Air Emissions Testing of EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, FGTURB/HRSG2, and EUAUXBOILER

Lansing Board of Water & Light
REO Cogeneration Plant
1201 South Washington Avenue
Lansing, Michigan

State Registration No. B2647
Renewable Operating Permit MI-ROP-B2647-2012

Prepared for
Lansing Board of Water & Light
Lansing, Michigan

Bureau Veritas Project No. 11013-000258.00
May 2, 2014

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Executive Summary

Lansing Board of Water & Light (BWL) retained Bureau Veritas North America, Inc. to test air emissions at the BWL's REO Town Cogeneration Plant in Lansing, Michigan. Lansing BWL operates:

- Two natural-gas-fired turbines (EUTURBINE1 and EUTURBINE2)
- Two heat recovery steam generators (HRSGs) with duct burners (EUHRSG1 and EUHRSG2)
- A natural-gas-fired auxiliary boiler (EUAUXBOILER)

When operating under the turbine and HRSG condition, the emission units are permitted under the FGTURB/HRSG1 and FGTURB/HRSG2 flexible group requirements.

The purpose of the emission test program was to satisfy winter season test requirements and evaluate compliance with two permits:

- Michigan Department of Environmental Quality (MDEQ) Permit to Install 149-10B, dated April 12, 2013, for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources
- Renewable Operating Permit (ROP) MI-ROP-B2647-2012, dated May 17, 2012, for the EUAUXBOILER source

Bureau Veritas measured carbon monoxide (CO) and particulate matter (PM) concentrations and calculated emission rates using United States Environmental Protection Agency (USEPA) sampling methods 1, 2, 3, 3A, 4, 5, 10, and 202. The emission units operated within 50 to 100 percent peak load during testing.

The tables on the following page compare the results of the testing to permit limits. Detailed results are presented in Tables 1 through 18 behind the Tables Tab of this report.

EUTURBINE1 and EUTURBINE2 Results

Parameter	Testing Load Condition	Units	Equipment								Limit
			EUTURBINE1				EUTURBINE2				
			Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
CO	60%	ppmv	15.6	29.2	18.9	21.2	19.2	19.1	19.3	19.2	**100**
		lb/hr	11.7	19.8	12.9	14.8	14.6	14.3	13.6	14.2	**48.2**
	80%	ppmv	25.6	26.9	25.7	26.1	51.8	26.7	28.6	35.7	**50**
		lb/hr	19.8	22.6	20.2	20.8	44.2	18.1	20.0	27.4	**48.2**
	100%	ppmv	29.7	21.0	17.2	22.6	18.9	15.0	11.0	15.0	**50**
		lb/hr	26.9	19.4	15.9	20.7	17.2	16.3	6.9	14.4	**48.2**
PM	100%	lb/hr	2.8	2.8	0.86	2.2	53	232	4.8	97	**2.0**
PM_{10}	100%	lb/hr	5.7	10	5.5	7.2	149	398	10	186	**5.0**
$PM_{2.5}$	100%	lb/hr	5.7	10	5.5	7.2	149	398	10	186	**5.0**

PM_{10} emissions include filterable and condensable sample fractions.
$PM_{2.5}$ emissions include filterable and condensable sample fractions.
ppmv: parts per million by volume dry at 15% oxygen
lb/hr = pound per hour

FGTURB/HRSG1 and FGTURB/HRSG2 Results

Parameter	Testing Load Condition	Units	Equipment								Limit
			FGTURB/HRSG1				FGTURB/HRSG2				
			Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
CO	50%	ppmv	20.0	16.5	17.5	18.0	19.8	19.2	18.2	19.1	**100**
		lb/hr	20.2	16.4	17.8	18.1	19.9	19.4	17.9	19.1	**51.7**
	75%	ppmv	20.3	18.6	20.9	19.9	20.9	20.5	20.7	20.7	**50**
		lb/hr	22.0	21.5	22.9	23.7	22.7	21.2	22.0	22.0	**51.7**
	100%	ppmv	13.3	15.8	12.5	13.9	16.7	14.9	14.4	15.3	**50**
		lb/hr	15.8	16.3	13.0	15.0	18.7	15.9	15.5	16.7	**51.7**
PM	100%	lb/hr	3.7	1.6	1.9	2.4	4.9	1.5	1.3	2.6	**2.1**
PM_{10}	100%	lb/hr	11	5.1	3.3	6.5	35	3.3	3.8	14	**5.5**
$PM_{2.5}$	100%	lb/hr	11	5.1	3.3	6.5	35	3.3	3.8	14	**5.5**

PM_{10} emissions include filterable and condensable sample fractions.
$PM_{2.5}$ emissions include filterable and condensable sample fractions.
ppmv: parts per million by volume dry at 15% oxygen
lb/hr = pound per hour

EUAUXBOILER Results

Parameter	Testing Load Condition	Units	Equipment				Limit
			EUAUXBOILER				
			Run 1	Run 2	Run 3	Average	
CO	100%	lb/MMBtu heat input	0.018	0.015	0.017	0.016	**0.04**
PM	100%	lb/hr	0.31	0.28	0.22	0.27	**0.5**
PM_{10}	100%	lb/hr	1.6	0.74	0.77	1.0	**1.8**
$PM_{2.5}$	100%	lb/hr	1.6	0.74	0.77	1.0	**1.8**

PM_{10} emissions include filterable and condensable sample fractions.
$PM_{2.5}$ emissions include filterable and condensable sample fractions.
lb/MMBtu: pounds per million British thermal unit
lb/hr = pound per hour

The average EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, FGTURB/HRSG2, and EUAUXBOILER emission results indicate compliance with the permit limits with the exception of the particulate matter results for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources. The particulate matter results for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources are inconsistent and appear to be anomalous compared to previous testing and should be considered void due to the possible impact of several factors. Refer to Section 5.0 for discussion of the particulate matter results.

1.0 Introduction

Lansing Board of Water & Light (BWL) retained Bureau Veritas North America, Inc. to test air emissions at the BWL's REO Town Cogeneration Plant in Lansing, Michigan. Lansing BWL operates:

- Two natural-gas-fired turbines (EUTURBINE1 and EUTURBINE2)
- Two heat recovery steam generators (HRSGs) with duct burners (EUHRSG1 and EUHRSG2)
- A natural-gas-fired auxiliary boiler (EUAUXBOILER)

When operating under the turbine and HRSG condition, the emission units are permitted under the FGTURB/HRSG1 and FGTURB/HRSG2 flexible group requirements.

The purpose of the emission test program was to satisfy winter season test requirements and evaluate compliance with two permits:

- Michigan Department of Environmental Quality (MDEQ) Permit to Install 149-10B, dated April 12, 2013, for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources
- Renewable Operating Permit (ROP) MI-ROP-B2647-2012, dated May 17, 2012, for the EUAUXBOILER source

1.1 Summary of Test Program

Bureau Veritas measured emissions as summarized in Table 1-1.

Table 1-1
Sources, Testing Load Conditions, and Parameters

Equipment	Testing Load Condition	Testing Conducted at each Source Location
EUTURBINE1 and EUTURBINE2	60%	Three 60-minute CO test runs
	80%	Three 60-minute CO test runs
	100%	Three 120-minute CO and PM test runs
FGTURB/HRSG1 and FGTURB/HRSG2	50%	Three 60-minute CO test runs
	75%	Three 60-minute CO test runs
	100%	Three 120-minute CO and PM test runs
EUAUXBOILER	100%	Three 120-minute CO and PM test runs

1.2 Purpose of Testing

The purpose of the emission test program was to satisfy winter season test requirements and evaluate compliance with two permits:

- Michigan Department of Environmental Quality (MDEQ) Permit to Install 149-10B, dated April 12, 2013 for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources

- Renewable Operating Permit (ROP) MI-ROP-B2647-2012, dated May 17, 2012 for the EUAUXBOILER source

1.3 Contact Information

Mr. Thomas Schmelter, Senior Project Manager with Bureau Veritas, directed the compliance testing program. Ms. Angie Goodman, Environmental Compliance Specialist, with Lansing Board of Water & Light, provided process coordination and arranged for facility operating parameters to be recorded. Messrs. Brad Myott and Tom Gasloli with MDEQ witnessed the testing. Contact information for these individuals is listed in Table 1-2.

