FINAL REPORT

SEBEWAING LIGHT AND WATER

SEBEWAING, MICHIGAN

COMPLIANCE TESTING REPORT: EUGEN8 EMISSIONS REPORT

RWDI #2409565

November 10, 2024

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by Sebewaing Light and Water (SLW) to complete the source testing program at their Pine Street Power Plant located in Sebewaing, Michigan. SLW operates two (2) engines (referred to as EUGEN7 or Engine 7 and EUGEN8 or Engine 8) that burns natural gas for electrical power generation. The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) Air Permit to Install (PTI) number 146-17A and 40 CFR Part 60, NSPS Subpart JJJJ. The test included measurements of total oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs, defined as non-methane hydrocarbons not including formaldehyde) and formaldehyde (HCOH) on EUGEN8. These emissions were calculated while the engine was operated within 10% of 100% peak load (or highest achievable load) combusting natural gas (~100% of Full Load for each Engine). And lastly, exhaust air flow rate was determined at the exhaust test ports. Testing was conducted on September 17, 2024.

EUGEN7 was inoperable upon arrival and was not tested during this mobilization. This testing report only covers EUGEN8.

The following tables represent a summary of the stack testing results.

Executive Summary Table i: Results Summary – EUGEN8

Parameter	Symbol	Units	Average	Limits
Nitrogen Oxides	NO_x	ppmvd	59.27	-
		ppmvd @ 15% O_2	38.3	82.0
		lb/hr	4.26	-
		g/HP-hr	0.43	0.50
Carbon Monoxide	CO	ppmvd	88.64	-
		ppmvd @ 15% O_2	57.3	270
		lb/hr	3.88	-
		g/HP-hr	0.39	0.90
Non-Methane Organic Compounds	NMOC	ppmvd	9.23	-
		ppmvd @ 15% O_2	5.96	60
		lb/hr	0.64	-
		g/HP-hr	0.06	0.70
Formaldehyde	HCOH	ppmvd	18.53	-
		lb/hr	0.87	-
		g/HP-hr	0.09	-

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Sebewaing Light and Water (SLW) to complete the source testing program at their Pine Street Power Plant located in Sebewaing, Michigan. SLW operates two (2) engines (referred to as EUGEN7 or Engine 7 and EUGEN8 or Engine 8) that burns natural gas for electrical power generation. The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) Air Permit to Install (PTI) number 146-17A and 40 CFR Part 60, NSPS Subpart JJJJ. The test included measurements of total oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs, defined as non-methane hydrocarbons not including formaldehyde) and formaldehyde (HCOH) on EUGEN8. These emissions were calculated while the engine was operated within 10% of 100% peak load (or highest achievable load) combusting natural gas (~100% of Full Load for each Engine). And lastly, exhaust air flow rate was determined at the exhaust test ports. Testing was conducted on September 17, 2024.

EUGEN7 was inoperable upon arrival and was not tested during this mobilization. This testing report only covers EUGEN8.

This stack testing study consisted of the following parameters:

- Velocity, flow rate and temperature;
- Nitrogen oxides (NO_x);
- Carbon Monoxide (CO);
- Oxygen (O_2);
- Volatile Organic Compounds (VOCs);
- Formaldehyde (HCOH); and
- Moisture (%).

1.1 Location and Date of Testing

The testing was completed on September 17, 2024, at the Sebewaing Light and Water facility located at 350 Pine St, Sebewaing, Michigan 48759.

1.2 Purpose of Testing

The test program was conducted to fulfill the requirements of the Michigan Department of Environment, Great Lakes and Energy (EGLE) Air Permit to Install (PTI) number 146-17A and 40 CFR Part 60, NSPS Subpart JJJJ.

1.3 Description of The Source

Engine 8 is a natural gas fired, four-cycle lean-burn internal combustion reciprocating engine that is rated at 4,601HP / 3.4MW generation capacity.

