SUMMARY

The compliance emissions testing was performed on Engine EUBG009 in fulfillment of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-N5575-2018. The testing was performed utilizing USEPA Methods 1-4, 3A, 7E, and 19 at the Exhaust Stack sampling location. The results of the testing are detailed in the following tables.

Engine EUBG009 NO_x Emission Test Results	
Run No.	**NOx Emissions (g/bhp-hr)**
1	6.2990
2	5.3430
3	6.0773
Average	5.9064
Emission Limit	6.600

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1. INTRODUCTION

This report presents the results of the source emissions testing conducted by Environmental Quality Management, Inc. (EQM) for TC Energy's ANR (ANR) Bridgman Compressor Station, near Bridgman, MI. In fulfillment of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-N5575-2018, the testing was performed utilizing USEPA Methods 1-4, 3A, 7E, and 19, at the Exhaust Stack sampling location.

To ensure that compliance with the emission limits is maintained, the Air Compliance Team of TC Energy's US Pipelines contracted Environmental Quality Management, Inc. (EQM) to perform source emissions testing on Engine EUBG009. The primary purpose of this testing program was to conduct emissions testing of the internal reciprocating Engine EUBG009, with an emission limit of 6.6 g/bhp/hr of NO_x at 100 percent torque.

EQM's responsibility was to conduct the compliance testing for the NOx emissions rates and perform data reduction for conformance evaluation. ANR's responsibility was to maintain process operating parameters and to assist in providing process operating data per compliance test requirements.

The following report provides information pertaining to TC Energy's process operations, and Compliance testing. The Compliance testing on Engine EUBG009 was performed on July 7, 2021, from 11:35 A.M. to 3:04 P.M.

The following requirements were specific for the testing program:

1. Equipment calibrations performed and calibration data provided.
2. Three (3) thirty (30) -minute, minimum, NOx, and O_2 test runs performed at the Engine EUBG009 pursuant to EPA Reference methods as described in 40 CFR, Part 60, Appendix A as approved by state.
3. Process manufacturing operations maintained within 10% of 100% of capacities and production and fuel consumption rates recorded during the emissions testing periods.
4. All testing and analyses performed in accordance with current EPA test methodologies and analytical procedures for NOx, and O_2, emissions determinations.

The testing program was approved by and/or coordinated with Tyrah Lydia, TC Energy's ANR Pipeline Company. The emission testing was managed by Karl Mast, Manager Emissions Measurement, EQM and was performed by Zach Hill, Testing Team Leader, EQM. The emission testing was observed by Matt Karl, MEGLE.

3. FACILITY AND PROCESS DESCRIPTION

TC Energy's ANR Bridgman Compressor Station (ANR) is located in Bridgman, MI and operates a natural gas fired compressor station. The plant is located at 3372 Browntown Road, Bridgman, MI, which is located in Berrien County.

The Clark TCVC-20M is a two- stroke lean burn natural gas fired internal combustion reciprocating engine driving gas compressors. The energy released during the combustion process drives integral reciprocating gas compressors, thus raising the pressure of the incoming natural gas to inject or withdraw natural gas from a natural gas storage field.

The following tables provide a summary of the production rates and general description of the unit for the Engine EUBG009 during the test:

Table 4. Engine EUBG009 Production Data (HP)

Run No.	Horsepower
1	11,771.0
2	11,004.0
3	11,194.0
Average	11,323.0
Permit Rated	12,000.0

Table 5. Engine EUBG009 Torque (%)

Run No.	Percent
1	102.2406
2	95.5785
3	96.9360
Average	98.2517

Table 6. Engine EUBG009 General Information

General Information

Date:	7-Jul-21
Company:	TC Energy
Station:	Bridgman
Unit:	9
Engine Type:	TCVC20/Clark
Serial Number:	162009
Rated RPM:	345 RPM
Rated BHP:	12000 BHP

Permit Limits

	ppm@15%	g/Bhp-Hr	lb/hr	TPY
NOx:		6.6		
CO:				
VOC:				
H2CO:				

