

REINHOLD ENVIRONMENTAL Ltd.



**2015 NO_x-Combustion Round Table
& Expo Presentations**

February 23 & 24, 2015, in Richmond, VA / Hosted by Dominion

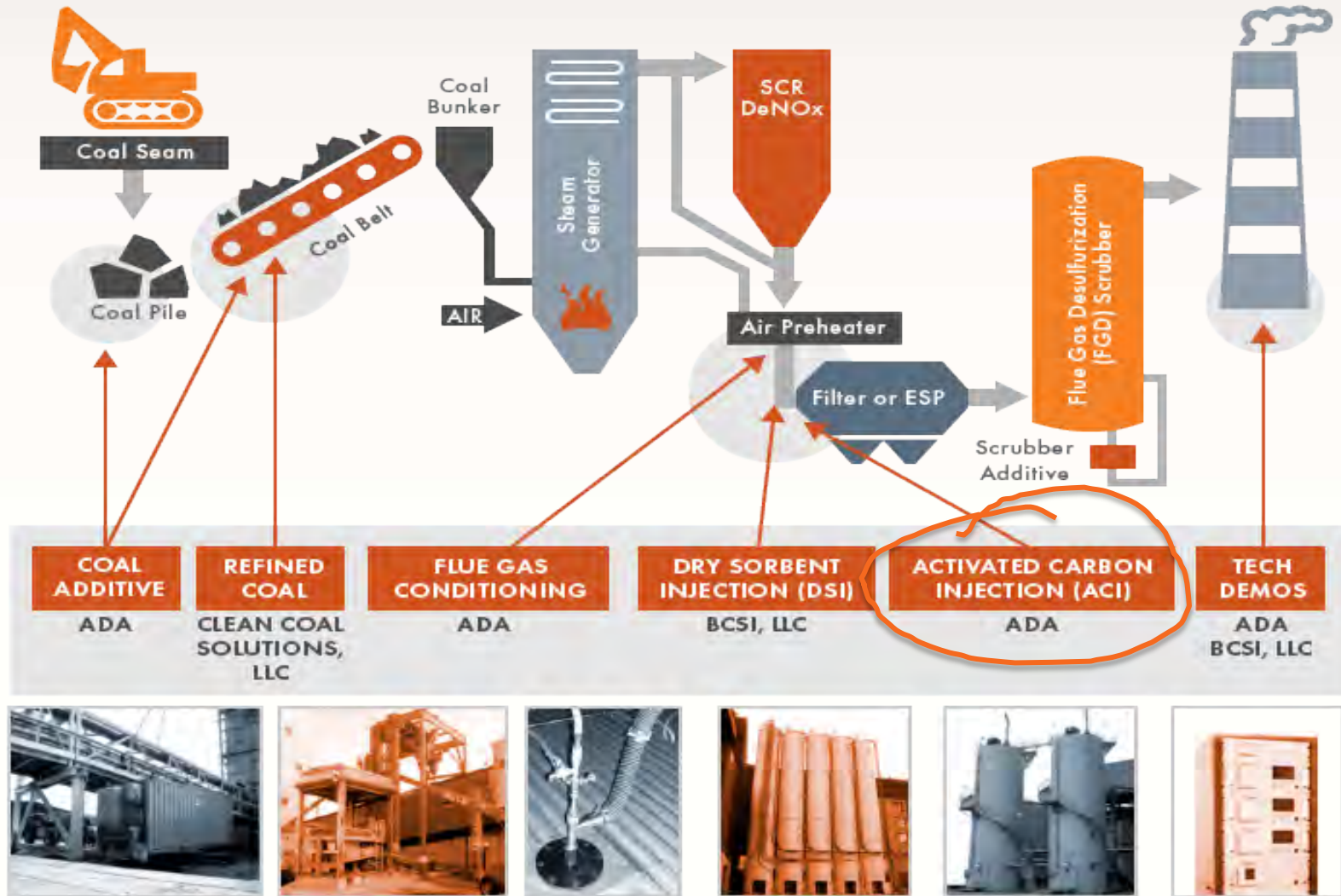
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ACI Lessons Learned