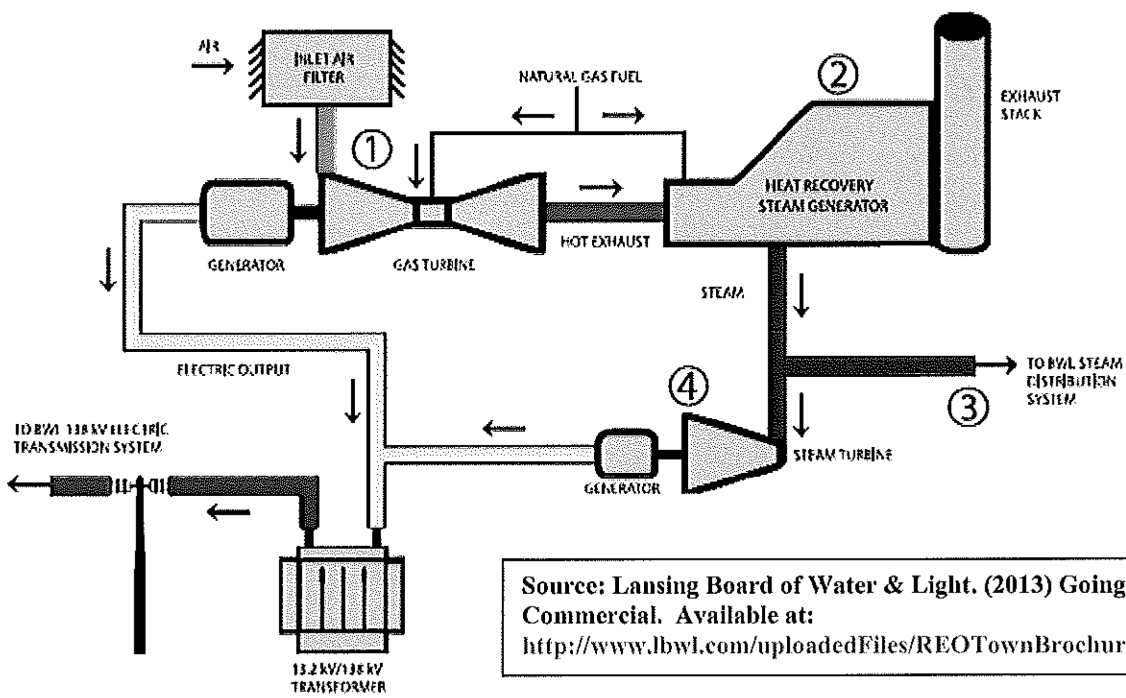
Table 1-2
Key Personnel

Permitee	Emission Testing Company
Lansing Board of Water & Light 1201 South Washington Avenue Lansing, Michigan 48910 Telephone 517.702.6000	Bureau Veritas North America, Inc. 22345 Roethel Drive Novi, Michigan 48375 Telephone 248.344.3003 Facsimile 248.344.2656
Angie Goodman Environmental Compliance Specialist Telephone 517.702.7059 ame1@LBWL.com	Thomas Schmelter, QSTI Senior Project Manager Telephone 248.344.3003 thomas.schmelter@us.bureauveritas.com
Michigan Department of Environmental Quality	
MDEQ – Air Quality Division Technical Programs Unit 525 West Allegan Street Lansing, Michigan 48909-7760 Telephone 517.335.3082 Facsimile 517.241.3571	MDEQ – Air Quality Division Technical Programs Unit 525 West Allegan Street Lansing, Michigan 48909-7760 Telephone 517.335.3082 Facsimile 517.241.3571
Brad Myott Environmental Quality Analyst Telephone 517.373.7084 myottb@michigan.gov	Tom Gasloli Environmental Quality Analyst Telephone 517.284.6778 gaslolit@michigan.gov

2.0 Source and Sampling Locations

2.1 Process Description

REO Town Cogeneration Plant is a combined-cycle cogeneration facility. A combined-cycle cogeneration facility uses natural gas to generate steam and electricity in a two-step process. First, a gas turbine burns natural gas to turn an electric generator. The hot exhaust gas is used to produce steam, which can be delivered to steam heating customers or used to turn a second electric generator. Figure 2-1 depicts the cogeneration process.



Source: Lansing Board of Water & Light. (2013) Going Commercial. Available at: http://www.lbwl.com/uploadedFiles/REOTownBrochure.pdf

1. Combustion Turbine-Generator - air & fuel are mixed to fire a turbine which turns a generator to produce electricity and hot exhaust.
2. Hot exhaust passes through a Heat Recovery Steam Generator (HRSG) to produce steam. The steam goes to one of two places:
3. The Steam can go to downtown steam customers or:
4. Steam can be used to turn a steam turbine-generator set to produce additional electricity.

Figure 2-1. Cogeneration Diagram

The facility operates two GE LM6000-PF natural-gas-fired turbines (EUTURBINE1 and EUTURBINE2), two heat recovery steam generators (HRSGs) with duct burners (EUHRSG1 and EUHRSG2) and a natural-gas-fired auxiliary boiler (EUAUXBOILER).

The turbines are equipped with HRSGs to produce steam from the turbine exhaust gas for use as process steam or to power a steam turbine generator to produce electric power. The HRSGs are equipped with duct burners to provide supplemental heat for steam production and power output. The auxiliary boiler serves as backup when a combustion turbine/HRSG is out of service and/or during periods of peak demand.

Operating parameters recorded during testing are included in Appendix E.

2.2 Control Equipment

The exhaust of the two natural-gas fired turbines is\\ discharged to the atmosphere without post combustion controls. Low-nitrogen-oxide (NO_x) burners are installed in EUAUXBOILER to reduce NO_x emissions. Low-NO_x burners reduce emissions by staging the combustion process to delay ignition, which results in a lower combustion temperature. The lower combustion temperature reduces thermal NO_x formation.

2.3 Flue Gas Sampling Locations

A description of the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, FGTURB/HRSG2, and EUAUXBOILER sampling locations is presented in the following sections. Figure 2-2 depicts the exhaust stack sampling locations.

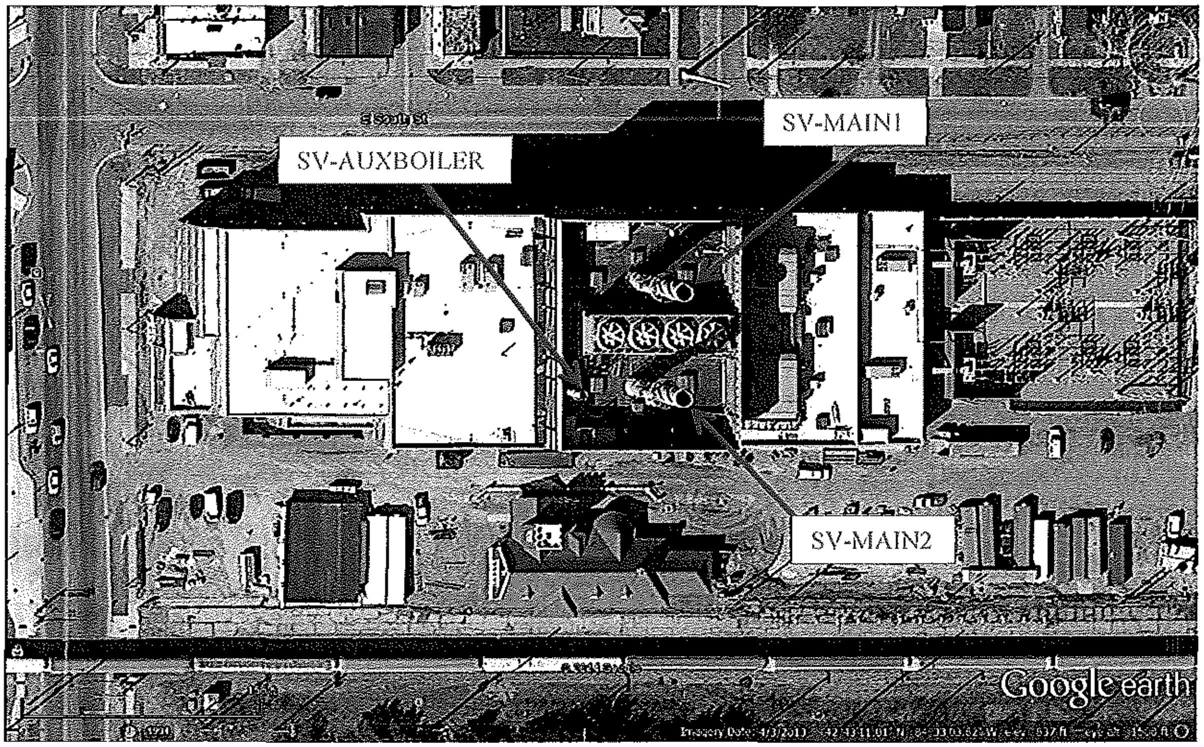


Figure 2-2. Aerial Photograph Showing Locations of Exhaust Stacks

2.3.1 Turbine and HRSG Sampling Locations

The EUTURBINE1 and FGTURB/HRSG1 sources discharge to stack SV-MAIN1 and the EUTURBINE2 and FGTURB/HRSG2 sources discharge to stack SV-MAIN2.

Four 4-inch-internal-diameter sampling ports oriented at 90° to one another are located in a straight section of each exhaust stack accessed via the roof. The north, south, east, and west ports were used for sampling during this test program. The sampling ports extend 12 inches outward from the stack interior wall. The ports are located at the following locations relative to the nearest flow disturbances:

- Approximately 35 feet downstream (~3.5 duct diameters) of the transition duct work existing the turbine.
- Approximately 77 feet upstream (~8 duct diameters) of the stack exit to the atmosphere.

Refer to Figure 2-3 for a portion of the diagram provided by BWL, showing EUTURBINE 1 and 2 with a stack diameter of 116 inches (9 ft 8 in).

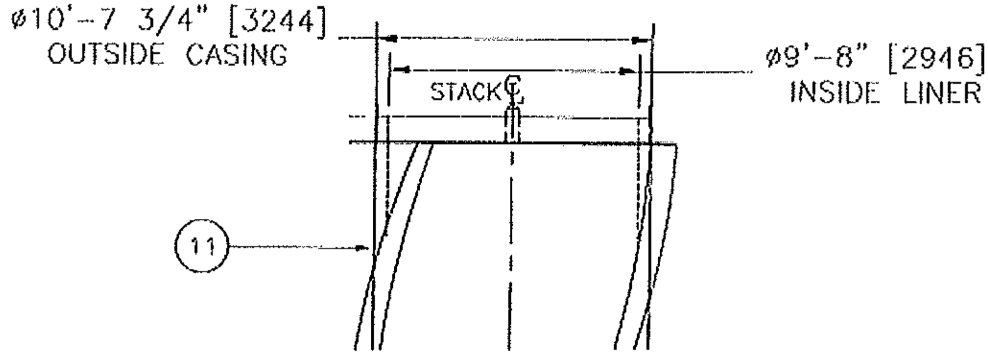


Figure 2-3. EUTURBINE1 and EUTURBINE2 Stack Diameter

Figure 1 in the Appendix shows the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources and the sampling ports and traverse point locations.

