PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at TC Energy in Eaton Rapids, MI was performed in accordance with the procedures set forth by the United States Environmental Protection Agency, and that the data and results submitted within this report are an exact representation of the testing.

Karl Mast
Test Supervisor

I, Karl Mast, do hereby attest that all work on this project was performed under my direct supervision, and that this report accurately and authentically presents the source emissions testing conducted at ANR Pipeline's Eaton Rapids Gas Storage System Compressor Station in Eaton Rapids, MI.

Karl Mast
Test Supervisor

SUMMARY

The compliance testing was performed on the Internal Combustion Reciprocating Engine EUERCOMP-B in accordance with the requirements of Permit MI-ROP-N3022-2020a in order to comply with Title 40, Code of Federal Regulations, Part 60, Appendix A. The results of the testing are detailed in the following tables.

Engine EUERCOMP-B				
Measured Unit	Rated Power (HP)	Permit Limit	Results	Pass/Fail
NOx Lb/Hr	2,650	52.6	8.15	Pass
NOx g/HP/Hr		3.0	1.66	Pass
CO Lb/Hr		49.1	6.15	Pass
CO g/HP/Hr		2.8	1.25	Pass
VOC Lb/Hr		21.03	1.15	Pass
VOC g/HP/Hr		1.2	0.89	Pass

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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 Pipeline (ANR) at Eaton Rapids Gas Storage System compressor station, near Eaton Rapids, MI, which is located in Eaton County.

The primary purpose of this testing program was to conduct emissions testing to determine that the Combustion Engine EUERCOMP-B (Engine B) at ANR Pipeline's gas compressor facility is in compliance with permit No. MI-ROP-N3022-2020a.

EQM's responsibility was to conduct the compliance testing for the O2, CO, VOC, and NOx emissions rates and perform data reduction for conformance evaluation. ANR Pipeline'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 B was performed on Tuesday, July 29, 2021, from 9:50 A.M. to 1:12 P.M.

The following requirements were specific for the testing program:

1. Equipment calibrations performed and calibration data provided.
2. Three (3) sixty (60) -minute, minimum, O_2, CO, VOC and NOx test runs performed at Engine B at maximum achievable load and speed according to pipeline conditions pursuant to EPA, Title 40, Code of Federal Regulations, Part 60, Appendix A.
3. Process manufacturing operations maintained at 100% of capacities based on pipeline conditions 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 O_2, CO, VOC, and NOx emissions determinations.
5. Stratification was found to be less than 5% in the engine exhaust(s).

The testing program was approved by and/or coordinated with Tyrah Lydia, TC Energy's ANR Pipeline Company. The emission testing was performed by Karl Mast, Manager, Emission Measurement and Project Manager, EQM, and Zach Hill, Test Technician, EQM. Matt Karl, Michigan EGLE observed the testing event.

2. TEST RESULTS SUMMARY

The compliance testing was performed on the Internal Combustion Reciprocating Engine EUERCOMP-B in accordance with the requirements of Permit MI-ROP-N3022-2020a in order to comply with Title 40, Code of Federal Regulations, Part 60, Appendix A. A summary of the test results is given below:

Table 1. Engine EUERCOMP-B Test Results Summary

Measured Unit	Rated Power (HP)	Permit Limit	Results	Pass/Fail
NOx Lb/Hr	2,650	52.6	8.15	Pass
NOx g/HP/Hr		3.0	1.66	Pass
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VOC Lb/Hr		21.03	1.15	Pass
VOC g/HP/Hr		1.2	0.89	Pass

Based on the information provided above, the Engine B 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 Tables 2-4.

Additional testing information may be found in Appendix A.

