



**Results of the July 18, 2023 Oxides of Nitrogen and  
Carbon Monoxide Emission Testing Performed on the  
Gas Turbines at the Vector Pipeline, L.P. - Washington  
Compressor Station Located in Macomb Township,  
Michigan**

Natural Gas Fired Turbines

EUTURBINE 1 & 2

**Facility Permit Number: MI-ROP-N7624-2019**

**State Registration Number: N7624**

**Barr Project No. 13981050.23**

Prepared for  
Vector Pipeline, L.P.

August 2023

Results of the July 18, 2023 Oxides of Nitrogen and Carbon Monoxide  
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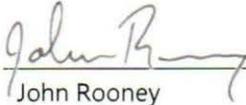
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## Report Certification

### 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



John Rooney

Sr. Air Sampling Technician  
Barr Engineering Co.

08/22/2023

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.



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

08/22/2023

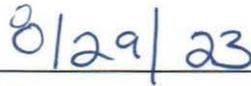
Date

**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 Back  
General Counsel, Chief Compliance Officer  
Vector Pipeline, L.P.



Date

## Executive Summary

Barr Engineering Co. (Barr) performed emissions testing at the Vector Pipeline, L.P. - Washington Compressor Station (Vector) located in Macomb Township, Michigan. Testing was completed for oxygen (O<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), and carbon monoxide (CO) at the Natural Gas Fired Turbine exhaust stacks on July 18, 2023. The testing was completed as required in the facility permit number MI-ROP-N7624-2019 and 40 CFR Part 60 subpart KKKK. 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			
	EUTURBINE1		EUTURBINE2	
Test Date	July 18, 2023		July 18, 2023	
Rate, % NGP	103	93	103	93
Oxygen dry, %	15.6	16.0	15.7	16.4
NO <sub>x</sub> ppm dry	5.9	10.0	6.5	10.0
NO <sub>x</sub> lb/hr	2.7	3.7	3.1	4.0
NO <sub>x</sub> ppm dry @ 15% O <sub>2</sub>	6.5	12.1	7.4	13.0
<b>NO<sub>x</sub> Limit, ppm dry @ 15% O<sub>2</sub></b>	<b>25</b>	<b>25</b>	<b>25</b>	<b>25</b>
CO, ppm dry	8.0	1.1	0.3	0.4
CO, Emission Rate lb/hr	2.2	0.3	0.1	0.1
<b>CO Emission Rate Limit, lb/hr<sup>1</sup></b>	<b>9.4</b>	<b>9.4</b>	<b>9.4</b>	<b>9.4</b>

<sup>1</sup>This emission rate limit is applicable for NGP rates above 92%

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## 1.0 Introduction

Barr Engineering Co. (Barr) performed emissions testing at the Vector Pipeline, L.P. - Washington Compressor Station (Vector) located in Macomb Township, Michigan. Testing was completed for oxygen (O<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), and carbon monoxide (CO) at the Natural Gas Fired Turbine exhaust stack on July 18, 2023. The testing was completed as required in the facility permit number MI-ROP-N7624-2019 and 40 CFR Part 60 subpart KKKK.

A test plan was mailed to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on March 9, 2022. A copy of the test plan is provided in Appendix F.

Testing was performed by John Rooney of Barr. Alex Smith and Matt DiPaola of Vector provided coordination of operations with the test team. The testing was witnessed by Noshin Khan of EGLE. A list of project participants is provided in Appendix G.

The Washington Compressor Station operates two natural gas turbines. The testing consisted of three 20-minute runs with each turbine operating at approximately 103% and 93% natural gas producer (NGP) speed for high and low load respectively. Results of the test are summarized in the next section. Supporting documentation and calculations are provided in the appendices.

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## 2.0 Results

The results of the EUTURBINE1 testing are provided in Tables 1 and 2. During the test, the NO<sub>x</sub> averaged 5.9 and 10.0 parts per million (ppm) on dry basis for high and low load respectively. The NO<sub>x</sub> concentration corrected to 15% O<sub>2</sub> averaged 6.5 and 12.1 ppm for high and low load respectively, which is below the permit limit and 25 ppm. The CO emission rate averaged 2.2 and 0.3 pound per hour (lb/hr) for high and low load respectively which is below the permitted limit of 9.4 lb/hr.