Figures 2-4 and 2-5 depict the SV-MAIN1 and SV-MAIN2 exhaust stacks and sampling locations.

Figure 2-4. SV-MAIN1 Exhaust Stack

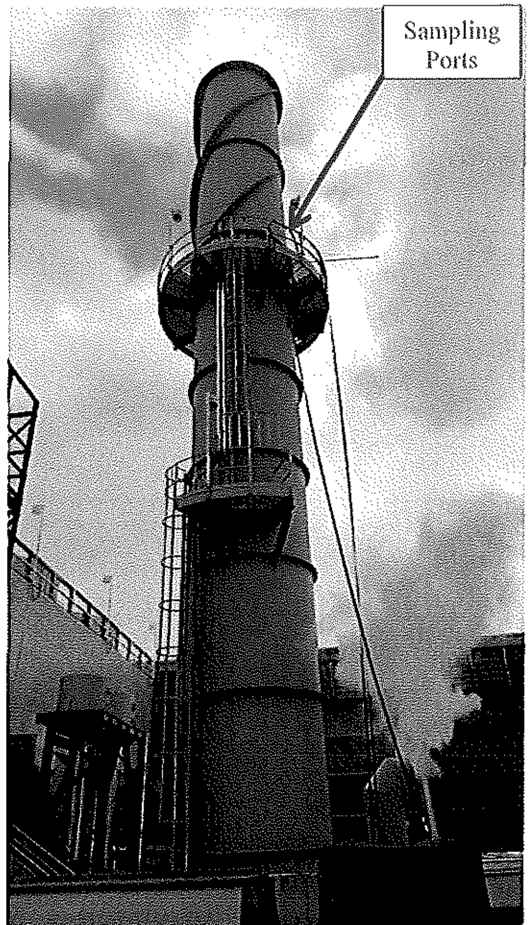


Figure 2-5. SV-MAIN2 Exhaust Stack

2.3.2 EUAUXBOILER Sampling Location

The EUAUXBOILER source exhausts through stack SV-AUXBOILER.

Two 4-inch-internal-diameter sampling ports oriented at 90° to one another are located in a straight section of the exhaust stack accessed via the roof. The south and east ports were used for sampling during this test program. The sampling ports extend 12 inches outward from the stack interior wall. The ports are located at the following locations relative to the nearest flow disturbances:

- Approximately 53 feet downstream (~5.3 duct diameters) of the transitional ductwork exiting the boiler.

- Approximately 45 feet upstream (~4.5 duct diameters) of the stack exit to the atmosphere.

Figure 2-6 is a portion of the diagram provided by BWL, showing EUAUXBOILER with a stack diameter of 58 inches.

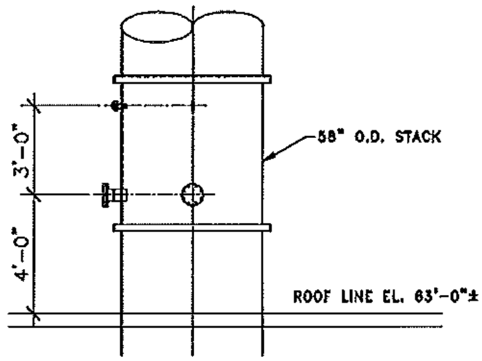


Figure 2-6. Showing EUAUXBOILER Stack Diameter

Figure 2 in the Appendix depicts the EUAUXBOILER source and the sampling ports and traverse point locations. Figure 2-7 depicts the SV-AUXBOILER exhaust stack and sampling location.

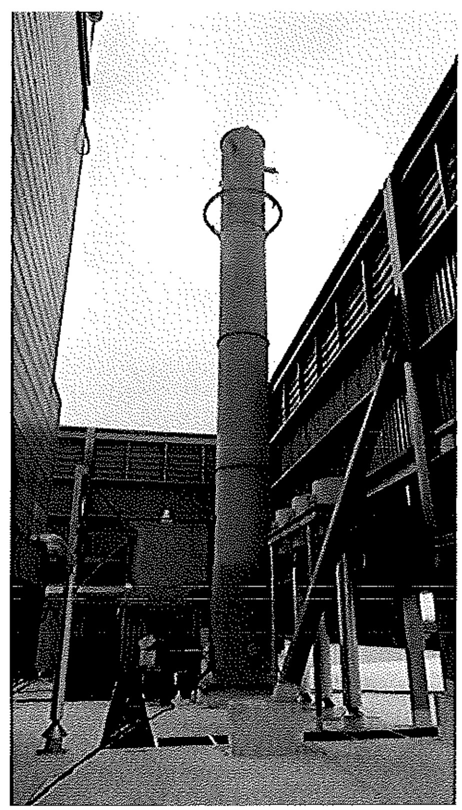


Figure 2-7. SV-AUXBOILER Exhaust Stack

2.4 Process Sampling Locations

Process sampling was not required during this test program. A process sample is a sample that is analyzed for operational parameters, such as calorific value of a fuel (e.g., natural gas, coal), organic compound content (e.g., paint coatings), or composition (e.g., polymers).

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The purpose of the emission test program was to satisfy certain requirements and evaluate compliance with the two permits.

Table 3-1 presents the sampling and analytical matrix.

Table 3-1
Test Matrix

Date (2014)	Source	Condition	Sample / Type of Pollutant	USEPA Sampling Method	Run	Sampling Time†	Test Duration (min)
February 18	EUTURBINE1	60% Load	CO, PM, $PM_{2.5}$, PM_{10}	1, 2, 3, 3A, 4, 10, and 202	1 2 3	13:50-14:50 15:10-16:10 16:35-17:35	60
	EUTURBINE1	80% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	9:10-10:10 10:25-11:25 11:45-12:45	60
	FGTURB/HRSG2	100% Load	CO, PM, $PM_{2.5}$, PM_{10}	1, 2, 3, 3A, 4, 5, 10, and 202	1 2 3	9:10-11:10 13:00-15:00 15:50-17:50	120
February 19	EUTURBINE2	100% Load	CO, PM, $PM_{2.5}$, PM_{10}	1, 2, 3, 3A, 4, 5, 10, and 202	1 2 3	8:30-10:30 12:53-14:53 15:45-17:45	120
	FGTURB/HRSG1	50% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	12:50-13:50 14:10-15:10 15:25-16:25	60
	FGTURB/HRSG1	75% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	8:30-9:30 9:51-10:51 11:08-12:08	60
February 20	EUTURBINE2	80% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	8:16-9:16 13:35-14:25 14:47-15:47	60
	FGTURB/HRSG1	100% Load	CO, PM, $PM_{2.5}$, PM_{10}	1, 2, 3, 3A, 4, 5, 10, and 202	1 2 3	8:12-10:12 10:45-12:45 13:05-15:05	120

Table 3-1
Test Matrix

Date (2014)	Source	Condition	Sample / Type of Pollutant	USEPA Sampling Method	Run	Sampling Time†	Test Duration (min)
February 21	EUTURBINE1	100% Load	CO, PM, $PM_{2.5}$, PM_{10}	1, 2, 3, 3A, 4, 5, 10, and 202	1 2 3	8:00-10:00 10:22-12:22 12:45-14:45	120
	FGTURB/HRSG2	50% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	12:05-13:05 13:15-14:15 14:25-15:25	60
	FGTURB/HRSG2	75% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	8:05-9:05 9:12-10:12 10:21-11:21	60
February 26	EUTURBINE2	60% Load	CO	1, 2, 3, 3A, 4, and 10	1 2 3	11:10-12:10 12:20-13:20 13:35-14:35	60
	EUAUXBOILER	100%	CO, PM, $PM_{2.5}$, PM_{10}	1, 2, 3, 3A, 4, 5, 10, and 202	1 2 3	7:55-9:55 10:20-12:20 13:00-15:00	120

† Times are for carbon monoxide emission measurements; particulate matter run stop times are approximately 15 minutes later due to sampling port changes.

3.2 Applicable Permit or Source Designation

The applicable permits are:

- MDEQ Permit to Install 149-10B, dated April 12, 2013, for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources

- Renewable Operating Permit MI-ROP-B2647-2012, dated May 17, 2012, for the EUAUXBOILER source.

The cover pages of the Permits are presented as Figures 3-1 and 3-2.

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

April 12, 2013

PERMIT TO INSTALL
149-10B

ISSUED TO
Lansing Board of Water and Light

LOCATED AT
1232 Haco Drive
Lansing, Michigan

IN THE COUNTY OF
Ingham

STATE REGISTRATION NUMBER
B2647

The Air Quality Division has approved this Permit to Install, pursuant to the delegation of authority from the Michigan Department of Environmental Quality. This permit is hereby issued in accordance with and subject to Section 5505(1) of Article II, Chapter I, Part 55, Air Pollution Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Pursuant to Air Pollution Control Rule 336.1201(1), this permit constitutes the permittee's authority to install the identified emission unit(s) in accordance with all administrative rules of the Department and the attached conditions. Operation of the emission unit(s) identified in this Permit to Install is allowed pursuant to Rule 336.1201(6).

