PARTICULATE MATTER EMISSION TESTS

Performed At The
Lansing Board of Water & Light
REO Town Generating Station
Combustion Turbine 1 (EUTURBINE1)
Combustion Turbine 2 (EUTURBINE2)
Heat Recovery Steam Generator 1 (FGTURB/HRSG1)
Heat Recovery Steam Generator 2 (FGTURB/HRSG2)
Lansing, Michigan

Test Dates
January 20 through 23, 2015

Report No.
TRC Environmental Corporation Report 209762A

Report Submittal Date
February 27, 2015

TRC Environmental Corporation
7521 Brush Hill Road
Burr Ridge, Illinois 60527
USA

T (312) 533-2042
F (312) 533-2070

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 Permit (ROP) 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 specified in Rule 213(3)(b)(ii), and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name: Lansing Board of Water & Light — County: Ingham

Source Address: 1201 South Washington Avenue — City: Lansing

AQD Source ID (SRN): B2647 — ROP No.: MI-ROP-B2647-2012 — ROP Section No.: NA

Please check the appropriate box(es):

☐ **Annual Compliance Certification (Pursuant to Rule 213(4)(c))**

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 ROP, 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 ROP.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, 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 ROP, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))**

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

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the ROP 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 ROP 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 NA To NA

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

Test report that evaluates compliance with specified source permit conditions. This form shall certify that the testing was conducted in accordance with the approved test protocol and that the facility operated in compliance with permit conditions or at the maximum operating conditions for the facility.

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

Mark Matus	Manager, Env Services	(517) 702-6153
Name of Responsible Official (print or type)	Title	Phone Number
Mark Matus		3/2/2015
Signature of Responsible Official		Date

* Photocopy this form as needed.

EQP 5736 (Rev 11-04)

TRC
Results you can rely on

PARTICULATE MATTER EMISSION TESTS

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed a particulate matter emission test program on the natural gas-fired Combustion Turbine 1 (EUTURBINE1) and Combustion Turbine 2 (EUTURBINE2) operated at the REO Town Generating Station of Lansing Board of Water & Light (LBWL) in Lansing, Michigan on January 20 through 23, 2015. The tests were authorized by and performed for LBWL.

The purpose of this test program was to determine total particulate matter (PM) emission rates at each combustion turbine stack location during two (2) test scenarios: with the duct burner in operation, and without the duct burner in operation. A natural-gas fired duct burner is associated with a heat recovery steam generator (HRSG) at each of the turbine locations, designated as FGTURB/HRSG1 and FGTURB/HRSG2.

1.1 Project Contact Information

Participants		
Test Facility	Lansing Board of Water & Light REO Town Cogeneration Plant 1203 S. Washington Avenue Lansing, Michigan 48901	Ms. Shannon Whiton Sr. Environmental Engineer 517-702-6003 (phone) smw@lbwl.com
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Mr. Gavin Lewis Field Engineer 219-613-0163 (phone) glewis@trcsolutions.com

The project was coordinated through Ms. Shannon Whiton of LBWL with collaboration by Paul Coleman of TRC. The tests were conducted by Ben Cacao, David Wells and Gavin Lewis of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual (QI) can be located in the appendix to this report.

2.0 SUMMARY OF RESULTS

The average total PM test results (including PM10 and PM2.5) are summarized in the table below. The detailed results of each test run are presented in Section 6.0.

Unit ID	Pollutant Tested		Measured Emissions	Emission Limit
EUTURBINE1	Filterable PM	lb/hr	0.08	2.0
	Condensable PM	lb/hr	0.31	---
	Total PM	lb/hr	0.39	5.0
FGTURB/HRSG1	Filterable PM	lb/hr	0.46	2.1
	Condensable PM	lb/hr	0.59	---
	Total PM	lb/hr	1.06	5.5
EUTURBINE2	Filterable PM	lb/hr	0.33	2.0
	Condensable PM	lb/hr	0.17	---
	Total PM	lb/hr	0.51	5.0
FGTURB/HRSG2	Filterable PM	lb/hr	0.16	2.1
	Condensable PM	lb/hr	0.11	---
	Total PM	lb/hr	0.28	5.5

