

**Air Emissions Testing  
of  
FGTURB/HRSG1 and FGTURB/HRSG2**

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

**State Registration No. B2647  
Permit to Install 149-10B**

Prepared for  
**Lansing Board of Water & Light  
Lansing, Michigan**

Bureau Veritas Project No. 11013-000258.00  
July 25, 2014

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Bureau Veritas North America, Inc.  
22345 Roethel Drive  
Novi, Michigan 48375  
248.344.1770  
[www.us.bureauveritas.com/hse](http://www.us.bureauveritas.com/hse)



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 Lansing Board of Water & Light County Ingham  
Source Address 1201 S. Washington Ave City Lansing  
AQD Source ID (SRN) B2647 RO Permit No. MI-ROP-B2647-2012 RO Permit Section No. \_\_\_\_\_

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).

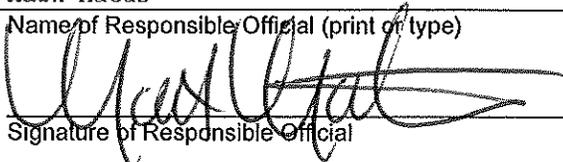
**Other Report Certification**

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

Additional monitoring reports or other applicable documents required by the RO Permit 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 plan 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 Env. Service, Manager 517-702-6153  
Name of Responsible Official (print or type) Title Phone Number  
 Signature of Responsible Official  
Date 7/25/2014



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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)

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 summer season test requirements and evaluate compliance with the following permit:

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

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, 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 8 behind the Tables Tab of this report.



### 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	28.3	24.9	23.8	25.7	28.3	27.0	24.7	26.7	100
		lb/hr	25.5	22.3	20.7	22.9	26.4	24.8	22.3	24.5	51.7
	75%	ppmv	18.7	17.6	17.3	17.9	28.4	27.6	27.9	28.0	50
		lb/hr	19.2	17.6	17.2	18.0	27.7	27.7	27.2	27.5	51.7
	100%	ppmv	26.4	27.7	23.0	25.7	21.7	19.9	20.7	20.8	50
		lb/hr	28.4	28.9	23.0	26.8	23.5	20.6	22.2	22.1	51.7
PM	100%	lb/hr	1.9	0.5	0.7	1.1	0.8	0.7	0.4	0.6	2.1
PM <sub>10</sub>	100%	lb/hr	3.3	1.6	2.0	2.3	6.5	9.1	0.7	5.4	5.5
PM <sub>2.5</sub>	100%	lb/hr	3.3	1.6	2.0	2.3	6.5	9.1	0.7	5.4	5.5

PM<sub>10</sub> emissions include filterable and condensable sample fractions.  
 PM<sub>2.5</sub> emissions include filterable and condensable sample fractions.  
 ppmv: parts per million by volume dry at 15% oxygen  
 lb/hr = pound per hour

The average FGTURB/HRSG1 and FGTURB/HRSG2 emission results indicate compliance with the permit limits.



# 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)

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 summer season test requirements and evaluate compliance with the following permit:

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

## 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
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



## 1.2 Purpose of Testing

The purpose of the emission test program was to satisfy summer season test requirements and evaluate compliance with the following permit:

