Source Test Report for
2022 Compliance Testing
Abatement Systems #100 and #200
Detroit-Hamtramck/Factory ZERO
General Motors, LLC
Detroit, Michigan

Prepared For:

Detroit-Hamtramck/Factory ZERO
General Motors, LLC
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For Submission To:

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

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TO ASTM D7036 ONLY
CERT #3925.01

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:	Kurt Wepprecht	**Date:**	09 / 02 / 2022
Name:	Kurt Wepprecht, QI	**Title:**	Vice President, Technical

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:**	09 / 06 / 2022
Name:	Henry M. Taylor, QSTO	**Title:**	Senior Reporting Specialist

Executive Summary

Montrose Air Quality Services, LLC (Montrose) was retained by General Motors, LLC (GM) to evaluate THC from the Abatement Systems (AB 100 and AB 200) at the Factory ZERO facility located at 2500 E. Grand Blvd, Detroit, MI, 48211. The testing program was conducted on August 2nd through 5th and 9th through 11th, 2022.

The testing consisted of two to four 60-minute test runs at each source. The results of the emission test program are summarized in Table I.

Table I
Executive Summary Table HCl Emission Rates Summary

Parameter/Units	Average Results	Emission Limits
RTO 110 Total Hydrocarbons, as Propane (THC)		
ppmvw	0.94	--
ppmvd	0.64	7
RTO 120 Total Hydrocarbons, as Propane (THC)		
ppmvw	2.39	--
ppmvd	2.42	7
RTO 130 Total Hydrocarbons, as Propane (THC)		
ppmvw	0.62	--
ppmvd	0.63	7

Table II
Executive Summary Table HCl Emission Rates Summary

Parameter/Units	Average Results	Emission Limits
RTO 210 Total Hydrocarbons, as Propane (THC)		
ppmvw	0.87	--
ppmvd	0.89	7
RTO 220 Total Hydrocarbons, as Propane (THC)		
ppmvw	2.00	--
ppmvd	2.05	7

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1.0 Introduction

1.1 Identification, Location, and Dates of Test

General Motors, LLC (GM) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance emissions test on the Abatement Systems (AB 100 and AB 200) at the Factory ZERO facility located in Detroit, Michigan.

The tests were conducted to meet the requirements of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Permit No. PTI-209-19A.

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

Table 1-1
Summary of Test Program

Test Date(s)	Unit ID/ Source Name	Activity/Parameters	Test Methods	No. of Runs	Duration (Minutes)
8/2/22-8/5/22 and	FGCONTROLS/ AB 100	Velocity/Volumetric Flow	EPA 1 & 2	4	60
8/9/22-8/11/22	(Booth)	O_2, CO_2	EPA 3	2-4	60
		Moisture	EPA 4	2-4	60
		THC	EPA 25A	2-4	60
8/2/22-8/5/22 and	FGCONTROLS/ AB 200	Velocity/Volumetric Flow	EPA 1 & 2	4	60
8/9/22-8/10/22	(Oven)	O_2, CO_2	EPA 3	4	60
		Moisture	EPA 4	4	60
		THC	EPA 25A	4	60

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.

The tests were conducted according to Test Plan No. MW023AS-018184-PP-486 dated July 1, 2022. During the testing it was determined that the natural gas from RTOs that were not being tested and were isolated from the system were contributing emissions to the combined stack. Based on a review of the system and approval of Gina Angelotti of the EGLE the testing location changed from the stack to the outlet of the individual RTO that was being tested. This outlet was prior to combined stack to allow for the gas concentration to be measured only for the single RTO.