The table below provides a reference to the test methods that were used, as well as the number and duration of each test run performed at each sampling location:

Unit ID/ Sample Location	Parameter Measured	Test Method	No. of Runs	Run Duration
EUTURBINE1, FGTURB/HRSG1, EUTURBINE2, FGTURB/HRSG2	Total Particulate Matter	USEPA Method 5/202	3	120 min

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. Source operation appeared normal during the entire test program. A total of three particulate matter (PM) test runs were performed at each combustion turbine stack location during two test scenarios (with and without

duct burner in operation). Each test run was 120 minutes in duration. The total PM emission rates (including PM10 and PM2.5) are reported in pounds per hour (lb/hr).

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of Sample Point Locations by USEPA Method 1

This method is applicable to gas streams flowing in ducts, stacks, and flues and is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rates from stationary sources. In order to qualify as an acceptable sample location, it must be located at a position at least two stack or duct equivalent diameters downstream and a half equivalent diameter upstream from any flow disturbance.

The cross-section of the measurement site (stack) was divided into a number of equal areas, and the traverse points were then located in the center of these areas. The minimum number of points were determined from Figure 1-1 (particulate) of USEPA Method 1.

4.2 Volumetric Flow Rate Determination by USEPA Method 2

This method is applicable for the determination of the average velocity and the volumetric flow rate of a gas stream.

The gas velocity head (ΔP) and temperature were measured at traverse points defined by USEPA Method 1. The velocity head was measured with a Type S (Stausscheibe or reverse type) pitot tube and oil-filled manometer; and the gas temperature was measured with a Type K thermocouple. The average gas velocity in the flue was calculated based on: the gas density (as determined by USEPA Methods 3 and 4); the flue gas pressure; the average of the square roots of the velocity heads at each traverse point, and the average flue gas temperature.

4.3 CO_2 and O_2 Determination by USEPA Method 3

This method is applicable for the determination of CO_2 and O_2 concentrations and dry molecular weight of a sample from an effluent gas stream of a fossil-fuel combustion process or other process.

A gas sample was extracted from a stack by following method: single-point, integrated sampling. The gas sample was analyzed for percent CO_2 and percent O_2 using a Fyrite analyzer.

4.4 Filterable PM Determination by USEPA Method 5

This method is applicable for the determination of PM emissions from stationary sources. USEPA Methods 2-4 were performed concurrently with USEPA Method 5.

Flue gas was withdrawn isokinetically from the source at traverse points determined per USEPA Method 1, and PM was collected in the nozzle, probe liner, and on a glass fiber filter. The probe liner and filter were maintained at a temperature of 120 ± 14°C (248 ± 25°F). The PM mass, which included any material that condensed at or above the filtration temperature, was determined gravimetrically after the removal of uncombined water.

4.5 Condensable PM Determination by USEPA Method 202 (As Revised December, 2010)

This method is applicable for the determination of condensable particulate matter (CPM) from stationary sources. CPM is measured in the emissions after removal from the stack and after passing through a filter.

The CPM was collected in dry impingers after filterable particulate material had been collected on filters maintained above 30°C (85°F) using Method 5 or 17 (Appendix A, 40CFR60) or 201A (Appendix M, 40CFR51) type sampling train. The sample train included a Method 23 type condenser capable of cooling the stack gas to less than 85°F, followed by a water dropout impinger. One modified Greenburg Smith impinger and a CPM filter followed the water dropout impinger. The impinger contents were immediately purged after the run with nitrogen (N2) to remove dissolved sulfur dioxide. The impinger solution was then extracted with hexane, and the CPM filter was extracted with water and hexane. The organic and aqueous fractions were then taken to dryness and the residues weighed. The total of all fractions represented the CPM.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Louisiana Environmental Lab Accreditation Program (LELAP) accreditation;
- Interim accreditation from the Stack Testing Accreditation Council (STAC) that our operations conform with the requirements of ASTM D 7036-04

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

TRC
Results you can rely on

METHOD 5/202 PARTICULATE TEST RESULTS SUMMARY

Company: LBWL
Plant: REO Town Generating Station
Unit: EUTURBINE 1
Location: Stack