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

## 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.

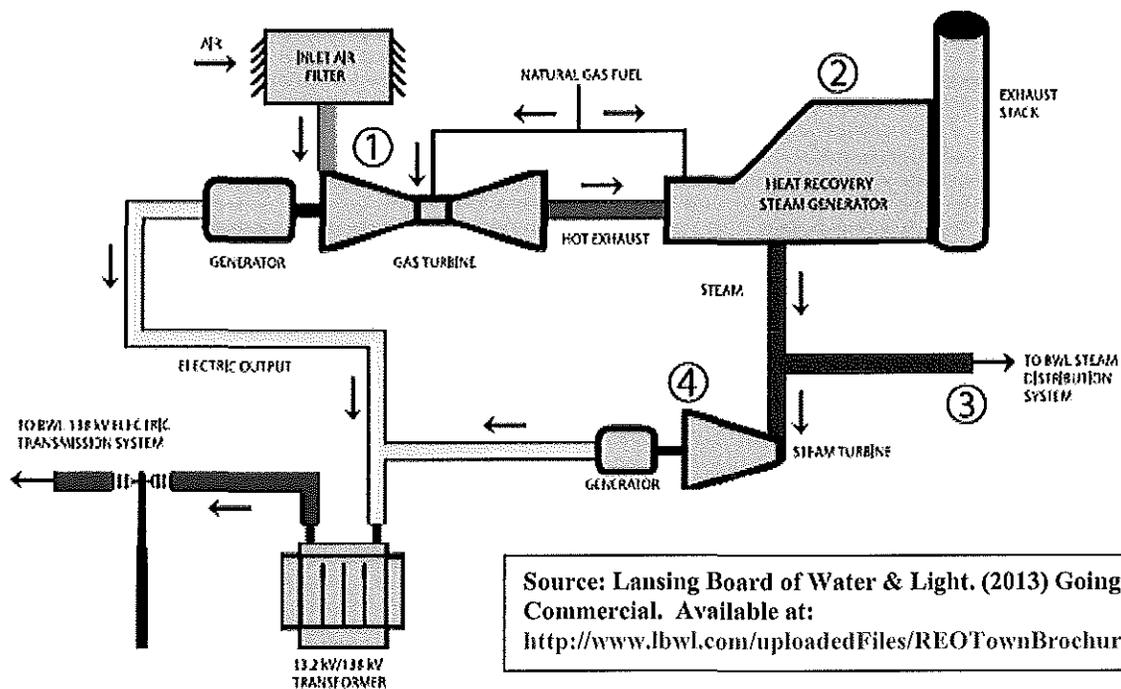
**Table 1-2  
Key Personnel**

<b>Permitee</b>	<b>Emission Testing Company</b>
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
Shannon Whiton Senior Environmental Engineer Telephone 517.702.6003 smw@LBWL.com	Thomas Schmelter, QSTI Senior Project Manager Telephone 248.344.3003 thomas.schmelter@us.bureauveritas.com
<b>Michigan Department of Environmental Quality</b>	
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.



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.

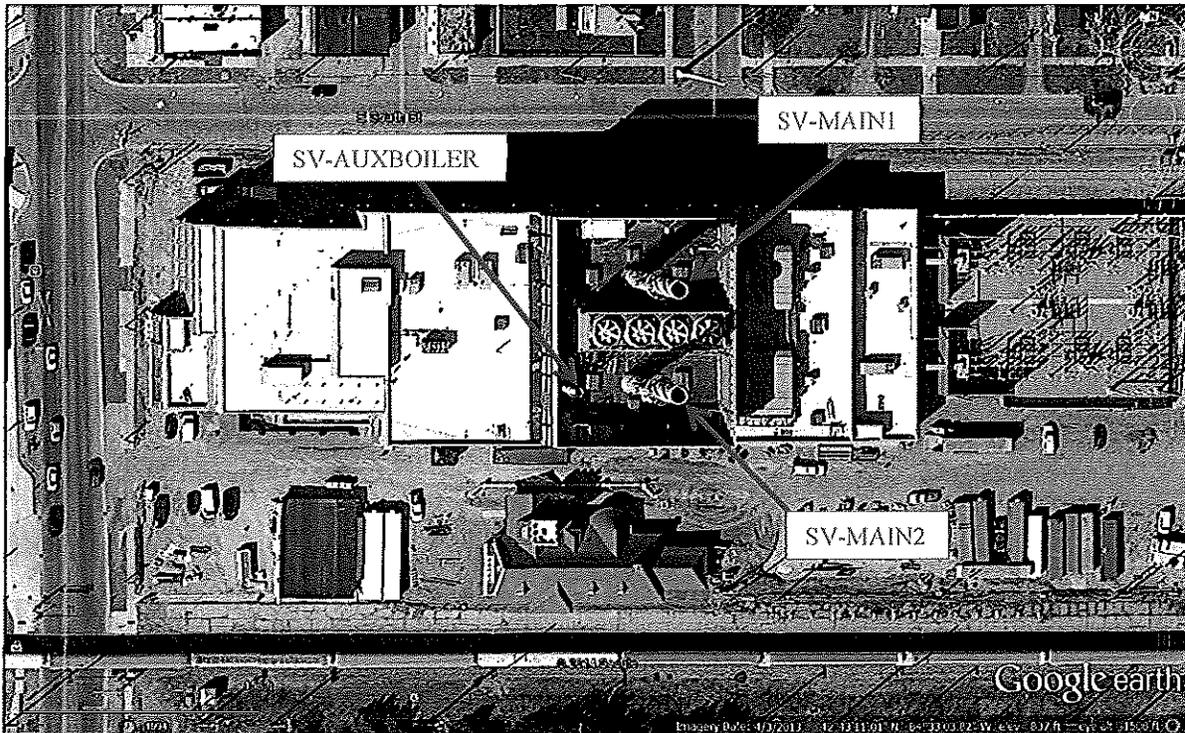
Operating parameters recorded during testing are included in Appendix E.