1.2 Purpose of Testing

The specific objectives were to:

- Determine the concentrations of VOC from the AB 100 and AB 200 RTOs
- Conduct the test program with a focus on safety

1.3 Source Description

GM Detroit-Hamtramck / Factory ZERO Assembly utilizes a paint shop consisting of an ELPO, a sealer line, primer, and topcoat (basecoat and clearcoat). The Factory ZERO paint shop consists of a single ELPO tank and two ELPO ovens, a sealer line, a single primer booth with two primer ovens, and six topcoat modules each with basecoat, heated flash, clearcoat and a curing oven at the end of the spray booth. Emissions from the ELPO tank, ELPO ovens, primer ovens, all topcoat heated flash, and all topcoat curing ovens are routed to AB #200. Emissions from the primer spray booth, basecoat spray booth, clear coat spray booth, and the observation zone are routed to AB #100. Each of the five RTOs are rated to provide a minimum destruction efficiency of 95% during normal production and a VOC outlet concentration of less than or equal to 7 ppm as propane during low production. Please note, all processes are running during the low production period. Routine maintenance, including visual inspections of the RTOs and systems have been performed on the RTOs in the last three months.

1.4 Test Program Contact

A list of project participants is included below:

Facility Information

Source Location:	General Motors, LLC Detroit-Hamtramck/Factory ZERO 2500 E. Grand Blvd Detroit, MI 48211
Project Contact:	Meghan Kennedy
Role:	Environmental Engineer
Telephone:	248-409-8974

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC 1371 Brummel Avenue Elk Grove Village, IL 60007
Contact:	Kurt Wepprecht
Title:	Vice President, Technical
Telephone:	630-860-4740
Email:	kwepprecht@montrose-env.com

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

Table 1-2
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
Matthew Libman	Montrose	Logistics Manager/Field Team Leader/QI/Trailer operator/Sample Recovery/Sample Train operator
Michael Hess	Montrose	Client Project Manager/QI/Trailer operator/Sample Recovery/Sample Train operator
Carlos Sandoval	Montrose	Shop Manager/Sample Recovery/Sample Train operator
John Ziber, Chris Ziber, Paul Repuyan	Montrose	Field Technician/Sample Recovery/Sample Train operator
Jacob Cartee	Montrose	Report preparation
Meghan Kennedy	GM	Client Liaison/Test Coordinator
Jessica Alderton	GM	Client Liaison/Test Coordinator
Gina Angelotti	EGLE	Observer

2.0 Summary of Results

2.1 Operating Data

The emission test was 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.

2.2 Applicable Permit

EGLE Permit No. PTI-209-19A for FGCONTROLS/AB 100 and FGCONTROLS/AB 200.

2.3 Results Summary and Emissions Regulations

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 1-3. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

Table 2-1
Summary of Average Compliance Results – AB 100

August 2 through 5 and 9 through 11, 2022

Parameter/Units	Average Results	Emission Limits
RTO 110 Total Hydrocarbons, as Propane (THC)		
ppmvw	0.94	--
ppmvd	0.64	7
RTO 120 Total Hydrocarbons, as Propane (THC)		
ppmvw	2.39	--
ppmvd	2.42	7
RTO 130 Total Hydrocarbons, as Propane (THC)		
ppmvw	0.62	--
ppmvd	0.63	7

Table 2-2
Summary of Average Compliance Results – AB 200

August 2 through 5 and 9 through 10, 2022

Parameter/Units	Average Results	Emission Limits
RTO 210 Total Hydrocarbons, as Propane (THC)		
ppmvw	0.87	--
ppmvd	0.89	7
RTO 220 Total Hydrocarbons, as Propane (THC)		
ppmvw	2.00	--
ppmvd	2.05	7

3.0 Source Description

3.1 Process Description and Control Equipment

The Factory ZERO paint shop consists of a single ELPO tank and two ELPO ovens, a sealer line, a single primer booth with two primer ovens, and six topcoat modules each with basecoat, heated flash, clearcoat and a curing oven at the end of the spray booth. Emissions from the ELPO tank, ELPO ovens, primer ovens, all topcoat heated flash, and all topcoat curing ovens are routed to AB #200. Emissions from the primer spray booth, basecoat spray booth, clear coat spray booth, and the observation zone are routed to AB #100. Each of the five RTOs are rated to provide a minimum destruction efficiency of 95% during normal production and a VOC outlet concentration of less than or equal to 7 ppm as propane during low production. Please note, all processes are running during the low production period. Routine maintenance, including visual inspections of the RTOs and systems have been performed on the RTOs in the last three months.

