



Results of the March 6, 2024, Oxides of Nitrogen and Carbon Monoxide Emission Testing Performed on the Gas Turbines at the Vector Pipeline, L.P. – Highland Compressor Station Located in Highland, Michigan

Natural Gas Fired Turbines EUTURBINE 1 & 2

Facility Permit Number: MI-ROP-N6838-2019

State Registration Number: N6838

Barr Project Number: 13981050.24

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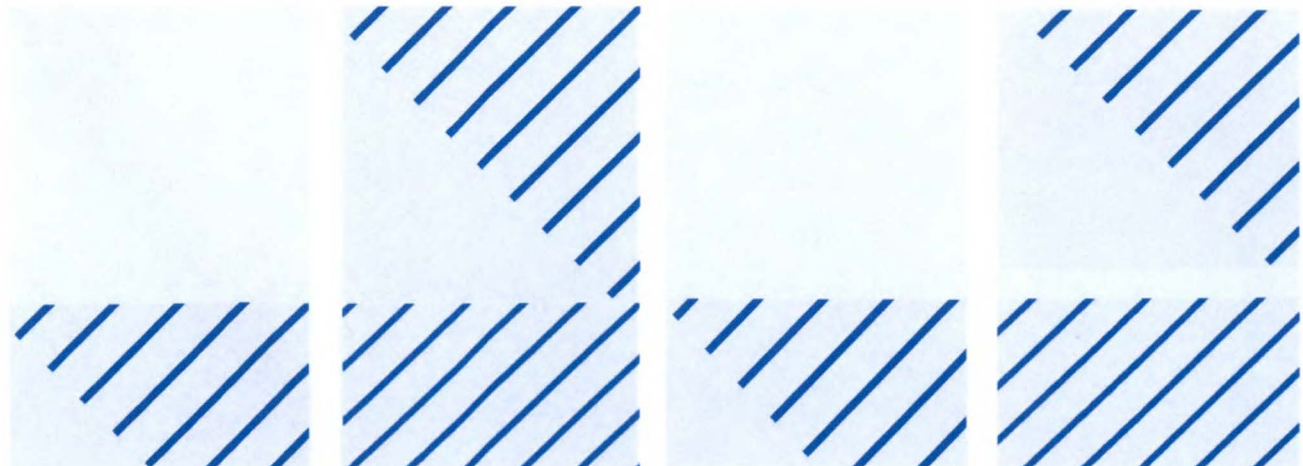
Prepared for
Vector Pipeline, L.P.

Prepared by
Barr Engineering Co.

April 2024

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Certification

Certification of Sampling Procedures:

I certify under penalty of law that the sampling procedures were performed in accordance with the approved test plan and that the data presented in this test report are, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below

A handwritten signature in blue ink, appearing to read "John Rooney", is written over a horizontal line.

John Rooney
Sr. Air Quality Engineer
Barr Engineering Co.

04/15/2024

Date

Certification of Test Report by Testing Company:

I certify under penalty of law that this test report and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the test information submitted. Based on my inquiry of the person or persons who performed sampling and analysis relating to the performance test, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below.

A handwritten signature in blue ink, appearing to read "Tom Kuchinski", is written over a horizontal line.

Tom Kuchinski
Stack Test Service Coordinator
Vice President
Barr Engineering Co.

04/15/2024

Date



Certification of Test Report by Owner or Operator of Emission Facility:

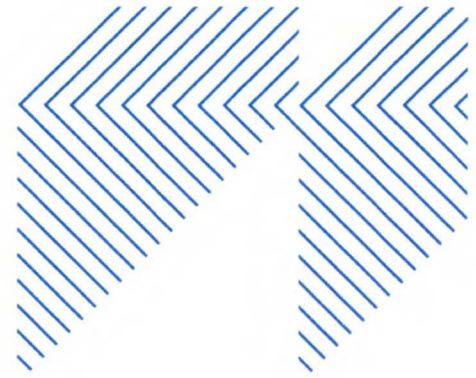
I certify under penalty of law that the information submitted in this test report accurately reflects the operating conditions at the emission facility during this performance test and describes the date and nature of all operational and maintenance activities that were performed on the process and control equipment during the month prior to the performance test. Based on my inquiry of the person or persons who performed the operational and maintenance activities, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below.

