COMPLIANCE STACK EMISSION TEST REPORT

LANDFILL GAS-FIRED RICE No. 2 (EUENGINE2)

Determination of Total Particulate Matter, Volatile Organic Compound, Carbon Monoxide, Nitrogen Oxide, and Formaldehyde Emissions

Utilizing US EPA Method 1, 2, 3A, 4, 5, 25A, 202, and 320

Test Date(s): June 19-20, 2019
Facility ID: B7227
Source Location: Lake Orion, Michigan
Permit: EGLE Permit No. MI-ROP-B7227-2015b

Prepared For:

General Motors LLC - Orion Assembly Plant
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Prepared By:

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STAC STACK TESTING ACCREDITATION COUNCIL

A2LA ACCREDITED TO ASTM D7036 ONLY CERT #3925.01

MONTROSE AIR QUALITY SERVICES

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TEST RESULTS SUMMARY

Test Date:	**June 19-20, 2019**
Source Name:	**RICE No. 2**
Source ID Number:	**EUENGINE2**
Sampling Location:	**Exhaust Duct**
Engine Load During Sampling (bhp)	**2,205**
Engine Rated Capacity (bhp)	*2,242*
Engine Load (% of rated capacity)	*98*
Permit Limit - Engine Load (% of rated capacity)	*90 - 110*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Total Particulate Matter Emissions (lb/hr)	**0.31**
Permit Limit - Total Particulate Matter Emissions (lb/hr)	*0.64*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
EGLE Permit No.	**MI-ROP-B7227-2015b**

* Production data was supplied by General Motors LLC - Orion Assembly Plant personnel.

TEST RESULTS SUMMARY - CONTINUED

Test Date:	**June 19-20, 2019**
Source Name:	**RICE No. 2**
Source ID Number:	**EUENGINE2**
Sampling Location:	**Exhaust Duct**
Engine Load During Sampling (bhp)	**2,230**
Engine Rated Capacity (bhp)	*2,242*
Engine Load (% rated of rated capacity)	*99*
Permit Limit - Engine Load (% of rated capacity)	*90 - 110*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Volatile Organic Compound Emissions (g/hp-hr as propane)†	**0.0**
Permit Limit - Volatile Organic Compound Emissions (g/hp-hr as propane)†	*1.0*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Volatile Organic Compound Emissions (lb/hr as propane)†	**0.0**
Permit Limt - Volatile Organic Compound Emissions (lb/hr as propane)†	*2.8*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Carbon Monoxide Emissions (g/hp-hr)	**2.1**
Permit Limt - Carbon Monoxide Emissions (g/hp-hr)	*3.5*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Carbon Monoxide Emissions (lb/hr)	**10.2**
Permit Limt - Carbon Monoxide Emissions (lb/hr)	*17.3*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Oxides of Nitrogen Emissions (g/hp-hr)	**0.5**
Permit Limit - Oxides of Nitrogen Emissions (g/hp-hr)	*2.0*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Oxides of Nitrogen Emissions (lb/hr)	**2.43**
Permit Limt - Oxides of Nitrogen Emissions (lb/hr)	*2.97*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
Formaldehyde Emissions (lb/hr)	**1.4**
Permit Limt - Formaldehyde Emissions (lb/hr)	*2.1*
Compliance Acceptability Criteria Met (Yes/No)	*Yes*
EGLE Permit No.	**MI-ROP-B7227-2015b**

* Production data was supplied by General Motors LLC - Orion Assembly Plant personnel.

† Methane corrected TGO values (VOC) were negative and assigned a value of zero. See Section 2.3 for details.

REVIEW AND CERTIFICATION

The results of the Compliance Test conducted on June 19-20, 2019 are a product of the application of the United States Environmental Protection Agency (US EPA) Stationary Source Sampling Methods listed in 40 CFR Part 60, Appendix A, 40 CFR Part 51, Appendix M, and 40 CFR Part 63, Appendix A, that were in effect at the time of this test.

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: 8-15-19

Name: Matthew Young Title: Client 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: _____ Date: 8-15-19

Name: Randal Tysar Title: District Manager

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

The General Motors LLC - Orion Assembly Plant (Facility ID: B7227), located in Lake Orion, Michigan, contracted Montrose Air Quality Services, LLC (Montrose) of Detroit, Michigan, to conduct compliance stack emission testing for their Landfill Gas-Fired Reciprocating Internal Combustion Engine (RICE) No. 2 (EUENGINE2). Testing was performed to satisfy the emissions testing requirements pursuant to Michigan Department of Environment, Great Lakes and Energy (EGLE) Renewable Operating Permit No. MI-ROP-B7227-2015b. The testing was performed on June 19-20, 2019.

Sampling was performed at the EUENGINE2 Exhaust Duct to determine the emissions of total particulate matter (PM), Volatile Organic Compounds (VOC), Carbon Monoxide (CO), Formaldehyde (CH_2O), and Oxides of Nitrogen (NO_x). Testing was conducted during 90% to 110% of maximum production. During this test, emissions from EUENGINE2 were uncontrolled.

The test methods that were conducted during this test were US EPA Method 1, 2, 3A, 4, 5, 25A, 202, and 320.

1.2 KEY PERSONNEL

The key personnel who coordinated this test program (and their phone numbers) were:

- Kim Crame, Environmental Engineer, General Motors LLC - Orion Assembly Plant, 248-941-5305
- Jessica Alderton, Senior Environmental Project Engineer, General Motors LLC, 586-863-8490
- Mark Dziadosz, Environmental Quality Analyst, Michigan Department of Environment, Great Lakes and Energy, 586-753-3745
- Matthew Young QSTI, Client Project Manager, Montrose, 248-548-7980

2.0 SUMMARY AND DISCUSSION OF TEST RESULTS

2.1 OBJECTIVES AND TEST MATRIX

The purpose of this test was to determine the emissions of total PM, VOC, CO, CH_2O, and NO_x at the EUENGINE2 Exhaust Duct during 90% to 110% of maximum production. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE Permit No. MI-ROP-B7227-2015b.

The specific test objectives for this test were as follows:

- Measure the concentrations of oxygen (O_2), carbon dioxide (CO_2), filterable PM, total gaseous organics (TGO), methane (CH_4), condensable PM, CO, CH_2O, nitric oxide (NO), and nitrogen dioxide (NO_2) at the EUENGINE2 Exhaust Duct.
- Measure the actual and dry standard volumetric flow rate of the stack gas at the EUENGINE2 Exhaust Duct.
- Utilize the above variables to determine the emissions of total PM, VOC (CH_4 corrected TGO), CO, CH_2O, and NO_x at the EUENGINE2 Exhaust Duct during 90% to 110% of maximum production.

Table 2.1 presents the sampling matrix log for this test.

