

REINHOLD ENVIRONMENTAL Ltd.



**2014 APC Round Table
& Expo Presentation**

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Advancing **Cleaner** Energy

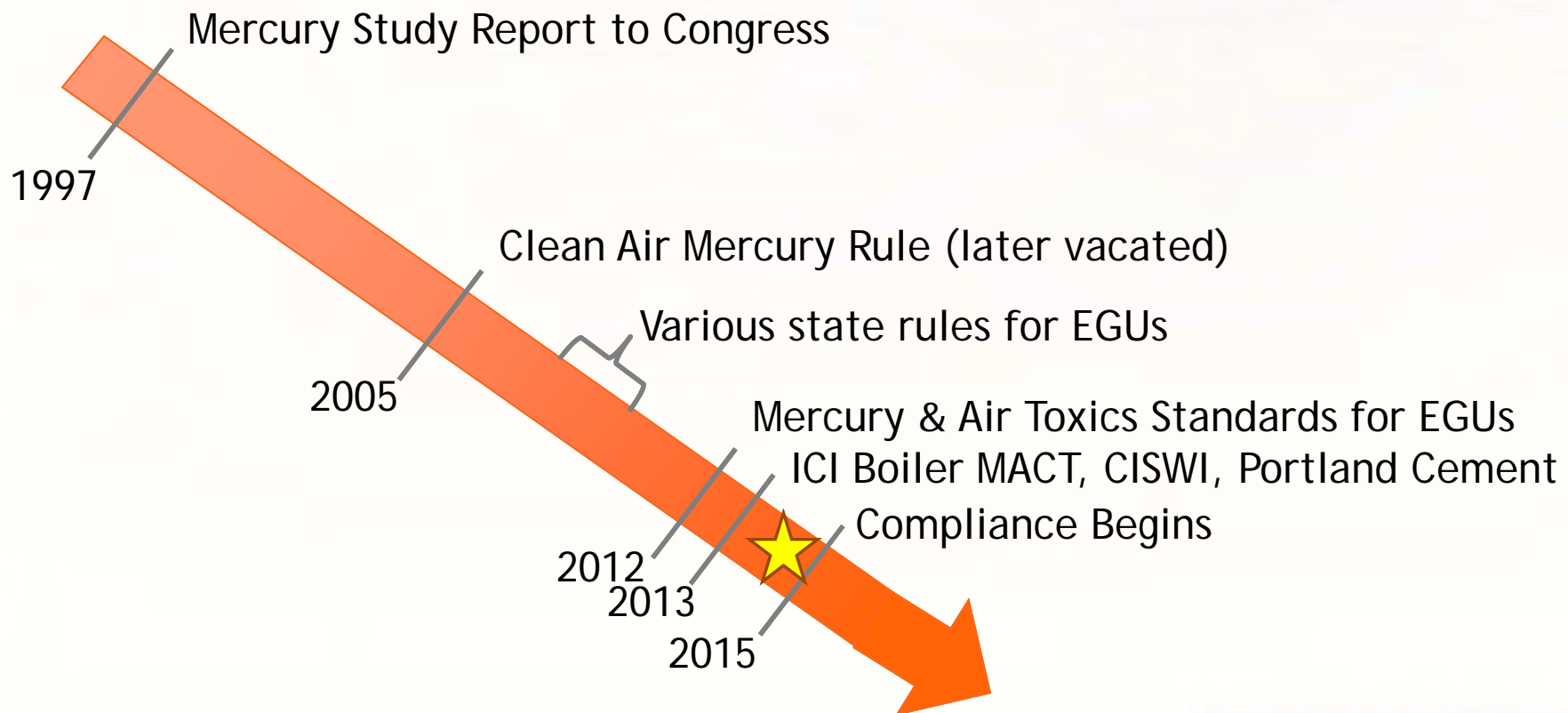
MATS and Performance Guarantee Testing

Connie Senior

Presented at Reinhold Air Pollution Control Conference, July 14-15, 2014

Mercury Control is Finally Here

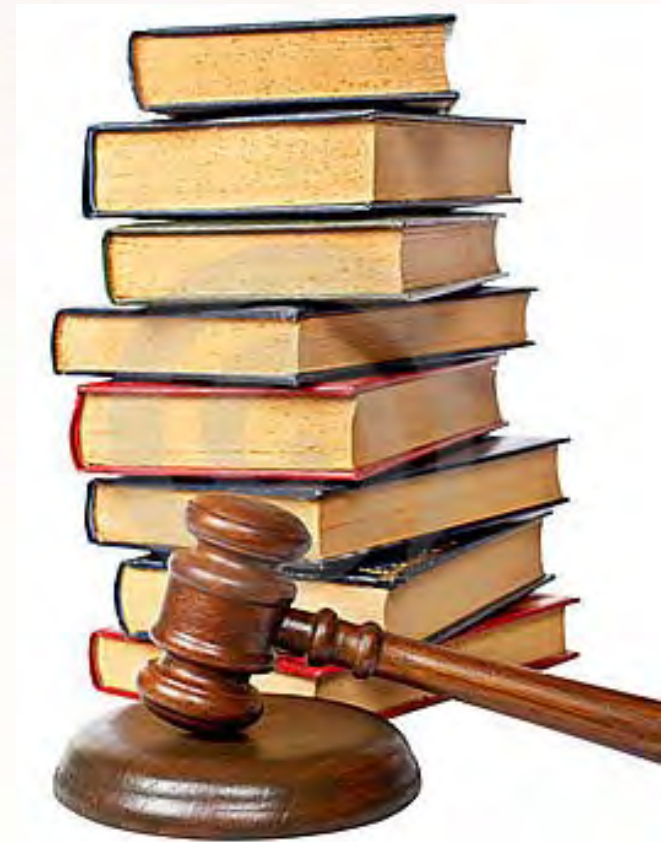
- ▶ But it's been a long time coming for EGU boilers, ICI boilers, and portland cement kilns