## **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 ( $\text{NO}_x$ ) burners are installed in EUAUXBOILER to reduce  $\text{NO}_x$  emissions. Low- $\text{NO}_x$  burners reduce emissions by staging the combustion process to delay ignition, which results in a lower combustion temperature. The lower combustion temperature reduces thermal  $\text{NO}_x$  formation.

## **2.3 Flue Gas Sampling Locations**

A description of the FGTURB/HRSG1 and FGTURB/HRSG2 sampling locations are presented in the following sections. Figure 2-2 depicts the exhaust stack sampling locations.



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

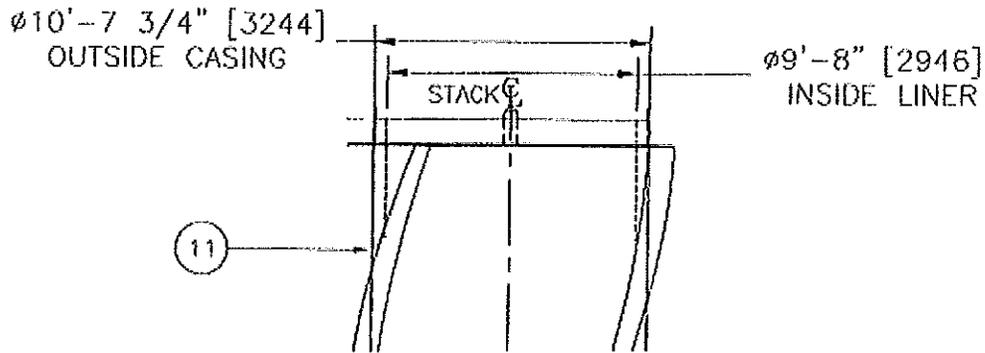
### **2.3.1 Turbine and HRSG Sampling Locations**

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

Four 6-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.

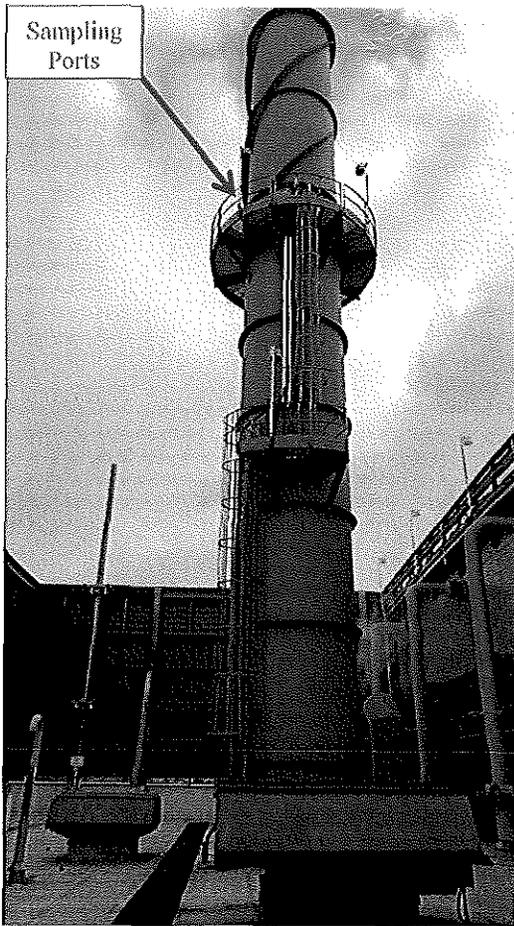
Refer to Figure 2-3 for a portion of the diagram provided by BWL, showing EUTURBINE 1 and 2 with a stack diameter of 116 inches (9 ft. 8 in). The stack diameter of 120 inches as measured by Bureau Veritas and others was used to calculate emissions.



