Source Test Report for 2022 Compliance Testing
General Motors, LLC
Orion Assembly
RICE Engines No. 1, 2, 3, and 4
Lake Orion, Michigan

Prepared For:

General Motors, LLC
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Prepared By:

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For Submission To:

Michigan Department of Environment, Great Lakes and Energy
525 West Allegan Street
Lansing, Michigan 48933

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Test Dates: June 15 -17, 2022
Submittal Date: August 15, 2022

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TO ASTM D7036 ONLY

Review and Certification

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature:		**Date:**	08 / 03 / 2022
Name:	Sean Wheeler, QI	**Title:**	Field Project Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature:	Henry M. Taylor	**Date:**	08 / 03 / 2022
Name:	Henry M Taylor, QSTO	**Title:**	Senior Reporting Specialist

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1.0 Introduction

1.1 Summary of Test Program

General Motors, LLC (GM) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance emissions test program on the Landfill Gas Fired (LFG) Reciprocating Internal Combustion Engines (RICE) designated as No. 1 (EUENGINE1), Engine No. 2 (EUENGINE2), No. 3 (EUENGINE3), and No. 4 (EUENGINE4) at the Orion Assembly facility located in Lake Orion, Michigan.

The tests were conducted to satisfy the emissions testing requirements pursuant to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit No. MI-ROP-B7227-2020 and 40 CFR Part 60 Subpart JJJJ.

The specific objectives were to:

- Determine the concentrations and emission rates of NO_x, CO, and VOC*
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

Table 1-1
Summary of Test Program

Test Dates	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
6/15/22-	RICE Engines	Velocity/Volumetric Flow	EPA 1 & 2	12	≥5
6/17/22	3, 2, 4, and 1	O_2, CO_2	EPA 3A	12	60
		Moisture	EPA 4	12	60
		NO_x	EPA 7E	12	60
		CO	EPA 10	12	60
		VOC	EPA 25A/18	12	60

*VOC is measured in terms of total non-methane hydrocarbons (TNMHC)

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To simplify this report, a list of Units and Abbreviations is included in Appendix D.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Table 1-2. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The tests were conducted according to the Test Plan No. MW023AS-015633-PP-410 dated March 24, 2022.

Table 1-2
Summary of Average Compliance Results – RICE Engine No. 3
June 15, 2022

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NOx as NO_2)		
lb/hr	2.19	2.97
g/hp-hr	0.47	2.0
Carbon Monoxide (CO)		
lb/hr	11.32	17.3
g/hp-hr	2.41	3.5
Total Non-Methane Hydrocarbons, as Carbon (VOC)		
lb/hr	1.35	2.8
g/hp-hr	0.29	1.0

Table 1-3
Summary of Average Compliance Results – RICE Engine No. 2
June 15 and 16, 2022

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x as NO_2)		
lb/hr	1.84	2.97
g/hp-hr	0.40	2.0
Carbon Monoxide (CO)		
lb/hr	10.76	17.3
g/hp-hr	2.33	3.5
Total Non-Methane Hydrocarbons, as Carbon (VOC)		
lb/hr	1.26	2.8
g/hp-hr	0.27	1.0

Table 1-4
Summary of Average Compliance Results – RICE Engine No. 4
June 16, 2022

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x as NO_2)		
lb/hr	2.22	2.97
g/hp-hr	0.47	2.0
Carbon Monoxide (CO)		
lb/hr	12.43	17.3
g/hp-hr	2.65	3.5
Total Non-Methane Hydrocarbons, as Carbon (VOC)		
lb/hr	1.43	2.8
g/hp-hr	0.31	1.0

Table 1-5
Summary of Average Compliance Results – RICE Engine No. 1
June 17, 2022

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x as NO_2)		
lb/hr	2.64	2.97
g/hp-hr	0.56	2.0
Carbon Monoxide (CO)		
lb/hr	12.02	17.3
g/hp-hr	2.56	3.5
Total Non-Methane Hydrocarbons, as Carbon (VOC)		
lb/hr	2.15	2.8
g/hp-hr	0.46	1.0

1.2 Key Personnel

A list of project participants is included below:

Facility Information

Source Location:	General Motors, LLC Orion Assembly 4555 Giddings Road Lake Orion, MI 48359
Project Contact:	Michael Kennedy
Role:	Senior Environmental Engineering
Company:	General Motors
Telephone:	248-392-0309
Email:	Michael.kennedy@gm.com

Agency Information

Regulatory Agency:	Jeremy Howe
Agency Contact:	EGLE
Telephone:	231-878-6687
Email:	Howej1@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC
Contact:	Sean Wheeler
Title:	Field Project Manager
Telephone:	630-860-4740
Email:	stwheeler@montrose-env.com

Laboratory Information

Laboratory:	Montrose
City, State:	Elk Grove Village, Illinois
Method:	18

Test personnel and observers are summarized in Table 1-6.