DATE OF RECEIPT OF ALL INFORMATION REQUIRED BY RULE 203: **March 22, 2013**	
DATE PERMIT TO INSTALL APPROVED: **April 12, 2013**	SIGNATURE:
DATE PERMIT VOIDED:	SIGNATURE:
DATE PERMIT REVOKED:	SIGNATURE:

Figure 3-1. PTI 149-10B Cover Page

Michigan Department of Environmental Quality
Air Quality Division

EFFECTIVE DATE: May 17, 2012

ISSUED TO

Lansing Board of Water & Light

State Registration Number (SRN): B2647

LOCATED AT

601 Island Avenue, Lansing, Ingham, Michigan

RENEWABLE OPERATING PERMIT

Permit Number: MI-ROP-B2647-2012

Expiration Date: May 17, 2017

Administratively Complete ROP Renewal Application Due Between
November 17, 2015 and November 17, 2016

This Renewable Operating Permit (ROP) is issued in accordance with and subject to Section 5506(3) of Part 55, Air Pollution Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451). Pursuant to Michigan Air Pollution Control Rule 210(1), this ROP constitutes the permittee's authority to operate the stationary source identified above in accordance with the general conditions, special conditions and attachments contained herein. Operation of the stationary source and all emission units listed in the permit are subject to all applicable future or amended rules and regulations pursuant to Act 451 and the federal Clean Air Act.

SOURCE-WIDE PERMIT TO INSTALL

Permit Number: MI-PTI-B2647-2012

This Permit to Install (PTI) is issued in accordance with and subject to Section 5505(5) of Act 451. Pursuant to Michigan Air Pollution Control Rule 214a, the terms and conditions herein, identified by the underlying applicable requirement citation of Rule 201(1)(a), constitute a federally enforceable PTI. The PTI terms and conditions do not expire and remain in effect unless the criteria of Rule 201(6) are met. Operation of all emission units identified in the PTI is subject to all applicable future or amended rules and regulations pursuant to Act 451 and the federal Clean Air Act.

Michigan Department of Environmental Quality

Michael McClellan, Lansing District Supervisor

Figure 3-2. MI-ROP-B2647-2012 Cover Page

3.3 Field Test Changes and Issues

Field test changes were communicated between Lansing Board of Water & Light, Bureau Veritas, and MDEQ personnel onsite. The following section summarizes the field test change and issues.

3.3.1 Leak Rate Adjustment

At the conclusion of Run 1 for the particulate matter test of EUTURBINE2 on February 19 and Run 1 for the FGTURB/HRSG2 on February 18, the measured post-test leak rate exceeded the method criterion of 0.020 cubic feet per minute. The leak rates were 0.030 cfm for the EUTURBINE2 run and 0.029 for the FGTURB/HRSG2 test. Following discussions while onsite, Mr. Gasloli, Environmental Quality Analyst with the MDEQ, indicated that it was acceptable to use the leak rate volume adjustment equation in Method 5 and shown below, to calculate an adjusted sample volume for these two runs:

$$\text{Adjusted } V_m = V_m - [(L_p - L_a)\ t_s]$$

Adjusted V_m = Adjusted sample volume (ft^3)
V_m = Sample volume (ft^3)
L_p = Post leak check rate (cfm)
L_a = Maximum acceptable leak check (cfm)
t_s = Total run sampling time (min)

The adjusted sample volume was used to calculate particulate matter concentrations and mass emission rates.

3.3.2 Stack Diameters

Bureau Veritas measured the stack diameters by measuring the distance from the far stack wall to the outer edge of the sample port. The length of the sample port is subtracted from this distance to calculate the stack diameter. Bureau Veritas recorded the measured stack diameters on the field sheets; however, as-built drawings of the stacks provided to Bureau Veritas by BWL indicate slightly lower stack diameters. The stack diameters obtained from the as-built drawings were used in the calculations. Bureau Veritas's stack diameter measurements were approximately 3% larger than the as-built stack diameters.

3.4 Summary of Results

The purpose of the emission test program was to satisfy winter test requirements and evaluate compliance with the permits.

Detailed results are presented in Tables 1 through 18 after the Table Tab of this report.

Graphs of the O_2 and CO_2, concentrations are presented after the Graphs Tab of this report.

Calibration and inspection sheets are presented in Appendix A.

Sample calculations are presented in Appendix B.

Field data sheets presented in Appendix C.

Computer-generated data sheets are presented in Appendix and D.

Facility operating parameters are presented in Appendix E.

Laboratory data are presented in Appendix F.

The results are compared to permit limits in Tables 3-2 through 3-4.

Table 3-2
EUTURBINE1 and EUTURBINE2 Results

Parameter	Testing Load Condition	Units	Equipment								Limit
			EUTURBINE1				EUTURBINE2				
			Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
CO	60%	ppmv	15.6	29.2	18.9	21.2	19.2	19.1	19.3	19.2	**100**
		lb/hr	11.7	19.8	12.9	14.8	14.6	14.3	13.6	14.2	**48.2**
	80%	ppmv	25.6	26.9	25.7	26.1	51.8	26.7	28.6	35.7	**50**
		lb/hr	19.8	22.6	20.2	20.8	44.2	18.1	20.0	27.4	**48.2**
	100%	ppmv	29.7	21.0	17.2	22.6	18.9	15.0	11.0	15.0	**50**
		lb/hr	26.9	19.4	15.9	20.7	17.2	16.3	6.9	14.4	**48.2**
PM	100%	lb/hr	2.8	2.8	0.86	2.2	53	232	4.8	97	**2.0**
PM_{10}	100%	lb/hr	5.7	10	5.5	7.2	149	398	10	186	**5.0**
$PM_{2.5}$	100%	lb/hr	5.7	10	5.5	7.2	149	398	10	186	**5.0**

PM_{10} emissions include filterable and condensable sample fractions.
$PM_{2.5}$ emissions include filterable and condensable sample fractions.
ppmv: parts per million by volume dry at 15% oxygen
lb/hr = pound per hour

Table 3-3
FGTURB/HRSG1 and FGTURB/HRSG2 Results

Parameter	Testing Load Condition	Units	Equipment								Limit
			FGTURB/HRSG1				FGTURB/HRSG2				
			Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average	
CO	50%	ppmv	20.0	16.5	17.5	18.0	19.8	19.2	18.2	19.1	**100**
		lb/hr	20.2	16.4	17.8	18.1	19.9	19.4	17.9	19.1	**51.7**
	75%	ppmv	20.3	18.6	20.9	19.9	20.9	20.5	20.7	20.7	**50**
		lb/hr	22.0	21.5	22.9	23.7	22.7	21.2	22.0	22.0	**51.7**
	100%	ppmv	13.3	15.8	12.5	13.9	16.7	14.9	14.4	15.3	**50**
		lb/hr	15.8	16.3	13.0	15.0	18.7	15.9	15.5	16.7	**51.7**
PM	100%	lb/hr	3.7	1.6	1.9	2.4	4.9	1.5	1.3	2.6	**2.1**
PM_{10}	100%	lb/hr	11	5.1	3.3	6.5	35	3.3	3.8	14	**5.5**
$PM_{2.5}$	100%	lb/hr	11	5.1	3.3	6.5	35	3.3	3.8	14	**5.5**

PM_{10} emissions include filterable and condensable sample fractions.
$PM_{2.5}$ emissions include filterable and condensable sample fractions.
ppmv: parts per million by volume dry at 15% oxygen
lb/hr = pound per hour

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Table 3-4
EUAUXBOILER Results

Parameter	Testing Load Condition	Units	Equipment				Limit
			EUAUXBOILER				
			Run 1	Run 2	Run 3	Average	
CO	100%	lb/MMBtu heat input	0.018	0.015	0.017	0.016	**0.04**
PM	100%	lb/hr	0.31	0.28	0.22	0.27	**0.5**
PM_{10}	100%	lb/hr	1.6	0.74	0.77	1.0	**1.8**
$PM_{2.5}$	100%	lb/hr	1.6	0.74	0.77	1.0	**1.8**

PM_{10} emissions include filterable and condensable sample fractions.
$PM_{2.5}$ emissions include filterable and condensable sample fractions.
lb/MMBtu: pounds per million British thermal unit
lb/hr = pound per hour

The average EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, FGTURB/HRSG2, and EUAUXBOILER emission results indicate compliance with the permit limits with the exception of the particulate matter results for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources. The particulate matter results for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources are inconsistent and appear to be anomalous compared to previous testing and should be considered void due to the possible impact of several factors. Refer to Section 5.0 for discussion of the particulate matter results.

4.0 Sampling and Analytical Procedures

Bureau Veritas measured emissions following the guidelines and procedures specified in 40 CFR 51, Appendix M, "Recommended Test Methods for State Implementation Plans," 40 CFR 60, Appendix A, "Standards of Performance for New Stationary Sources," and State of Michigan Part 10 Rules, "Intermittent Testing and Sampling." The sampling and analytical methods used are indicated in the following table:

Table 4-1
Emission Test Methods

Sampling Method	Parameter	Analysis
USEPA 1 and 2	Gas stream volumetric flowrate	Field measurement, S-type Pitot tube
USEPA 3	Molecular weight	Fyrite® analyzer
USEPA 3A	Molecular weight	Instrument analysis
USEPA 4	Moisture content	Gravimetric
USEPA 5	Particulate matter	Gravimetric
USEPA 10	Carbon monoxide	Infrared absorbance
USEPA 202	Condensable particulate matter	Gravimetric

4.1 Sampling Train and Procedures

Because the EUTURBINE1 and FGTURB/HRSG1 sources exhaust through SV-MAIN1 stack, the EUTURBINE2 and FGTURB/HRSG2 sources exhaust through the SV-MAIN2 stack, and the EUAUXBOILER exhausts through the SV-AUXBOIL stack, emissions measurements were conducted at a total of three stacks (collectively "the Test Stacks"). The emission test parameters and sampling procedure at each sampling location are provided in Table 4-2.

