

COMPLIANCE STACK EMISSION TEST REPORT

ENGINE No. 1 (EUENGINE1) AND ENGINE No. 2 (EUENGINE2)

Determination of Carbon Monoxide Destruction Efficiencies

Utilizing US EPA Methods 3A and 10

Test Date(s): May 7, 2019
State Registration Number: B7529
Facility Name: Bay City Electric, Light, & Power
Water Street Facility
Source Location: Bay City, Michigan
Permit: EGLE Permit-to-Install No. 587-96A

Prepared For:

Bay City Electric, Light, & Power - Water Street Facility
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REVIEW AND CERTIFICATION

The results of the Compliance Test conducted on May 7, 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 - Water Street Facility contracted Montrose Air Quality Services, LLC (Montrose) of Detroit, Michigan, to conduct compliance stack emission testing for Engine No. 1 (EUENGINE1) and Engine No. 2 (EUENGINE2) located at the Bay City Electric, Light, & Power - Water Street Facility (State Registration Number: B7529) in Bay City, Michigan. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE Permit-to-Install (PTI) No. 587-96A and 40 CFR Part 63, Subpart ZZZZ. The testing was performed on May 7, 2019.

Simultaneous sampling was performed at the Engine No. 1 Catalytic Oxidizer (CAT-OX) Inlet Ducts 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 (O₂). Simultaneous sampling was also performed at the Engine No. 2 CAT-OX Inlet Ducts and Outlet to determine the CO DE of the CAT-OX associated with Engine No. 2 at 15% O₂. Testing was conducted during normal operations. During this test, emissions from Engines No. 1 and No. 2 were controlled by their respective CAT-OX's.

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

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's associated with Engines No. 1 and No. 2 at 15% O₂ during normal operations. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE PTI No. 587-96A. 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% O₂.

The specific test objectives for this test are as follows:

- Simultaneously measure the concentrations of O₂ and CO at the Engine No. 1 CAT-OX Inlet Ducts and Outlet.
- Simultaneously measure the concentrations of O₂ and CO at the Engine No. 2 CAT-OX Inlet Ducts and Outlet.
- Utilize the above variables to determine the CO DE of the CAT-OX's associated with Engine No. 1 and Engine No. 2 at 15% O₂ 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 Ducts and Outlet and at the Engine No. 2 CAT-OX Inlet Ducts and Outlet to determine the CO DE of the CAT-OX's associated with Engines No. 1 and No. 2 at 15% O₂. These sampling trains measured the gas stream concentrations of O₂ and CO.

Table 2.2 displays the CO DE of the CAT-OX associated with Engine No. 1 at 15% O₂ during normal operations.

Table 2.3 displays the CO DE of the CAT-OX associated with Engine No. 2 at 15% O₂ during normal operations.

Bay City Electric, Light, Power - Water Street Facility
 May 2019 Engine No. 1 (EUENGINE1) and No. 2 (EUENGINE2) Compliance Test

**TABLE 2.1
 SAMPLING MATRIX OF TEST METHODS UTILIZED**

Date	Run No.	Sampling Location	US EPA METHOD 3A (O ₂)	US EPA METHOD 10 (CO)
			Sampling Time / Duration (min)	Sampling Time / Duration (min)
5/7/2019	1	Engine No. 1 CAT-OX Inlet Ducts	12:25 - 13:30 / 60	12:25 - 13:30 / 60
5/7/2019	2	Engine No. 1 CAT-OX Inlet Ducts	13:43 - 14:48 / 60	13:43 - 14:48 / 60
5/7/2019	3	Engine No. 1 CAT-OX Inlet Ducts	14:59 - 16:13 / 60	14:59 - 16:13 / 60
5/7/2019	1	Engine No. 1 CAT-OX Outlet	12:25 - 13:30 / 60	12:25 - 13:30 / 60
5/7/2019	2	Engine No. 1 CAT-OX Outlet	13:43 - 14:48 / 60	13:43 - 14:48 / 60
5/7/2019	3	Engine No. 1 CAT-OX Outlet	14:59 - 16:13 / 60	14:59 - 16:13 / 60
5/7/2019	1	Engine No. 2 CAT-OX Inlet Ducts	7:57 - 9:03 / 60	7:57 - 9:03 / 60
5/7/2019	2	Engine No. 2 CAT-OX Inlet Ducts	9:14 - 10:19 / 60	9:14 - 10:19 / 60
5/7/2019	3	Engine No. 2 CAT-OX Inlet Ducts	10:30 - 11:35 / 60	10:30 - 11:35 / 60
5/7/2019	1	Engine No. 2 CAT-OX Outlet	7:57 - 9:03 / 60	7:57 - 9:03 / 60
5/7/2019	2	Engine No. 2 CAT-OX Outlet	9:14 - 10:19 / 60	9:14 - 10:19 / 60
5/7/2019	3	Engine No. 2 CAT-OX Outlet	10:30 - 11:35 / 60	10:30 - 11:35 / 60