Table 1-6
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
Brandon Check	Montrose	Client Project Manager/Field Team Leader/QI/Trailer Operator/Sample Recovery
Blu Kaput	Montrose	CEMS Equipment Manager/Trailer Operator/ Sample Train Operator
Jack Hutchison	Montrose	Report Preparation
Michael Kennedy	Montrose	Client Liaison/Test Coordinator

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

General Motors LLC -Orion Assembly Plant operates five LFG RICE generators to produce electricity. Each engine generator is rated at 1600 kW electrical output (2242 bph) The total combined maximum electrical output is 8000 kW or 8 MW. The maximum heat input capacity for each engine is approximately 15 MMBtu/hr. The heat capacity of landfill gas is estimated at 500 Btu/scf. GM's Orion Assembly Plant is located near two nonhazardous solid waste landfills and has access to the landfill gas. The engine generators are specifically designed to burn the landfill gas. The combined exhaust from all five engine generators vents through the existing powerhouse stack located at the plant. Four of the five LFG RICE generators (EUENGINE1, EUENGINE2, EUENGINE3, EUENGINE4) were tested during the event.

All four engines had top end overhauls completed in April and May, which consists of servicing cylinder heads and turbochargers. These are conducted approximately every 8,000 hours. Additionally, regular maintenance consisting of oil changes, filter and spark plug changes, and other typical preventative maintenance items have occurred within the three-month period prior to testing.

2.2 Flue Gas Sampling Locations

Information regarding the sampling locations is presented in Table 2-1.

Table 2-1
Sampling Locations

Sampling Location	Stack Inside Diameter (in.)	Distance from Nearest Disturbance		Number of Traverse Points
		Downstream EPA "B" (in./dia.)	Upstream EPA "A" (in./dia.)	
RICE Engines Nos. 3, 2, 4, 1	15.5	120 / 7.7	36 / 2.3	Flow: 16 (8/port)

Sample locations were verified in the field to conform to EPA Method 1. Absence of cyclonic flow conditions was confirmed following EPA Method 1, Section 11.4. See Appendix A.1 for more information.

2.3 Operating Conditions and Process Data

Emission tests were performed while the units and air pollution control devices were operating at the conditions required by the permit.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The process data that was provided is presented in Appendix B. Data collected includes the following parameters:

- Engine energy: KW, BHP

3.0 Sampling and Analytical Procedures

3.1 Test Methods

The test methods for this test program have been presented in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 1, Sample and Velocity Traverses for Stationary Sources

EPA Method 1 is used to assure that representative measurements of volumetric flow rate are obtained by dividing the cross-section of the stack or duct into equal areas, and then locating a traverse point within each of the equal areas. Acceptable sample locations must be located at least two stack or duct equivalent diameters downstream from a flow disturbance and one-half equivalent diameter upstream from a flow disturbance.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - None
- Method Exceptions:
  - None

The sample port and traverse point locations are detailed in Appendix A.