4.0 Sampling and Analytical Procedures

4.1 Sampling Train and Field Procedures

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_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 4-1.

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_2 and CO_2 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_2 and percent O_2 using either an Orsat or a Fyrite analyzer.

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

- Method Options:
  - An Orsat analyzer was used to measure the analyte concentrations
- Method Exceptions:
  - The sample was collected into a Tedlar Bag from the back of the sample train for the duration of each test run.
- Target and/or Minimum Required Sample Duration: 60 minutes

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.

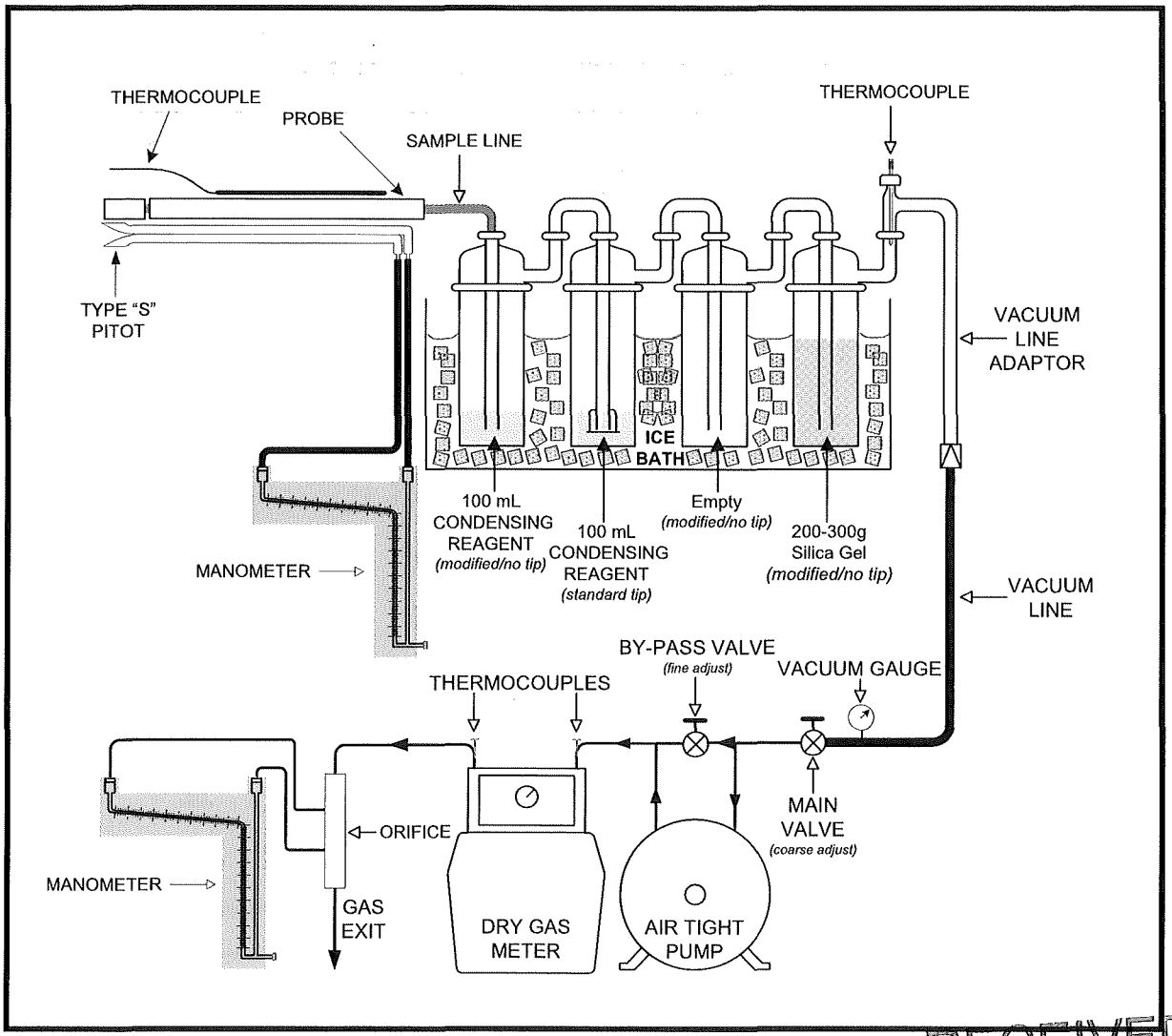
Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - Moisture sampling is performed as part of the pollutant sample trains
  - 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
- Target and/or Minimum Required Sample Duration: 60 minutes