All times are Eastern Daylight Time.

**TABLE 2.2
 EMISSION RESULTS**

Parameter	Engine No. 1 CAT-OX Inlet Ducts				Engine No. 1 CAT-OX Outlet			
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average
CO Destruction Efficiency (%)	-	-	-	-	69	71	72	71
CO Concentration (ppmvd corrected to 15% O ₂)	301.7	304.5	300.1	302.1	93.9	88.6	84.7	89.1
CO Concentration (ppmvd)	440.9	445.7	443.5	443.4	139.5	131.5	125.8	132.3
Percent by Volume Oxygen in Stack Gas (%-dry)	12.28	12.26	12.18	12.24	12.14	12.14	12.14	12.14
Measured Stack Inner Diameter (in)		24.0				48.0		

**TABLE 2.3
 EMISSION RESULTS**

Parameter	Engine No. 2 CAT-OX Inlet Ducts				Engine No. 2 CAT-OX Outlet			
	Run 1	Run 2	Run 3	Average	Run 1	Run 2	Run 3	Average
CO Destruction Efficiency (%)	-	-	-	-	79	80	79	79
CO Concentration (ppmvd corrected to 15% O ₂)	327.3	314.5	302.4	314.8	67.6	63.6	63.2	64.8
CO Concentration (ppmvd)	457.6	444.0	432.4	444.6	97.6	92.2	91.7	93.8
Percent by Volume Oxygen in Stack Gas (%-dry)	12.65	12.57	12.46	12.56	12.39	12.35	12.33	12.36
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 Water Street Facility in Bay City, Michigan. Engine No. 1 (EUENGINE1) and Engine No. 2 (EUENGINE2) fire approximately 95% natural gas and 5% diesel fuel. Engine No. 1 generates 5,757 kilowatts and 8,000 horsepower. Engine No. 2 generates 6,955 kilowatts and 9,630 horsepower. Engines No. 1 and No. 2 were in operation for this test event.

Figure 3.1 depicts the sampling location schematic.

3.2 CONTROL EQUIPMENT DESCRIPTION

During this test, emissions from Engines No. 1 and No. 2 were controlled by their respective CAT-OX's. Each CAT-OX was equipped with two inlet ducts which serviced the cylinders on each side of the engine.

3.3 SAMPLING LOCATION(S)

3.3.1 Engines No. 1 and No. 2 CAT-OX Inlet Ducts

The Engine No. 1 and Engine No. 2 CAT-OX Inlet Ducts had measured inner diameters of 24.0-inches and were oriented in the horizontal plane. For each duct, a single sampling port was located at a site that met US EPA Method 1, Section 11.1.1 criteria. During emissions sampling, both CAT-OX inlet ducts were traversed for duct gas O₂ and CO concentration determinations.

3.3.2 Engines No. 1 and No. 2 CAT-OX Outlets

The Engines No. 1 and No. 2 CAT-OX Outlets had measured inner diameters of 48.0-inches and were oriented in the vertical plane. For each stack, 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 stacks were traversed for stack gas O₂ 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