Connie Senior & Cody Wilson ~ NOx Roundtable ~ February 23-24, 2014

ADA-ES Emission Control Products



INSTALLATION AND STARTUP ACTIVITIES

□ Install

- Typical contract - 50 hrs. (one trip including travel)
- Inspect Mechanical/Electrical as per drawings
- Confirm and finalize equipment tags
- Talk to installer to identify any issues and provide solutions
- Generate punch list (if required) to be completed prior to system startup.
- Customer sign off on install checkout documents

□ Startup

- Typical contract - 50 hrs. (one trip including travel)
- Dry run equipment prior to carbon arrival and verify all operational requirements (Logic/DCS Controls)
- Receive Carbon
- Calibrate Feeders
- Verify Feeder Capabilities as required per contract
- Generate punch list (if required) to be completed prior to turnover
- Customer sign off on Startup checkout documents

COMMON AVOIDABLE OCCURRENCES LEADING TO PROJECT DELAYS



- ❑ No DCS support
- ❑ Electrical support not available
- ❑ Mechanical support not available
- ❑ No Power to the silo
- ❑ Work restrictions (short work week - no weekends)
- ❑ Cannot complete startup - could not inject PAC due to unit being down
- ❑ Electricians still landing DCS wiring hoping to be finished tomorrow sometime
- ❑ Cannot get equipment unlocked to proceed with checkout
 - ❑ Operations support not available
- ❑ PAC delivery not scheduled until December will continue with startup activities as allowed.

PRE STARTUP START-UP SCHEDULE



Pre System Installation Requirements		
Site	Date	Project Number
Site Contact Name and Title:	Site contact email and phone:	
ADA-ES Project Manager:	ADA-ES Project Manager email and phone:	
Description of Required Field Activity (All items to be completed two (2) weeks prior to the ADA-ES System Installation Trip)		
Foundation Complete and Ready for Silo Delivery	Date Scheduled/Completed _____	Initials _____
Silo Erected and Grouted per Installation Guide	Date Scheduled/Completed _____	Initials _____
Accessory Buildings Installed (If Applicable)	Date Scheduled/Completed _____	Initials _____
Silo/Skid Stairs and Platforms fully installed	Date Scheduled/Completed _____	Initials _____
Injection location stairs/platforms fully installed	Date Scheduled/Completed _____	Initials _____
All Field Installed Components Installed and Verified per Field Assembly Drawings	Date Scheduled/Completed _____	Initials _____
Plant to System 480VAC wiring complete and verified	Date Scheduled/Completed _____	Initials _____
Plant to System 480 VAC wiring meggered	Date Scheduled/Completed _____	Initials _____
Plant to System 480 VAC rotational checks completed for all rotating equipment	Date Scheduled/Completed _____	Initials _____
Plant to System 120 VAC wiring complete and verified	Date Scheduled/Completed _____	Initials _____
Plant to System IO wired	Date Scheduled/Completed _____	Initials _____
Plant to System IO confirmed for proper signal voltage	Date Scheduled/Completed _____	Initials _____
Plant Controls in place and operational	Date Scheduled/Completed _____	Initials _____
Control Signal Source DCS/Silo Confirmed	Date Scheduled/Completed _____	Initials _____
Supporting Documents		
Yellow lined electrical drawings showing completed items	Available Yes <input type="checkbox"/> No <input type="checkbox"/>	
Copy of Motor Checkout Sheets	Available Yes <input type="checkbox"/> No <input type="checkbox"/>	
Copy of Instrument Checkout Sheets	Available Yes <input type="checkbox"/> No <input type="checkbox"/>	
Person(s) Responsible for required field activities		
Name _____	Date _____	
Confirmation Field Activities Completed		
Name _____	Date _____	
Distribution: <input type="checkbox"/> ADA-ES Project Manager <input type="checkbox"/> ADA-ES Project Folder <input type="checkbox"/> Site Contact		