1.4 Personnel Involved in Testing

Table 1.4.1: List of Testing Personnel

Charlene Hudson Superintendent CHudson@slandw.com	**Sebewaing Light and Water** 350 Pine Street Sebewaing, MI 48759	(989) 883-2700
Amy Beaver Environmental Quality Analysis BeaverA3@michigan.gov	**State of Michigan** Department of Environment, Great Lakes, and Energy	(517) 855-1366
Ben Durham Senior Field Technician Ben.Durham@rwdi.com	**RWDI USA LLC** 24445 Forterra Dr Warren, MI 48089	(734) 474-1731
Mason Sakshaug Supervisor, Source Mason.Sakshaug@rwdi.com		(989) 323-0355

2 SUMMARY OF RESULTS

2.1 Operating Data

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

- Natural gas usage (ft^3/hr)
- Air to fuel ratio
- Engine exhaust temperature (°F)
- Pressure drop over the oxidation catalyst (in. H2O)
- Hour meter reading

2.2 Applicable Permit Number

Michigan Department of Environment, Great Lakes and Energy (EGLE) Air Permit to Install (PTI) number 146-17A and 40 CFR Part 60, NSPS Subpart JJJJ.

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

The engine is equipped with an oxidation catalyst.

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 natural gas to produce power.

3.4 Normal Rated Capacity of Process

Engine 8 has a 4,601HP / 3.4MW generation capacity.

3.5 Process Instrumentation Monitored During the Testing

Engine parameters included the following:

- Natural gas usage (ft^3/hr)
- Air to fuel ratio
- Engine exhaust temperature (°F)
- Pressure drop over the oxidation catalyst (in. H2O)
- Hour meter reading

4 POLLUTANTS TO BE MEASURED

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

5 SAMPLING AND ANALYSIS PROCEDURES

The following section provides brief descriptions of the proposed sampling methods and discusses any proposed 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 the USEPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)" from the outlet only. Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer. Volumetric flow rates were determined following the equal area method as outlined in US EPA 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 digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in US EPA Method 3A "Determination of Molecular Weight of Dry Stack Gas" for O_2. USEPA Method 320 was used for CO_2 content.

Stack moisture content was determined in accordance with USEPA Method 320.

5.2 NO_x, CO, VOC and HCOH by USEPA Method 320

Emissions testing was performed at the outlet of each engine. Pollutant concentrations were determined utilizing RWDI's continuous emissions monitoring system (CEM) which consists of the FTIR and oxygen analyzer (measuring on a dry basis).

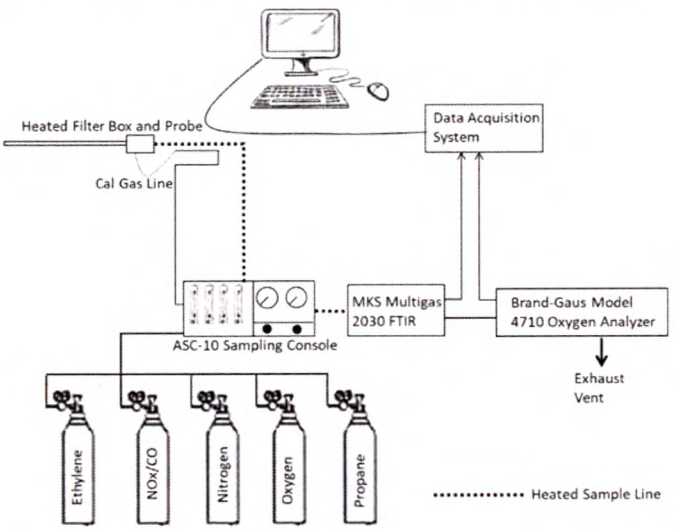
Stack gas concentrations for NO_x, CO, H_2O, HCOH, CO_2 and O_2 were measured using EPA Reference Methods 320 and 3A.

Oxygen measurements were taken continuously following USEPA Method 3A on the outlet (using a dry oxygen analyzer). Three points (16.7%, 50% and 83.3% of inner diameter) on a line passing through the centroidal area of the stack were sampled for twenty minutes for each of the tests.

Regular performance checks on the CEMS were carried out by zero and span calibration checks on the oxygen analyzer and necessary QA procedures on the FTIR using USEPA Protocol calibration gases. These checks will verify the ongoing precision of the FTIR with time by introducing pollutant-free nitrogen followed by known calibration gas (span) into the FTIR. 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.