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Table 4-2
Emissions Test Parameters

Parameter	Exhaust Stack			USEPA Reference	
	SV-MAIN1	SV-MAIN2	SV-AUXBOIL	Method	Title
Sampling ports and traverse points	•	•	•	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	•	•	•	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	•	•	•	3	Gas Analysis for the Determination of Dry Molecular Weight
Molecular weight	•	•	•	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)
Moisture content	•	•	•	4	Determination of Moisture Content in Stack Gases (approximation method)
PM	•	•	•	5	Determination of Particulate Matter Emissions from Stationary Sources
Carbon monoxide	•	•	•	10	Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Condensable PM	•	•	•	202	Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

Method 1, "Sample and Velocity Traverses for Stationary Sources," from 40 CFR 60, Appendix A, was used to evaluate the sampling location and the number of traverse points for sampling and the measurement of velocity profiles. Details of the sampling location and number of velocity traverse points are presented in the Table 4-3.

Table 4-3
Sampling Location and Number of Traverse Points

Sampling Location	Duct Diameter† (inch)	Distance from Ports to Upstream Flow Disturbance (diameters)	Distance from Ports to Downstream Flow Disturbances (diameters)	Number of Ports	Traverse Points per Port	Total Points†	Cyclonic Flow Check Average Null Angle
SV-MAIN1	116	~8	~3.5	4	3	12	2°
SV-MAIN2	116	~8	~3.5	4	3	12	2°
SV-AUXBOIL	58	~4.5	~5.3	2	6	12	5°

† Duct diameters reported are based on as-built drawings provided by BWL.

Figure 1 in the Appendix depicts the EUTURBINE1 and EUTURBINE2 source sampling locations and traverse points and Figure 2 depicts the EUAUXBOILER source sampling location and traverse points.

Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to measure flue gas velocity and calculate volumetric flowrate. S-type Pitot tubes and thermocouple assemblies calibrated in accordance with Method 2, Section 10.0, connected to an oil-filled manometer or electronic manometer were used during testing. Because the dimensions of the Pitot tube met the requirements outlined in Method 2, Section 10.1, and were within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. Refer to Appendix A for the calibration and inspection sheets. Refer to Appendix B for sample calculations of flue gas velocity and volumetric flow rate.

Cyclonic Flow Check. Bureau Veritas evaluated whether cyclonic flow was present at the sampling location. Cyclonic flow is defined as a flow condition with an average null angle greater than 20°. The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head reading—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack walls when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20 degrees, the flue gas is considered to be cyclonic at that sampling location and an alternative location should be found.

The measurements indicate the absence of cyclonic flow at the sampling location. Field data sheets are included in Appendix C. Computer-generated field data sheets are included in Appendix D.

4.1.2 Molecular Weight (USEPA Method 3)

The carbon dioxide contribution to stack gas molecular weight was measured using Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." Flue gas was extracted from the stack through a probe positioned near the centroid of the duct and directed into a Fyrite® gas analyzer. The concentrations of carbon dioxide (CO_2) were measured by chemical absorption with a Fyrite® gas analyzer to within ±0.5%. The average CO_2 result of the grab samples were used to calculate molecular weight.

4.1.3 Moisture Content (USEPA Method 4)

The moisture of the flue gas was measured following the procedures in USEPA Method 4, "Determination of Moisture Content in Stack Gases," in conjunction with USEPA Method 202. Prior to testing, Bureau Veritas estimated the moisture content using the wet bulb-dry bulb technique, stoichiometric calculations, or review of psychrometric charts. Figure 3 depicts the USEPA Method 4 sampling train.

4.1.4 Filterable and Condensable Particulate Matter (USEPA Methods 5 and 202)

USEPA Methods 5, "Determination of Particulate Matter Emissions from Stationary Sources" and 202, "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources," were used to measure particulate matter emissions at each source. USEPA Method 5 measures filterable particulate matter (PM), while the Method 202 train collects condensable material (CPM). Figure 4 depicts the USEPA Methods 5 and 202 sampling train.

CPM is defined as material that is in vapor phase at stack conditions, but condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid PM immediately after discharge from the stack. Method 202 collects CPM within a water-dropout impinger, modified Greenburg-Smith impinger, and a Teflon filter.

The sum of the Method 5 (FPM) and Method 202 (CPM) mass collected represents particulate matter with a nominal aerodynamic diameter less than 10 microns (PM_{10}).

Bureau Veritas' modular Methods 5 and 202 isokinetic stack sampling system consisted of the following (in order from the stack to the control case):

- A quartz glass button-hook nozzle.
- A heated (248±25°F) quartz glass-lined probe.

- A desiccated and pre-weighed 110-millimeter-diameter quartz fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.

- A USEPA Method 23-type stack gas condenser with water recirculation pump.

- A set of four impingers with the configuration shown in Table 4-4.

- A second (back-half) CPM Teflon filter inserted between the second and third impingers and maintained at a temperature <85°F.

- A sampling line.

- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-4
Method 202 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Amount of Contents
1	Modified – dropout	Empty	0 milliliter
2	Modified	Empty	0 milliliter
CPM Filter			
3	Modified	HPLC water	100 milliliter
4	Modified	Silica gel desiccant	~200-300 grams

Before testing, a preliminary velocity traverse was performed and a calculated nozzle size that would allow isokinetic sampling at an ideal average rate of 0.75 cubic feet per minute. Bureau Veritas selected a pre-cleaned borosilicate glass nozzle with an inner diameter that approximates the calculated ideal value. The nozzle was measured with calipers across three cross-sectional chords to evaluate the inside diameter. The nozzle was rinsed and brushed with acetone and connected to the borosilicate glass-lined sample probe or filter holder.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a velocity head of 3 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 15 inches of mercury to the sampling train. The dry-gas meter was monitored to measure the sample train leakage rate was less than 0.02 cubic feet per minute. The sampling probe was then inserted into the sampling port to begin sampling.

Ice was placed around Impingers 3 and 4. The Method 5 probe and filter temperatures were allowed to stabilize at 248±25 °F before each sample run. After the desired operating conditions were coordinated with the facility, testing was initiated. Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate within ±10 % for the duration of the test.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the impingers and filter were transported to the recovery area. The filter was recovered using Teflon-lined tweezers and placed in a Petri dish, sealed with Teflon tape, and labeled as FPM Container 1. The nozzle, probe, and the front half of the filter holder assembly was brushed and, at a minimum, triple-rinsed with acetone to recover particulate matter. The acetone rinses were collected in pre-cleaned sample containers, sealed with Teflon tape, and labeled as FPM Container 2.

The mass of liquid collected in each impinger was measured using an electronic scale accurate to ±0.5 gram. These data were used to calculate the moisture content of the sampled flue gas.

After weighing the impinger but prior to the recovery of the Method 202 train and immediately after the conclusion of the test, the impinger train was purged with filtered 99.9% pure nitrogen gas to remove dissolved sulfur gases from the impingers. The nitrogen purge was conducted because water condensed in the first two impingers.

The contents of the first two impingers were collected in a glass sample container labeled as "CPM Container 1, aqueous liquid impinger contents." The back of the filter-holder, glass-lined probe, condenser, Impingers 1 and 2, front-half of the CPM filter holder, and all connecting glassware was rinsed twice with HPLC water and the recovery rinsate was added to CPM Container 1. Following the HPLC water rinse, the back of the filter-holder, probe extension, condenser, Impingers 1 and 2, front-half of the CPM filter holder, and connecting glassware were rinsed with acetone and then rinsed twice with hexane. The acetone and hexane rinses were collected in a glass sample container labeled as "CPM Container 2, organic rinses."

The CPM filter was recovered using Teflon-lined tweezers and placed in a Petri dish or glass sample container; the container was sealed with Teflon tape, and labeled as "CPM Container 3, CPM filter sample."

The mass of condensate collected in Impingers 3 and 4 was measured to calculate the moisture content of the flue gas; the contents of these impingers were not recovered.

The Method 5 and 202 sample containers, including a field train recovery blank, acetone, HPLC water, and hexane blanks were transported to the laboratory for analysis. Because the glassware was pre-cleaned and baked at a temperature above 300°C for greater than 6 hours, a field train proof blank was not required.

4.1.5 O_2 and CO (USEPA Methods 3A and 10)

Oxygen concentrations were measured following USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (instrumental analyzer procedure). Carbon monoxide concentrations were measured using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (instrument analyzer procedure)." These sampling methods are similar with the exception of the analyzer specifications. Sampling for O_2 and CO consisted of extracting flue gas from the exhaust duct through:

- A stainless-steel probe.
- Heated Teflon sample line to prevent condensation.
- A chilled Teflon impinger train with peristaltic pump to remove moisture from the sampled gas stream prior to entering the analyzer.
- Paramagnetic analyzer to measure O_2 concentrations and a gas filter wheel infrared analyzer to measure CO concentrations.

