

FINAL REPORT



BLUE WATER RENEWABLES, LLC

SMITHS CREEK, MICHIGAN

COMPLIANCE TESTING REPORT: NOX, CO, AND NMOC EU-ICEENGINE 1 & EU-ICEENGINE 2

RWDI #2407209

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by Blue Water Renewables, LLC (Blue Water) to complete the emission sampling program at the Smiths Creek Landfill facility located at 6779 Smiths Creek Road, Smiths Creek, Michigan 48074. Blue Water operates two (2) landfill-fired engines (FG-ICEENGINE/FG-ICEENGINE-BWR2) (referred to as Engine 1 and Engine 2). Testing consisted of emissions for nitrogen oxides (NO_x), carbon monoxide (CO), non-methane organic compounds (NMOC). The testing was required by Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

Compliance testing was completed for EU-ICEENGINE 1 (Engine 1) and EU-ICEENGINE 2 (Engine 2) on April 25th, 2024.

Executive Table i: Results Summary – EU-ICEENGINE 1

Source	Analyte	Units	Average	Limit
Engine 1	NO _x	ppmv _d @ 15% O ₂	32.85	150.0
		lb/hr	2.33	3.0
		g/hp-hr	0.53	2.0
	CO	ppmv _d @ 15% O ₂	356.92	610
		lb/hr	15.44	16.3
		g/hp-hr	3.37	5.0
	NMOC	g/hp-hr	<0.0007	1.0

Executive Table ii: Results Summary – EU-ICEENGINE 2

Source	Analyte	Units	Average	Limit
Engine 2	NO _x	ppmv _d @ 15% O ₂	35.23	150.0
		lb/hr	2.53	3.0
		g/hp-hr	0.55	2.0
	CO	ppmv _d @ 15% O ₂	249.46	610
		lb/hr	10.91	16.3
		g/hp-hr	2.59	5.0
	NMOC	g/hp-hr	<0.0007	1.0



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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Blue Water Renewables, LLC (Blue Water) to complete the emission sampling program at the Smiths Creek Landfill facility located at 6779 Smiths Creek Road, Smiths Creek, Michigan 48074. Blue Water operates two (2) landfill-fired engines (FG-ICEENGINES/FG-ICEENGINES-BWR2) (referred to as Engine 1 and Engine 2). Testing consisted of emissions for nitrogen oxides (NO_x), carbon monoxide (CO), non-methane organic compounds (NMOC). The testing was required by Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

Compliance testing was completed for EU-ICEENGINE 1 and EU-ICEENGINE 2 on April 25th, 2024.

1.1 Location and Date of Testing

The testing program was completed on April 23rd, 2024 – April 25th, 2024 at the Smiths Creek Landfill/Blue Water facility located at 6779 Smiths Creek Road, Smiths Creek, Michigan.

1.2 Purpose of the Testing

The purpose of testing was to show compliance with Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

1.3 Description of the Source

Blue Water Renewables operates two Caterpillar G3520C Engines with associated generator sets. The engines are fueled by landfill gas generated by the landfill and produce electricity which is sent to the electric grid.



1.4 Personnel Involved in Testing

Table 1.4.1: List of Testing Personnel

Maureen Bennett Environmental Engineer Maureen.Bennett@dteenergy.com	Blue Water Renewables, LLC 6779 Smiths Creek Road Smiths Creek, MI 48074	(734) 834-0005
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Roy Zimmer Field Technician Roy.Zimmer@rwdi.com		

2 SUMMARY OF RESULTS

2.1 Operating Data

Operational data collected during the testing included the following (found in **Appendix A**):

- Engine Power Output (kW);
- Engine Speed;
- Engine Operating Horsepower (BHP);
- Fuel flow;
- Engine Serial Number; and
- Engine Total Operating Hours.

2.2 Applicable Permit Number

Title 40 of the Code of Federal Regulations (40CFR), Subpart JJJJ, Permit No. MI-ROP-N6207-2018, and Michigan Department of Environment, Great Lakes, and Energy (EGLE) MI-PTI-N6207-2018.

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

Refer to Section 1.3 for a description of the process.

Engine 1 and Engine 2 have catalytic converters for emissions control.

3.2 Process Flow Sheet or Diagram

A process schematic can be provided upon request.

3.3 Type and Quantity of Raw and Finished Materials

The Engines use landfill gas to produce power.

3.4 Normal Rated Capacity of Process

Both engines are identical spark ignition, lean burn, reciprocating internal combustion engines (Caterpillar G3520C, 2,333 bhp at 100% load) for combusting treated landfill gas to produce electricity (1.6-megawatt gross electrical output).

3.5 Process Instrumentation Monitored During the Testing

Engine parameters included the following:

- Engine Power Output (kW);
- Engine Speed;
- Engine Operating Horsepower (BHP);
- Fuel flow;
- Engine Serial Number; and
- Engine Total Operating Hours.

4 POLLUTANTS TO BE MEASURED

Testing consisted of emissions for nitrogen oxides (NO_x), carbon monoxide (CO), non-methane organic compounds (NMOC).



5 SAMPLING AND ANALYSIS PROCEDURES

The following section provides brief descriptions of the sampling methods and discusses of any modifications to the reference test methods.

5.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocities and flow rates were determined following USEPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)". Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer or digital manometer. Volumetric flow rates were determined following the equal area method as outlined in USEPA Method 2. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a calibrated digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in USEPA Method 3A for oxygen and carbon dioxide.