Table 2. Operating Parameters and Ambient Conditions-Engine B

Run	1	2	3	
Date	07/29/21	07/29/21	07/29/21	
Time	9:50	11:01	12:13	
Engine Operating Conditions	HS-HT	HS-HT	HS-HT	Averages
Unit Horsepower from Control Panel	2,273.0	2,206.0	2,204.0	2,227.7
Unit Speed (rpm)	847.0	824.0	822.0	831.0
Compressor Suction Pressure (PSIG)	572.0	566.0	571.0	569.7
Compressor Suction Temperature (°F)	64.7	64.5	64.8	64.7
Compressor Discharge Pressure (PSIG)	1394.0	1394.0	1396.0	1,394.7
Compressor Discharge Temperature (°F)	88.6	88.2	88.9	88.6
% Load	85.8	83.2	83.2	84.1
% Torque	91.1	90.9	91.1	91.0
Heat Rate (BTU/HP-hr)	6,380.7	6,267.9	6,308.7	6,319.1
Ambient Conditions				
Ambient Temperature (°F)	78.00	79.00	79.00	78.67
Barometric Pressure (psi)	14.24	14.24	14.24	14.24
Ambient Relative Humidity (%)	71.00	71.00	71.00	71.00
Absolute Humidity (grains/LB)	105.70	109.32	109.32	108.11

Table 3. Emissions Concentrations & Calculated Mass Emissions/Calculated Emissions Concentrations/Calculated Flows/Fuel Flows-Engine B

Run	1	2	3	
Date	07/29/21	07/29/21	07/29/21	
Time	9:50	11:01	12:13	
Emissions Concentrations & Calculated Mass Emissions				
NO_x ppm (BIAS Corrected)	292.66	296.39	300.88	296.64
NO_X g/BHP-HR	1.66	1.65	1.67	1.66
NO_X LB/HR	8.34	8.01	8.11	8.15
CO ppm (BIAS Corrected)	362.65	363.76	376.67	367.69
CO g/BHP-HR	1.26	1.23	1.27	1.25
CO LB/HR	6.29	5.99	6.18	6.15
THC ppmvw (As Propane) - Method 25A	431.89	436.70	505.19	457.93
Methane ppmvw	1179.00	1198.70	1391.30	1256.33
Non-Methane/Non-Ethane VOCs ppmvd (As Propane)	43.59	42.05	45.50	43.71
THC g/BHP-HR **	0.85	0.84	0.97	0.89
VOC LB/HR (As Propane) ** - Using Method 18 THC	1.19	1.09	1.18	1.15
VOC g/BHP-hr (As Propane) ** - Using Method 25A Measured THC	0.24	0.23	0.24	0.24
THC LB/HR **	3.21	3.08	3.55	3.28
% O_2 (BIAS Corrected)	8.68	8.62	8.51	8.60
Calculated Flows				
Fuel Flow - (SCFM)	250.17	238.50	239.83	242.83
Fuel Flow - (SCFH)	15,010	14,310	14,390	14,570
Exhaust Flow Method 19 (scfm)	3,970	3,767	3,754	3,830
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	15.01	14.31	14.39	14.57
Fuel Flow (SCFH) From Fuel Orifice	14,445	13,771	13,872	14,029
Fuel Gas Differential Pressure ("H_2O)	34.30	31.7	32.5	33
Fuel Gas Static Pressure (PSIG)	73.80	72.5	71.5	73
Fuel Gas Temperature (^{0}F)	73.00	73.7	73.1	73
** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION	Run 1	Run 2	Run 3	
* BASED ON CARBON BALANCE (STOICH. + 02)				
- A/F IS TOTAL MASS RATIO				

3. PROCESS DESCRIPTION

TC Energy's ANR Eaton Rapids Compressor Station is located at 3349 S Waverly, Eaton Rapids, Michigan. The plant operates three Superior model no. 16SGTB, 2650 HP natural gas fired internal combustion reciprocating engines. The engine are labeled EUERCOMP-B was tested for this event.

