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TEST RESULTS SUMMARY

Source Name:	**Natural Gas-Fired Turbine**
Source ID Number:	**EUTURBINE1**
Control Device:	**Dry Low NO_x Burners**
Test Date:	**May 29, 2019**
Sampling Location:	**Turbine Exhaust Duct**
Natural Gas Flowrates (MSCF/Day)*	**1.97**
NO_x Concentration (ppm)†	**7.03**
Permit Limit - NO_x ppm †	25
Emission Results Below Permit Limit	*YES*
Permit No.	**EGLE ROP No. MI-ROP-N8151-2016**

* Production data was supplied by Vector Pipeline L.P. - Athens Compressor Station personnel.

† Corrected to 15% Oxygen

REVIEW AND CERTIFICATION

The results of the Compliance Test conducted on May 29, 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: _____ pp. Date: 7-11-19

Name: Mason Sakshaug Title: Field 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: 7-11-19

Name: Randal Tysar Title: District Manager

1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

The Vector Pipeline L.P. - Athens Compressor Station (Facility ID: N8151), located in Athens, Michigan, contracted Montrose Air Quality Services, LLC (Montrose) of Detroit, Michigan, to conduct compliance stack emission testing for their Natural Gas-Fired Turbine (EUTURBINE1). 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-N6838-2016. Testing was performed on May 29, 2019.

Sampling was performed at the Turbine Exhaust Duct to measure the concentration of nitrogen oxides (NO_x) ppmvd corrected to 15% Oxygen (O_2). Testing was conducted during operations within ±25 percent of 100 percent peak load. During this test emissions from the turbine were controlled using dry low NO_x emission control (SoLoNOx) technology.

The test methods that were conducted during this test were US EPA Methods 3A and 7E.

1.2 KEY PERSONNEL

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

- James Snider, Environmental Specialist, Vector Pipeline, 218-269-0591
- Mason Sakshaug QI, Field Project Manager, Montrose, 989-323-0355

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 NO_x at the Turbine Exhaust Duct during operations within ±25 percent of 100 percent peak load. Testing was performed to satisfy the emissions testing requirements pursuant to EGLE Renewable Operating Permit No. MI-ROP-N6838-2016.

The specific test objectives for this test were as follows:

- Measure the concentration of O_2 and NO_x at the Turbine Exhaust Duct.
- Utilize the above variables to determine the concentration of NO_x (ppm) corrected to 15% O_2 at the Turbine Exhaust Duct during operations within ±25 percent of 100 percent peak load.

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

A single sampling train was utilized during each run at the Turbine Exhaust Duct to determine the concentration of NO_x ppmvd corrected to 15% O_2. This sampling train measured the duct gas concentrations of O_2 and NO_x.

Table 2.2 displays the concentration of NO_x ppmvd corrected to 15% O_2 measured at the Turbine Exhaust Duct during operations within ±25 percent of 100 percent peak load.

Table 2.3 displays the results of the Stratification Test performed during Run 1 at the Turbine Exhaust Duct. As displayed, the difference between the individual diluent concentrations and the mean concentration met the Stratification Acceptance Criteria as specified in US EPA Method 7E, Section 8.1.2. For subsequent runs, a single point was utilized to perform sampling.

The graphs that present the raw, uncorrected concentration data measured in the field by the US EPA Method 3A and 7E sampling systems at the Turbine Exhaust Duct are located in the Field Data section of the Appendix.

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 7E (NO_x) Sampling Time / Duration (min)
5/29/2019	1	Turbine Exhaust Duct	8:08 - 8:48 / 40	8:08 - 8:48 / 40
5/29/2019	2	Turbine Exhaust Duct	8:58 - 9:18 / 20	8:58 - 9:18 / 20
5/29/2019	3	Turbine Exhaust Duct	9:27 - 9:47 / 20	9:27 - 9:47 / 20

All times are Eastern Daylight Time.

