TEST REPORT
MERCURY AND AIR TOXICS STANDARDS (MATS)
GRAND HAVEN BOARD OF LIGHT AND POWER
BOILER 3
GRAND HAVEN, MICHIGAN

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AIR QUALITY DIVISION

Prepared For:

Grand Haven Board of Light and Power
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Prepared By:

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STAC STACK TESTING ACCREDITATION COUNCIL
ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

MONTROSE AIR QUALITY SERVICES

REPORT CERTIFICATION

STATEMENT OF CONFORMANCE AND TEST REPORT CERTIFICATION

I certify, to the best of my knowledge, that this test program was conducted in a manner conforming to the criteria set forth in ASTM D7036-04: Standard Practice for Competence of Air Emission Testing Bodies, and that project management and supervision of all project related activities were performed by qualified individuals as defined by this practice.

I further certify that this test report and all attachments were prepared under my direction or supervision in accordance with the Montrose Air Quality Services, LLC quality management system designed to ensure that qualified personnel gathered and evaluated the test information submitted. Based on my inquiry of the person or persons who performed the sampling and analysis relating to this performance test, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate and complete.

Performance data is available upon request.

Cathy Busse
Technical Writer
Montrose Air Quality Services, LLC

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Quality Assurance Manager
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1.0 PROJECT OVERVIEW

1.1 GENERAL

Montrose Air Quality Services, LLC (Montrose) formerly known as Airtech Environmental Services Inc. (Airtech) located at 1371 Brummel Avenue, Elk Grove Village, Illinois was contracted by the Grand Haven Board of Light and Power (GHBLP) to determine compliance with the "Mercury and Air Toxics Standards" (MATS) at their facility located in Grand Haven, 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

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 GHBLP; 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 June 11 through July 30, 2018. Coordinating the field portion of the test program were:

Paul Cederquist – Grand Haven Board of Light & Power

Brandon Check, QSTI – Airtech Environmental Services Inc.

1.2 METHODOLOGY

1.2.1 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 Montrose 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 Montrose personnel at the Montrose 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).

1.2.2 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)(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.

1.3 PARAMETERS

The following gas parameter was determined at the test location:

- total vapor phase mercury concentration

1.4 DISCUSSION OF RESULTS

A complete summary of the test results is presented in Table 1[1].

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

TABLE 1-1
TEST RESULTS AND REGULATORY LIMITS

	Average Emission Rate (lb/TBtu)	Average Emission Rate (lb/GWh)
Results	0.762	0.00260
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:

TABLE 1-2
STANDARD DEVIATION TRAINS A AND B

Difference Results	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Criteria
Train A (µg/dscm)	0.590	0.517	0.847	0.819	0.376	0.440	NA
Train B (µg/dscm)	0.689	0.448	0.970	0.984	0.350	0.419	NA
Diff. (µg/dscm)	0.0992	0.0691	0.123	0.165	0.0263	0.0204	<0.2

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

TABLE 1-3
MERCURY BREAKTHROUGH

Breakthrough Results	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Criteria
Train A (%)	0.255	0.393	0.277	0.0633	0.154	0.0505	<10
Train B (%)	0.264	1.27	0.194	0.0233	0.122	0.0904	<10

[1]MEASUREMENT UNCERTAINTY STATEMENT
Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, Montrose personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of the Montrose Quality Manual and ASTM D7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

A summary of the spike recoveries for each test run is shown below. The average mercury spike recovery was 101 percent.

TABLE 1-4
SPIKE RECOVERY

Spike Results	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Criteria
Recovery – R (%)	111	85.8	106	114	94.8	95.9	85<R<115

The meter used from June 18 through June 22, 2018 and July 12 through July 16, 2018 to pull mercury samples through the tubes malfunctioned. The data collected during this time frame was not used as part of the results.

The carbon dioxide values used to calculate lb/MMBtu emission rates was taken from plant operating data. The moisture value was assumed to be 8%.

