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**Source Test Report for 2022 Compliance Testing  
Paint Shop Regenerative Thermal Oxidizer  
General Motors, LLC  
Orion Assembly  
Lake Orion, Michigan**

**Prepared For:**

**General Motors, LLC  
4555 Giddings Road  
Lake Orion, MI 48359**

**Prepared By:**

**Montrose Air Quality Services, LLC  
1371 Brummel Ave  
Elk Grove Village, IL 60007**

**For Submission To:**

**Michigan Department of Environment, Great Lakes, and Energy  
27700 Donald Court  
Warren, MI 48092**

**Document Number: MW023AS-009183-RT-1472**

**Test Date: July 18, 2022**

**Submittal Date: September 14, 2022**

*B7227\_test\_20220718*



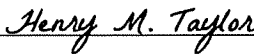
## Review and Certification

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 / 19 / 2022

**Name:** Sean Wheeler, QI **Title:** Field Project Manager, QI

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:**  **Date:** 08 / 22 / 2022

**Name:** Henry M. Taylor, QSTO **Title:** Senior Reporting Specialist

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**Summary of Average Compliance Results – Paint Shop RTO July 18, 2022**

Parameter/Units	Average Results	Emission Limits
<b>Combined Inlet Total Hydrocarbons (THC), as Propane</b>		
ppmvw	225.1	--
lb/hr	84.7	--
<b>Outlet Total Hydrocarbons (THC), as Propane</b>		
ppmvw	4.3	--
lb/hr	1.90	--
DE, %	97.74	>95

## 1.0 Introduction

### 1.1 Summary of Test Program

General Motors, LLC (GM) contracted Montrose Air Quality Services, LLC (Montrose) on July 18, 2022 to perform a compliance emissions test program on the Paint Shop (FG-FACILITY) RTO system at the Orion Assembly facility (State Registration Number: B7227) 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. Testing was conducted during representative Paint Shop operations and a RTO combustion chamber temperature of >1400 °F.

The specific objectives were to:

- Determine the VOC\* concentration at the Paint Shop RTO Combined Inlet Duct and RTO Outlet
- Determine the volumetric flow rate of the gas stream at the Paint Shop RTO Roof Inlet (Ovens), RTO Inside Inlet (Spray Booths), and RTO Outlet
- Conduct the test program with a focus on safety

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

**Table 1-1**  
**Summary of Test Program**

Test Date	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
7/18/22	RTO Inlets	Velocity/Volumetric Flow	EPA 1 & 2	6	60
	(Roof and Inside)	O <sub>2</sub> , CO <sub>2</sub>	EPA 3	6	60
		Moisture	EPA 4	6	60
7/18/22	RTO Combined Inlet Duct	THC	EPA 25A	6	60
7/18/22	RTO Outlet	Velocity/Volumetric Flow	EPA 1 & 2	3	60
		O <sub>2</sub> , CO <sub>2</sub>	EPA 3	3	60
		Moisture	EPA 4	3	60
		THC	EPA 25A	3	60

\*VOC is measured in terms of total hydrocarbons (THC) as propane.

To simplify this report, a list of Units and Abbreviations is included in Appendix C.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. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The test was conducted according to the Test Plan No. 009183-PP-442 submitted September 3, 2021.

## 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 Engineer  
Company: General Motors  
Telephone: 248-392-0309  
Email: Michael.kennedy@gm.com

### Agency Information

Regulatory Agency: EGLE  
Agency Contact: Jeremy Howe  
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

Test personnel and observers are summarized in Table 1-2.

**Table 1-2**  
**Test Personnel and Observers**

Name	Affiliation	Role/Responsibility
Brian Romani	Montrose	Field Project Manager/Field Team Leader/QSTI/Trailer Operator
Hayden Carl, John Ziber	Montrose	Technician/Sample Train Operator
Jack Hutchison	Montrose	Report Preparation
Michael Kennedy	GM	Client Liaison/Test Coordinator
Gina Angellotti	EGLE	Test Observer



## **2.0 Test Discussion and Results**

### **2.1 Test Objectives**

Testing was performed on the FG-FACILITY RTO System to satisfy the emissions requirements pursuant to EGLE Renewable Operating Permit No. MI-ROP-B7227-2020.

