EMISSIONS COMPLIANCE STUDY

Performed At The
Northern Natural Gas Co.
East Wakefield Compressor Station
Turbine 1 (EUTURBINE1)
Wakefield, Michigan

Permit Number : Permit to Install (PTI) 3-18
State Registration Number (SRN) : P0890

Test Date(s)
March 5, 2024

Report No.
TRC Environmental Corporation Report 586673.EW24

Report Submittal Date
March 29, 2024

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Report Certification

I certify that to the best of my knowledge:

- Testing data and all corresponding information have been checked for accuracy and completeness.
- Sampling and analysis have been conducted in accordance with the approved protocol and applicable reference methods (as applicable).
- All deviations, method modifications, or sampling and analytical anomalies are summarized in the appropriate report narrative(s).

David Wainio
Emissions Testing Group Manager

March 27, 2024
Date

TRC was operating in conformance with the requirements of ASTM D7036-04 during this test program.

Bruce Randall
TRC Emission Testing Technical Director

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1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed an emissions compliance test program on the Turbine 1 at the East Wakefield Compressor Station of Northern Natural Gas Co. (NNG) in Wakefield, Michigan on March 5, 2024. The tests were authorized by and performed for NNG.

The tests were performed in order to determine compliance with the NOx part per million (ppm) at 15 percent oxygen, NOx lb/hr and the total potential sulfur pound per million btu (lb/MMBtu) emission limit from the Michigan Department of Environment, Great Lakes and Energy PTI No. 3-18 for Turbine 1. The test program was conducted according to the TRC site-specific test plan. Any changes from the test plan or problems encountered during the tests are addressed in Section 2.0.

1.1 Project Contact Information

Participants		
Test Facility	Northern Natural Gas Co. East Wakefield Compressor Station 280 M 28, 3.7 miles North of Harrison Street Wakefield, Michigan 49968	Dylan Berg 402-206-6722 Dylan.Berg@nngco.com
Test Coordinator	Northern Natural Gas Co. 1120 Centre Pointe Drive, Suite 400 Mendota Heights, Minnesota 55120	Kelly Henry Division Environmental Specialist 651-456-1712 Kelly.Henry@nngco.com
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 1301 Corporate Center Drive - Suite 177 Eagan, Minnesota 55121	David Wainio Emissions Testing Group Manager 651-249-8776 (phone) dwainio@trccompanies.com

The tests were conducted by David Wainio and Jacob Voss of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual (QI) can be located in the appendix to this report.

The Michigan Deparment of Environment, Great Lakes and Energy (EGLE) was informed of, but did observe the testing.

1.2 Facility and Process Description

The Northern Natural Gas – East Wakefield facility is located near 280 M 28 about 3.7 miles North of Harrison Street near Wakefield, Michigan. The East Wakefield facility is used to pressurize natural gas in order to facilitate its transmission through the pipeline system. The facility currently consists of two natural gas-fired stationary combustion turbines (EUTURBINE1 and EUTURBINE2). Both turbines are Solar Saturn 20-1600 gas turbines and rated at 1,679 HP each.

2.0 SUMMARY OF RESULTS

The results of this test program are summarized in the table below. Detailed individual run results are presented in Section 6.0.

Turbine 1

Source ID	Regulated Constituent	Limitation Basis	Permitted Emission Limit	Measured Emissions
EUTURBINE1	NOx	40 CFR pt. 60, subpart KKKK and EGLE PTI 3-18	≤ 100 ppm @ 15% O_2	74.26 ppm @ 15% O_2
			≤ 7.24 lb/hr	5.06 lb/hr

Fuel Gas SO2

Source ID	Regulated Constituent	Limitation Basis	Permitted Emission Limit	Measured Emissions
FGTURBINES	Total Sulfur Content	40 CFR pt. 60, subpart KKKK and EGLE PTI 3-18	0.06 lb/MMbtu	6.73 E-05 lb/MMBtu

The test plan originally stated that the runs would be 60 minutes in length. The test plan approval letter allowed for the test runs to be 20 minutes in length therefore 20-minute runs were used for the testing.

