COMPLIANCE TEST REPORT
ANR PIPELINE-LINCOLN COMPRESSOR STATION
CATERPILLAR EMERGENCY GENERATOR APU

Prepared for:

TC Energy

TC Energy's ANR Pipeline Company
Lake George, MI

Prepared by:

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PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at TC Energy in Lake George, 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 Lincoln Compressor Station in Lake George, MI.

Karl Mast
Test Supervisor

SUMMARY

The compliance testing was performed on the Caterpillar Generator APU in accordance with the requirements of Permit MI-ROP-N-2019, SRN#: N5586, in order to comply with Title 40, Code of Federal Regulations, Part 60, Subpart JJJJ. The results of the testing are detailed in the following tables.

Emergency Generator-APU				
Measured Unit	Rated Power (HP/KW)	Permit Limit	Results	Pass/Fail
NOx ppmvd @ 15% O2	670.5/500	160 ppmvd @ 15% O2	140.42	Pass
CO ppmvd @ 15% O_2	670.5/500	540 ppmvd @ 15% O_2	7.37	Pass
VOC ppmvd @ 15% O_2	670.5/500	86 ppmvd @ 15% O_2	58.25	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 Co. (ANR) at the Lincoln compressor station, near Lake George, MI, which is located in Clare County.

The primary purpose of this testing program was to conduct emissions testing to determine compliance with Permit MI-ROP-N-2019 for the Emergency Generator APU at ANR Pipeline's gas compressor facility.

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 the Caterpillar Emergency Generator APU was performed on Tuesday, January 21, 2020 from 11:45 A.M. to 3:14 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 Emergency Generator APU at maximum achievable load and speed according to pipeline conditions pursuant to EPA, Title 40, Code of Federal Regulations, Part 60, Subpart JJJJ. For determination of VOC concentrations, samples were analyzed as prescribed in Reference Method 18 to reduce methane levels.
3. Process manufacturing operations maintained at 100 +/- 10 percent peak load condition, or at maximum achievable load according with ambient conditions, 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 turbine exhausts.
6. Diluent corrected stratification test was performed in accordance with Subpart JJJJ.

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, Project Manager, EQM and Zach Hill, Field Activities Team Leader, EQM,. The emission testing was observed by Jeremy Howe, MEGLE.

2. TEST RESULTS SUMMARY

The compliance testing was performed on the Emergency Generator APU in accordance with the requirements of the Title 40, Code of Federal Regulations, Part 60 (40 CFR 60, Appendix A [Subpart JJJJ]). A summary of the test results is given below:

Table 1. Test Results Summary -NO_x CO, & VOC-Emergency Generator APU

Emergency Generator-APU				
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NOx ppmvd @ 15% O2	670.5/500	160 ppmvd @ 15% O2	140.42	Pass
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Based on the information provided above, the Emergency Generator APU 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.

Additional testing information may be found in Appendix A.

Table 2. Operating & Ambient Conditions, Concentrations, & Emissions
Generator APU

Summary of Stack Gas Parameters and Test Results APU Lincoln, MI US EPA Test Method 2, 3A, 7, 10, 18, & 25A Outlet Page 1 of 1					
	RUN NUMBER	***O-1***	***O-2***	***O-3***	
	RUN DATE	***1/21/2020***	***1/21/2020***	***1/21/2020***	***Average***
	RUN TIME	***1145-1244***	***1310-1409***	***1415-1514***	
	MEASURED DATA				
CO_2	Carbon Dioxide content, % by volume	8.0	8.0	8.0	8.0
O_2	Oxygen content, % by volume	7.7	7.8	7.7	7.7
N_2	Nitrogen content, % by volume	84.3	84.2	84.4	84.3
C_p	Pitot Tube Coefficient	0.84	0.84	0.84	0.84
	Circular Stack? 1=Y,0=N:	1	1	1	1.0000
As	Diameter or Dimensions, inches:	10.00	10.00	10.00	10.00
	CALCULATED DATA				
P_s	Stack Pressure, inches Hg	29.15	29.15	29.15	29.15
B_{ws}	Moisture, % by volume	12.1	11.9	11.3	11.8
M_d	Molecular Weight (d.b.), lb/lb•mole	29.59	29.59	29.59	29.59
A	Stack Area, ft^2	0.545	0.545	0.545	0.55
	Kilowatts	**466.4**	**466.13**	**465.88**	
	Oxygen				
O_2	**Concentration PPM Dry**	**7.66**	**7.82**	**7.65**	**7.71**
	Nitrogen Oxides				
NO_x	**Concentration PPM Dry**	**321.09**	**305.96**	**314.79**	**313.95**
NO_x	**Concentration PPM Dry @ 15% O_2**	**143.08**	**138.01**	**140.17**	**140.42**
	Carbon Monoxide				
CO	**Concentration PPM Dry**	**16.88**	**16.64**	**15.93**	**16.48**
CO	**Concentration PPM Dry @ 15% O_2**	**7.52**	**7.51**	**7.09**	**7.37**
	Total Hydrocarbons				
THC	**Concentration PPM Wet C1**	**1350.1**	**1341.82**	**1047.3**	**1246.41**
THC	**Concentration PPM Dry C1**	**1513.50**	**1501.87**	**1165.76**	**1393.71**
CH_4	**Concentration PPM Bag Sample**	**1040**	**823**	**1150**	**1004.33**
VOC	**Concentration PPM Dry C1**	**473.50**	**678.87**	**15.76**	**389.37**
VOC	**Concentration PPM Dry C3**	**157.83**	**226.29**	**5.25**	**129.79**
VOC	**Concentration PPM Dry @ 15% O_2**	**70.33**	**102.07**	**2.34**	**58.25**