2.2 FIELD TEST CHANGES AND PROBLEMS

2.2.1 US EPA Method 5/202 Sampling

The use of an unheated probe for the US EPA Method 5/202 sampling train was approved by Mark Dziados, EGLE.

2.2.2 Process Down

During Run 1, at the EUENGINE2 Exhaust Duct, US EPA Method 5/202 sampling was paused after 104 minutes because the process went down. After an 86 minute pause sampling was resumed (16 minutes) until 120 minutes of sample was collected.

2.3 PRESENTATION OF RESULTS

Three sampling trains were utilized during each run at the EUENGINE2 Exhaust Duct to determine the emissions of total PM, VOC, CO, CH_2O, and NO_x. One sampling train measured the duct gas volumetric flow rate, moisture content, and concentrations filterable PM and condensable PM. The second sampling train measured the concentrations of O_2 CO_2, CH_4, and TGO. The third sampling train measured the concentrations of CO, NO, NO_2, and CH_2O.

Table 2.2 displays the emissions of total PM, filterable PM, and condensable PM measured at the EUENGINE2 Exhaust Duct during 90% to 110% of maximum production.

Table 2.3 displays the emissions of VOC, CO, CH_2O, and NO_x measured at the EUENGINE2 Exhaust Duct during 90% to 110% of maximum production.

The VOC (CH_4 corrected TGO) concentrations displayed in Table 2.3 for Runs 1 to 3 were calculated to be negative, a zero value was assigned to these concentrations resulting in zero VOC emissions at the EUENGINE2 Exhaust Duct.

The graphs that present the raw, uncorrected concentration data measured in the field by the US EPA Method 3A and 25A sampling systems at the EUENGINE2 Exhaust Stack are located in the Field Data section of the Appendix.

Since EUENGINE2 was rated at 1600 kW (2242 brake horsepower (bhp)), the engine load (bhp) for each run was calculated by multiplying the engine load (kW) for each run by 2242 bhp / 1600 kW. Engine load (kW) data was provided by General Motors LLC - Orion Assembly Plant personnel. Tables 2.2 and 2.3 display the process data in kW-hr and in

TABLE 2.1
SAMPLING MATRIX OF TEST METHODS UTILIZED

Date	Run No.	Sampling Location	US EPA METHODS 1/2 (Flow) Sampling Time / Duration (min)	US EPA METHOD 4 ($\%H_2O$) Sampling Time / Duration (min)	US EPA METHOD 5 (Filterable PM) Sampling Time / Duration (min)	US EPA METHOD 202 (Condensable PM) Sampling Time / Duration (min)
6/19/2019	1	EUENGINE2 Exhaust Duct	14:21 - 17:47 / 120	14:21 - 17:47 / 120	14:21 - 17:47 / 120	14:21 - 17:47 / 120
6/20/2019	2	EUENGINE2 Exhaust Duct	8:54 - 10:54 / 120	8:54 - 10:54 / 120	8:54 - 10:54 / 120	8:54 - 10:54 / 120
6/20/2019	3	EUENGINE2 Exhaust Duct	11:25 - 13:25 / 120	11:25 - 13:25 / 120	11:25 - 13:25 / 120	11:25 - 13:25 / 120

Date	Run No.	Sampling Location	US EPA METHOD 3A (O_2/CO_2) Sampling Time / Duration (min)	US EPA METHOD 25A (TGO) Sampling Time / Duration (min)	US EPA METHOD 25A (CH_4) Sampling Time / Duration (min)	US EPA METHOD 320 (CO, NO_x, CH_2O) Sampling Time / Duration (min)
6/19/2019	1	EUENGINE2 Exhaust Duct	14:21 - 15:21 / 60	14:21 - 15:21 / 60	14:21 - 15:21 / 60	14:21 - 15:21 / 60
6/20/2019	2	EUENGINE2 Exhaust Duct	8:54 - 9:54 / 60	8:54 - 9:54 / 60	8:54 - 9:54 / 60	8:54 - 9:54 / 60
6/20/2019	3	EUENGINE2 Exhaust Duct	11:25 - 12:25 / 60	11:25 - 12:25 / 60	11:25 - 12:25 / 60	11:25 - 12:25 / 60

All times are Eastern Daylight Time.

TABLE 2.2
EMISSION RESULTS

Parameter	EUENGINE2 Exhaust Duct			
	Run 1	Run 2	Run 3	Average
Engine Load (kW)*	1,530	1,597	1,594	1,573
Engine Load (bhp)*	2,143	2,237	2,233	2,205
Total Particulate Matter Emissions (lb/hr)	0.31	0.32	0.29	0.31
Filterable Particulate Matter Emissions (lb/hr)	0.11	0.11	0.10	0.11
Filterable Particulate Matter Concentration (grains/dscf)	0.0030	0.0030	0.0027	0.0029
Condensable Particulate Matter Emissions (lb/hr)	0.20	0.20	0.19	0.20
Condensable Particulate Matter Concentration (grains/dscf)	0.0054	0.0055	0.0051	0.0053
Stack Gas Average Flow Rate (acfm)	13,809	14,078	14,114	14,001
Stack Gas Average Flow Rate (scfm)	4,955	5,028	5,038	5,007
Stack Gas Average Flow Rate (dscfm)	4,319	4,364	4,371	4,351
Stack Gas Average Velocity (fpm)	10,539	10,744	10,771	10,685
Stack Gas Average Static Pressure (in-H_2O)	1.62	1.62	1.62	1.62
Stack Gas Average Temperature (°F)	959	957	958	958
Stack Gas Percent by Volume Moisture (%H_2O)	12.84	13.21	13.24	13.10
Measured Stack Inner Diameter (in)		15.5		
Percent by Volume Carbon Dioxide in Stack Gas (%-dry)	11.47	11.45	11.51	11.48
Percent by Volume Oxygen in Stack Gas (%-dry)	7.72	7.67	7.69	7.69
Percent by Volume Nitrogen in Stack Gas (%-dry)	80.81	80.88	80.81	80.83

* Process data was provided by General Motors LLC - Orion Assembly Plant personnel. See Section 2.3 for details.