3.1.2 EPA Method 2, Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

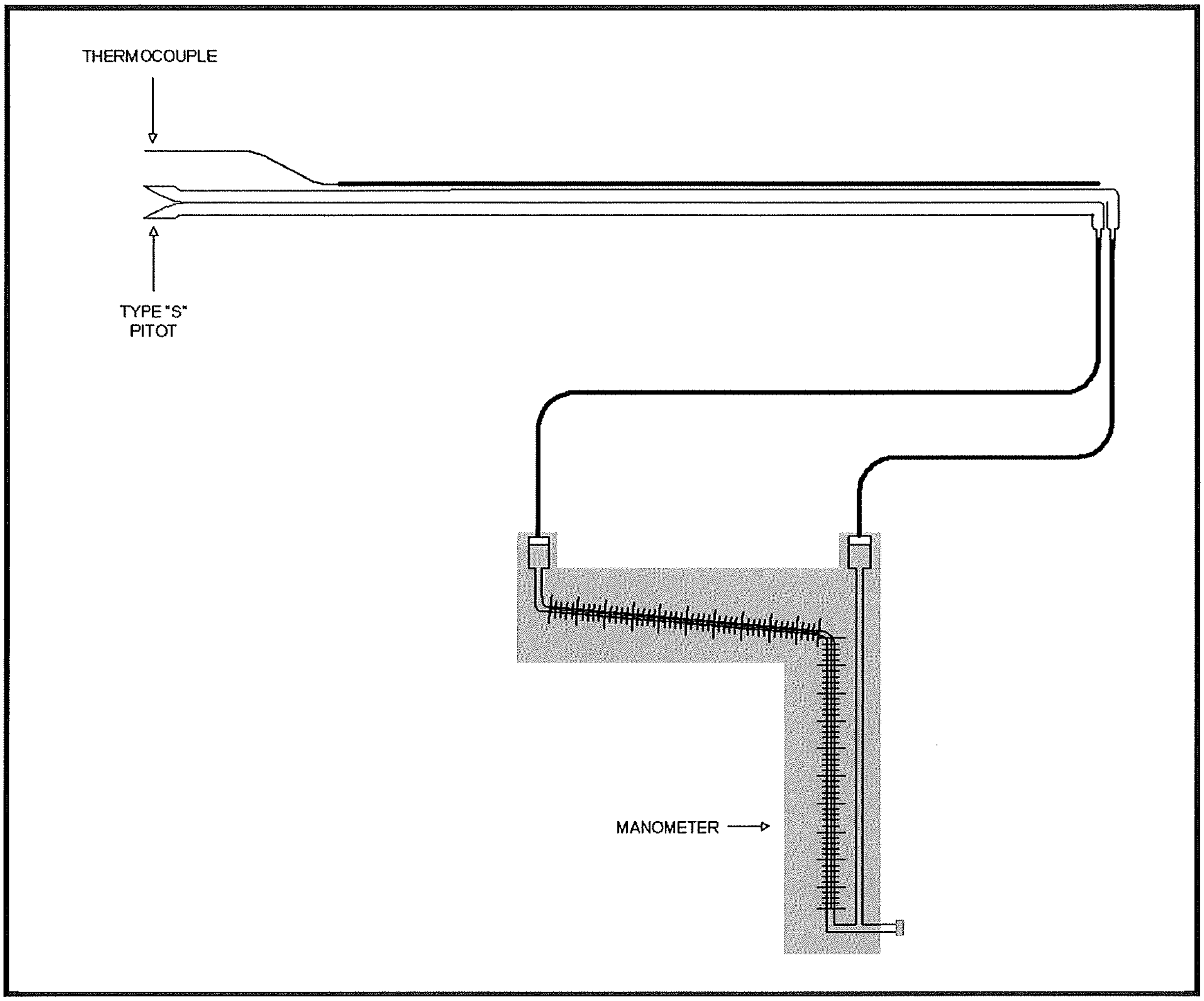
EPA Method 2 is used to measure the gas velocity using an S-type pitot tube connected to a pressure measurement device, and to measure the gas temperature using a calibrated thermocouple connected to a thermocouple indicator. Typically, Type S (Stausscheibe) pitot tubes conforming to the geometric specifications in the test method are used, along with an inclined manometer. The measurements are made at traverse points specified by EPA Method 1. The molecular weight of the gas stream is determined from independent measurements of O_2, CO_2, and moisture. The stack gas volumetric flow rate is calculated using the measured average velocity head, the area of the duct at the measurement plane, the measured average temperature, the measured duct static pressure, the molecular weight of the gas stream, and the measured moisture.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - S-type pitot tube coefficient is 0.84
- Method Exceptions:
  - None

The typical sampling system is detailed in Figure 3-1.

Figure 3-1
EPA Method 2 Sampling Train



3.1.3 EPA Methods 3A, 7E, and 10, Determination of Oxygen, Carbon Dioxide, Nitrogen Oxides, and Carbon Monoxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedures)

