APEX COMPANIES, LLC

Air Emissions Report
EUBLR Compliance Testing and RATA
Cadillac Renewable Energy
Cadillac, Michigan

PREPARED FOR:
Cadillac Renewable Energy
1525 Miltner Street
Cadillac, Michigan 49601

Apex Project No. 22008171

October 4, 2022

Apex Companies, LLC
46555 Humboldt Drive, Suite 103
Novi, Michigan 48377

APEX

Table of Contents

Tables

Figures

Appendix

Tables

Figures

Graphs

Appendix

Executive Summary

Cadillac Renewable Energy retained Apex Companies, LLC (Apex) to conduct air emissions testing at the Cadillac Renewable Energy facility in Cadillac, Michigan. The purpose of the air emission testing was to (1) evaluate compliance with certain emission limits for one wood-fired boiler (EUBLR) in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N1395-2021, effective January 8, 2021, and (2) perform Relative Accuracy Test Audits (RATAs) on several analyzers associated with EUBLR.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1 through 5, 3A, 7E, 10, 19, 25A, 205, SW-846 0010, and Performance Specifications PS-2, PS-3, PS-4, and PS-6.

Detailed results are presented in Tables 1 through 11 after the Tables Tab of this report. The following tables summarize the results of the testing conducted on August 23 through 25, 2022.

EUBLR Emissions Results

Parameter	Unit	Average Result	Permit Limit
Particulate matter	lb/hr	0.6	15.7
	lb/MMBtu	0.001	0.03
VOCs	lb/hr	0.4	22.5
	lb/MMBtu	0.001	0.043
Benzo(*a*)pyrene	lb/hr	<0.0012	0.0054
	μg/m³	<3.0	10

VOCs: volatile organic compounds
lb/hr: pound per hour
lb/MMBtu: pound per million British thermal unit
μg/m³: microgram per cubic meter

EUBLR Relative Accuracy Test Audit Results

Parameter	Average RM Result	Average CEMS Result	Difference between CEMS and RM	Relative Accuracy (%)	Performance Specification
Flowrate, Low Load (scf/hr)	4,788,074	4,631,892	156,183	**4.1%**	**≤10% RM†**
Flowrate, Mid Load (scf/hr)	6,258,910	6,203,536	55,373	**2.4%**	**≤10% RM†**
Flowrate, High Load (scf/hr)	7,602,876	7,439,368	163,508	**2.8%**	**≤10% RM†**
Moisture content (%)	21.9	20.9	1.0	**6.0%**	**≤10% RM†**
Oxygen (%)	5.63	5.70	-0.07	**1.7%**	**≤10% RM†**
Nitrogen oxides (ppm)	96.4	95.6	0.8	**1.6%**	**≤10% RM†**
Nitrogen oxides (lb/MMBtu)	0.1457	0.1450	0.0007	**1.1%**	**≤10% RM†**
Carbon monoxide (lb/hr)	7.60	8.08	-0.48	**0.3%**	**≤5% AS**
Carbon monoxide (lb/MMBtu)	0.0257	0.0280	-0.0023	**0.7%**	**≤5% AS**

CEMS: continuous emission monitoring system
scf/hr: standard cubic foot per hour
ppm: part per million
lb/MMBtu: pound per million British thermal unit
lb/hr: pound per hour
RM: Reference Method
AS: Applicable Standard
† Relative accuracy ≤10% RM requires semi-annual testing, and ≤7.5% RM requires annual testing

1.0 Introduction

1.1 Summary of Test Program

Cadillac Renewable Energy retained Apex Companies, LLC (Apex) to conduct air emissions testing at the Cadillac Renewable Energy facility in Cadillac, Michigan. The purpose of the air emission testing was to (1) evaluate compliance with certain emission limits for one wood-fired boiler (EUBLR) in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N1395-2021, effective January 8, 2021, and (2) perform Relative Accuracy Test Audits (RATAs) on several analyzers associated with EUBLR.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1 through 5, 3A, 7E, 10, 19, 25A, 205, SW-846 0010, and Performance Specifications PS-2, PS-3, PS-4, and PS-6.

Table 1-1 lists the emission source tested, parameters, and test dates.

Table 1-1
Source Tested, Parameters, and Test Dates

Source	Test Parameter	Test Date(s)
EUBLR	Particulate matter (PM) Volatile organic compounds (VOCs) Benzo(*a*)pyrene (BaP) Carbon monoxide (CO) Nitrogen oxides (NO_X) Oxygen (O_2) Moisture content Flowrate	August 23, 2022 August 24. 2022 August 25, 2022

1.2 Key Personnel

The key personnel involved in this test program are listed in Table 1-2. Mr. David Kawasaki, with Apex, led the emission testing program. Mr. Ryan Putvin, Mr. Chase Shepherd, and Mr. Jeremy Quist, all with Cadillac Renewable Energy, provided process coordination and recorded operating parameters. Mr. Jeremy Howe, Mr. Dave Bowman, and Mr. Daniel Droste, all with EGLE, witnessed the testing and verified production parameters were recorded.

Table 1-2
Key Contact Information

Client	Apex
Ryan Putvin O&M Manager **Cadillac Renewable Energy** 1525 Miltner Street Cadillac, Michigan 49601 Phone: 231.779.8609x3 rputvin@atlanticpower.com	David Kawasaki, QSTI Senior Engineer **Apex Companies, LLC** 46555 Humboldt Drive, Suite 103 Novi, Michigan 48377 Phone: 248.590.5134 david.kawasaki@apexcos.com
EGLE	
Dave Bowman Environmental Quality Analyst **EGLE Air Quality Division** 2100 West M-32 Gaylord, Michigan 49735 Phone: 989.395.6298 bowmand7@michigan.gov	Jeremy Howe Supervisor, Technical Programs Unit **EGLE Air Quality Division** P.O. Box 30260 Lansing, Michigan 48909 Phone: 231.878.6687 howej1@michigan.gov

2.0 Source and Sampling Locations

2.1 Process Description

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.

Operating parameters were measured and recorded by Cadillac Renewable Energy personnel during testing. Table 2-1 summarizes the operating conditions during testing of EUBLR. Additional operating parameter data are included in Appendix F.

Table 2-1
Summary of EUBLR Electricity Production

Test Run	Boiler High Load, Aug. 23 (MW)	Boiler Mid Load, Aug. 24 (MW)	Boiler Low Load, Aug. 25 (MW)
1	35.1	24.2	15.7
2	35.1	23.4	15.4
3	34.5	23.2	15.1
4	33.3	24.4	15.2
5	34.0	23.9	15.0
6	34.2	24.6	14.9
7	33.9	25.1	15.0
8	34.3	25.0	15.0
9	34.4	24.5	15.1
Average	**34.3**	**24.3**	**15.2**

2.2 Control Equipment Description

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.

The flow rate CERMS installed on the EUBLR exhaust stack is used to evaluate continuous compliance with permit limits.

2.3 Flue Gas Sampling Location

Four sampling ports oriented at 90° to one another are located in a straight section of a 96 inch-internal-diameter duct. The sampling ports are located:

- Approximately 36 feet (4.5 duct diameters) from the nearest downstream disturbance.
- Approximately 60 feet (7.5 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible from a platform on the stack. The platform is accessed via stairs and ladder. A photograph of the EUBLR outlet sampling location is presented in Figure 2-1. Figure 1 in the Appendix depicts the EUBLR outlet sampling ports and traverse point locations.