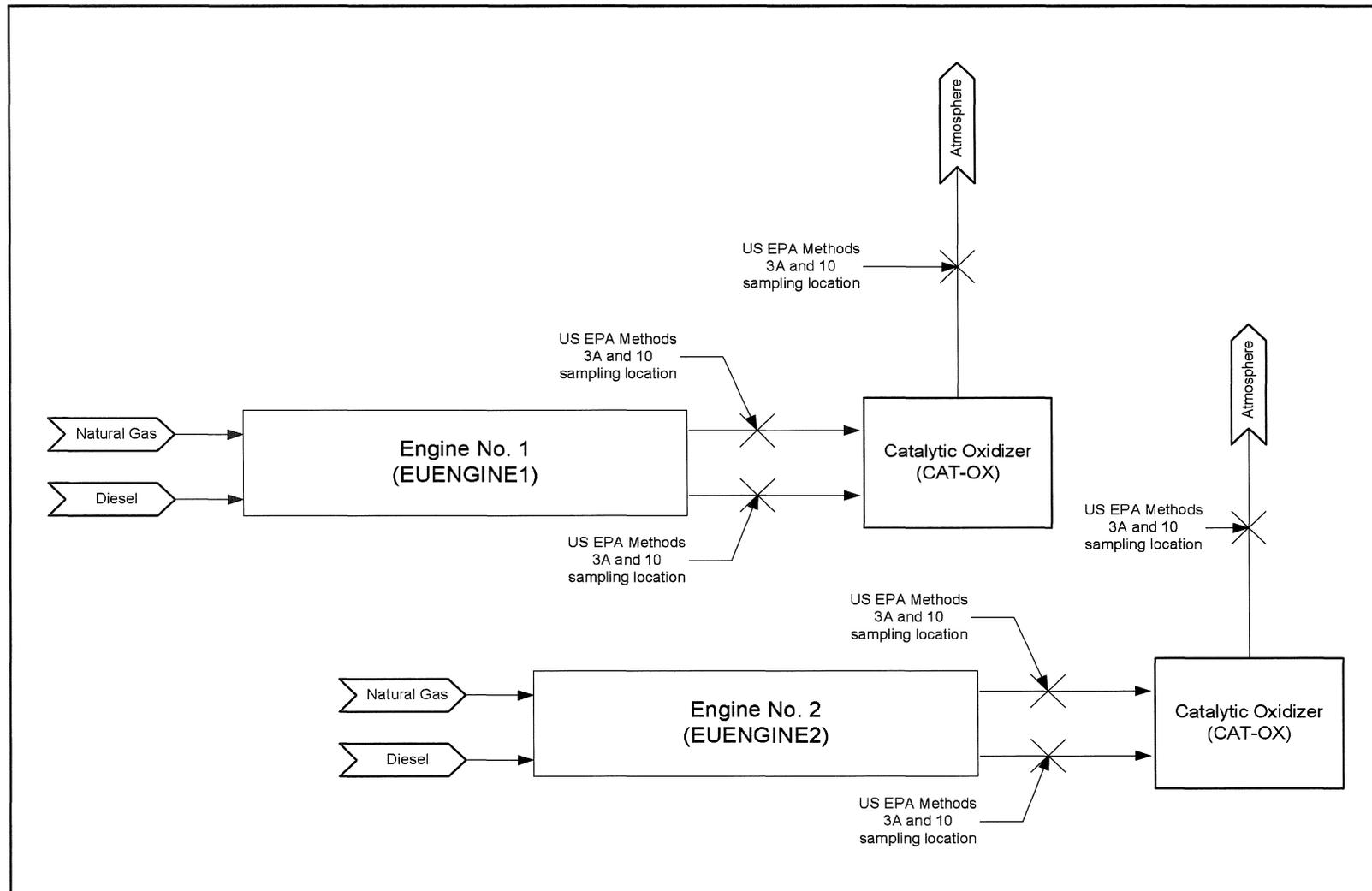


FIGURE 3.2
ENGINES No.1 and