TABLE 2.2
EMISSION RESULTS

Parameter	Turbine Exhaust Duct			
	Run 1	Run 2	Run 3	Average
Nitrogen Oxides Concentration Corrected to 15% O_2 (ppmvd)	7.01	7.01	7.05	7.03
Nitrogen Oxides Concentration (ppmvd)	16.6	16.8	17.0	16.8
Percent by Volume Oxygen in Stack Gas (%-dry)	6.93	6.76	6.71	6.80
Measured Stack Inner Dimensions (in)†		91.0		

* Process data was provided by Vector Pipeline LP personnel.
† The Turbine Exhaust Duct was rectangular in shape.

TABLE 2.3
12-POINT STRATIFICATION TEST

	DURATION	OXYGEN	
	PASS	MINIMUM SINGLE POINT TRAVERSE	Difference from Mean
Point Number	(min)	(%)	(%)
1	2.0	15.80	0.33
2	2.0	15.80	0.33
3	2.0	15.80	0.33
4	2.0	15.80	0.33
5	2.0	15.90	0.23
6	2.0	16.00	0.13
7	2.0	16.10	0.03
8	2.0	16.30	-0.17
9	2.0	16.30	-0.17
10	2.0	16.30	-0.17
11	2.0	16.35	-0.22
12	2.0	16.30	-0.17
13	2.0	16.40	-0.27
14	2.0	16.40	-0.27
15	2.0	16.40	-0.27
	Mean	16.13	

3.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

3.1 PROCESS DESCRIPTION AND OPERATION

Vector Pipeline L.P. - Athens Compressor Station operates a 120 MMBtu/hr natural gas-fired turbine. The turbine was in operation for this test event.

The turbine is equipped with two separate shafts. The first shaft controls the speed of the compressor turbine (i.e., the NGP), and the second shaft controls the speed of power turbine and natural gas compressor. The turbine can be regulated in terms of turbine load as well as power turbine and NGP rotational speeds.

Figure 3.1 depicts the sampling location schematic.

3.2 CONTROL EQUIPMENT DESCRIPTION

During this test, emissions from the turbine were controlled using SoLoNOx technology.