Monitoring was conducted by drawing a sample stream of flue gases through a stainless-steel probe attached to a heated filter and a heated sample line that is attached to the MAX Analytical ASC-10ST sampling console. Lengths of unheated sample line was kept to a minimum and insulated. The ASC-10ST sampling console delivers a continuous sample to the MKS MultiGas 2030 FTIR and oxygen analyzer for analysis. The heated filter and line were maintained at approximately 191°C (375°F) and the MKS MultiGas 2030 FTIR and ASC-10ST gas components were kept at 191°C (375°F). The end of the probe was connected to a heated Teflon sample line, which will deliver the sample gases from the stack to the FTIR system. The heated sample line was designed to maintain the gas temperature at approximately 375°F to prevent condensation of stack gas moisture within the line and condition air to the same temperature as the FTIR. A schematic of the sampling system setup is depicted in **Figure 5.2a.**

Figure 5.2a: MKS 2030 Multigas FTIR/ASC-10ST/Model 4710 Sampling System Schematic



The ASC-10ST was used to deliver calibration gases (Calibration Transfer Standard (CTS), QA Spike and Nitrogen) to the FTIR in direct (to analyzer) and system (to probe) modes.

A laptop computer was utilized for operating the MKS MultiGas 2030 FTIR and MAX Analytical ASC-10ST sampling console and logging the multi-gas FTIR data. Data was logged as one-minute averages for the actual test period (FTIR PRN files and Spectra). All concentration data was determined using the MKS 2030 MultiGas FTIR software. A typical MKS 2030 FTIR and ASC-10 ST configuration is depicted in **Figure 5.2b.**

For oxygen measurement only, 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 ±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 ±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 ±3% throughout a test run. The analyzer will measure the respective gas concentrations on a wet volumetric basis which was converted to a dry volumetric number.

The probe tip was equipped with a heated filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which will deliver the sample gases from the stack to the FTIR/4710 Oxygen analyzer system. The heated sample line was designed to maintain the gas temperature at approximately 375°F to prevent condensation of stack gas moisture within the line.

Figure 5.2b: Typical MKS 2030 Multigas FTIR and ASC-10ST Configuration

5.3 Facility Description

SLW- Pine Street Plant is a power generation facility that operates two (2) natural gas fired, four-cycle lean-burn internal combustion reciprocating engines. Both engines are equipped with an oxidation catalyst that controls engine exhaust before venting into the atmosphere. For the purposes of the test protocol, Engine#7 (Emission Unit-EUGEN7 rated at 6,023HP / 4.4MW generation capacity) and Engine#8 (Emission Unit- EUGEN8 rated at 4,601HP / 3.4MW generation capacity) are required to be tested for CO, NO_x, VOCs and HCOH to determine compliance with the air permit, Michigan Air Toxics Rule R 336.1225 and NSPS Subpart JJJJ regulations.

6 NUMBER AND LENGTH OF SAMPLING RUNS

Testing consisted of three (3) 1-hour tests on Engine 8.

7 STACK INFORMATION

Table 7.1: Summary of the Stack Characteristics

Source	Diameter	Approximate Duct Diameters from Flow Disturbance	Number of Ports	Points per Traverse	Total Points per Test
EUGEN8	27"	2.85 downstream and 2.85 upstream	2	8	16 Flow

8 FLUE GAS CONDITIONS

Table 8.1: Flue Gas Conditions

Parameter	Flue Gas Conditions		
	Stack Temperature (°F)	Flow Rate (dscfm)	Moisture (%)
EUGEN8	626.9	10,062	9.96

9 TEST RESULTS AND DISCUSSION

9.1 Detailed Results

The following tables give a summary of the results. Detailed results for all the analytes are provided in **Appendices B and C.**