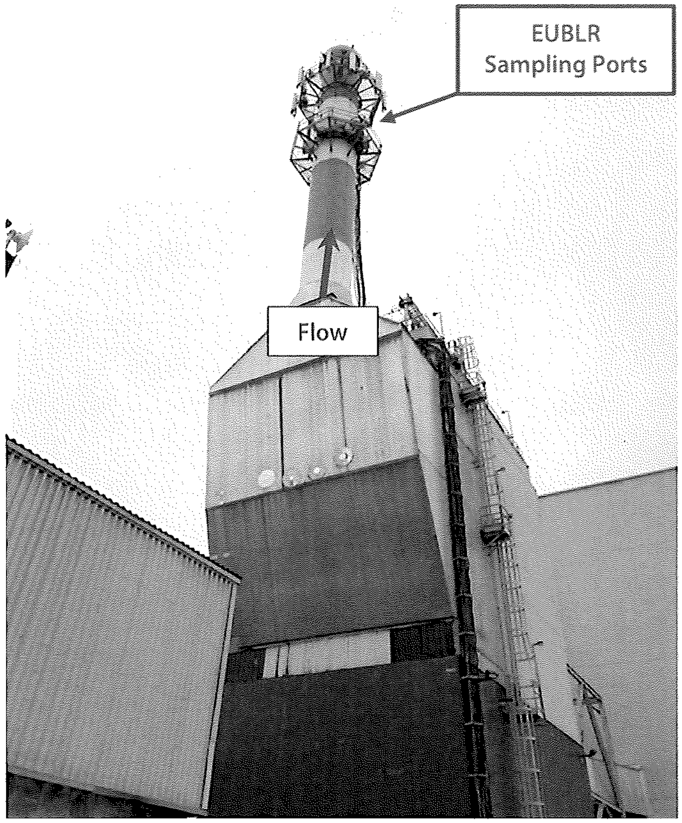


Figure 2-1. EUBLR Outlet Sampling Location

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 objective of the air emission testing was to (1) evaluate compliance with certain emission limits for one wood-fired boiler (EUBLR) in EGLE ROP MI-ROP-N1395-2021, effective January 8, 2021, and (2) perform RATAs on several analyzers associated with EUBLR.

Table 3-1 summarizes the sampling and analytical matrix.

Table 3-1
Sampling and Analytical Matrix

Sampling Location	Sample/Type of Pollutant	Sample Method	Date (2022)	Run	Start Time	End Time	Analytical Laboratory
EUBLR (High Load)	Flowrate, molecular weight, moisture content, PM, BaP	USEPA 1, 2, 3, 4, 5, 19, SW-846 0010	Aug. 23	1	1144	1500	Bureau Veritas Laboratories
				2	1523	1829	
			Aug. 24	3	0713	1018	
	Flowrate, molecular weight, moisture content, VOCs	USEPA 1, 2, 3, 4, 19, 25A, 205	Aug. 23	1	1155	1255	Not applicable
				2	1305	1405	
				3	1417	1517	
	Flowrate, molecular weight, moisture content	USEPA 1, 2, 3, 4, PS-6	Aug. 23	1	1200	1211	Not applicable
				2	1212	1223	
				3	1224	1235	
				4	1302	1313	
				5	1314	1325	
				6	1326	1337	
				7	1405	1416	
				8	1417	1428	
				9	1429	1440	
EUBLR (Mid Load)	Flowrate, molecular weight, moisture content	USEPA 1, 2, 3, 4, PS-6	Aug. 24	1	1139	1150	Not applicable
				2	1151	1202	
				3	1203	1214	
				4	1226	1237	
				5	1238	1249	
				6	1250	1301	
				7	1313	1324	
				8	1325	1336	
				9	1337	1348	
EUBLR (Low Load)	Flowrate, molecular weight, moisture content, O_2, NO_x, CO	USEPA 1, 2, 3A, 4, 7E, 10, 19, 205, PS-2, PS-3, PS-4, PS-6	Aug. 25	1	0701	0726	Not applicable
				2	0742	0807	
				3	0820	0845	
				4	0848	0913	
				5	0926	0951	
				6	0954	1019	
				7	1031	1056	
				8	1100	1125	
				9	1136	1201	

3.2 Field Test Changes and Issues

Communication between Cadillac Renewable Energy, Apex, and EGLE allowed the testing to be completed as proposed on the July 13, 2022 Intent-to-Test Plan, with the following exceptions:

- Analyzer RATAs (oxygen, moisture content, nitrogen oxides, and carbon monoxide) were conducted on the EUBLR Low load. The change was made because the Low load is the most common and normal operation.
- USEPA Method 3, instead of USEPA Method 3A, was used for molecular weight measurements on the High and Mid loads.
- An expired gas cylinder (CC96621) was used for carbon monoxide calibrations during testing. The cylinder was recertified post-test and the recertified values were used for calibration and bias corrections. The difference between the expired value and the post-test recertified value did not affect test results.

3.3 Summary of Results

The results of testing are presented in Tables 3-2 and 3-3. Detailed results are presented in the Appendix Tables 1 through 11 after the Tables Tab of this report. Graphs are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
EUBLR Emissions Results

Parameter	Unit	Run 1	Run 2	Run 3	Average Result	Permit Limit
Particulate matter	lb/hr	0.4	0.7	0.7	**0.6**	**15.7**
	lb/MMBtu	0.001	0.001	0.001	**0.001**	**0.03**
VOCs	lb/hr	0.4	0.4	0.4	**0.4**	**22.5**
	lb/MMBtu	0.001	0.001	0.001	**0.001**	**0.043**
Benzo(*a*)pyrene	lb/hr	<0.0011	<0.0012	<0.0012	**<0.0012**	**0.0054**
	μg/m^3	<2.9	<3.1	<3.0	**<3.0**	**10**

VOCs: volatile organic compounds
lb/hr: pound per hour
lb/MMBtu: pound per million British thermal unit
μg/m^3: microgram per cubic meter

Table 3-3
EUBLR Relative Accuracy Test Audit Results

Parameter	Average RM Result	Average CEMS Result	Difference between CEMS and RM	Relative Accuracy (%)	Performance Specification
Flowrate, Low Load (scf/hr)	4,788,074	4,631,892	156,183	**4.1%**	**≤10% RM†**
Flowrate, Mid Load (scf/hr)	6,258,910	6,203,536	55,373	**2.4%**	**≤10% RM†**
Flowrate, High Load (scf/hr)	7,602,876	7,439,368	163,508	**2.8%**	**≤10% RM†**
Moisture content (%)	21.9	20.9	1.0	**6.0%**	**≤10% RM†**
Oxygen (%)	5.63	5.70	-0.07	**1.7%**	**≤10% RM†**
Nitrogen oxides (ppm)	96.4	95.6	0.8	**1.6%**	**≤10% RM†**
Nitrogen oxides (lb/MMBtu)	0.1457	0.1450	0.0007	**1.1%**	**≤10% RM†**
Carbon monoxide (lb/hr)	7.60	8.08	-0.48	**0.3%**	**≤5% AS**
Carbon monoxide (lb/MMBtu)	0.0257	0.0280	-0.0023	**0.7%**	**≤5% AS**

CEMS: continuous emission monitoring system
scf/hr: standard cubic foot per hour
ppm: part per million
lb/MMBtu: pound per million British thermal unit
lb/hr: pound per hour
RM: Reference Method
AS: Applicable Standard
† Relative accuracy ≤10% RM requires semi-annual testing, and ≤7.5% RM requires annual testing

4.0 Sampling and Analytical Procedures

Apex measured emissions in accordance with USEPA sampling methods. Table 4-1 presents the emissions test parameters and sampling methods.

Table 4-1
Emission Testing Methods

Parameter	EUBLR	USEPA Reference	
		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
Oxygen (O_2) and carbon dioxide (CO_2)	•	3A	Determination of Oxygen and Carbon Dioxide Emissions from Stationary Sources (Instrument Analyzer Procedure)
Moisture content	•	4	Determination of Moisture Content in Stack Gases
Particulate matter	•	5	Determination of Particulate Matter Emissions from Stationary Sources
Nitrogen oxides (NO_X)	•	7E	Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrument Analyzer Procedure)
Carbon monoxide (CO)	•	10	Determination of Carbon Monoxide Emissions from Stationary Sources (Instrument Analyzer Procedure)
Emission rate	•	19	Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates
Volatile organic compounds (VOCs)	•	25A	Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer
Gas dilution	•	205	Verification of Gas Dilution Systems for Field Instrument Calibrations
Benzo(*a*)pyrene (BaP)	•	SW-846 0010	Semi-Volatile Principal Organic Hazardous Compounds from Incineration Systems
NO_X RATA	•	PS-2	Specifications and Test Procedures for SO_2 and NO_x Continuous Emission Monitoring Systems in Stationary Sources
O_2 RATA	•	PS-3	Specifications and Test Procedures for O_2 and CO_2 Continuous Emission Monitoring Systems in Stationary Sources
CO RATA	•	PS-4	Specifications and Test Procedures for Carbon Monoxide Continuous Emission Monitoring Systems in Stationary Sources
Flow RATA	•	PS-6	Specifications and Test Procedures for Continuous Emission Rate Monitoring Systems in Stationary Sources

4.1 Emission Test Methods

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," was used to evaluate the sampling locations and the number of traverse points for sampling and the measurement of velocity profiles. Figure 1 in the Appendix depicts the source locations and traverse points.