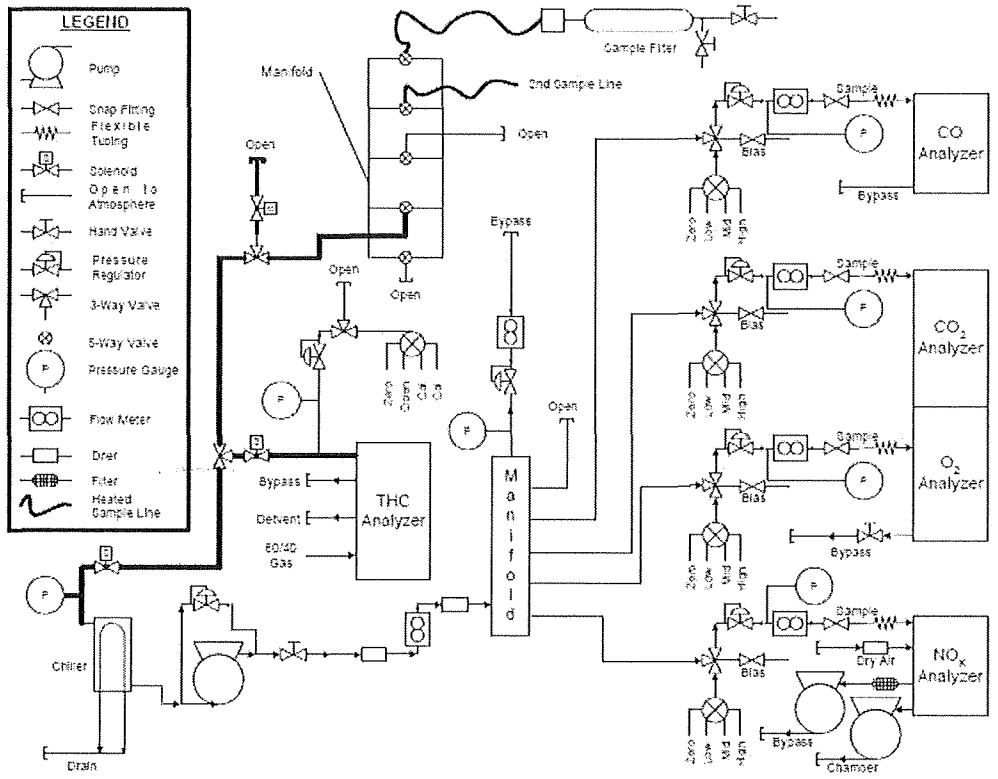
The White Superior 16SGTB is a four-stroke lean burn natural gas fired internal combustion reciprocating engine driving gas compressors. The energy released during the combustion process drives integral reciprocating gas compressors, thus raising the pressure of the incoming natural gas to inject or withdraw natural gas from a natural gas storage field.

The following tables provide a summary of the production rates for the Engine B during the test:

Table 4. Production Data-Horsepower (HP)

Run No.	Horsepower
1	2,273.0
2	2,206.0
3	2,204.0
Average	2,227.7
Rated HP	2,650

Figure 1. Flow Schematic



Additional Information pertaining to the Fuel Flows may be found in Appendix B.

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 10 – Determination of Carbon Monoxide Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 25A – Determination of VOC Emissions From Stationary Sources (Instrumental Analyzer Procedure)

USEPA Methods 3A, 7E, 10, and 25A 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 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

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

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

VOC ppmvd

$$VOC_{ppmvd} = \frac{THC_{ppmvw} - \frac{1}{3}CH_{4\,ppmvd} - \frac{2}{3}C_2H_{6\,ppmvd}}{1 - \left(\frac{\%H_2O}{100}\right)}$$

Mass Emission Calculations Lbs/Hr
Mass Emission Calculations

The F-factor method will be used to calculate mass emission rates for NO_x, CO, and VOC. The fuel specific F_d factor will be used as described in equation 3 of EPA Method 19.

Where:

EM:	Pollutant emission rate, lb/hr
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, measure on a dry basis
GCV:	Upper dry heating value of fuel, Btu/dscf

Mass Emission Calculations g/bhp-hr

$$EM_{\frac{g}{bhp-hr}} = EM_{\frac{lbs}{hr}} \times F_d \times \frac{4536g}{BHP}$$

To Convert from:	To	Multiply by:
ppmvd NO_x	lb/scf	1.194×10^{-7}
ppmvd CO		7.268×10^{-8}
ppmvd VOC		1.1444×10^{-8}

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 Engine B located at TC Energy's ANR Pipeline Company's Eaton Rapids Compressor Station located in Eaton Rapids, MI. The testing was conducted on July 29, 2021.

During the course of the testing, the Engine B conformed to the requirements of Code of Federal Regulations, Title 40, Part 60, Appendix A.

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

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