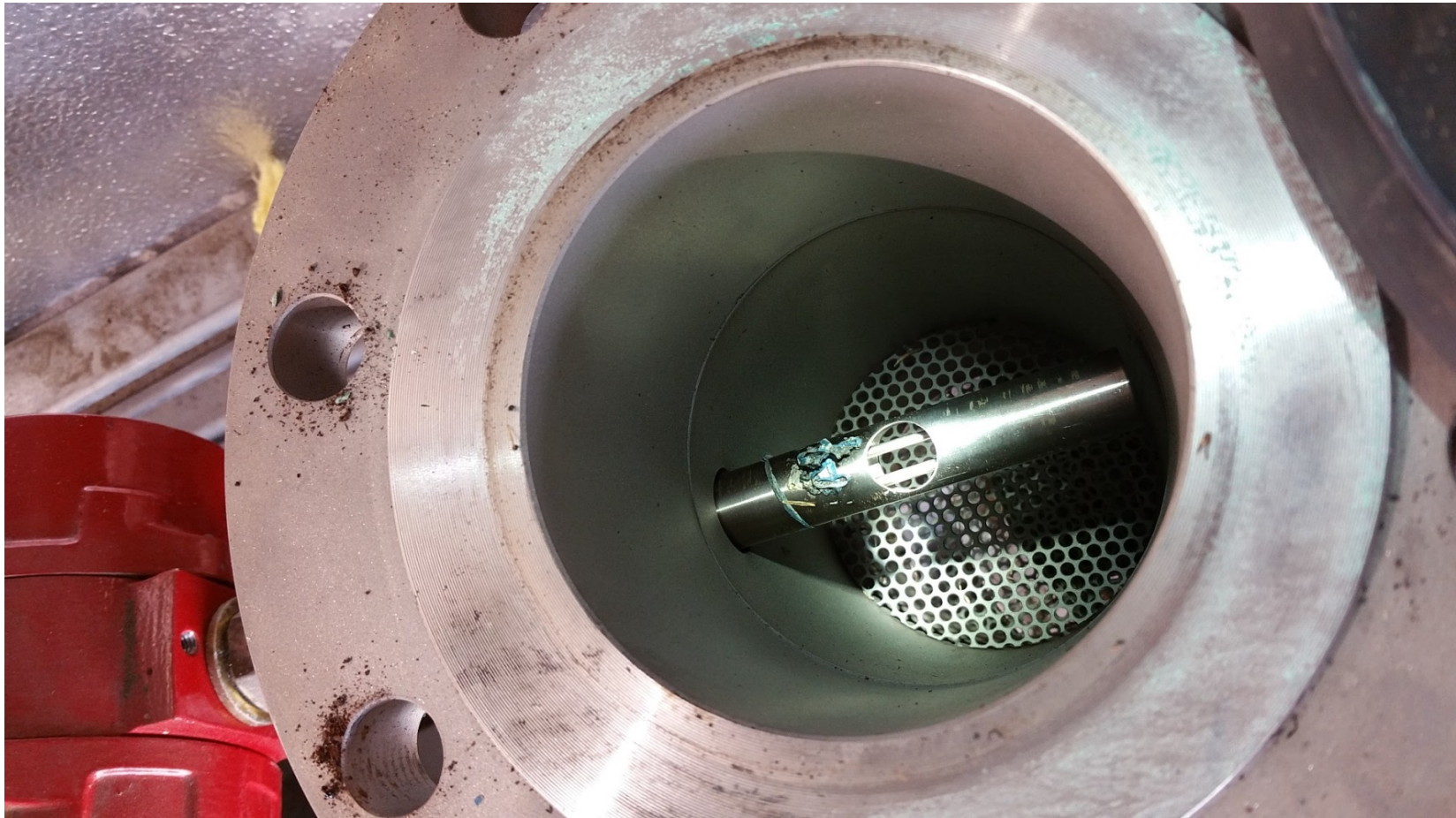
Red Hills Lessons Learned

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Red Hills Lessons Learned

- Rat's Nest in Blower Elbow
- Caught in mesh filter upstream of flow meter



Gorgas Lessons Learned

- Rotary Valve Gasket Changeout
- Crane Problems
- Keeping Most Up-to-date Version of PLC Software



Gorgas Lessons Learned

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Gaston Lessons Learned

- Gaston Truck Belly Line Strainer
- Hopper weight pulled into the DCS
- Control rotary valve with weight
- Bridging inside of hopper



Barry Lessons Learned

- Refill Timer Leading to System Trips
- Doubling Powering Causing Bad Quality
- Blower VFD's Operating too High
- Silo Inlet Filter Pluggages
- Isolation Valve Installed on Fill Line
- Rotary Valve Gasket Changeout
- Rejected PAC Truck