USEPA 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 flowrates. S-type Pitot tubes and thermocouple assemblies, calibrated in accordance with Method 2, Section 10.0, were used during testing. Because the dimensions of the Pitot tubes met the requirements outlined in Method 2, Section 10.1, and are within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. The digital manometer and thermometer are calibrated using calibration standards that are traceable to National Institute of Standards and Technology (NIST). Pitot tube inspection sheets are included in Appendix A.

Cyclonic Flow Check. Apex 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°, the flue gas is considered to be cyclonic at that sampling location and an alternative location should be selected.

The average of the measured traverse point flue gas velocity null angles were less than 20° at the sampling location. The measurements indicate the absence of cyclonic flow.

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)

USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight," was used to determine the molecular weight of the flue gas. Flue gas was extracted from the stack through a probe and directed into a Fyrite® gas analyzer. The concentrations of carbon dioxide (CO_2) and oxygen (O_2) were measured by chemical absorption to within ±0.5%. The average CO_2 and O_2 results of the grab samples were used to calculate molecular weight.

4.1.3 Moisture Content (USEPA Method 4)

USEPA Method 4, "Determination of Moisture Content in Stack Gases" was used to determine the moisture content of the flue gas. Refer to Figure 4-1 for a drawing of the USEPA Method 4 sampling train.

Apex's modular USEPA Method 4 stack sampling system consists of:

- A stainless steel probe.
- Tygon® umbilical line connecting the probe to the impingers.
- A set of four impingers with the configuration shown in Table 4-2.
- A sampling line.

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

Table 4-2
USEPA Method 4 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Contents
1	Modified	Water	~100 grams
2	Greenburg Smith	Water	~100 grams
3	Modified	Empty	0 grams
4	Modified	Silica desiccant	~300 grams

Prior to initiating a test run, the sampling train was leak-checked by capping the probe tip and applying a vacuum of at least 5 inches of mercury to the sampling train. The dry-gas meter was monitored for approximately 1 minute to verify the sample train leak rate was less than 0.02 cfm. The sample probe was then inserted into the sampling port near the centroid of the stack in preparation of sampling. Flue gas was extracted at a constant rate from the stack, with moisture removed from the sample stream by the chilled impingers.

At the conclusion of the test run, a post-test leak check was conducted and the impinger train was carefully disassembled. The weight of liquid or silica gel in each impinger was measured with a scale capable of measuring to the nearest 0.5 gram. The weight of water collected within the impingers and volume of flue gas sampled were used to calculate the percent moisture content.

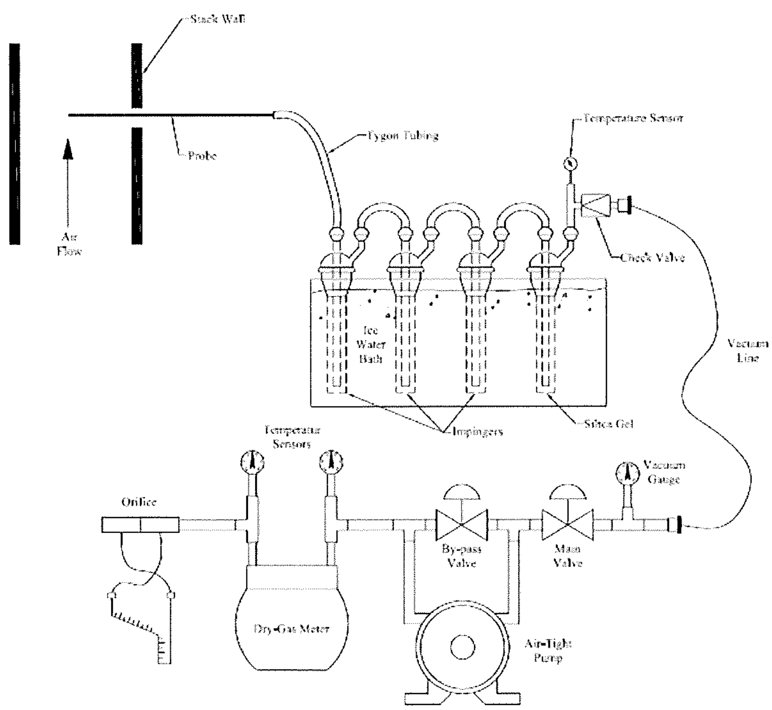


Figure 4-1. USEPA Method 4 Sampling Train

4.1.4 Filterable Particulate Matter (USEPA Method 5) and Benzo(a)pyrene (USEPA Method SW-846 0010)

USEPA Method 5, "Determination of Particulate Emissions from Stationary Sources," was used to measure the filterable "front-half" particulate matter emissions. The "front half" refers to the filterable particulate mass collected from the nozzle, probe, and filter. USEPA Method SW-846 0010, "Semi-Volatile Principal Organic Hazardous Compounds from Incineration Systems," was used to measure benzo(*a*)pyrene emissions. Figure 4-2 depicts the USEPA Methods 5 and SW-846 0010 sampling train.

Apex's modular isokinetic stack sampling system consists of the following:

- A glass button-hook nozzle.
- A heated (248±25°F) glass-lined probe.
- A pre-cleaned glass 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 glass recirculating ice water condenser system.
- A XAD-2 sorbent trap.
- A set of four impingers with the configuration shown in Table 4-3.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-3
USEPA Methods 5 and SW-846 0010 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Contents
1	Modified	Water	~100 grams
2	Greenburg Smith	Water	~100 grams
3	Modified	Empty	0 grams
4	Modified	Silica desiccant	~300 grams

Prior to testing, a preliminary velocity traverse was performed and a nozzle size was calculated that allowed isokinetic sampling at an average rate of approximately 0.75 cubic feet per minute (cfm). Apex selected a pre-cleaned nozzle that had an inner diameter that approximates the calculated ideal value. The nozzle was inspected and measured with calipers across three cross-sectional chords to evaluate the inside diameter; rinsed and brushed with acetone; and connected to the sample probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a velocity head of 3.0 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of at least 5 inches of mercury to the sampling train. The dry-gas meter was then monitored (for approximately 1 minute) to measure that the sample train leak rate was less than 0.02 cubic feet per minute (cfm). The probe and filter heaters were turned on, and the sample probe was inserted into the sampling port to begin sampling.

Ice was placed around the impingers, and the 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 100±10 % for the duration of the test. Data were recorded at each of the traverse points.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the condenser, XAD-2 trap, impingers, and filter was transported to the recovery area. The XAD-2 trap was removed from the sampling train, tightly capped at both ends, labeled, covered with aluminum foil, and stored in an iced cooler to be transported to the laboratory. The filter was recovered using Teflon-lined tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed. The nozzle, probe, filter housing, and condenser were brushed and triple rinsed with acetone and stored in a pre-cleaned sample container. Then, the nozzle, probe, filter housing, and condenser were brushed and triple rinsed with a 1:1 v/v mix of methylene chloride and methanol, which was collected in a separate pre-cleaned sample container.

At the end of a test run, the liquid volume collected in each impinger, including the silica gel, was weighed. These volumes were used to calculate moisture content of the flue gas. The impinger water was recovered into a pre-cleaned sample container. Then, the impingers were rinsed with a 1:1 v/v mix of methylene chloride and methanol, which were collected in a separate pre-cleaned sample container.

Apex labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. Immediately after recovery, the sample containers were stored. The sample containers were transported to Bureau Veritas Laboratories in Mississauga, Ontario, Canada for analysis. The laboratory analytical results are included in Appendix E.