Agenda

- ▶ Overview of the MATS rule
- ▶ Compliance measurement under MATS
- ▶ Performance guarantee testing of Hg control equipment

- ▶ Clean Air Act (CAA) regulates emissions of Hazardous Air Pollutants (HAPs) from many sources in the U.S.
- ▶ EPA enforces CAA by making rules specific to sources and HAPs
- ▶ Mercury and Air Toxics Standard (MATS) applies to Electricity Generating Units (EGUs)



EGUs Regulated by MATS

- ▶ Boilers with >25 MW of electricity generated with >30% to the grid
- ▶ Fuels: Coal, Waste Coal, Oil, Syngas from Coal, Petcoke
 - ▶ Coal-fired sources include conventional combustion and IGCC
 - ▶ Oil-fired sources include those burning continental and non-continental oil as well as petcoke



Hazardous Air Pollutants in MATS

- ▶ CAA Section 112 specifies Hazardous Air Pollutants (HAPs), including metals:
 - ▶ Antimony Compounds
 - ▶ Arsenic Compounds (inorganic including arsine)
 - ▶ Beryllium Compounds
 - ▶ Cadmium Compounds
 - ▶ Chromium Compounds
 - ▶ Cobalt Compounds
 - ▶ Lead Compounds
 - ▶ Manganese Compounds
 - ▶ Mercury Compounds
 - ▶ Nickel Compounds
 - ▶ Radionuclides (including radon)
 - ▶ Selenium Compounds
- ▶ Acid gases, including HCl, HF
- ▶ Organic compounds, including dioxins/furans

Existing Coal-Fired Utility Boilers



- ▶ Focus of this talk: MATS limits for existing coal-fired EGUs
- ▶ Regulated HAPs are metals, acid gases, dioxins/furans
 - ▶ Surrogates or work-practice standards utilized in some cases
- ▶ Separate limits for
 - ▶ IGCC
 - ▶ Lignite-fired boilers
 - ▶ Bituminous- or subbituminous-fired boilers
- ▶ Sources must be in compliance by April, 2015
 - ▶ One-year extension may be granted by state (>100 plants have been granted extensions)
 - ▶ Additional one-year extension may be granted by EPA

Work Practice Standards

- ▶ Work practice standards, instead of numerical limits, to limit emissions of organic air toxics, including dioxins/furans
 - Dioxins and furans form as a result of inefficient combustion
 - Work practice standards require an initial performance test program for each unit that includes inspection, adjustment, and/or maintenance and repairs to ensure optimal combustion
- ▶ The initial tune-up is part of the initial compliance demonstration
- ▶ Subsequent tune-ups are required at least once every 36-calendar months (or 48 months if utilizing a neural-net combustion control system)
- ▶ Annual Reports are required

MATS Final Limits: Existing Coal-Fired Utility Boilers



| | Coal-fired EGUs: Bituminous, Subbituminous | Coal-fired EGUs: Lignite | IGCC |
|---|--|--------------------------|-----------------|
| HCl OR | 0.0020 lb/MMBtu | 0.0020 lb/MMBtu | 0.0005 lb/MMBtu |
| SO ₂ (surrogate for HCl) | 0.2 lb/MMBtu | 0.2 lb/MMBtu | NA |
| Mercury, Hg | 1.2 lb/TBtu | 4.0 lb/TBtu | 2.5 lb/TBtu |
| Antimony, Sb | 0.8 lb/TBtu | 0.8 lb/TBtu | 1.4 lb/TBtu |
| Arsenic, As | 1.1 lb/TBtu | 1.1 lb/TBtu | 1.5 lb/TBtu |
| Beryllium, Be | 0.2 lb/TBtu | 0.2 lb/TBtu | 0.1 lb/TBtu |
| Cadmium, Cd | 0.3 lb/TBtu | 0.3 lb/TBtu | 0.15 lb/TBtu |
| Chromium, Cr | 2.8 lb/TBtu | 2.8 lb/TBtu | 2.9 lb/TBtu |
| Cobalt, Co | 0.8 lb/TBtu | 0.8 lb/TBtu | 1.2 lb/TBtu |
| Lead, Pb | 1.2 lb/TBtu | 1.2 lb/TBtu | 190 lb/MMBtu |
| Manganese, Mn | 4.0 lb/TBtu | 4.0 lb/TBtu | 2.5 lb/TBtu |
| Nickel, Ni | 3.5 lb/TBtu | 3.5 lb/TBtu | 6.5 lb/TBtu |
| Selenium, Se OR | 5.0 lb/TBtu | 5.0 lb/TBtu | 22 lb/TBtu |
| Total non-Hg metals OR | 5.0E-5 lb/MMBtu | 5.0E-5 lb/MMBtu | 6.0E-5 lb/MMBtu |
| Filterable particulate matter, FPM (surrogate for non-Hg metals) | 0.03 lb/MMBtu | 0.03 lb/MMBtu | 0.04 lb/MMBtu |