Barry Lessons Learned

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Barry Lessons Learned

- Refill Timer Leading to System Trips
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- Blower VFD's Operating too High
- Silo Inlet Filter Pluggages
- Isolation Valve Installed on Fill Line
- Rotary Valve Gasket Changeout
- Rejected PAC Truck
- ANOTHER Rat's Nest Problem in the Blower Line



Common Lessons Learned

- Less PAC than Originally Forecasted for MATS Compliance
- Greater Turndown in Feedrate Would Be Beneficial
 - Different Feeder Screws?
- Remove PLC for Complete DCS Control of ACI System

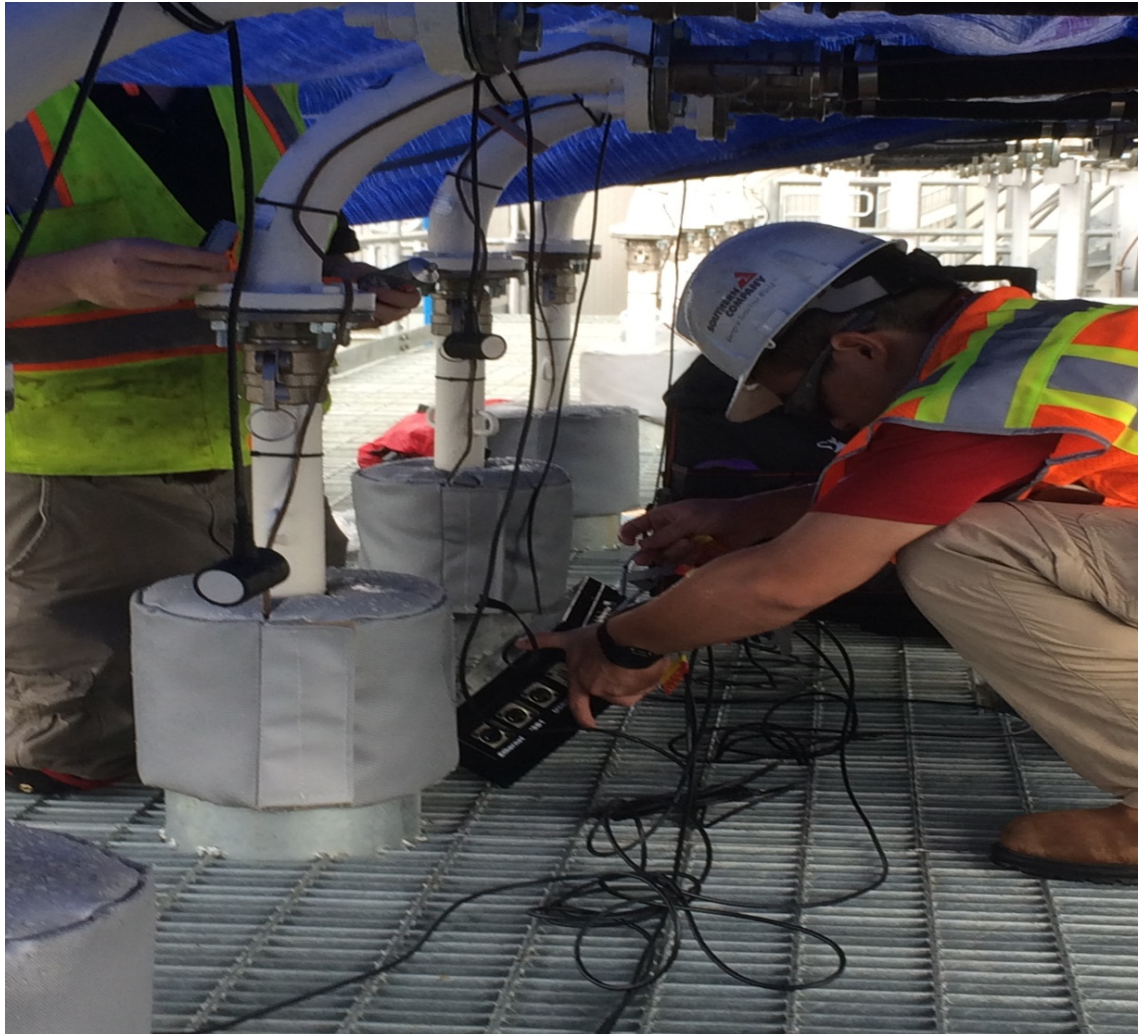
Acoustic Testing



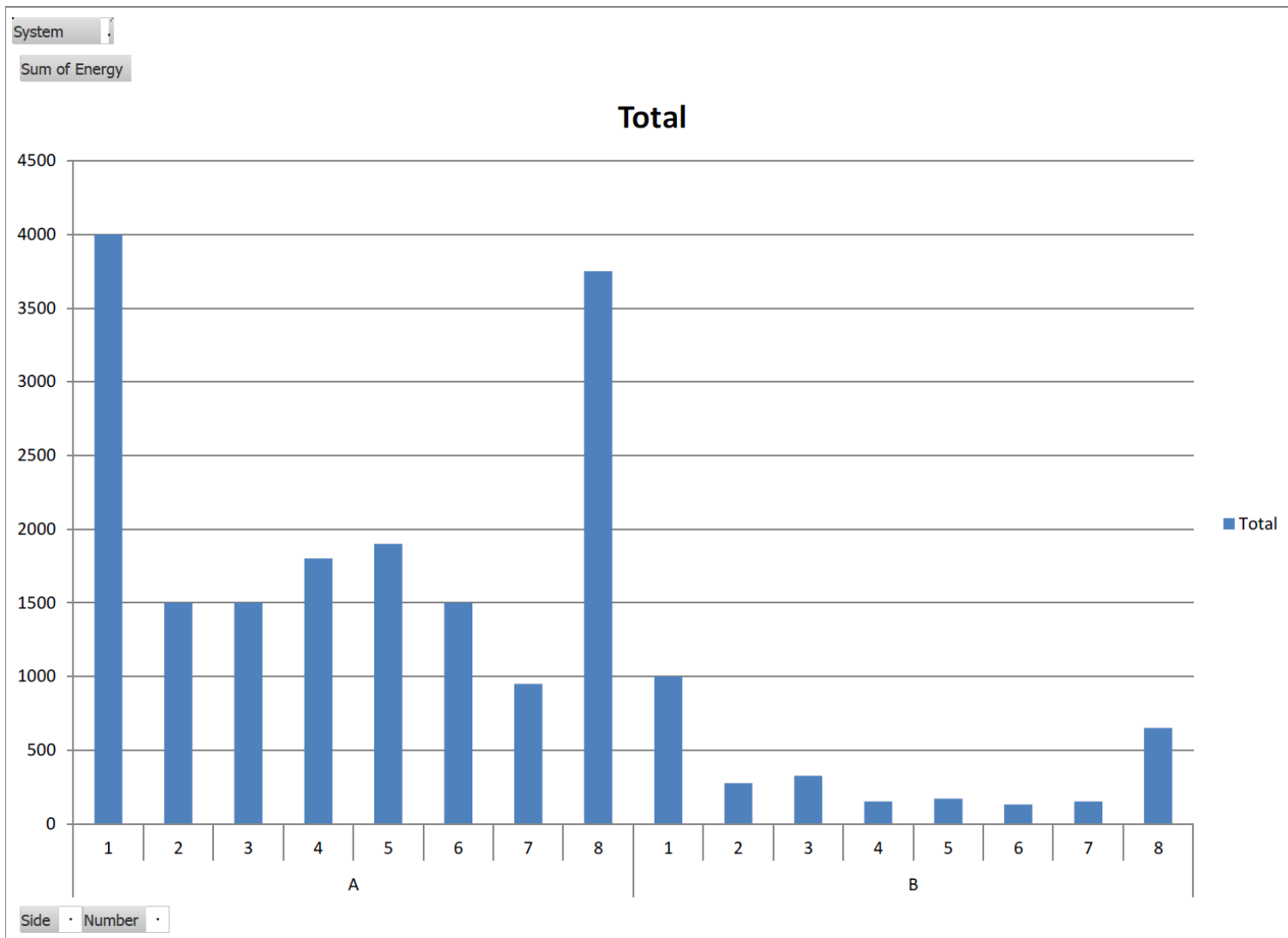
OPERATIONS