Table 9.1.1: Results Summary – EUGEN8

Parameter	Symbol	Units	Average	Limits
Nitrogen Oxides	NO_x	ppmvd	59.27	-
		ppmvd @ 15% O_2	38.3	82.0
		lb/hr	4.26	-
		g/HP-hr	0.43	0.50
Carbon Monoxide	CO	ppmvd	88.64	-
		ppmvd @ 15% O_2	57.3	270
		lb/hr	3.88	-
		g/HP-hr	0.39	0.90
Non-Methane Organic Compounds	NMOC	ppmvd	9.23	-
		ppmvd @ 15% O_2	6.0	60
		lb/hr	0.64	-
		g/HP-hr	0.06	0.70
Formaldehyde	HCOH	ppmvd	18.53	-
		lb/hr	0.87	-
		g/HP-hr	0.087	-

9.2 Discussion of Results

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

9.3 Variations in Testing Procedure

Testing was completed as detailed on Engine 8 in the test plan submitted to EGLE. Engine 7 was inoperable during the mobilization and was not tested.

9.4 Modifications to the Testing Program

Engine 7 was unable to be started during the testing program so the scheduled testing was removed from the testing program. Only Engine 8 was tested.

9.5 Process Upset Conditions During Testing

The process was not upset during testing.

9.6 Maintenance Performed in Last Three Months

Only routine maintenance has been performed on the units in the previous three months.

9.7 Re-Test

This was not a retest.

9.8 Audit Samples

This test did not require audit samples.

9.9 Process Data

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

9.10 Field Notes

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

9.11 Calibration Data

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

9.12 Example Calculations

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

9.13 Source Testing 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**.

9.14 Laboratory Data

There was no laboratory data affiliated with this testing.

TABLES

Table 1: Summary of Emissions - EUGEN8

Sebewaing Light and Water

Facility: Sebewaing Light and Water
City: Sebewaing, Michigan
Source: EUGEN8
Date: 9/17/2024

	Symbol	Units	Test 1	Test 2	Test 3	Average	Corrected to 15% O_2	Limits
Nitrogen Oxides Concentration	NO_x	ppmvd	60.02	58.92	58.87	59.27	38.28	82.0
Carbon Monoxide Concentration	CO	ppmvd	87.68	88.49	89.75	88.64	57.25	270
Formaldehyde Concentration	HCOH	ppmvd	18.35	18.47	18.75	18.53	-	
Oxygen Concentration	O_2	$\%_{dry}$	11.79	11.74	11.76	11.77	-	-
VOC (as propane) Concentration	VOC	ppmvd	9.07	9.21	9.40	9.23	5.96	60
Nitrogen Oxides Emission Rate	NO_x	pph	4.36	4.27	4.14	4.26	-	-
Carbon Monoxide Emission Rate	CO	pph	3.88	3.90	3.85	3.88	-	-
Formaldehyde Emission Rate	HCOH	pph	0.870	0.873	0.862	0.869	-	-
Non-Methane Organic Compounds Emission Rate	NMOC	pph	0.63	0.64	0.63	0.64	-	-
Nitrogen Oxides Concentration	NO_x	g/HP-hr	0.4383	0.4288	0.4170	0.4281	-	0.50
Carbon Monoxide Concentration	CO	g/HP-hr	0.39	0.39	0.39	0.39	-	0.90
VOC (as propane) Concentration	C3H8	g/HP-hr	0.063	0.064	0.064	0.064	-	0.70