3.3 SAMPLING LOCATION(S)

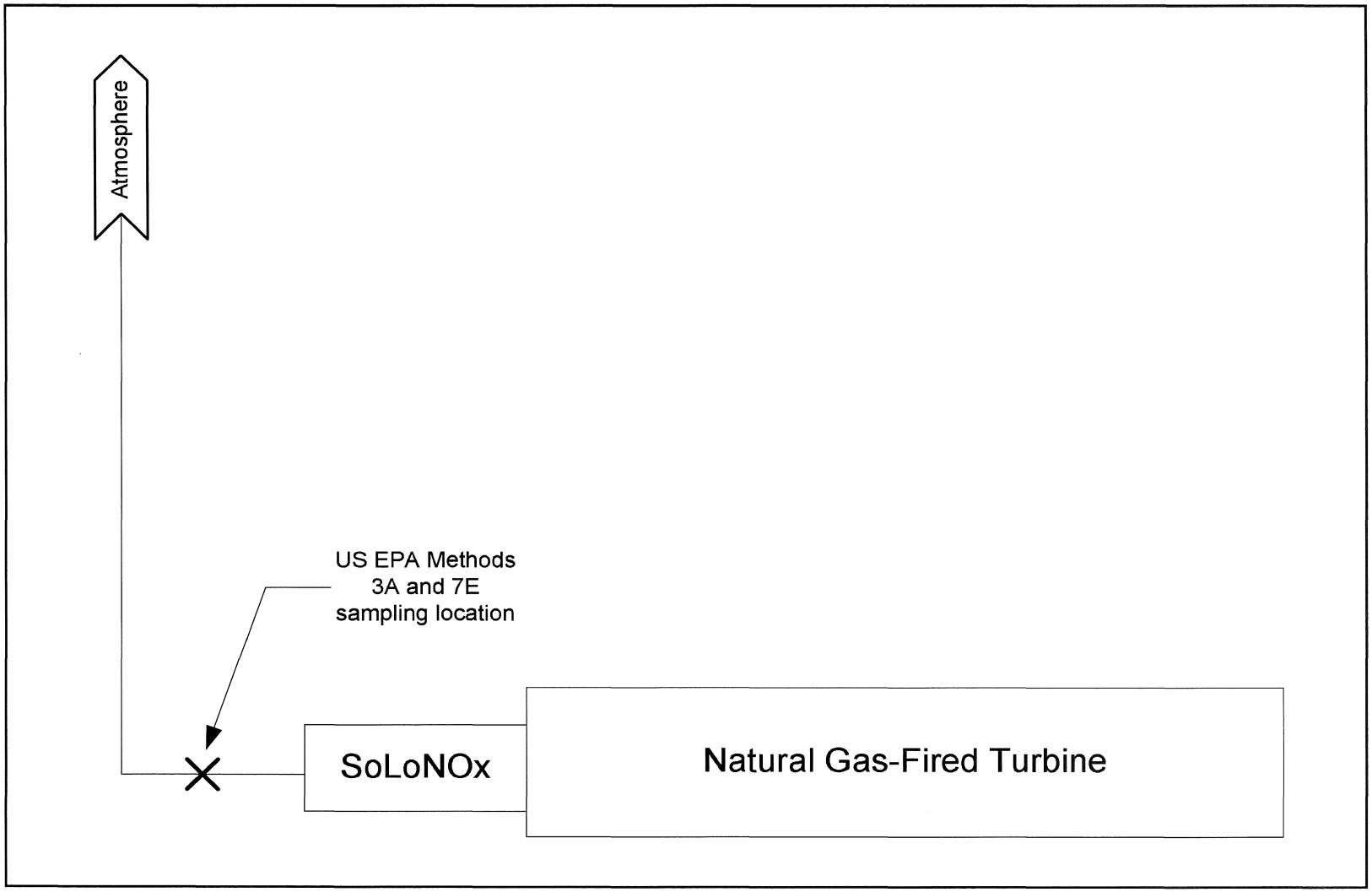
The Turbine Exhaust Duct was rectangular in shape with a measured width and depth of 91.0-inches. The duct was oriented in the horizontal plane and was accessed from the ground. Five sampling ports were located equidistant from one another at a location that met US EPA Method 1, Section 11.1.1 criteria. During Run 1 emissions sampling, a stratification test was performed; and three of the duct sampling ports were traversed for duct gas O_2 and NO_x concentration determinations. During emission sampling for the remainder of the runs at the Turbine Exhaust Duct, a single point was used for duct gas O_2 and NO_x concentration determinations.

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
NATURAL GAS-FIRED TURBINE SAMPLING LOCATION SCHEMATIC



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 7E: "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)"

