

FINAL REPORT



WASHINGTON 10 STORAGE CORPORATION

WASHINGTON TOWNSHIP, MICHIGAN

WASHINGTON 10 COMPRESSOR STATION:
2023 FGENGINE2 EMISSIONS REPORT

RWDI #2403298

July 24, 2024

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by Washington 10 Storage Corporation (Washington 10) to complete the emission sampling program at the Washington 10 Compressor Station located at 12700 30 Mile Rd, Washington Township, Michigan. The facility operates under the State of Michigan Department of Environment, Great Lakes and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N3391-2023. Under the ROP, the facility operates three (3) 4,000 HP natural gas fired reciprocating engines used to drive natural gas compressors for transport between storage field and pipeline system under Flexible Group FG-ENGINES1. There are three (3) 4-stroke lean-burn, 4,735 HP Caterpillar natural gas fired reciprocating engines under Flexible Group FG-ENGINES2. The engines generate line pressure assisting the transmission of natural gas into and out of the gas storage field as well as to and from the pipeline transmission system in Southeast Michigan.

Due to insufficient operating conditions, the testing for Flexible Group FG-ENGINES1 at 60% torque for Engines 1 & 2 was not completed, and the testing at 100% torque was not completed for Engines 1, 2, or 3. This testing will be completed at a later date.

Testing program included the following:

- CO Destruction Efficiency (DE) testing from EUENGINE4, EU-ENGINE5 and EU-ENGINE6 under Flexible Group FG-ENGINES2 to validate that the catalyst is capable of achieving a 93% destruction efficiency (or greater) as per 40 CFR Part 63 Subparts A and ZZZZ.
- Testing at the outlet of EU-ENGINE3 under Flexible Group FG-ENGINES1 at 60% Torque for Non-Methane Organic Compounds (NMOC) and Carbon Monoxide (CO).

Executive Table i: EUENGINE4-6 CO Destruction Efficiency & Inlet Emission Rates

Unit	Carbon Monoxide	
	Destruction Efficiency (%)	Pre-Catalyst g/hp-hr
EUENGINE4	99.0	1.94
EUENGINE5	98.4	1.95
EUENGINE6	95.4	2.24
Permit Limit	Min. 93.0	Max. 2.5

Executive Table ii: EUENGINE3 CO & NMOC Emission Rates at 60% Torque and 100% Power

Unit	Carbon Monoxide	NMOC
	g/hp-hr	g/hp-hr
EUENGINE3	1.25	0.14
Permit Limit	No Limit for Scenario of 60% Torque and 100% Power	



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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Washington 10 Storage Corporation (Washington 10) to complete the emission sampling program at the Washington 10 Compressor Station located at 12700 30 Mile Rd, Washington Township, Michigan. The facility operates under the State of Michigan Department of Environment, Great Lakes and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N3391-2023. Under the ROP, the facility operates three (3) 4,000 HP natural gas fired reciprocating engines used to drive natural gas compressors for transport between storage field and pipeline system under Flexible Group FG-ENGINES1. There are three (3) 4-stroke lean-burn, 4,735 HP Caterpillar natural gas fired reciprocating engines under Flexible Group FG-ENGINES2. The engines generate line pressure assisting the transmission of natural gas into and out of the gas storage field as well as to and from the pipeline transmission system in Southeast Michigan.

Due to insufficient operating conditions, the testing for Flexible Group FG-ENGINES1 at 60% torque for Engines 1 & 2 was not completed, and the testing at 100% torque was not completed for Engines 1, 2, or 3. This testing will be completed at a later date.

1.1 Location and Dates of Testing

The test program took place during the week of June 3rdrd, 2024.

1.2 Purpose of Testing

This testing was conducted to show compliance with MI-ROP-N3391-2023 and 40 CFR Part 63 Subpart ZZZZ.

