Regulatory Information

Permit No.	EGLE Renewable Operating Permit (ROP) No. MI-ROP-N1395-2021
Regulatory Citation	40 CFR Part 60 & 40 CFR Part 75
Regulatory Agency	US EPA Region 5

Source Information

Source Name	*Source ID*	*Target Parameters*
Wood-Fired Boiler	EUBLR	Volumetric Flow Rate, Moisture, O_2, CO, NOx

Contact Information

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Analytical Laboratory
Not Applicable

Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.

	12/19/23
Kenji Kinoshita **Alliance Technical Group, LLC**	Date

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1.0 Introduction

Alliance Technical Group, LLC (Alliance) conducted performance specification (PS) testing at the Cadillac Renewable Energy facility in Cadillac, Michigan. Portions of the facility are subject to provisions of the 40 CFR Part 60 and 40 CFR Part 75. The facility operates under Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-N1395-2021. PS testing consisted of performing Relative Accuracy Test Audits (RATAs) on one flowrate analyzer, one moisture analyzer, one oxygen (O_2) analyzer, one carbon monoxide (CO) analyzer, and one nitrogen oxides (NOx) analyzer, that service the wood-fired boiler (EUBLR).

1.1 Facility, Process & Control Equipment Descriptions

Cadillac Renewable Energy operates a spreader-stoker design boiler (EUBLR), with a steam rating of 334,085 pound per hour (lb/hr) at 1,025 pound per square inch gage (psig) firing on wood fuel. The steam turbine/generator has a rated output of 39.6 megawatt (MW). Natural gas is used as a startup fuel.

A selective non-catalytic reduction (SNCR) system, a multiclone dust collector, and an electrostatic precipitator (ESP) serve as pollution control equipment for the EUBLR source. Air flow rates are monitored by a Dwyer Flow Gauge, serial number N44P-E.

1.2 CEMS Descriptions

EUBLR

	Pollutant	Pollutant	Pollutant
Parameter:	O_2 (Dry)	CO	NOx
Make:	Teledyne	Teledyne	Teledyne
Model:	T802	T300M	T200H
Serial No.:	247	925	898
Span:	0-25 %	0-500 PPM	0-100 PPM

1.3 Project Team

Personnel involved in this project are identified in the following table.

Table 1-1: Project Team

Facility Personnel	Ryan Putvin
Apex Personnel	Derek Wong
Regulatory Personnel - EGLE	Jeremy Howe Dave Bowman Daniel Droste
Alliance Personnel	Kenji Kinoshita Moritz Stuehn

1.4 Site Specific Test Plan & Notification

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP), submitted to EGLE on October 30, 2023.

2.0 Summary of Results

Alliance conducted PS testing at the Cadillac Renewable Energy facility in Cadillac, Michigan on November 29, 2023. Testing consisted of performing RATAs on one flowrate analyzer, one moisture analyzer, one O_2 analyzer, one CO analyzer, and one NOx analyzer, that service the wood-fired boiler (EUBLR).

Tables 2-1 and 2-2 provide a summary of the emission testing results with comparisons to the applicable NESHAP and EGLE permit limits. Any difference between the summary results listed in the following tables and the detailed results contained in appendices is due to rounding for presentation.

Table 2-1: Summary of P75 Performance Specification Test Results – EUBLR

CEMS	Performance Test Data		Relative Accuracy		BAF
	Reference Method Data	CEMS Data	Performance Required	Performance Demonstrated	
Moisture Data					
Moisture Content, %	20.9	20.9	≤ 7.5% [1]	4.31 %	1.000
Nitrogen Oxides Data					
Emission Factor, lb/MMBtu (O_2 dry)	0.153	0.145	≤ 7.5% [1]	6.23 %	1.060
Oxygen Data					
Concentration, % dry	6.83	6.73	≤ 7.5% [1]	1.56 %	1.000
Volumetric Flow Rate					
High Load Flow Rate, kscfh (wet)	7,550,771	7,549,607	≤ 7.5% [1]	0.82 %	1.000
Low Load Flow Rate, kscfh (wet)	4,853,920	4,851,573	≤ 7.5% [1]	2 %	1.000

[1] RATA frequency of four (4) operating quarters.

Table 2-2: Summary of P60 Performance Specification Test Results – EUBLR

CEMS	Performance Test Data		Relative Accuracy	
	Reference Method Data	CEMS Data	Performance Required	Performance Demonstrated
Nitrogen Oxides Data				
Concentration, ppmvd	93.6	88.9	≤ 10 %	5.53 % [1]
Carbon Monoxide Data				
Emission Rate, lb/hr	10.3	10.9	≤ 10 %	0.42 % [2]
Emission Factor, lb/MMBtu	0.037	0.038	≤ 10 %	0.47 % [2]

[1] Calculated using the mean reference method.
[2] Calculated using the applicable source standard for carbon monoxide (CO).

3.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix C.

Table 3-1: Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1, 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3	Fyrite Analysis
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Moisture Content	4	Gravimetric Analysis
Nitrogen Oxides	7E	Instrumental Analysis
Carbon Monoxide	10	Instrumental Analysis
Mass Emission Factors	19	Fuel Factors/Heat Inputs

3.1 U.S. EPA Reference Test Methods 1 and 2 – Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-2 (measuring velocity alone) in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

Stack gas velocity pressure and temperature readings were recorded before and after each test run. The data collected before and after each test run was averaged. The averages were utilized to calculate the volumetric flow rate in accordance with U.S. EPA Reference Test Method 2.

