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Report on the Shiras Coal Unit #3
3rd Quarter Particulate Matter Test Program

Conducted for Marquette Board of Light & Power
at the Shiras Facility Located at
400 East Hampton Street
Marquette, Michigan

Report No. 5940 Unit 3 3rdQ PM
November 4, 2016

DEQ
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name Marquette Board of Light and Power County Marquette

Source Address 400 East Hampton City Marquette

AQD Source ID (SRN) B1833 RO Permit No. MI-ROP-B1833-2013 RO Permit Section No. NA

Please check the appropriate box(es):

☐ **Annual Compliance Certification (General Condition No. 28 and No. 29 of the RO Permit)**

Reporting period (provide inclusive dates): From ______ To ______

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (General Condition No. 23 of the RO Permit)**

Reporting period (provide inclusive dates): From ______ To ______

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From 7-1-2016 To 9-30-2016

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

2016 Quarter 3 Particulate Emission Testing

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete, and that any observed, documented or known instances of noncompliance have been reported as deviations, including situations where a different or no monitoring method is specified by the RO Permit.

Tom Skewis	Environmental Technician	906.225.8670
Name of Responsible Official (print or type)	Title	Phone Number

	11-9-16
Signature of Responsible Official	Date

* Photocopy this form as needed.

EQP 5736 (8/99)

Project Overview

General

Airtech Environmental Services Inc. (Airtech) was contracted by Marquette Board of Light & Power (MBLP) to perform an air emissions test program at the Shiras Steam Plant Facility located in Marquette, Michigan. The objective of the test program was to determine compliance with both the "Mercury and Air Toxics Standards" (MATS) and also by Renewable Operating Permit MI-ROP-B1833-2013 of the coal-fired unit, designated Shiras Coal Unit #3. The specific objective of the test program was as follows:

- Perform MATS quarterly testing to determine the concentration of filterable particulate matter (PM) at the exhaust of one (1), coal-fired boiler, designated as Unit 3
- Perform emission testing to verify the particulate matter (PM) emission rate from Boiler #3 required under Renewable Operating Permit MI-ROP-B1833-2013

Testing was conducted to meet the requirements of MBLP; the Michigan Department of Environmental Quality (MDEQ); the United States Environmental Protection Agency (U.S. EPA); and 40 CFR Parts 60 and 75, as applicable.

Testing was performed on September 13, 2016. Coordinating the field aspects of the test program were:

Tom Skewis – Marquette Board of Light & Power
Riley Kloss - Airtech Environmental Services Inc.

Methodology

MATS Method 5 was used to determine the PM concentrations at the test location. A sample of the gas stream was withdrawn isokinetically from the stack and the particulate matter in the sample gas stream was collected in a glass probe and on a quartz fiber filter. The weight of particulate collected with the sample train combined with the volume of dry gas withdrawn from the stack was then used to calculate the particulate concentration. To limit the acid gas bias in the sampling train, the probe and filter were operated at 320°F, +/- 25°F in lieu of the 248°F, +/- 25°F required by Method 5.

To convert the PM concentrations to mass emission rates and to provide the necessary data to maintain isokinetics, the volumetric flow rate through the exhaust stack was determined in conjunction with each MATS Method 5 test run using EPA Methods 1, 2, 3A and 4. Particulate results are expressed in units of grains per dry standard cubic foot (gr/dscf), in units of pounds per hour (lb/hr), in units of lb/MMBtu, and in units of pounds of particulate matter per thousand pounds of exhaust gas (lbs PM/1,000lbs of exhaust gas).

Parameters

The following parameters were determined at the test location:

- gas velocity
- gas temperature
- moisture content
- oxygen concentration
- carbon dioxide concentration
- particulate matter concentration

Special Considerations

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

- Under §63.10005(h)(2)(i), the minimum sample volume specified in Table 2 was increased nominally by a factor of two (i.e. 2x1.00 dscm; 2x0.75)
- Under §63.10007(A) (2), the unit was operated at maximum normal operating load conditions during each periodic (e.g., quarterly) performance test. Maximum normal operating load is generally between 90 and 110 percent of design capacity but should be representative of site specific normal operations during each test run.
- Under Table 5 (1) (f) and 5 (3) (f), emissions concentrations for PM were converted to lb/MMBtu emissions rates, using the calculations found in EPA Method 19. An appropriate F- factor was used from Table 1 in section 3.3.5 of Appendix F to part 75. The F-factor was 9,820 for subbituminous coal.

Results

As stated in CFR 63.7(e)(3), each performance test shall consist of three (3) separate runs using the applicable test method. Each run shall be conducted for the time and under the conditions specified in the relevant standard. For the purpose of determining compliance with a relevant standard, the arithmetic mean of the results of the three (3) runs shall apply.