1.3 Description of Source

The facility operates three (3) 4,000 HP natural gas fired reciprocating engines used to drive natural gas compressors for transport between storage field and pipeline system under Flexible Group FG-ENGINES1 and three (3) 4-stroke lean-burn, 4,735 HP Caterpillar natural gas fired reciprocating engines under Flexible Group FG-ENGINES2. The engines generate line pressure assisting the transmission of natural gas into and out of the gas storage field as well as to and from the pipeline transmission system in southeast Michigan.



1.4 Personnel Involved in Testing

Table 1.4.1: Testing Personnel

Kimberly Walker Environmental Technical Specialist Kimberly.Walker@dtmidstream.com	DT Midstream, Inc,	(724) 954-5329
Joseph Kotwicki Supervisor, Operations Joseph.kotwicki@dtmidstream.com	Washington 10 Storage Corporation	(248) 672-9894
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Brad Bergeron Technical Director Brad.Bergeron@rwdi.com		(248) 234-3885
Mason Sakshaug Senior Scientist Mason.Sakshaug@rwdi.com		(989) 323-0355
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Cade Smith Field Technician Cade.Smith@rwdi.com		

2 SUMMARY OF RESULTS

2.1 Operating Data

Operating parameters used to regulate the compressor engines include speed (RPM) and torque (HP). Additional parameters monitored include fuel flow, inlet & exhaust temperature & pressure, timing, and fuel analysis. Operating parameters for each test can be found in **Appendix A**.

2.2 Applicable Permit Number

MI-ROP-N3391-2023 and 40 CFR Part 63 Subpart ZZZZ.



3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

EUENGINE1-6 are equipped with an oxidation catalyst which controls emissions.

3.2 Process Flow Sheet or Diagram (if applicable)

A process flow diagram is available upon request.

3.3 Type and Quantity of Raw and Finished Materials

EUENGINE1-6 are natural gas-fired reciprocating units.

3.4 Normal Rated Capacity of Process

The engines are rated at 4,000 or 4,735 HP and were ran at maximum achievable load.

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Description of Sampling Train and Field Procedures

4.1.1 Carbon Monoxide, Oxides of Nitrogen, and Oxygen

CO, and O₂ 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 was 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 each 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. 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 was designed to maintain the gas temperature above 250°F 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 delivered the gas in series to the CO and O₂ analyzers. Each of these analyzers measure the respective gas concentrations on a dry volumetric basis.

4.1.2 Non-Methane Organic Compounds

Non-Methane Organic Compounds (as propane) for VOCs and CH₄ concentrations were recorded simultaneously for each test. The measurements were taken continuously following USEPA Method 25A on each engine (using a non-methane/methane 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 up the heated line to the probe tip. The calibration error check was performed to confirm that the analyzer response is within ±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 check was used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and mid gas calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. During these checks, the calibration gases were introduced into the sampling system at the probe tip 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 the gas analyzer, which measures the pollutant or diluent concentrations in the gas. 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 to prevent condensation of stack gas moisture within the line.

To subtract methane from THC, the methane must be converted from methane as methane to methane as propane and then subtracted from the THC number. The methane response factor (RF) is used in the conversion and is determined each test by introducing a known methane concentration to the analyzer and dividing the methane channel response by the THC channel response. Dividing methane by the RF gives methane as propane and is then subtracted from the THC concentration.

Moisture tests were completed on VOC test runs as per USEPA Method 4.



4.1.3 Verification of Gas Dilution Systems for Field Instrument Calibration

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included in the Source Testing Report. A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas mixtures. The gas dilution system consists of calibrated orifices for mass flow controllers and dilutes a high-level calibration gas to within $\pm 2\%$ 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 US EPA Method 205 "*Verification of Gas Dilution Systems for Field Instrument Calibrations*". The gas divider dilutions were measured to evaluate that the responses are within $\pm 2\%$ of predicted values. In addition, a certified mid-level calibration gas within $\pm 10\%$ of one of the tested dilution gases was introduced into an analyzer to ensure the response of the gas calibration was within $\pm 2\%$ of gas divider dilution concentration.