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

FIGURE 4-1
EPA METHOD 4 DETACHED WITH 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

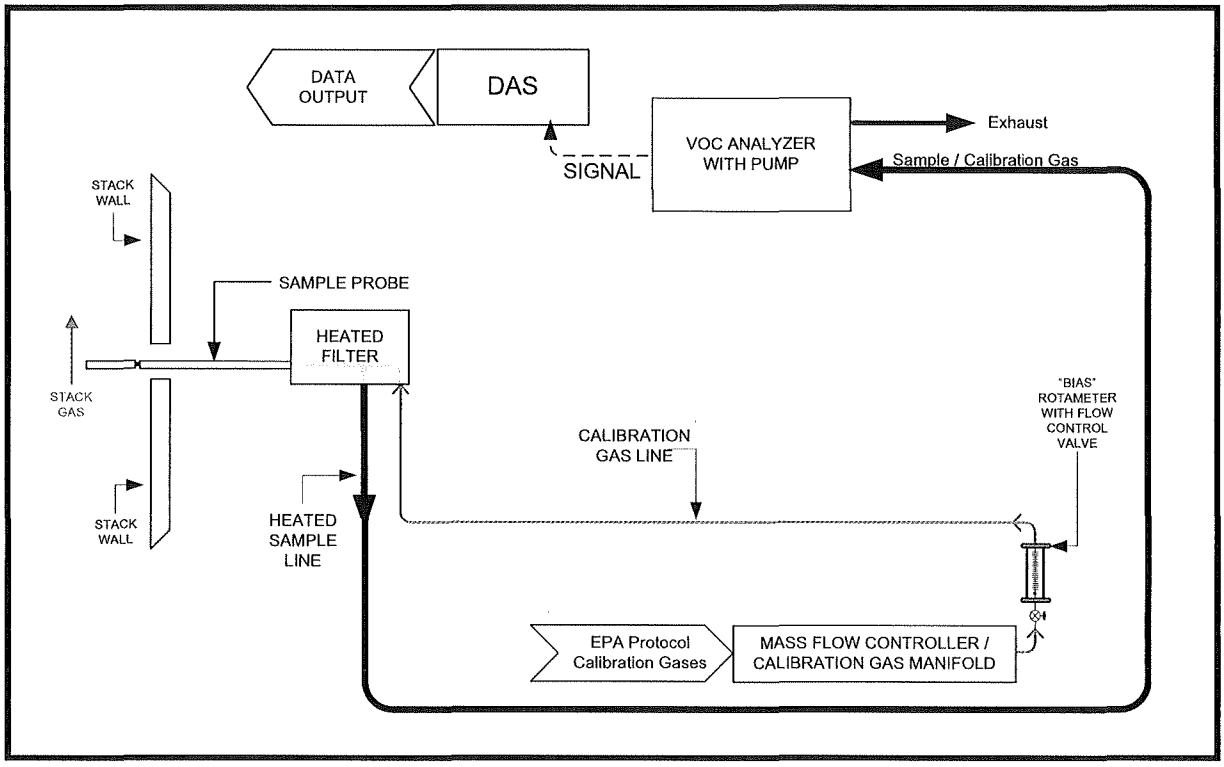
glass fiber filter to a FIA. Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

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

- Method Options:
  - Results are reported in terms of propane
- Method Exceptions:
  - None
- Target and/or Minimum Required Sample Duration: 60 minutes

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

FIGURE 4-2
EPA METHOD M25A SAMPLING TRAIN



4.2 Recovery and Analytical Procedures

Recovery and analytical procedures are not necessary for the methods being tested.