TABLE 2.3
EMISSION RESULTS

Parameter	EUENGINE2 Exhaust Duct			
	Run 1	Run 2	Run 3	Average
Engine Load (kW)*	1,580	1,600	1,593	1,591
Engine Load (bhp)*	2,214	2,242	2,233	2,230
Volatile Organic Compound Emissions (g/bhp-hr as propane)†	0.0	0.0	0.0	0.0
Volatile Organic Compound Emissions (lb/hr as propane)†	0.0	0.0	0.0	0.0
Methane Corrected Total Gaseous Organic Concentration (ppmvw as propane)†	0.0	0.0	0.0	0.0
Total Gaseous Organic Concentration (ppmvw as propane)	477	489	483	483
Methane Concentration (ppmvw as propane)	544	540	538	540
Carbon Monoxide Emissions (g/bhp-hr)	2.0	2.1	2.1	2.1
Carbon Monoxide Emissions (lb/hr)	9.87	10.3	10.3	10.2
Carbon Monoxide Concentration (ppmvd)	524	540	541	535
Oxides of Nitrogen Emissions (g/bhp-hr)	0.52	0.48	0.48	0.49
Oxides of Nitrogen Emissions (lb/hr)	2.52	2.38	2.38	2.43
Nitrogen Oxide Concentration (ppmvd)	13.3	9.8	7.3	10.1
Nitrogen Dioxide Concentration (ppmvd)	72.9	69.9	71.4	71.4
Formaldehyde Emissions (lb/hr)	1.4	1.4	1.4	1.4
Formaldehyde Concentration (ppmvd)	68.9	69.3	69.3	68.9

* Process data was provided by General Motors LLC - Orion Assembly Plant personnel. See Section 2.3 for details
† Methane corrected TGO (VOC) emissions were negative and assigned a value of zero. See Section 2.3 for details.

3.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

3.1 PROCESS DESCRIPTION AND OPERATION

3.1.1 EMISSION UNIT TYPE

General Motors LLC - Orion Assembly Plant operates five landfill gas engine generators to produce electricity at the plant. Each engine generator is rated at 1600 kW electrical output (2242 bhp). The total combined maximum electrical output will be 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.

3.1.2 TYPE AND QUANTITY OF RAW MATERIALS

The engine generator burns landfill gas and generates electrical output.

3.1.3 BATCH OPERATIONS

There are no batch operations.

3.1.4 PROCESS REGULATION

The engines are designed to use an air to fuel ratio control system. If the air to fuel ratio control system is not operating to design specification, the engine will shut down.

3.1.5 PROCESS RATING

Each engine generator is rated at 1600 kW electrical output (2242 bhp). The total combined maximum electrical output will be 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. During this test EUENGINE2 was operating at a three-run average of 99% of rated capacity during US EPA Method 3A, 7E, and 320 sampling and at a three-run average of 98% of rated capacity during US EPA Method 5/202 sampling.

Figure 3.1 schematically depicts the sampling location.

3.2 CONTROL EQUIPMENT DESCRIPTION

During this test, emissions from EUENGINE2 were uncontrolled.

3.3 SAMPLING LOCATION(S)

The EUENGINE2 Exhaust Duct had a measured inner diameter of 15.5-inches, was oriented in the horizontal plane, and was accessed by scaffolding. Two sampling ports were located 90° apart from one another at a location that met US EPA Method 1, Section 11.1.1 criteria. Prior to emissions sampling, the duct was traversed to verify the absence of cyclonic flow. An average yaw angle of 6.7° was measured. Therefore, the sampling location also met US EPA Method 1, Section 11.4.2 criteria. Due to duct access restrictions, emissions sampling was performed at the side port where the duct was traversed for duct gas volumetric flow rate, moisture content, filterable PM, and condensable PM concentration determinations. A point, at the top port located within the central 10% of the duct cross-sectional area, was utilized for O_2, CO_2, CH_4 and TGO concentration determination. A second point, at the top port, was utilized for CO, CH_2 NO, and NO_2 concentration determination.

Figure 3.2 schematically illustrates the traverse point and sample port locations utilized.

3.4 PROCESS SAMPLING LOCATION(S)

The US EPA Reference Test Methods performed did not specifically require that process samples were to be taken during the performance of this testing event. It is in the best knowledge of Montrose that no process samples were obtained and therefore no process sampling location was identified in this report.

