AIRTECH
Environmental
Services Inc.

1371 Brummel Ave • Elk Grove Village, IL 60007
Phone: (630) 860-4740 • Fax: (847) 258-3755
www.airtechenv.com

RECEIVED
JUL 26 2017
AIR QUALITY DIVISION

Report on the Mercury and Air Toxics Standards (MATS) Mercury Air Emissions Test Program

Unit 3 Exhaust
Marquette Board of Light and Power
2200 Wright Street
Marquette, MI 49855

Report No. 159878-6421 LEE 2017
July 17, 2017

Project Overview

General

Airtech Environmental Services Inc. (Airtech) was contracted by Marquette Board of Light and Power (MBLP) to determine compliance with the "Mercury and Air Toxics Standards" (MATS) at the Shiras Steam Plant located in Marquette, Michigan. The specific objective of this test program was as follows:

- Determine the concentration of mercury (Hg) over a thirty (30) "boiler operating day" period from the exhaust of one (1) coal-fired boiler, designated Unit 3

The purpose of this test program is to determine compliance with the "Mercury and Air Toxics Standards" (MATS) and "National Emission Standards for Hazardous Air Pollutants" (NESHAP) rule issued pursuant to Clean Air Act (CAA) section 112. Testing was performed to meet the requirements of MBLP; the Shiras Steam Plant; the Michigan Department of Environmental Quality (MDEQ); the United States Environmental Protection Agency (U.S. EPA); and 40 CFR Part 63, Subpart UUUUU, as applicable.

Testing took place on March 28 through April 26, 2017. Coordinating the field portion of the test program were:

Thomas Skewis – Marquette Board of Light & Power
Brandon Check, QSTI – Airtech Environmental Services Inc.

Methodology

30-Day Hg Testing Methodology

EPA Method 30B was used to determine the concentration of vapor-phase Hg at the test location. A sample of the gas stream was withdrawn at a constant rate from the test location. Vapor phase Hg in the gas stream collected on paired, glass, in-situ sorbent traps packed with a carbon media designed to collect both gaseous oxidized mercury (Hg^{+2}) and gaseous elemental mercury (Hg^0). The mass of Hg collected with each trap was compared to the volume of dry gas sampled to calculate the total Hg concentration. Ohio Lumex, Co. provided all sorbent traps used for this project.

Daily status checks of the EPA Method 30B sampling train parameters was conducted remotely by Airtech personnel, using an automated Apex Instruments XC-6000EM mercury emissions sampler equipped with a logging computer. Traps were replaced every five (5) to eight (8) days. The fuel specific default moisture value of 8.0% was used to convert the milligram per dry standard cubic meter results to a "wet" concentration.

Analysis of sorbent traps was performed by Airtech personnel at the Airtech laboratory located in Elk Grove Village, Illinois, using an Ohio Lumex Model RA-915$^+$ low level mercury analyzer combined with the M324 sorbent tube attachment.

Results of the Hg testing are expressed in units of micrograms per dry standard cubic meter (µg/dscm), in units of micrograms per standard cubic meter (µg/scm), in units of pounds per trillion British thermal units (lb/TBtu) and pounds per gigawatt hour (lb/GWh).

Special Considerations

Per the requirements of 40 CFR Part 63, Subpart UUUUU, the following strategies were utilized throughout the test program:

- Under §63.10005(h)(3), the Method 30B sampling probe tip was to be located at a point within the 10 percent (10%) centroidal area of the duct at a location that meets EPA Method 1 criteria.
- Under §63.10005(h)(3)(i)(A), diluent gas (CO_2 or O_2) data, using the diluent gas monitor that has been certified according to part 75 of this chapter (i.e. plant CEMS data) was used.
- Under §63.10005(h)(3)(i)(B), stack gas flow rate data, using the flow rate monitor that has been certified according to part 75 of this chapter. (i.e. plant CEMS data) was used.
- Under §63.10005(h)(3)(ii), plant CEMS data used to measure CO_2 (or O_2) concentration, and/or flow rate, and/or moisture, was recorded by plant personnel as hourly average values of each parameter throughout the 30-boiler operating day test period.
- Under Table 5 (4) LEE Testing (f), emissions concentrations for Hg were converted from the LEE test to lb/TBtu or lb/GWh emissions rates, using the calculations found in EPA Method 19.

