COMPLIANCE STACK EMISSION TEST REPORT

ENGINE No. 1 (EU00001)

Determination of Carbon Monoxide Destruction Efficiency

Utilizing US EPA Methods 3A and 10

Test Date(s): May 8, 2019
State Registration Number: N3195
Facility Name: Bay City Electric, Light, & Power
Henry Street Facility
Source Location: Bay City, Michigan
Permit: EGLE Permit-to-Install No. 823-91B

Prepared For:

Bay City Electric, Light, & Power - Henry Street Facility
604 North Henry Street • Bay City, MI 48706

Prepared By:

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Document Number: M049AS-527109-RT-17R0
Document Date: June 18, 2019
Test Plan: 049AS-527109-PP-3

ACCREDITED
TO ASTM D7036 ONLY

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REVIEW AND CERTIFICATION

The results of the Compliance Test conducted on May 8, 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, 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: ______________________

Name: Steven Smith 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: ______________________

Name: Randal Tysar Title: District Manager

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

Bay City Electric, Light, & Power - Henry Street Facility contracted Montrose Air Quality Services, LLC (Montrose) of Detroit, Michigan, to conduct compliance stack emission testing for Engine No. 1 (EU00001) located at the Bay City Electric, Light, & Power - Henry Street Facility (State Registration Number: N3195) in Bay City, Michigan. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE Permit-to-Install (PTI) No. 823-91B and 40 CFR Part 63, Subpart ZZZZ. The testing was performed on May 8, 2019.

Simultaneous sampling was performed at the Engine No. 1 Catalytic Oxidizer (CAT-OX) Inlet Duct and Engine No. 1 CAT-OX Outlet to determine the carbon monoxide (CO) destruction efficiency (DE) of the CAT-OX associated with Engine No. 1 at 15% oxygen (O_2). Testing was conducted during normal operations. During this test, emissions from Engine No. 1 were controlled by a CAT-OX.

The test methods that were conducted during this test were US EPA Methods 3A and 10.

Due to necessary maintenance, Engine No. 2 (EU00002) testing was postponed and has been rescheduled for June 27, 2019.

1.2 KEY PERSONNEL

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

- Lee Techlin, Generation and Maintenance Supervisor, Bay City Electric Light & Power, 989-894-8223
- Eric Marko, Senior Staff Engineer, NTH Consultants, 440-781-2429
- Dave Patterson, EQA 11, EGLE, 517-284-6782
- Karen Kajiya-Mills, Environmental Manager, Michigan Department of Environment, Great Lakes and Energy, 517-284-6780
- Kathy Brewer, EQA 12, Michigan Department of Environment, Great Lakes and Energy, 989-439-2100
- Steve Smith, Client Project Manager, Montrose, 734-751-9701
- Shane Rabideau, Field Technician, Montrose, 810-656-3986

2.0 SUMMARY AND DISCUSSION OF TEST RESULTS

2.1 OBJECTIVES AND TEST MATRIX

The purpose of this test was to determine the CO DE of the CAT-OX associated with Engine No. 1 at 15% O_2 during normal operations. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE PTI No. 823-91B. The emission testing is required by the National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines codified at Title 40, Part 63, Subpart ZZZZ of the Code of Federal Regulations (40 63, Subpart ZZZZ). This standard requires a CO control efficiency across the catalyst bed of at least 70% at 15% O_2.

The specific test objectives for this test are as follows:

- Simultaneously measure the concentrations of O_2 and CO at the Engine No. 1 CAT-OX Inlet Duct and Outlet.
- Utilize the above variables to determine the CO DE of the CAT-OX associated with Engine No. 1 at 15% O_2 during normal operations.

Table 2.1 presents the sampling matrix log for this test.

2.2 FIELD TEST CHANGES AND PROBLEMS

No field test changes or problems occurred during the performance of this test that would bias the accuracy of the results of this test.