Table 2: Flow Measurements - EUGEN8

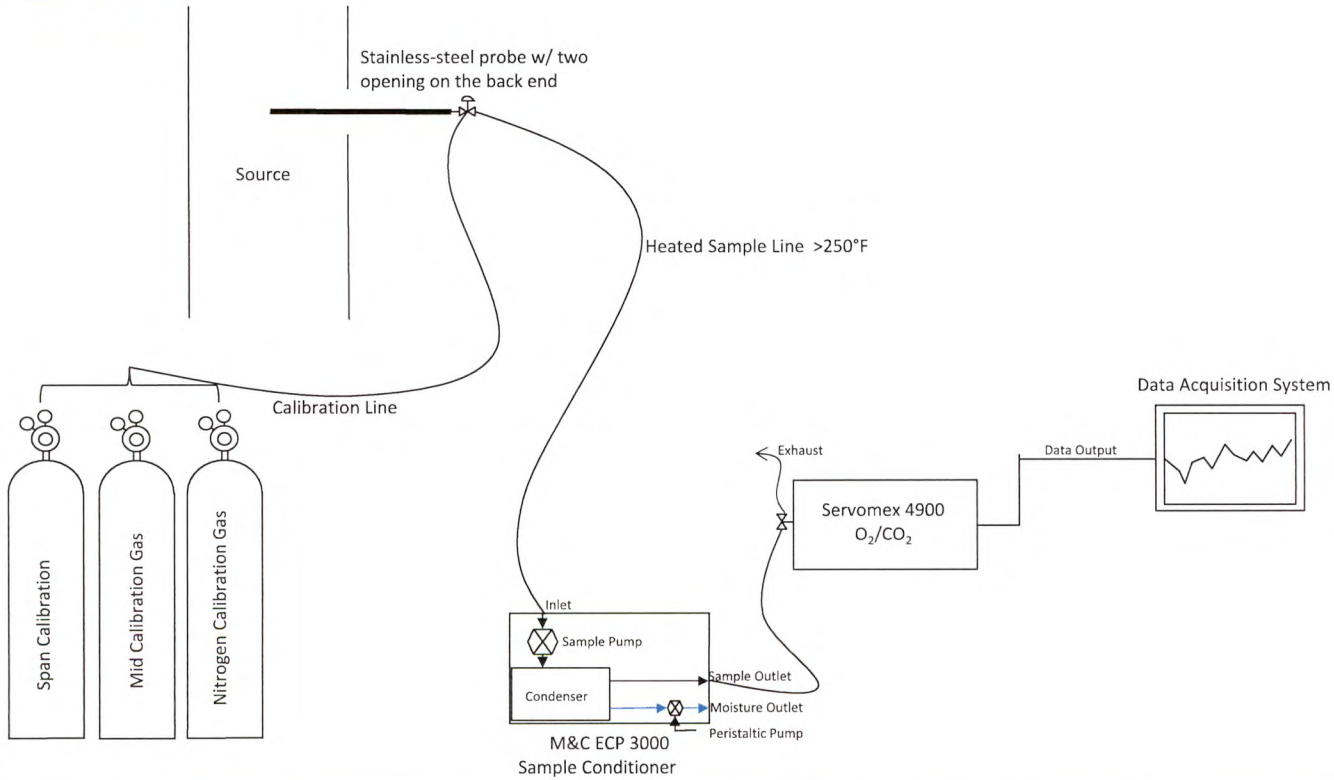
Sebewaing Light and Water

Facility: Sebewaing Light and Water
City: Sebewaing, Michigan
Source: EUGEN8

Parameter	Units	Test 1	Test 2	Test 3	Average
Stack Gas Temperature	°F	622.4	629.4	628.9	626.9
Stack Gas Moisture	%	9.76	10.09	10.04	9.96
Velocity	ft/min	5881.4	5923.6	5752.3	5852.4
Actual Flowrate	acfm	23,385	23,553	22,872	23,270
Dry Reference Flowrate	dscfm	10,176	10,146	9,863	10,062
Dry Reference Flowrate	m^3/s	4.80	4.79	4.65	4.75