2.0 SUMMARY OF RESULTS

TABLE 2-1
SUMMARY OF THE BOILER 3 MERCURY RESULTS

Test Parameters	Run 1	Run 2	Run 3	Run 4
Start Date	6/11/18	6/25/18	7/2/18	7/5/18
Start Time	15:35	9:29	11:01	5:35
Stop Date	6/18/2018	7/2/2018	7/5/2018	7/12/2018
Stop Time	12:44	9:27	3:59	9:18
Process Conditions				
Load (MW)	56.9	56.7	37.1	50.3
Unit Conditions				
Carbon Dioxide (%)	9.81	9.84	7.06	9.22
CO_2 Based fuel Factor (F_c, scf/MMBtu)	1,840	1,840	1,840	1,840
Moisture (%)	8.0	8.0	8.0	8.0
Total Mercury Results				
Concentration Train A (µg/dscm)	0.590	0.517	0.847	0.819
Concentration Train B (µg/dscm)	0.689	0.448	0.970	0.984
Average Concentration (µg/dscm)	0.639	0.482	0.909	0.901
Concentration Train A (µg/scm)	0.543	0.475	0.780	0.753
Concentration Train B (µg/scm)	0.634	0.412	0.893	0.905
Average Concentration (µg/scm)	0.588	0.444	0.836	0.829
Emission Rate Train A (lb/MMBtu, F_c)	0.000000636	0.000000555	0.00000127	0.000000939
Emission Rate Train B (lb/MMBtu, F_c)	0.000000742	0.000000481	0.00000145	0.00000113
Average Emission Rate (lb/MMBtu, F_c)	0.000000689	0.000000518	0.00000136	0.00000103
Emission Rate Train A (lb/Tbtu, F_c)	0.636	0.555	1.27	0.939
Emission Rate Train A (lb/Tbtu, F_c)	0.742	0.481	1.45	1.13
Average Emission Rate (lb/Tbtu, F_c)	0.689	0.518	1.36	1.03
Emission Rate Train A (lb/GW-hr)	0.00216	0.00189	0.00432	0.00320
Emission Rate Train B (lb/GW-hr)	0.00253	0.00164	0.00494	0.00384
Average Emission Rate (lb/GW-hr)	0.00235	0.00176	0.00463	0.00352

TABLE 2-1
SUMMARY OF THE BOILER 3 MERCURY RESULTS (CONTINUED)

Test Parameters	Run 5	Run 6	Average
Start Date	7/16/18	7/23/18	
Start Time	12:03	11:12	
Stop Date	7/23/2018	7/30/2018	
Stop Time	10:12	10:07	
Process Conditions			
Load (MW)	41.5	41.5	**47.3**
Unit Conditions			
Carbon Dioxide (%)	8.55	8.64	**8.9**
CO_2 Based fuel Factor (F_c, scf/MMBtu)	1,840	1,840	**1,840**
Moisture (%)	8.0	8.0	**8.0**
Total Mercury Results			
Concentration Train A (µg/dscm)	0.376	0.440	**0.598**
Concentration Train B (µg/dscm)	0.350	0.419	**0.643**
Average Concentration (µg/dscm)	0.363	0.429	**0.621**
Concentration Train A (µg/scm)	0.346	0.405	**0.550**
Concentration Train B (µg/scm)	0.322	0.386	**0.592**
Average Concentration (µg/scm)	0.334	0.395	**0.571**
Emission Rate Train A (lb/MMBtu, F_c)	0.000000465	0.000000538	**0.000000734**
Emission Rate Train B (lb/MMBtu, F_c)	0.000000433	0.000000513	**0.000000791**
Average Emission Rate (lb/MMBtu, F_c)	0.000000449	0.000000525	**0.000000762**
Emission Rate Train A (lb/Tbtu, F_c)	0.465	0.538	**0.734**
Emission Rate Train A (lb/Tbtu, F_c)	0.433	0.513	**0.791**
Average Emission Rate (lb/Tbtu, F_c)	0.449	0.525	**0.762**
Emission Rate Train A (lb/GW-hr)	0.00158	0.00183	**0.00250**
Emission Rate Train B (lb/GW-hr)	0.00147	0.00175	**0.00269**
Average Emission Rate (lb/GW-hr)	0.00153	0.00179	**0.00260**

3.0 TEST PROCEDURES

3.1 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

3.2 METHOD DESCRIPTION

3.2.1 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).

3.2.2 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 seven to eight (7-8) 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 Montrose 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 Montrose personnel at the Montrose 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.

4.0 DESCRIPTION OF INSTALLATION

The J.B. Sims Generating Station is a coal fired steam-generating plant with a net capacity of approximately 70-80 MW. Only the Sims III unit at this location remains operational. Sims III is equipped with low NOX burner technology, electrostatic precipitator and a wet lime flue gas desulfurization unit.