4.3 Sample Ports and Traverse Points

Information regarding the sampling locations is presented in Table 4-1.

Table 4-1
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.)	
AB 100 RTO Stack	108.0	360/3.33	792/7.33	Flow: 16 (8/port) Gaseous: 1
AB 200 RTO Stack	89.5	360/4.02	792/8.85	Flow: 16 (8/port) Gaseous: 1

The 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.

5.0 Test Discussion and Results

5.1 Presentation of Results

The average results are compared to the permit limits in Table 1-3 and 1-4. The results of individual compliance test runs performed on the RTO Exhausts are presented in Tables 5-1 through 5-5. The additional test runs performed on the combined stack are presented in Tables 5-6 and 5-7. 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 5-1
THC Emissions Results -
AB 100 (RTO 110 Outlet)

Parameter/Units	Run 3	Run 4	Average
Date	8/5/2022	8/10/2022	--
Time	08:21-09:21	13:28-14:28	--
RTO 1 Flue Gas Parameters			
CO_2, % volume dry	1.2	1.0	1.1
O_2, % volume dry	19.8	20.0	19.9
moisture content, % volume	2.6	0.1	1.4
RTO 1 Total Hydrocarbons, as Propane (THC)			
ppmvw	1.10	0.78	0.94
ppmvd	1.13	0.79	0.64

Table 5-2
THC Emissions Results -
AB 100 (RTO 120 Outlet)

Parameter/Units	Run 3	Run 4	Average
Date	8/5/2022	8/9/2022	--
Time	06:38-07:38	12:12-13:12	--
RTO 2 Flue Gas Parameters			
CO_2, % volume dry	1.0	1.0	1.0
O_2, % volume dry	20.0	20.0	20.0
moisture content, % volume	2.5	0.6	1.6
RTO 2 Total Hydrocarbons, as Propane (THC)			
ppmvw	2.06	2.71	2.39
ppmvd	2.11	2.72	2.42

Table 5-3
THC Emissions Results -
AB 100 (RTO 130 Outlet)

Parameter/Units	Run 1	Run 2	Average
Date	8/9/2022	8/11/22	--
Time	09:20-10:20	10:30-11:30	--
RTO 3 Flue Gas Parameters			
CO_2, % volume dry	1.0	1.0	1.0
O_2, % volume dry	20.0	20.0	20.0
moisture content, % volume	1.6	1.0	1.3
RTO 3 Total Hydrocarbons, as Propane (THC)			
ppmvw	0.55	0.69	0.62
ppmvd	0.56	0.69	0.63

Table 5-4
THC Emissions Results -
AB 200 (RTO 210 Outlet)

Parameter/Units	Run 3	Run 4	Average
Date	8/5/2022	8/9/2022	--
Time	08:25-09:25	09:45-10:45	--
RTO 1 Flue Gas Parameters			
CO_2, % volume dry	1.6	1.4	1.5
O_2, % volume dry	19.0	19.0	19.0
moisture content, % volume	2.1	2.2	2.2
RTO 1 Total Hydrocarbons, as Propane (THC)			
ppmvw	0.95	0.79	0.87
ppmvd	0.97	0.81	0.89

Table 5-5
THC Emissions Results -
AB 200 (RTO 220 Outlet)

Parameter/Units	Run 3	Run 4	Average
Date	8/5/2022	8/10/2022	--
Time	06:58-07:58	13:38-14:38	--
RTO 2 Flue Gas Parameters			
CO_2, % volume dry	1.4	1.6	1.5
O_2, % volume dry	19.4	19.2	19.3
moisture content, % volume	2.1	2.3	2.2
RTO 2 Total Hydrocarbons, as Propane (THC)			
ppmvw	2.44	1.56	2.00
ppmvd	2.49	1.60	2.05

Table 5-6
THC Emissions Results -
AB 100 (RTO 110 Combined Stack)