The results of the EUTURBINE2 testing are provided in Tables 3 and 4. During the test the NO<sub>x</sub> averaged 6.5 and 10.0 ppm on dry basis for high and low load respectively. The NO<sub>x</sub> concentration corrected to 15% O<sub>2</sub> averaged 7.4 and 13.0 ppm for high and low load respectively, which is below the permit limit and 25 ppm. The CO emission rate averaged 0.1 and 0.1 lb/hr for high and low load respectively which is below the permitted limit of 9.4 lb/hr.

The NO<sub>x</sub> 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 highest achievable load, given pipeline and weather conditions, on the day of the test. No testing or operations difficulties were noted.

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## 3.0 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 Washington Compressor Station (located in Macomb Township, Michigan) consists of two Solar Turbines model "Mars 100" 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.

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## 4.0 Stack Testing Procedures and Methods

Testing was performed at the exhaust stacks of the turbines. A test location site diagram (identical for both turbines) is provided in Figures 1 and 2.

A three-point stratification check was performed that exhibited less than five percent difference from the average concentration for O<sub>2</sub> and NO<sub>x</sub> for both turbines. Testing was performed from a single point most representative of the average concentration. 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<sub>x</sub> analyzer Model 200H was used for the determination of NO<sub>x</sub> on dry basis. The instrument was calibrated per EPA Method 7E criteria. A NO<sub>x</sub> instrument convertor efficiency test was performed using an EPA Protocol 1 mixture of NO<sub>2</sub> gas, 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

**TABLE 1**  
**GASEOUS POLLUTANT TEST RESULTS SUMMARY**  
**Gas Turbine (EUTURBINE1 /SVTURBINE1)**  
**High Load**

Parameter	Run 1	Run 2	Run 3	Average
Test Date	7/18/2023	7/18/2023	7/18/2023	--
Test Period	1010-1029	1030-1049	1050-1109	--
<b>EPA Method 3A Results</b>				
O <sub>2</sub> Concentration, % dry	15.5	15.6	15.6	15.6
<b>EPA Method 7E Results</b>				
NO <sub>x</sub> Concentration, ppm dry	5.8	5.9	6.1	5.9
NO <sub>x</sub> Concentration, ppm dry @ 15%O <sub>2</sub>	6.4	6.6	6.7	6.5
<b>EPA Method 10 Results</b>				
CO Concentration, ppm dry	11.7	7.3	4.9	8.0
CO Emission Rate, lb/hr	3.2	2.0	1.3	2.2
<b>Process Operating Data</b>				
NGP, %	103.0	103.0	103.0	103.0
Fuel Gas Flow Rate, SCFM	1,755	1,747	1,736	1,746
Fuel Gas Composition, Fd	---	---	---	8,649

**TABLE 2**  
GASEOUS POLLUTANT TEST RESULTS SUMMARY  
Gas Turbine (EUTURBINE1 /SVTURBINE1)  
Low Load

Parameter	Run 1	Run 2	Run 3	Average
Test Date	7/18/2023	7/18/2023	7/18/2023	--
Test Period	1210-1229	1230-1249	1250-1309	--
EPA Method 3A Results				
O <sub>2</sub> Concentration, % dry	16.0	16.0	16.0	16.0
EPA Method 7E Results				
NO <sub>x</sub> Concentration, ppm dry	10.0	10.0	10.0	10.0
NO <sub>x</sub> Concentration, ppm dry @ 15%O <sub>2</sub>	12.1	12.1	12.1	12.1
EPA Method 10 Results				
CO Concentration, ppm dry	1.6	1.0	0.7	1.1
CO Emission Rate, lb/hr	0.4	0.2	0.2	0.3
Process Operating Data				
NGP, %	93.0	93.0	93.0	93.0
Fuel Gas Flow Rate, SCFM	1,322	1,323	1,320	1,322
Fuel Gas Composition, Fd	---	---	---	8,649