4.2 Description of Recovery and Analytical Procedures

There were no samples to recover during this test program. All testing used real time data from the analyzers.

4.3 Sampling Port Description

A figure of the testing sites is provided in the **Figures** section.



5 TEST RESULTS AND DISCUSSION

5.1 Detailed Results

The following tables give the averages for each permit requirement. The **Tables** section and **Appendix B** provide a detailed breakdown of each test.

Executive Table i: EUENGINE4-6 CO Destruction Efficiency & Inlet Emission Rates

Unit	Carbon Monoxide	
	Destruction Efficiency (%)	Pre-Catalyst g/hp-hr
EUENGINE4	99.0	1.94
EUENGINE5	98.4	1.95
EUENGINE6	95.4	2.24
Permit Limit	Min. 93.0	Max. 2.5

Executive Table ii: EUENGINE3 CO & NMOC Emission Rates at 60% Torque and 100% Power

Unit	Carbon Monoxide	NMOC
	g/hp-hr	g/hp-hr
EUENGINE3	1.25	0.14
Permit Limit	No Limit for Scenario of 60% Torque and 100% Power	

5.2 Discussion of Results

Each unit was verified to meet the CO Destruction Efficiency and the CO/NMOC emission limits (g/hp-hr).

5.3 Variations in Testing Procedures

For any test that concluded with a negative NMOC result, 0.1 ppm was used as an MDL for all calculations.

5.4 Process Upset Conditions During Testing

There were normal process breaks during production.

5.5 Maintenance Performed in Last Three Months

Regular maintenance is performed monthly.

5.6 Re-Test

This was not a retest.



5.7 Audit Samples

This test did not require any audit samples.

5.8 Field Data Sheets

Field data sheets can be found in **Appendix C**.

5.9 Calibration Data

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

5.10 Example Calculations

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

5.11 Laboratory Data

There was no laboratory data from this testing program.

TABLES



Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
EUENGINE4-6	3	Oxygen	U.S. EPA ^[1] Method 3A
	3	Carbon Monoxide	U.S. EPA ^[1] Method 10
EUENGINE3 60% Torque	3	Oxygen	U.S. EPA ^[1] Method 3A
	3	Carbon Monoxide	U.S. EPA ^[1] Method 10
	3	Non-Methane Organic Compounds	U.S. EPA ^[1] Method 25A

Notes:

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

Table 2: Sampling Time Summary

Source and Test #		Sampling Date	Start Time	End Time
EUENGINE4				
	Test #1	4-Jun-24	8:05 AM	9:04 AM
	Test #2	4-Jun-24	9:25 AM	10:24 AM
	Test #3	4-Jun-24	10:40 AM	11:39 AM
EUENGINE5				
	Test #1	3-Jun-24	8:45 AM	9:44 AM
	Test #2	3-Jun-24	10:05 AM	11:04 AM
	Test #3	3-Jun-24	11:22 AM	12:21 PM
EUENGINE6				
	Test #1	3-Jun-24	12:50 PM	1:49 PM
	Test #2	3-Jun-24	2:05 PM	3:04 PM
	Test #3	3-Jun-24	3:20 PM	4:19 PM
EUENGINE6 - 60% Torque				
	Test #1	5-Jun-24	10:12 AM	11:11 AM
	Test #2	5-Jun-24	11:45 AM	12:44 PM
	Test #3	5-Jun-24	1:10 PM	2:09 PM