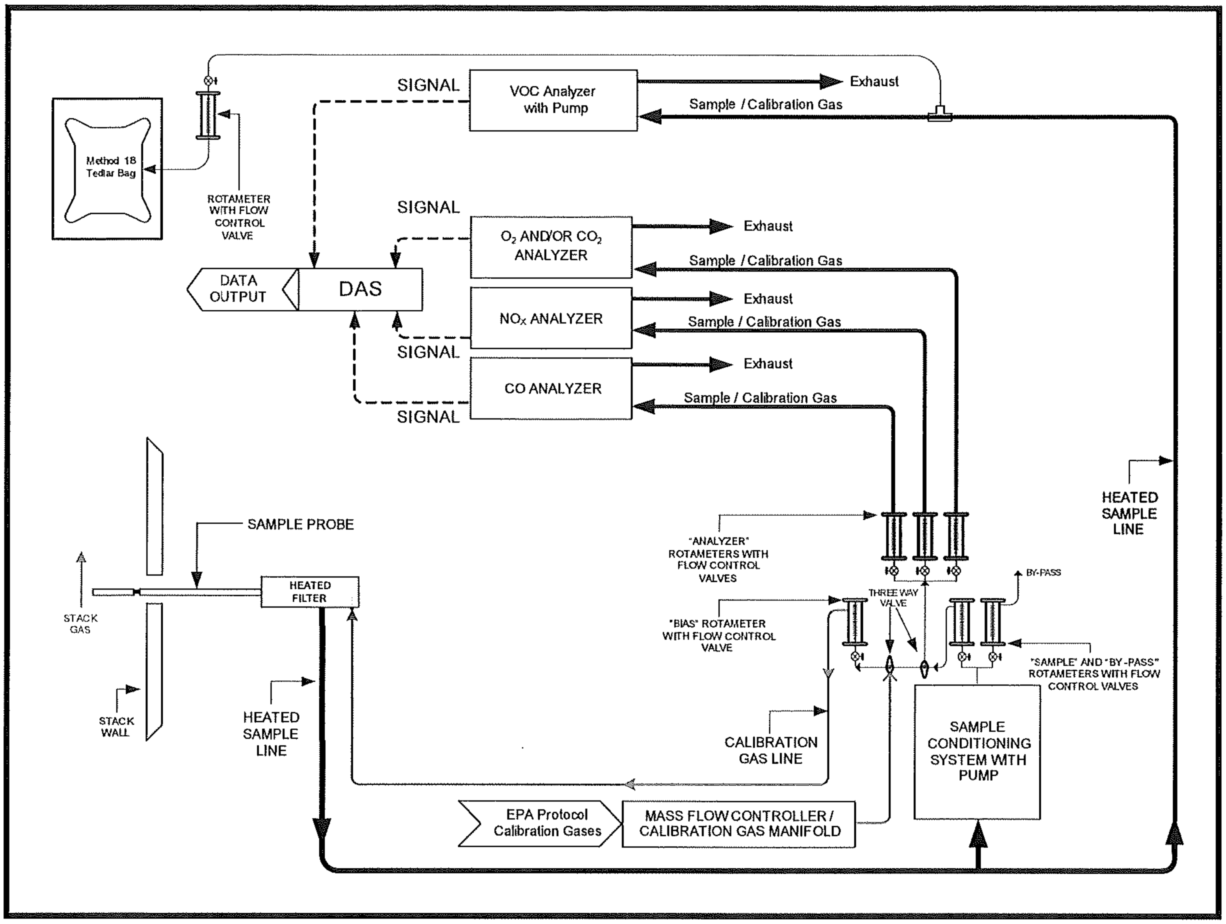
Concentrations of O_2, CO_2, NO_x, and CO are measured simultaneously using EPA Methods 3A, 7E, and 10, which are instrumental test methods. Conditioned gas is sent to a series of analyzers to measure the gaseous emission concentrations. The performance requirements of the method must be met to validate the data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - A dry extractive sampling system is used to report emissions on a dry basis
  - A paramagnetic analyzer is used to measure O_2
  - A nondispersive infrared analyzer is used to measure CO_2
  - A chemiluminescent analyzer is used to measure NO_x
  - A gas filter correlation nondispersive infrared analyzer is used to measure CO
- Method Exceptions:
  - None
- Target and/or Minimum Required Sample Duration: 60 minutes

The typical sampling system is detailed in Figure 3-2.

Figure 3-2
EPA Method 3A, 7E, 10, 18 (Bag), and 25A Sampling Train



3.1.4 EPA Method 4, Determination of Moisture Content in Stack Gas

EPA Method 4 is a manual, non-isokinetic method used to measure the moisture content of gas streams. Gas is sampled at a constant sampling rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed in an ice water bath. The impingers are weighed after each run to determine the percent moisture.