Unite. Innovate. Execute. **Generation**

Acoustic Testing

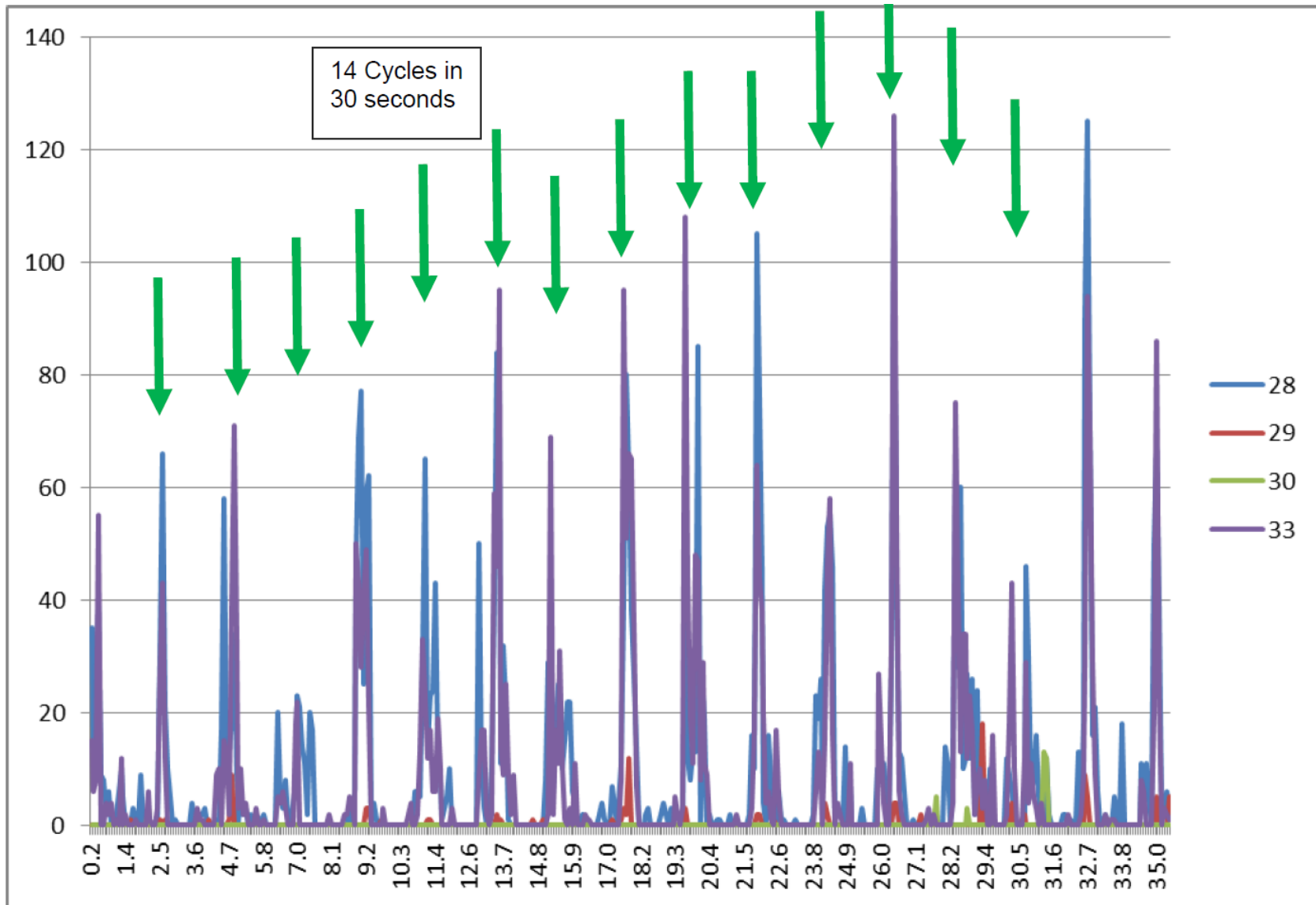


Acoustic Testing

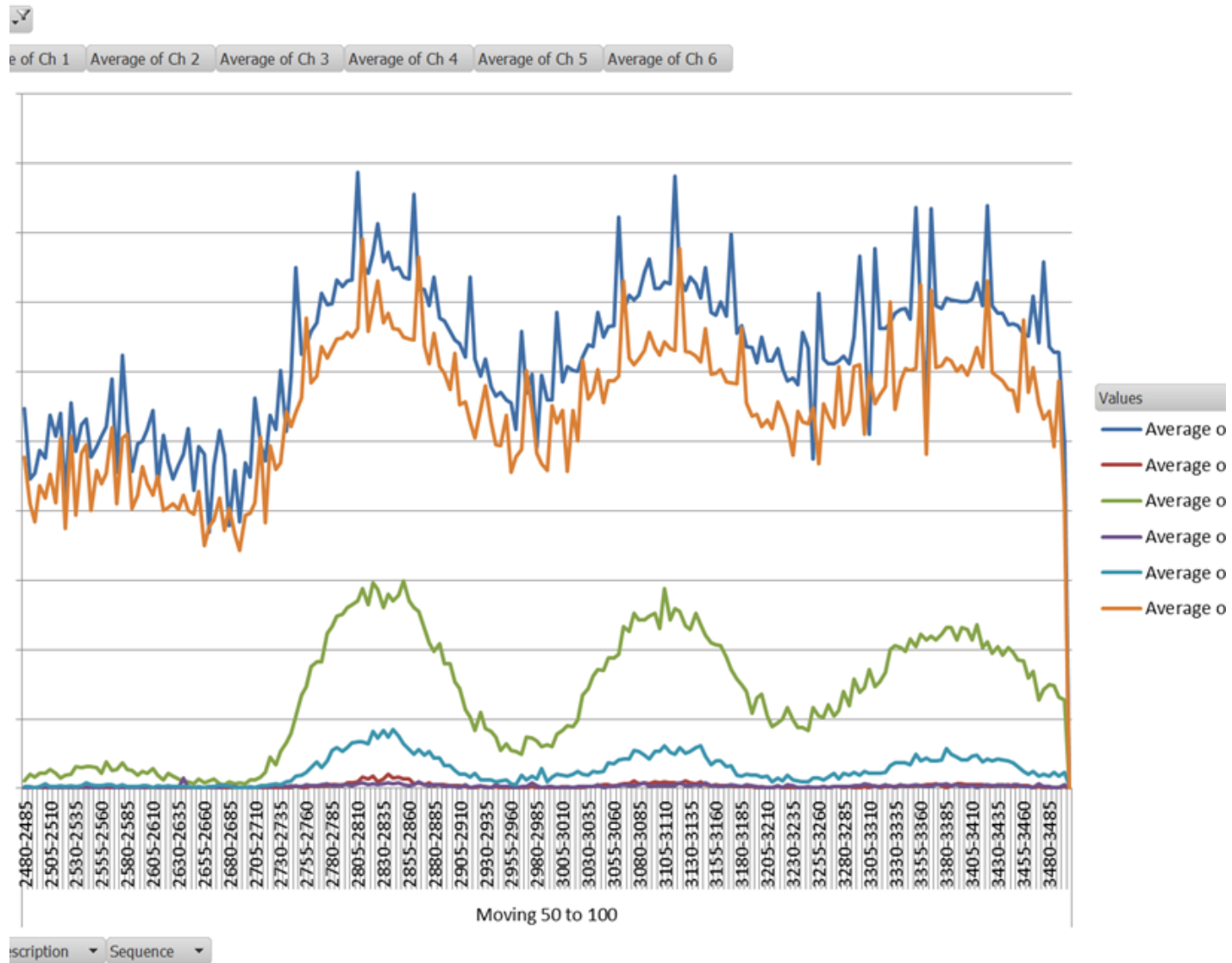


Cumulative AE Energy during a 30 second monitoring period broken down by side and lance number