Data were recorded at 1-second intervals with data acquisition software (DAS). Recorded pollutant concentrations were averaged over the duration of each test run and reported in 1-minute averages. Refer to Appendix C for the field data sheets.

A calibration error check was performed by introducing zero-, mid-, and high-level calibration gases directly into each analyzer. The calibration error check was performed to evaluate the analyzers response within the acceptable ±2% of the calibration span.

Prior to each test run, a system-bias test was performed; in this test, known concentrations of calibration gases were introduced at the sampling probe tip to measure if the analyzer's response was within ±5% of the calibration span. At the conclusion of the each test run, an additional system-bias check was performed to evaluate the drift from pre- and post-test system-bias checks. Since the analyzer's drift were less than 3.0% of calibration span, the tests were considered valid.

Calibration data and USEPA Protocol 1 certification sheets for the calibration gases used are included in Appendix A.

Figure 5 depicts the USEPA Methods 3A and 10 sampling train.

4.2 Procedures for Obtaining Process Data

Process data were recorded by Lansing Board of Water & Light personnel. Recorded process data were provided to Bureau Veritas at the conclusion of the testing. The process data are included in Appendix E.

4.3 Sampling Identification and Custody

USEPA Methods 5 and 202 recovery and analytical procedures were applicable to this test program. Applicable chain of custody procedures followed guidelines outlined within ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures." Detailed sampling and recovery procedures are described in Section 4.0. For each sample collected (i.e. filter, probe rinse) sample identification and custody procedures were completed as follows:

- Containers were sealed with Teflon tape to prevent contamination.
- Containers were labeled with test number, location, and test date.
- The level of fluid was marked on the outside of the sample containers to identify if leakage occurred prior to receipt of the samples by the laboratory.
- Containers were placed in a cooler for storage.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sampling Chain-of-Custody Procedures."
- Samples were transported to the laboratory under chain of custody.

Chains of custody and laboratory analytical results are included in Appendix F.

5.0 QA/QC Activities

Equipment used in this emissions test program passed quality assurance/quality control (QA/QC) procedures. Refer to Appendix A for equipment inspection and calibration documents. Field data sheets are presented in Appendix C. Computer-generated Data Sheets are presented within Appendix D.

5.1 Pretest QA/QC Activities

Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume and Principles: Volume III, Stationary Source Specific Methods." Refer to Appendix A for pre-test inspection and calibration sheets.

5.2 QA/QC Audits

The results of select sampling and equipment QA/QC audits and the acceptable USEPA tolerance are presented in the following sections. Calibration and inspection sheets for dry-gas meters (DGM), thermocouples, and Pitot tubes are presented in Appendix A.

5.2.1 Methods 5 and 202 QA/QC Audits

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The following table summarizes the QA/QC audits conducted on each sampling train.

Table 5-1
Methods 5 and 202 Sampling Train QA/QC Audits

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
EUTURBINE1					February 21, 2014
Average velocity pressure head (in H_2O)	2.1	2.2	2.2	>0.05 in H_2O†	Valid
Sampling train leak check Post–test	0.005 ft^3 for 1 min at 7 in Hg	0.004 ft^3 for 1 min at 10 in Hg	0.000 ft^3 for 1 min at 10 in Hg	<0.020 ft^3 for 1 minute at ≥ recorded during test	Valid
Sampling vacuum (in Hg)	3 to 5	4 to 6	4		

Table 5-1
Methods 5 and 202 Sampling Train QA/QC Audits

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
EUTURBINE2					February 19, 2014
Average velocity pressure head (in H_2O)	2.0	2.0	2.1	>0.05 in $H_2O^{\dagger}$	Valid
Sampling train leak check Post–test	0.029 ft^3 for 1 min at 5 in $Hg^{\ddagger}$	0.017 ft^3 for 1 min at 6 in Hg	0.015 ft^3 for 1 min at 7 in Hg	<0.020 ft^3 for 1 minute at ≥ recorded during test	Run 1 sample volume adjusted based on post-test leak rate
Sampling vacuum (in Hg)	2 to 5	4 to 5	5 to 6		
FGTURB/HRSG1					February 20, 2014
Average velocity pressure head (in H_2O)	1.5	1.3	1.3	>0.05 in $H_2O^{\dagger}$	Valid
Sampling train leak check Post–test	0.010 ft^3 for 1 min at 8 in Hg	0.000 ft^3 for 1 min at 10 in Hg	0.006 ft^3 for 1 min at 7 in Hg	<0.020 ft^3 for 1 minute at ≥ recorded during test	Valid
Sampling vacuum (in Hg)	3 to 6	2 to 5	2 to 6		
FGTURB/HRSG2					February 18, 2014
Average velocity pressure head (in H_2O)	1.5	1.3	1.3	>0.05 in $H_2O^{\dagger}$	Valid
Sampling train leak check Post–test	0.030 ft^3 for 1 min at 7 in $Hg^{\ddagger}$	0.010 ft^3 for 1 min at 7 in Hg	0.005 ft^3 for 1 min at 7 in Hg	<0.020 ft^3 for 1 minute at ≥ recorded during test	Run 1 sample volume adjusted based on post-test leak rate
Sampling vacuum (in Hg)	3 to 5	3 to 5	to 6		
EUAUXBOILER					February 26, 2014
Average velocity pressure head (in H_2O)	0.94	0.9	1.0	>0.05 in $H_2O^{\dagger}$	Valid
Sampling train leak check Post–test	0.005 ft^3 for 1 min at 7 in Hg	0.002 ft^3 for 1 min at 11 in Hg	0.005 ft^3 for 1 min at 13 in Hg	<0.020 ft^3 for 1 minute at ≥ recorded during test	Valid
Sampling vacuum (in Hg)	4 to 6	6 to 11	6 to 12		

† Manometer capable of reading 0 to 10 in H_2O acceptable for measuring differential pressure head above 0.05 in H_2O

‡ MDEQ personnel indicated that it was acceptable to use the leak rate volume adjustment equation shown here to calculate an adjusted sample volume: Adjusted $V_m = V_m - [(L_p - L_a)\, t_s]$. See Section 3.3.

5.2.2 Dry-Gas Meter QA/QC Audits

The following table summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Dry-gas meters 2 and 7 were used during this testing to measure particulate matter and moisture content at the generator exhaust. Refer to Appendix A for the pre-test and post-test dry-gas meter calibrations.

Table 5-2
Dry-Gas Meter Calibration QA/QC Audit

Test Method	Meter Box	Pre-test DGM Calibration Factor (Y) (dimensionless)	Post-Test DGM Calibration Check Value (Y_{qa}) (dimensionless)	Absolute Difference Between Pre- and Post-test DGM Calibrations	Acceptable Tolerance	Calibration Result
Methods 5/202	2	1.001 (Jan. 23, 2014)	1.009 (Feb. 28, 2014)	0.008	≤0.05	Valid
Methods 5/202	7	1.015 (Jan. 23, 2014)	1.022 (Mar. 11, 2014)	0.007	≤0.05	Valid

5.2.3 Thermocouple QA/QC Audits

Temperature measurements using thermocouples and digital pyrometers were compared to a reference temperature (i.e., ice water bath, boiling water) prior to testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are presented in Appendix A.

5.3 QA/QC Blanks

Reagent and field blanks were analyzed for particulate matter. The results of the blanks are presented in Table 5-3. The blank results indicate that it is possible that contamination occurred in the field.

Table 5-3
QA/QC Blanks

Sample Identification	Result	Comment
M5 Acetone Blank	2.3 mg 0.01mg/ml	Reporting limit is 0.5 mg. Blank corrections were applied.
M5 Filter Blank	<0.5 mg	Filter blank corrections not applied.
CPM Acetone Field Reagent Blank #6, Water Field Reagent Blank #7, Hexane Field Reagent Blank #8	31.5 mg	Consists of inorganic CPM (0.50 mg) and organic CPM (31 mg).
CPM Acetone Field Reagent Blank #6	2.9 mg 0.008 mg/ml	Sample Volume 380 ml
CPM Water Field Reagent Blank #7	0.5 mg 0.001 mg/ml	Sample Volume 420 ml
CPM Hexane Field Reagent Blank #8	28.1 mg 0.069 mg/ml	Sample Volume 410 ml
Field Train Recovery Blank	11.0 mg	Consists of inorganic CPM (2.1 mg) and organic CPM (8.9 mg).

The PM results of the CPM hexane reagent blank #8 and field train recovery blank indicate the potential for contamination to have occurred in the field. Hexane reagent is used to extract the organic fraction of the condensable particulate matter catch by rinsing of the impingers and connecting glassware.

The field train recovery blank was recovered after the first particulate matter test run on the first test day. The field train recovery blank is collected by assembling the sampling train as if it will be used for testing with the addition of 100 milliliters of water to the first impinger. The assembled train is then purged with nitrogen for one hour and recovered as described in Section 4.1.4.

The potential field contamination would positively bias the results higher than actual emissions (i.e., overestimate the emission rate). The maximum blank correction of 2.0 mg, allowed by USEPA Method 202, was subtracted from the total CPM catch weight of the test runs. Because the field train recovery blank was 11.0 milligrams the allowable blank correction is lower than indicated by the QA/QC analysis. Therefore, the USEPA Method 202 PM results are likely biased high.