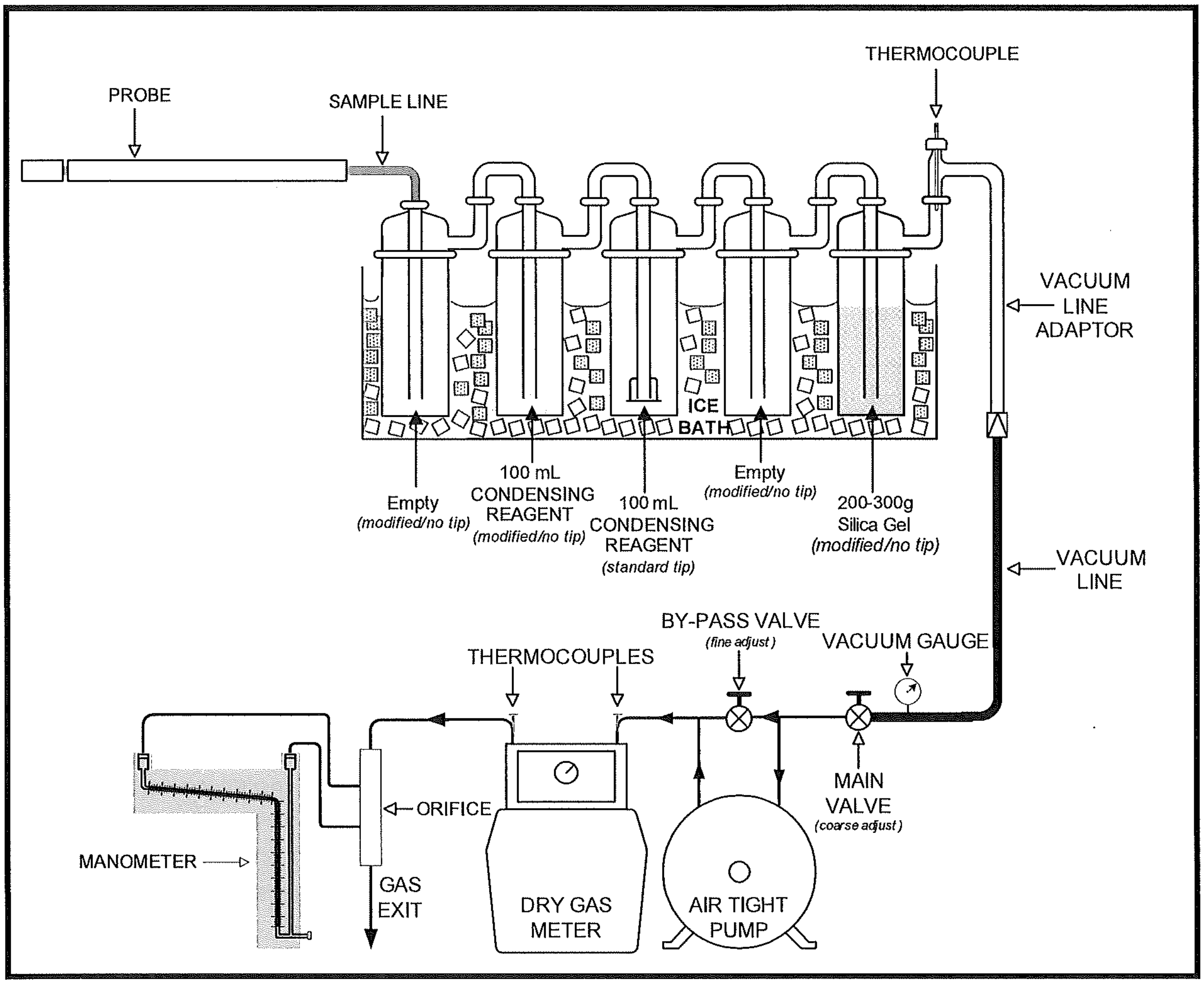
Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Montrose used knockout jars with flexible gum rubber tubing in place of the Greenburg-Smith impinger train per 40 CFR Part 60, Appendix A, Method 5 §6.1.1.8.
  - Condensed water is measured gravimetrically

- Method Exceptions:
  - Moisture sampling is performed as a stand-alone method at a single point in the centroid of the stack
- Target and/or Minimum Required Sample Duration: 60 minutes

The typical sampling system is detailed in Figure 3-3.

Figure 3-3
EPA Method 4 (Detached) (KO) Sampling Train



3.1.5 EPA Method 25A, Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer and EPA Method 18, Measurement of Gaseous Organic Compound Emissions by Gas Chromatography

EPA Method 25A is an instrumental test method used to measure the concentration of THC in stack gas. A gas sample is extracted from the source through a heated sample line and glass fiber filter to an FIA. Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

EPA Method 18 is used to measure gaseous organic compounds from stationary sources. The major organic components of a gas mixture are separated by GC and are individually quantified using a FID, PID, ECD, or other appropriate detection principles. The retention times of each separated component are compared with those of known compounds under identical conditions. The GC analyst confirms the identity and approximate concentrations of the organic emission components beforehand. With this information, the analyst then prepares or purchases commercially available standard mixtures to calibrate the GC under conditions identical to those of the samples. The analyst also determines the need for sample dilution to avoid detector saturation, gas stream filtration to eliminate particulate matter, and prevention of moisture condensation.