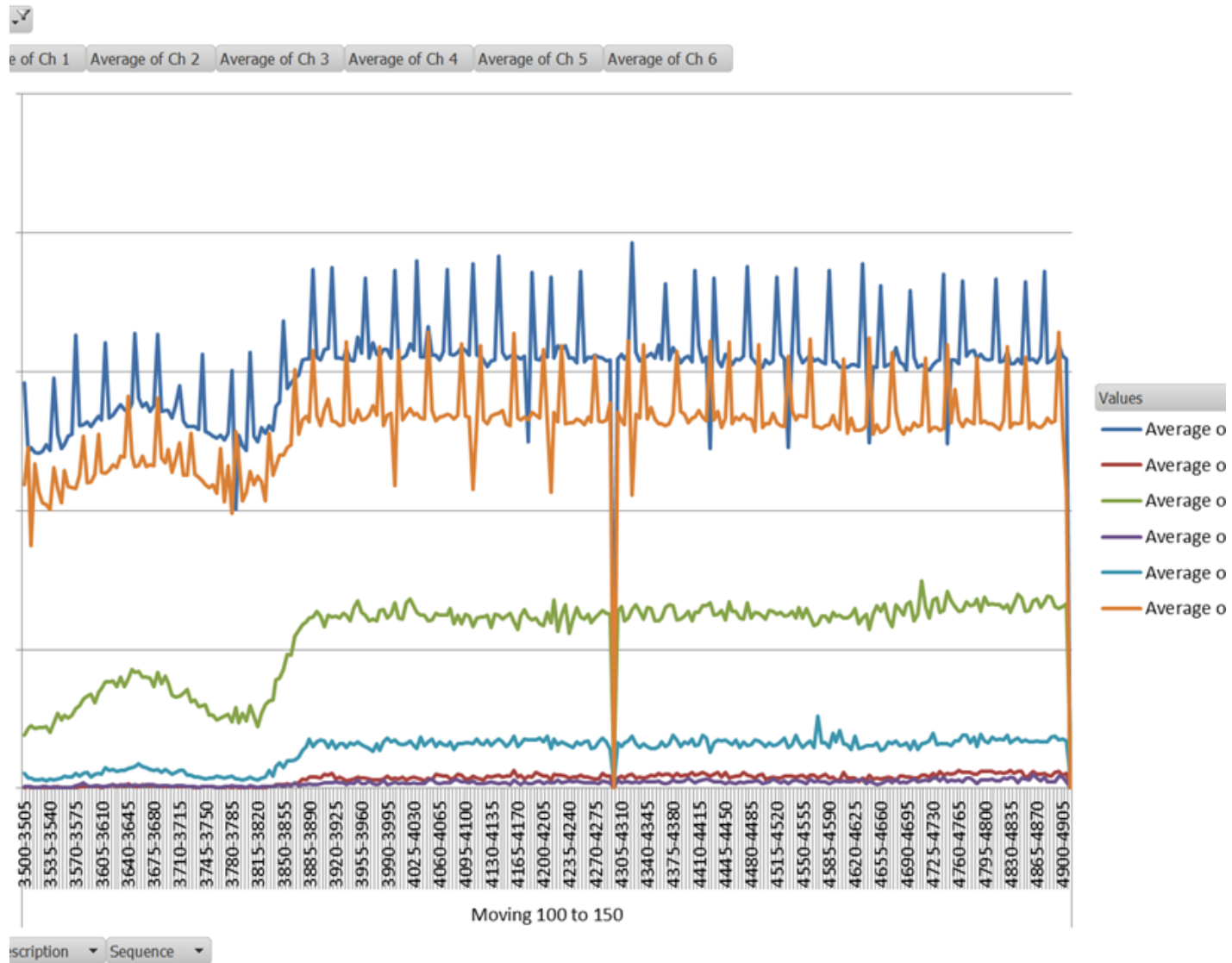
Acoustic Testing



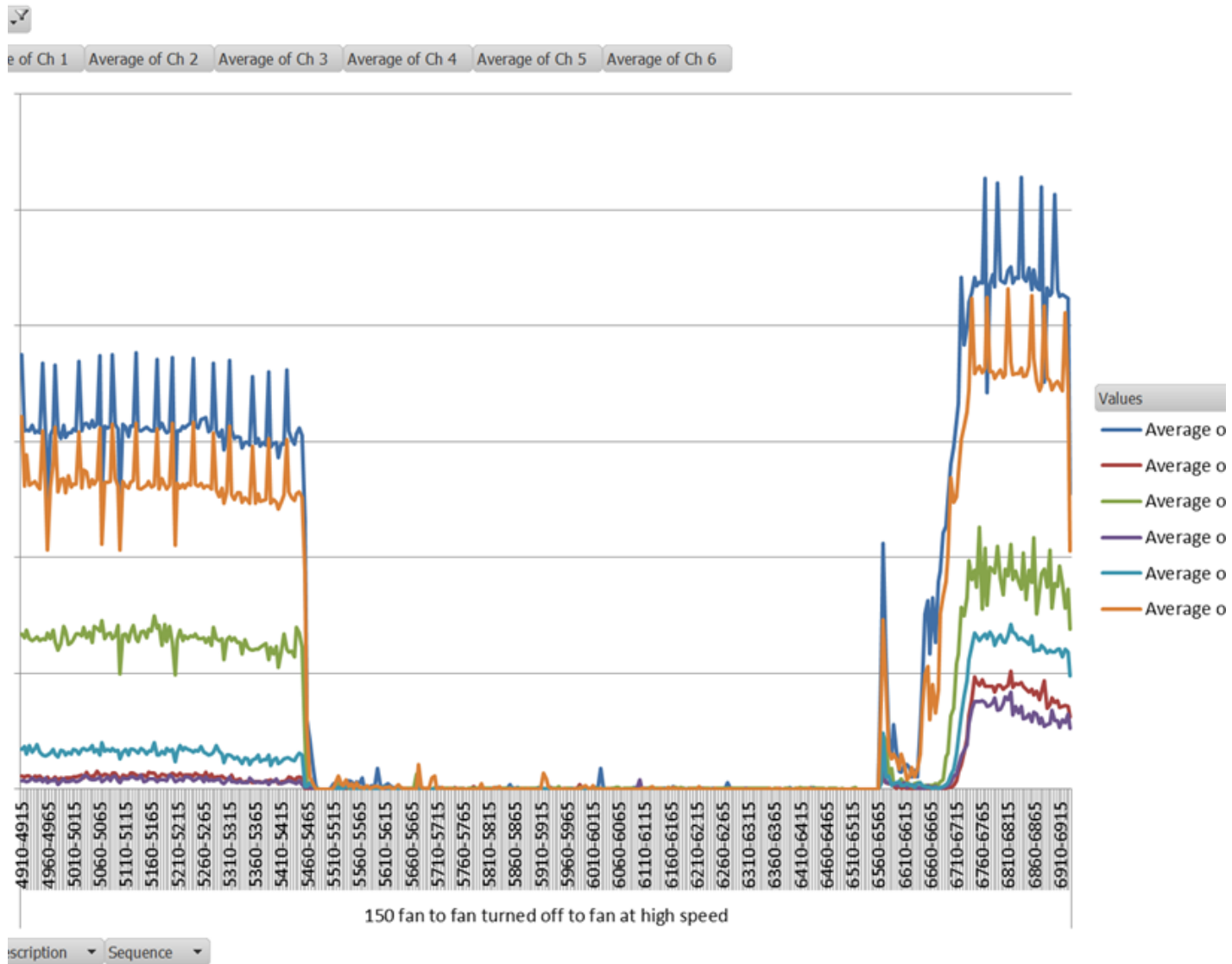
Acoustic Testing