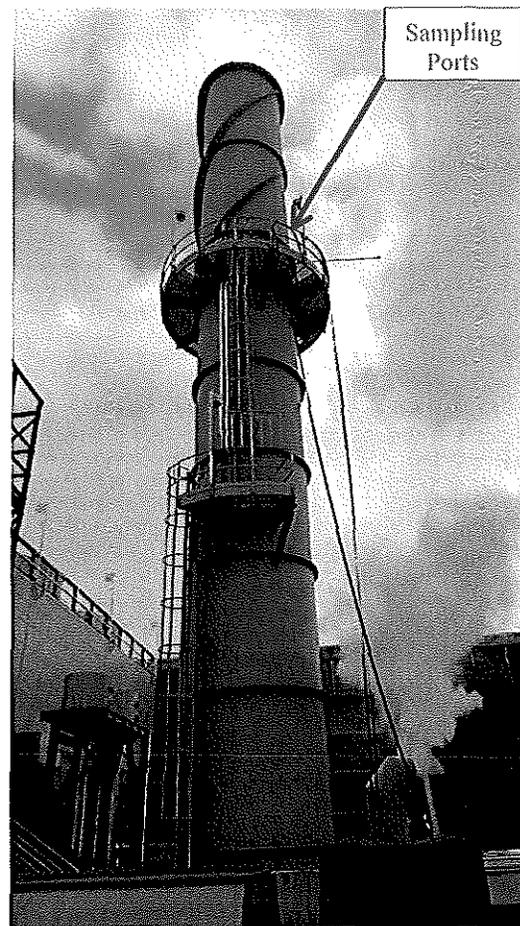
**Figure 2-3. EUTURBINE1 and EUTURBINE2 Stack Diameter**

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**

## 2.4 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 permit limits.

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 <sup>†</sup>	Test Duration (min)
June 10	FGTURB/HRSG1	50% Load	CO	1, 2, 3A, 4, 10	1 2 3	12:17-13:17 13:26-14:26 14:35-15:35	60
	FGTURB/HRSG1	75% Load	CO	1, 2, 3A, 4, 10	1 2 3	7:50-8:50 9:00-10:00 10:11-11:11	60
June 11	FGTURB/HRSG1	100% Load	CO, PM, PM <sub>2.5</sub> , PM <sub>10</sub>	1, 2, 3A, 4, 5, 10, and 202	1 2 3	8:00-10:30 11:03-13:08 13:45-15:50	120
June 12	FGTURB/HRSG2	50% Load	CO	1, 2, 3A, 4, and 10	1 2 3	11:25-12:25 12:33-13:33 13:42-14:42	60
	FGTURB/HRSG2	75% Load	CO	1, 2, 3A, 4, 10	1 2 3	7:26-8:26 8:35-9:35 9:43-10:43	60
June 13	FGTURB/HRSG2	100% Load	CO, PM, PM <sub>2.5</sub> , PM <sub>10</sub>	1, 2, 3A, 4, 5, 10, and 202	1 2 3	7:30-9:34 10:16-12:19 12:49-15:03	120

<sup>†</sup> Times include sampling port changes.