2.3 PRESENTATION OF RESULTS

Single sampling trains were utilized during each run at the Engine No. 1 CAT-OX Inlet and Outlet to determine the CO DE of the CAT-OX associated with Engine No. 1 at 15% O_2 These sampling trains measured the gas stream concentrations of O_2 and CO.

Table 2.2 displays the CO DE of the CAT-OX associated with Engine No. 1 at 15% O_2 during normal operations.

TABLE 2.1
SAMPLING MATRIX OF TEST METHODS UTILIZED

Date	Run No.	Sampling Location	US EPA METHOD 3A (O_2) Sampling Time / Duration (min)	US EPA METHOD 10 (CO) Sampling Time / Duration (min)
5/8/2019	1	Engine No. 1 CAT-OX Inlet Duct	11:17 - 12:24 / 60	11:17 - 12:24 / 60
5/8/2019	2	Engine No. 1 CAT-OX Inlet Duct	12:36 - 13:43 / 60	12:36 - 13:43 / 60
5/8/2019	3	Engine No. 1 CAT-OX Inlet Duct	13:54 - 15:00 / 60	13:54 - 15:00 / 60
5/8/2019	1	Engine No. 1 CAT-OX Outlet	11:17 - 12:24 / 60	11:17 - 12:24 / 60
5/8/2019	2	Engine No. 1 CAT-OX Outlet	12:36 - 13:43 / 60	12:36 - 13:43 / 60
5/8/2019	3	Engine No. 1 CAT-OX Outlet	13:54 - 15:00 / 60	13:54 - 15:00 / 60

All times are Eastern Daylight Time.

TABLE 2.2
EMISSION RESULTS

Parameter	Engine No. 1 CAT-OX Inlet Duct				Engine No. 1 CAT-OX Outlet			
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average
CO Destruction Efficiency (%)	-	-	-	-	**71**	**72**	**73**	**72**
CO Concentration (ppmvd corrected to 15% O_2)	167.1	167.0	166.2	166.8	47.8	46.0	45.1	46.3
CO Concentration (ppmvd)	273.4	270.9	269.6	271.3	77.5	74.6	73.5	75.2
Percent by Volume Oxygen in Stack Gas (%-dry)	11.25	11.33	11.33	11.30	11.33	11.32	11.27	11.31
Measured Stack Inner Diameter (in)	24.0				48.0			

3.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

3.1 PROCESS DESCRIPTION AND OPERATION

Bay City Electric, Light, & Power operates two dual fuel engines at its Henry Street Facility in Bay City, Michigan. Engine No. 1 (EU00001) and Engine No. 2 (EU00002) fire approximately 95% natural gas and 5% diesel fuel. These engines generate 7,790 kilowatts. Engine No. 1 was in operation for this test event.

Figure 3.1 depicts the sampling location schematic.

3.2 CONTROL EQUIPMENT DESCRIPTION

During this test, emissions from Engine No. 1 were controlled by a CAT-OX.

3.3 SAMPLING LOCATION(S)

3.3.1 Engine No. 1 CAT-OX Inlet Duct

The Engine No. 1 CAT-OX Inlet Duct had a measured inner diameter of 24.0-inches and was oriented in the vertical plane. Two sampling ports were located 90° apart from one another at a location that met US EPA Method 1, Section 11.1.1 criteria. During emissions sampling, the duct was traversed for duct gas O_2 and CO concentration determinations.

3.3.2 Engine No. 1 CAT-OX Outlet

The Engine No. 1 CAT-OX Outlet had a measured inner diameter of 48.0-inches and was oriented in the vertical plane. Two sampling ports were located 90° apart from one another at a location that met US EPA Method 1, Section 11.1.1 criteria. During emissions sampling, the stack was traversed for stack gas O_2 and CO concentration determinations.