MATS Final Limits: Existing Coal-Fired Utility Boilers



| | Coal-fired EGUs: Bituminous, Subbituminous | Coal-fired EGUs: Lignite | IGCC |
|--|--|-----------------------------|-----------------|
| HCl | 0.0020 lb/MMBtu | 0.0020 lb/MMBtu | 0.0005 lb/MMBtu |
| Mercury, Hg | 1.2 lb/TBtu | 4.0 lb/TBtu | 2.5 lb/TBtu |
| Filterable particulate matter, FPM | 0.03 lb/MMBtu | 0.03 lb/MMBtu | 0.04 lb/MMBtu |

What Do These Limits Mean?

Examples of Typical Coals

Final MACT Limits:

| PM, lb/MMBtu | HCl, lb/MMBtu | SO ₂ , lb/MMBtu ¹ | Hg, lb/TBtu |
|-----------------|------------------|--|-------------|
| 0.03 | 0.002 | 0.2 | 1.2 |

Estimated emission at final MACT Limit:

| Filterable PM ² , gr/dscf | HCl ² , ppmvd | SO ₂ (Alternate) ^{1,2} , ppmvd | Mercury ² , ug/dscm |
|--|-----------------------------|--|-----------------------------------|
| 0.020 | 2.0 | 112 | 1.8 |

Estimated control efficiency, based on fuel:

| HCl | SO ₂ ¹ | Mercury |
|-----|------------------------------|---------|
| 98% | 94% | 85% |

Estimated emission at final MACT Limit:

| Filterable PM ² , gr/dscf | HCl ² , ppmvd | SO ₂ (Alternate) ^{1,2} , ppmvd | Mercury ² , ug/dscm |
|--|-----------------------------|--|-----------------------------------|
| 0.018 | 1.9 | 105 | 1.7 |

Estimated control efficiency, based on fuel:

| HCl | SO ₂ ¹ | Mercury |
|-----|------------------------------|---------|
| 6% | 70% | 85% |

Final MACT Limits:

| PM, lb/MMBtu | HCl, lb/MMBtu | SO ₂ , lb/MMBtu ¹ | Hg, lb/TBtu |
|-----------------|------------------|--|-------------|
| 0.03 | 0.002 | 0.2 | 4 |

Estimated emission at final MACT Limit:

| Filterable PM ² , gr/dscf | HCl ² , ppmvd | SO ₂ (Alternate) ^{1,2} , ppmvd | Mercury ² , ug/dscm |
|--|-----------------------------|--|-----------------------------------|
| 0.018 | 1.9 | 105 | 5.6 |

Estimated control efficiency, based on fuel:

| HCl | SO ₂ ¹ | Mercury |
|-----|------------------------------|---------|
| 82% | 91% | 63% |

¹Alternate acid gas limit for units with scrubbers

²Concentrations at 3% O₂

Overview of the MATS Rule for Existing Coal-Fired EGUs



- ***Multi-pollutant standards***
 - Hg, HCl, filterable particulate matter (FPM)
 - Alternate compliance via SO₂ control (acid gases) or direct measurement of non-Hg metals
- ***Separate limits*** for
 - IGCC
 - Petcoke-fired boilers
 - Lignite-fired boilers
 - Bituminous- or subbituminous-fired boilers
- ***Work practice standards (combustion tune-up)*** for control of dioxins/furans
- ***Separate limits for new and existing units***

How Do You Comply with MATS?

Let's Talk Measurements



- EPA favors continuous monitoring systems with relative accuracy testing using EPA Reference Methods and Performance Specifications
- Low Emitting EGU (LEE) status qualification for specific pollutants reduces testing burden

Mercury Compliance Measurements



- ▶ Hg CEMS or sorbent trap monitoring system used for both initial compliance and continuous compliance, except where the low emitting EGU (LEE) requirements apply
- ▶ Prior to compliance, all EPA protocols for testing and calibration completed, monitoring plan submitted to EPA 60 days before initial performance evaluation
- ▶ Initial performance test consists of all valid data recorded with the certified Hg monitoring system in the 30 boiler operating days of data collected with the certified monitoring system by the initial compliance demonstration date