Test Run Number	1	2	3	Average
Source Condition	HRSG OFF	HRSG OFF	HRSG OFF	
Date	1/20/2015	1/20/2015	1/20/2015	
Start Time	9:20	14:10	17:09	
End Time	11:35	16:22	19:19	
Sample Duration (min):	120.0	120.0	120.0	120.0
Average Gas Temp (^{o}F):	830.7	839.1	841.3	837.0
Fractional Gas Moisture Content:	0.062	0.063	0.058	0.061
Gas CO_2 Content (%vol):	3.5	3.5	3.5	3.5
Gas O_2 Content (%vol):	16.0	16.0	16.0	16.0
Gas Wet MW (lb/lbmole-mole):	28.50	28.49	28.56	28.52
Average Gas Vel (ft/sec):	131.19	130.80	129.80	130.60
Measured Volumetric Flow Rate				
Q (actual ft^3/min):	576,885	575,179	570,796	574,287
Q_{std} (std ft^3/min):	227,768	226,013	223,910	225,897
$Q_{std(dry)}$ (dry std ft^3/min):	213,619	211,666	211,016	212,100
Sample Volume (dry std ft^3):	96.463	96.271	96.602	96.445
PM Collected (mg):				
Filterable	0.600	0.000	0.200	0.267
Condensable:	1.400	0.800	1.000	1.067
Total:	2.000	0.800	1.200	1.333
PM Concentration (gr/dscf):				
Filterable	0.0001	0.0000	0.0000	0.0000
Condensable:	0.0002	0.0001	0.0002	0.0002
Total:	0.0003	0.0001	0.0002	0.0002
PM Emission Rate (lb/hr based on measured volumetric flow rate):				
Filterable:	0.18	0.00	0.06	0.08
Condensable:	0.41	0.23	0.29	0.31
Total:	0.59	0.23	0.35	0.39
Isokinetic Variance	98.2	98.9	99.5	98.9

TRC
Results you can rely on

METHOD 5/202 PARTICULATE TEST RESULTS SUMMARY

Company: LBWL
Plant: REO Town Generating Station
Unit: FGTURB/HRSG1
Location: Stack

Test Run Number	1	2	3	Average
Source Condition	HRSG On	HRSG On	HRSG On	
Date	1/21/2015	1/21/2015	1/21/2015	
Start Time	8:35	11:55	15:20	
End Time	10:46	14:10	17:37	
Sample Duration (min):	120.0	120.0	120.0	120.0
Average Gas Temp (°F):	362.9	361.4	361.7	362.0
Fractional Gas Moisture Content:	0.071	0.069	0.072	0.071
Gas CO_2 Content (%vol):	3.0	3.0	3.5	3.2
Gas O_2 Content (%vol):	13.0	13.0	13.0	13.0
Gas Wet MW (lb/lbmole-mole):	28.22	28.24	28.28	28.25
Average Gas Vel (ft/sec):	86.34	82.60	82.01	83.65
Measured Volumetric Flow Rate				
Q (actual ft^3/min):	379,686	363,244	360,635	367,855
Q_{std} (std ft^3/min):	235,932	226,138	224,424	228,831
$Q_{std(dry)}$ (dry std ft^3/min):	219,290	210,424	208,253	212,656
Sample Volume (dry std ft^3):	99.532	97.228	95.518	97.426
PM Collected (mg):				
Filterable	2.000	1.200	1.600	1.600
Condensable:	1.500	3.500	1.200	2.067
Total:	3.500	4.700	2.800	3.667
PM Concentration (gr/dscf):				
Filterable	0.0003	0.0002	0.0003	0.0003
Condensable:	0.0002	0.0006	0.0002	0.0003
Total:	0.0005	0.0007	0.0005	0.0006
PM Emission Rate (lb/hr based on measured volumetric flow rate):				
Filterable:	0.58	0.34	0.46	0.46
Condensable:	0.44	1.00	0.35	0.59
Total:	1.02	1.35	0.81	1.06
Isokinetic Variance	98.7	100.5	99.7	99.6

TRC
Results you can rely on

METHOD 5/202 PARTICULATE TEST RESULTS SUMMARY

Company: LBWL
Plant: REO Town Generating Station
Unit: EUTURBINE 2
Location: Stack