Figures 3.2 to 3.3 schematically illustrate 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
ENGINES No. 1 AND No. 2 SAMPLING LOCATION SCHEMATIC

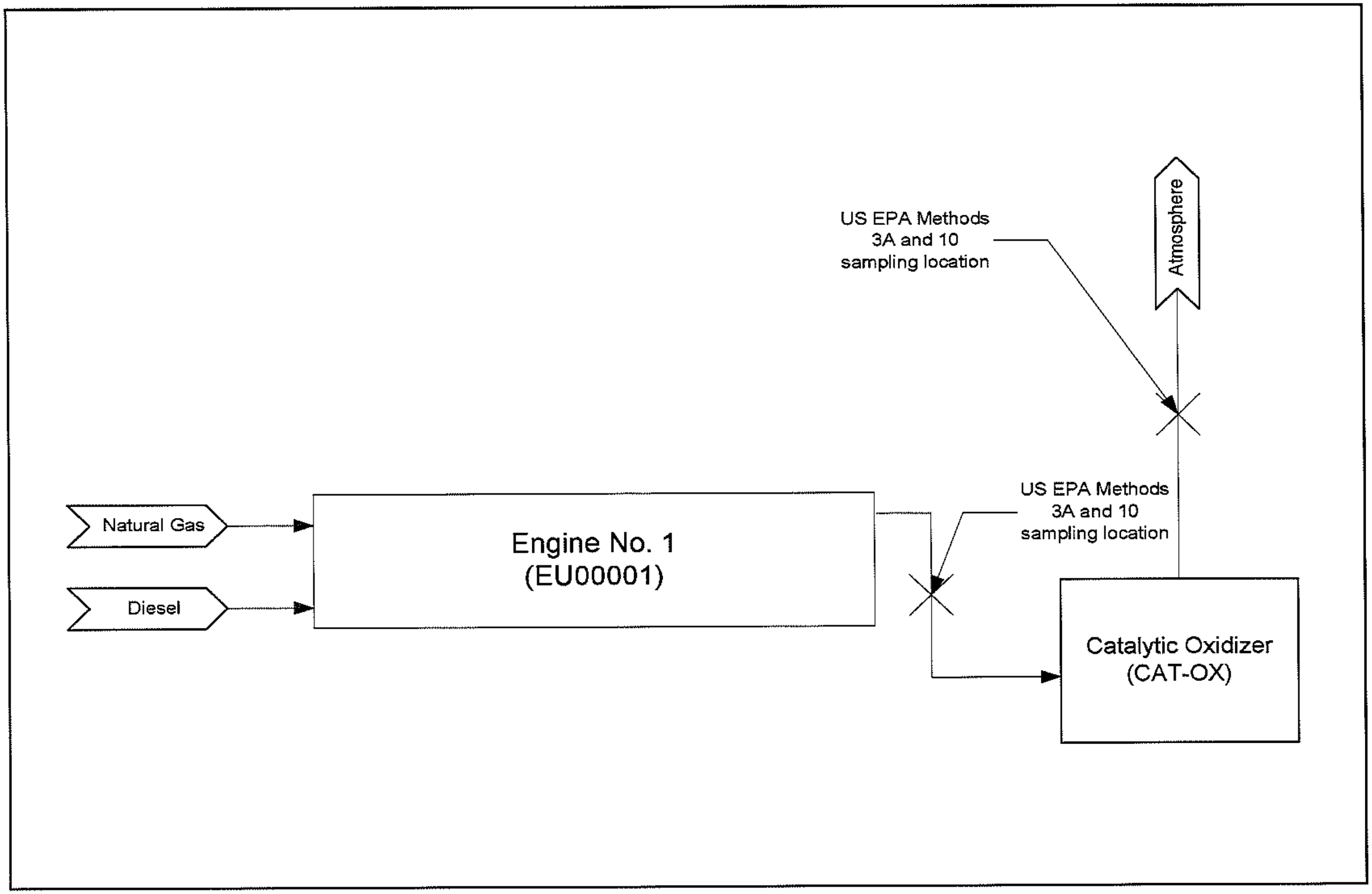
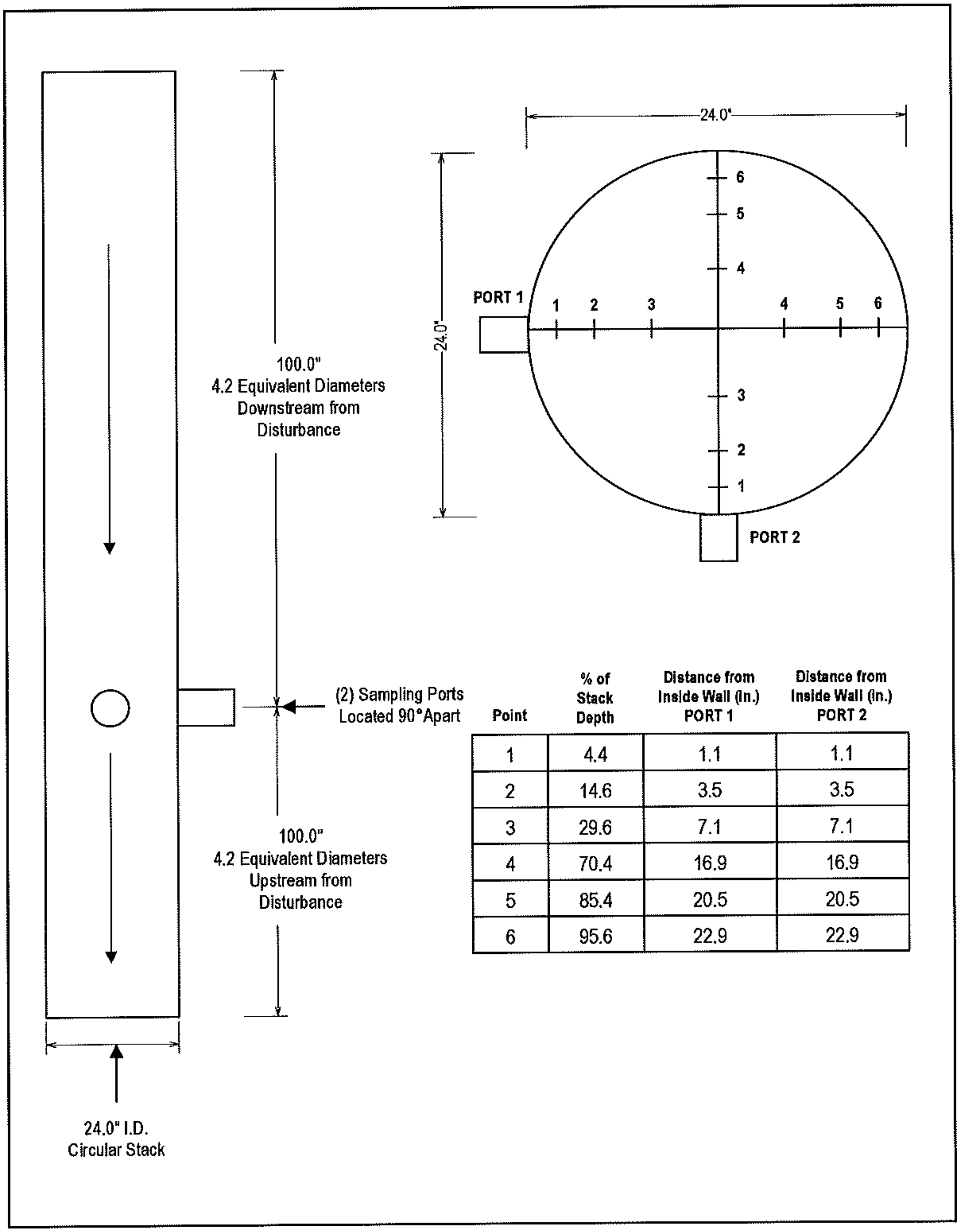
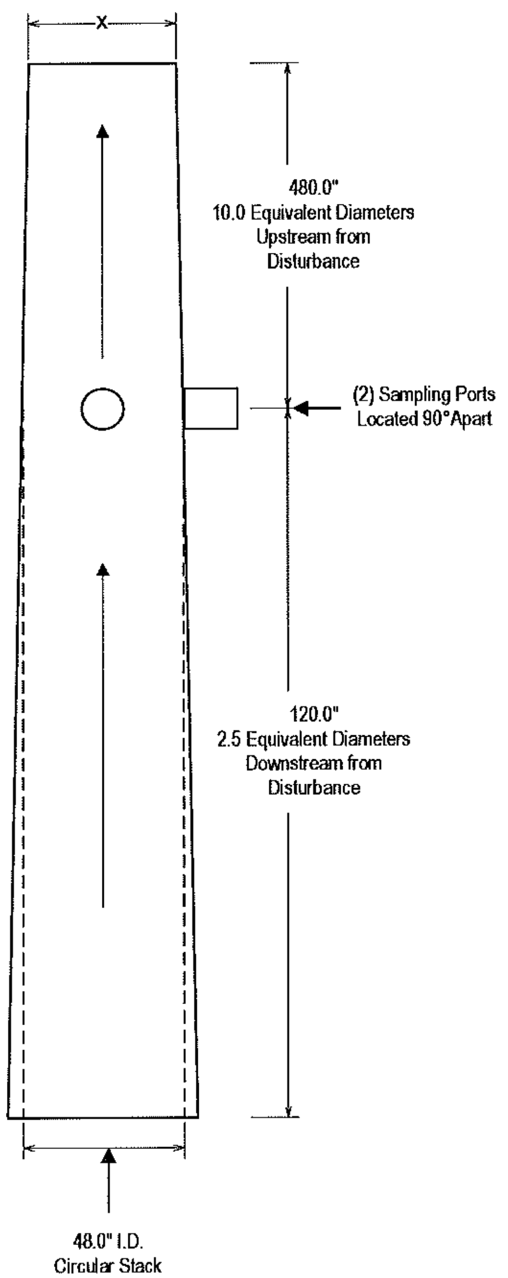