MATS Hg Measurement CEMS



- ▶ Representative samples of flue gas are continuously extracted from the stack or duct
- ▶ Particulate matter is removed (i.e., filtered) from the gas samples
- ▶ Hg analyzer measures vapor phase Hg⁰ and total Hg (only total Hg needed for MATS compliance)

▶ Typical Hg CEMS Components:

- Probe
- PM filter
- Sample conditioning
- Sample transport (sample line and pump)
- Gas analyzer (with or without converters)
- Calibration gas system



MATS Hg Measurement Sorbent Traps

- ▶ Known volumes of flue gas are continuously extracted from the stack or duct through paired, in-stack sorbent traps. Vapor phase Hg is collected on the sorbent medium
 - Typical sorbent medium is halogenated carbon
 - Paired sorbent traps are used for quality-assurance purposes and to ensure measurement precision
- ▶ A pair of sorbent traps is typically used for 24 to 168 hours (but may be used for up to 14 operating days when the Hg concentration is very low), before being removed and analyzed

▶ Typical Sorbent Trap Components:

- Dual trains w/sampling probes and paired sorbent traps. The sorbent traps have three sections: (1) main sample collection section; (2) breakthrough section; and (3) section spiked with a known mass of Hg⁰, for QA/QC .
- Moisture removal system
- Vacuum pump
- Sample gas flow meter



MATS Hg Measurement Sorbent Traps



- ▶ Sorbent trap system must be operated and maintained according to Performance Specification 12B in 40 CFR Part 60, Appendix B
- ▶ Leak checks must be performed (before and after sampling)
- ▶ Paired sorbent trap consistency/agreement is required
- ▶ A minimum % recovery of the spiked Hg⁰ in the third section is required
- ▶ Sample recovery techniques include acid leaching, digestion, thermal desorption
- ▶ Analytical methods include UV atomic fluorescence, UV atomic absorption, and X-ray fluorescence
- ▶ Analyzer calibration is required

Certification of Hg Monitoring Systems

- ▶ Each Hg CEMS or sorbent trap monitoring system must be initially certified
- ▶ For Hg CEMS, the following certification tests are required:
 - 7-day calibration error test, using elemental or oxidized Hg standards
 - Linearity check, using elemental Hg standards
 - 3-level system integrity check, using oxidized Hg standards
 - Cycle time test, using elemental or oxidized Hg standards (not required for integrated batch sampling-type CEMS)
 - Relative accuracy test audit (RATA). Note that a bias test is not required. Allowable reference methods for the RATA include EPA Methods 29, 30A, 30B, and ASTM D6784-02 (the Ontario Hydro Method)
- ▶ All Hg calibration gas standards must be traceable to the National Institute of Standards and Technology (NIST)
 - EPA , in cooperation with industry, NIST, and outside consultants, has developed interim traceability protocols
 - These are cited in Subpart UUUUU, Appendix A, sections 3.1.4 and 3.1.5

Certification of Hg Monitoring Systems

- ▶ For sorbent trap monitoring systems, only a RATA is required:
 - During the RATA, the monitoring system must be operated according to Performance Specification 12B
 - The sorbent material must be the same type that is used for daily operation of the system
 - The sorbent traps used for the RATA may be smaller than those used for daily operation
 - The allowable breakthrough in the second section of the traps depends on the Hg concentration level in the stack gas For sorbent traps, a RATA must also be performed

On-going Quality-Assurance For Hg Monitoring Systems

- ▶ For Hg CEMS, the following QA tests are required:
 - Daily calibration error tests , using elemental or oxidized Hg standards
 - Weekly single-point system integrity checks , using oxidized Hg standards
 - Quarterly linearity checks, using elemental Hg standards or 3-level system integrity checks using oxidized Hg standards
 - Annual RATAs
- ▶ For sorbent trap monitoring systems:
 - The system must be operated and maintained according to PS 12B
 - Annual RATAs are required
 - Quarterly calibration of the gas flow meter and auxiliary equipment is required
- ▶ The on-going QA/QC requirements and acceptance criteria for Hg CEMS and sorbent trap monitoring systems are summarized in Appendix

Non-Hg Metals Compliance Measurements



- ▶ Several alternatives:
 1. To comply with the filterable PM emission limit, you must conduct filterable PM emissions testing using EPA Method 5 to determine initial compliance
 2. To comply with the total non-mercury HAP metals emission limit or the individual non-mercury HAP metals emissions limits, you must conduct HAP metals testing using EPA Method 29
 3. To comply using PM continuous parameter monitoring system (CPMS) to monitor compliance with the operating limit, you must install a PM CPMS and establish the operating limit during the initial compliance test for filterable PM, total non-mercury HAP metals, or individual non-mercury HAP metals
 4. You may also opt to install and operate a PM CEMS, and then the requirements for quarterly testing with Method 5, or annual testing and use of a PM CPMS, are no longer applicable