5.4 QA/QC Issues

Bureau Veritas reviewed the QA/QC data and noted the following issues:

- The hexane reagent blank result was 8.9 milligrams. Before the testing, Bureau Veritas analyzed an HPLC hexane reagent blank and a hexane reagent blank obtained from the dispenser bottles used in the field. The pre-test results were all less than 0.6 milligrams; therefore, contamination likely occurred in the field. However, after the testing, Bureau Veritas analyzed additional hexane reagent blank samples. These hexane reagent blank samples were collected from the reagent containers supplied by the manufacturer. The results of the post-test reagent blank sample analysis were all less than 0.5 milligrams.

  As required by USEPA Method 202, Bureau Veritas followed the pre-test sample train cleaning procedures and baked the glassware above 300°C for greater than 6 hours; however, the field train recovery blank result was 11.0 milligrams. This result indicates the potential for issues with the Run 1 recovery, glassware, or reagents.

  It should be noted, that Method 202 sample contamination greater than the blank subtraction of 2.0 milligrams has been documented by USEPA and is a known issue.

  As noted in Section 5.3, the results of the hexane and field train recovery blanks indicate the potential for field contamination; this indicates the USEPA Method 202 results are positively biased. The maximum blank correction was applied to each of the test runs.

- During the extraction process of the aqueous fraction of the USEPA Method 202 EUAUXBOILER Run 1 sample, there was a laboratory equipment malfunction and the aqueous portion of the sample was lost. The inorganic condensable particulate matter result was voided for this sample; the Run 1 result does not include an inorganic fraction and is therefore biased low.

  However, because less than 2 milligrams of inorganic condensable particulate matter were collected during Runs 2 and 3, it is likely the inorganic fraction for Run 1 would be similar.

  Because the average EUAUXBOILER PM_{10} and $PM_{2.5}$ result is 1.0 lb/hr and less than the permit limit of 1.8 lb/hr by approximately 40 percent, this issue is unlikely to have affected the evaluation of compliance for this source.

- As discussed in Section 3.3.1, the Run 1 post-test leak checks of the EUTURBINE2 and FGTURB/HRSG2 tests exceeded the method criterion of 0.020 cubic feet per minute. As approved by the MDEQ, the sample volume was adjusted based on the post-test leak rate.

  Bureau Veritas reviewed the post-test leak check QA/QC issue and the analytical results. Although, the test runs were accepted in the field with MDEQ approval, the Run 1 results for the EUTURBINE2 and FGTURB/HRSG2 sources appear to be biased high. In addition, the Run 2 result of the EUTURBINE2 sampling appears positively biased (overestimated). The cause of the positive bias is unclear and likely attributed to many variables.

  For the EUTURBINE2 sampling, an extended time was necessary in preparing a leak-free sampling train for Run 2. During the pre-test leak check procedure, ambient air enters the sample train. Because the cooling tower exhaust engulfs the stack platform where the pre-test leak check was performed, the potential for cooling tower water exhaust to enter the sample exists. Dissolved solids within cooling tower exhausts can contain minerals and chemicals for corrosion inhibition. Up to 48.5 cubic feet of ambient air were collected by the Run 2 sampling train during the pre-test leak check for Run 2. Refer to Figure 5-1 and 5-2 for photographs of the EUTURBINE2 stack conditions on February 19, 2014.

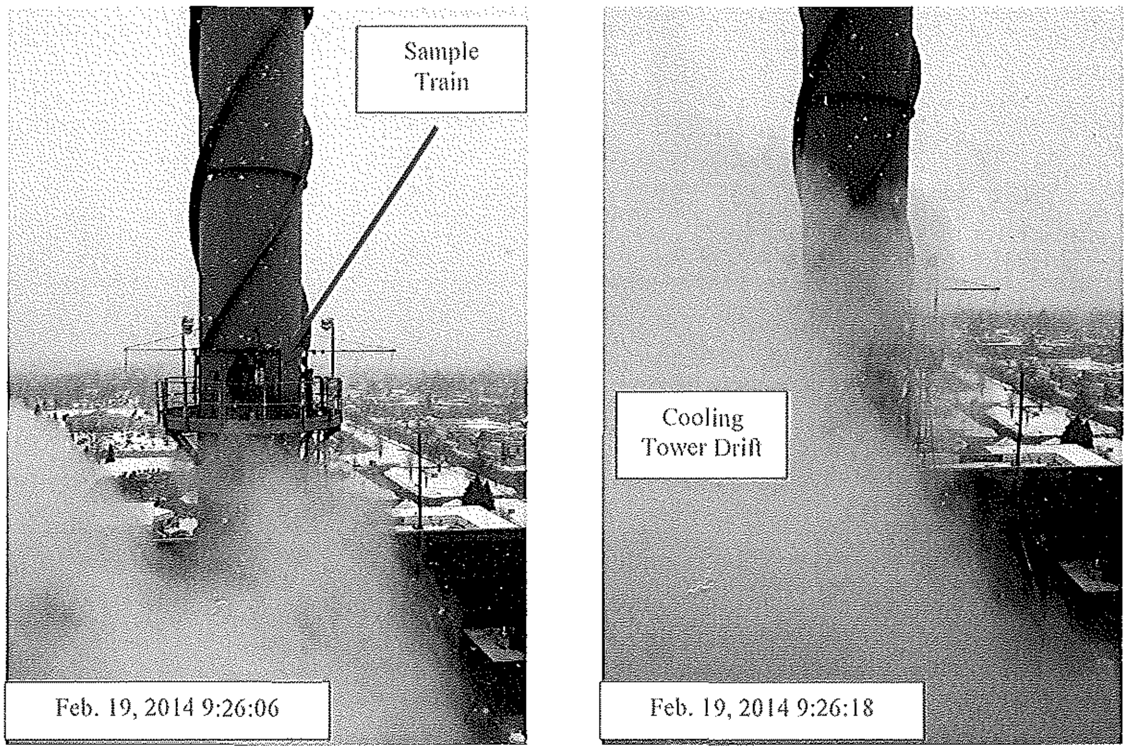

Figure 5-1. EUTURBINE2 Photographs on February 19, 2014 – Run 1

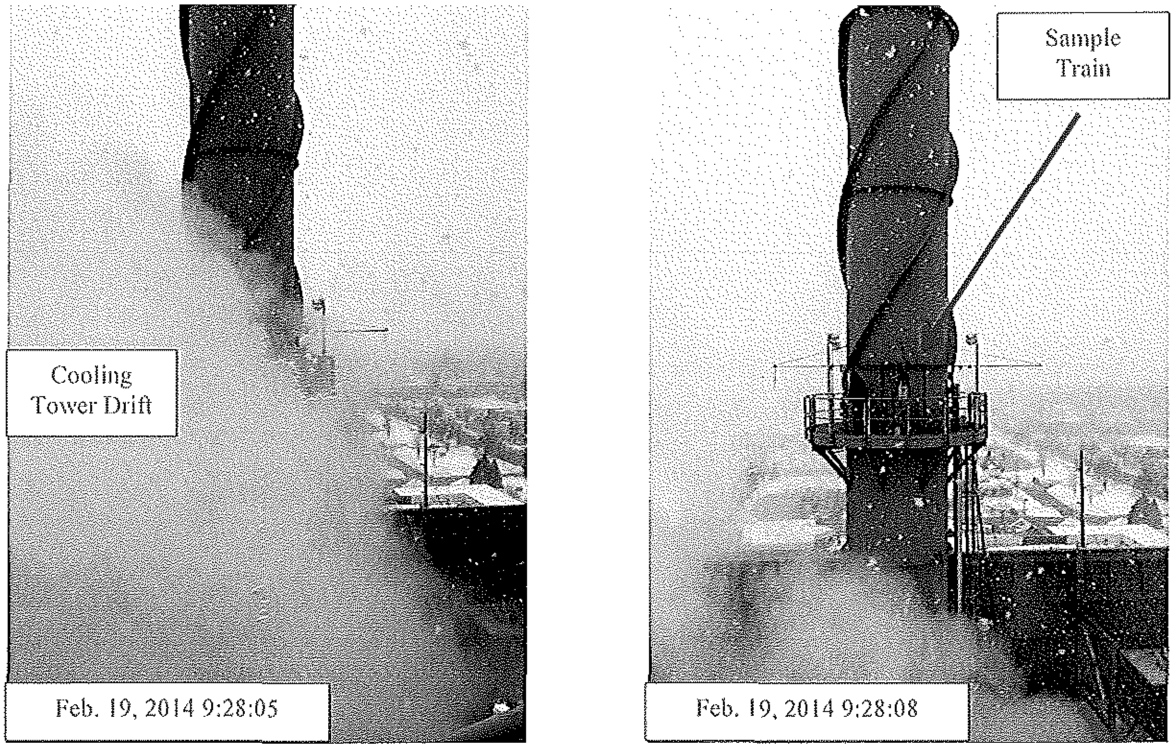

Figure 5-2. EUTURBINE2 Photographs on February 19, 2014 – Run 1

Although, the post-test leak check was within the method criterion for Run 2, Bureau Veritas concluded sufficient leak check issues were encountered and the glass sampling probe liner was replaced prior to initiating Run 3. The stack gas temperature exceeded 800°F and was at times as high as 900°F. At these extreme temperatures, it is possible the probe liner cracked or connecting graphite ferrules deteriorated during testing, allowing infiltration of non-stack gas into the sampling train.

Figure 5-3 shows a photograph of the EUTURBINE2 samples. Figure 5-4 shows the probe liner heating elements and damage due to the extreme temperatures. Figure 5-5 presents the graphite ferrule and union connecting the glass sample probe to the glass nozzle.