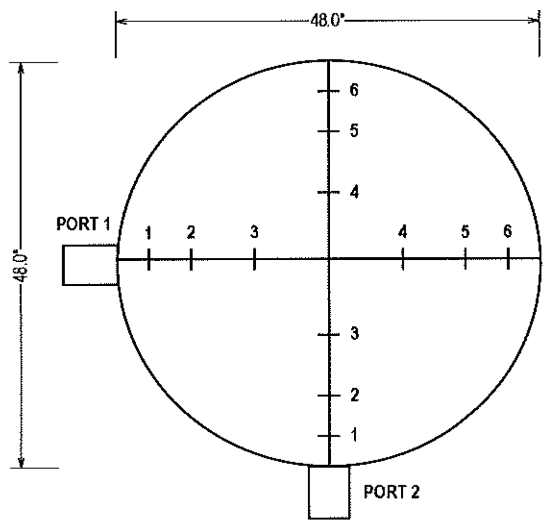
FIGURE 3.2
ENGINE No. 1 CAT-OX INLET TRAVERSE POINT LOCATION DRAWING



Point	% of Stack Depth	Distance from Inside Wall (In.) PORT 1	Distance from Inside Wall (In.) PORT 2
1	4.4	1.1	1.1
2	14.6	3.5	3.5
3	29.6	7.1	7.1
4	70.4	16.9	16.9
5	85.4	20.5	20.5
6	95.6	22.9	22.9

FIGURE 3.3
ENGINE No. 1 CAT-OX OUTLET TRAVERSE POINT LOCATION DRAWING





Point	% of Stack Depth	Distance from Inside Wall (in.) PORT 1	Distance from Inside Wall (in.) PORT 2
1	4.4	2.1	2.1
2	14.6	7.0	7.0
3	29.6	14.2	14.2
4	70.4	33.8	33.8
5	85.4	41.0	41.0
6	95.6	45.9	45.9

X= The exhaust outlet for Engine No. 1 is ≤34-inches.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

4.1.1 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.