Table 3 - EUENGINE4 CO Testing Summary

RWDI Project #2403298

Inlet				O ₂		CO		CO Emission Rate				Natural Gas Usage	Natural Gas Usage
Test ID	Date	Start	End	%		ppm		lbs/mmBTU		lbs/hr		MMBTU/hr	ft ³ /hr
				Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet		
1	2024-06-04	8:05	9:04	11.0	11.0	431.1	4.7	0.57	0.006	17.2	0.19	30.1	28,124
2	2024-06-04	9:25	10:24	11.1	11.0	435.4	4.5	0.59	0.006	17.7	0.18	30.1	28,193
3	2024-06-04	10:40	11:39	11.0	11.1	432.6	3.8	0.58	0.005	16.7	0.15	28.9	26,996
Average				11.0	11.0	433.0	4.3	0.58	0.006	17.2	0.17	29.7	27,771

	Horsepower	CO Emission Rate		DE
Test ID	bhp	g/bhp-hr		%
		Inlet	Outlet	
1	4091	1.91	0.021	98.9%
2	4116	1.95	0.020	99.0%
3	3884	1.95	0.017	99.1%
Average	4030	1.94	0.019	99.0%

MMBTU = 1068.9 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU
 lb/MMBTU =CO ppm x 0.0000000726 x 8710 x (20.9/20.9-Actual O2)

Table 4 - EUENGINE5 CO DE Testing Summary

RWDI Project #2403298

Inlet				O ₂		CO		CO Emission Rate				Natural Gas Usage	Natural Gas Usage
Test ID	Date	Start	End	%		ppm		lbs/mmBTU		lbs/hr		MMBTU/hr	ft ³ /hr
				Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet		
1	2024-06-03	8:45	9:44	11.7	11.8	400.5	6.8	0.58	0.010	17.6	0.30	30.5	28,516
2	2024-06-03	10:05	11:04	11.7	11.8	411.5	6.7	0.59	0.010	18.8	0.31	31.6	29,535
3	2024-06-03	11:22	12:21	11.7	11.7	420.8	6.7	0.60	0.010	19.2	0.31	31.9	29,788
Average				11.7	11.8	410.9	6.7	0.59	0.010	18.5	0.30	31.3	29,280

	Horsepower	CO Emission Rate		DE
Test ID	bhp	g/bhp-hr		%
		Inlet	Outlet	
1	4177	1.91	0.033	98.3%
2	4350	1.96	0.032	98.4%
3	4402	1.98	0.032	98.4%
Average	4310	1.95	0.032	98.4%

MMBTU = 1070.2 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU
 lb/MMBTU = CO ppm x 0.0000000726 x 8710 x (20.9/20.9-Actual O2)

Table 5 - EUENGINE6 CO DE Testing Summary

RWDI Project #2403298

Inlet				O ₂		CO		CO Emission Rate				Natural Gas Usage	Natural Gas Usage
Test ID	Date	Start	End	%		ppm		lbs/mmBTU		lbs/hr		MMBTU/hr	ft ³ /hr
				Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet		
1	2024-06-03	12:50	13:49	11.6	11.6	481.5	23.8	0.68	0.034	20.4	1.02	29.8	27,882
2	2024-06-03	14:05	15:04	11.6	11.6	481.9	21.5	0.69	0.031	20.4	0.91	29.7	27,783
3	2024-06-03	15:20	16:19	11.6	11.7	484.6	20.7	0.69	0.030	20.7	0.89	30.0	27,992
Average				11.6	11.6	482.7	22.0	0.69	0.031	20.5	0.94	29.8	27,886

	Horsepower	CO Emission Rate		DE
Test ID	bhp	g/bhp-hr		%
		Inlet	Outlet	
1	4157	2.23	0.11	95.0%
2	4142	2.24	0.10	95.5%
3	4165	2.26	0.10	95.7%
Average	4155	2.24	0.10	95.4%

MMBTU = 1070.2 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU
 lb/MMBTU =CO ppm x 0.0000000726 x 8710 x (20.9/20.9-Actual O2)