No. 2 CAT-OX INLETS TRAVERSE POINT LOCATION DRAWING

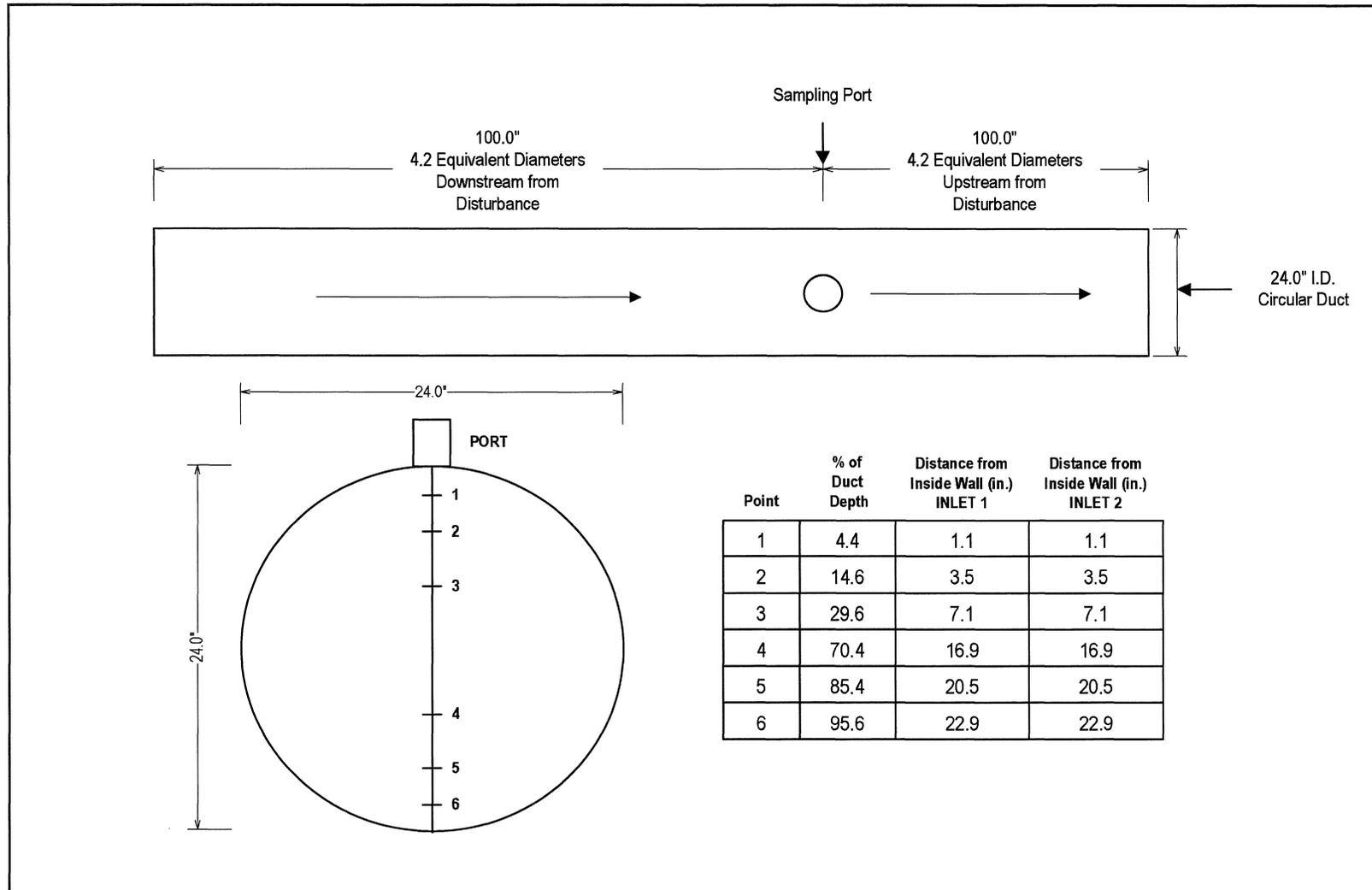
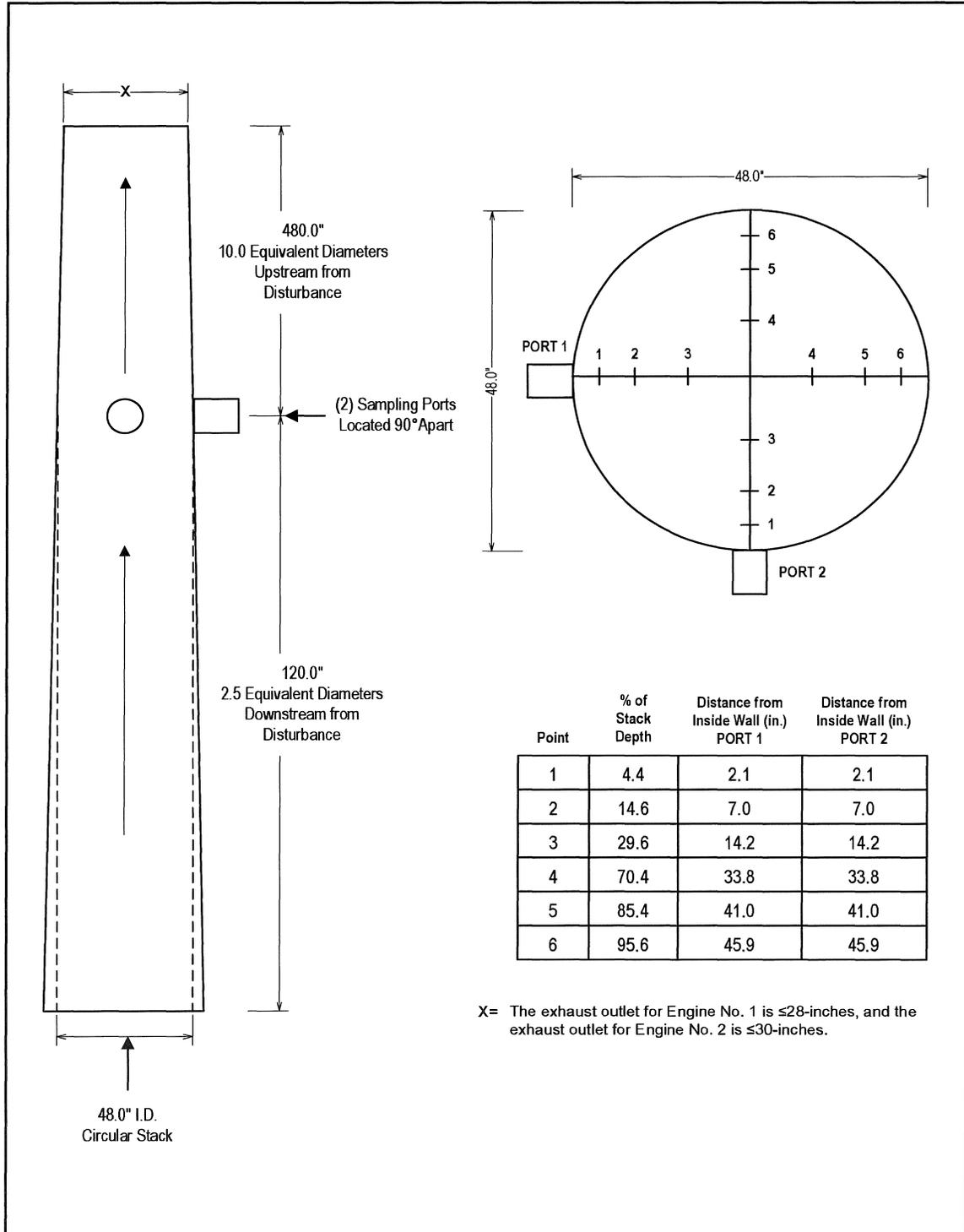