4.1.2 US EPA Method 10: "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)"

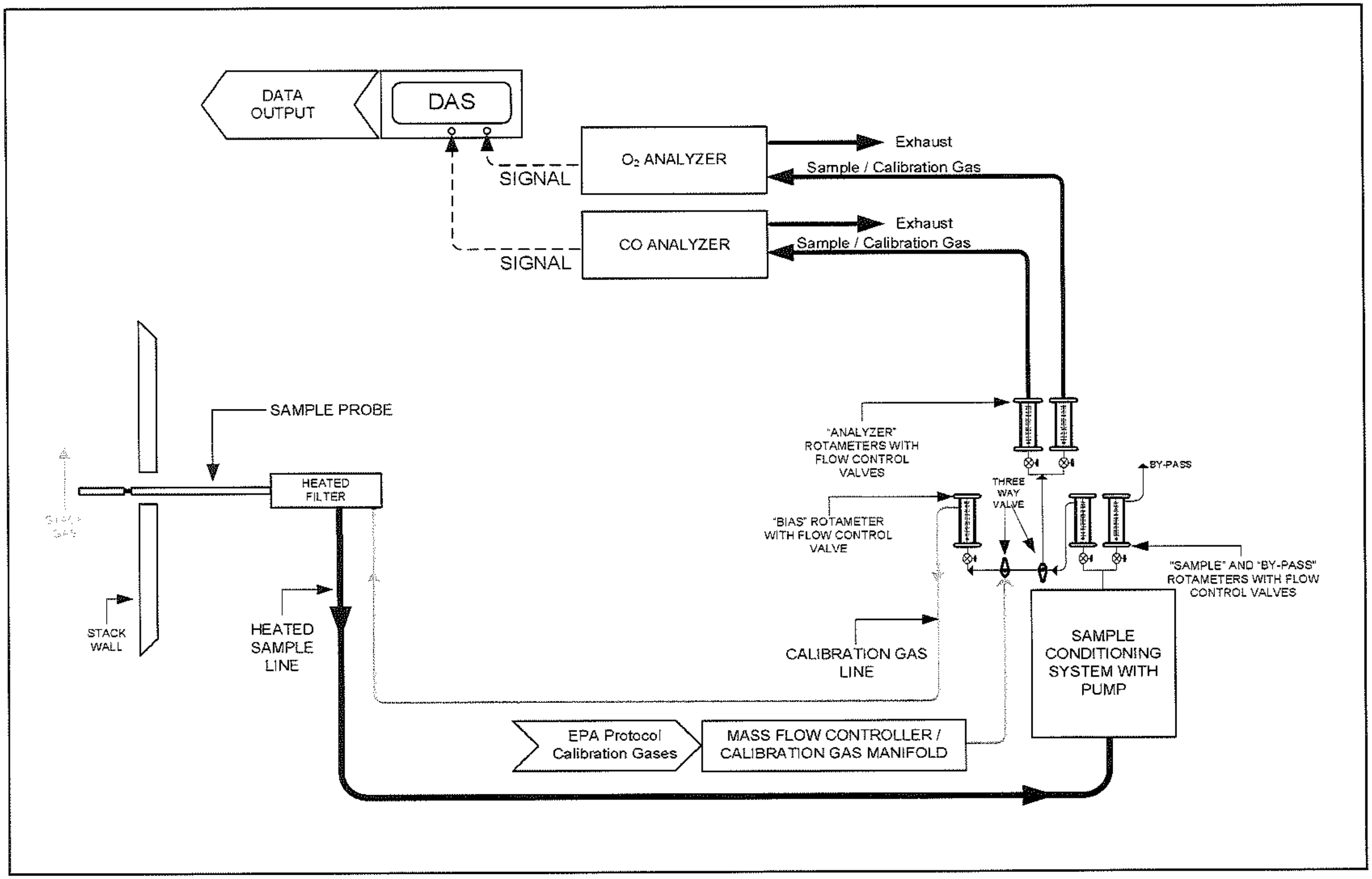
Principle: A gas sample is continuously extracted from the effluent stream. A portion of the sample stream is conveyed to an instrumental analyzer for determination of CO concentration. Performance specifications and test procedures are provided to ensure reliable data. This method was utilized in its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

