# Relative Accuracy Test Audit

Cadillac Renewable Energy
1525 Miltner Street
Cadillac, Michigan 49601

Source Tested: Wood-Fired Boiler (EUBLR)
Test Dates: August 20 and 21, 2024

Project No. AST-2024-3292

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Prepared By
Alliance Technical Group, LLC
20 Parkway View Drive
Pittsburgh, Pennsylvania 15205

## Regulatory Information

| | |
|---|---|
| *Permit No.* | EGLE Renewable Operating Permit (ROP) No. MI-ROP-N1395-2021 |
| *Regulatory Citation* | 40 CFR Part 60 and 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, $NO_x$ |

## Contact Information

*Test Location*
Cadillac Renewable Energy
1525 Miltner Street
Cadillac, Michigan 49601

Facility Contact
Ryan Putvin
rputvin@atlanticpower.com
(231) 779-8609

Apex Companies, LLC Contact
Dr. Derek Wong
derek.wong@apexcos.com
(284) 875-7581

*Test Company*
Alliance Technical Group, LLC
20 Parkway View Drive
Pittsburgh, Pennsylvania 15205

Project Manager
Kenji Kinoshita
kenji.kinoshita@alliancetg.com
(412) 676-9415

Field Team Leader
Tyler Branca
tyler.branca@alliancetg.com
(724) 456-2116

QA/QC Manager
Kathleen Shonk
katie.shonk@alliancetg.com
(812) 452-4785

Report Coordinator
Kyla Schlink
kyla.schlink@alliancetg.com
(812) 452-4785

Report Reviewer
Kimberly Dyehouse
kimberly.dyehouse@alliancetg.com
(812) 452-4785

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.

**Kenji Kinoshita**
**Alliance Technical Group, LLC**

9/12/24

Date

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# Introduction

## 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 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 ($NO_x$) analyzer, which service the wood-fired boiler (EUBLR).

## 1.1 Facility, Process and 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 gauge (psig) firing with wood fuel. The steam turbine/generator has a rated output of 39.6 megawatts (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 | $NO_x$ |
| 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**

| | |
|---|---|
| **Apex Personnel** | Dr. Derek Wong, P.E. |
| **Facility Personnel** | Ryan Putvin |
| **Regulatory Personnel - EGLE** | Jeremy Howe<br>Shane Nixon<br>Tammie Puite<br>Lindsey Wells |
| **Alliance Personnel** | Tyler Branca<br>Ryne Cooper<br>Dennis Haynes |

### 1.4 Site Specific Test Plan and Notification

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP), submitted to EGLE on July 16, 2024.

# Summary of Results

## 2.0 Summary of Results

Alliance conducted PS testing at the Cadillac Renewable Energy facility in Cadillac, Michigan, on August 20 and 21, 2024. Testing consisted of performing RATAs on one flowrate analyzer, one moisture analyzer, one $O_2$ analyzer, one CO analyzer, and one $NO_x$ analyzer, which 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 Completed on August 20, 2024, with exception of High Load Flow on August 21, 2024**

| CEMS | Performance Test Data | | Relative Accuracy | | BAF |
|---|---|---|---|---|---|
| | Reference Method Data | CEMS Data | Performance Required | Performance Demonstrated | |
| **Moisture** | | | | | |
| Moisture Content, % | 22.61 | 21.68 | ≤20% | 6.59% | No |
| **Nitrogen Oxides** | | | | | |
| Emission Factor, lb/MMBtu ($O_2$ dry) | 0.151 | 0.145 | ≤7.5% [1] | 6.81% | 1.037 |
| **Oxygen** | | | | | |
| Concentration, % wet | 4.9 | 5.0 | ≤ .5% [1] | 1.92% | 1.000 |
| **Volumetric Flow Rate** | | | | | |
| High Load Flow Rate, kscfh (wet) | 6,974,889 | 6,827,778 | ≤7.5% [1] | 3.23% | 1.022 |
| Low Load Flow Rate, kscfh (wet) | 4,157,556 | 4,046,222 | ≤7.5% [1] | 4.39% | 1.028 |

[1] RATA frequency of four operating quarters.

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**Table 2-2: Summary of P60 Performance Specification Test Results – EUBLR**
**Completed on August 20, 2024**

| CEMS | Performance Test Data | | Relative Accuracy | |
|---|---|---|---|---|
| | Reference Method Data | CEMS Data | Performance Required | Performance Demonstrated |
| **Nitrogen Oxides Data** | | | | |
| Concentration, ppmvd | 94.81 | 91.53 | ≤20% | 6.68% [1] |
| Emission Rate, lb/hr | 35.59 | 34.40 | ≤20% | 8.6% [1] |
| **Carbon Monoxide Data** | | | | |
| Concentration, ppmvd | 28.37 | 27.40 | ≤10% | 4.16% [2] |
| Emission Rate, lb/hr | 6.51 | 6.33 | ≤5% | 0.18% [2] |
| Emission Factor, lb/MMBtu | 0.0272 | 0.0261 | ≤5% | 0.31% [2] |

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

# Testing Methodology

## 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 | 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 expressed in 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.

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

### 3.2 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 3.7.

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

### 3.3 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 weighed before and after each test run on the same balance to determine the amount of moisture condensed.

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

The nitrogen oxides ($NO_x$) 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 3.7.

The relative accuracy of the $NO_x$ CEMS was determined based on procedures found in 40 CFR 60, Performance Specification 2 and 40 CFR 75, Appendices A and B.

### 3.5 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 3.7.

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

### 3.6 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.

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

Cylinder calibration gases used met EPA Protocol 1 (±2%) standards. Copies of all calibration gas certificates are included in the Quality Assurance/Quality Control Appendix.

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% of the Calibration Span or 0.5 ppmv/% absolute difference.

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% 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% 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% 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% of the Calibration Span or 0.5 ppmv/% absolute difference.

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% 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.

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

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% 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% 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% or 1.0 ppmv/0.5% from the average concentration, then three point sampling was conducted (stacks less than 7.8 feet in diameter - 16.7, 50.0 and 83.3% 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% 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.

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% of the cylinder concentration.

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.