Stack moisture content was determined in accordance with USEPA Method 4.

5.2 NMOC by USEPA Method 25A

The Non-Methane Organic Compounds (NMOC) measurements were taken continuously following the USEPA Method 25A on the outlet.

The compliance test consisted of three 60-minute tests. Regular performance checks on CEMS were carried out by zero and span calibration checks using USEPA Protocol calibration gases. These checks then verify the ongoing precision of the monitor with time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases was reviewed frequently as an ongoing indication of analyzer performance. USEPA Method 205 was used to calibrate the analyzer.

Prior to testing, a 4-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, low, mid, and high-level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response is within $\pm 5\%$ of the certified calibration gas introduced. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre- and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than $\pm 3\%$ throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. Upscale is either the mid- or high-range gas, whichever most closely approximates the flue gas level. During these checks, the calibration gases were introduced into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.



A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tip was equipped with a sintered stainless-steel filter for particulate removal or heated filter system. The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the CEM system. The heated sample line is designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

5.3 Oxides of Nitrogen and Carbon Monoxide

CO and NO_x concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system. Prior to testing, a 3-point analyzer calibration error check was conducted using USEPA protocol gases. The 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 confirm that the analyzer response is within $\pm 2\%$ of the certified calibration gas introduced. 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 the analyzers response was within $\pm 5\%$ of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than $\pm 3\%$ throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run in order to quantify measurement system calibration drift and sampling system bias. Upscale is either the mid- or high-range gas, whichever most closely approximates the flue gas level. During these checks, the calibration gases were introduced into the sampling system at the probe outlet so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to a series of gas analyzers, which measure the pollutant or diluent concentrations in the gas. The analyzers were calibrated on-site using EPA Protocol No. 1 certified calibration mixtures. The probe tip was equipped with a sintered stainless-steel filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the CEM system. The heated sample line maintained the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line.

Before entering the analyzers, the gas sample passed directly into a refrigerated condenser, which cools the gas to approximately 35°F to remove the stack gas moisture. After passing through the condenser, the dry gas entered a Teflon-head diaphragm pump and a flow control panel, which then delivered the gas in series to the CO and NO_x analyzers. Each of these analyzers then measured the respective gas concentrations on a dry volumetric basis.

6 NUMBER AND LENGTH OF SAMPLING RUNS

Testing consisted of triplicate 1-hour tests on each Engine.



7 STACK INFORMATION

Engine 1 and Engine 2 had identical stack measurements.

Table 7.1: Summary of the Stack Characteristics

Source	Parameter	Diameter	Approximate Duct Diameters from Flow Disturbance	Number of Ports	Points per Traverse	Total Points per Test
EU-ICEENGINE 1	CO, NOx, NMOC, O ₂ , CO ₂ , moisture, flow	15.5"	72" (4.6 dia.) downstream and 24" (1.5 dia.) upstream	2	8 Flow 3 CEMS	16 Flow 3 CEMS
EU-ICEENGINE 2	CO, NOx, NMOC, O ₂ , CO ₂ , moisture, flow	15.5"	72" (4.6 dia.) downstream and 24" (1.5 dia.) upstream	2	8 Flow 3 CEMS	16 Flow 3 CEMS

8 FLUE GAS CONDITIONS

Table 8.1: Flue Gas Conditions

Parameter	Flue Gas Conditions		
	Stack Temperature	Flow Rate	Percent Moisture
EU-ICEENGINE 1	924°F	4,566 dscfm	12.15%
EU-ICEENGINE 2	928°F	4,599 dscfm	12.29%

9 TEST RESULTS AND DISCUSSION

9.1 Detailed Results

Detailed results for all analytes are provided in **Appendices B & C**.

Table 9.1.1: Results Summary – EU-ICEENGINE 1

Source	Analyte	Units	Average	Limit
Engine 1	NO _x	ppmv _d @ 15% O ₂	32.85	150.0
		lb/hr	2.33	3.0
		g/hp-hr	0.53	2.0
	CO	ppmv _d @ 15% O ₂	356.92	610
		lb/hr	15.44	16.3
		g/hp-hr	3.37	5.0
	NMOC	g/hp-hr	<0.0007	1.0

Table 9.1.2: Results Summary – EU-ICEENGINE 2

Source	Analyte	Units	Average	Limit
Engine 2	NO _x	ppmv _d @ 15% O ₂	35.23	150.0
		lb/hr	2.53	3.0
		g/hp-hr	0.55	2.0
	CO	ppmv _d @ 15% O ₂	249.46	610
		lb/hr	10.91	16.3
		g/hp-hr	2.59	5.0
	NMOC	g/hp-hr	<0.0007	1.0

9.2 Discussion of Results

The detailed results of individual tests can be found in **Appendices B and C**.

9.3 Variations in Testing Procedures

In the instance of a negative NMOC number (due to the methane subtraction), a value of <0.10 ppmv was used.



9.4 Process Upset Conditions During Testing

There were no upsets in the process during testing.

9.5 Maintenance Performed in Last Three Months

All maintenance in the last three months has been routine.

9.6 Re-Test

This was not a retest.

9.7 Audit Samples

This test did not require any audit samples.

9.8 Process Data

Process data can be found in **Appendix A**.