Operational data collected during testing is presented in Section 3 and Appendix B.

### **2.2 Field Test Deviations and Exceptions**

No field deviations or exceptions from the test plan or test methods occurred during this test program with the exception of the procedure in Section 4.1.4.

### **2.3 Presentation of Results**

The average results are compared to the permit limits in the Summary of Average Compliance Results. The results of individual compliance test runs performed are presented in Tables 2-1 and 2-2. 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 2-1  
THC Emissions Results -  
Paint Shop RTO Inlets**

Parameter/Units	Run 1	Run 2	Run 3	Average
<b>Date</b>	7/18/2022	7/18/2022	7/18/2022	--
<b>Time</b>	07:00-08:00	09:50-10:50	13:05-14:05	--
<b>Roof Inlet Sampling &amp; Flue Gas Parameters</b>				
flue gas temperature, °F	290	292	295	292
volumetric flow rate, acfm	35,047	36,170	35,805	35,674
volumetric flow rate, scfm	23,630	24,322	23,981	23,978
volumetric flow rate, dscfm	23,099	23,728	23,257	23,361
CO <sub>2</sub> , % volume dry	0.0	0.0	0.0	0.0
O <sub>2</sub> , % volume dry	20.8	20.8	20.8	20.8
moisture, %	2.28	2.48	3.06	2.61
<b>Inside Inlet Sampling &amp; Flue Gas Parameters</b>				
flue gas temperature, °F	105	103	106	105
volumetric flow rate, acfm	33,472	34,671	35,080	34,407
volumetric flow rate, scfm	29,996	31,181	31,381	30,853
volumetric flow rate, dscfm	29,078	30,239	30,468	29,928
CO <sub>2</sub> , % volume dry	0.0	0.0	0.0	0.0
O <sub>2</sub> , % volume dry	20.8	20.8	20.8	20.8
moisture, %	3.10	3.06	2.95	3.04
<b>Combined Inlet Duct Total Hydrocarbons as Propane Emissions</b>				
combined volumetric flow rate, scfm	53,625	55,503	55,362	54,830
ppmvw	233.9	235.7	205.8	225.1
lb/hr	86.6	90.3	78.7	85.2

**Table 2-2  
THC Emissions Results -  
Paint Shop RTO Outlet**

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	7/18/22	7/18/22	7/18/22	--
Time	07:00-08:00	09:50-10:50	13:05-14:05	--
<b>Outlet Sampling &amp; Flue Gas Parameters</b>				
flue gas temperature, °F	259	293	271	274
volumetric flow rate, acfm	90,808	96,743	92,628	93,393
volumetric flow rate, scfm	63,981	65,073	64,159	64,404
volumetric flow rate, dscfm	61,890	62,262	61,998	62,050
CO <sub>2</sub> , % volume dry	0.0	0.0	0.0	0.0
O <sub>2</sub> , % volume dry	20.5	20.5	20.5	20.5
moisture, %	3.31	4.36	3.41	3.69
<b>Outlet Total Hydrocarbons as Propane Emissions</b>				
ppmvw	4.2	4.3	4.5	4.3
lb/hr	1.83	1.91	1.97	1.90
DE, %	97.88	97.87	97.48	97.74

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### 3.0 Plant and Sampling Location Descriptions

#### 3.1 Process Description, Operation, and Control Equipment

General Motors, LLC - Orion Assembly utilizes a paint shop consisting of an ELPO, a sealer line, and Integrated Process (primer, basecoat, and clearcoat in one continuous booth system). The Orion paint shop consists of a single ELPO tank and oven, a sealer line with an oven, two integrated process lines each containing two heated flash zones and a curing oven at the end of the spray booth and a single RTO for all abated exhausts.