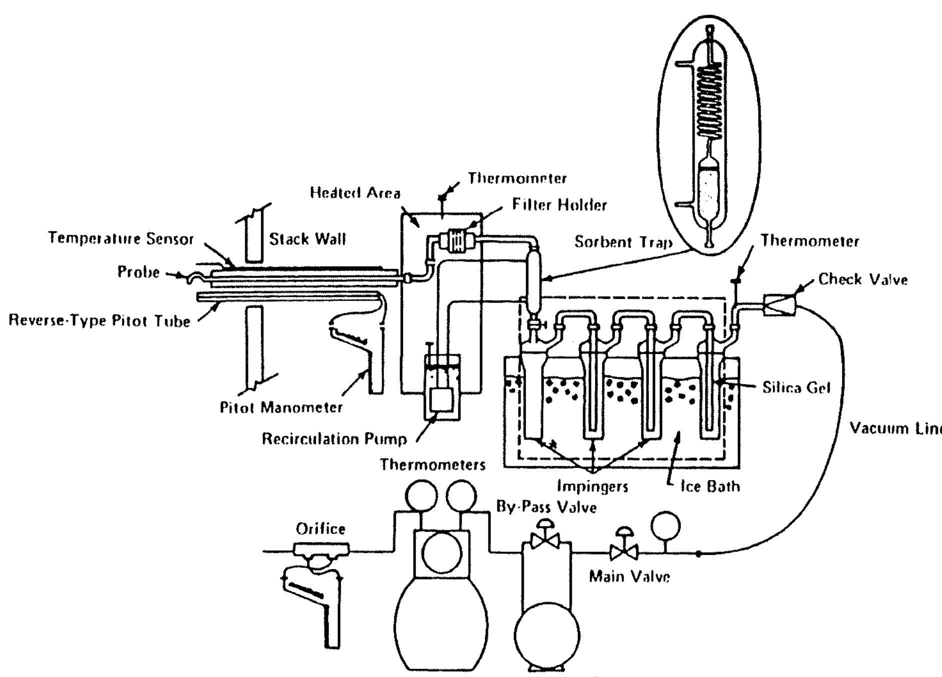


Figure 4-2. USEPA Methods 5 and SW-846 0010 Sampling Train

4.1.5 Oxygen, Carbon Dioxide, Nitrogen Oxides, and Carbon Monoxide (USEPA Methods 3A, 7E, and 10)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations from Stationary Sources (Instrumental Analyzer Procedure)," was used to measure oxygen (O_2) and carbon dioxide (CO_2) concentrations in the flue gas. USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)," was used to measure nitrogen oxides (NO_X) concentrations in the flue gas. USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)," was used to measure carbon monoxide (CO) concentrations in the flue gas. Flue gas was continuously sampled in the stack and conveyed to an analyzer for concentration measurements. Flue gas was extracted from the stack through:

- A stainless-steel probe.
- Heated Teflon sample line to prevent condensation.
- A chilled Teflon impinger train (equipped with a peristaltic pump) to remove moisture from the sampled gas stream prior to entering the analyzer.
- O_2, CO_2, NOx, and CO analyzers.

Figure 4-3 depicts the USEPA Methods 3A, 7E, and 10 sampling train. Data was recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded concentrations were averaged over the duration of each test run.

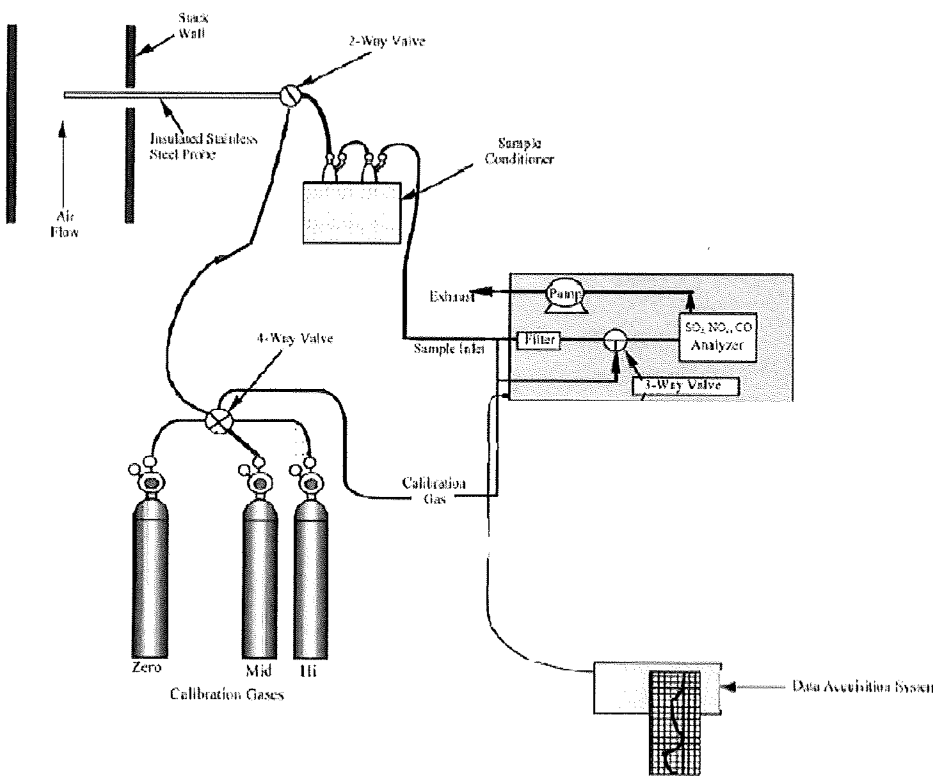


Figure 4-3. USEPA Methods 3A, 7E, and 10 Sampling Train

Testing was conducted along the 3-point short line, at depths of 0.4, 1.2, and 2.0 meters into the stack.

The pollutant concentrations were measured using an analyzer calibrated with zero-, mid-, and high-USEPA-Traceability-Protocol-certified calibration gases. The mid-level gas was 40 to 60% of the high-level (also referred to as span) gas.

Calibration Error Check. A calibration error check was performed by introducing zero-, mid-, and high-level calibration gases directly into the analyzer. The calibration error check was performed to verify the analyzer response was within ±2% of the certified calibration gas introduced.

System Bias Test. Prior to each test run, a system bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if an analyzer's response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run, an additional system-bias check was performed to evaluate the analyzer drift from pre- and post-test system-bias checks. The system-bias check evaluates the analyzer drift against the ±3% quality assurance/quality control (QA/QC) requirement.

The analyzer drift data was used to correct the measured flue gas concentrations. Recorded concentrations were averaged over the duration of each test run.

NO/NO2 Conversion Check. An NO/NO_2 conversion check was performed prior to testing by introducing an NO_2 calibration gas into the NO_X analyzer. The analyzer's NO_X concentration response was greater than 90% of the introduced NO_2 calibration gas concentration and met the converter efficiency requirement of Section 13.5 of USEPA Method 7E.

4.1.6 Emission Rate (USEPA Method 19)

USEPA Method 19, "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates," was used to calculate emission rates of PM, VOC, NO_X, and CO in pounds per million British thermal units. Oxygen concentrations and standard F-factors from USEPA Method 19, Table 19-2 were used to calculate emission rates using USEPA Method 19 Equation 19-1:

$$E = C_d F_d \left(\frac{20.9}{20.9 - \%O_{2d}} \right)$$

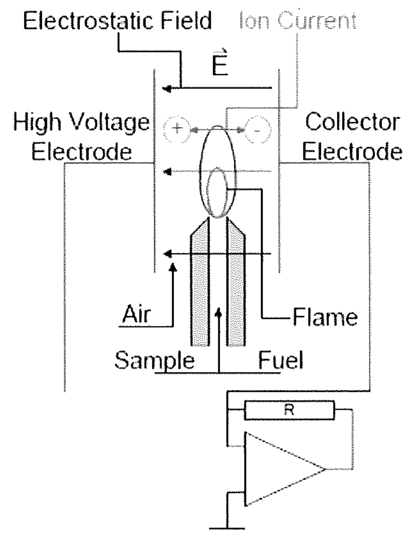
Where:

E	=	Pollutant emission rate (lb/MMBtu)
C_d	=	Pollutant concentration, dry basis (lb/dscf)
F_d	=	F factor (dscf/MMBtu)
$\%O_{2d}$	=	Oxygen concentration, dry basis (%, dry)

4.1.7 Volatile Organic Compounds (USEPA Method 25A)

USEPA Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer," was used to measure volatile organic compound concentrations in the flue gas. Samples were collected through a stainless-steel probe and heated sample line into an analyzer.

A flame ionization detector (FID) determines the average hydrocarbon concentration in part per million by volume (ppmv) of VOC as the calibration gas (i.e., propane). The FID is fueled by 100% hydrogen, which generates a flame with a negligible number of ions. Flue gas is introduced into the FID and enters the flame chamber. The combustion of flue gas generates electrically charged ions. The analyzer applies a polarizing voltage between two electrodes around the flame, producing an electrostatic field. Negatively charged ions, or anions, migrate to a collector electrode, while positive charged ions, or cations, migrate to a high-voltage electrode. The current between the electrodes is directly proportional to the hydrocarbon concentration in the sample. The flame chamber is depicted at right.