FIGURES

Figure No. 1: USEPA Method 3A Schematic



USEPA Method 3A

Sebewaing Light and Water

Pine Street Power Plant

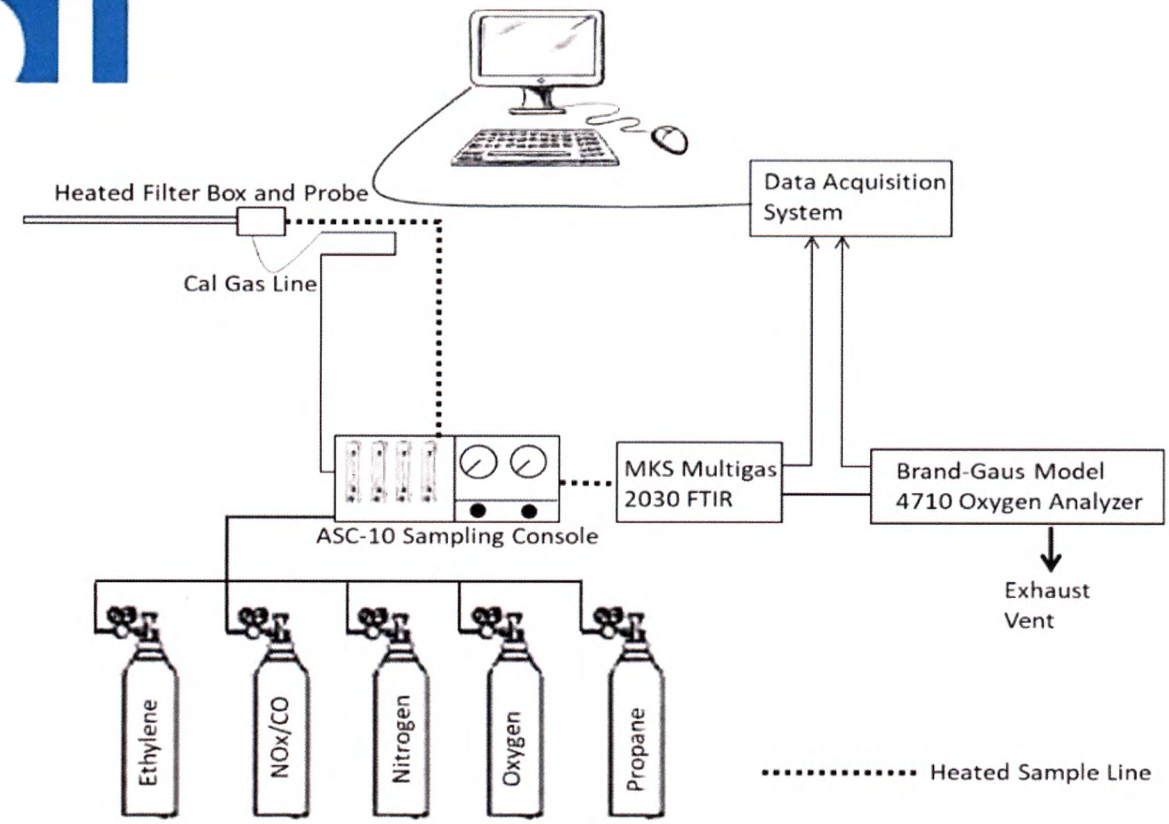
EUGEN8

Sebewaing, MI

Project# 2409565

Date: September 17, 2024

Figure No. 2: USEPA Method 320 Schematic



USEPA Method 320

Sebewaing Light & Power

Pine Street

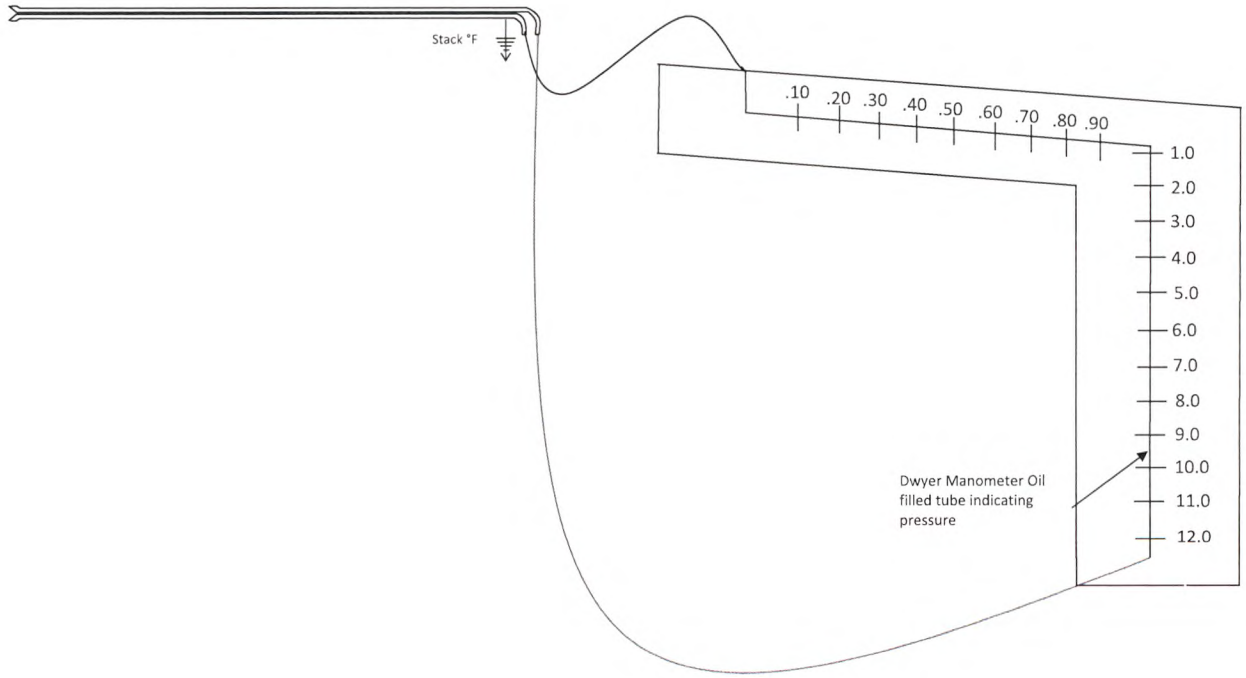
EUGEN8

Sebewaing, MI

Project# 2409565

Date: September 17, 2024

Figure No. 3: USEPA Method 2 Schematic