**TABLE 3**  
GASEOUS POLLUTANT TEST RESULTS SUMMARY  
Gas Turbine (EUTURBINE2 /SVTURBINE2)  
Low Load

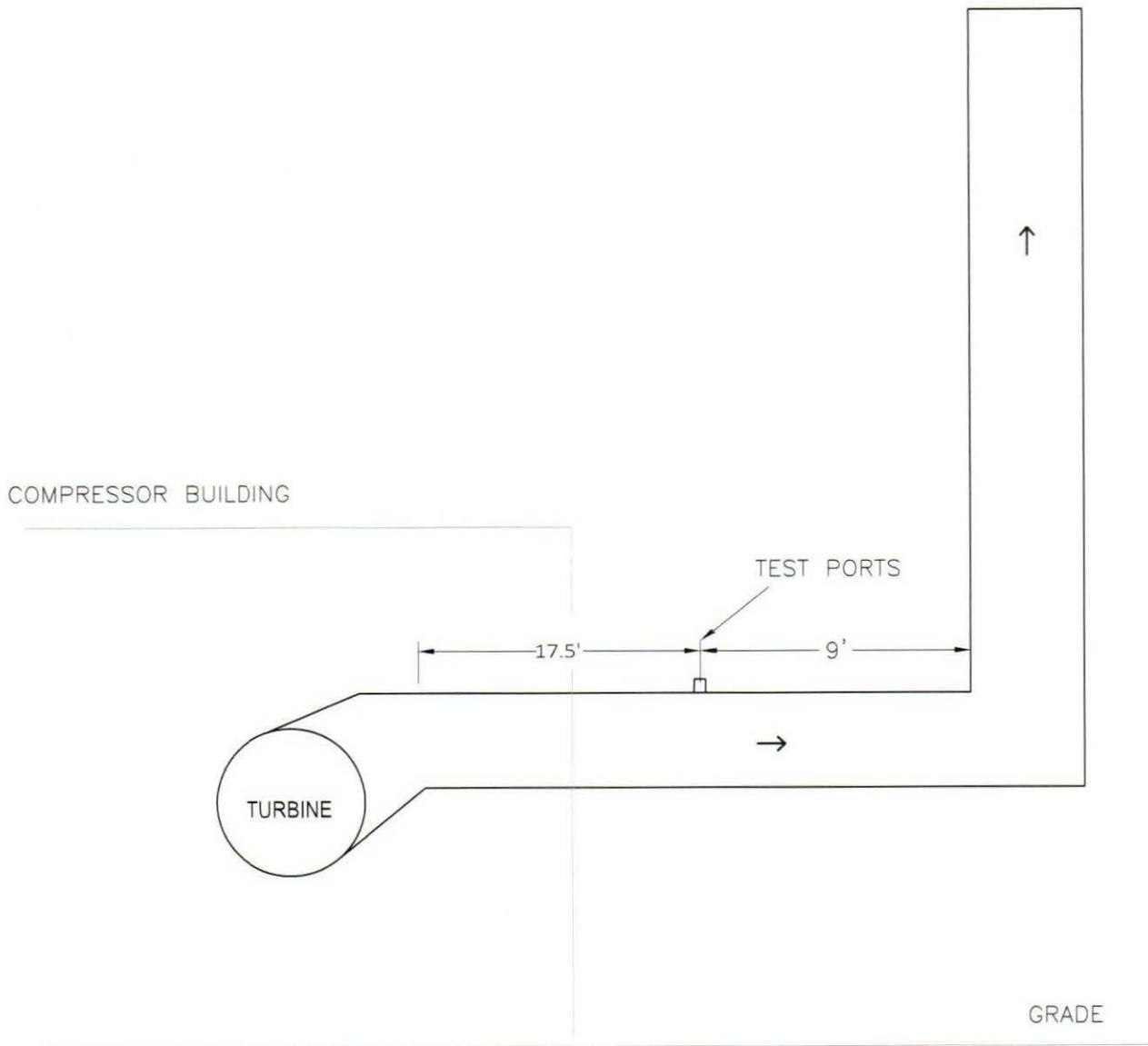
Parameter	Run 1	Run 2	Run 3	Average
Test Date	7/18/2023	7/18/2023	7/18/2023	--
Test Period	1420-1439	1440-1459	1500-1519	--
EPA Method 3A Results				
O <sub>2</sub> Concentration, % dry	16.3	16.4	16.4	16.4
EPA Method 7E Results				
NO <sub>x</sub> Concentration, ppm dry	10.0	10.1	10.0	10.0
NO <sub>x</sub> Concentration, ppm dry @ 15%O <sub>2</sub>	12.9	13.1	13.0	13.0
EPA Method 10 Results				
CO Concentration, ppm dry	0.5	0.3	0.4	0.4
CO Emission Rate, lb/hr	0.1	0.1	0.1	0.1
Process Operating Data				
NGP, %	93.0	93.0	93.0	93.0
Fuel Gas Flow Rate, SCFM	1,314	1,311	1,310	1,312
Fuel Gas Composition, Fd	---	---	---	8,649

