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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 conducted on Engine EUBG009 was performed on September 3, 2020, from 8:30 A.M. to 9:59 A.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 at 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, and Kameron King, Test Technician, EQM. The emission testing was observed by Matt Deskins and Lindsey Wells, MEGLE.

2. TEST RESULTS SUMMARY

The compliance testing was performed on Engine EUBG009 in fulfillment of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-N5575-2018. A summary of the test results is given below:

Table 1. Test Results Summary-Test Results-Engine EUBG009

Engine EUBG009 NO_x Emission Test Results	
Run No.	NOx Emissions (g/bhp-hr)
1	4.305
2	4.236
3	4.144
Average	4.228
Emission Limit	6.600

Based on the information provided above, the Engine EUBG009 met the acceptance criteria during the course of the testing. A complete list of performance parameters for each test run that was performed at the stack sampling locations can be found in Table 2-3.

Table 2. Engine Operating & Ambient Conditions-Engine EUBG009

Run	1	2	3	
Date	09/03/20	09/03/20	09/03/20	
Time	8:30	9:00	9:30	
Engine Operating Conditions	HS-HT	HS-HT	HS-HT	Averages
Unit Horsepower from Control Panel	10,723.0	10,794.0	10,606.0	10,707.667
Unit Speed (rpm)	331.0	330.0	330.0	330.333
Compressor Suction Pressure (PSIG)	666.0	664.0	663.0	664.333
Compressor Suction Temperature (°F)	68.9	68.9	68.7	68.833
Compressor Discharge Pressure (PSIG)	837.0	843.0	843.0	841.000
Compressor Discharge Temperature (°F)	103.1	104.5	104.4	104.000
Compressor Flow (MMSCF/D)	898.2	870.4	832.7	867.100
% Load	89.4	90.0	88.4	89.231
% Torque	93.1	94.0	92.4	93.192
Heat Rate (BTU/HP-hr)	6,759.0	6,746.2	6,724.0	6,743.087
Ambient Conditions				
Ambient Temperature (°F)	75.50	77.60	81.50	78.200
Barometric Pressure (psi)	14.242	14.248	14.246	14.245
Ambient Relative Humidity (%)	79.00	79.00	64.00	74.000
Absolute Humidity (grains/LB)	226.43	243.55	223.21	231.062

Table 3. Emissions Concentrations, & Calculated Mass Emissions, Concentrations, and Flows-Engine EUBG009

Run	1	2	3	
Date	09/03/20	09/03/20	09/03/20	
Time	8:30	9:00	9:30	
Emissions Concentrations & Calculated Mass Emissions				Averages
NO_x ppm (BIAS Corrected)	416.320	409.880	403.400	409.867
NO_X g/BHP-HR	4.305	4.236	4.144	4.228
NO_X LB/HR	101.769	100.809	96.893	99.823
NO_X (ppm @ 15% O_2)	344.984	340.125	333.809	339.640
NO_X (ppm @ 15% O_2, ISO)	780.679	801.319	736.054	772.684
NOx LB/MMBTU	1.270	1.252	1.229	1.251
NO_X Tons/Year	445.75	441.54	424.39	437.23
NO_X LB/MMSCF Fuel	1.174127E-03	1.157590E-03	1.136094E-03	1.155937E-03
% O_2 (BIAS Corrected)	13.78	13.79	13.77	13.78
Calculated Emissions Concentrations				
% CO_2 (Wet) *	3.61	3.59	3.61	3.60
%CO_2 (Dry) *	4.08	4.08	4.09	4.08
% H_2O *	11.68	11.94	11.63	11.75
% O_2 (Wet) *	12.17	12.14	12.17	12.16
% N_2 + CO (Wet) *	72.54	72.33	72.58	72.49
Calculated Flows				
Fuel Flow - (SCFM)	1236.500	1242.333	1216.667	1231.833
Fuel Flow - (SCFH)	74190.000	74540.000	73000.000	73910.000
Fuel Flow (LB/HR)	3426.194	3442.357	3371.238	3413.263
Fuel Flow (MMcf/hr)	3.43E-02	3.44E-02	3.37E-02	3.41E-02
Exhaust Flow (LB/HR)	129,572.717	129,873.916	126,748.956	128,731.863
Exhaust Flow (WSCFM)	35,585.189	35,792.181	34,976.207	35,451.192
Air Flow (WSCFM)	32,847.911	33,048.887	32,276.097	32,724.298
Exhaust Flow Method 19 (wscfm)	34,052.591	34,261.358	33,459.398	33,924.449
Exhaust Flow Method 19 (lbm/min)	1,602.510	1,614.194	1,574.253	1,596.986
Exhaust Flow Carbon Balance (lbm/min)	2,638.791	2,654.803	2,592.986	2,628.860
Air flow Beshouri (scfm)	34,328.499	34,536.802	33,732.602	34,199.301
BSAC, #/BHP-hr	13.961	13.954	13.869	13.928
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	74.19	74.54	73.00	73.91
** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION	Run 1	Run 2	Run 3	
* BASED ON CARBON BALANCE (STOICH. + O2)				
- A/F IS TOTAL MASS RATIO				