USEPA Method 2

Sebewaing Light & Power

Pine Street

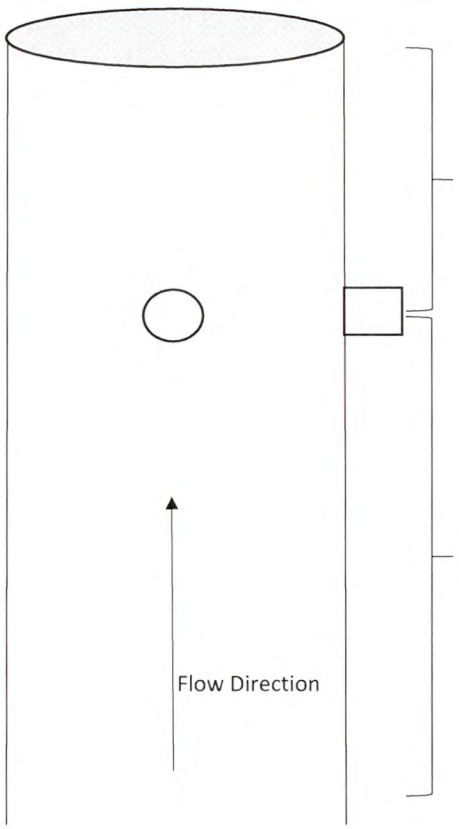
EUGEN8

Sebewaing , MI

Project #2409565

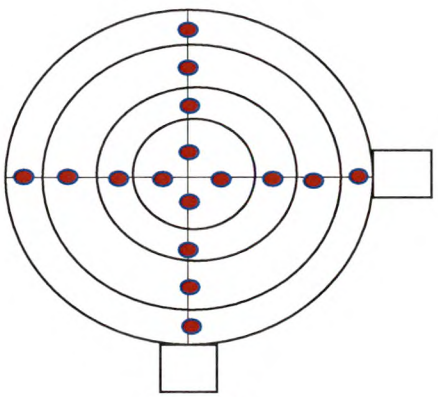
Date: September 17, 2024

Figure No. 4: EUGEN8 Stack Diagram



Diameter: 27

Sampling Points (in.)	
1	1.00
2	2.84
3	5.24
4	8.72
5	18.28
6	21.76
7	24.17
8	26.00



Not to scale

EUGEN8
Sebewaing Light & Power
Pine Street
Sebewaing, MI

Date:
17-Sep-24

RWDI USA LLC
24445 Forterra Drive
Warren, MI 48089