Parameters

The following gas parameter was determined at the test location:

- total vapor phase mercury concentration

Discussion of Results

A complete summary of the test results is presented in Table 1 on Page 5.

The data below summarizes the test results compared to the regulatory limits.

	Average Emission Rate (lbTBtu)	Average Emission Rate (lb/GWh)
Results	0.681	0.00232
Limit	1.2	0.013

A summary of the deviation between the mercury results for Trains A (Unspiked) and B (Spiked) is shown in the table below:

Difference Results	Run 1	Run 2	Run 3	Run 4	Criteria
Train A (µg/dscm)	0.373	0.958	0.842	0.975	NA
Train B (µg/dscm)	0.922	0.884	0.874	1.04	NA
Diff. (µg/dscm)	0.0652	0.0756	0.0846	0.0906	<0.2

A summary of the percent mercury breakthrough into the second fraction of the each trap for Trains A (Unspiked) and B (Spiked) is shown below:

Breakthrough Results	Run 1	Run 2	Run 3	Run 4	Criteria
Train A (%)	0.254	0.0612	0.0692	0.151	<10
Train B (%)	0.0611	0.0809	0.0331	0.0302	<10

A summary of the spike recoveries for each test run is shown below. The average mercury spike recovery was 95.7 percent.

Spike Results	Run 1	Run 2	Run 3	Run 4	Criteria
Recovery – R (%)	108	92.1	91.2	92.0	85<R<115

Prepared by:	Reviewed by:
Cathy Busse	Roy Slick
Cathy Busse, Technical Writer	Roy Slick, Technical Writer

Summary of Results

Table 1 – Summary of the Unit 3 Mercury Results

Test Parameters	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Average**
Date	3/28/17	4/5/17	4/13/17	4/21/17	
Start Time	10:57	11:46	12:32	13:13	
Date	4/5/17	4/13/17	4/18/17	4/26/17	
Stop Time	11:01	11:46	12:31	13:12	
Process Conditions					
Load (MW)	33	33	31	31	
Unit Conditions					
Carbon Dioxide (%)	11.9	12.0	11.8	11.7	**11.9**
CO_2 Based fuel Factor (F_c, scf/MMBtu)	1,840	1,840	1,840	1,840	**1,840**
Moisture (%)	8.0	8.0	8.0	8.0	**8.0**
Total Mercury Results					
Average Concentration (µg/dscm)	0.405	0.921	0.799	0.928	**0.763**
Average Concentration (µg/scm)	0.373	0.847	0.735	0.854	**0.702**
Average Concentration (lb/scf)	2.33E-11	5.29E-11	4.59E-11	5.33E-11	**4.38E-11**
Average Emission Rate (lb/MMBtu, F_c)	3.60E-07	8.11E-07	7.16E-07	8.39E-07	**6.81E-07**
Average Emission Rate (lb/TBtu, F_c)	0.360	0.811	0.716	0.839	**0.681**
Average Emission Rate (lb/GWh)	0.00123	0.00276	0.00244	0.00286	**0.00232**

Test Procedures

Method Listing

The following test methods were referenced for the test program. These methods can be found in 40 CFR, Part 60, Appendix A.

Method 19	Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides Emission Rates
Method 30B	Determination of Total Vapor Phase Mercury Emissions from Coal-Fired Combustion Sources Using Carbon Sorbent Traps

Method Description

EPA Method 19

EPA Method 19 was used to calculate the Hg emission rates, based on the CO_2 content of the sample gas and an appropriate F factor, which is the ratio of combustion gas volumes to heat inputs. For the testing reported in this document, the standard CO_2 based F factor of 1,840 for sub-bituminous coal used to calculate emission rates in terms of pounds per trillion Btu (lb/TBtu).

EPA Method 30B

The total vapor phase mercury (Hg) concentration at the test location was determined using EPA Method 30B. A known volume of flue gas was extracted from the test location through paired, in-stack, sorbent media traps. After sampling, the traps were prepared for analysis by thermal desorption and analyzed using atomic absorption spectrometry.