FIGURE 3.1
EUENGINE2 SAMPLING LOCATION SCHEMATIC

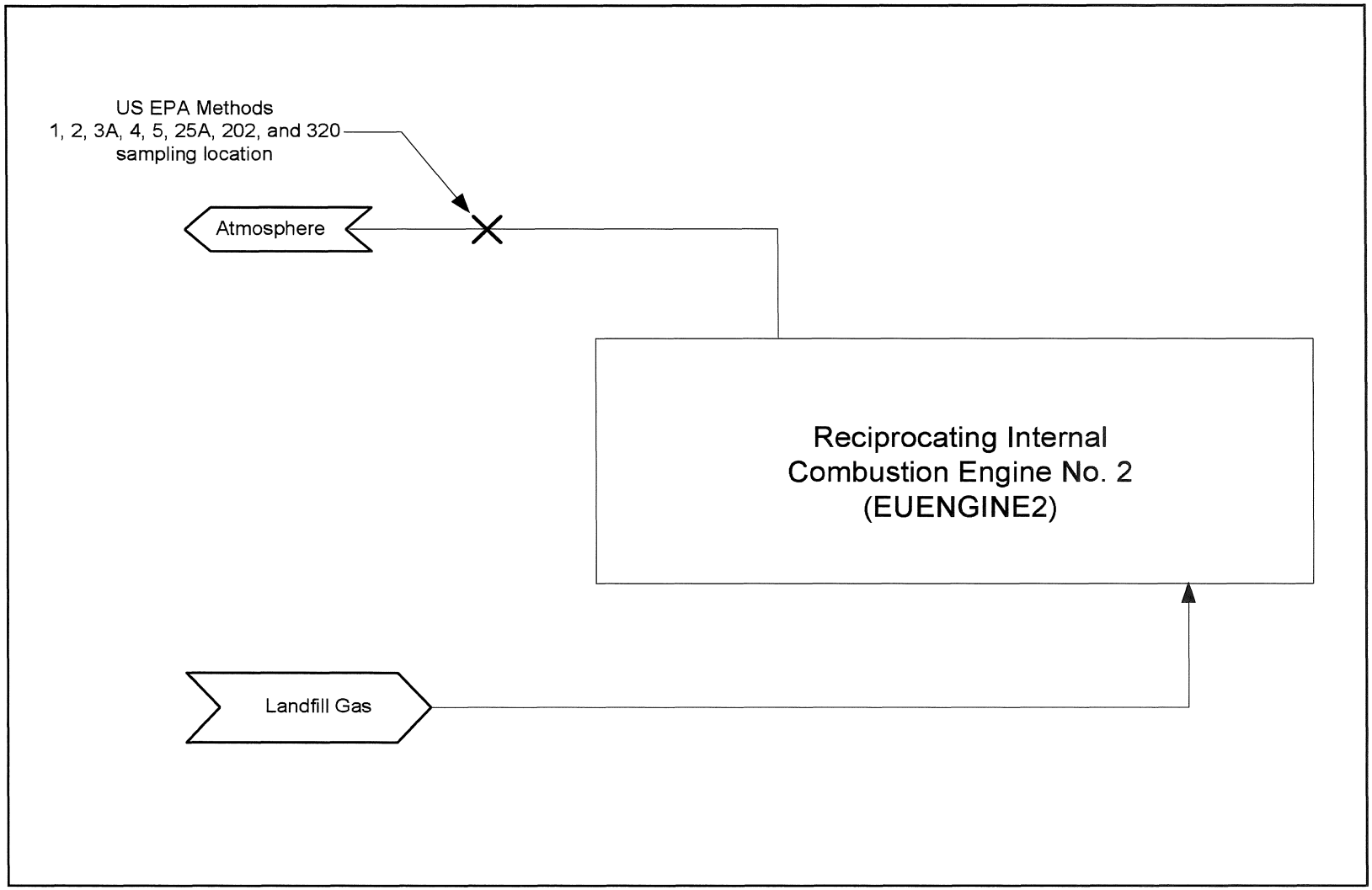
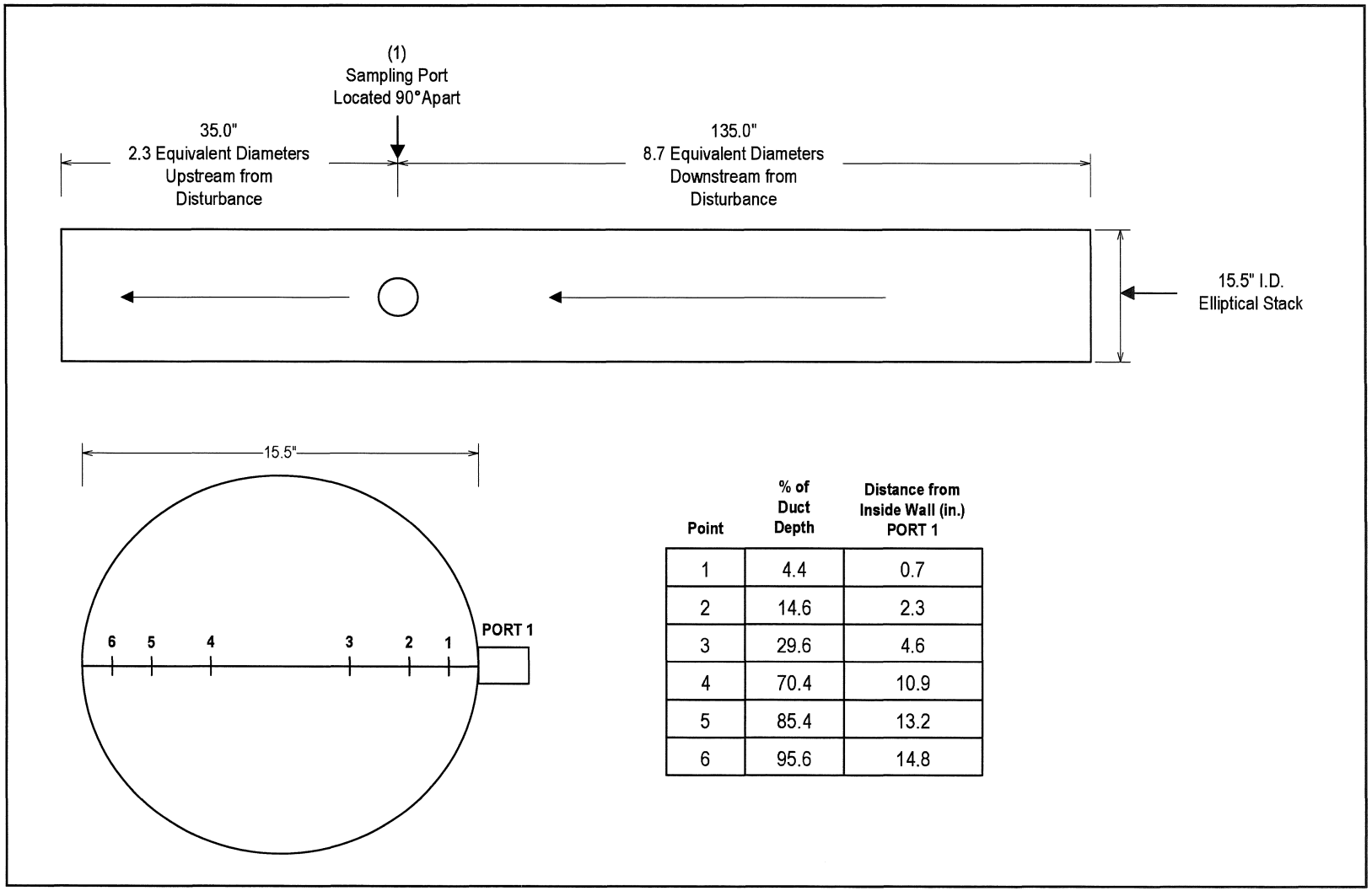


FIGURE 3.2
EUENGINE2 EXHAUST TRAVERSE POINT LOCATION DRAWING



Point	% of Duct Depth	Distance from Inside Wall (in.) PORT 1
1	4.4	0.7
2	14.6	2.3
3	29.6	4.6
4	70.4	10.9
5	85.4	13.2
6	95.6	14.8

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

4.1.1 US EPA Method 1: "Sample and Velocity Traverses for Stationary Sources"

Principle: To aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these equal areas. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.2 US EPA Method 2: "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"

Principle: The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.3 US EPA Method 3A: "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"

Principle: A gas sample is continuously extracted from the effluent stream. A portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of O_2 and CO_2 concentration(s). Performance specifications and test procedures are provided to ensure reliable data. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.4 US EPA Method 4: "Determination of Moisture Content in Stack Gases"

Principle: A gas sample is extracted at a constant rate from the source; moisture is removed from the sample stream and determined either volumetrically or gravimetrically. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.5 US EPA Method 5: "Determination of Particulate Emissions from Stationary Sources (Filterable PM Only)"

Principle: Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature of 120 ± 14°C (248 ± 25°F) or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. The PM mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after the removal of uncombined water. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A. During this test event the probe for

4.1.6 US EPA Method 25A: "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

Principle: A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents. Performance specifications and test procedures are provided to ensure reliable data. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 60, Appendix A.