The relative accuracy of the CERMS was determined based on procedures found in 40 CFR 75, Appendices A & B.

3.2 U.S. EPA Reference Test Method 3 – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3. One (1) integrated Tedlar bag sample was collected during each test run. The bag samples were analyzed on site with a Fyrite O_2/CO_2 analyzer. The Fyrite solutions were verified by conducting a calibration check with EPA Protocol 1 O_2/CO_2 gas. The remaining stack gas constituent was assumed to be nitrogen for the stack gas molecular weight determination.

3.3 U.S. EPA Reference Test Method 3A – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3A. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.8.

The relative accuracy of the O_2 CEMS was determined based on procedures found in 40 CFR 75, Appendices A & B.

3.4 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content (BWS) was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. Prior to testing, each impinger was filled with a known quantity of water or silica gel. Each impinger was analyzed gravimetrically before and after each test run on the same balance to determine the amount of moisture condensed.

3.5 U.S. EPA Reference Test Method 7E – Nitrogen Oxides

The nitrogen oxides (NOx) testing was conducted in accordance with U.S. EPA Reference Test Method 7E. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.8.

The relative accuracy of the NOx CEMS will be determined based on procedures found in 40 CFR 60, Performance Specification 2 and 40 CFR 75, Appendices A & B.

3.6 U.S. EPA Reference Test Method 10 – Carbon Monoxide

The carbon monoxide (CO) testing was conducted in accordance with U.S. EPA Reference Test Method 10. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system, and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.8.

The relative accuracy of the CO CEMS will be determined based on procedures found in CFR 60, Performance Specification 4.

3.7 U.S. EPA Reference Test Method 19 – Mass Emission Factors

The mass emission factor (lb/MMBtu) were calculated using the pollutant concentration, O_2 concentration and the standard F-factors from USEPA Method 19, Table 19-2.

3.8 Quality Assurance/Quality Control – U.S. EPA Reference Test Methods 3A, 7E and 10

EPA Protocol 1 Calibration Gases

Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

Direct Calibration & Calibration Error Test

Low Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low-Level gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas. For the Calibration Error Test, Low, Mid, and High Level calibration gases were sequentially introduced directly to the analyzer. All values were within 2.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

System Bias and Response Time

High or Mid Level gas (whichever was closer to the stack gas concentration) was introduced at the probe and the time required for the analyzer reading to reach 95 percent or 0.5 ppmv/% (whichever was less restrictive) of the gas concentration was recorded. The analyzer reading was observed until it reached a stable value, and this value was recorded. Next, Low Level gas was introduced at the probe and the time required for the analyzer reading to decrease to a value within 5.0 percent or 0.5 ppmv/% (whichever was less restrictive) was recorded. If the Low-Level gas was zero gas, the response was 0.5 ppmv/% or 5.0 percent of the upscale gas concentration (whichever was less restrictive). The analyzer reading was observed until it reached a stable value and this value was recorded. The measurement system response time and initial system bias were determined from these data. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

Post Test System Bias Checks

High or Mid Level gas (whichever was closer to the stack gas concentration) was introduced at the probe. After the analyzer response was stable, the value was recorded. Next, Low Level gas was introduced at the probe, and the analyzer value recorded once it reached a stable response. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference or the data was invalidated and the Calibration Error Test and System Bias were repeated.

Post Test Drift Checks

Drift between pre- and post-run System Bias was within 3 percent of the Calibration Span or 0.5 ppmv/% absolute difference. If the drift exceeded 3 percent or 0.5 ppmv/%, the Calibration Error Test and System Bias were repeated.

Stratification Check

To determine the number of sampling points, a gas stratification check was conducted prior to initiating testing. The pollutant concentrations were measured at three points (16.7, 50.0 and 83.3 percent of the measurement line). Each traverse point was sampled for a minimum of twice the system response time.

If the pollutant concentration at each traverse point did not differ more than 5 percent or 0.5 ppmv/0.3% (whichever was less restrictive) of the average pollutant concentration, then single point sampling was conducted during the test runs. If the pollutant concentration did not meet these specifications but differed less than 10 percent or 1.0 ppmv/0.5% from the average concentration, then three (3) point sampling was conducted (stacks less than 7.8 feet in diameter - 16.7, 50.0 and 83.3 percent of the measurement line; stacks greater than 7.8 feet in diameter – 0.4, 1.0, and 2.0 meters from the stack wall). If the pollutant concentration differed by more than 10 percent or 1.0 ppmv/0.5% from the average concentration, then sampling was conducted at a minimum of twelve (12) traverse points. Copies of stratification check data can be found in the Quality Assurance/Quality Control Appendix.

NO_x Converter Check

An NO_2 – NO converter check was performed on the analyzer prior to initiating testing and at the completion of testing. An approximately 50 ppm nitrogen dioxide cylinder gas was introduced directly to the NOx analyzer and the instrument response was recorded in an electronic data sheet. The instrument response was within +/- 10 percent of the cylinder concentration.

Data Collection

A Data Acquisition System with battery backup was used to record the instrument response in one (1) minute averages. The data was continuously stored as a *.CSV file in Excel format on the hard drive of a computer. At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.