Run 1 appears to be an outlier, yielding a much higher filterable PM result than the average. All necessary quality assurance and control (QA/QC) was followed in the sample collection and analysis. Furthermore, an MDEQ inspector was at the sample location for the duration of all test runs and cited no issues with the operation of the sampling apparatus or the sample recovery. A possible explanation for the higher result is the potential for port scrapings during the traverse and port change. Though Run 1 is an outlier, it was still used to calculate the arithmetic mean emission rate of 0.00880 lb/MMBtu.

A complete summary of test results is presented in Table 1 on Page 4.

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Summary of Results

Table 1 – Summary of Filterable Particulate Matter Results

Test Parameters	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	9/13/2016	9/13/2016	9/13/2016	
Start Time	10:06	12:52	15:37	
Stop Time	12:05	14:46	17:30	
Plant Data				
Steam Flow (lb/hr)	361,210	363,590	363,311	
Gas Conditions				
Temperature (°F)	227	227	231	**228**
Volumetric Flow Rate (acfm)	180,000	187,200	183,700	**183,600**
Volumetric Flow Rate (scfm)	134,500	140,000	136,600	**137,100**
Volumetric Flow Rate (dscfm)	112,900	116,700	113,600	**114,400**
Carbon Dioxide (% dry)	12.5	12.5	12.6	**12.5**
Oxygen (% dry)	7.5	7.5	7.5	**7.5**
Moisture (%)	16.1	16.7	16.9	**16.6**
Particulate Results				
Concentration (grains/dscf)	0.00791	0.00182	0.00234	**0.00402**
Emission Rate (lb/mmBtu)	0.0173	0.00399	0.00512	**0.00880**
Emission Rate (lb/hr)	7.65	1.82	2.28	**3.92**
Emission Rate (lb PM/1,000 lb exhaust gas)	2.12E-08	5.01E-09	6.28E-09	**1.08E-08**

Test Procedures

Method Listing

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

Method 1	Sample and velocity traverse for stationary sources
Method 2	Determination of stack gas velocity and volumetric flow rate (type S pitot tube)
Method 3A	Determination of oxygen and carbon dioxide concentrations in emissions from stationary sources (Instrumental analyzer procedure)
Method 4	Determination of moisture content in stack gases
Method 5	Determination of Particulate Emissions from Stationary Sources
Method 19	Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides Emission Rates

Method Descriptions

Method 1

Method 1 was used to determine the suitability of each test location and to determine the sample points used for the gas velocity and particulate concentration determinations. The test location conformed to the minimum requirements of being located at least 2.0 diameters downstream and at least 0.5 diameters upstream from the nearest flow disturbance.

The Unit 3 test location is a round, vertical duct with a diameter of 159 inches. Six points in each of four test ports were traversed for each test run. The test location was located approximately 8.0 duct diameters downstream and approximately 2.0 diameters upstream from the nearest flow disturbance. A cross-section of the test location, indicating the traverse points is shown in Figure 1 of the Appendix.

Method 2

Method 2 was used to determine the gas velocity through each test location using a Type-S pitot tube and an incline plane oil manometer. The values measured in Method 2, along with the measurements made in Methods 3A and 4, were used to calculate the volumetric flow rate through the test location. A diagram of the Method 2 apparatus is shown as part of the Method 5 sampling train in Figure 2 of the Appendix.

The manometer was leveled and "zeroed" prior to each test run. The sample train was leak checked before and after each run by pressurizing the positive side, or "high" side, of the pitot tube, creating a deflection on the manometer of at least three inches H_2O. The leak check was considered valid if the manometer remained stable for 15 seconds. This procedure was repeated on the negative side by generating a vacuum of at least three inches H_2O. The velocity head pressure and gas temperature were then determined at each point specified in Method 1. The static pressure of the stack was measured using a water filled U-tube manometer. In addition, the barometric pressure was measured and recorded.

Method 3A

The carbon dioxide and oxygen contents were determined at the test location using EPA Method 3A. A gas sample was collected into a Tedlar bag from the back of each sample train for the duration of each test run. Analysis was performed using a Servomex 1440 infrared carbon dioxide analyzer/paramagnetic oxygen analyzer. The analyzers were calibrated immediately prior to analysis of the bag samples using the procedures outlined in Method 3A using EPA Protocol calibration gases.

The carbon dioxide content and oxygen content were used to calculate the dry molecular weight of the gas stream. The molecular weight was then used, along with the moisture content determined by EPA Method 4, for the calculation of the volumetric flow rate. For these calculations, the balance of the gas stream was assumed to be nitrogen since the other gas stream components are insignificant for the purposes of calculating molecular weight.