STARTUP SCHEDULE



ADA-ES System Startup Schedule Installation, Startup and Training:		
Installation Trip – Field service personnel will check to ensure all electrical and mechanical field assembled items are complete and checked out. The system will be powered up, individual components will be verified operational, and control signals/alarms will be simulated. The system will be started and operated in without material/chemical and run through a series of operational checks and simulated faults. Once the installation trip is complete, material/chemical may be received.		
Startup Trip – Field service personnel will verify/update any programming and pressure and level setpoints, calibrate the feeders and verify the system is ready for operation. The system will then convey material/chemical gradually increasing to the guaranteed feed rate and run at full load for a period of time. The system will be verified as complete and signed over to the customer as ready for use.		
Training Trip – Field service personnel will provide in-person classroom training for a minimum of one session (total number will be dependent on the contract) covering operation and maintenance. Video recording of the training sessions is not permitted.		
Site	Date	Project Number
Site Contact Name and Title:	ADA-ES Project Manager	
Site Contact Email and Phone:	ADA-ES Project Manager Email and Phone:	
ADA-ES Contract Info: Hours Allocated: Install: _____ Startup: _____ Other: _____ # Trips: _____	Site Access Requirements (training, drug screening, etc.):	
Outage dates for tie in of ADA-ES system: <input type="checkbox"/> YES <input type="checkbox"/> NO Dates: _____		
Available dates for Material/Chemical injection into ductwork: <input type="checkbox"/> YES <input type="checkbox"/> NO Dates: _____		
Material/Chemical Delivery Scheduled: <input type="checkbox"/> YES <input type="checkbox"/> NO Dates: _____		
Requested ADA-ES System Install/Startup/Training Schedule (8-10weeks notice typically required):		
Inter-related Equipment Startup that Impacts ADA-ES System Startup:		
Required Support:		
DCS Support Available	Confirmed _____	Initials _____
Electrical and Mechanical Support Available	Confirmed _____	Initials _____
Ability to Inject Air and Material/Chemical into Duct	Confirmed _____	Initials _____
Person(s) Responsible for required field activities		
_____ <i>Name</i> <i>Date</i>		
Confirmation Field Activities Completed		
_____ <i>Name</i> <i>Date</i>		
Distribution: <input type="checkbox"/> ADA-ES Project Manager <input type="checkbox"/> ADA-ES Project Folder <input type="checkbox"/> Site Contact		

WHAT IS GOOD FOR YOUR PROJECT

- **Standard System if Possible**
 - If you do have a unique system or system components be prepared for additional install or startup activities related to these components.
- **Consistency in personnel**
 - Have found that most sites like to have the same ADA contacts throughout the project. There is a comfort and trust developed between the parties.
 - May be difficult to maintain if schedules need to be extended
 - Have experienced changing of contact personnel from the utility side that impacts communication (almost like starting from the beginning again)
- **Reality in Scheduling**
 - If you truly are not ready - it is OK to say so and reschedule. We would prefer to be productive and efficient with our time on site - as do you.
 - We have seen more schedule adjustments since we developed the check-sheets related to the install and startup activities (this is a good thing)
- **Communication**
 - Utility/Engineering, Construction Team, ADA coordination prior to silo arriving on site (is everyone on the same page)
 - Regular scheduled communication between all participants to quickly identify and resolve issues
- **Communication**
- **Communication**

SYSTEM FUNCTIONALITY CHECKLIST

BEFORE YOU FILL THE SILO...