Total non-methane hydrocarbons concentrations are determined by subtracting methane from THC.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Results are reported in terms of propane
  - Integrated bag sampling and analysis is performed for Method 18
- Method Exceptions:
  - None
- Target Analytes: Total non-methane hydrocarbons
- Target and/or Minimum Required Sample Duration: 60 minutes
- Analytical Laboratory: Montrose, Elk Grove Village, Illinois

The typical sampling system is detailed in Figure 3-2.

3.2 Process Test Methods

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 Test Discussion and Results

4.1 Field Test Deviations and Exceptions

No field deviations or exceptions from the test plan or test methods occurred during this test program other than the Method 4 exceptions in 3.1.4.

4.2 Presentation of Results

The average results are compared to the permit limits in Table 1-2. The results of individual compliance test runs performed are presented in Tables 4-1 through 4-4. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

Table 4-1
NO_x, CO, and TNMHC Emissions Results - RICE Engine No. 3

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	6/15/2022	6/15/2022	6/15/2022	--
Time	06:26-07:26	07:44-08:44	09:22-10:22	--
Process Data				
kW	1590.1	1586.5	1591.1	1589.3
BHP	2132.4	2127.5	2133.8	2131.2
fuel flow, SCFM	555.1	546.8	553.0	551.6
Sampling & Flue Gas Parameters				
flue gas temperature, °F	857	881	877	872
volumetric flow rate, acfm	14,701	14,550	14,659	14,636
volumetric flow rate, scfm	5,726	5,566	5,625	5,639
volumetric flow rate, dscfm	5,121	4,826	4,915	4,954
CO_2, % volume dry	11.5	11.6	11.8	11.6
O_2, % volume dry	8.0	7.9	7.9	7.9
moisture content, % volume	10.6	13.3	12.7	12.2
Nitrogen Oxides (NO_x)				
ppmvd	61.0	61.0	62.9	61.6
lb/hr	2.24	2.11	2.21	2.19
g/hp-hr	0.48	0.45	0.47	0.47
Carbon Monoxide (CO)				
ppmvd	516.0	523.7	532.8	524.1
lb/hr	11.53	11.02	11.42	11.32
g/hp-hr	2.45	2.35	2.43	2.41
Total Non-Methane Hydrocarbons (TNMHC), as Carbon (VOC)				
THC as C_3, ppmvd	600.0	626.4	612.4	612.9
THC as C_1, ppmvd	1800.1	1879.1	1837.2	1838.8
THC as C_1, lb/hr	70.78	71.81	70.96	71.18
methane, ppmvd	1827	1812	1806	1815
methane, lb/hr	71.67	69.12	69.61	70.14
TNMHC, lb/hr	0.00	2.69	1.35	1.35
TNMHC, g/hp-hr	0.00	0.57	0.29	0.29

Table 4-2
NO_x, CO, and TNMHC Emissions Results - RICE Engine No. 2

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	6/15/2022	6/16/2022	6/16/2022	--
Time	10:55-11:55	06:20-07:20	07:36-08:36	--
Process Data				
kW	1530.8	1599.4	1587.3	1572.5
BHP	2051.4	2143.4	2127.2	2107.3
fuel flow, SCFM	527.0	551.9	544.9	541.2
Sampling & Flue Gas Parameters				
flue gas temperature, °F	848	857	862	855
volumetric flow rate, acfm	14,382	14,093	13,688	14,054
volumetric flow rate, scfm	5,644	5,483	5,307	5,478
volumetric flow rate, dscfm	4,920	4,892	4,608	4,807
CO_2, % volume dry	11.5	11.4	11.3	11.4
O_2, % volume dry	8.2	8.0	7.8	8.0
moisture content, % volume	12.8	10.8	13.2	12.3
Nitrogen Oxides (NO_x)				
ppmvd	55.2	54.9	53.5	54.2
lb/hr	1.95	1.92	1.76	1.84
g/hp-hr	0.43	0.41	0.38	0.40
Carbon Monoxide (CO)				
ppmvd	508.1	516.9	522.0	519.5
lb/hr	10.90	11.03	10.49	10.76
g/hp-hr	2.41	2.33	2.24	2.33
Total Non-Methane Hydrocarbons (TNMHC), as Carbon (VOC)				
THC as C_3, ppmvd	601.7	601.5	629.7	615.6
THC as C_1, ppmvd	1804.9	1804.4	1889.0	1846.7
THC as C_1, lb/hr	69.95	67.93	68.84	68.39
methane, ppmvd	1797	1799	1789	1795
methane, lb/hr	70.5	67.6	65.1	67.7
TNMHC, lb/hr	0.0	0.0	3.8	1.3
TNMHC, g/hp-hr	0.00	0.00	0.80	0.27