FIGURE 3.3
ENGINES No. 1 and No. 2 CAT-OX OUTLET TRAVERSE POINT LOCATION DRAWING



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 O₂ and CO₂ 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)"

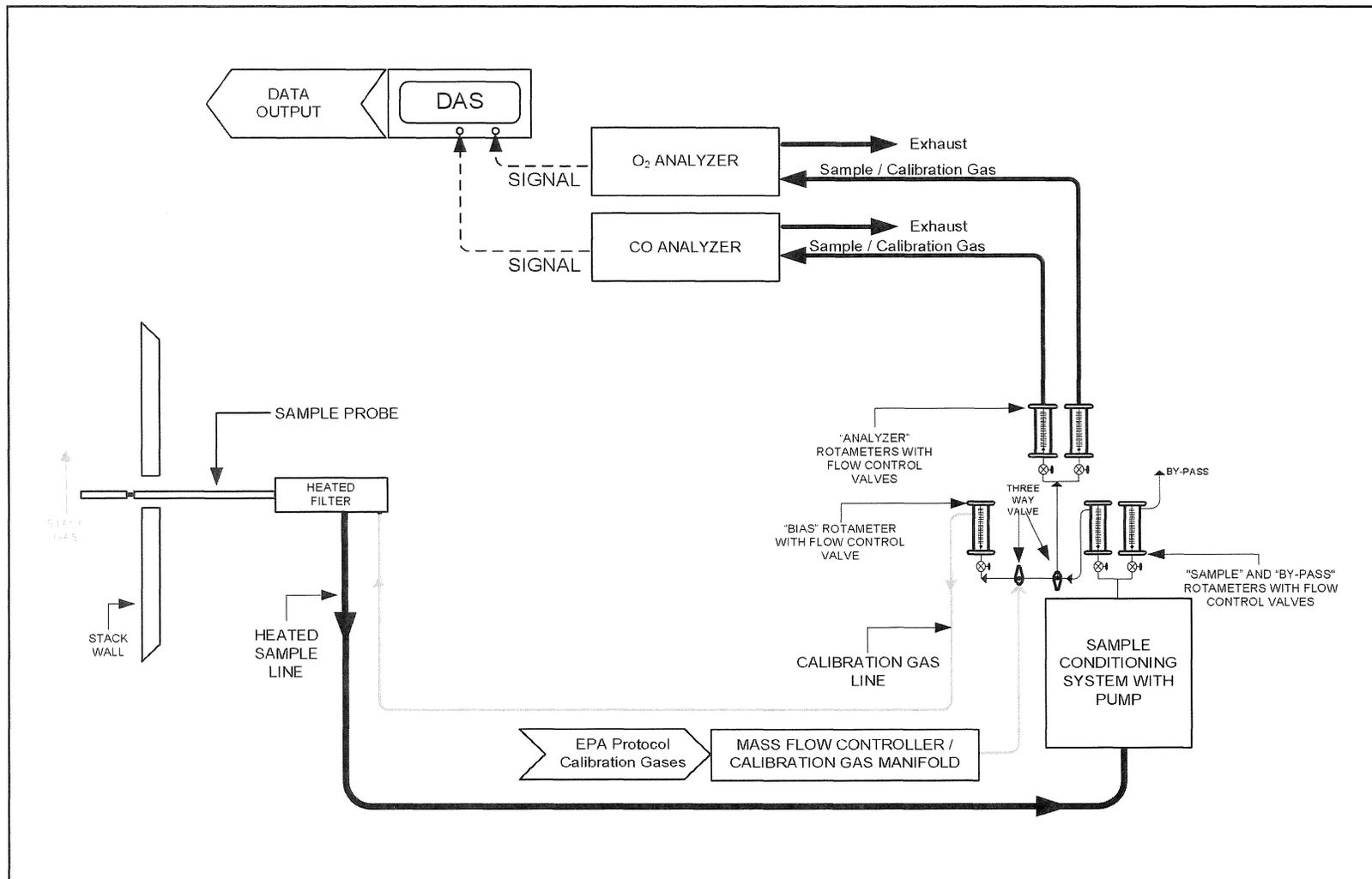
Principle: A gas sample is continuously extracted from the effluent stream. A portion of the sample stream is conveyed to an instrumental analyzer for determination of CO concentration. Performance specifications and test procedures are provided to ensure reliable data. This method was utilized in its 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 - Water 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



5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA AUDITS

Tables 5.1.1 to 5.5 illustrate the QA audits that were performed during this test.

Tables 5.1.1 to 5.4.2 illustrate the O₂ 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 $\pm 3\%$ of span for the Zero and Calibration Drift Checks, $\pm 5\%$ of span for the System Calibration Bias Checks, and $\pm 2\%$ of span for the Calibration Error Checks.

Table 5.5 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 $\pm 2\%$ of the predicted value. The average concentration output of the mid-level gas was also within $\pm 2\%$ 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 (O₂) ANALYZER CALIBRATION AND QA**