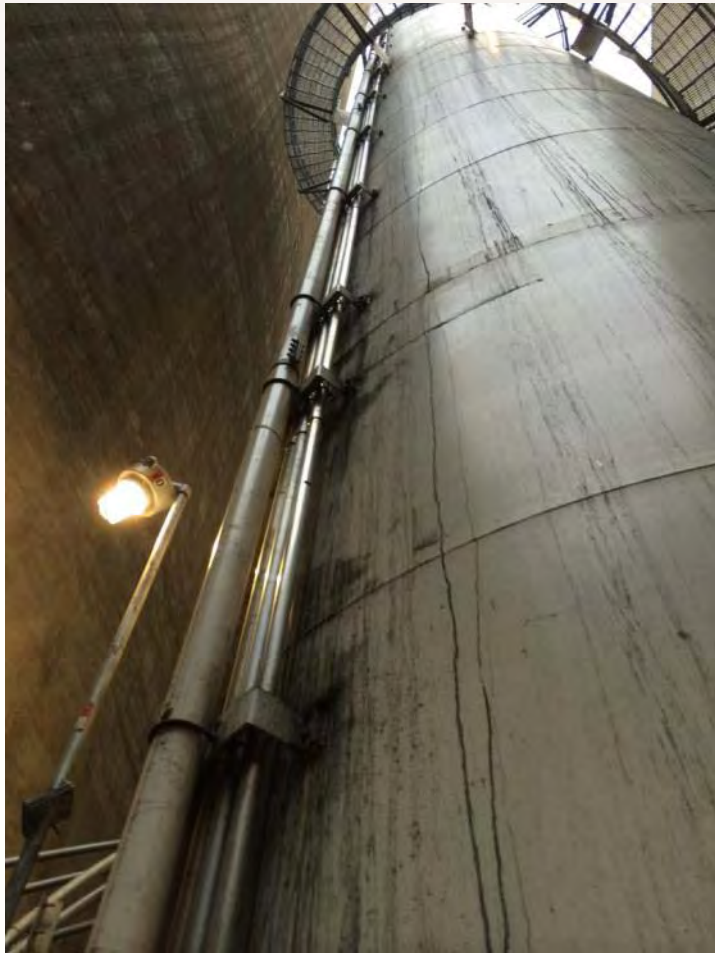
- ▶ **Truck Unloading Panel**
 - Bin Vent Filter cartridge pulse sequence
 - Bin Vent High DP Alarm
 - High Level Alarm from level transmitters
 - Low Level Alarm
 - Low-low Level Alarm
 - Air Pressure Low Alarm
- ▶ **Verify the sequencing of the silo cone air fluidizers**

INITIAL SILO FILL

- ▶ Inspect the interior of the silo for debris/water
- ▶ Inspect for leaks in Fill Line Connection
- ▶ Inspect for leaks at the silo manway