The sampling train utilized during this testing project is depicted in Figure 4.1.

4.2 PROCEDURES FOR OBTAINING PROCESS DATA

Process data was recorded by Bay City Electric, Light, & Power - Henry Street Facility 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 located in the Appendix.

FIGURE 4.1
US EPA METHODS 3A and 10 SAMPLING TRAIN SCHEMATIC



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5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA AUDITS

Tables 5.1.1 to 5.3 illustrate the QA audits that were performed during this test.

Tables 5.1.1 to 5.2.2 illustrate the O_2 and CO calibration audits which were performed during this test (and integral to performing US EPA Method 3A and 10 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 5.3 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 mid-level gas was also within ±2% of the certified concentration.

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 5.1.1
US EPA METHOD 3A (O_2) ANALYZER CALIBRATION AND QA

	Engine No. 1 CAT-OX Inlet 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 (%)	0.07	N/A	0.00	N/A	0.03	N/A
Final System Calibration Response for Zero Gas (%)	0.00	N/A	0.03	N/A	0.00	N/A
Actual Concentration of the Upscale Calibration Gas (%)	10.04	N/A	10.04	N/A	10.04	N/A
Initial System Calibration Response for Upscale Gas (%)	10.08	N/A	9.91	N/A	9.93	N/A
Final System Calibration Response for Upscale Gas (%)	9.91	N/A	9.93	N/A	9.90	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.25	YES	-0.10	YES	0.05	YES
Final System Calibration Bias for Zero Gas (% of Span)	-0.10	YES	0.05	YES	-0.10	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.05	YES	-0.80	YES	-0.70	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.80	YES	-0.70	YES	-0.85	YES
System Drift for Zero Gas (% of Span)	-0.35	YES	0.15	YES	-0.15	YES
System Drift for Upscale Gas (% of Span)	-0.85	YES	0.10	YES	-0.15	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.10	YES	0.10	YES	0.10	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.15	YES	0.15	YES	0.15	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.05	YES	0.05	YES	0.05	YES

TABLE 5.1.2
US EPA METHOD 10 ANALYZER CALIBRATION AND QA

	Engine No. 1 CAT-OX Inlet Duct					
CARBON MONOXIDE ANALYZER	RUN 1	Acceptable	RUN 2	Acceptable	RUN 3	Acceptable
Analyzer Span During Test Run (ppm)	990	YES	990	YES	990	YES
Initial System Calibration Response for Zero Gas (ppm)	2.34	N/A	3.21	N/A	3.09	N/A
Final System Calibration Response for Zero Gas (ppm)	3.21	N/A	3.09	N/A	3.16	N/A
Actual Concentration of the Upscale Calibration Gas (ppm)	498	N/A	498	N/A	498	N/A
Initial System Calibration Response for Upscale Gas (ppm)	498	N/A	497	N/A	498	N/A
Final System Calibration Response for Upscale Gas (ppm)	497	N/A	498	N/A	499	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.12	YES	0.21	YES	0.20	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.21	YES	0.20	YES	0.21	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.72	YES	0.67	YES	0.76	YES
Final System Calibration Bias for Upscale Gas (% of Span)	0.67	YES	0.76	YES	0.89	YES
System Drift for Zero Gas (% of Span)	0.09	YES	-0.01	YES	0.01	YES
System Drift for Upscale Gas (% of Span)	-0.05	YES	0.08	YES	0.13	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.11	YES	0.11	YES	0.11	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	-0.76	YES	-0.76	YES	-0.76	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.30	YES	0.30	YES	0.30	YES