4.1.7 US EPA Method 202: "Determination of Condensable Particulate Emissions from Stationary Sources"

Principle: Condensable Particulate Matter (CPM) is collected in dry impingers after filterable PM has been collected on a filter maintained as specified in either Method 5 of appendix A-3 to part 60, US EPA Method 17 of appendix A-6 to part 60, or US EPA Method 201A of appendix M to this part. The organic and aqueous fractions of the impingers and an out-of-stack CPM filter are then taken to dryness and weighed. The total of the impinger fractions and the CPM filter represents the CPM. Compared to the version of US EPA Method 202 that was promulgated on December 17, 1991, this method eliminates the use of water as the collection media in impingers and includes the addition of a condenser followed by a water dropout impinger immediately after the final in-stack or heated filter. This method also includes the addition of one modified Greenburg Smith impinger (backup impinger) and a CPM filter following the water dropout impinger. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 51, Appendix M.

4.1.8 US EPA Method 320: "Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy"

Infrared absorption spectroscopy is performed by directing an infrared beam through a sample to a detector. The frequency-dependent infrared absorbance of the sample is measured by comparing this detector signal (single beam spectrum) to a signal obtained without a sample in the beam path (background). Most molecules absorb infrared radiation and the absorbance occurs in a characteristic and reproducible pattern. The infrared spectrum measures fundamental molecular properties and a compound can be identified from its infrared spectrum alone. Within constraints, there is a linear relationship between infrared absorption and compound concentration. If this frequency dependent relationship (absorptivity) is known (measured), it can be used to determine compound concentration in a sample mixture. This method was utilized in its entirety as per the procedures outlined in 40 CFR Part 63, Appendix A.

The sampling trains utilized during this testing project are depicted in Figures 4.1 to 4.3.

4.2 PROCEDURES FOR OBTAINING PROCESS DATA

Process data was recorded by General Motors LLC - Orion Assembly Plant personnel utilizing their typical record keeping procedures. Recorded process data was provided to Montrose personnel at the conclusion of this test event. The process data is displayed in Tables 2.2 and 2.3 and is located in the Process Data section of the Appendix. The process data recorded by the plant's PLC monitor was 14 minutes behind Eastern Daylight Time.