Test Run Number	1	2	3	Average
Source Condition	HRSG OFF	HRSG OFF	HRSG OFF	
Date	1/22/2015	1/22/2015	1/22/2015	
Start Time	9:55	13:18	16:10	
End Time	12:09	15:26	18:18	
Sample Duration (min):	120.0	120.0	120.0	120.0
Average Gas Temp (°F):	834.5	839.4	838.9	837.6
Fractional Gas Moisture Content:	0.062	0.063	0.062	0.062
Gas CO_2 Content (%vol):	3.0	3.0	3.0	3.0
Gas O_2 Content (%vol):	14.0	14.0	13.0	13.7
Gas Wet MW (lb/lbmole-mole):	28.36	28.35	28.32	28.34
Average Gas Vel (ft/sec):	128.98	128.28	128.87	128.71
Measured Volumetric Flow Rate				
Q (actual ft^3/min):	567,167	564,087	566,692	565,982
Q_{std} (std ft^3/min):	226,367	224,307	225,401	225,359
$Q_{std(dry)}$ (dry std ft^3/min):	212,366	210,245	211,457	211,356
Sample Volume (dry std ft^3):	96.190	96.086	96.380	96.219
PM Collected (mg):				
Filterable	3.100	0.300	0.000	1.133
Condensable:	0.900	0.000	0.900	0.600
Total:	4.000	0.300	0.900	1.733
PM Concentration (gr/dscf):				
Filterable	0.0005	0.0000	0.0000	0.0002
Condensable:	0.0001	0.0000	0.0001	0.0001
Total:	0.0006	0.0000	0.0001	0.0003
PM Emission Rate (lb/hr based on measured volumetric flow rate):				
Filterable:	0.91	0.09	0.00	0.33
Condensable:	0.26	0.00	0.26	0.17
Total:	1.17	0.09	0.26	0.51
Isokinetic Variance	98.5	99.4	99.1	99.0

TRC
Results you can rely on

METHOD 5/202 PARTICULATE TEST RESULTS SUMMARY

Company: LBWL
Plant: REO Town Generating Station
Unit: FGTURB/HRSG2
Location: Stack

Test Run Number	1	2	3	Average
Source Condition	HRSG ON	HRSG ON	HRSG ON	
Date	1/23/2015	1/23/2015	1/23/2015	
Start Time	9:15	12:28	15:20	
End Time	11:24	14:36	17:27	
Sample Duration (min):	120.0	120.0	120.0	120.0
Average Gas Temp ($^{\circ}$F):	362.7	361.0	361.0	361.6
Fractional Gas Moisture Content:	0.070	0.071	0.071	0.071
Gas CO_2 Content (%vol):	2.0	2.0	2.5	2.2
Gas O_2 Content (%vol):	13.0	13.0	13.0	13.0
Gas Wet MW (lb/lbmole-mole):	28.08	28.07	28.15	28.10
Average Gas Vel (ft/sec):	81.72	81.84	81.42	81.66
Measured Volumetric Flow Rate				
Q (actual ft^3/min):	359,342	359,862	358,022	359,075
Q_{std} (std ft^3/min):	224,889	225,694	224,528	225,037
$Q_{std(dry)}$ (dry std ft^3/min):	209,090	209,649	208,685	209,141
Sample Volume (dry std ft^3):	95.848	97.587	97.688	97.041
PM Collected (mg):				
Filterable	1.500	0.000	0.200	0.567
Condensable:	0.500	0.000	0.700	0.400
Total:	2.000	0.000	0.900	0.967
PM Concentration (gr/dscf):				
Filterable	0.0002	0.0000	0.0000	0.0001
Condensable:	0.0001	0.0000	0.0001	0.0001
Total:	0.0003	0.0000	0.0001	0.0002
PM Emission Rate (lb/hr based on measured volumetric flow rate):				
Filterable:	0.43	0.00	0.06	0.16
Condensable:	0.14	0.00	0.20	0.11
Total:	0.58	0.00	0.25	0.28
Isokinetic Variance	99.7	101.2	101.8	100.9