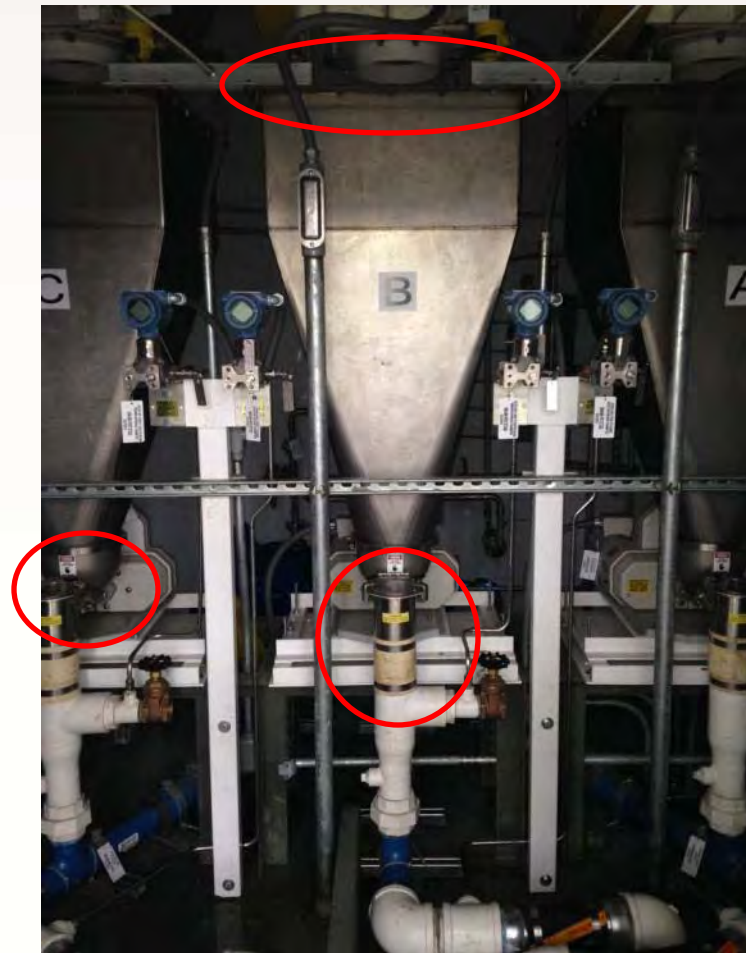


INITIAL SILO FILL



INITIAL HOPPER FILL

- ▶ Look for leaks in:
 - Hopper Lid
 - Hopper connection to feeder section
 - Screw Feeder tube connections
 - NOTE: small amount of grease on connections and seals can be very effective on small leaks



SYSTEM FUNCTIONALITY CHECKLIST

- ▶ Start Train in Auto Mode
- ▶ Verify that the diverter valve aligns to the correct conveying line and the blower starts
- ▶ Verify the feeder starts and the speed is controlled by the VFD
- ▶ Verify that the rotary valve stops when the hopper level switch is covered

SYSTEM FUNCTIONALITY CHECKLIST

- ▶ Verify the rotary valve starts per the demand signal from the gravimetric controller
- ▶ Verify the silo outlet fluidizing nozzle pulses after 20 seconds of rotary valve operation
- ▶ Simulate different feeder speeds with the VFD

System Functionality Checklist

- ▶ Verify weigh controller determines the feeder speed
- ▶ Verify the diverter valves can not change while a blower is running or in the event of a train fault
- ▶ Switch the train to maintenance Mode

System Functionality Checklist

- ▶ Verify the rotary valve and feeder screws can be started/stopped independently
- ▶ Verify the feeder speed can be entered manually by the operator
- ▶ Verify the diverter valve can be switched independently as long as the blowers are not in operation

TUNING YOUR SILO

- ▶ Open Knife Gate Valves
- ▶ Fill Hoppers
- ▶ Remove Drop Tube Assembly
- ▶ High Speed - 20, 40, 60 Hz
- ▶ Low Speed - 20, 40, 60 Hz
- ▶ Calculate Equivalent Speed
- ▶ Calibrate on the gravimetric feeder

FEEDING SORBENT

- ▶ Lance Isolation Valves Are Open
- ▶ Diverter Valves Properly Aligned
- ▶ Eductor Discharge Pressure
- ▶ Check that there are no leaks in conveying line components
- ▶ Only One Truck



ISSUES THAT MAY ARISE

- ▶ Motor/Blower Misalignment
- ▶ Low Blower Discharge Pressure
 - Leaks Under Insulation
- ▶ Improper Gaskets
- ▶ Misaligned Flex Hoses

ISSUES THAT MAY ARISE

- ▶ Eductor High/Low Tripping
- ▶ Rotary Valve timer
- ▶ Pressurizing Hoppers
 - Vent Hoses
 - 3” Eductor Opening
- ▶ Ratholing

Motor/Blower Misalignment



LOW BLOWER DISCHARGE PRESSURE

- ▶ First thing to check is the blower intake filters
- ▶ Can also take those off, and feed an electrical snake through the blower intake line to check for pluggages

LOW BLOWER DISCHARGE PRESSURE

- ▶ Has been observed at a few sites
- ▶ Caused by a leak, downstream of the blower, underneath the insulation