FIGURE 4.1
US EPA METHOD 5/202 SAMPLING TRAIN SCHEMATIC

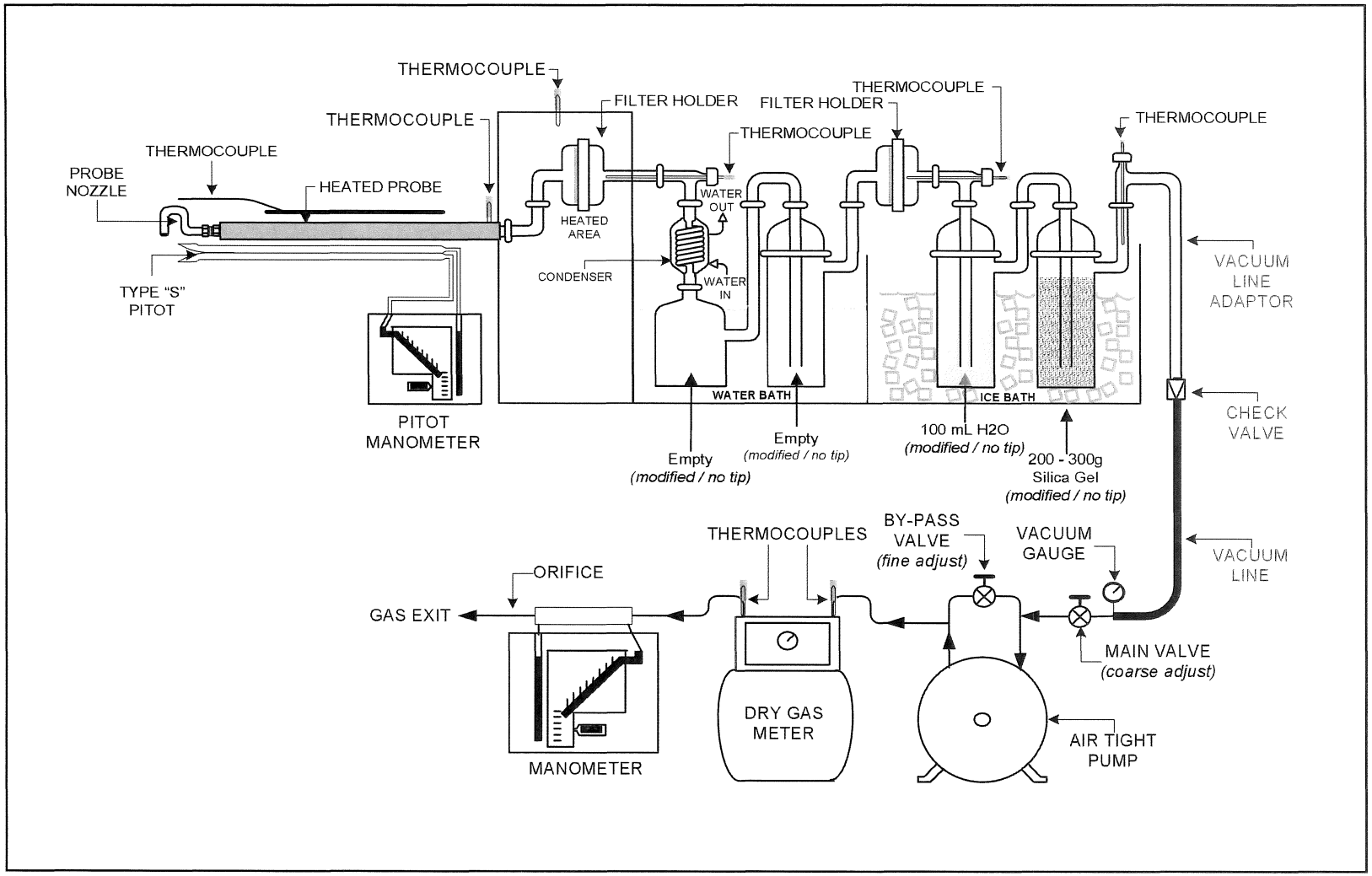


FIGURE 4.2
US EPA METHOD 3A AND 25A SAMPLING TRAIN SCHEMATIC

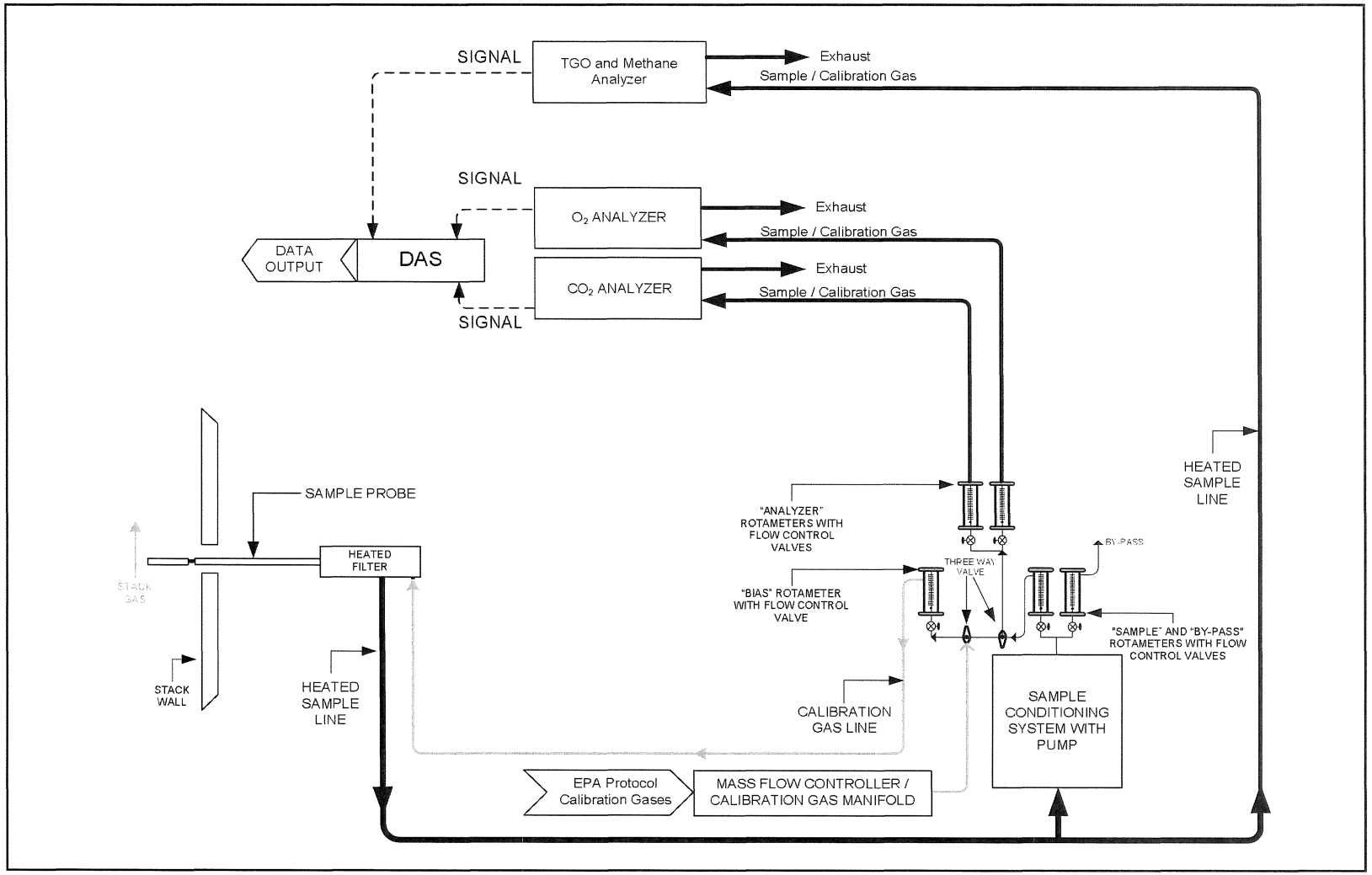
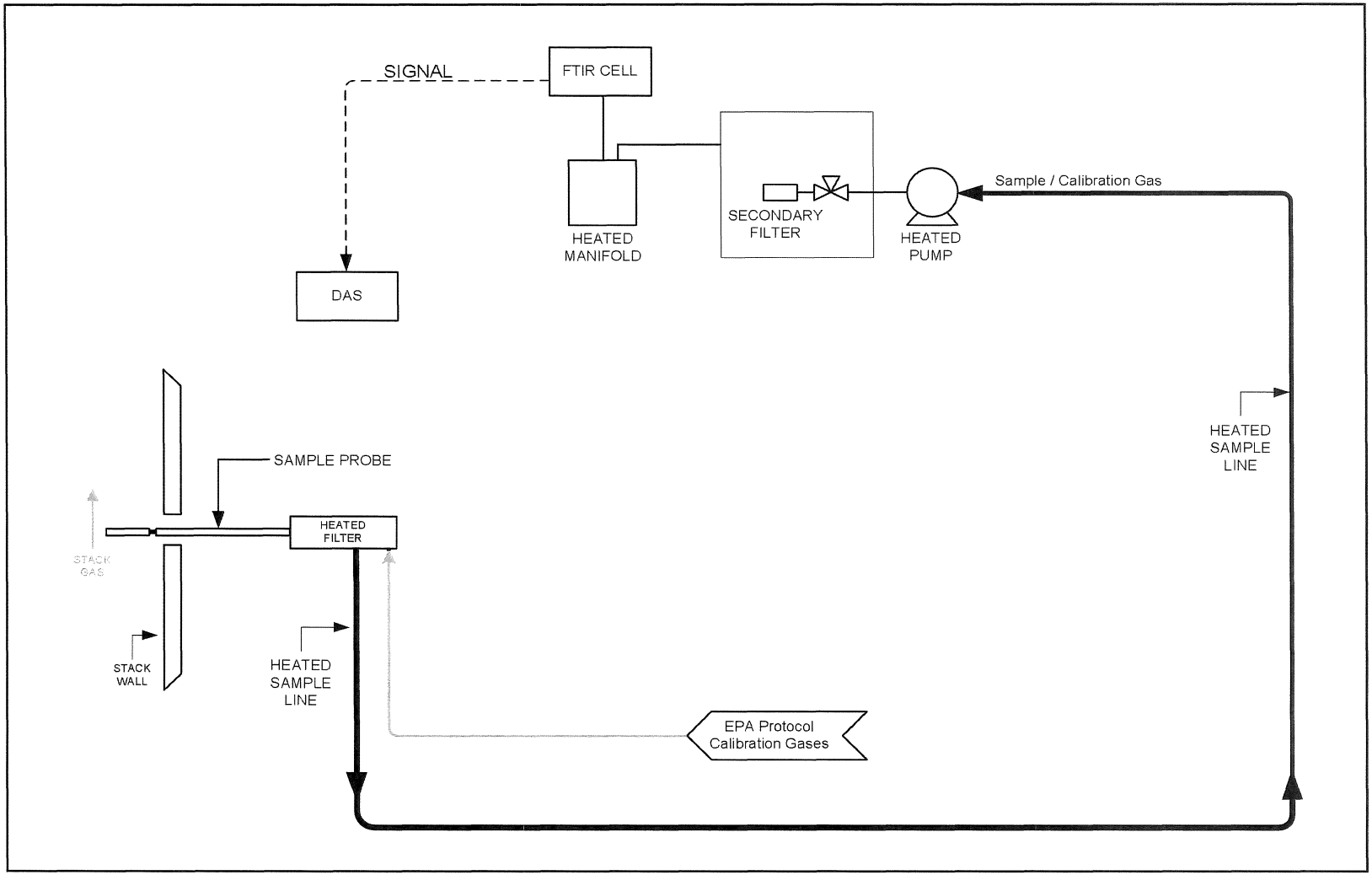


FIGURE 4.3
US EPA METHOD 320 SAMPLING TRAIN SCHEMATIC



5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA AUDITS

Tables 5.1 to 5.8 illustrate the QA audits that were performed during this test.