Table 6a: EUENGINE3 at 60% Torque CO Testing Summary

RWDI Project #2403298

Test ID	Date	Start	End	O ₂	CO	CO Emission Rate			Natural Gas Usage		Engine BHP
				%	ppm	lbs/mmBTU	lbs/hr	g/hp-hr	MMBTU/hr	ft ³ /hr	BHP
1	2024-06-05	10:12	11:11	15.8	150.7	0.39	6.28	1.21	16.0	15,000	2,350
2	2024-06-05	11:45	12:44	16.0	148.7	0.40	6.87	1.32	17.1	16,000	2,370
3	2024-06-05	13:10	14:09	16.0	147.6	0.40	6.42	1.22	16.0	15,000	2,387
Average				16.0	149.0	0.40	6.52	1.25	16.4	15,333	2,369

lb/MMBTU = CO ppm x 0.0000000726 x 8710 x (20.9/20.9-Actual O₂)

MMBTU = 1067.55 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU

Table 6b: EUENGINE3 at 60% Torque NMOC Testing Summary

RWDI Project #2403298

Test ID	Date	Start	End	O ₂	THC (as propane)	CH ₄ (as Methane)	Response Factor (Methane to Propane)	CH ₄ (as Propane)	NMOC (as Propane)	NMOC Emission Rate		
				%	ppm	ppm	Reponse Factor	ppm	ppm	lbs/mmBTU	lbs/hr	g/hp-hr
				Outlet	Outlet	Outlet	Outlet	Outlet	Outlet	Outlet	Outlet	Outlet
1	2024-06-05	10:12	11:11	15.8	293.2	675.8	2.42	279.0	14.2	0.058	0.93	0.18
2	2024-06-05	11:45	12:44	16.0	310.2	672.2	2.29	294.0	16.3	0.069	1.18	0.23
3	2024-06-05	13:10	14:09	16.0	300.1	699.2	2.30	304.1	0.1	0.00043	0.0068	0.0013
Average				16.0	301.2	682.4	2.34	292.3	10.2	0.043	0.71	0.14

MMBTU = 1067.55 BTU/sft3 natural gas x ft3 of natural gas x 1 MMBTU/1,000,000 BTU

lb/MMBTU = THC (propane) ppm x 0.00000114 x 8710 x (20.9/20.9-Actual O2)

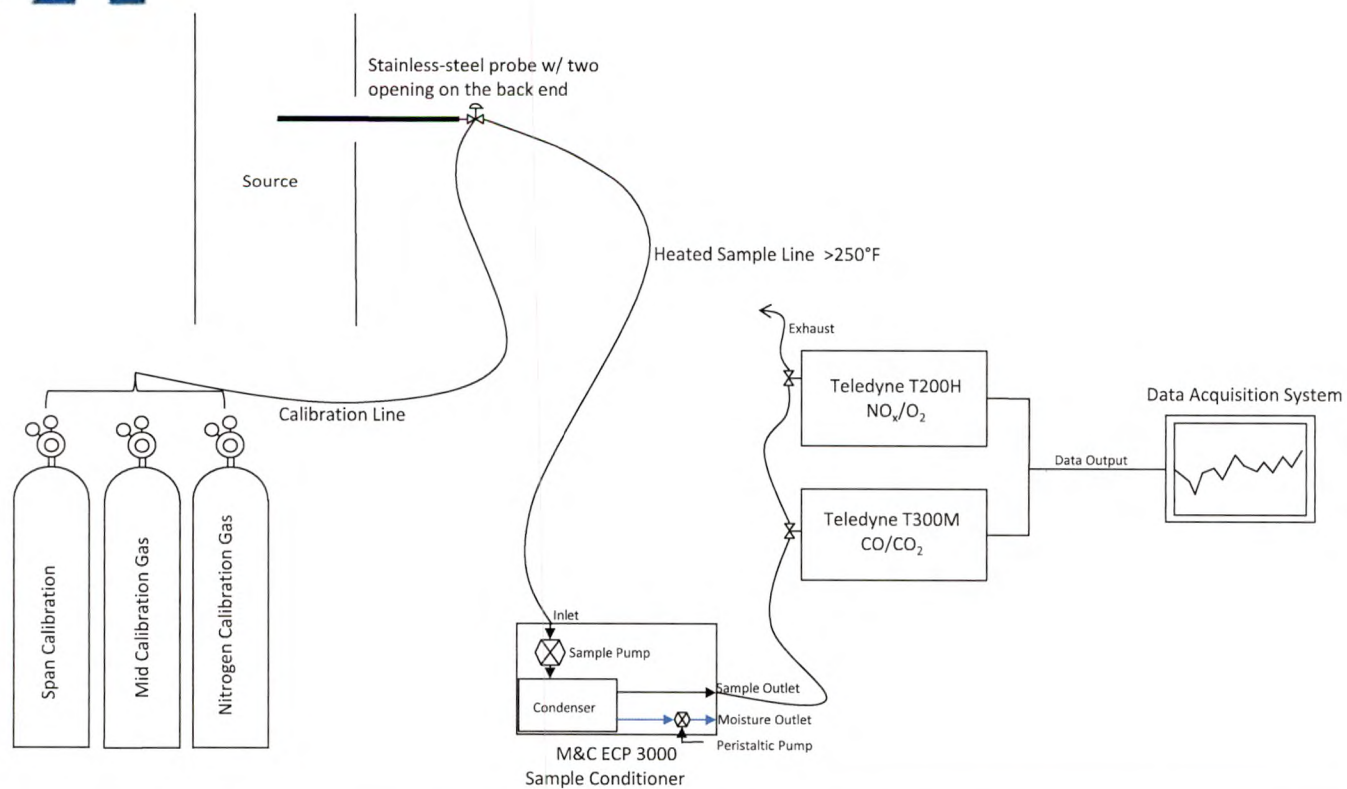
Needs to be filled in
Linked to CEMs Bias calcs