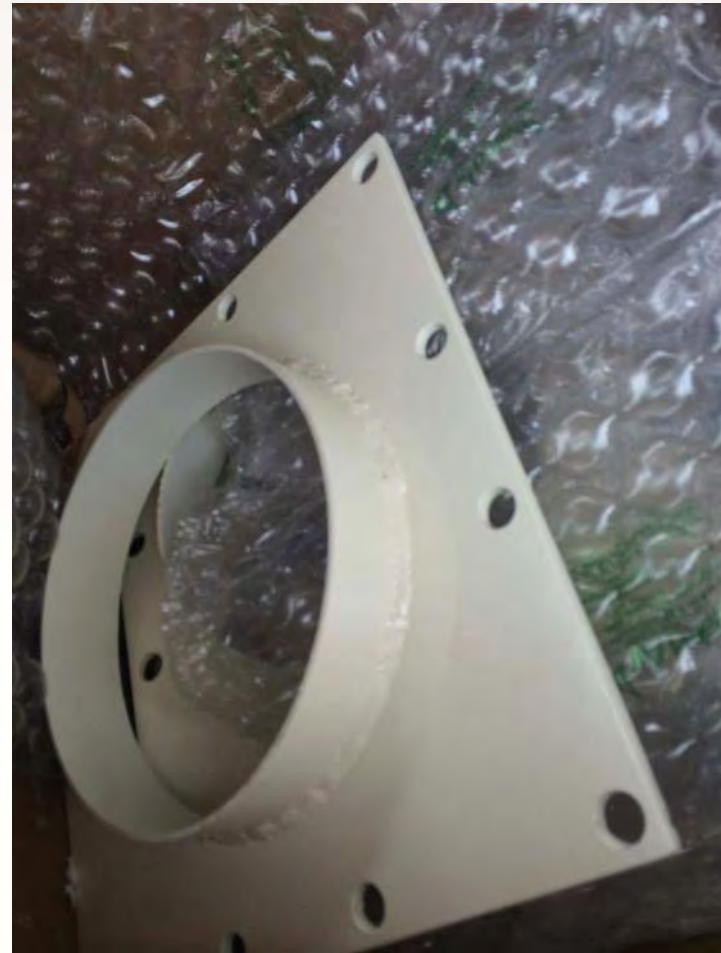
IMPROPER GASKETS

- ▶ Make sure you have appropriate gaskets installed above and below rotary valve and you have a sturdy spool piece feeding into the hopper

CHECK CONNECTIONS



Proper GASKETS



Misaligned Flex Hoses



Flex Hose Alignment



FLEX HOSE ALIGNMENT



EDUCTOR HIGH ALARM

- ▶ Can be expected to occur if the eductor valve is not wide open and/or when transitioning to higher feedrates
 - Solution is to open the eductor valve and increase the blower speed

EDUCTOR LOW ALARM

- ▶ Occurs when the eductor pressure hits zero or goes positive
- ▶ Results in lots of carbon blown into the feeder room
- ▶ Would continuously occur during silo fills
- ▶ We attributed this to the pressurization of our weigh hoppers



PRESSURIZING the Hoppers



PRESSURIZING THE HOPPERS

- ▶ Rotary Valve would fill
- ▶ Due to blinding the fabric, the displaced air couldn't escape through the filter sock quickly enough
- ▶ The Gravimetric weigh scale would see an enormous spike
- ▶ Would eventually settle down as the rotary valve filled again and started it all over

VENT HOSES

We replaced the filter sock with a 4" vent hose that connected from the roof of the hopper, in place of the filter, to the top of the drop tube assembly



3" EDUCTOR OPENING

- ▶ Learned that 3" will trip the system on too little eductor suction
- ▶ Some type of valve was necessary



3" EDUCTOR OPENING

- ▶ Once low suction was solved, we noticed the system was able to follow feedrate demand much more smoothly



RATHOLING

- ▶ Simultaneously with the pressuring hopper issue, we suspected rat-holing inside the hoppers, especially at high feed rates
- ▶ Plant personnel have inspected the hopper through the vent opening and confirmed bridging of PAC
- ▶ Consistent with all OIS data we've been monitoring

RATHOLING



- ▶ ADA provided hopper air fluidizers to ‘de-clump’ carbon and promote PAC flow

RATHOLING

- ▶ Will be fed compressed air down from the same lines that run to the silo fluidizers



PURPOSE OF PERFORMANCE TESTING



- ▶ Before the compliance date arrives, the Hg control equipment must be functioning and able to meet compliance



PROCESS PERFORMANCE TESTING

- ▶ One or more of the following tests will probably be required by the Contract for the Hg control system:
 - Hg emission rate and/or other process variables that are part of the guarantee (e.g., SO₃ concentration at sorbent injection location)
 - Maximum feed rate of sorbent or additive
 - System energy consumption
 - System pressure drop change
 - Sound/noise level