Method 4

The moisture content at the test location was determined using Method 4. A known volume of sample gas was withdrawn from the source and the moisture was condensed and measured. The dry standard volume of the sample gas was then compared to the volume of moisture collected to determine the moisture content of the sample gas. A diagram of the Method 4 apparatus is shown in as part of the Method 5 sampling train in Figure 2 of the Appendix.

To condense the water vapor, the gas sample passed through a series of four impingers. The first two impingers each contained 100 ml of water. The third impinger was initally empty and the fourth contained a known weight of silica gel to absorb any remaining water vapor. The sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 inches Hg.

The volume of dry gas exiting the gas condenser system was measured with a dry gas meter. After leaving the dry gas meter, the sample stream passed through an orifice used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane, oil manometer. The gas meter reading, gas meter inlet and outlet temperatures, gas meter static pressure and pump vacuum were recorded for each sample point.

After the test run, the sample train was leak checked at a vacuum greater than the highest vacuum encountered during the test run. The tests were considered valid since the leak rate was less than 0.02 cfm. The amount of water collected in the condenser system was measured gravimetrically. The net weight gain of water was converted to a volume of wet gas and then compared to the amount of dry gas sampled to determine the moisture content.

Method 5

Method 5 was used to determine the PM concentration at the test location. A sample of the gas stream was withdrawn isokinetically from the stack and the particulate matter in the sample gas stream was collected in a glass probe and on a glass fiber filter. The weight of FPM collected combined with the volume of dry gas withdrawn from the stack was used to calculate the FPM concentration. A diagram showing the major components of the Method 5 sampling train is shown in Figure 2 of the Appendix.

Prior to testing, the components were washed using detergent and then rinsed with tap water, de-ionized water, and acetone. After drying, all components were sealed with parafilm or Teflon tape.

The sample probe consisted of a glass liner and glass nozzle. Sample gas passed through the nozzle and probe assembly and then through a glass fiber filter heated to 320°F (+/- 25°F). After exiting the filter, the sample gas passed through the four-impinger condenser system described in Method 4. The dry gas exiting the moisture condenser system then passed through a sample pump and a dry gas meter to measure the gas volume. After leaving the dry gas meter, the sample stream passed through an orifice used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane, oil manometer.

Whatman 934-AH glass fiber filters were used as the substrate for the particulate sampling. The filter was loaded into a glass filter holder with a Teflon support screen that was prepared in the same manner as the other components of the sample train. Prior to the test run, the filter was desiccated for at least 24 hours and then weighed to the nearest 0.0001g until a constant weight was achieved. The weight of the filter was considered constant only when two consecutive weights taken at least six hours apart were within 0.0005g of each other.

The probe was thoroughly pre-cleaned with acetone and the probe wash saved as a quality assurance check. The condenser system was then prepared as outlined in Method 4. The sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 inches Hg. A leak check was considered valid if the leak rate was less than 0.02 cfm or four percent of the average sample rate. When not in operation inside the stack, the nozzle was sealed with Teflon tape.

The probe tip was then placed at each of the sample points determined in Method 1. The velocity at the sample point was determined using Method 2. Sample gas was withdrawn from the source at a rate such that the velocity at the opening of the nozzle matched the velocity of the stack gas at the sample point (isokinetically). The gas velocity pressure (ΔP), gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure (ΔH) and pump vacuum were recorded for each sample point.

After the test run, the train was leak checked at a vacuum greater than the highest vacuum encountered during the test run. The condensate weight gain of the impinger contents was determined as outlined in Method 4 and discarded. The probe liner and nozzle were washed with acetone and the rinse saved in a 250 ml glass jar equipped with a Teflon lined lid. Teflon tape was used to seal the filter assembly. The filter was removed from the filter holder and sealed in a plastic petri dish once testing was completed.

Analysis of the samples for PM was performed on-site. Each probe rinse was transferred to a tared beaker, evaporated to dryness, desiccated for 24 hours and weighed to a constant weight. Each filter was desiccated for 24 hours and weighed to a constant weight. The weight-gain of the probe rinse and filter from a test run yield the total weight of particulate collected. To eliminate interference in establishing a constant weight, both the analytical balance and the desiccators were equipped with an ion generating polonium strip designed to eliminate static electricity that may collect on the samples.

Method 19

EPA Method 19 was used to calculate pollutant emission rates in terms of pounds per million Btu (lb/mmBtu). The calculation was based on the oxygen content of the sample gas and an appropriate F factor, which is the ratio of combustion gas volumes to heat inputs. In order to calculate the pounds per million Btu (lb/mmBtu) emission rates, an Fd factor of 9,820 was used as per EPA Method 19.