Amy J Back

Amy Back
General Counsel, Chief Compliance Office
Vector Pipeline, L.P.

4/16/2024

Date



Results of the March 6, 2024, Oxides of Nitrogen and Carbon Monoxide Emission Testing Performed on the Gas Turbines at the Vector Pipeline, L.P. – Highland Compressor Station Located in Highland, Michigan

April 2024

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Executive Summary

Barr Engineering Co. (Barr) performed emissions testing at the Vector Pipeline, L.P. - Highland Compressor Station (Vector) located in Highland, Michigan. Testing was completed for oxygen (O₂), oxides of nitrogen (NO_x), and carbon monoxide (CO) at the Natural Gas Fired Turbine exhaust stacks on March 6, 2024. The testing was completed as required in the facility permit number MI-ROP-N6838-2019 and 40 CFR Part 60 subpart GG. A summary of the test results and applicable limits is provided in the table below.

Table ES 1 Executive Summary Table

EPA Method 3A, 7E, 10, and 19	Average Test Results							
	EUTUBINE1				EUTURBINE2			
	March 6, 2024				March 6, 2024			
Test Date	March 6, 2024				March 6, 2024			
Rate, % NGP	90	94	98	103	90	94	98	103
Oxygen dry, %	16.7	16.1	15.9	15.6	16.7	16.1	15.9	15.6
NO _x ppm dry	37.2	8.8	6.7	7.0	37.2	8.8	6.7	7.0
NO _x lb/hr	8.25	7.22	7.42	14.99	14.77	3.73	3.07	3.54
NO_x Emission Rate Limit, lb/hr	18.95				18.95			
CO, ppm dry	2.7	0.3	0.3	42.8	58.3	0.3	0.3	0.4
CO, Emission Rate lb/hr	0.83	0.08	0.09	10.37	14.07	0.07	0.09	0.13
CO Emission Rate Limit, lb/hr	12.57	12.57	12.57	400	400	12.57	12.57	12.57

1 Introduction

Barr Engineering Co. (Barr) performed emissions testing at the Vector Pipeline, L.P. - Highland Compressor Station (Vector) located in Highland, Michigan. Testing was completed for oxygen (O₂), oxides of nitrogen (NO_x), and carbon monoxide (CO) at the Natural Gas Fired Turbine exhaust stack on March 6, 2024. The testing was completed as required in the facility permit number MI-ROP-N6838-2019 and 40 CFR Part 60 subpart GG.

A test plan was emailed to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on February 2, 2024. A copy of the test plan is provided in Appendix F.

Testing was performed by John Rooney of Barr. Alex Smith, Jennifer Brennan, and Matt DiPaola of Vector provided coordination of operations with the test team. The testing was witnessed by Owen Pierce and Andrew Riley of EGLE. A list of project participants is provided in Appendix G.

The Highland Compressor Station operates two natural gas turbines. The testing consisted of three 20-minute runs with each turbine operating at approximately 90%, 94%, 98% and 103% natural gas producer (NGP) speed. Results of the test are summarized in the next section. Supporting documentation and calculations are provided in the appendices.

2 Results

The results of the EUTURBINE1 testing are provided in Table 1. During the test, the NO_x emissions rate averaged 9.47 pounds per hour (lb/hr) which is below the permitted limit. The CO emission rate averaged 2.84 lb/hr which is below the permitted limit.

The results of the EUTURBINE2 testing are provided in Table 2. During the test, the NO_x emissions rate averaged 6.28 lb/hr which is below the permitted limit. The CO emission rate averaged 3.59 lb/hr which is below the permitted limit.

The NO_x emission rate was calculated using the site-specific fuel F-factor and fuel consumption rates. A fuel gas sample was collected and analyzed for determination of the heat content and F-factor. The fuel analysis was performed by SPL of Houston, Texas. Fuel gas calculations and analytical results can be found in Appendix A and E, respectively.

The instrument output recorded during the testing is provided in Appendix B. The compliance data recorded for each test run is highlighted by a gray box. Instrument calibration data recorded before and after the compliance test runs, including bias and drift checks, is also included in Appendix B with notes specifying the calibration or check being performed.

The emission unit was tested at the achievable loads, given pipeline and weather conditions, on the day of the test. No testing or operations difficulties were noted.