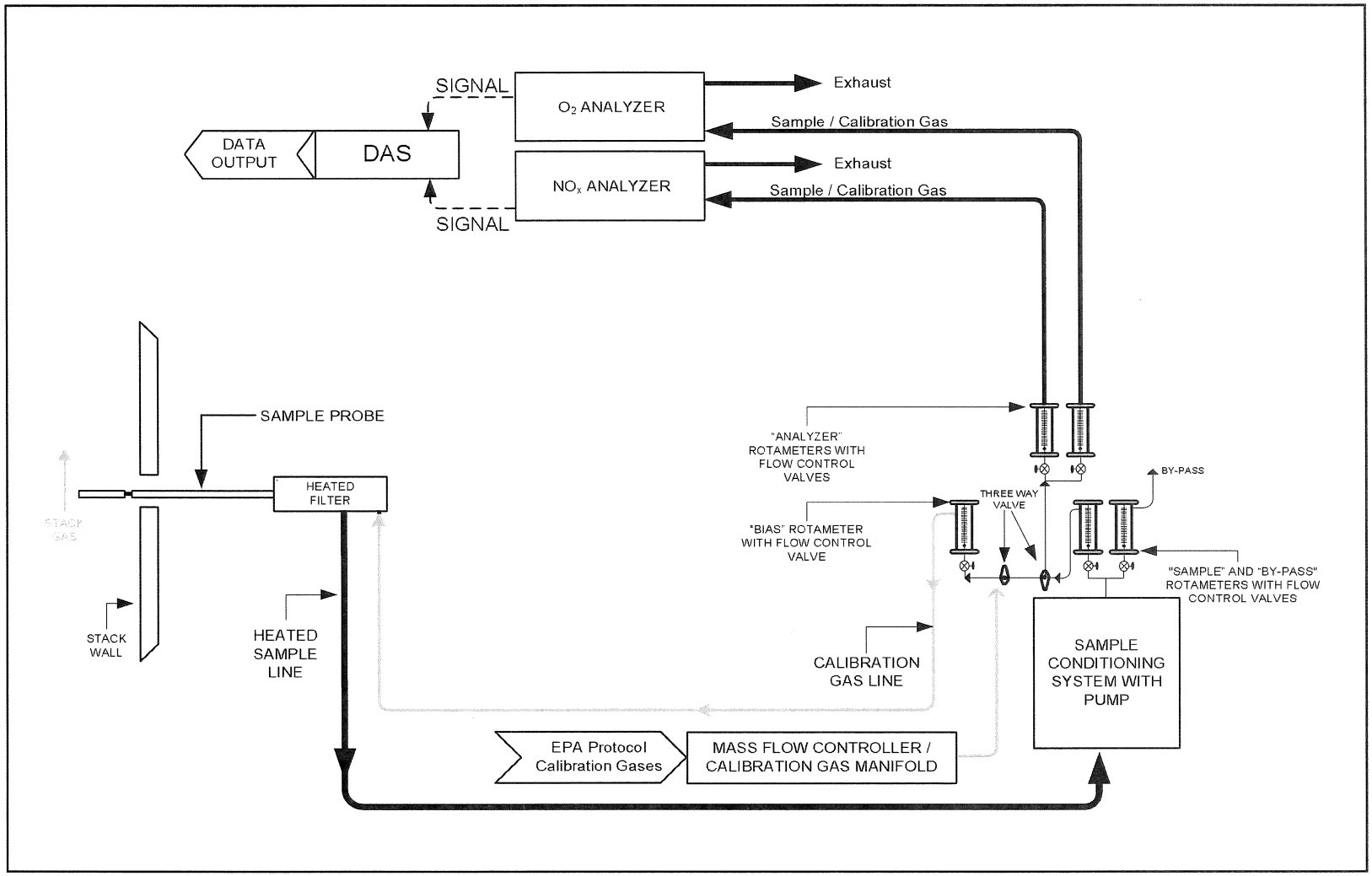
Principle: A gas sample is continuously extracted from the effluent stream. A portion of the sample stream is conveyed to an instrumental analyzer for the determination of NO_x concentration. NO and NO_2 may be measured separately or simultaneously. For the purposes of this method, NO_x is the sum of NO and NO_2. 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 Vector Pipeline L.P. - Athens Compressor Station 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 METHOD 3A and 7E SAMPLING TRAIN SCHEMATIC



5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA AUDITS

Tables 5.1 to 5.3 illustrate the QA audits that were performed during this test.

Tables 5.1 and 5.2 illustrate the O_2 and NO_x calibration audits which were performed during this test (and integral to performing US EPA Method 3A and 7E 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 NO_2 to NO converter efficiency check. The converter efficiency check was conducted as per the procedures contained in US EPA Method 7E, Section 8.2.4.1 which requires a conversion of at least 90%. As shown an average converter efficiency of 91.02% was achieved for the NO_x analyzer utilized at the Turbine Exhaust Duct.