The meter box and sampling trains used during sampling performed within the requirements of their respective methods as is shown in Tables 5.1 and 5.2. All post-test leak checks were well below the applicable limit. Minimum metered volumes and percent isokinetics were also met where applicable.

Tables 5.3 and 5.4 illustrate the O_2 and CO_2 calibration audits which were performed during this test (and integral to performing US EPA Method 3A correctly) were all within the Measurement System Performance Specifications of ±3% of span for the Zero and Calibration Drift Checks, ±5% of span for the System Calibration Bias Checks, and ±2% of span for the Calibration Error Checks.

Table 5.5 illustrates the FIA calibration audits for TGO and CH_4 which were performed during this test (and integral to performing US EPA Method 25A correctly) were, except where noted, within the Measurement System Performance Specifications of ±3% of span for the Zero and Calibration Drift Checks, and ±5% of the respective cylinder concentrations for the Calibration Error Checks.

Table 5.6 displays the US EPA Method 205 field evaluation of the calibration gas dilution system utilized during this test event. As shown, the average concentration output at each dilution level was within ±2% of the predicted value. The average concentration output of the direct inject gas was also within ±2% of the certified concentration.

Table 5.7 displays the US EPA Method 320 sampling system QA performed on site. As displayed all spike and recoveries were within the 70% to 130% range.

Table 5.8 displays the results of the Field Train Blank as per US EPA Method 202, Section 9.10. The sampling train glassware that was used to collect condensable PM samples was baked as per US EPA Method 202 Section 8.4.

5.2 QA/QC PROBLEMS

No QA/QC problems occurred during this test event.

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 presented in the report appendices.

TABLE 5.1
US EPA METHOD 5/202 SAMPLING TRAIN AUDIT RESULTS

Parameter	Run 1	Run 2	Run 3
Sampling Location	**EUENGINE2 Exhaust Duct**		
Post-Test Leak Rate Observed (cfm)	0.010	0.000	0.000
Applicable Method Allowable Leak Rate (cfm)	0.020	0.020	0.020
Acceptable	Yes	Yes	Yes
Volume of Dry Gas Collected (dscf)	95.085	96.326	96.438
Recommended Volume of Dry Gas Collected (dscf)	21.000	21.000	21.000
Acceptable	Yes	Yes	Yes
Percent of Isokinetic Sampling Rate (%)	100.0	100.2	100.2
Applicable Method Allowable Isokinetic Sampling Rate (%)	100 ± 10	100 ± 10	100 ± 10
Acceptable	Yes	Yes	Yes

TABLE 5.2
US EPA METHOD 5/202 DRY GAS METER AUDIT RESULTS

Sampling Location	Pre-Test Dry Gas Meter Calibration Factor (Y)	Average Post-Test Dry Gas Meter Calibration Check Value (Yqa)	Post Test Dry Gas Meter Calibration Check Value Difference From Pre-Test Calibration Factor (%)	Applicable Method Allowable Difference (%)	Acceptable
EUENGINE2 Exhaust Duct	1.016	1.002	1.34%	5.00%	Yes

TABLE 5.3
US EPA METHOD 3A (O_2) ANALYZER CALIBRATION AND QA

	EUENGINE2 Exhaust Duct					
OXYGEN ANALYZER	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (%)	20.1	YES	20.1	YES	20.1	YES
Initial System Calibration Response for Zero Gas (%)	0.10	N/A	0.23	N/A	0.08	N/A
Final System Calibration Response for Zero Gas (%)	0.10	N/A	0.08	N/A	0.10	N/A
Actual Concentration of the Upscale Calibration Gas (%)	10.03	N/A	10.03	N/A	10.03	N/A
Initial System Calibration Response for Upscale Gas (%)	10.29	N/A	10.33	N/A	10.28	N/A
Final System Calibration Response for Upscale Gas (%)	10.22	N/A	10.28	N/A	10.16	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.45	YES	0.95	YES	0.20	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.45	YES	0.20	YES	0.30	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-0.05	YES	0.15	YES	-0.10	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.40	YES	-0.10	YES	-0.70	YES
System Drift for Zero Gas (% of Span)	0.00	YES	-0.75	YES	0.10	YES
System Drift for Upscale Gas (% of Span)	-0.35	YES	-0.25	YES	-0.60	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.05	YES	0.20	YES	0.20	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	1.35	YES	1.35	YES	1.35	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	-0.35	YES	0.10	YES	0.10	YES

TABLE 5.4
US EPA METHOD 3A (CO_2) ANALYZER CALIBRATION AND QA

	EUENGINE2 Exhaust Duct					
CARBON DIOXIDE ANALYZER	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (%)	20.17	YES	20.17	YES	20.17	YES
Initial System Calibration Response for Zero Gas (%)	0.14	N/A	0.28	N/A	0.13	N/A
Final System Calibration Response for Zero Gas (%)	0.17	N/A	0.13	N/A	0.29	N/A
Actual Concentration of the Upscale Calibration Gas (%)	10.08	N/A	10.08	N/A	10.08	N/A
Initial System Calibration Response for Upscale Gas (%)	10.36	N/A	10.42	N/A	10.48	N/A
Final System Calibration Response for Upscale Gas (%)	10.47	N/A	10.48	N/A	10.42	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.64	YES	1.14	YES	0.40	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.79	YES	0.40	YES	1.19	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-0.59	YES	-0.55	YES	-0.25	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.05	YES	-0.25	YES	-0.55	YES
System Drift for Zero Gas (% of Span)	0.15	YES	-0.74	YES	0.79	YES
System Drift for Upscale Gas (% of Span)	0.55	YES	0.30	YES	-0.30	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.05	YES	0.25	YES	0.25	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	1.98	YES	2.23	YES*	2.23	YES*
Analyzer Calibration Error for High-Level Gas (% of Span)	0.59	YES	0.25	YES	0.25	YES

* Acceptable per US EPA Method 3A.