3 Process Description

The Vector pipeline is a strategic link in the transportation of natural gas produced in the Appalachian region and Western Canada. The pipeline-quality gas is transported within 36-inch and 42-inch pipelines for approximately 350 miles through Canada and the United States. The Pipeline route starts in Joliet, Illinois and runs through Indiana and Michigan before terminating in Dawn, Ontario, Canada. The pipeline has five compressor stations with a combined total horsepower of 120,000.

The Highland Compressor Station (located in Highland, Michigan) consists of two Solar Turbines model "Mars 100s" with rated capacities of 120 MMBtu/hr. The turbines act as a driver for the recompression of pipeline quality natural gas to the required pipeline pressure. The turbines are equipped with SoLoNOx technology for the control of NOx emissions. The turbine/compressor unit operation varies throughout the year as pressure load requirements fluctuate.

Process data and sample gas analysis information are provided in Appendix E.

4 Stack Testing Procedures and Methods

Testing was performed in the exhaust ducts of the turbines. A test location site diagram (identical for both turbines) is provided in Figure 1.

A twelve-point stratification check was performed that exhibited less than five percent difference from the average concentration for NO_x corrected to 15% O₂ for both turbines. Testing was performed from a single point near the center of the ductwork. The traverse point locations are shown in Figure 2.

Oxygen concentrations were determined with a Servomex 1440 analyzer. The instrument was calibrated per EPA Method 3A specifications. All calibration data is provided in Appendix C and the calibration gas certifications are provided in Appendix D.

A Teledyne API NO_x analyzer Model 200H was used for the determination of NO_x on dry basis. The instrument was calibrated per EPA Method 7E criteria. A nitrogen dioxide (NO₂) converter test was performed prior to testing and the converter efficiency met the requirement of greater than 90 percent.

A Thermo Model 48i analyzer was used to measure CO concentrations on a dry basis. The instrument was calibrated per EPA Method 10 criteria.

EPA Method 19 was used to calculate an oxygen-based fuel factor for the natural gas, as well as emissions in units of pounds per hour (lb/hr).

The sample system consisted of a heated probe of sufficient length for the stack connected to a heated filter. The sample gas was transported to the test trailer through heated Teflon tubing via a vacuum pump to a thermoelectric condenser which removed moisture in the sample gas. The sample gas was directed to the analyzers with a bypass of excess sample to atmosphere. The analyzer readings were recorded with a data logger which reads every second and averages the data in 1-minute values, and these 1-minute values are provided in Appendix B.

The analyzers were calibrated directly to demonstrate linearity using EPA protocol 1 calibration gases in accordance with respective method criteria. A low (zero nitrogen) and upscale gas for each pollutant was then introduced at the probe to demonstrate acceptable system bias. Post run(s) system bias and drift determinations were made. All method criteria were met for this test.

Tables

Vector Pipeline, L.P.
Highland Compressor Station
Highland, Michigan

Barr Engineering Co.
April 02, 2024

TABLE 1
GASEOUS POLLUTANT TEST RESULTS SUMMARY
EUTURBINE1 (SVTURBINE1)

Parameter	Test 1 Average	Test 2 Average	Test 3 Average	Test 4 Average	All Test Average
Turbine Load Condition	103% NGP	98% NGP	94% NGP	90% NGP	--
Test Run Numbers	1 - 3	4 - 6	7 - 9	10 - 12	--
Test Date	3/6/2024	3/6/2024	3/6/2024	3/6/2024	--
Test Period	0820 - 0931	0945 - 1045	1102 - 1202	1221 - 1321	--
EPA Method 3A Results					
O ₂ Concentration, % dry	15.7	15.9	16.1	16.8	16.1
EPA Method 7E Results					
NO _x Concentration, ppm dry	16.7	15.6	17.2	37.6	21.8
NO _x Emission Rate, lb/hr	8.25	7.22	7.42	14.99	9.47
EPA Method 10 Results					
CO Concentration, ppm dry	2.7	0.3	0.3	42.8	11.5
CO Emission Rate, lb/hr	0.83	0.08	0.09	10.37	2.84