9.9 Field Notes

Field notes can be found in **Appendix D**.

9.10 Calibration Data

Calibration can be found in **Appendix E**.

9.11 Example Calculations

Example calculations can be found in **Appendix F**.

9.12 Laboratory Data

There was no laboratory data affiliated with this testing.

9.13 Source Testing Plan and EGLE Correspondence

Copy of the correspondence received from the Source Testing Plan from EGLE and the Source Testing Plan submitted can be found in **Appendix G**.



TABLES

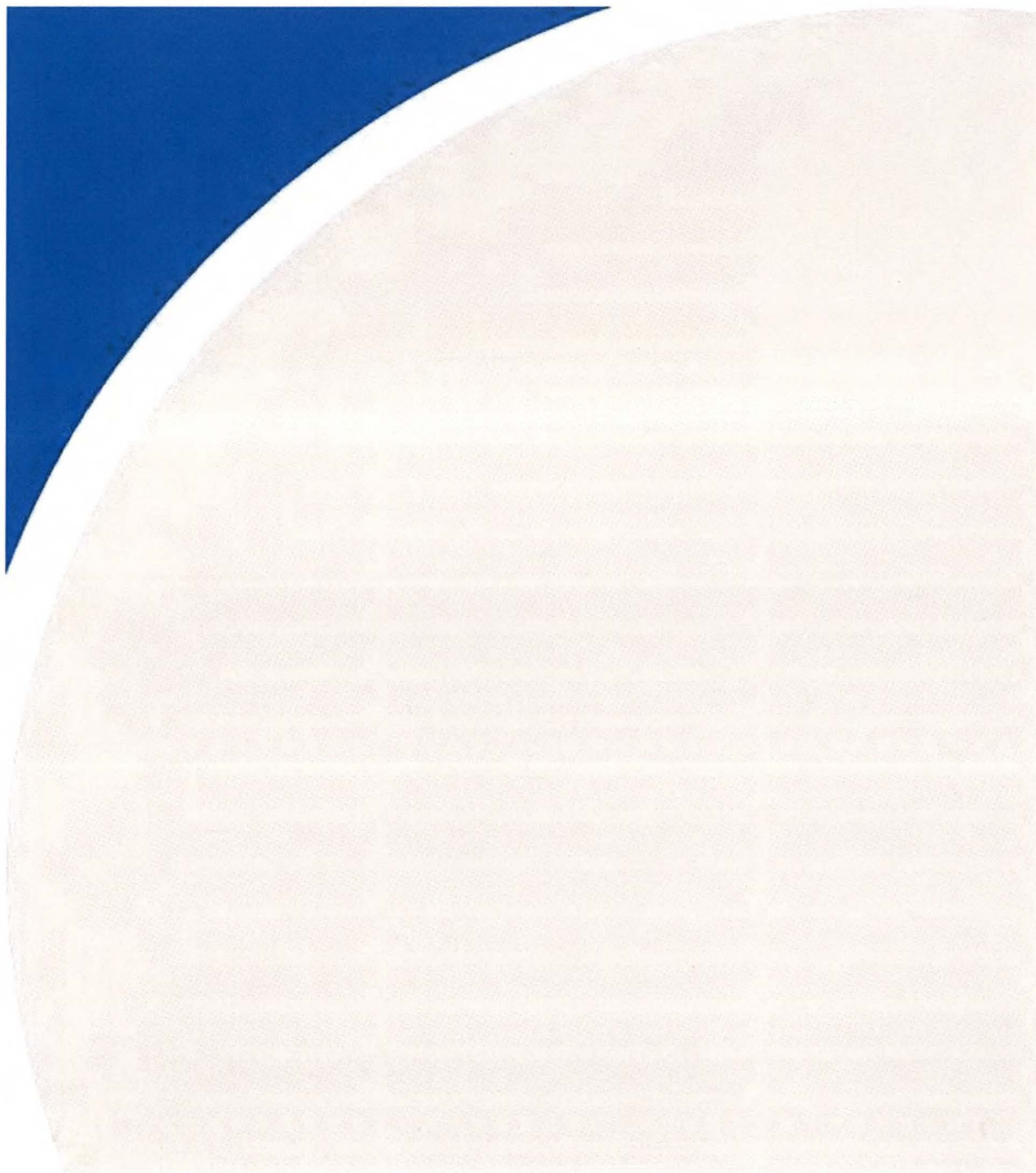


Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
EU-ICEENGINE 1	3	dscfm	U.S. EPA [1] Methods 1-4
	3	O ₂	U.S. EPA [1] Method 3A
	3	NO _x	U.S. EPA [1] Method 7E
	3	CO ₂	U.S. EPA [1] Method 10
	3	THC & CH ₄	U.S. EPA [1] Method 25A
	N/A	Calibration	U.S. EPA [1] Method 205
EU-ICEENGINE 2	3	dscfm	U.S. EPA [1] Methods 1-4
	3	O ₂	U.S. EPA [1] Method 3A
	3	NO _x	U.S. EPA [1] Method 7E
	3	CO ₂	U.S. EPA [1] Method 10
	3	THC & CH ₄	U.S. EPA [1] Method 25A
	N/A	Calibration	U.S. EPA [1] Method 205

Notes:

[1] U.S. EPA - United States Environmental Protection Agency

Table 2A: Sampling Summary - Engine 1

Test #	Sampling Date	Start Time	End Time
1	25-Apr-24	8:35	9:34
2		10:15	11:14
3		11:50	12:49

Table 2B: Sampling Summary - Engine 2

Test #	Sampling Date	Start Time	End Time
1	25-Apr-24	13:35	14:34
2		15:05	16:04
3		16:29	17:28

Table 3: Summary of Emissions - EU-ICEENGINE 1

Blue Water Renewables

Facility: Blue Water Renewables

City: Smith's Creek, MI

Source: Engine #1

Date: 4/25/2024

	Symbol	Units	Test 1	Test 2	Test 3	Average	Corrected to 15% O ₂	Limits
Nitrogen Oxides Concentration	NO _x	ppmvd	86.36	64.55	63.89	71.60	32.85	150.0
Carbon Monoxide Concentration	CO	ppmvd	832.59	751.51	749.74	777.95	356.92	610
Oxygen Concentration	O ₂	% _{dry}	7.90	8.11	8.12	8.04	-	-
Total Hydrocarbons (as propane) Concentration	THC	ppmv	444.39	486.64	487.10	472.71	-	-
Total Hydrocarbons (as propane) Concentration	THC	ppmvd	505.44	553.30	555.51	538.09	-	-
Methane (as methane) Concentration	CH ₄	ppmv	1164.61	1282.17	1268.03	1,238.27	-	-
Methane (as methane) Concentration	CH ₄	ppmvd	1324.62	1457.81	1446.12	1,409.52	-	-
Methane (as propane) Concentration	CH ₄	ppmvd	552.34	605.12	608.00	588.49	-	-
Non-Methane Organic Compounds Concentration	NMOC	ppmvd	<0.10	<0.10	<0.10	<0.10	-	-
Nitrogen Oxides Emission Rate	NO _x	pph	2.83	2.11	2.07	2.33	-	3.0
Carbon Monoxide Emission Rate	CO	pph	16.59	14.95	14.79	15.44	-	16.3
Non-Methane Organic Compounds Emission Rate	NMOC	pph	<0.003	<0.003	<0.003	<0.003	-	-
Nitrogen Oxides Concentration	NO _x	g/HP-hr	0.60	0.45	0.45	0.53	-	2.0
Carbon Monoxide Concentration	CO	g/HP-hr	3.52	3.22	3.19	3.37	-	5.0
Non-Methane Organic Compounds Concentration	NMOC	g/HP-hr	<0.0007	<0.0007	<0.0007	<0.0007	-	1.0

Reaction factor for methane subtraction: 2.40 2.41 2.38

For Tests 1, 2 and 3, NMOC numbers were negative after methane subtraction and are being reported as <0.10

Table 4: EU-ICEENGINE 1 Flow Measurements

Blue Water Renewables

Facility: Blue Water Renewables

City: Smith's Creek, MI

Source: Engine #1

Parameter	Units	Test 1	Test 2	Test 3	Average
Stack Gas Temperature	°F	925.4	922.9	922.9	923.7
Stack Gas Moisture	%	12.08	12.05	12.31	12.15
Velocity	ft/sec	173.0	172.3	171.2	172.2
Actual Flowrate	acfm	13,603	13,550	13,462	13,538
Dry Reference Flowrate	dscfm	4,584	4,575	4,539	4,566
Dry Reference Flowrate	m ³ /s	2.16	2.16	2.14	2.15

Table 5: EU-ICEENGINE 1 Process Data

Blue Water Renewables

Facility: Blue Water Renewables

City: Smith's Creek, MI

Source: Engine #1

Max Horspower: 2233

Max Kilowatt: 1665

Test	Time	Kilowatts (KW)	Brake Horse Power (BHP)	Load (%)
1	8:35	1,594	2,137.6	95.7%
	8:50	1,604	2,151.0	96.3%
	9:05	1,605	2,152.3	96.4%
	9:20	1,605	2,152.3	96.4%
	9:35	1,573	2,109.4	94.5%
	Average	1,596	2,140.5	95.9%
2	10:15	1,565	2098.7	94.0%
	10:30	1,577	2114.8	94.7%
	10:45	1,569	2104.0	94.2%
	11:00	1,568	2102.7	94.2%
	11:15	1,560	2092.0	93.7%
	Average	1,568	2102.4	94.2%
3	11:50	1,564	2097.3	93.9%
	12:05	1,566	2100.0	94.0%
	12:20	1,568	2102.7	94.2%
	12:35	1,570	2105.4	94.3%
	12:50	1,572	2108.1	94.4%
	Average	1,568	2,102.7	94.2%