Acid Gas Compliance Monitoring



- ▶ Several alternatives here, too:
 1. To use an HCl CEMS for compliance, you need not conduct an initial stack test for HCl, but can use 30 boiler operating days of data collected with the certified HCl CEMS by the initial compliance demonstration date
 2. If using the alternative SO₂ limit in place of the HCl limit (for boilers with FGD technology), you can use 30 boiler operating days of data collected with the certified SO₂ CEMS by the initial compliance demonstration date and the SO₂ CEMS is used thereafter to demonstrate continuous compliance
 3. If not using the SO₂ or HCl CEMS options, you must conduct an initial stack test for HCl using EPA Method 26, 26A, or 320 or you can use EPA Method 26 or 320 or ASTM Method D6348-03 (Reapproved 2010) with additional quality assurance if no entrained water droplets exist in the exhaust gas, but you must use Method 26A if entrained water droplets exist in the exhaust gas

Low Emitting EGU (LEE)



- ▶ What qualifies?
 - Less than 10 percent of the applicable Hg emissions limit or less than 29 pounds of Hg per year
 - Less than 50% of the applicable limit for other pollutants in MATS
- ▶ If you think you qualify for Hg, you must
 - Conduct an initial Method 30B test over 30 days and follow the calculation procedures in the final rule to document a potential to emit, and
 - Conduct subsequent performance tests on an annual basis to demonstrate that the unit continues to qualify
- ▶ If you qualify as a LEE for other pollutants, you must conduct an initial performance test and then subsequent performance tests every 3 years to demonstrate that the unit continues to qualify

How Are You Going to Comply with MATS Limits on Hg Emissions?



- ▶ Use existing APCD equipment, particularly scrubbers, if there's enough oxidized Hg that can be captured
- ▶ Add new Hg control equipment, for example:
 - Sorbent injection
 - Halogen/oxidizing agent addition

Purpose of Performance Testing



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



Path to Performance Testing

Availability
test (>30 days)

Process performance tests

- Hg emission rate
- Max. feed rate
- System energy consumption
- System pressure drop change
- Sound/noise level

Mechanical
performance test

Equipment
installation

Mechanical Performance Testing

- ▶ When installation is complete, the equipment can be operated properly without endangering personnel, causing damage to equipment or damage to the transmission system
- ▶ Vendor's commissioning staff should provide mechanical completion tests documentation to the Purchaser, which should include the following:
 - Instrument check-out and calibration data sheets
 - Construction tests and inspections (alignments, holiday test, hydro test reports, etc.)
 - Factory test reports
 - "Marked Up" drawings (process and instrument diagrams, electrical single line diagrams, control logic diagrams, sketches, etc.)
 - List of incomplete Work items remaining on the system
 - Electrical test data sheets
 - Any third-party vendor field reports



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: Choosing a Contractor

- ▶ Once you have a list of potential contractors, Request for Quotation (RFQ) for performance testing should be issued
 - Sufficient detail about the test methods and testing schedule needs to be included to get a good quote
 - Thinking about this in advance will make things go smoother during the testing!

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.
 - SO₃ concentration at the ACl injection location, if specified in Contract

Emissions Testing: Set It Up Right

- ▶ 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 guarantees as specified in the Contract, which might include:

| Sample | Analyses or Reason for Sample |
|---------------------------|--|
| Coal* | <ul style="list-style-type: none"> 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

Emissions Testing: Execution



- ▶ A typical emissions performance test schedule:

| | |
|----------|---|
| | DAY 1 |
| 7:30 AM | Arrive at site |
| 8:00 AM | Pre-test meeting in Control room with plant staff and test contractor |
| 8:30 AM | Preparation of sample test trains, flow check of flue gas, and preparation of sampling systems for coal, etc. |
| 9:30 AM | Start of Run #1 |
| 11:30 AM | End of Run #1 |
| 12:30 PM | Finish recovery of test train samples from Run #1, coal and other samples |
| 1:30 PM | Start of Run #2 |
| 3:30 PM | End of Run #2 |
| 4:30 PM | Finish recovery of test train samples from Run #2, also coal and other samples |
| | DAY 2 |
| 7:30 AM | Arrive at site |
| 8:00 AM | Pre-test meeting in Control room with plant staff and test contractor |
| 8:30 AM | Preparation of sample test trains, flow check of flue gas, and preparation of sampling systems for coal, etc. |
| 9:30 AM | Start of Run #3 |
| 11:30 AM | End of Run #3 |
| 12:30 PM | Finish recovery of test train samples from Run #3, coal and other samples. |

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., $\mu\text{g}/\text{dscm} \Rightarrow \text{lb}/\text{TBtu}$)

Availability Testing

- ▶ After successful conclusion of the Performance Test, Availability Test can begin and should cover a continuous period of hours or days as specified by the Contract
- ▶ Throughout the Availability Test Period, the Vendor-supplied equipment should be operated by the Owner's staff in accordance with training and the Operating and Maintenance manuals supplied by Vendor
- ▶ During the Availability Test, unit outage and derate data for the station are collected and an Equivalent Availability Factor calculated in accordance with NERC GADS procedures
- ▶ Outages or derates caused by Vendor-supplied equipment or systems would be recorded and used in computing the Equivalent Availability Factor during the Availability Test
- ▶ Outages or derates caused by the errors of the Owner's Operating Personnel or any other cause not attributable to the Vendor's Equipment or the work, should not be included in calculating the Equivalent Availability Factor



Questions?

connies@adaes.com

Thank you for attending!