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Table 4-3
NO_x, CO, and TNMHC Emissions Results - RICE Engine No. 4

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	6/16/2022	6/16/2022	6/16/2022	--
Time	09:39-10:39	10:58-11:58	12:15-13:15	--
Process Data				
kW	1591.4	1578.7	1589.9	1586.7
BHP	2132.7	2115.7	2130.6	2126.3
fuel flow, SCFM	547.7	548.9	554.0	550.2
Sampling & Flue Gas Parameters				
flue gas temperature, °F	848	912	915	914
volumetric flow rate, acfm	13,598	14,323	14,084	14,002
volumetric flow rate, scfm	5,327	5,349	5,248	5,308
volumetric flow rate, dscfm	4,623	4,632	4,579	4,611
CO_2, % volume dry	11.6	11.7	11.6	11.6
O_2, % volume dry	7.8	7.8	7.9	7.9
moisture content, % volume	13.2	13.4	12.8	13.1
Nitrogen Oxides (NO_x)				
ppmvd	66.5	67.0	68.2	67.2
lb/hr	2.20	2.22	2.24	2.22
g/hp-hr	0.47	0.48	0.48	0.47
Carbon Monoxide (CO)				
ppmvd	618.4	621.6	616.1	618.8
lb/hr	12.47	12.56	12.31	12.43
g/hp-hr	2.65	2.69	2.62	2.65
Total Non-Methane Hydrocarbons (TNMHC), as Carbon (VOC)				
THC as C_3, ppmvd	661.0	677.9	665.5	671.7
THC as C_1, ppmvd	1982.9	2033.6	1996.6	2004.4
THC as C_1, lb/hr	72.53	74.69	71.95	73.32
methane, ppmvd	1967	1979	1961	1969
methane, lb/hr	71.82	72.54	70.53	71.63
TNMHC, lb/hr	0.71	2.16	1.42	1.43
TNMHC, g/hp-hr	0.15	0.46	0.30	0.31

Table 4-4
NO_x, CO, and TNMHC Emissions Results -
RICE Engine No. 1

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	6/17/2022	6/17/2022	6/17/2022	--
Time	08:46-09:46	10:02-11:02	11:21-12:21	--
Process Data				
kW	1585.5	1581.1	1590.6	1585.8
BHP	2126.2	2120.3	2133.1	2126.5
fuel flow, SCFM	568.5	568.9	570.1	569.2
Sampling & Flue Gas Parameters				
flue gas temperature, °F	838	824	833	832
volumetric flow rate, acfm	13,124	13,949	14,243	13,772
volumetric flow rate, scfm	5,169	5,554	5,631	5,452
volumetric flow rate, dscfm	4,572	4,912	5,008	4,830
CO_2, % volume dry	11.3	11.3	11.3	11.3
O_2, % volume dry	8.3	8.4	8.4	8.3
moisture content, % volume	11.6	11.6	11.1	11.4
Nitrogen Oxides (NO_x)				
ppmvd	73.0	77.7	78.1	76.3
lb/hr	2.39	2.74	2.80	2.64
g/hp-hr	0.51	0.59	0.60	0.56
Carbon Monoxide (CO)				
ppmvd	568.3	569.9	572.9	570.4
lb/hr	11.33	12.21	12.51	12.02
g/hp-hr	2.42	2.61	2.66	2.56
Total Non-Methane Hydrocarbons (TNMHC), as Carbon (VOC)				
THC as C_3, ppmvd	665.9	656.7	649.1	657.2
THC as C_1, ppmvd	1997.7	1970.0	1947.3	1971.7
THC as C_1, lb/hr	70.91	75.14	75.30	73.78
methane, ppmvd	1909	1917	1925	1917
methane, lb/hr	67.62	72.99	74.29	71.63
TNMHC, lb/hr	3.29	2.15	1.01	2.15
TNMHC, g/hp-hr	0.70	0.46	0.21	0.46

5.0 Internal QA/QC Activities

5.1 QA/QC Audits

The meter box and sampling train used during sampling performed within the requirements of their respective methods. All post-test leak checks and minimum metered volumes met the applicable QA/QC criteria.