KW to BHP Conversion Factor: 1.341

Table 6: Summary of Emissions - EU-ICEENGINE 2

Blue Water Renewables

Facility: Blue Water Renewables

City: Smith's Creek, MI

Source: Engine #2

Date: 4/25/2024

	Symbol	Units	Test 1	Test 2	Test 3	Average	Corrected to 15% O ₂	Limits
Nitrogen Oxides Concentration	NO _x	ppmvd	78.49	76.48	76.07	77.01	35.23	150.0
Carbon Monoxide Concentration	CO	ppmvd	647.46	555.22	433.19	545.29	249.46	610
Oxygen Concentration	O ₂	% _{dry}	8.01	8.01	7.99	8.00	-	-
Total Hydrocarbons (as propane) Concentration	THC	ppmv	401.72	408.96	417.38	409.35	-	-
Total Hydrocarbons (as propane) Concentration	THC	ppmvd	457.65	468.24	474.19	466.69	-	-
Methane (as methane) Concentration	CH ₄	ppmv	1071.39	1097.41	1114.13	1,094.31	-	-
Methane (as methane) Concentration	CH ₄	ppmvd	1220.54	1256.48	1265.77	1,247.59	-	-
Methane (as propane) Concentration	CH ₄	ppmvd	507.08	540.01	533.25	526.78	-	-
Non-Methane Organic Compounds Concentration	NMOC	ppmvd	<0.10	<0.10	<0.10	<0.10	-	-
Nitrogen Oxides Emission Rate	NO _x	pph	2.59	2.51	2.49	2.53	-	3.0
Carbon Monoxide Emission Rate	CO	pph	13.01	11.09	8.62	10.91	-	16.3
Non-Methane Organic Compounds Emission Rate	NMOC	pph	<0.003	<0.003	<0.003	<0.003	-	-
Nitrogen Oxides Concentration	NO _x	g/HP-hr	0.56	0.54	0.53	0.55	-	2.0
Carbon Monoxide Concentration	CO	g/HP-hr	2.79	2.39	1.85	2.59	-	5.0
Non-Methane Organic Compounds Concentration	NMOC	g/HP-hr	<0.0007	<0.0007	<0.0007	<0.0007	-	1.0

Reaction factor for methane subtraction: 2.41 2.33 2.37

For Tests 1, 2 and 3, NMOC numbers were negative after methane subtraction and are being reported as <0.10.

Table 7: EU-ICEENGINE 2 Flow Measurements

Blue Water Renewables

Facility: Blue Water Renewables

City: Smith's Creek, MI

Source: Engine #2

Parameter	Units	Test 1	Test 2	Test 3	Average
Stack Gas Temperature	°F	928	927	929	928
Stack Gas Moisture	%	12.22	12.66	11.98	12.29
Velocity	ft/sec	174.7	173.9	173.3	174.0
Actual Flowrate	acfm	13,734	13,676	13,629	13,679
Dry Reference Flowrate	dscfm	4,625	4,594	4,579	4,599
Dry Reference Flowrate	m ³ /s	2.19	2.17	2.16	2.17

Table 8: EU-ICEENGINE 2 Process Data

Blue Water Renewables

Facility: Blue Water Renewables

City: Smith's Creek, MI

Source: Engine #2

Max Horspower: 2233

Max Kilowatt: 1665

Test	Time	Kilowatts (KW)	Brake Horse Power (BHP)	Load (%)
1	13:35	1,577	2,114.8	94.7%
	13:50	1,578	2,116.1	94.8%
	14:05	1,579	2,117.4	94.8%
	14:20	1,577	2,114.8	94.7%
	14:35	1,571	2,106.7	94.3%
	Average	1,576	2,114.0	94.7%
2	15:05	1,567	2101.3	94.1%
	15:20	1,571	2106.7	94.3%
	15:35	1,575	2112.1	94.6%
	15:50	1,570	2105.4	94.3%
	16:05	1,578	2116.1	94.8%
	Average	1,572	2108.3	94.4%
3	16:29	1,581	2120.1	94.9%
	16:44	1,579	2117.4	94.8%
	16:59	1,571	2106.7	94.3%
	17:14	1,571	2106.7	94.3%
	17:29	1,583	2122.8	95.1%
	Average	1,577	2,114.8	94.7%