Engine No. 1 CAT-OX Inlet Ducts						
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 (%)	0.01	N/A	0.02	N/A	0.02	N/A
Final System Calibration Response for Zero Gas (%)	0.02	N/A	0.02	N/A	0.01	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 (%)	9.98	N/A	9.97	N/A	10.00	N/A
Final System Calibration Response for Upscale Gas (%)	9.97	N/A	10.00	N/A	9.95	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	-0.20	YES	-0.15	YES	-0.15	YES
Final System Calibration Bias for Zero Gas (% of Span)	-0.15	YES	-0.15	YES	-0.20	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-0.55	YES	-0.60	YES	-0.45	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.60	YES	-0.45	YES	-0.70	YES
System Drift for Zero Gas (% of Span)	0.05	YES	0.00	YES	-0.05	YES
System Drift for Upscale Gas (% of Span)	-0.05	YES	0.15	YES	-0.25	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.25	YES	0.25	YES	0.25	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.25	YES	0.25	YES	0.25	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.20	YES	0.20	YES	0.20	YES

**TABLE 5.1.2
 US EPA METHOD 10 ANALYZER CALIBRATION AND QA**

Engine No. 1 CAT-OX Inlet Ducts						
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)	2.89	N/A	2.47	N/A	2.49	N/A
Final System Calibration Response for Zero Gas (ppm)	2.47	N/A	2.49	N/A	2.46	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)	497	N/A	497	N/A	495	N/A
Final System Calibration Response for Upscale Gas (ppm)	497	N/A	495	N/A	497	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.24	YES	0.20	YES	0.20	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.20	YES	0.20	YES	0.20	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.54	YES	0.53	YES	0.35	YES
Final System Calibration Bias for Upscale Gas (% of Span)	0.53	YES	0.35	YES	0.52	YES
System Drift for Zero Gas (% of Span)	-0.04	YES	0.00	YES	0.00	YES
System Drift for Upscale Gas (% of Span)	-0.02	YES	-0.18	YES	0.17	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.05	YES	0.05	YES	0.05	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)	0.14	YES	0.14	YES	0.14	YES

**TABLE 5.2.1
 US EPA METHOD 3A (O₂) 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	20.2	YES	20.1	YES
Initial System Calibration Response for Zero Gas (%)	0.18	N/A	0.20	N/A	0.20	N/A
Final System Calibration Response for Zero Gas (%)	0.20	N/A	0.20	N/A	0.20	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 (%)	10.13	N/A	10.18	N/A	10.14	N/A
Final System Calibration Response for Upscale Gas (%)	10.18	N/A	10.14	N/A	10.15	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.60	YES	0.69	YES	0.70	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.70	YES	0.69	YES	0.70	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.10	YES	0.35	YES	0.15	YES
Final System Calibration Bias for Upscale Gas (% of Span)	0.35	YES	0.15	YES	0.20	YES
System Drift for Zero Gas (% of Span)	0.10	YES	0.00	YES	0.00	YES
System Drift for Upscale Gas (% of Span)	0.25	YES	-0.20	YES	0.05	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.30	YES	0.30	YES	0.30	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.35	YES	0.35	YES	0.35	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.40	YES	-0.10	YES	0.40	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)	0.94	N/A	0.93	N/A	1.10	N/A
Final System Calibration Response for Zero Gas (ppm)	0.93	N/A	1.10	N/A	1.18	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	101	N/A	100	N/A
Final System Calibration Response for Upscale Gas (ppm)	101	N/A	100	N/A	100	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	-0.93	YES	-0.94	YES	-0.85	YES
Final System Calibration Bias for Zero Gas (% of Span)	-0.94	YES	-0.85	YES	-0.81	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-1.24	YES	-0.51	YES	-0.96	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.51	YES	-0.96	YES	-1.09	YES
System Drift for Zero Gas (% of Span)	-0.01	YES	0.09	YES	0.04	YES
System Drift for Upscale Gas (% of Span)	0.73	YES	-0.45	YES	-0.13	YES
Analyzer Calibration Error for Zero Gas (% of Span)	1.43	YES	1.43	YES	1.43	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	1.18	YES	1.18	YES	1.18	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.15	YES	0.15	YES	0.15	YES