3. PROCESS DESCRIPTION

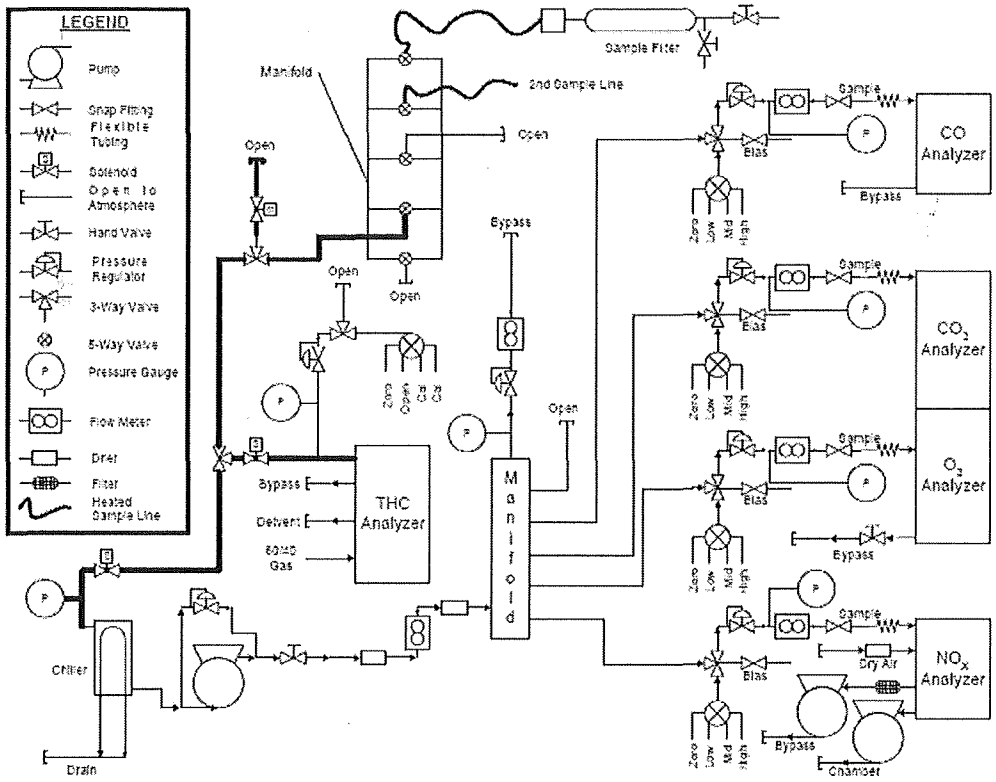
TC Energy's ANR Lincoln Compressor Station is located at 3991 South Hickory, Lake George, Michigan. The plant operates a Caterpillar 3412C, which is a natural gas fired internal combustion reciprocating engine with a rating of 500 Kilowatts and 670.5 Horsepower. It is utilized for supporting energy needs for the station.

The following tables provide a summary of the production rates for the Emergency Generator APU during the test:

Table 3. Production Data

Generator APU Horse Power (HP/KW)		
Run No.	**APU HP**	**APU KW**
1	625.5	466.4
2	625.1	466.1
3	624.8	465.9
Average	625.1	466.1
Rated	670.5	500

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 18 – Determination of VOC Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 25A – Determination of VOC Emissions From Stationary Sources (Instrumental Analyzer Procedure)
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USEPA Methods 3A, 7E, 10, 18 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

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

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 g/bhp-hr

$$Em = Cd \times Fd \times \frac{20.9}{(20.9 - \%O_2)} \times Qh \times \frac{GCV}{10^6} \times \frac{453.6}{BHP}$$

Where:

E_m: Pollutant concentration, $NOx_{(g/bhp\text{-}hr)}$
Cd: Pollutant concentration, NOx lb/scf
$\%O_2$: Oxygen concentration in percent, measured on a dry basis
Fd: Fuel specific F-factor, dscf/MMBtu
Qh: Fuel rate, scf/hr
GCV: Heating value fuel, Btu/scf

To convert from ppmvd NOx to lb/scf NOx, multiply the ppmvd value by 1.194×10^{-7}

To convert from ppmvd CO to lb/scf CO, multiply the ppmvd value by 7.268×10^{-8}

Mass Emission Calculations lb/hr

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

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

Kilowatt to Horsepower Calculation

kW X 1.341=HP

Where:

kW Kilowatt
HP: Horsepower

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 Generator APU at TC Energy's ANR Pipeline Company's Lincoln Compressor Station located in Lake George, MI. The testing was conducted on January 21, 2020.

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

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

A. FIELD TEST DATA