The table below summarizes the test methods used, as well as the number and duration of each at each test location:

Unit ID/ Sample Location	Parameter Measured	Test Method	No. of Runs	Run Duration
EUTURBINE1	NOx O2, Fuel Rate	USEPA 1, 3A, 7E, 19	3	20 min
Facility (FGTURBINES)	Sulfur Dioxide (SO2)	ASTM D6228 Fuel Analysis	1	Grab

3.0 DISCUSSION OF RESULTS

The results demonstrate that the turbine is in compliance with the applicable limits. Turbine 1 was used to demonstrate compliance with the lb/hr NOx limit with each run being 20 minutes in length. Stratification checks were conducted prior to the first run. The results of this check allowed for the sampling for the testing to be conducted at a single point. Turbine 1 operated at a calculated heat input of 18.2 MMBtu/hr and with an average horsepower of 1,300 which is 77.4% of the unit's capacity. NOx lb/hr was calculated using the equation presented in the FAQ for EPA Method 19 for determining lb/hr values based of a stack flow that is calculated from fuel flow and fuel heat content.

No problems were encountered with the testing equipment during the test program. The results presented in this report contain no known errors. No other changes or problems were encountered that required modification of any procedures presented in the test plan. No adverse test or environmental conditions were encountered during the conduct of this test program.

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of Sample Point Locations by USEPA Method 1

This method is applicable to gas streams flowing in ducts, stacks, and flues and is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rates from stationary sources. In order to qualify as an acceptable sample location, it must be located at a position at least two stack or duct equivalent diameters downstream and a half equivalent diameter upstream from any flow disturbance.

The cross-section of the measurement site was divided into a number of equal areas, and the traverse points were then located in the center of these areas. The minimum number of points were determined from Figure 1-2 (non-particulate) of USEPA Method 1.

4.2 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system. The number of points at which sample was collected was determined in accordance with Method 7E specifications.

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol gases. Three-point linearity checks were performed prior to sampling, and in the event of a failing system bias or drift test (and subsequent corrective action). System bias and drift checks were performed using the low-level gas and either the mid- or high-level gas prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

4.2.1 O_2 Determination by USEPA Method 3A

This method is applicable for the determination of O_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O_2 analyzer was equipped with a paramagnetic-based detector.

4.2.2 CO_2 Determination by USEPA Method 3A

This method is applicable for the determination of CO_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The CO_2 analyzer was equipped with a non-dispersive infrared (IR) detector.

4.2.3 NO_x Determination by USEPA Method 7E

This method is applicable for the determination of NO_x concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The NOx analyzer utilizes a photomultiplier tube to measures the linear and proportional luminescence caused by the reaction of nitric oxide and ozone.

4.3 Determination of NO_x Emission Rates by USEPA Method 19

Where specified by an applicable subpart of the regulations, this method is applicable for the determination of (a) PM, SO_2, and NO_x emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions.

Emission Rates. Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) were used to calculate pollutant emission rates from pollutant concentrations.

4.4 Determination of SO2 Emission Rates by Fuel Sample

The SO_2 performance tests were conducted using the methodology specified in §60.4415(a)(2). A representative fuel sample was collected manually and analyzed for total sulfur content using approved methodology, ASTM D6228.
Equation D-1h from Appendix D to 40CFR75 (Section 2.3.2.1 SO_2 Emission Rate) was used to calculate the SO2 emission rate for natural gas combustion. In Equation D-1h, the total sulfur content and GCV values are used to calculate the SO_2 emission rate, with the result rounded to the nearest 0.0001 lb/mmBtu.

$$ER = \left[\frac{2.0}{7000}\right] \times [10^6] \times \left[\frac{S_{total}}{GCV}\right]$$

Where:
ER = SO_2 emission rate for natural gas combustion, lb/mmBtu.
S_{total} = Total sulfur content of the natural gas, gr/100scf.
GCV = Gross calorific value of the natural gas, Btu/100scf.
7000 = Conversion of grains/100scf to lb/100scf.