**TABLE 5.3.1
 US EPA METHOD 3A (O₂) ANALYZER CALIBRATION AND QA**

Engine No. 2 CAT-OX Inlet Ducts						
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 (%)	0.18	N/A	0.04	N/A	0.05	N/A
Final System Calibration Response for Zero Gas (%)	0.04	N/A	0.05	N/A	0.01	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 (%)	10.10	N/A	10.00	N/A	9.99	N/A
Final System Calibration Response for Upscale Gas (%)	10.00	N/A	9.99	N/A	9.98	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.65	YES	-0.05	YES	0.00	YES
Final System Calibration Bias for Zero Gas (% of Span)	-0.05	YES	0.00	YES	-0.20	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.05	YES	-0.45	YES	-0.50	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-0.45	YES	-0.50	YES	-0.55	YES
System Drift for Zero Gas (% of Span)	-0.70	YES	0.05	YES	-0.20	YES
System Drift for Upscale Gas (% of Span)	-0.50	YES	-0.05	YES	-0.05	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.25	YES	0.25	YES	0.25	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.25	YES	0.25	YES	0.25	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.20	YES	0.20	YES	0.20	YES

**TABLE 5.3.2
 US EPA METHOD 10 ANALYZER CALIBRATION AND QA**

Engine No. 2 CAT-OX Inlet Ducts						
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)	2.45	N/A	2.74	N/A	2.42	N/A
Final System Calibration Response for Zero Gas (ppm)	2.74	N/A	2.42	N/A	2.89	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	498	N/A	499	N/A
Final System Calibration Response for Upscale Gas (ppm)	498	N/A	499	N/A	497	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.20	YES	0.23	YES	0.19	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.23	YES	0.19	YES	0.24	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	0.62	YES	0.66	YES	0.68	YES
Final System Calibration Bias for Upscale Gas (% of Span)	0.66	YES	0.68	YES	0.54	YES
System Drift for Zero Gas (% of Span)	0.03	YES	-0.03	YES	0.05	YES
System Drift for Upscale Gas (% of Span)	0.04	YES	0.03	YES	-0.14	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.05	YES	0.05	YES	0.05	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)	0.14	YES	0.14	YES	0.14	YES

**TABLE 5.4.1
 US EPA METHOD 3A (O₂) ANALYZER CALIBRATION AND QA**

Engine No. 2 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 (%)	0.19	N/A	0.18	N/A	0.18	N/A
Final System Calibration Response for Zero Gas (%)	0.18	N/A	0.18	N/A	0.18	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	10.11	N/A	10.13	N/A
Final System Calibration Response for Upscale Gas (%)	10.11	N/A	10.13	N/A	10.13	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.65	YES	0.60	YES	0.60	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.60	YES	0.60	YES	0.60	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-0.10	YES	0.00	YES	0.10	YES
Final System Calibration Bias for Upscale Gas (% of Span)	0.00	YES	0.10	YES	0.10	YES
System Drift for Zero Gas (% of Span)	-0.05	YES	0.00	YES	0.00	YES
System Drift for Upscale Gas (% of Span)	0.10	YES	0.10	YES	0.00	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.30	YES	0.30	YES	0.30	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	0.35	YES	0.35	YES	0.35	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.40	YES	0.40	YES	0.40	YES

**TABLE 5.4.2
 US EPA METHOD 10 ANALYZER CALIBRATION AND QA**

Engine No. 2 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)	2.29	N/A	1.25	N/A	1.03	N/A
Final System Calibration Response for Zero Gas (ppm)	1.25	N/A	1.03	N/A	0.94	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)	99	N/A	100	N/A	101	N/A
Final System Calibration Response for Upscale Gas (ppm)	100	N/A	101	N/A	100	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	-0.22	YES	-0.77	YES	-0.88	YES
Final System Calibration Bias for Zero Gas (% of Span)	-0.77	YES	-0.88	YES	-0.93	YES
Initial System Calibration Bias for Upscale Gas (% of Span)	-1.73	YES	-1.07	YES	-0.88	YES
Final System Calibration Bias for Upscale Gas (% of Span)	-1.07	YES	-0.88	YES	-1.24	YES
System Drift for Zero Gas (% of Span)	-0.55	YES	-0.12	YES	-0.05	YES
System Drift for Upscale Gas (% of Span)	0.66	YES	0.19	YES	-0.36	YES
Analyzer Calibration Error for Zero Gas (% of Span)	1.43	YES	1.43	YES	1.43	YES
Analyzer Calibration Error for Mid-Level Gas (% of Span)	1.18	YES	1.18	YES	1.18	YES
Analyzer Calibration Error for High-Level Gas (% of Span)	0.15	YES	0.15	YES	0.15	YES

**TABLE 5.5
 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