The analytical matrix interference test was performed and the minimum mass of Hg that could be collected per sample was determined by Ohio Lumex. Through the use of this minimum mass and previous data collected at the test locations, target sample volumes and sample rates were determined. Each test run was approximately five (5) days in length.

Sample gas passed through the sorbent traps, a heated sample line and then through a gas condenser system. The volume of dry gas exiting the gas condenser system was measured with a dry gas meter. A diagram of the Method 30B sampling system is shown in Figure 2 of the Appendix.

Prior to the test run, each sample train was leak checked by capping the sorbent trap and pulling a vacuum of 15" Hg. The leak rate for an individual train did not exceed four percent of the target sampling rate. After the leak check, the trap was uncapped, placed in the stack, and sampling was initiated at the predetermined flow rate. The sample flow rate, gas meter reading, the stack temperature, dry gas meter temperatures, the temperatures of heated equipment and the sampling system vacuum readings were recorded periodically during the sampling period.

After the test run, each train was leak checked at the maximum vacuum reached during the sampling period. The leak rate did not exceed four percent of the average sampling rate for the data collection period. Each trap was then removed from the probe by an individual wearing gloves, and sealed at both ends. Any deposited material on the outside of the trap was removed. The sorbent trap was placed in an appropriate sample storage container and stored and transported to the laboratory according to procedures in ASTM WK223.

Handling of samples on-site was performed by Airtech personnel. Samplers used clean proper PPE for each sample to prevent cross contamination.

Analysis of the samples followed the procedures outlined in EPA Method 30B. Analysis of sorbent traps was performed by Airtech personnel at the Airtech laboratory located in Elk Grove Village, Illinois, using an Ohio Lumex Model RA-915$^+$ low level mercury analyzer combined with the M324 sorbent tube attachment. The analyzer was calibrated per EPA Method 30B. A known volume of mercury standard was pipetted onto clean sorbent. The sorbent was placed in a small ladle and sodium carbonate was added to prevent interference from iodine, which is contained in the sorbent. The ladle was then placed in the RP-M324 furnace, which was purged with air. The air, containing the desorbed mercury, passed through to the RA-915+ mercury analyzer. The analyzer uses the principle of Zeeman atomic absorption spectrometry for analysis.

The back half and front half of each trap was prepared and analyzed separately in order to calculate collection efficiency. The sorbent contained in each section of the trap was removed from the trap and placed in a small ladle. The sorbent was then analyzed as outlined previously.

A field recovery test was performed by collecting four (4) sets of paired samples with one (1) of each pair spiked with a known level of Hg. Ohio Lumex performed the spiking of sorbent traps. The stack gas was sampled with the two (2) trains simultaneously using the procedures outlined previously. The total sample volume was within 20 percent of the target sample volume for the field sample test runs. The sorbent traps from the two (2) trains were analyzed using the analytical procedures and instrumentation as outlined previously. The fraction of spiked Hg recovered (R) were determined for a total of three runs. The average of the three R values was between 85 and 115 percent.

Description of Installation

The table below lists the major components of the installed CEMS and their associated serial numbers:

Unit #3 Exhaust

Component	Manufacturer	Model No.	Serial Number
CO_2 Analyzer – Diluent Monitor	Thermo	410i	0814930305
NO_X Analyzer	Thermo	42i-D	0609416181
SO2 Analyzer	Thermo	43i	0609416182
Flow	Sick Mahaik	FlOWSIC100	8508724

Unit #3 Inlet

Component	Manufacturer	Model No.	Serial Number
CO_2 Analyzer	Thermo	410i	814930306
SO2 Analyzer	Thermo	43i	1006241005