Using the voltage analog signal, measured by the FID, the concentration of VOCs was recorded by a data acquisition system (DAS). The average concentration of VOCs is reported as the calibration gas (i.e., propane) in equivalent units.

Before testing, the analyzer was calibrated by introducing a zero-calibration range gas (<1% of span value) and high-calibration range gas (80-90% span value) to the tip of the sampling probe. The span value was set to 1.5 to 2.5 times the expected concentration (e.g., 0-100 ppmv). Next, a low-calibration range gas (25-35% of span value) and mid-calibration range gas (45-55% of span value) were introduced. The analyzers are considered to be calibrated when the analyzer response is ±5% of the calibration gas value.

At the conclusion of a test run, a calibration drift test was performed by introducing the zero- and low-calibration gas to the tip of the sampling probe. The test run data was considered valid if the calibration drift test demonstrated the analyzers are responding within 3% of the calibration span from pre-test to post-test calibrations.

Figure 4-4 depicts the USEPA Method 25A sampling train.

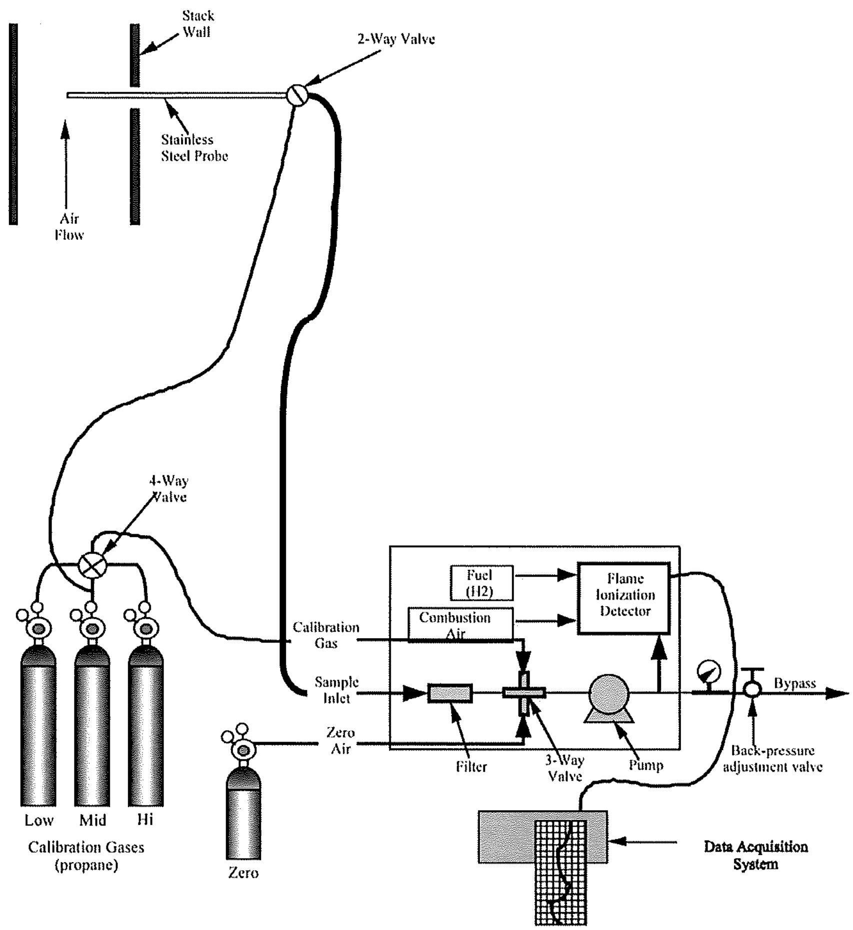


Figure 4-4. USEPA Method 25A Sampling Train

4.1.8 Gas Dilution (USEPA Method 205)

USEPA Method 205, "Verification of Gas Dilution Systems for Field Instrument Calibrations," was used to introduce known values of calibration gases into the analyzers. The gas dilution system consists of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with USEPA Method 205.

Prior to testing, the gas divider dilutions were measured to evaluate that they were within ±2% of predicted values. Two sets of three dilutions of the high-level calibration gas were performed. In addition, a certified mid-level calibration gas was introduced into an analyzer; this calibration gas concentration was within ±10% of a gas divider dilution concentration.

4.2 Process Data

Cadillac Renewable Energy personnel recorded process data during testing. EGLE personnel verified the requested operating and process data were recorded. Process data are included in Appendix F.

5.0 Quality Assurance and Quality Control

5.1 QA/QC Procedures

Equipment used in this emissions test program passed Quality Assurance (QA) and Quality Control (QC) procedures. Refer to Appendix A for equipment calibrations. 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 III, Stationary Source-Specific Methods."

5.2 QA/QC Audits

Onsite QA/QC procedures (i.e., Pitot tube inspections, nozzle size verifications, leak check, calculation of isokinetic sampling rates, calibrations) were performed in accordance with the respective USEPA sampling methods. Equipment inspection and calibration measurements are presented in Appendix A.

Offsite QA audits include dry-gas meter and thermocouple calibrations.

5.2.1 Sampling Train QA/QC

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Table 5-1 summarizes the QA/QC audits conducted on each sampling train.

Table 5-1
USEPA Methods 4, 5, and SW-846 0010 Sampling Train QA/QC

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
Particulate Matter and Benzo(*a*)pyrene					
Average velocity pressure head (in H_2O)	0.89	0.94	0.96	>0.05 in H_2O	Valid
Sampling train post-test leak check	0 ft^3 for 1 min at 10 in Hg	0 ft^3 for 1 min at 9 in Hg	0 ft^3 for 1 min at 10 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	7.5 to 10	5 to 6.5	7 to 9		
Moisture Content for High Load RATA					
Sampling train post-test leak check	0 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 5 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
Moisture Content for Mid Load RATA					
Sampling train post-test leak check	0 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 4 in Hg	0 ft^3 for 1 min at 5 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
Moisture Content for Low Load RATA					
Sampling train post-test leak check	0 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 5 in Hg	0 ft^3 for 1 min at 5 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
Parameter	**Run 4**	**Run 5**	**Run 6**	**Method Requirement**	**Comment**
Moisture Content for Low Load RATA					
Sampling train post-test leak check	0 ft^3 for 1 min at 6 in Hg	0 ft^3 for 1 min at 6 in Hg	0 ft^3 for 1 min at 6 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		
Parameter	**Run 7**	**Run 8**	**Run 9**	**Method Requirement**	**Comment**
Moisture Content for Low Load RATA					
Sampling train post-test leak check	0 ft^3 for 1 min at 6 in Hg	0 ft^3 for 1 min at 6 in Hg	0 ft^3 for 1 min at 6 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	1	1	1		

5.2.2 Instrument Analyzer QA/QC

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Table 5-2 summarizes the gas cylinders used during this test program. Analyzer calibration, bias, and drift data are included in Appendix A.

Table 5-2
Calibration Gas Cylinder Information

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Nitrogen	Airgas	CC354795	99.9995%	2/4/2029
Oxygen, Carbon dioxide	Airgas	CC58208	21.91% 22.27%	6/22/2030
Oxygen, Carbon dioxide	Airgas	CC217580	8.994% 9.890%	7/6/2030
Nitrogen oxides	Airgas	AAL-5925	845.6 ppm	3/13/2025
Nitrogen oxides	Airgas	CC73761	500.7 ppm	5/14/2023
Nitrogen dioxide	Airgas	CC500150	19.76 ppm	3/10/2024
Carbon monoxide	Airgas	CC96621	471.9 ppm	9/16/2030
Air	Airgas	AAL-13128	--	12/6/2029
Propane	Airgas	SG9150203BAL	109.6 ppm	3/2/2028
Propane	Airgas	CC469693	85.46 ppm	5/9/2026

5.2.3 Dry-Gas Meter QA/QC

Table 5-3 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Complete dry-gas meter calibrations are included in Appendix A.

Table 5-3
Dry-Gas Meter Calibration QA/QC

Dry-Gas Meter	Pre-test DGM Calibration Factor	Post-test DGM Calibration Factor	Difference Between Pre- and Post-test Calibrations	Acceptable Tolerance	Comment
1	0.995 (8/5/2022)	1.005 (9/8/2022)	0.010	±0.05	Valid
2	0.980 (5/3/2022)	1.003 (9/8/2022)	0.023	±0.05	Valid

5.2.4 Thermocouple QA/QC

Temperature measurements using thermocouples and digital pyrometers were compared to a reference temperature prior to testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are included in Appendix A.