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	10,723.0
2	10,794.0
3	10,606.0
Average	10,707.667

Table 5. Engine EUBG009 Torque (%)

Run No.	Percent
1	93.1
2	94.0
3	92.4
Average	93.192

Table 6. Engine EUBG009 General Information

General Information

Date:	3-Sep-20
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

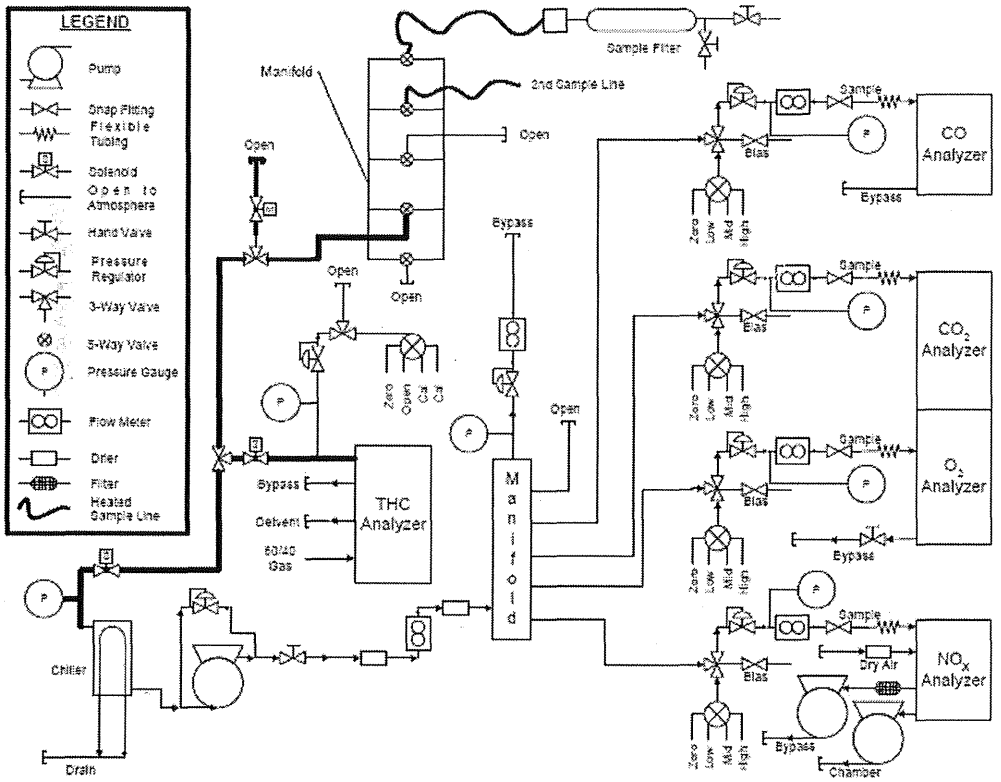
Fuel Gas Analysis

Constituent	Mole Percent
Nitrogen	0.379
Carbon Dioxide	0.178
Methane	90.303
Ethane	8.777
Propane	0.306
I-Butane	0.022
N-Butane	0.020
I-Pentane	0.004
N-Pentane	0.002
Hexane +	0.009
Total	100.000

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.

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

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

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 September 3, 2020.

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.