KW to BHP Conversion Factor: 1.341



FIGURES

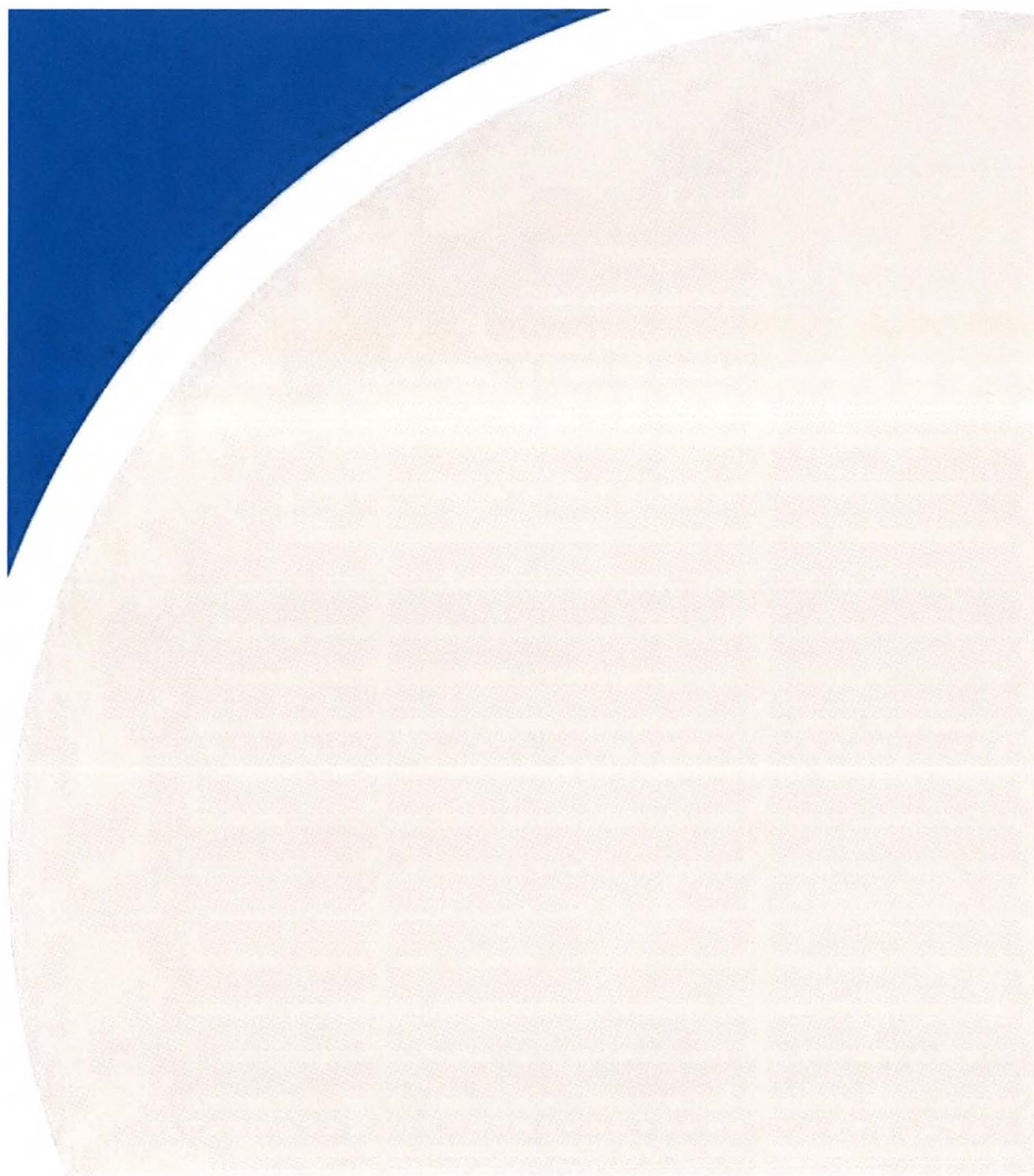
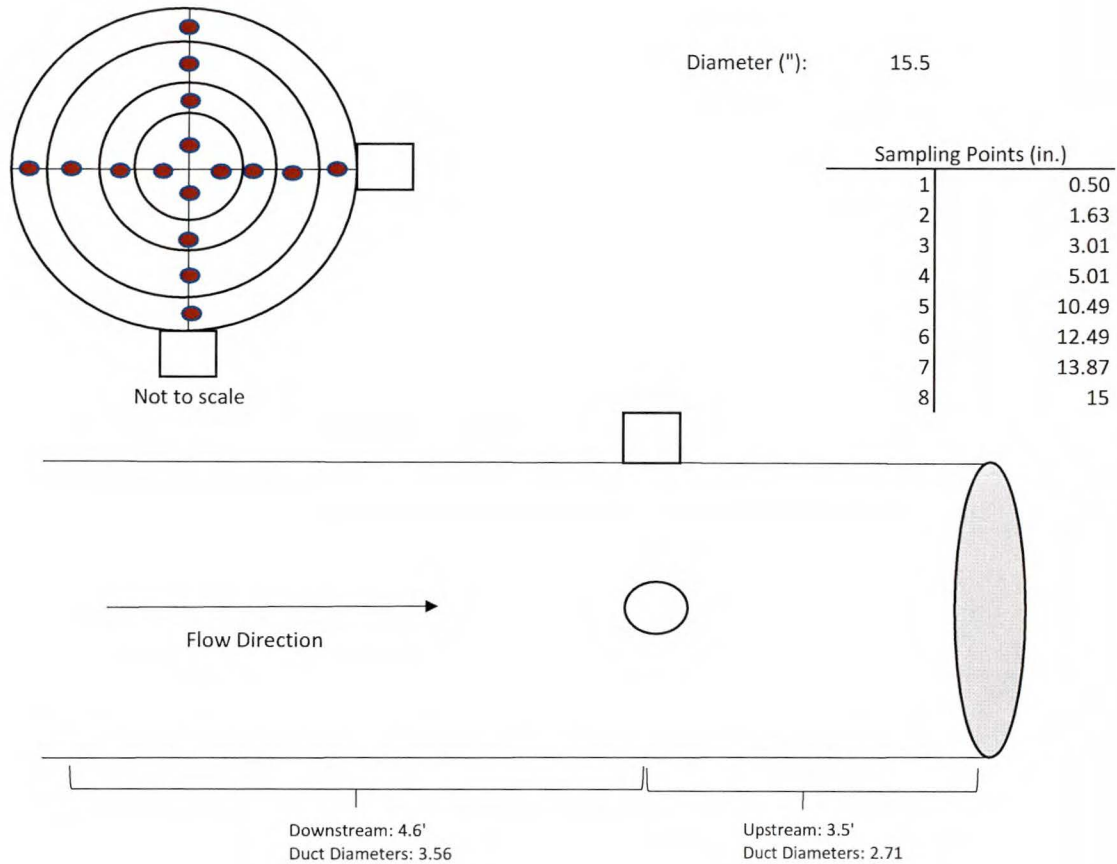