EPA Method 3A, 7E, and 10 calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

EPA Method 25A FIA calibration audits were within the measurement system performance specifications for the calibration drift checks and calibration error checks.

The NO_2 to NO converter efficiency check of the analyzer was conducted per the procedures in EPA Method 7E, Section 8.2.4. The conversion efficiency met the criteria.

EPA Method 18 analytical QA/QC results are included in the laboratory report. The method QA/QC criteria were met.

5.2 QA/QC Discussion

All QA/QC criteria were met during this test program.

5.3 Quality Statement

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

Appendix A
Field Data and Calculations

Appendix A.1
Sampling Locations

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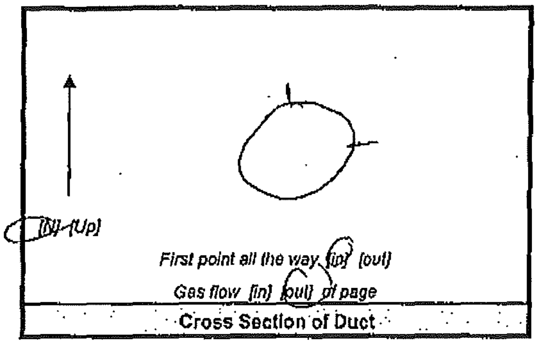
EPA Method 1

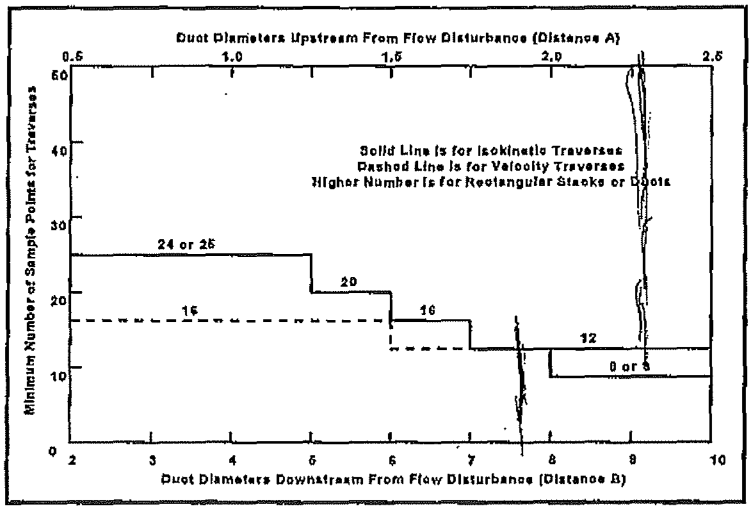
Sample and Velocity Traverses Datasheet

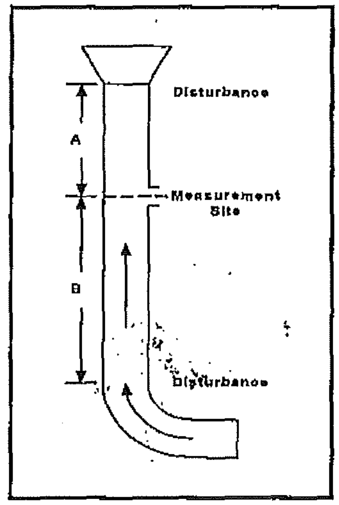
LOCATION ENGINE 3,2,4,1

Client	GM
Project No:	015633
Plant	LAKE ORION
Date	6-14-22
Technician	BC
Duct Diameter (in.)	15.5"
Port Diameter (in.)	
Port Length (in.)	7"
Port Type	FLANGE
Distance A (ft)	36"
Distance B (ft)	120"
Distance A (Duct Diameters)	2.3
Distance B (Duct Diameters)	7.7



For rectangular ducts $ED = \frac{2LW}{(L+W)}$





Location Schematic and Notes	Traverse Point	Distance (in.)
AREA = 1.3104 SQ FT	1	7.50
	2	8.62
	3	10.00
	4	12.01
	5	17.49
	6	19.50
	7	20.88
	8	22.00
	9	
	10	
	11	
	12	
	13	
	14	
Indicate sample ports, height from grade, types of disturbances, access, unistrut configuration, etc.	15	
Distance to point must include length of port	16	