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	8/2/2022	8/3/2022	8/5/2022	--
Time	09:34-10:34	08:13-09:13	08:21-09:21	--
RTO 1 Flue Gas Parameters				
flue gas temperature, °F	189	186	190	188
volumetric flow rate, acfm	129,192	128,761	131,217	129,723
volumetric flow rate, scfm	102,907	102,829	104,893	103,543
volumetric flow rate, dscfm	99,547	100,356	102,155	100,656
CO_2, % volume dry	1.0	1.0	1.2	1.1
O_2, % volume dry	20.0	20.0	19.8	19.9
moisture content, % volume	3.3	2.4	2.6	2.8
RTO 1 Total Hydrocarbons, as Propane (THC)				
ppmvw	0.79	0.89	1.14	0.94
ppmvd	0.82	0.92	1.17	0.97
lb/hr	0.56	0.63	0.82	0.67

Table 5-7
THC Emissions Results -
AB 100 (RTO 120 Combined Stack)

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	8/3/2022	8/4/2022	8/5/2022	--
Time	10:25-11:40	08:00-09:00	06:38-07:38	--
RTO 2 Flue Gas Parameters				
flue gas temperature, °F	186	188	189	188
volumetric flow rate, acfm	126,561	137,016	130,796	131,458
volumetric flow rate, scfm	101,072	109,232	104,718	105,007
volumetric flow rate, dscfm	98,199	106,738	102,143	102,360
CO_2, % volume dry	1.0	1.0	1.0	1.0
O_2, % volume dry	19.8	19.8	20.0	19.9
moisture content, % volume	2.9	2.3	2.5	2.6
RTO 2 Total Hydrocarbons, as Propane (THC)				
ppmvw	2.81	3.98	2.15	2.98
ppmvd	2.89	4.07	2.20	3.05
lb/hr	1.95	2.99	1.54	2.16

Table 5-8
THC Emissions Results -
AB 200 (RTO 210 Combined Stack)

Parameter/Units	Run 1	Run 2	Run 4	Average
Date	8/2/2022	8/3/2022	8/9/2022	--
Time	09:54-10:54	08:25-09:25	09:45-10:45	--
RTO 1 Flue Gas Parameters				
flue gas temperature, °F	276	271	267	271
volumetric flow rate, acfm	90,026	91,171	89,025	90,074
volumetric flow rate, scfm	63,312	64,468	63,434	63,738
volumetric flow rate, dscfm	62,001	63,052	62,045	62,366
CO_2, % volume dry	1.0	1.0	1.4	1.1
O_2, % volume dry	19.8	19.8	19.0	19.5
moisture content, % volume	2.1	2.2	2.2	2.2
RTO 1 Total Hydrocarbons, as Propane (THC)				
ppmvw	1.61	1.21	0.79	1.20
ppmvd	1.64	1.24	0.81	1.23
lb/hr	0.70	0.54	0.35	0.53

Table 5-9
THC Emissions Results -
AB 200 (RTO 220 Combined Stack)

Parameter/Units	Run 1	Run 2	Run 4	Average
Date	8/3/2022	8/3/2022	8/10/2022	--
Time	08:22-09:22	10:45-11:45	13:38-14:38	--
RTO 2 Flue Gas Parameters				
flue gas temperature, °F	271	272	237	260
volumetric flow rate, acfm	88,919	89,874	84,925	87,906
volumetric flow rate, scfm	62,956	63,388	63,428	63,257
volumetric flow rate, dscfm	61,668	61,481	62,012	61,720
CO_2, % volume dry	1.4	1.2	1.6	1.4
O_2, % volume dry	19.6	19.6	19.2	19.5
moisture content, % volume	2.1	3.0	2.3	2.5
RTO 2 Total Hydrocarbons, as Propane (THC)				
ppmvw	0.75	2.44	1.03	1.41
ppmvd	0.76	2.52	1.06	1.45
lb/hr	0.32	1.06	0.45	0.79

6.0 Internal QA/QC Activities

6.1 QA/QC Audits

The meter boxes and sampling trains 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.

6.2 QA/QC Discussion

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

6.3 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).

Appendix A
Field Data and Calculations

Appendix A.1
Sampling Locations