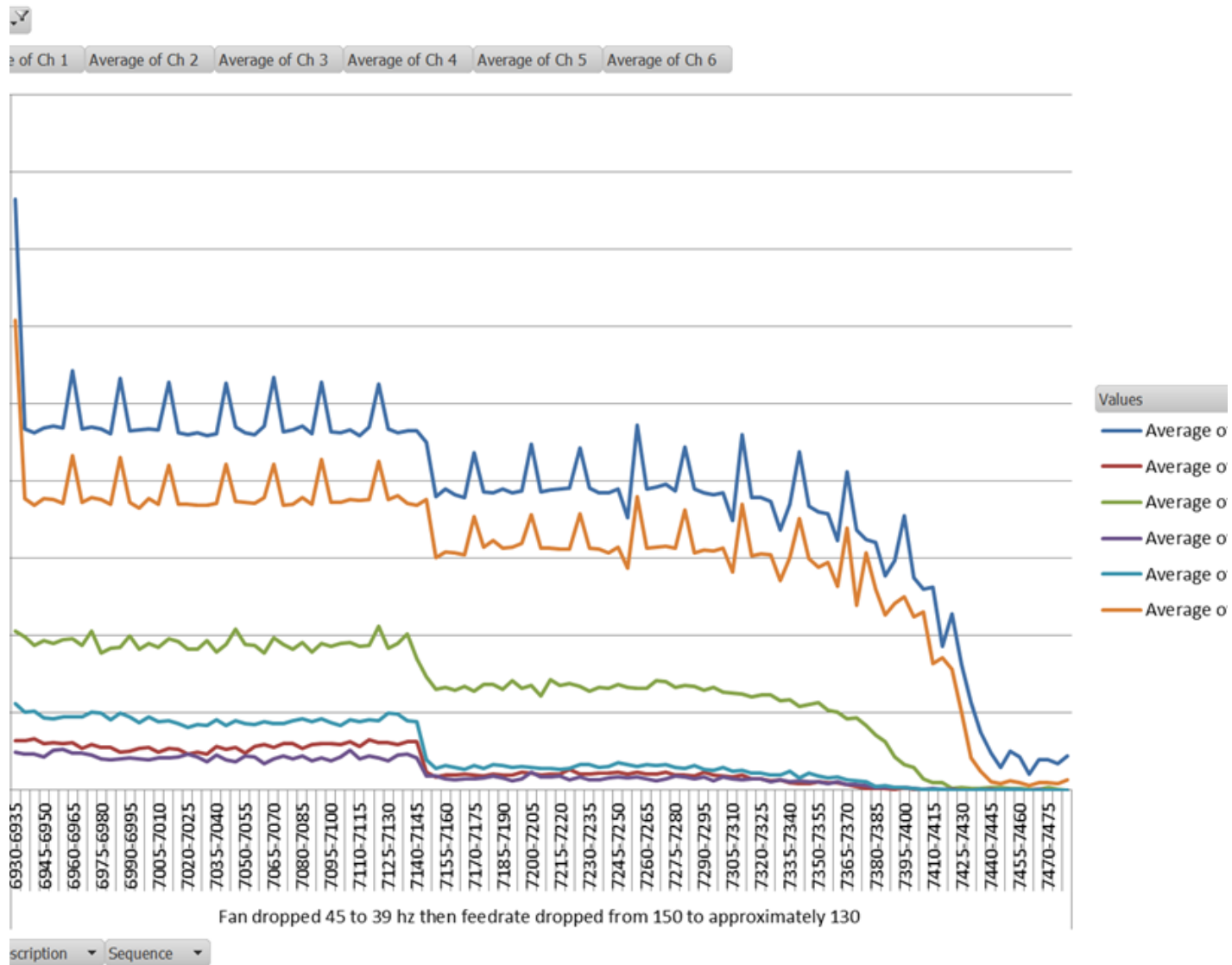
Acoustic Testing



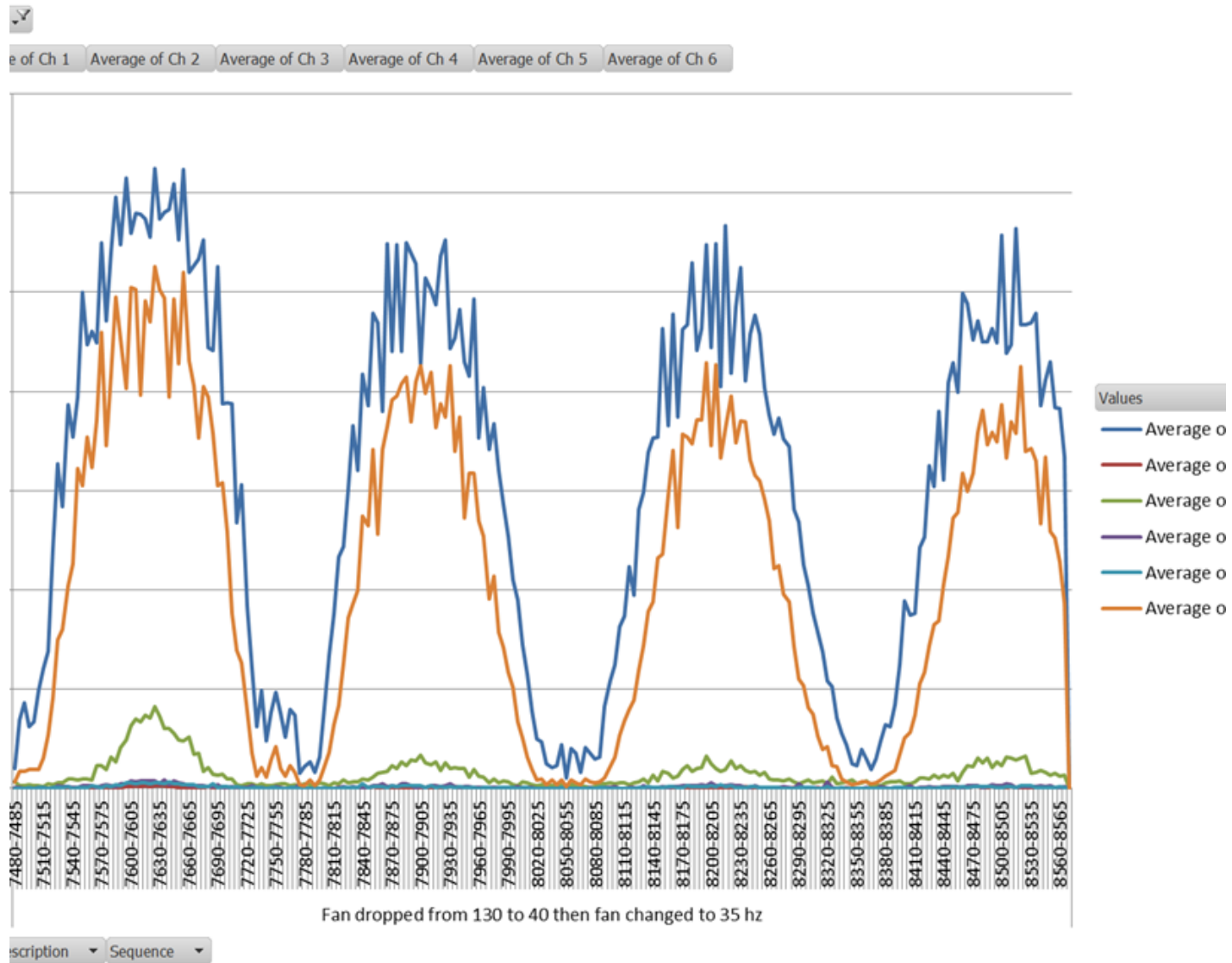
Acoustic Testing



Acoustic Testing



Acoustic Testing



Thank You.

Contact Us:

888.843.8416

www.ADA-CS.com

joe.wong@ada-cs.com

sheila.glesmann@ada-cs.com

dabonner@southernco.com