5.2.5 Laboratory Blanks QA/QC

QA/QC blanks were analyzed for the parameters of interest. The results are presented in Table 5-4. Blank corrections were not applied to the sample results. Blank and sample laboratory results are included in Appendix E.

Table 5-4
Laboratory Blanks QA/QC

Sample Identification	Result	Comment
Method 5 Filter Blank	0.90 mg	Reporting limit is 0.30 milligrams.
Method 5 Acetone Blank	3.1 mg	Reporting limit is 0.5 milligrams. Sample volume was 180 milliliters.
Method 0010 Field Blank	<10 µg	Reporting limit is 10 micrograms.

5.3 Data Reduction and Validation

The emissions testing Project Manager and/or the QA/QC Officer validated computer spreadsheets. The computer spreadsheets were used to ensure that field calculations were accurate. Random inspection of the field data sheets were conducted to verify data have been recorded appropriately. At the completion of a test, the raw field data were entered into computer spreadsheets to provide applicable onsite emissions calculations. The computer data were checked against the raw field sheets for accuracy during review of the report.

5.4 Sample Identification and Custody

The Apex project manager was responsible for the handling and procurement of the data collected in the field. The project manager ensured the data sheets are accounted for and completed in their entirety. 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 4.1. For each sample collected (i.e., impinger), sample identification and custody procedures were completed as follows:

- Containers were sealed 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 indicate if leakage occurred prior to receipt of the samples by the laboratory.
- Containers were placed in a cooler for storage, if necessary.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010).
- Samples were transported to the laboratory under chain of custody.

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

5.5 QA/QC Problems

Equipment audits and QA/QC procedures demonstrate sample collection accuracy and compliance for the test runs.

6.0 Limitations

The information and opinions rendered in this report are exclusively for use by Cadillac Renewable Energy. Apex Companies, LLC will not distribute or publish this report without consent of Cadillac Renewable Energy except as required by law or court order. The information and opinions are given in response to a limited assignment and should be implemented only in light of that assignment. Apex Companies, LLC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

Submitted by:

David Kawasaki, QSTI
Senior Engineer
Apex Companies, LLC
david.kawasaki@apexcos.com
248.590.5134

Derek R. Wong, Ph.D., P.E.
National Account Manager
Apex Companies, LLC
derek.wong@apexcos.com
248.875.7581

Tables

APEX

Table 1 - EUBLR Particulate Matter and Benzo(a)pyrene Results

Facility	**Cadillac Renewable Energy**				
Source Designation	**EUBLR**				
Test Date		**Aug 23, 2022**	**Aug 23, 2022**	**Aug 24, 2022**	
Meter/Nozzle Information		**Run 1**	**Run 2**	**Run 3**	**Average**
Meter Temperature, T_m	°F	90	87	77	85
Meter Pressure, P_m	in Hg	30.05	30.06	30.15	30.09
Measured Sample Volume, V_m	ft^3	127.70	119.32	120.31	122.44
Sample Volume, V_m	std ft^3	121.75	114.37	117.91	118.01
Sample Volume, V_m	std m^3	3.45	3.24	3.34	3.34
Condensate Volume, V_w	std ft^3	32.41	35.31	34.84	34.18
Gas Density, ρ_s	std lb/ft^3	0.0732	0.0724	0.0726	0.0727
Total weight of sampled gas	lb	11.286	10.829	8.804	10.306
Nozzle Size, A_n	ft^2	0.0003142	0.0003142	0.0003142	0.0003142
Isokinetic Variation, I	%	104	98	98	100.09
Stack Data					
Average Stack Temperature, T_s	°F	329	332	332	331
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.92	30.92	30.92	30.92
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	28.20	27.87	27.97	28.02
Stack Gas Specific Gravity, G_s		0.97	0.96	0.97	0.97
Percent Moisture, B_{ws}	%	21.02	23.59	22.81	22.47
Water Vapor Volume (fraction)		0.210	0.236	0.228	0.225
Pressure, P_s	in Hg	29.88	29.88	29.97	29.91
Average Stack Velocity, V_s	ft/sec	65.33	67.77	68.48	67.19
Area of Stack	ft^2	50.27	50.27	50.27	50.27
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	197,033	204,378	206,538	202,650
Flowrate	ft^3/min, standard wet	131,654	136,087	138,013	135,251
Flowrate	ft^3/min, standard dry	103,977	103,987	106,534	104,833
Flowrate	m^3/min, standard dry	2,944	2,945	3,017	2,969
Collected Mass					
Particulate Matter Acetone Wash	mg	2.4	2.6	2.1	2.4
Particulate Matter Filter	mg	1.20	3.20	3.90	2.8
Total Filterable Particulate Matter (FPM)	mg	3.6	5.8	6.0	5.1
Benzo(a)pyrene	µg	<10	<10	<10	<10
Concentration					
Particulate Matter (FPM)	mg/dscf	0.03	0.05	0.05	0.04
Particulate Matter (FPM)	grain/dscf	0.0005	0.0008	0.0008	0.0007
Benzo(a)pyrene	µg/dscf	<0.08	<0.09	<0.08	<0.08
Benzo(a)pyrene	µg/dscm	<2.9	<3.1	<3.0	<3.0
Mass Emission Rate					
Particulate Matter (FPM)	lb/hr	0.4	0.7	0.7	0.6
Benzo(a)pyrene	lb/hr	<0.0011	<0.0012	<0.0012	<0.0012
Particulate Matter (FPM)	lb/MMBtu	0.001	0.001	0.001	0.001

Table 2
EUBLR VOC Results
Cadillac Renewable Energy
Cadillac, Michigan
Apex Project No. CAD008-0202012-22008171
Sampling Date: August 23, 2022

Parameter	Units	Run 1	Run 2	Run 3	Average
Sampling Time		1155-1255	1305-1405	1417-1517	
Average Gas Stream Volumetric Flowrate	scfm	126,541	126,621	126,982	126,715
Average Gas Stream Volumetric Flowrate	dscfm	103,523	103,261	104,704	103,829
Oxygen Concentration	%	3.0	3.0	3.0	3.0
VOC Concentration (C_{avg})	ppmvw	-0.3	-0.3	0.0	-0.2
Average Corrected VOC Concentration (C_{gas})†	ppmvw	0.4	0.4	0.5	0.4
VOC Mass Emission Rate	**lb/hr**	**0.4**	**0.4**	**0.4**	**0.4**
VOC Mass Emission Rate	**lb/MMBtu**	**0.001**	**0.001**	**0.001**	**0.001**

† corrected for analyzer drift
scfm standard cubic feet per minute
dscfm dry standard cubic feet per minute
ppmvw part per million by volume, wet
lb/hr pound per hour

APEX

Table 3

EUBLR Flowrate (High Load) Relative Accuracy Test Audit Results

Cadillac Renewable Energy

Cadillac, Michigan

Apex Project No. CAD008-0202012-22008171

Sampling Dates: August 23, 2022

Run	Date	Time	RM scfh	CERM scfh	Difference scfh
1	8/23/2022	12:00-12:11	7,560,866	7,486,765	74,101
2	8/23/2022	12:12-12:23	7,634,409	7,444,818	189,591
3	8/23/2022	12:24-12:35	7,582,085	7,452,511	129,574
4	8/23/2022	13:02-13:13	7,600,073	7,358,184	241,889
5	8/23/2022	13:14-13:25	7,528,448	7,435,622	92,826
6	8/23/2022	13:26-13:37	7,663,174	7,461,470	201,704
7	8/23/2022	14:05-14:16	7,654,907	7,449,485	205,422
8	8/23/2022	14:17-14:28	7,698,867	7,476,320	222,547
9	8/23/2022	14:29-14:40	7,503,055	7,389,136	113,919
Mean			7,602,876	7,439,368	163,508
Standard Deviation					61,365
Confidence Coefficient					47,169

Average RM value	7,602,876 scfh
Relative Accuracy	2.8 %
Relative Accuracy Performance Specification	**The RA of the CERMS must be no greater than 10 percent**

APEX

Table 4
EUBLR Flowrate (Mid Load) Relative Accuracy Test Audit Results
Cadillac Renewable Energy
Cadillac, Michigan
Apex Project No. CAD008-0202012-22008171
Sampling Dates: August 24, 2022