FIGURES





Figure No. 1: USEPA Method 3A,7E,10 Schematic



USEPA Method 3A,7E,10

DT Midstream

Washington 10

EUENGINE3-6

Washington Township, Michigan

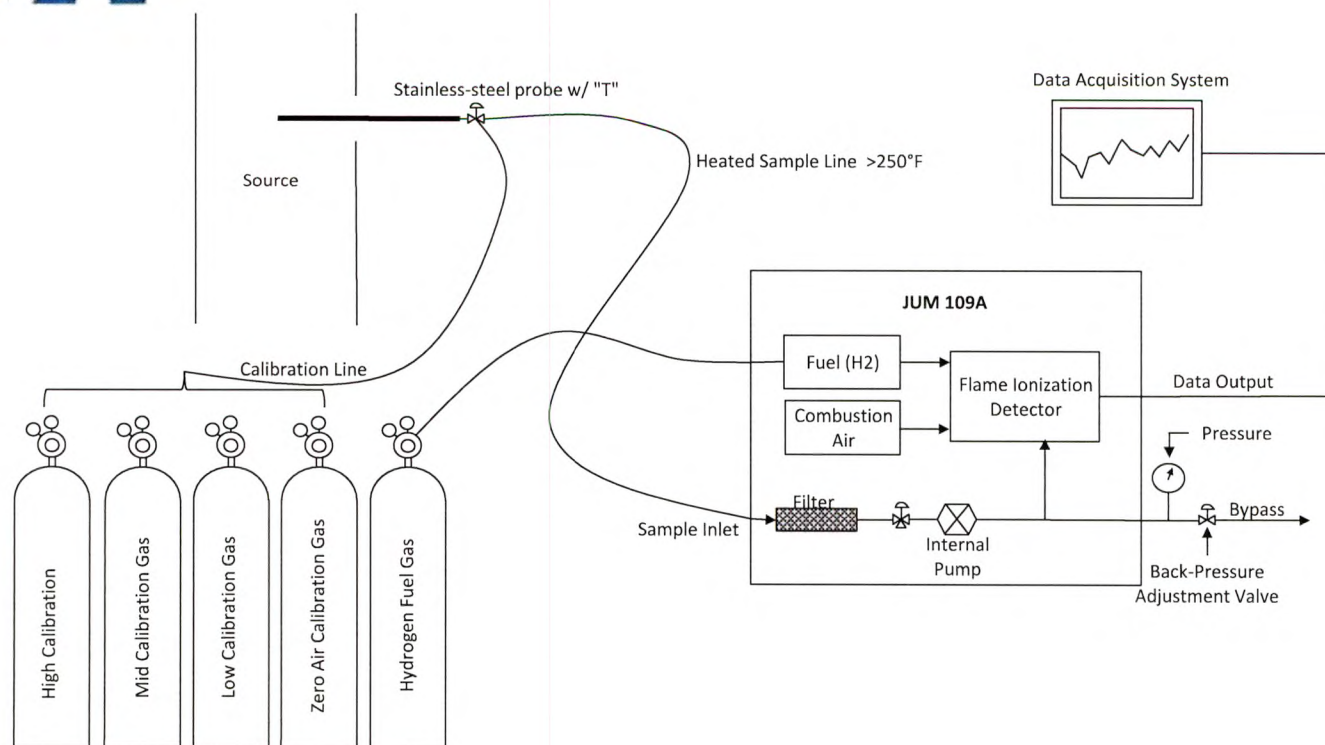
Project# 2403298

Date: Week of June 3rd, 2024