Appendix: Flue Gas Test Methods



| Method Number | Title |
|---------------|--|
| 1 | SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES |
| 2 | DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE) |
| 2F | DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE WITH THREE-DIMENSIONAL PROBES |
| 2G | DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE WITH TWO-DIMENSIONAL PROBES |
| 3A | DETERMINATION OF OXYGEN AND CARBON DIOXIDE CONCENTRATIONS IN EMISSIONS FROM STATIONARY SOURCES |
| 4 | DETERMINATION OF MOISTURE CONTENT IN STACK GASES |
| 5 | DETERMINATION OF PARTICULATE MATTER EMISSIONS FROM STATIONARY SOURCES |
| 5B | DETERMINATION OF NONSULFURIC ACID PARTICULATE MATTER EMISSIONS FROM STATIONARY SOURCES |
| 5I | DETERMINATION OF LOW LEVEL PARTICULATE MATTER EMISSIONS FROM STATIONARY SOURCES |
| 6C | DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES |
| 7E | DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES |
| 9 | VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES |
| 17 | DETERMINATION OF PARTICULATE MATTER EMISSIONS FROM STATIONARY SOURCES |
| 19 | DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDE EMISSION RATES |
| 26 | DETERMINATION OF HYDROGEN HALIDE AND HALOGEN EMISSIONS FROM STATIONARY SOURCES NON-ISOKINETIC METHOD |
| 26A | DETERMINATION OF HYDROGEN HALIDE AND HALOGEN EMISSIONS FROM STATIONARY SOURCES ISOKINETIC METHOD |
| 30A | DETERMINATION OF TOTAL VAPOR PHASE MERCURY EMISSIONS FROM STATIONARY SOURCES (INSTRUMENTAL ANALYZER PROCEDURE) |
| 30B | DETERMINATION OF TOTAL MERCURY EMISSIONS FROM STATIONARY SOURCES (SORBENT TRAP PROCEDURE) |
| 201A | DETERMINATION OF PM10 AND PM2.5 EMISSIONS FROM STATIONARY SOURCES (Constant Sampling Rate Procedure) |
| 203 | DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES BY CONTINUOUS OPACITY MONITORING SYSTEMS |
| CTM-013 | CONDITIONAL TEST METHOD FOR THE DETERMINATION OF SULFURIC ACID VAPOR AND SULFUR DIOXIDE EMISSIONS BY THE CONTROLLED CONDENSATION TRAIN |
| CTM-027 | CONDITIONAL TEST METHOD FOR THE COLLECTION AND ANALYSIS OF AMMONIA FROM STATIONARY SOURCES |
| PS-15 | PERFORMANCE SPECIFICATION FOR EXTRACTIVE FTIR CONTINUOUS EMISSIONS MONITOR SYSTEMS IN STATIONARY SOURCES |

Appendix: Sampling Methods



| Standard Number | Description |
|-----------------|---|
| ASTM D2013 | Standard Practice for Preparing Coal Samples for Analysis |
| ASTM D2234 | Standard Methods for Collection of a Gross Sample of Coal |
| ASTM D3172 | Standard Practice for Proximate Analysis of Coal and Coke |
| ASTM D3176 | Standard Practice for Ultimate Analysis of Coal & Coke |
| ASTM D3684 | Standard Test Method for Total Mercury in Coal |
| ASTM D6721 | Chlorine in Coal |

Appendix: Certification for CEMS

| For this required certification test..... | The main performance specification ¹ is..... | The alternate performance specification ¹ is..... | And the conditions of the alternate specification are..... |
|---|---|--|---|
| 7-day calibration error test ² | $ R - A \leq 5.0\%$ of span value, for both the zero and upscale gases, on each of the 7 days | $ R - A \leq 1.0 \mu\text{g}/\text{scm}$ | The alternate specification may be used on any day of the test. |
| Linearity check ³ | $ R - A_{\text{avg}} \leq 10.0\%$ of the reference gas concentration at each calibration gas level | $ R - A_{\text{avg}} \leq 0.8 \mu\text{g}/\text{scm}$ | The alternate specification may be used at any gas level |
| 3-level system integrity check ⁴ | $ R - A_{\text{avg}} \leq 10.0\%$ of the reference gas concentration at each calibration gas level | $ R - A_{\text{avg}} \leq 0.8 \mu\text{g}/\text{scm}$ | The alternate specification may be used at any gas level |
| RATA | 20.0% RA | $ RM_{\text{avg}} - C_{\text{avg}} \leq 1.0 \mu\text{g}/\text{scm}$ | $RM_{\text{avg}} < 5.0 \mu\text{g}/\text{scm}$ |
| Cycle time test ⁵ | 15 minutes | ----- | ----- |

¹ "R" is the reference gas value; "A" is the analyzer reading; "A_{avg}" is the average analyzer reading; "RM_{avg}" is the mean reference method value; and "C_{avg}" is the mean CEMS value

² Using NIST-traceable elemental or oxidized Hg standards. The test may be performed on 7 consecutive operating days, if necessary.