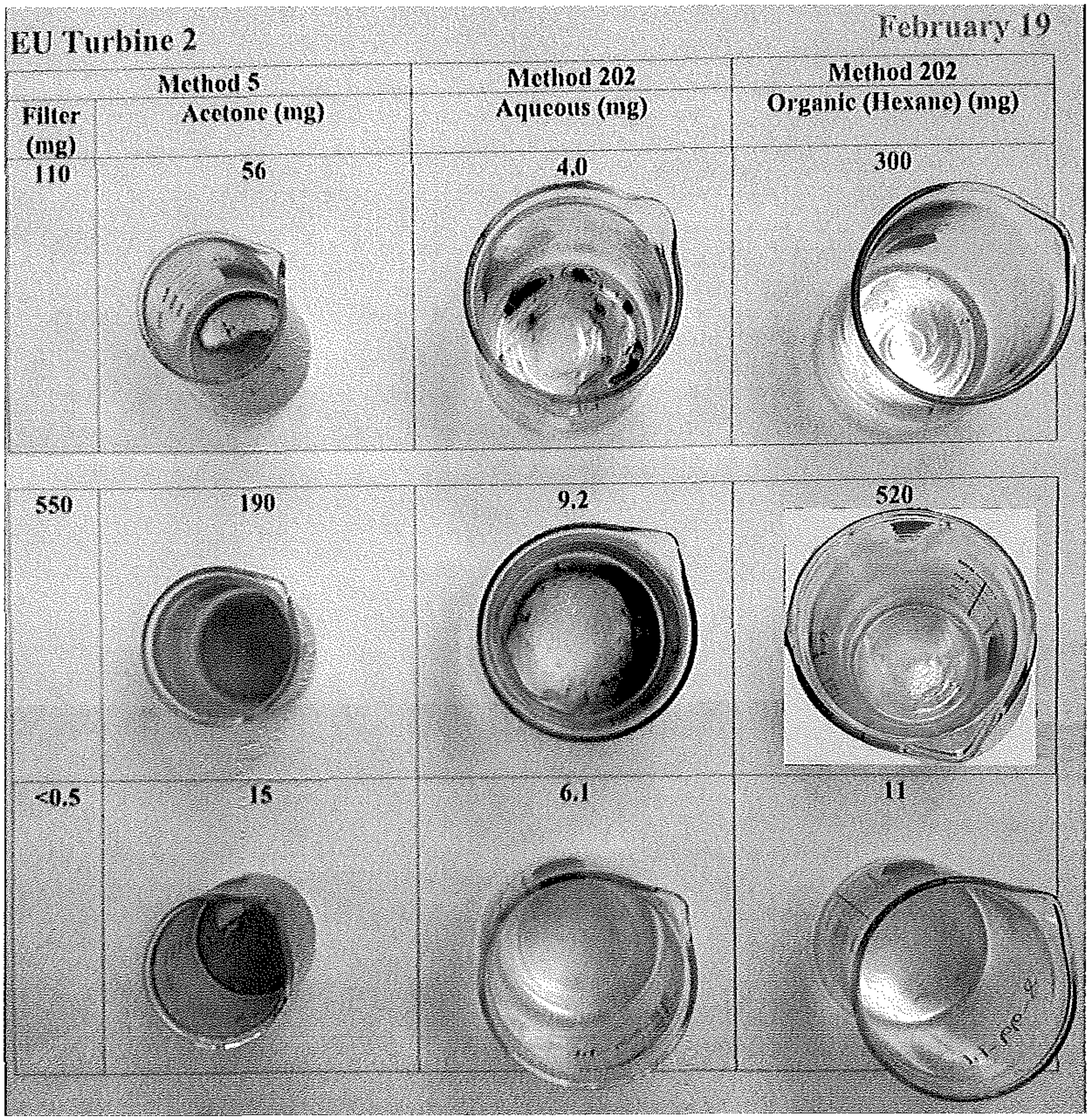

Figure 5-3. Composite Photograph of Beakers from Runs 1, 2, and 3 of the EUTURBINE2 Analysis

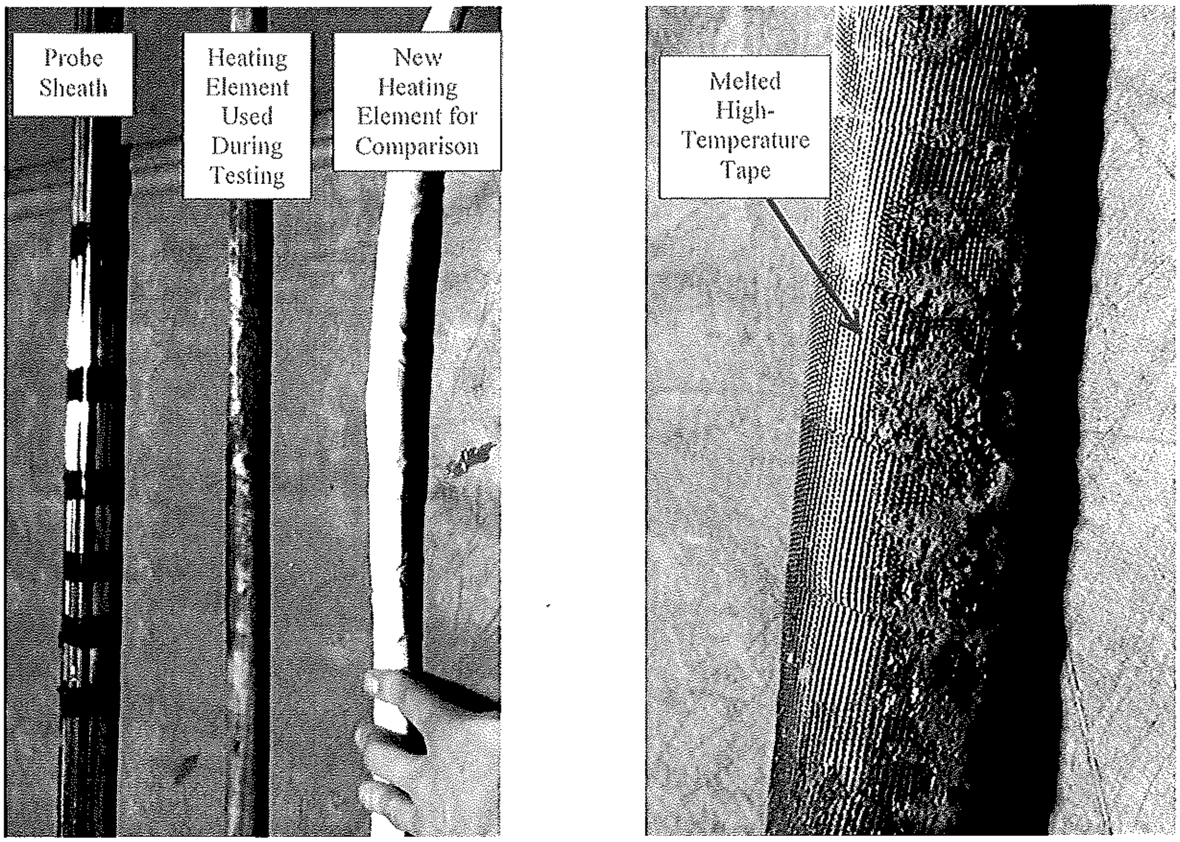

Figure 5-4. Probe Liner Heating Element from EUTURBINE2 Tests

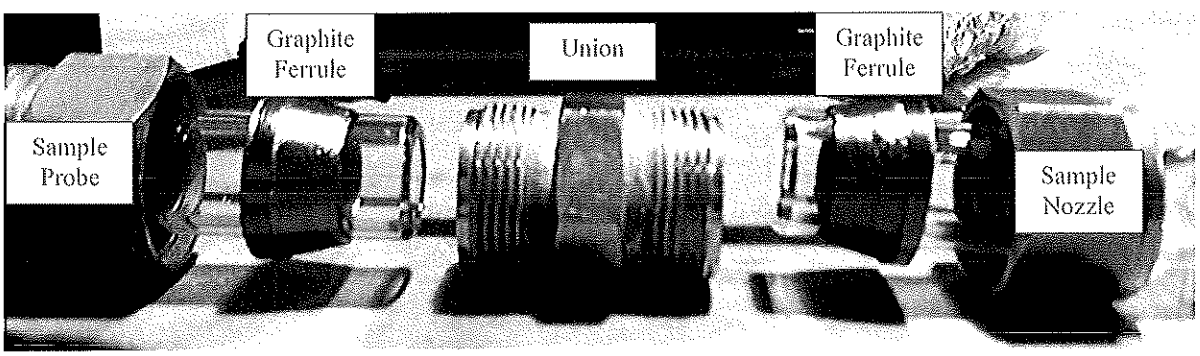

Figure 5-5. Graphite Ferrule and Union Connection

Although, high-temperature corrosion, oxidation, and particle deposition on internal components is documented to occur within natural gas fired turbines, the particulate matter results appear unreasonably high. As the cause is not definitive and the results could be attributed to a number of complex factors, it is Bureau Veritas' opinion the particulate matter results for the EUTURBINE1, EUTURBINE2, FGTURB/HRSG1, and FGTURB/HRSG2 sources should be voided.

Bureau Veritas followed the USEPA Method 5 and 202 pre-test and sampling procedures and review of these procedures did not identify the source of bias.

Limitations

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