Maintenance was performed in the Paint Shop in the 3 months prior to testing. The thermocouples were replaced, the RTO damper and the fan bearing were lubricated, and the RTO combustion air blower filter was cleaned in July 2022 in accordance with the Site's Operation and Maintenance Plan.

The compliance test was conducted on the Paint Shop RTO System.

#### 3.2 Control Equipment Description

During the test, emissions from FG-FACILITY were controlled by the RTO

#### 3.3 Flue Gas Sampling Location

Information regarding the sampling locations are presented in Table 3-1.

**Table 3-1  
Sampling Locations**

Sampling Locations	Stack Inside Diameter (in.)	Distance from Nearest Disturbance		Number of Traverse Points
		Downstream EPA "B" (in./dia.)	Upstream EPA "A" (in./dia.)	
Roof Inlet (Ovens)	46.0	352.9 / 7.7	118.0 / 2.6	Flow: 16 (8/port)
Inside Inlet (Spray Booth)	45.5	210 / 4.6	170 / 3.7	Flow: 16 (8/port)
Outlet	67.5	840 / 12.4	300 / 4.4	Flow: 16 (8/port) Gaseous: 1

The sample locations were verified in the field to conform to EPA Method 1. During the emission sampling, a single point, located within the central 10% of the RTO Combined Inlet Duct's cross-sectional area, was utilized for VOC concentration determination. See Appendix A.1 for more information.

#### 3.4 Operating Conditions and Process Data

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:

- Vehicles painted, jobs/hr
- RTO temperature, °F
- The RTO chamber retention time is 0.910387 seconds

## 4.0 Sampling and Analytical Procedures

### 4.1 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.

#### 4.1.1 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.

#### 4.1.2 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<sub>2</sub>, CO<sub>2</sub>, 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:
  - A pressure transducer multimeter is used to measure velocity
- Method Exceptions:
  - None

#### 4.1.3 EPA Method 3, Gas Analysis for the Determination of Dry Molecular Weight

EPA Method 3 is used to measure the percent O<sub>2</sub> and CO<sub>2</sub> in the gas stream. A gas sample is extracted from a stack by one of the following methods: (1) single-point, grab sampling; (2) single-point, integrated sampling; or (3) multi-point, integrated sampling. The gas sample is analyzed for percent CO<sub>2</sub> and percent O<sub>2</sub> using either an Orsat or a Fyrite analyzer.

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

- Method Options:
  - An Orsat analyzer is used to measure the analyte concentrations
  - The sample is collected into a Tedlar bag from the back of the sample train for the duration of the test run
- Method Exceptions:
  - None