³ Using NIST-traceable elemental Hg standards

⁴ Using NIST-traceable oxidized Hg standards

⁵ Using NIST-traceable elemental or oxidized Hg standards. This test is not required for integrated batch sampling-type CEMS.

Appendix: On-going QA /QC Requirements for Hg CEMS



| Perform this type of QA test.... | At this frequency.... | With these qualifications and exceptions.... | Acceptance criteria.... |
|--|-----------------------|--|--|
| Calibration error test | Daily | <ul style="list-style-type: none"> Use either a mid- or high- level gas Use either elemental or oxidized Hg Calibrations are not required when the unit is not in operation. | $ R - A \leq 5.0\%$ of span value <u>or</u> $ R - A \leq 1.0 \mu\text{g/scm}$ |
| Single-level system integrity check | Weekly | <ul style="list-style-type: none"> Use oxidized Hg ---either mid- or high-level Not required if daily calibrations are done with a NIST-traceable source of oxidized Hg | $ R - A_{\text{avg}} \leq 10.0\%$ of the reference gas value <u>or</u> $ R - A_{\text{avg}} \leq 0.8 \mu\text{g/scm}$ |
| Linearity check <u>or</u> 3-level system integrity check | Quarterly | <ul style="list-style-type: none"> Required in each "QA operating quarter" --and no less than once every 4 calendar quarters 168 operating hour grace period available Use elemental Hg for linearity check Use oxidized Hg for system integrity check⁴ | $ R - A_{\text{avg}} \leq 10.0\%$ of the reference gas value, at each calibration gas level <u>or</u> $ R - A_{\text{avg}} \leq 0.8 \mu\text{g/scm}$ |
| RATA | Annual ⁶ | <ul style="list-style-type: none"> Test deadline may be extended for "non-QA operating quarters", up to a maximum of 8 quarters from the quarter of the previous test. 720 operating hour grace period available | 20.0% RA <u>or</u> $ RM_{\text{avg}} - C_{\text{avg}} \leq 1.0 \mu\text{g/scm}$, <u>if</u> $RM_{\text{avg}} < 5.0 \mu\text{g/scm}$ |

Appendix: Normal Operation and QA/QC for Sorbent Trap Systems (PS 12B)



| QA/QC test or specification | Acceptance criteria | Frequency | Consequences if not met |
|--|---|---|--|
| Pre-monitoring leak check | $\leq 4\%$ of target sampling rate | Prior to monitoring | Monitoring must not commence until the leak check is passed. |
| Post-monitoring leak check | $\leq 4\%$ of average sampling rate | After monitoring | Invalidate the data from the paired traps or, if certain conditions are met, report adjusted data from a single trap (PS 12B, Section 12.8.1.3). |
| Ratio of stack gas flow rate to sample flow rate | Hourly ratio may not deviate from the reference ratio by more than $\pm 25\%$. | Every hour throughout monitoring period | Invalidate the data from the paired traps or, if certain conditions are met, report adjusted data from a single trap (PS 12B, Section 12.8.1.3). |
| Sorbent trap section 2 breakthrough | $\leq 5\%$ of Section 1 Hg mass (for daily operation) ¹ | Every sample | Invalidate the data from the paired traps or, if certain conditions are met, report adjusted data from a single trap (PS 12B, Section 12.8.1.3). |

¹ For the RATA, Section 2 breakthrough depends on C_{Hg} stack gas Hg concentration. Allowable breakthrough is $\leq 10\%$ of Section 1 mass if C_{Hg} is $> 1 \mu\text{g}/\text{m}^3$; $\leq 20\%$ of Section 1 mass if C_{Hg} is > 0.5 and $\leq 1 \mu\text{g}/\text{m}^3$; $\leq 50\%$ of Section 1 mass if C_{Hg} is > 0.1 and $\leq 0.5 \mu\text{g}/\text{m}^3$. There is no breakthrough criterion if C_{Hg} is $< 0.1 \mu\text{g}/\text{m}^3$.

Appendix: Normal Operation and QA/QC for Sorbent Trap Systems (PS 12B)



| QA/QC test or specification | Acceptance criteria | Frequency | Consequences if not met |
|---|--|--|--|
| Paired sorbent trap agreement | $\leq 10\%$ Relative Deviation (RD) if the average concentration is $> 1.0 \mu\text{g}/\text{m}^3$ | Every sample | Either invalidate the data from the paired traps or report the results from the trap with the higher Hg concentration. |
| | $\leq 20\%$ RD if the average concentration is $\leq 1.0 \mu\text{g}/\text{m}^3$ | | |
| | Results also acceptable if difference between paired traps is $\leq 0.03 \mu\text{g}/\text{m}^3$ | | |
| Spike Recovery Study | Average recovery between 85% and 115% for each of the 3 spike concentration levels | Prior to analyzing field samples and prior to use of new sorbent media | Field samples must not be analyzed until the percent recovery criteria has been met. |
| Multipoint analyzer calibration | Each analyzer reading within $\pm 10\%$ of true value and $r^2 \geq 0.99$ | On the day of analysis, before analyzing any samples | Recalibrate until successful |
| Analysis of independent calibration standard. | Within $\pm 10\%$ of true value | Following daily calibration, prior to analyzing field samples | Recalibrate and repeat independent standard analysis until successful. |
| Spike recovery from section 3 of both sorbent traps | 75–125% of spike amount | Every sample | Invalidate the data from the paired traps or, if certain conditions are met, report adjusted data from a single trap (PS 12B, Section 12.8.1.3). |