Limits are actuallly listed as average values

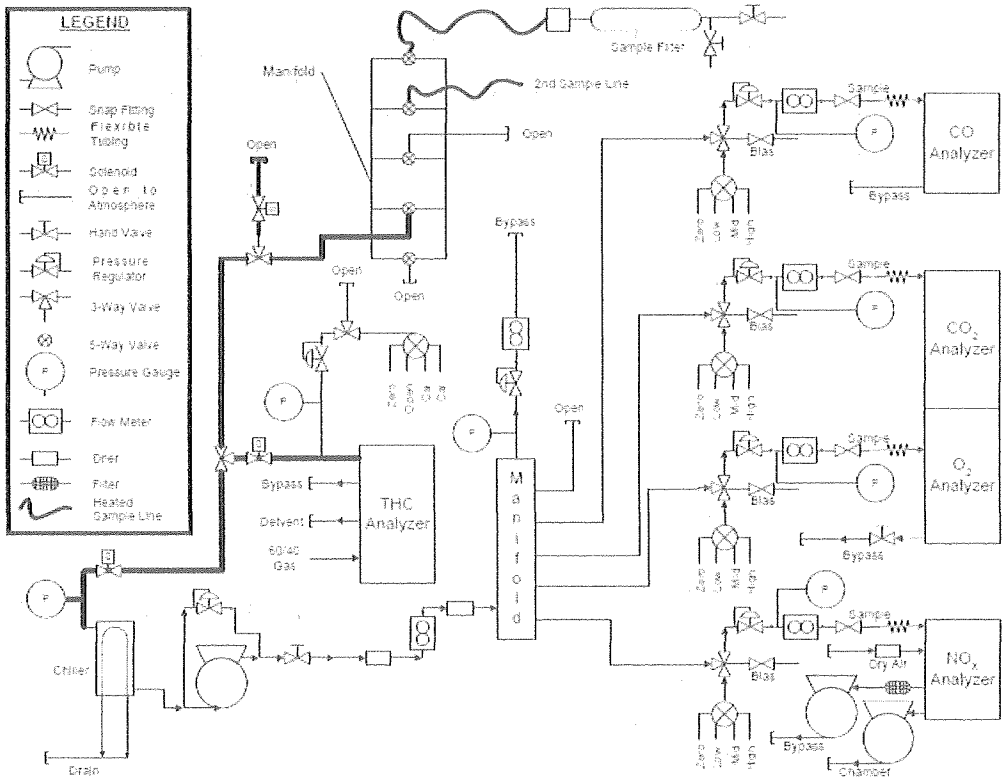
Fuel Gas Analysis

Constituent	Mole Percent
Nitrogen	0.379
Carbon Dioxide	0.184
Methane	91.389
Ethane	7.772
Propane	0.239
I-Butane	0.015
N-Butane	0.013
I-Pentane	0.002
N-Pentane	0.000
Hexane +	0.007
Total	100.00

Fuel Meter Type

Enter Type from List Below	2
Orifice Meter (upstream pressure tap):	1
Orifice Meter (downstream pressure tap):	2
Electronic Flow Meter (EFM):	3
Venturi (Nozzle) Meter:	4
Roots Meter w/ Accumulator:	5
Pipe I.D.:	3.068
Orifice I.D.:	1.5

Figure 1. Engine EUBG009-Flow Schematic



4. TEST PROCEDURES

EQM and EQM's affiliates and subcontractors use current U.S. EPA accepted testing methodologies in their Air Quality Programs as listed in the U.S. Code of Federal Regulations, Title 40, Part 60, Appendix A. For this testing program, the following specific methodologies were utilized:

- U.S. EPA Method 3A – Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 7E – Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 19– Determination of Stack Gas Volumetric Flow Rate by Fuel "F" Factor and Heat Input

USEPA Methods 3A and 7E were performed at the Exhaust Stack sampling location by continuously extracting a gas sample from the stack through a single point stainless steel sample probe. The extracted sample was pulled through a series of filters to remove any particulate matter. Directly after the probe, the sample was conditioned by a series of refrigeration dryers to remove moisture from the gas stream. After the refrigeration dryers, the sample was transported through a Teflon® line to the analyzers. The flow of the stack gas sample was regulated at a constant rate to minimize drift.

At the start of the day, each monitor was checked for calibration error by introducing zero, mid-range and high-range EPA Protocol 1 gases to the measurement system at a point upstream of the analyzers. In this report, the calibration error test is referred to as instrument calibration. The gas was injected into the sampling valve located at the outlet of the sampling probe. The bias test was conducted before and after each consecutive test run by introducing zero and upscale calibration gases for each monitor. The upscale calibration gases used for each monitor were the high calibration gases.