TABLE 5.2.1
US EPA METHOD 3A (O_2) ANALYZER CALIBRATION AND QA

	Engine No. 1 CAT-OX Outlet					
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 (%)	0.13	N/A	0.14	N/A	0.12	N/A
Final System Calibration Response for Zero Gas (%)	0.14	N/A	0.12	N/A	0.13	N/A
Actual Concentration of the Upscale Calibration Gas (%)	10.04	N/A	10.04	N/A	10.04	N/A
Initial System Calibration Response for Upscale Gas (%)	10.09	N/A	10.08	N/A	10.07	N/A
Final System Calibration Response for Upscale Gas (%)	10.08	N/A	10.07	N/A	10.12	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.65	YES	0.70	YES	0.60	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.70	YES	0.60	YES	0.65	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.05	YES	0.00	YES	-0.05	YES
Final System Calibration Bias for Upscale Gas (% of Span)	0.00	YES	-0.05	YES	0.20	YES
System Drift for Zero Gas (% of Span)	0.05	YES	-0.10	YES	0.05	YES
System Drift for Upscale Gas (% of Span)	-0.05	YES	-0.05	YES	0.25	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.00	YES	0.00	YES	0.00	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.20	YES	0.20	YES	0.20	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.45	YES	0.45	YES	0.45	YES

TABLE 5.2.2
US EPA METHOD 10 ANALYZER CALIBRATION AND QA

	Engine No. 1 CAT-OX Outlet					
CARBON MONOXIDE ANALYZER	**RUN 1**	**Acceptable**	**RUN 2**	**Acceptable**	**RUN 3**	**Acceptable**
Analyzer Span During Test Run (ppm)	190	YES	190	YES	190	YES
Initial System Calibration Response for Zero Gas (ppm)	0.95	N/A	0.93	N/A	0.92	N/A
Final System Calibration Response for Zero Gas (ppm)	0.93	N/A	0.92	N/A	0.93	N/A
Actual Concentration of the Upscale Calibration Gas (ppm)	100	N/A	100	N/A	100	N/A
Initial System Calibration Response for Upscale Gas (ppm)	100	N/A	100	N/A	100	N/A
Final System Calibration Response for Upscale Gas (ppm)	100	N/A	100	N/A	101	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.36	YES	0.35	YES	0.34	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.35	YES	0.34	YES	0.35	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-0.55	YES	-0.45	YES	-0.47	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.45	YES	-0.47	YES	-0.20	YES
System Drift for Zero Gas (% of Span)	-0.01	YES	-0.01	YES	0.01	YES
System Drift for Upscale Gas (% of Span)	0.10	YES	-0.03	YES	0.27	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.14	YES	0.14	YES	0.14	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.62	YES	0.62	YES	0.62	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.23	YES	0.23	YES	0.23	YES

TABLE 5.3
US EPA METHOD 205 GAS DILUTION SYSTEM QA

Analyzer Serial Number:	266
Dilution System Serial Number:	8240
CGD Mass Flow Controllers Used:	1 and 2

	Dilution Level 1	Dilution Level 2	Mid-Level Gas
Calibration Tag Value (ppm):	792.3	792.3	49.67
Dilution Ratio:	8.80	15.85	-
Predicted Diluted Value (ppm):	90.00	50.00	-
Injection 1 Response (ppm):	89.02	49.35	49.24
Injection 2 Response (ppm):	88.97	49.63	49.81
Injection 3 Response (ppm):	89.28	49.54	49.72
Average Response (ppm):	89.09	49.51	49.59
Difference From Predicted (%):	1.01	0.99	0.16
Acceptable (YES/NO):	yes	yes	yes