#### 4.1.4 EPA Method 4, Determination of Moisture Content in Stack Gas

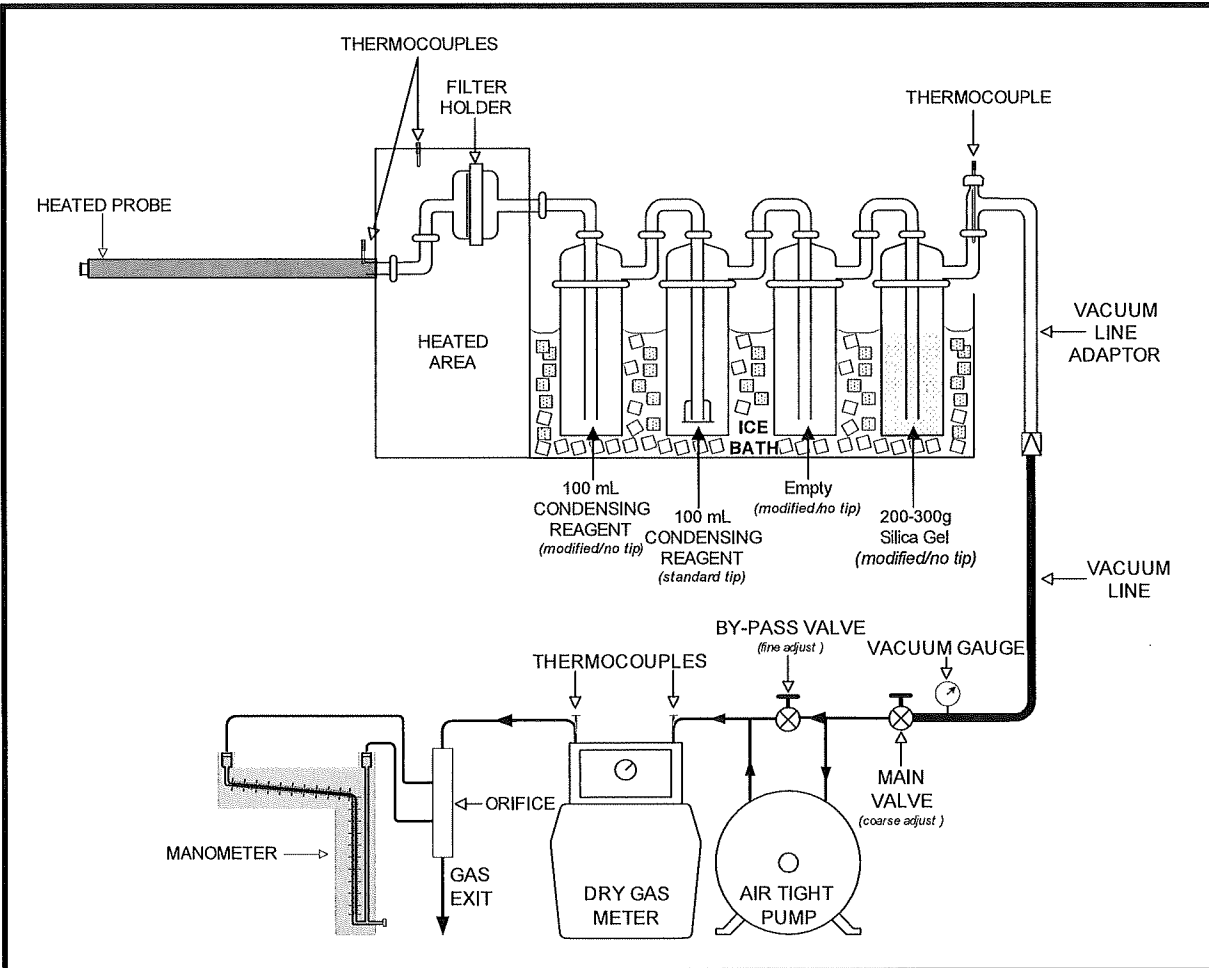
EPA Method 4 is a manual, non-isokinetic method used to measure the moisture content of gas streams. Gas is sampled at a constant sampling rate through a probe and impinger train. Moisture is removed using a series of pre-weighed impingers containing methodology-specific liquids and silica gel immersed 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:
  - The reference method is used to measure moisture
  - Since it is theoretically impossible for measured moisture to be higher than psychrometric moisture, the psychrometric moisture is also calculated, and the lower moisture value is used in the calculations
- Method Exceptions:
  - Moisture sampling is performed as a stand-alone method at a single point in the centroid of the stack
  - At the inside inlet, wet bulb and dry bulb stack gas temperatures are used to calculate the moisture using psychrometry

The typical sampling system is detailed in Figure 4-1.