Vector Pipeline, L.P.
Highland Compressor Station
Highland, Michigan

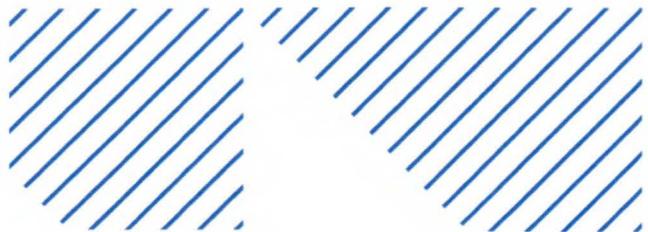
Barr Engineering Co.
April 02, 2024

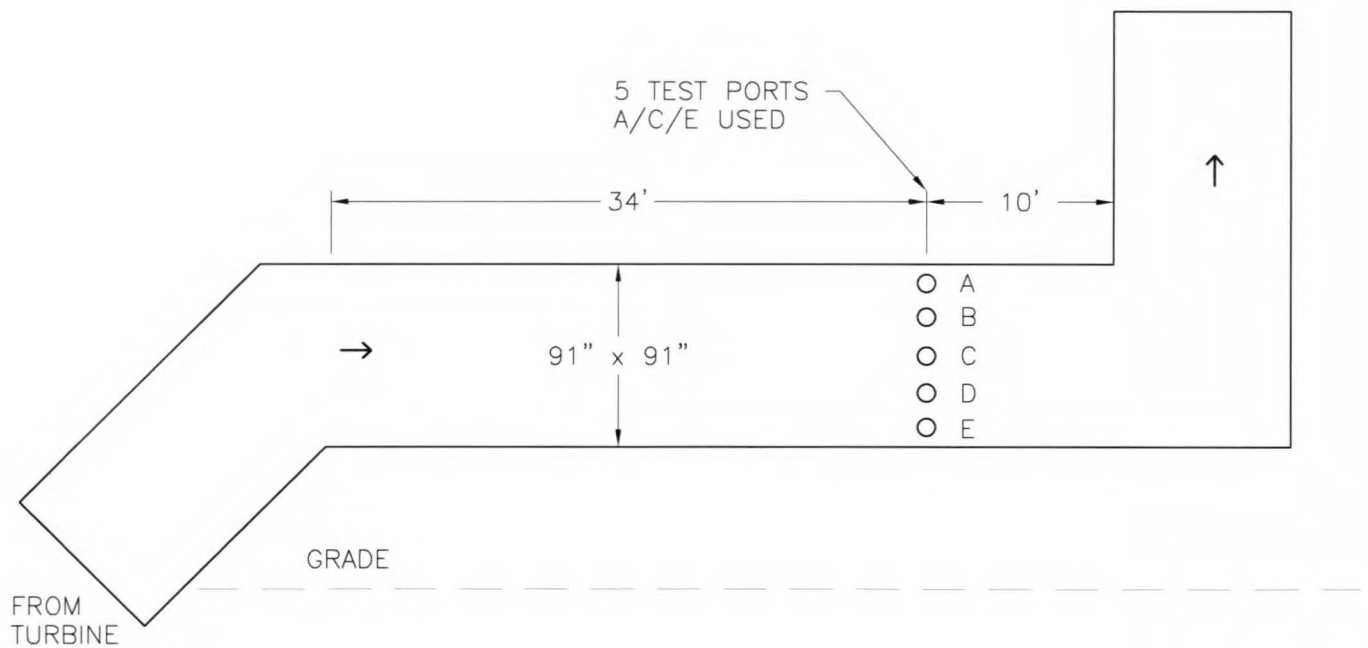
TABLE 2
GASEOUS POLLUTANT TEST RESULTS SUMMARY
EUTURBINE2 (SVTURBINE2)

Parameter	Test 1 Average	Test 2 Average	Test 3 Average	Test 4 Average	All Test Average
Turbine Load Condition	90% NGP	94% NGP	98% NGP	103% NGP	--
Test Run Numbers	1 - 3	4 - 6	7 - 9	10 - 12	--
Test Date	3/6/2024	3/6/2024	3/6/2024	3/6/2024	--
Test Period	1400 - 1555	1609 - 1709	1735 - 1835	1901 - 2001	--
EPA Method 3A Results					
O ₂ Concentration, % dry	16.7	16.1	15.9	15.6	16.1
EPA Method 7E Results					
NO _x Concentration, ppm dry	37.2	8.8	6.7	7.0	14.9
NO _x Emission Rate, lb/hr	14.77	3.73	3.07	3.54	6.28
EPA Method 10 Results					
CO Concentration, ppm dry	58.3	0.3	0.3	0.4	14.8
CO Emission Rate, lb/hr	14.07	0.07	0.09	0.13	3.59