Figure No. 1



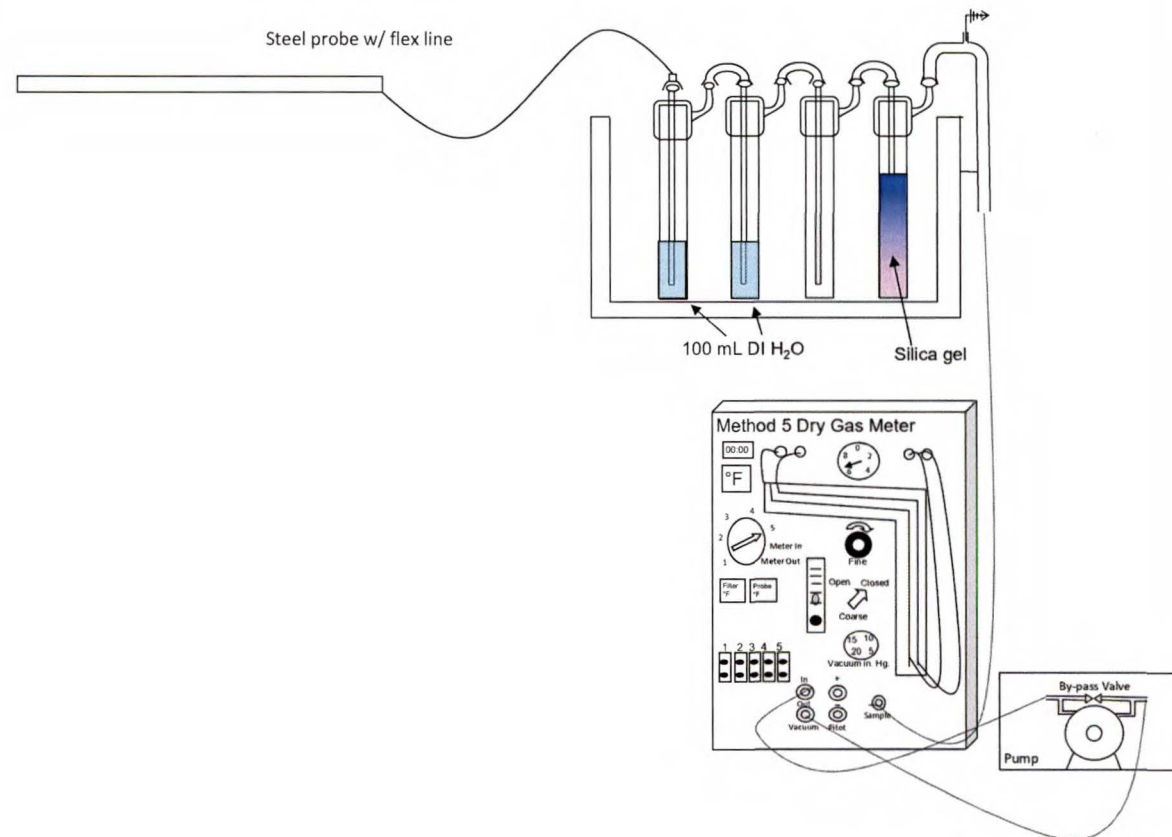
Engine #1 & #2
Bluewater Renewables
Smiths Creek, Michigan

Date:
25-Apr-24

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309



Figure No. 2



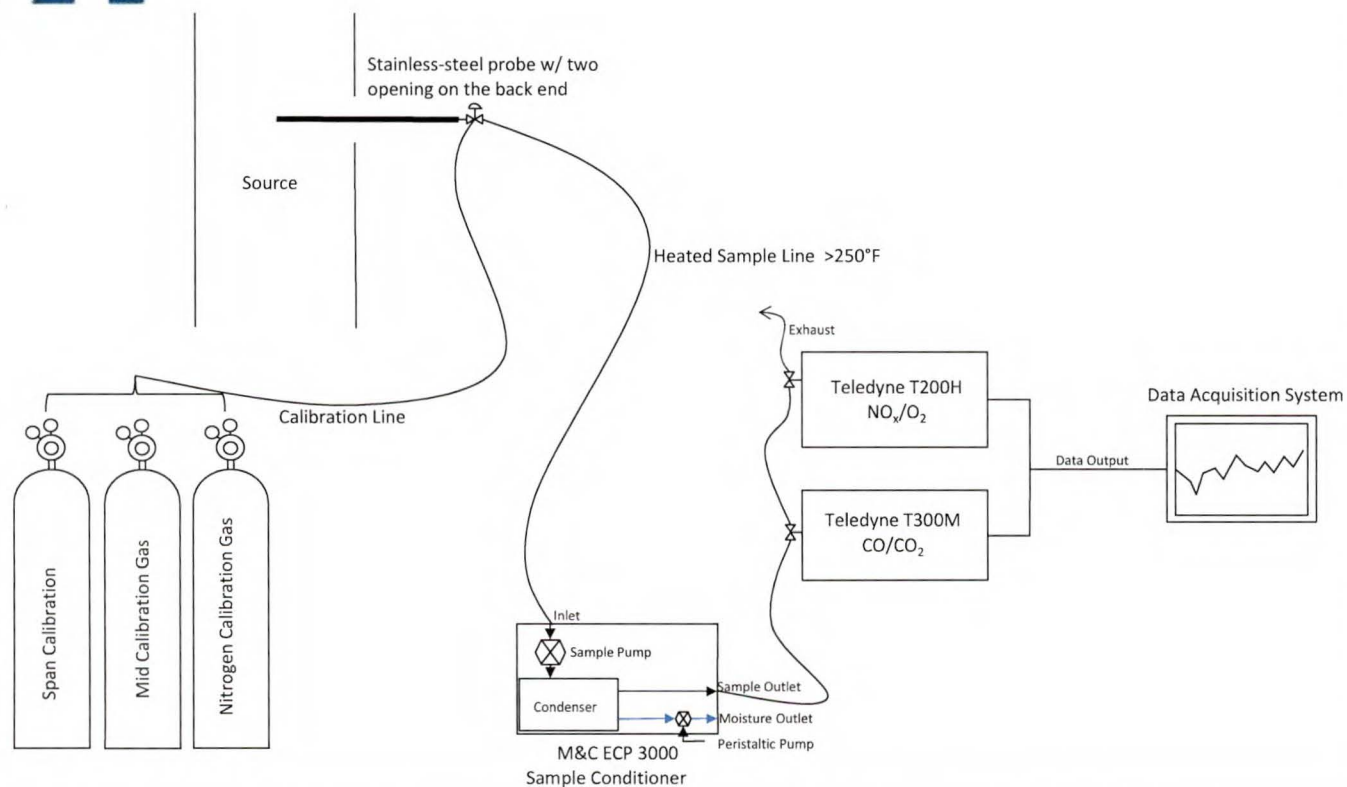
USEPA Method 4
Bluewater Renewables
Smiths Creek, Michigan