TABLE 5.5
US EPA METHOD 25A ANALYZER CALIBRATION AND QA

	EUENGINE2 Exhaust Duct					
FID ANALYZER (TGO)	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (ppmv as propane)	901.4	YES	901.4	YES	901.4	YES
Average Stack Gas Concentration (ppmv as propane)	473.5	YES	483.7	YES	469.5	YES
Zero Drift (% of Span)	0.06	YES	0.06	YES	0.02	YES
Calibration Drift for Mid-Level Gas (% of Span)	-0.61	YES	-1.02	YES	-0.99	YES
Calibration Error for Low-Level Gas (% of Cal. Gas Tag Value)	-1.78	YES	-1.33	YES	-1.33	YES
Calibration Error for Mid-Level Gas (% of Cal. Gas Tag Value)	0.17	YES	0.15	YES	0.15	YES

	EUENGINE2 Exhaust Duct					
FID ANALYZER (CH_4)	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (ppmv as propane)	2,995	YES	2,995	YES	2,995	YES
Average Stack Gas Concentration (ppmv as propane)	1,213	YES	1,222	YES	1,188	YES
Zero Drift (% of Span)	0.06	YES	0.06	YES	0.02	YES
Calibration Drift for Mid-Level Gas (% of Span)	-0.61	YES	-1.02	YES	-0.99	YES
Calibration Error for Low-Level Gas (% of Cal. Gas Tag Value)	-1.78	YES	-1.33	YES	-1.33	YES
Calibration Error for Mid-Level Gas (% of Cal. Gas Tag Value)	0.17	YES	0.15	YES	0.15	YES

TABLE 5.6
US EPA METHOD 205 GAS DILUTION SYSTEM QA

Analyzer Serial Number: 06111923-99
Dilution System Serial Number: 6014
CGD Mass Flow Controllers Used: 1 and 2

	Dilution Level 1	Dilution Level 2	Direct Inject Gas
Calibration Tag Value (ppm):	901.4	901.4	90.68
Dilution Ratio:	9.023	18.06	-
Predicted Diluted Value (ppm):	99.9	49.9	-
Injection 1 Response (ppm):	101.40	49.91	91.59
Injection 2 Response (ppm):	100.44	49.95	91.20
Injection 3 Response (ppm):	100.23	49.88	91.01
Average Response (ppm):	100.69	49.91	91.27
Difference From Predicted (%):	-0.79	-0.03	-0.65
Acceptable (Yes/No):	Yes	Yes	Yes

TABLE 5.7
US EPA METHOD 320 SAMPLING SYSTEM QA

Date/Time (Start)	Analyte (ppm)	Sample Concentration	Native Concentration	Spiked Concentration	Dilution Factor	Recovery (%)	Acceptable
6/19/2019 11:29	SF_6	5.36	0.00	0.41	0.08	-	-
6/19/2019 11:29	Acetaldehyde	197.43	4.85	19.27	-	99.0	YES
6/19/2019 11:29	Methanol	189.83	1.25	16.79	-	107.9	YES
6/20/2019 7:40	SF_6	5.47	0.01	0.43	0.08	-	-
6/20/2019 7:40	Acetaldehyde	198.97	4.18	19.00	-	98.1	YES
6/20/2019 7:40	Methanol	190.53	1.81	16.29	-	98.6	YES
6/20/2019 10:06	SF_6	5.47	0.00	0.41	0.07	-	-
6/20/2019 10:06	Acetaldehyde	198.97	4.60	19.13	-	100.3	YES
6/20/2019 10:06	Methanol	190.53	2.17	15.60	-	96.3	YES

TABLE 5.8
US EPA METHOD 202 FIELD TRAIN BLANK RESULTS

Parameter	Field Train Recovery Blank (FTB)
Organic Catch Weight (mg)	0.83
Inorganic Catch Weight (mg)	3.28
Total Field Train Blank Catch Weight (mg)	4.11
Maximum Allowable Blank Correction (mg)	2.00

APPENDIX

APPENDIX CHECKLIST - M049AS-554742-RT-85R0

A-PROCESS DATA
- [x] Process Operational Data

B-LABORATORY DATA
- [x] Laboratory Reports

C-FIELD DATA
- [x] Calculation Spreadsheet(s) and Example Calculations

- [x] Test Log (CEMS/FTIR Methods)
- [x] CEMS Graphs
- [ ] Main Method Field Data Sheets
- [x] Isokinetic Field Data Sheets
- [ ] US EPA Method 9 Field Data
- [x] Sample Recovery & Calibration Check Data
- [ ] US EPA Method 3 / Dry MW Calculation
- [ ] US EPA Method 2 Flow Data Sheets
- [x] US EPA Method 1 Cyclonic Flow
- [x] US EPA Method 1 Preliminary Field Data

D-CALIBRATIONS AND CERTIFICATIONS

D.1-CEMS/FTIR ANALYZERS
- [x] Analyzer Calibration Error, System Bias, and System Drift
- [ ] US EPA Method 7E Converter Efficiency Check
- [x] US EPA Method 205 Calibration Gas Dilution System Evaluation

D.2-FIELD EQUIPMENT
- [ ] Probe Nozzle Inspections
- [x] Pre-Test Pitot Tube / Probe Inspections
- [x] Post-Test Pitot Tube / Probe Inspections

- [x] Pre-Test Thermocouple System Audit
- [x] Post-Test Thermocouple Check

- [ ] 10-Minute Calibrations
- [x] Pre-Test Meter Box Calibration
- [ ] Post-Test dry Gas Meter ALT-009 Leak Check

- [ ] Post-Test Dry Gas Meter / Orifice and Console Calibration

- [ ] Post-Test Mini Meter / Orifice and Console Calibration

- [x] Calibration Kit (00) Audit

- [ ] Digital Pressure Gauge / Barometer Audit
- [ ] Thermometer Audit

- [ ] Equipment Calibration Histories

D-CALIBRATIONS AND CERTIFICATIONS (continued)

D.3-REFERENCE EQUIPMENT/STANDARDS
- [x] Calibration Gas Certifications
- [x] Calibration Gas Diluter Certifications
- [x] True Primary Flow Standard Certification

- [x] Field Balance Calibration Weights Certifications
- [ ] Field / Shop Balance Calibration Certifications
- [ ] Daily Field/Shop Balance Audit

- [ ] Micromanometer Certificate

- [x] Reference Meter Calibration
- [ ] Reference Field Hygrometer Calibration

- [ ] VE Azimuth Tables
- [ ] VE Declination
- [ ] VE Certificates

- [ ] Reference Digital Pressure Gauge Certification
- [ ] Reference Thermometer (Omega) Certification
- [ ] Reference Ruler Certification
- [ ] Reference Protractor Certification
- [ ] Reference Caliper Certification

D.4-MONTROSE STAC & PERSONNEL
- [x] Montrose - Accreditation Certificate
- [x] Montrose Personnel - QI/QSTI Certificates/Conformance Documents

D.5-ITT / TEST PROTOCOL / TEST PLAN
- [x] Intent to Test Notification / Test Protocol / Test Plan