Figures

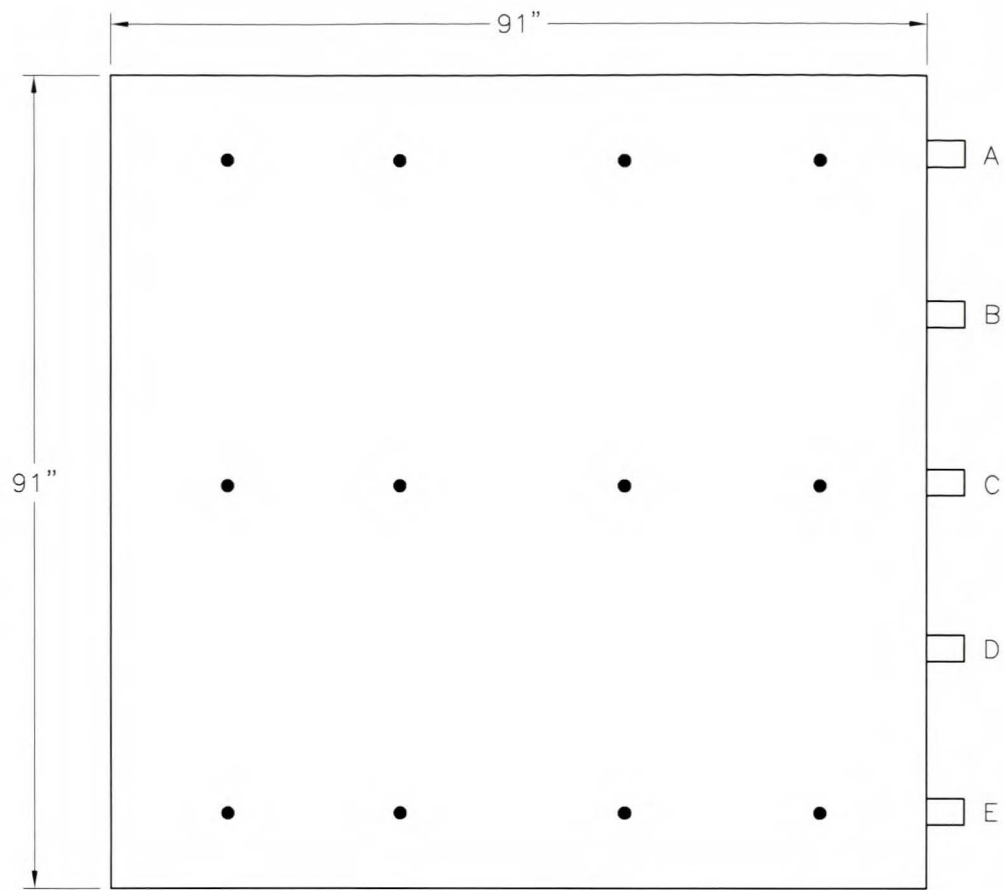




TEST PORT LOCATIONS
VECTOR PIPELINE, L.P.
HIGHLAND COMPRESSOR STATION
HIGHLAND, MICHIGAN
EUTURBINE1 & EUTURBINE2 (SVTURBINE1 & SVTURBINE2)

NOT TO SCALE

FIGURE 1



NO. OF TEST PORTS	5, 3 USED
PORT LENGTH	4.0"
PORT DIAMETER	4.0"
NO. OF TRAVERSE POINTS	12
DUCT DIAMETER	91" x 91"

● SAMPLE POINTS

POINT	INSERTION DEPTH IN "
1	11.4
2	34.1
3	56.9
4	79.6

TRAVERSE POINT LOCATIONS
 VECTOR PIPELINE, L.P.
 HIGHLAND COMPRESSOR STATION
 HIGHLAND, MICHIGAN
 EUTURBINE1 & EUTURBINE2 (SVTURBINE1 & SVTURBINE2)

NOT TO SCALE

FIGURE 2