Measurement System Performance Specifications were as follows:

- Analyzer Calibration Error - Less than +/- 2% of the span of the zero, mid-range and high-range calibration gases.
- Sampling System Bias - Less than +/-5% of the span for the zero, mid-range and high-range calibration gases.
- Zero Drift - Less than +/-3% of the span over the period of each test run.
- Calibration Drift - Less than +/-3% of the span over the period of each set of runs.

During the first run, it was noticed that there was an issue with the analyzer O2 system internally. EQM changed to a different analyzer, in which all proper checks were made prior to restarting the compliance test. The failed run data may be found in Appendix A and process information for the mentioned run may be found in Appendix B

Calculations that were used in this testing event for the Engine EUBG009 are as follows:

Calibration Correction

$$C_{GAS} = (C_R - C_O)\frac{C_{MA}}{C_M - C_O}$$

Where:

C_{GAS}:	Corrected flue gas concentration (ppmvd)
C_R:	Flue gas concentration (ppmvd)
C_O:	Average of initial and final zero checks (ppmvd)
C_M:	Average of initial and final span checks (ppmvd)
C_{MA}:	Actual concentration of span gas (ppmvd)

EPA F-Factor

$$F_d = \frac{\left[\left(3.64 \cdot H_{Wt\%} \cdot 100\right) + \left(1.53 \cdot C_{Wt\%} \cdot 100\right)\right]}{\frac{GCV}{\rho_{FuelGas}}} \cdot 10^6 + \frac{\left[\left(0.14 \cdot N_{2Wt\%} \cdot 100\right) - \left(0.46 \cdot O_{2Wt\%} \cdot 100\right)\right]}{\frac{GCV}{\rho_{FuelGas}}} \cdot 10^6$$

Where:

F_d:	Fuel specific F-factor, dscf/MMBtu
$H_{Wt\%}$:	Hydrogen weight percent
$C_{Wt\%}$:	Carbon weight percent
$N_{2Wt\%}$:	Nitrogen weight percent
$O_{2Wt\%}$:	Oxygen weight percent
GCV:	Heating value of the fuel, BTU/dscf
$\rho_{Fuel\ Gas}$:	Density of the fuel gas, lb/scf

Mass Emissions Calculations g/bhr/hr

$$NOx_{\frac{g}{bhp-hr}} = C_d \times F_d \times \frac{20.9}{20.9 - \%O_2} \times Q_h \times \frac{GCV}{10^6} \times \frac{453.6}{Bhp}$$

Where:

C_d:	Pollutant concentration, lb/scf
F_d:	Fuel specific F-factor, dscf/MMBtu
Q_h:	Fuel flow, scf/hr
$\%O_2$:	Oxygen concentration in percent, measured on a dry basis
GCV:	Upper dry heating value of fuel, Btu/dscf

5. QUALITY ASSURANCE PROCEDURES

Each reference method presented in the U.S. Code of Federal Regulations details the instrument calibration requirements, sample recovery and analysis, data reduction and verification, types of equipment required, and the appropriate sampling and analytical procedures to ensure maximum performance and accuracy. EQM and EQM's affiliates and subcontractors adhere to the guidelines for quality control set forth by the United States Environmental Protection Agency. These procedures are outlined in the following documents:

- Code of Federal Regulations, Title 40, Part 51
- Code of Federal Regulations, Title 40, Part 60
- Quality Assurance Handbook, Volume 1, EPA 600/9-76-005
- Quality Assurance Handbook, Volume 2, EPA 600/4-77-027a
- Quality Assurance Handbook, Volume 3, EPA 600/4-77-027b

6. CONCLUSIONS

An Emissions Test was conducted on the internal combustion reciprocating Engine EUBG009 at TC Energy's ANR Pipeline Company's Sandwich Compressor Station located in Bridgman, Michigan. The testing was conducted on July 7, 2021.

During the course of the testing, the Engine EUBG009 conformed to the requirements of Code Of Federal Regulations, Title 40, Part 60, Appendix A, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines.

The usefulness and/or significance of the emissions values presented in this document as they relate to the compliance status of the Engine EUBG009 emissions shall be determined by others.

For additional information pertaining to the testing program see Appendix E of this report.

A. FIELD TEST DATA