Run	Date	Time	RM scfh	CERM scfh	Difference scfh
1	8/24/2022	11:39-11:50	6,206,816	6,240,387	-33,571
2	8/24/2022	11:51-12:02	6,143,969	6,288,533	-144,564
3	8/24/2022	12:03-12:14	6,227,544	6,222,611	4,933
4	8/24/2022	12:26-12:37	6,227,900	6,172,332	55,568
5	8/24/2022	12:38-12:49	6,277,159	6,243,060	34,099
6	8/24/2022	12:50-13:01	6,320,230	6,313,148	7,082
7	8/24/2022	13:13-13:24	6,331,062	6,163,708	167,354
8	8/24/2022	13:25-13:36	6,374,943	6,106,869	268,074
9	8/24/2022	13:37-13:48	6,220,562	6,081,179	139,383
Mean			6,258,910	6,203,536	55,373
Standard Deviation					121,477
Confidence Coefficient					93,376

Average RM value 6,258,910 scfh

Relative Accuracy 2.4 %

Relative Accuracy Performance Specification **The RA of the CERMS must be no greater than 10 percent**

APEX

Table 5
EUBLR Moisture Relative Accuracy Test Audit Results
Cadillac Renewable Energy
Cadillac, Michigan
Apex Project No. CAD008-0202012-22008171
Sampling Dates: August 25, 2022

Run	Date	Time	RM %	CERM %	Difference %
1	8/25/2022	0701-0726	22.8	21.1	1.8
2	8/25/2022	0742-0807	21.5	20.8	0.7
3	8/25/2022	0820-0845	22.0	20.9	1.0
4	8/25/2022	0848-0913	22.1	21.0	1.1
5	8/25/2022	0926-0951	22.0	20.7	1.3
6	8/25/2022	0954-1019	21.6	20.8	0.7
7	8/25/2022	1031-1056	21.9	21.0	1.0
8	8/25/2022	1100-1125	21.7	20.6	1.0
9	8/25/2022	1136-1201	21.5	20.9	0.6
Mean			21.9	20.9	1.0
Standard Deviation					0.4
Confidence Coefficient					0.3

Average RM value 21.9 %

Relative Accuracy 6.0 %

Relative Accuracy Performance Specification **The RA of the CERMS must be no greater than 10 percent**

Table 6

EUBLR Oxygen Relative Accuracy Test Audit Results

Cadillac Renewable Energy

Cadillac, Michigan

Apex Project No. CAD008-0202012-22008171

Sampling Dates: August 25, 2022

Run	Date	Time	RM %	CERM %	Difference %
1	8/25/2022	0701-0726	5.59	5.65	-0.06
2	8/25/2022	0742-0807	5.55	5.67	-0.12
3	8/25/2022	0820-0845	5.84	5.87	-0.03
4	8/25/2022	0848-0913	5.71	5.75	-0.04
5	8/25/2022	0926-0951	5.67	5.76	-0.09
6	8/25/2022	0954-1019	5.70	5.78	-0.08
7	8/25/2022	1031-1056	5.68	5.74	-0.06
8	8/25/2022	1100-1125	5.36	5.47	-0.11
9	8/25/2022	1136-1201	5.55	5.61	-0.06
Mean			5.63	5.70	-0.07
Standard Deviation					0.03
Confidence Coefficient					0.02

Average RM value 5.63 %

Relative Accuracy 1.7 %

Relative Accuracy Performance Specification **The RA of the CERMS must be no greater than 10 percent**

APEX

Table 7
EUBLR Nitrogen Oxides (ppm) Relative Accuracy Test Audit Results
Cadillac Renewable Energy
Cadillac, Michigan
Apex Project No. CAD008-0202012-22008171
Sampling Dates: August 25, 2022

			Reference Method					CERM	Difference
Run	Date	Time	DSCFM	O2 (%)	ppm	lb/hr	lb/MMBtu	ppm	ppm
1	8/25/2022	0701-0726	62,561	5.6	95.6	42.90	0.1441	96.0	-0.4
2	8/25/2022	0742-0807	62,474	5.5	99.0	44.34	0.1488	96.5	2.5
3	8/25/2022	0820-0845	61,852	5.8	95.8	42.49	0.1468	94.4	1.4
4	8/25/2022	0848-0913	62,671	5.7	95.8	43.07	0.1456	95.1	0.7
5	8/25/2022	0926-0951	62,105	5.7	96.9	43.15	0.1468	95.5	1.4
6	8/25/2022	0954-1019	62,987	5.7	95.2	42.99	0.1445	94.5	0.7
7	8/25/2022	1031-1056	62,697	5.7	94.4	42.45	0.1432	93.5	0.9
8	8/25/2022	1100-1125	61,538	5.4	98.5	43.48	0.1463	98.7	-0.1
9	8/25/2022	1136-1201	62,053	5.5	96.3	42.84	0.1447	95.8	0.5
Mean			62,326		96.4	43.1	0.1457	95.6	0.8
Standard Deviation									0.9
Confidence Coefficient									0.66

Average RM value 96.4 ppm

Relative Accuracy 1.6 %

Relative Accuracy Performance Specification **The RA of the CERMS must be no greater than 10 percent**

APEX

Table 8

EUBLR Nitrogen Oxides (lb/MMBtu) Relative Accuracy Test Audit Results

Cadillac Renewable Energy

Cadillac, Michigan

Apex Project No. CAD008-0202012-22008171

Sampling Dates: August 25, 2022

Run	Date	Time	Reference Method					CERM	Difference
			DSCFM	O2 (%)	ppm	lb/hr	lb/MMBtu	lb/MMBtu	lb/MMBtu
1	8/25/2022	0701-0726	62,561	5.6	95.6	42.90	0.1441	0.1452	-0.0011
2	8/25/2022	0742-0807	62,474	5.5	99.0	44.34	0.1488	0.1461	0.0027
3	8/25/2022	0820-0845	61,852	5.8	95.8	42.49	0.1468	0.1449	0.0019
4	8/25/2022	0848-0913	62,671	5.7	95.8	43.07	0.1456	0.1448	0.0008
5	8/25/2022	0926-0951	62,105	5.7	96.9	43.15	0.1468	0.1455	0.0013
6	8/25/2022	0954-1019	62,987	5.7	95.2	42.99	0.1445	0.1442	0.0003
7	8/25/2022	1031-1056	62,697	5.7	94.4	42.45	0.1432	0.1422	0.0010
8	8/25/2022	1100-1125	61,538	5.4	98.5	43.48	0.1463	0.1476	-0.0013
9	8/25/2022	1136-1201	62,053	5.5	96.3	42.84	0.1447	0.1444	0.0003
Mean			62,326		96.4	43.1	0.1457	0.1450	0.0007
Standard Deviation									0.0013
Confidence Coefficient									0.0010

Average RM value	0.1457 lb/MMBtu
Relative Accuracy	1.1 %
Relative Accuracy Performance Specification	**The RA of the CERMS must be no greater than 10 percent**

APEX

Table 9

EUBLR Carbon Monoxide (lb/hr) Relative Accuracy Test Audit Results

Cadillac Renewable Energy

Cadillac, Michigan

Apex Project No. CAD008-0202012-22008171

Sampling Dates: August 25, 2022

Run	Date	Time	Reference Method DSCFM	O2 (%)	ppm	lb/hr	lb/MMBtu	CERM lb/hr	Difference lb/hr
1	8/25/2022	0701-0726	62,561	5.6	31.0	8.46	0.0284	8.98	-0.52
2	8/25/2022	0742-0807	62,474	5.5	29.4	8.02	0.0269	8.74	-0.72
3	8/25/2022	0820-0845	61,852	5.8	31.9	8.61	0.0297	9.15	-0.54
4	8/25/2022	0848-0913	62,671	5.7	30.6	8.36	0.0283	8.61	-0.25
5	8/25/2022	0926-0951	62,105	5.7	26.9	7.30	0.0248	7.62	-0.32
6	8/25/2022	0954-1019	62,987	5.7	24.7	6.78	0.0228	7.28	-0.50
7	8/25/2022	1031-1056	62,697	5.7	26.8	7.33	0.0247	7.48	-0.15
8	8/25/2022	1100-1125	61,538	5.4	23.9	6.41	0.0216	7.10	-0.69
9	8/25/2022	1136-1201	62,053	5.5	26.3	7.11	0.0240	7.74	-0.63
Mean			62,326		27.9	7.60	0.0257	8.08	-0.48
Standard Deviation									0.20
Confidence Coefficient									0.15