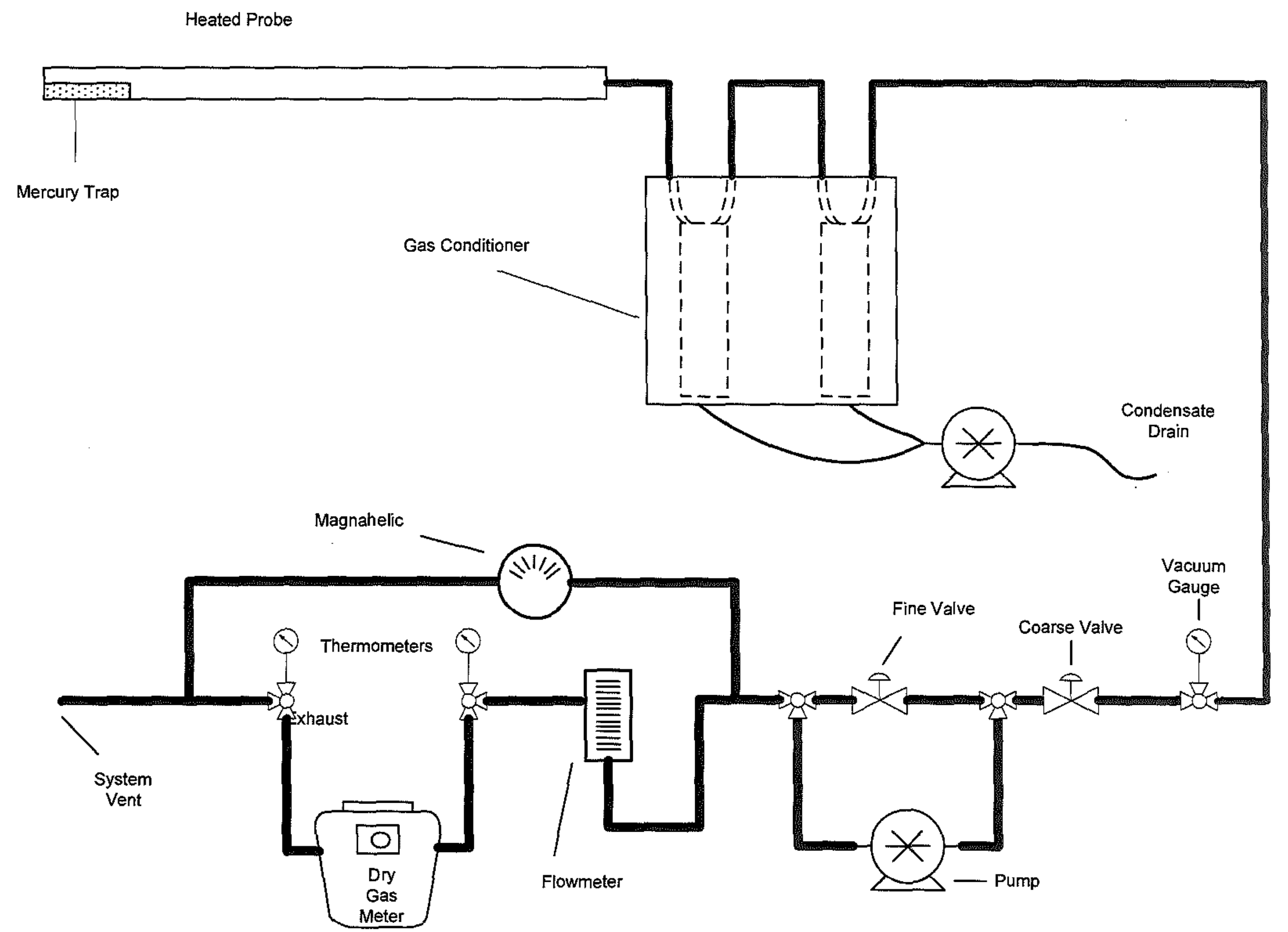
The following table summarizes the constituents monitored by the CEMS, the detection principle for each constituent, the units reported for each constituent and the analyzer operating ranges:

Unit #3 Exhaust

Constituent	Detection Principle	Units	Range
Carbon Dioxide	non-dispersive infrared	(%)	0-20
Nitrogen Oxides	chemiluminescence	(ppm)	0-300
Sulfur Dioxide	pulsed fluorescence	(ppm)	0-130, 0-700

Unit #3 Inlet

Constituent	Detection Principle	Units	Range
Carbon Dioxide	non-dispersive infrared	(%)	0-20
Sulfur Dioxide	pulsed fluorescence	(ppm)	0-700



EPA Method 30B:
Total Vapor Phase Mercury Sampling Train

Figure 1

AIRTECH
Environmental Services Inc.