Figure No. 2: USEPA Method 25A Schematic



USEPA Method 25A

DT Midstream

Washington 10

EUENGINE3

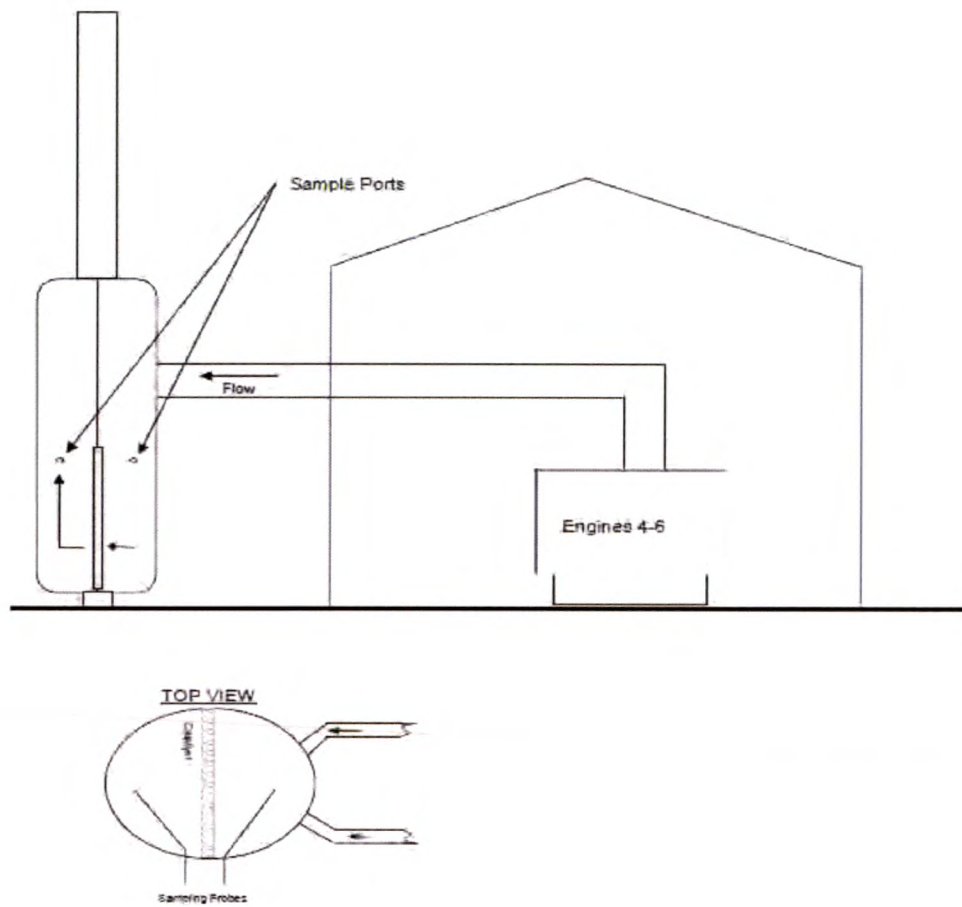
Washington Township, Michigan

Project# 2403298

Date: Week of June 3rd, 2024



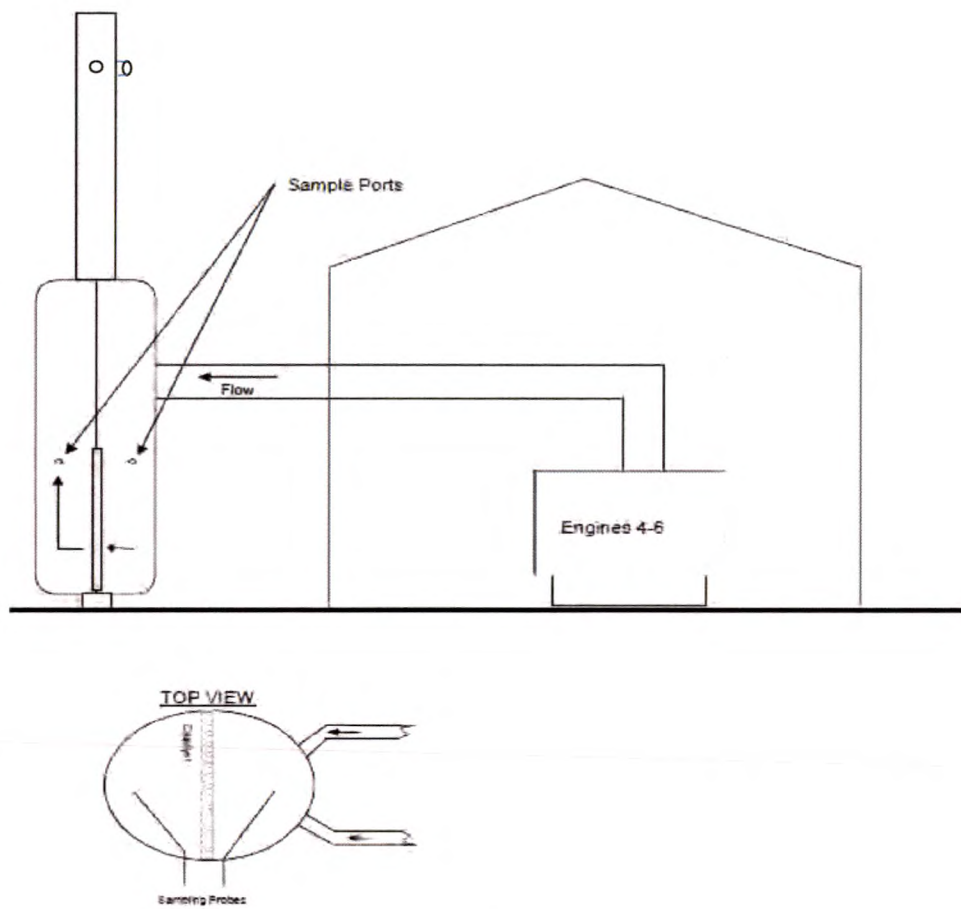
Figure No. 3: EUENGINE4-6 Stack Diagram



DT Midstream
Washington 10
Washington Township, Michigan
Week of June 3rd, 2024



Figure No. 4: EUENGINE1-3 Stack Diagram



DT Midstream
Washington 10
Washington Township, Michigan
Week of June 3rd, 2024