2.0 = Ratio of lb SO_2/lb S.
10_6 = Conversion factor (Btu/mmBtu).

4.5 Determination of F-Factors by USEPA Method 19

This method is applicable for the determination of the pollutant emission rate using oxygen (O_2) or carbon dioxide (CO_2) concentrations and the appropriate F factor (the ratio of combustion gas volumes to heat inputs) and the pollutant concentration. The appropriate F-Factor was calculated from fuel analyses using the equations in Section 12.3.3.1 of Method 19.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Accreditation from the Louisiana Environmental Laboratory Accreditation Program (LELAP);
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: *"AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of uncertainty for test methods may be found."* TRC conforms with this section by using approved test protocols for all tests.

6.0 TEST RESULTS SUMMARY

Instrumental Reference Method
Calibration Corrected Test Data

Project Number:	586673.EW24	Start Date:	3/5/24
Customer:	Northern Natural Gas	End Date:	3/5/24
Unit Identification:	Turbine 1	Facility:	East Wakefield Compressor Statio
Sample Location:	Exhaust Duct	Recorded by:	David Wainio
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	>75% Capacity	Fd Factor:	8666

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOX ppmvd	SO2 ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	3/5/24	8:35	8:54	63.14	-	-	3.08	15.83
2	3/5/24	9:10	9:29	63.55	-	-	3.07	15.89
3	3/5/24	9:45	10:04	62.89	-	-	3.00	15.92
Average				63.20	-	-	3.05	15.88

Moisture Correction Applied To "As Measured Data": None

Reference Method Results, CEM Moisture Basis

Run #	NOX ppmvd	SO2 ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry	Bws	Fc Factor	Fd Factor
1	63.14	-	-	3.08	15.83	-	-	8666
2	63.55	-	-	3.07	15.89	-	-	8666
3	62.89	-	-	3.00	15.92	-	-	8666
Average	63.20	-	-	3.05	15.88	-	-	8666

Emission Rate Calculation Summary

Run #	NOX lb/MMBtu	SO2 lb/MMBtu	CO lb/MMBtu	NOX lb/hr	SO2 lb/hr	CO lb/hr	Flow DSCFM
1	0.269	-	-	5.13	-	-	11,351
2	0.274	-	-	5.07	-	-	11,146
3	0.273	-	-	4.97	-	-	11,020
Average	0.272	-	-	5.06	-	-	11,172

Results Corrected to a Reference O_2 Concentration

Run #	NO_x ppmvd corrected to 15% Oxygen	SO_2 ppmvd corrected to N/A	CO ppmvd corrected to N/A
1	73.44	-	-
2	74.81	-	-
3	74.52	-	-
Average	74.26	-	-

SO_2 Emission Rate Test Results Summary
Fuel-Based Determination

Project Number:	586673.EW24	Start Date:	3/5/2024
Customer:	Northern Natural Gas	End Date:	3/5/2024
Unit Identification:	Turbine 1 (EUTURBINE1)	Facility:	East Wakefield Compressor Station
Sample Location:	Exhaust Duct	Recorded by:	David Wainio
RM Probe Type:	Extractive (Dry)		
Load Level/Condition:	> 75% Capacity		

Run		Start	End	Heat Input	Power Rate	SO_2 Emission Factors		
#	Date	Time	Time	MMBtu/hr	MWh	lb/MMBtu	ng/J	lb/MWh
1	3/5/2024	8:35	8:54	19.06	0.33	**6.73E-05**	**4.42E-03**	3.89E-03
2	3/5/2024	9:10	9:29	18.50	0.32			3.87E-03
3	3/5/2024	9:45	10:04	18.18	0.32			3.85E-03
Average				**18.58**	**0.32**			**3.87E-03**