EMISSIONS TESTING: CHOOSING A CONTRACTOR

- ▶ Finding a qualified emissions testing contractor is one of the most important factors in the success of the performance test
- ▶ How do you know a contractor is qualified?
 - Stack Testing Accreditation Council (STAC) developed Qualified Source Testing Individual/Qualified Source Testing Observer (QSTI/QSTO) certification program
 - List of accredited organizations can be found here:
<http://www.betterdata.org/accreditedorganizations.htm>

EMISSIONS TESTING: SAMPLE LOCATIONS

- ▶ Walkdown of sample locations (preferably with testing contractor) conducted to identify existing sample ports for inlet and outlet measurements
 - ▶ Ports should have 4-inch flanges and enough clearance to insert probes
 - ▶ Ports may have to be added for measurement locations specified in the Contract
 - ▶ If outlet measurements are not taken at the stack, but in a flue gas duct (e.g., ESP outlet) measurements of velocities at the duct location should be made to verify flow rate and uniformity (EPA Method 2 or 2F)

EMISSIONS TESTING: TEST METHODS (INLET)

- ▶ Emissions testing at the injection system *inlet*, prior to the point of sorbent injection, should include:

Emission	Test Method
O ₂ /CO ₂	EPA Method 3A
Moisture	EPA Method 4
Flow Rate (if EPA Method 1 compliant ports exist)	EPA Method 2 or 2F
Temperature	EPA Method 2 or 2F
SO ₃ , H ₂ SO ₄ (if specified in Contract)	Modified* EPA CTM-013
NH ₃ (If SCR is present)	EPA CTM-027

- ▶ *Sampling apparatus/method must be operated to prevent reaction between SO₃ and sorbent particles in the sampling system.
Verification of Inlet Hg concentration may be specified in the Contract, requiring coal sampling and/or flue gas sampling upstream of sorbent injection

EMISSIONS TESTING: TEST METHODS (OUTLET)

- ▶ Emissions testing at the system outlet should include:

Emission	Test Method
O ₂ /CO ₂	EPA Method 3A
Moisture	EPA Method 4
Flow Rate	EPA Method 2 or 2F
Mercury	EPA Method 30B or Hg CEMS
Temperature	EPA Method 2 or 2F

- ▶ Outlet sample location can be the stack or the outlet of the particulate control device, depending on the Contract
- ▶ If there is a guarantee related to re-emission of Hg from a wet scrubber, speciated mercury measurements (CEMS or trap) might be made at the FGD inlet

EMISSIONS TESTING: SET IT UP RIGHT



- ▶ Conditions for the performance guarantee emissions test should be fixed, including
 - Load (MW, million Btu heat input/hr) as close to but not greater than design maximum
 - Load stabilized at least two hours before the start of the performance test and held constant ($\pm 2\%$ - 3%) during all runs of the performance test
 - Fuel being fired should be as close to process design as practical and should not change over the course of the performance tests
 - Performance test run not overlapping the scheduled daily calibration of installed CEMS
 - Air Preheater outlet temperature at or below maximum temperature in Contract.
 - Flue gas flow rate (acfm) at injection point at or below maximum specified in Contract.
 - SO_3 concentration at the ACI injection location, if specified in Contract

EMISSIONS TESTING: SET IT UP RIGHT



- ▶ Conditions for the performance guarantee emissions test should be fixed (e.g., load) as per the Contract
- ▶ The downstream equipment can include an ESP, a baghouse, and/or a flue gas desulfurization system
- ▶ Each of these control systems needs to come to, if not a steady state, then at least a steady level of sorbent, mercury re-emission additive, or FGD process chemistry, some suggestions are:

ESP, 1 day	PAC buildup on the collecting electrodes/plates could affect the electrical operation of the ESP, with a minor effect on Hg removal.
Baghouse, 3-5 days	PAC starts to accumulate on the bags, through multiple cleaning cycles. This can affect both Hg removal and pressure drop. The baghouse should be allowed to come to steady state.
Dry FGD/FF, 5-7 days	Recycle of the FF ash back into the dry FGD will take a few days to come to steady state. Hg sorbent will be recycled along with the lime from the dry FGD.
Wet FGD, 1 week minimum	Either with additives or sorbent injection, it may take a considerable time for the chemistry in the FGD slurry to stabilize, depending on the blowdown rate and volume of absorber tank.