Applicable Standard (Permit Limit)	209.2 lb/hr
Average RM value (permit limit used if <50% of standard)	209.2 lb/hr
Relative Accuracy	0.3 %
Relative Accuracy Performance Specification	**The RA of the CERMS must be no greater than 5 percent**

APEX

Table 10

EUBLR Carbon Monoxide (lb/MMBtu) Relative Accuracy Test Audit Results

Cadillac Renewable Energy

Cadillac, Michigan

Apex Project No. CAD008-0202012-22008171

Sampling Dates: August 25, 2022

Run	Date	Time	Reference Method					CERM	Difference
			DSCFM	O2 (%)	ppm	lb/hr	lb/MMBtu	lb/MMBtu	lb/MMBtu
1	8/25/2022	0701-0726	62,561	5.6	31.0	8.46	0.0284	0.0303	-0.0019
2	8/25/2022	0742-0807	62,474	5.5	29.4	8.02	0.0269	0.0299	-0.0030
3	8/25/2022	0820-0845	61,852	5.8	31.9	8.61	0.0297	0.0317	-0.0020
4	8/25/2022	0848-0913	62,671	5.7	30.6	8.36	0.0283	0.0298	-0.0015
5	8/25/2022	0926-0951	62,105	5.7	26.9	7.30	0.0248	0.0267	-0.0019
6	8/25/2022	0954-1019	62,987	5.7	24.7	6.78	0.0228	0.0255	-0.0027
7	8/25/2022	1031-1056	62,697	5.7	26.8	7.33	0.0247	0.0262	-0.0015
8	8/25/2022	1100-1125	61,538	5.4	23.9	6.41	0.0216	0.0246	-0.0030
9	8/25/2022	1136-1201	62,053	5.5	26.3	7.11	0.0240	0.0269	-0.0029
Mean			62,326		27.9	7.60	0.0257	0.0280	-0.0023
Standard Deviation									0.0006
Confidence Coefficient									0.0005

Applicable Standard (Permit Limit)	0.4000 lb/MMBtu
Average RM value (permit limit used if <50% of standard)	0.4000 lb/MMBtu
Relative Accuracy	0.7 %
Relative Accuracy Performance Specification	**The RA of the CERMS must be no greater than 5 percent**

Table 11

EUBLR Flowrate (Low Load) Relative Accuracy Test Audit Results

Cadillac Renewable Energy

Cadillac, Michigan

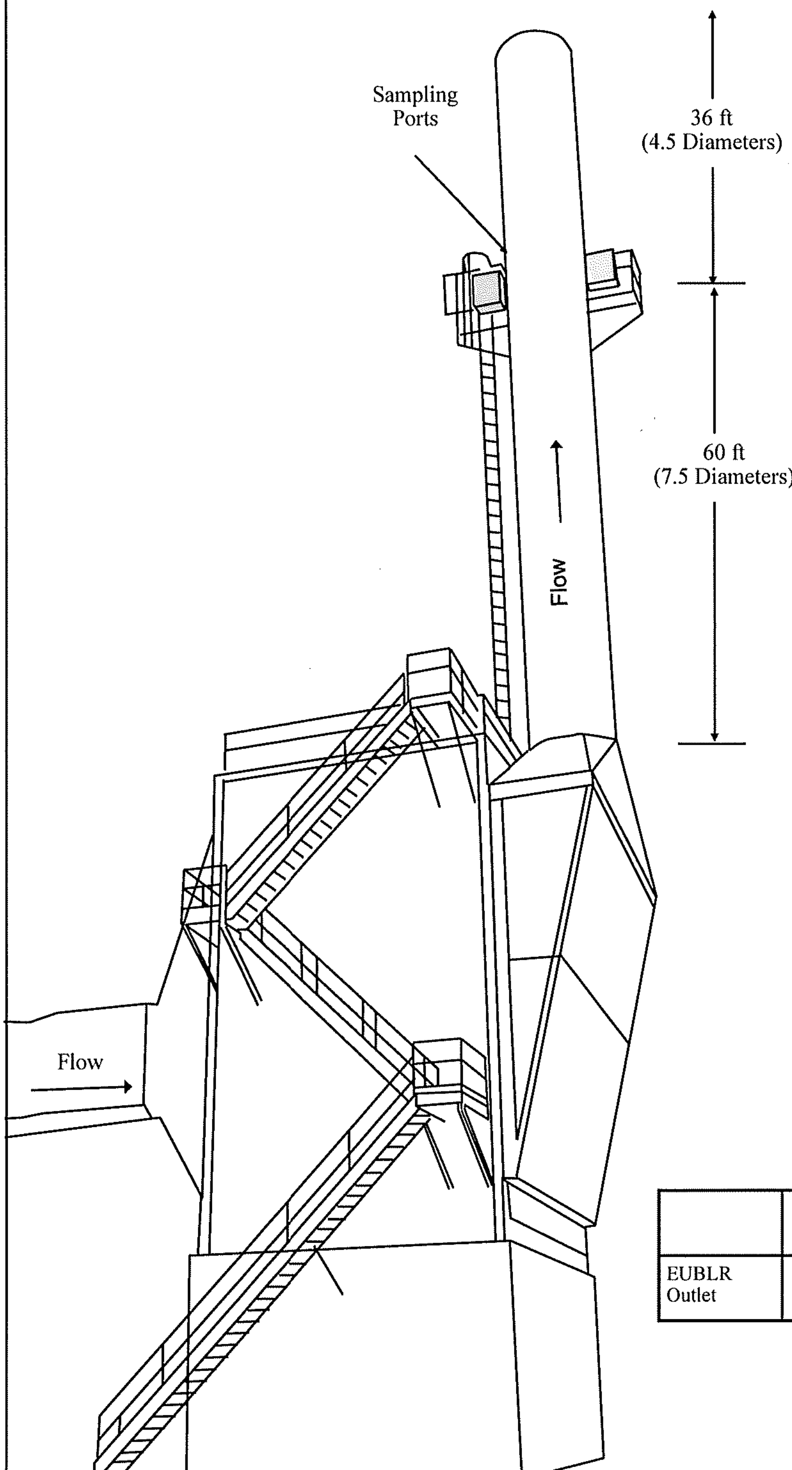
Apex Project No. CAD008-0202012-22008171

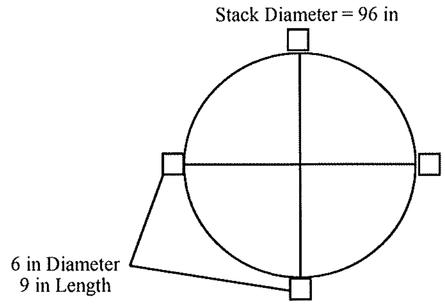
Sampling Dates: August 25, 2022

Run	Date	Time	RM scfh	CERM scfh	Difference scfh
1	8/25/2022	0701-0726	4,864,209	4,758,825	105,384
2	8/25/2022	0742-0807	4,775,738	4,677,211	98,527
3	8/25/2022	0820-0845	4,756,410	4,677,488	78,922
4	8/25/2022	0848-0913	4,825,772	4,653,742	172,030
5	8/25/2022	0926-0951	4,777,698	4,593,865	183,833
6	8/25/2022	0954-1019	4,819,552	4,591,525	228,027
7	8/25/2022	1031-1056	4,817,020	4,584,208	232,812
8	8/25/2022	1100-1125	4,714,463	4,557,530	156,933
9	8/25/2022	1136-1201	4,741,807	4,592,632	149,175
Mean			4,788,074	4,631,892	156,183
Standard Deviation					54,741
Confidence Coefficient					42,078

Average RM value	4,788,074 scfh
Relative Accuracy	4.1 %
Relative Accuracy Performance Specification	**The RA of the CERMS must be no greater than 10 percent**

Figures





Traverse Point	Distance from Wall (in)
1	4.2
2	14.0
3	28.4

	Distance from Ports to Nearest Upstream Bend/Disturbance	Distance from Ports to Nearest Downstream Bend/Disturbance
EUBLR Outlet	60 feet (7.5 diameters)	36 feet (4.5 diameters)

Scale: Not to Scale Date: September 8, 2022 Project No. 22008171	**EUBLR Outlet Sampling Ports and Traverse Point Locations** **Cadillac Renewable Energy** **Cadillac, Michigan**	APEX	FIGURE 1