**FIGURE 4-1**  
**EPA Method 4 (No Pitots) Sampling Train**





#### 4.1.5 EPA Method 25A, Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

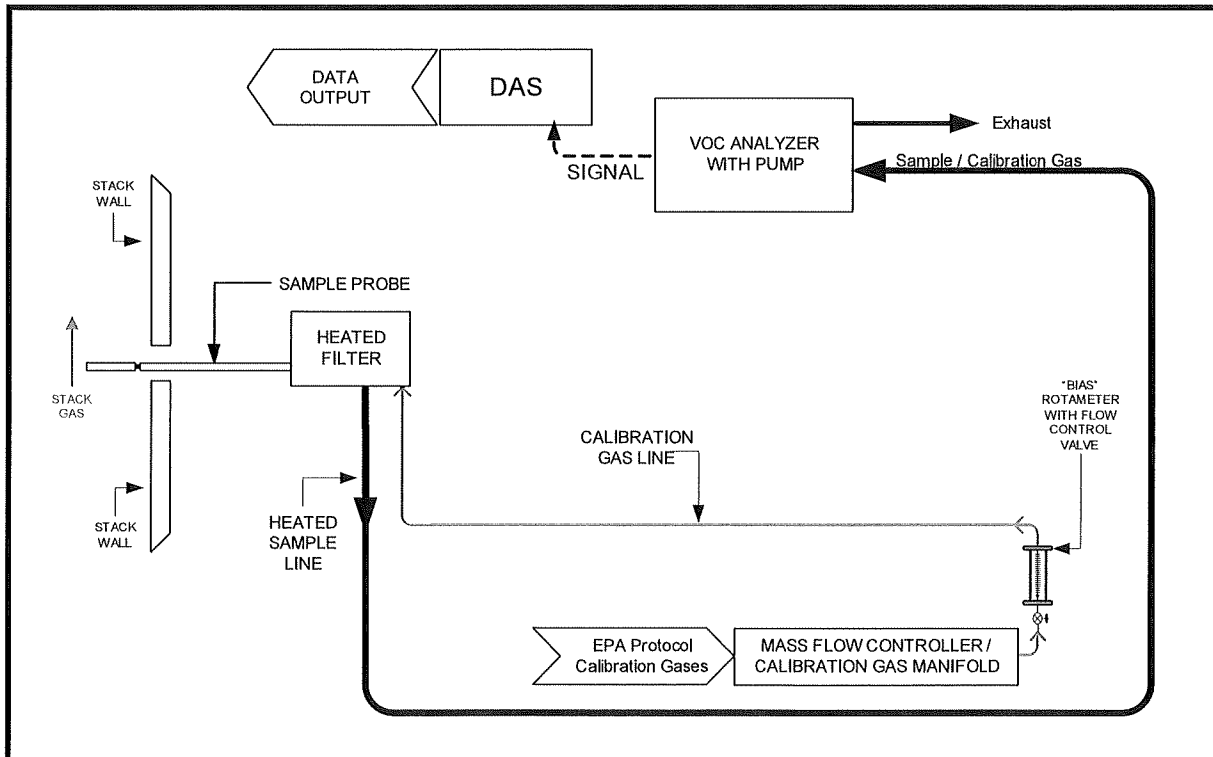
EPA Method 25A is an instrumental test method used to measure the concentration of THC in stack gas. A gas sample is extracted from the source through a heated sample line and glass fiber filter to a FIA. Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

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

- Method Options:
  - Results are reported in terms of propane
- Method Exceptions:
  - None

The typical sampling system is detailed in Figure 4-2.

**Figure 4-2  
EPA Method 25A Sampling Train**



## 4.2 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.

## 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, minimum metered volumes, and minimum sample durations met the applicable QA/QC criteria.

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

### 5.2 QA/QC Discussion

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

Detailed tabulations of results including process operating conditions and flue gas conditions are included in Section 2 and Appendix A.

Discussion of the significance of results relative to operating parameters and emission regulations are in Section 2.

The major maintenance performed within 3 months of testing is presented in Section 3.

Sample calculations, field data sheets, cyclonic flow checks and laboratory data are included in the appendices.

### 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 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).



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## Appendix A Field Data and Calculations

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## **Appendix A.1**

### **Sampling Locations**