EMISSIONS TESTING: EXECUTION



- ▶ During the emissions performance guarantee test, data are collected to verify the conditions of the test, subject to any conditions around the guarantees as specified in the Contract, which might include:
 - Load
 - Flue gas flow rate at air preheater outlet
 - Inlet mercury concentration
 - Temperature (typically air preheater outlet temperature)
 - SO₃ concentration (typically at air preheater outlet)
 - NH₃ concentration (typically at air preheater outlet)
- ▶ Information from Plant Information system or Historian should be archived (load, temperatures, flow rates) for the test periods

EMISSIONS TESTING: EXECUTION



- ▶ During the emissions performance guarantee test, samples are collected to verify the conditions of the test, subject to any conditions around the

Sample	Analyses or Reason for Sample
Coal*	Ultimate Analysis Proximate Analysis Mercury Concentration Chlorine Concentration
Fuel Additive	To be analyzed if there are issues with mercury emissions reduction and speciation of mercury to ionic form
Wet FGD Scrubber Blowdown	To be analyzed if there are questions on mercury re-emission levels in the Wet FGD system and it is necessary to analyze for the concentration of re-emission additive
Sorbent	Sample held in the event that there are issues regarding the sorbent

*See Appendix for sampling and analysis methods

EMISSIONS TESTING: EXECUTION



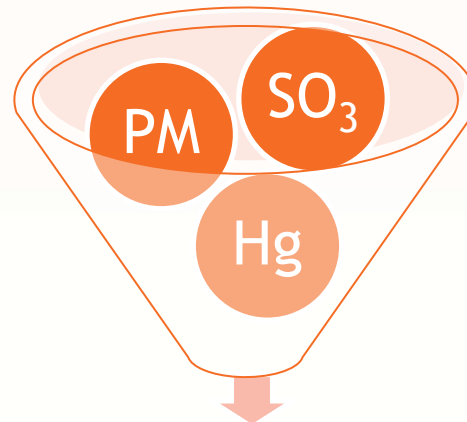
- ▶ Each mercury emissions performance test should consist of a minimum of 3 runs, which pass all applicable QA/QC tests
- ▶ Method 30B run times should be 1 to 3 hours, depending on the expected level of Hg in the flue gas
 - Spiked traps should be at a level appropriate to the flue gas concentration
 - If possible, analyze traps on site to provide quicker feedback
- ▶ If using Hg CEM for performance test
 - All applicable certifications and calibrations must be current
 - Averaging period (sample duration) should be agreed upon in advance

DATA ANALYSIS

- ▶ Hg emissions test runs should pass all QA/QC to be acceptable
- ▶ What if one of the 3 runs is an outlier?
 - Check for outlier using Dixon's Q-test (described in EPA Quality Assurance Handbook)
- ▶ Elimination of one out of the 3 runs as invalid will mean that the performance test results depend upon the average of the 2 remaining runs
 - Use of only 2 runs to determine performance should be established as an agreed-upon approach, if possible, during Contract negotiations but certainly prior to the Performance Testing
- ▶ In order to compare results of runs to guarantee conditions, it might be necessary to convert to conditions or units specified for the guarantees (e.g., $\mu\text{g}/\text{dscm} \Rightarrow \text{lb}/\text{TBtu}$)

What Happens Next?

- ▶ This is where an experienced eye is needed
- ▶ Software can process thousands of data points from many sources, but expertise is needed to interpret alert and develop recommendation



Small Team of Experts
Watching for You

- ▶ Provide insight on issue to the user

Approach to Cost Effective MATS Compliance



MANAGE COMPLIANCE THROUGH KNOWLEDGE OF KEY FACTORS INFLUENCING HG REMOVAL



QUESTIONS?

- ▶ Connie Senior

connies@adaes.com

- ▶ Cody Wilson

cody.wilson@adaes.com