Appendix: Normal Operation and QA/QC for Sorbent Trap Systems (PS 12B)



| QA/QC test or specification | Acceptance criteria | Frequency | Consequences if not met |
|--------------------------------|--|---|---|
| Relative Accuracy | RA \leq 20.0% of RM mean value; or if RM mean value \leq 5.0 $\mu\text{g}/\text{scm}$, absolute difference between RM and sorbent trap monitoring system mean values \leq 1.0 $\mu\text{g}/\text{scm}$ | RA specification must be met for initial certification and annually ² thereafter | Data from the system are invalid until a RATA is passed. |
| Gas flow meter calibration | An initial calibration factor (Y) has been determined at 3 settings; for mass flow meters, initial calibration with stack gas has been performed. For subsequent calibrations, Y within \pm 5% of average value from the most recent 3-point calibration | At 3 settings prior to initial use and at least quarterly at one setting thereafter | Recalibrate meter at 3 settings to determine a new value of Y. |
| Temperature sensor calibration | Absolute temperature measured by sensor within \pm 1.5% of a reference sensor | Prior to initial use and at least quarterly thereafter | Recalibrate; sensor may not be used until specification is met. |
| Barometer calibration | Absolute pressure measured by instrument within \pm 10 mm Hg of reading with a NIST-traceable barometer | Prior to initial use and at least quarterly thereafter | Recalibrate; instrument may not be used until specification is met. |

² "Annually" means once every four QA operating quarters. Limited extensions of the RATA deadline are allowed for "non-QA" quarters--the maximum allowable extension is 8 calendar quarters from the previous RATA. A 720 operating hour grace period is available.

Appendix: Hg Emissions Reporting

- ▶ For units that qualify as LEEs for Hg, the results of all 30-day demonstration tests must be submitted to EPA database, using the Electronic Reporting Tool (ERT)
 - Results must be submitted within 60 days after completing each test.

- ▶ For units that continuously monitor Hg emissions:
 - A monitoring plan must be developed and maintained
 - The Hg CEMS or sorbent trap monitoring system(s) and any required additional monitoring systems must be represented in the monitoring plan
 - Monitoring plan data must be submitted to EPA electronically and updated when necessary
 - Hourly Hg concentration data must be reported electronically to EPA
 - Data from Hg CEMS are reduced to hourly averages
 - For sorbent trap monitoring systems, the Hg concentration obtained from the analysis of a pair of traps is reported for each hour of the data collection period

Appendix: Hg Emissions Reporting

- ▶ Quarterly electronic reporting of Hg emissions is required, no later than 30 days after the end of each calendar quarter
- ▶ Hourly records of any additional data needed to convert Hg concentration to units of the emission standard (e.g., stack gas flow rate and/or moisture content, CO₂ or O₂ concentration, electrical load) must be included in the electronic quarterly reports
- ▶ The additional monitoring system(s) used to convert Hg concentration to units of the standard must meet the requirements of 40 CFR Part 75
- ▶ For sorbent trap monitoring systems, certain other hourly data must be reported (i.e., sample flow rate, gas flow meter reading, and the ratio of stack gas flow rate to sample flow rate)
- ▶ The data acquisition and handling system (DAHS) must be programmed to provide an hourly data stream in the units of the applicable Hg emission standard (lb/TBtu or lb/GWh)
- ▶ Hg emission rates are calculated only for operating hours in which valid data are obtained for all parameters in the applicable equation(s). For the purposes of Subpart UUUUU, Part 75 substitute data are not considered to be valid data.

Appendix: Hg Emissions Reporting

- ▶ Operating hours in which a valid Hg emission rate is not obtained are counted as hours of monitoring system downtime
- ▶ Only unadjusted monitoring data are used to calculate Hg emission rates. Bias adjustment factors (BAFs) are not applied to any of the parameters
- ▶ The results of all required certification and QA tests of Hg CEMS, sorbent trap monitoring systems, and the additional monitoring system(s) used to convert Hg concentration to units of the standard must be reported electronically
- ▶ For Hg CEMS and sorbent trap monitoring systems, RATA results and test details must also be submitted to the EPA database via ERT, within 60 days after completing each test
- ▶ Compliance with the 30 (or in some cases, 90) operating day rolling average Hg emission rates is assessed in the semiannual reports required under §63.10031