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309
April 25th, 2024





Figure No. 3



USEPA Method 3A,7E,10

Bluewater Renewables
Smiths Creek, Michigan

RWDI USA LLC

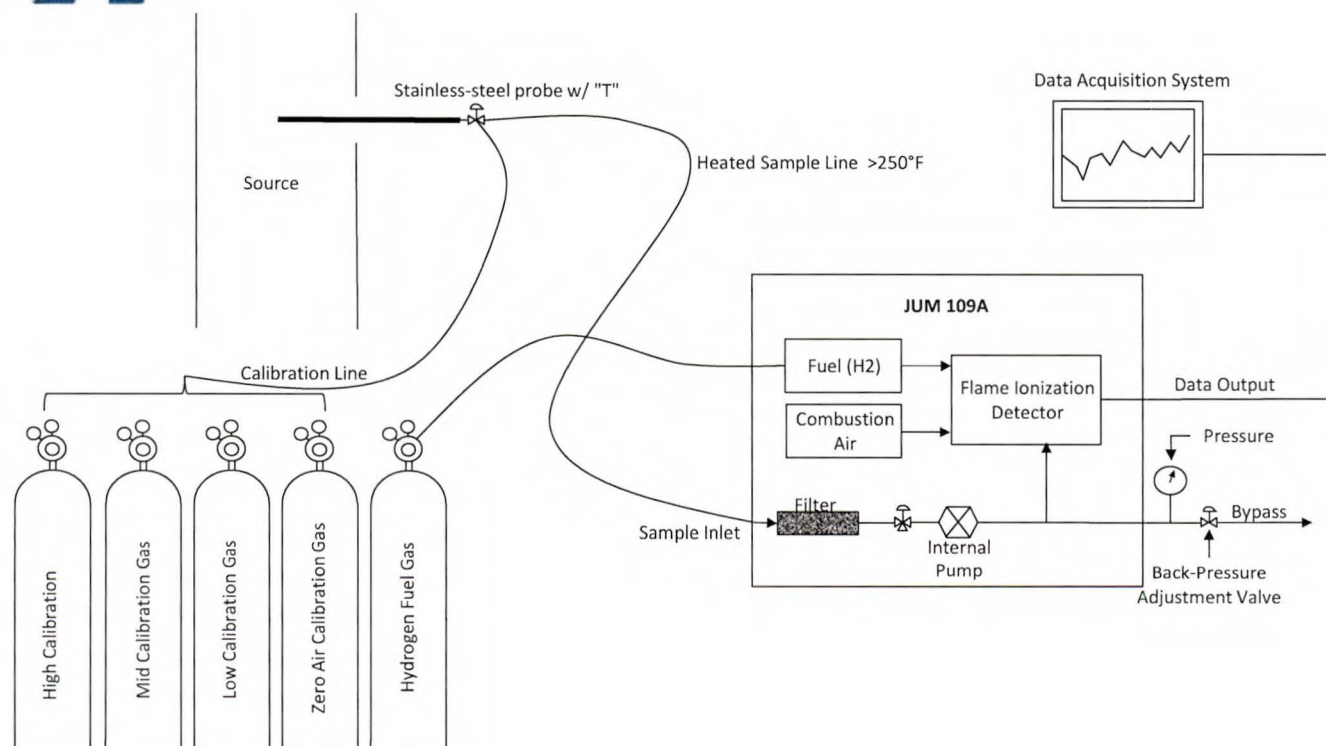
2239 Star Court
Rochester Hills, MI 48309

April 25th, 2024





Figure No. 4



USEPA Method 25A

Bluewater Renewables
Smiths Creek, Michigan

Date: April 25, 2024

RWDI USA LLC
2239 Star Court
Rochester Hills, MI 48309