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 3A (O_2) ANALYZER CALIBRATION AND QA

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 (%)	0.03	N/A	0.03	N/A	0.05	N/A
Final System Calibration Response for Zero Gas (%)	0.03	N/A	0.05	N/A	0.03	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	10.06	N/A	10.03	N/A
Final System Calibration Response for Upscale Gas (%)	10.06	N/A	10.03	N/A	10.06	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.15	YES	0.15	YES	0.25	YES
Final System Calibration Bias for Zero Gas (% of Span)	0.15	YES	0.25	YES	0.15	YES
tial System Calibration Bias for Upscale Gas (% of Span)	-0.30	YES	-0.40	YES	-0.55	YES
nal System Calibration Bias for Upscale Gas (% of Span)	-0.40	YES	-0.55	YES	-0.40	YES
System Drift for Zero Gas (% of Span)	0.00	YES	0.10	YES	-0.10	YES
System Drift for Upscale Gas (% of Span)	-0.10	YES	-0.15	YES	0.15	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.00	YES	0.00	YES	0.00	YES
nalyzer Calibration Error for Mid-Level Gas (% of Span)	0.50	YES	0.50	YES	0.50	YES
nalyzer Calibration Error for High-Level Gas (% of Span)	0.40	YES	0.40	YES	0.40	YES

TABLE 5.2
US EPA METHOD 7E ANALYZER CALIBRATION AND QA

NITROGEN OXIDES ANALYZER	RUN 1	Acceptable	RUN 2	Acceptable	RUN 3	Acceptable
Analyzer Span During Test Run (ppm)	50	YES	50	YES	50	YES
Initial System Calibration Response for Zero Gas (ppm)	0.0	N/A	0.0	N/A	0.0	N/A
Final System Calibration Response for Zero Gas (ppm)	0.0	N/A	0.0	N/A	0.0	N/A
ctual Concentration of the Upscale Calibration Gas (ppm)	25.4	N/A	25.4	N/A	25.4	N/A
itial System Calibration Response for Upscale Gas (ppm)	24.3	N/A	25.1	N/A	24.2	N/A
nal System Calibration Response for Upscale Gas (ppm)	25.1	N/A	24.2	N/A	24.6	N/A
Initial System Calibration Bias for Zero Gas (% of Span)	0.00	YES	-0.02	YES	0.04	YES
Final System Calibration Bias for Zero Gas (% of Span)	-0.02	YES	0.04	YES	-0.02	YES
tial System Calibration Bias for Upscale Gas (% of Span)	-1.26	YES	0.30	YES	-1.47	YES
nal System Calibration Bias for Upscale Gas (% of Span)	0.30	YES	-1.47	YES	-0.70	YES
System Drift for Zero Gas (% of Span)	-0.02	YES	0.06	YES	-0.06	YES
System Drift for Upscale Gas (% of Span)	1.55	YES	-1.77	YES	0.78	YES
Analyzer Calibration Error for Zero Gas (% of Span)	0.02	YES	0.02	YES	0.02	YES
nalyzer Calibration Error for Mid-Level Gas (% of Span)	-0.94	YES	-0.88	YES	-0.88	YES
nalyzer Calibration Error for High-Level Gas (% of Span)	-0.04	YES	-0.04	YES	-0.04	YES

TABLE 5.3
US EPA METHOD 7E NO_x CONVERTER CHECK

Date / Time	Certified Cylinder Concentration (ppm NO_2)	Analyzer Concentration (ppm NO_x)	Conversion Efficiency (%)	Required Conversion Efficiency (%)	Acceptable
5/29/2019 10:32	49.68	45.22	91.02	90.00	Yes

Analyzer Serial Number: 42CHL-62301-334
Cylinder Number: CC501876