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**TABLE 4**  
GASEOUS POLLUTANT TEST RESULTS SUMMARY  
Gas Turbine (EUTURBINE2 /SVTURBINE2)  
High Load

Parameter	Run 1	Run 2	Run 3	Average
Test Date	7/18/2023	7/18/2023	7/18/2023	--
Test Period	1600-1619	1620-1639	1640-1659	--
EPA Method 3A Results				
O <sub>2</sub> Concentration, % dry	15.7	15.7	15.7	15.7
EPA Method 7E Results				
NO <sub>x</sub> Concentration, ppm dry	6.8	6.5	6.4	6.5
NO <sub>x</sub> Concentration, ppm dry @ 15%O <sub>2</sub>	7.7	7.4	7.2	7.4
EPA Method 10 Results				
CO Concentration, ppm dry	0.2	0.6	0.1	0.3
CO Emission Rate, lb/hr	0.0	0.2	0.0	0.1
Process Operating Data				
NGP, %	103.0	103.0	103.0	103.0
Fuel Gas Flow Rate, SCFM	1,780	1,773	1,777	1,776
Fuel Gas Composition, Fd	---	---	---	8,649

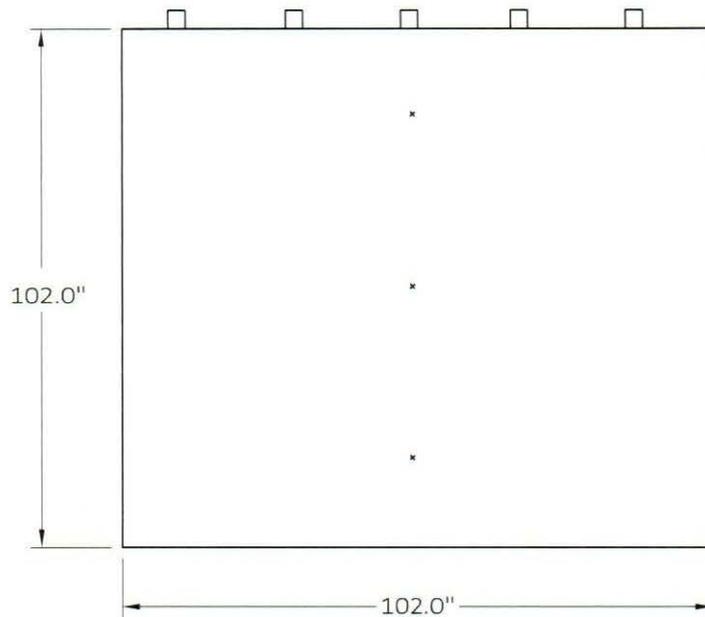
## Figures



TEST PORT LOCATION  
VECTOR PIPELINE, L.P.  
NATURAL GAS FIRED TURBINE(S)

NOT TO SCALE

FIGURE 1



NO. OF TEST PORTS	5, 1 USED
PORT LENGTH	24"
PORT DIAMETER	6"
NO. OF TRAV. POINTS	3
DUCT MEASUREMENTS	102.0" X 102.0"

\* ANALYZER PTS

POINT	INSERTION DEPTH IN "
1	15.8
2	47.2
3	78.8

TRAVERSE POINT LOCATIONS  
VECTOR PIPELINE, L.P.  
NATURAL GAS FIRED TURBINE(S)

NOT TO SCALE

FIGURE 2

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## Appendices