1. INTRODUCTION

This report presents the results of the source emissions testing conducted by Environmental Quality Management, Inc. (EQ) for TransCanada's ANR Storage Company's (ANR) Rapid River Compressor Station, near Kalkaska, MI.

The primary purpose of this testing program was to conduct emissions testing to determine compliance on the internal combustion reciprocating engine, labeled EURRCOMP-A (Unit A) in fulfillment with the Renewable Operating Permit requirements (ROP No. B7197-2017, Section D.V.1.) issued by the Michigan Department of Environment, Great Lakes, and Energy (MEGLE).

The following report provides information pertaining to TransCanada's process operations, and Compliance testing. The Compliance testing conducted on Unit A was performed on April 14, 2020, from 10:30 A.M. to 12:39 P.M.

The following requirements were specific for the testing program:

1. Equipment calibrations performed and calibration data provided.
2. Three (3) one (1) -hour, minimum, NOx and O2 test runs performed at the Unit A pursuant to EPA Reference methods as described in 40 CFR, Part 60, Appendix A.
3. Process manufacturing operations maintained at 100% of capacities based on pipeline conditions. 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 NO_x and O_2 emissions determinations.
5. Stratification was found to be less than 5% in the engine exhaust from previous data in 2010 that Robert Dickman approved to be included in this report.

The testing program was approved by and/or coordinated with Tyrah Lydia, TC Energy's ANR Pipeline Company. The emission testing was overseen by Karl Mast, Manager, Emission Measurement, EQM, performed by Zach Hill, Field Activity Team Leader, EQM and Kameron King, Test Technician, EQM. The emission testing was observed by Robert Dickman, MEGLE
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2. TEST RESULTS SUMMARY

The compliance testing was performed on Unit A in accordance with the requirements (ROP No. B7197-2017, Section D.V.1.) issued by the Michigan Department of Environmental Quality, Air Quality Division. A summary of the test results is given below:

Table 1. NO_x Lb/Hr Results-Limit 99.2 Lbs/Hr

Engine	Run 1	Run 2	Run 3	Average
Unit A	59.29	59.56	60.53	59.79

Based on the information provided above, the Unit A 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 2-6.

Additional testing information may be found in Appendix A.

Table 2. Operating Parameters and Ambient Conditions-Unit A

Run	1	2	3	
Date	04/14/20	04/14/20	04/14/20	
Time	10:30	11:40	12:50	
Engine Operating Conditions	HS-HT	HS-HT	HS-HT	Averages
Unit Horsepower from Control Panel	3,432.0	3,435.0	3,414.0	3,427.0
Unit Speed (rpm)	342.0	342.0	340.0	341.3
Compressor Suction Pressure (PSIG)	764.0	762.0	761.0	762.3
Compressor Suction Temperature (^{o}F)	44.0	44.0	44.0	44.0
Compressor Discharge Pressure (PSIG)	2557.0	2560.0	2562.0	2,559.7
Compressor Flow (MMSCF/D)	55.7	55.7	55.0	55.4
% Load	91.5	91.6	91.0	91.4
% Torque	93.7	93.7	93.7	93.7
Heat Rate (BTU/HP-hr)	6,984.3	6,978.2	7,021.1	6,994.5
Ambient Conditions				
Ambient Temperature (^{o}F)	22.00	29.00	30.00	27.00
Barometric Pressure (psi)	14.12	14.13	14.13	14.13
Ambient Relative Humidity (%)	84.00	57.00	62.00	67.67
Absolute Humidity (grains/LB)	31.28	28.35	32.14	30.59

Table 3. Emissions Concentrations/Calculated Mass Emissions & Emissions Concentrations & Flows – Unit A

Run	1	2	3	
Date	04/14/20	04/14/20	04/14/20	
Time	10:30	11:40	12:50	
Emissions Concentrations & Calculated Mass Emissions				Averages
NO_x ppm (BIAS Corrected)	1065.20	1075.33	1088.57	1076.37
NO_X g/BHP-HR	7.84	7.87	8.04	7.91
NO_X LB/HR	59.29	59.56	60.53	59.79
NO_X (ppm @ 15% O_2)	606.63	609.46	619.34	611.81
NO_X (ppm @ 15% O_2, ISO)	953.68	929.55	951.39	944.87
NOx LB/MMBTU	2.24	2.25	2.28	2.26
NO_X Tons/Year	259.68	260.89	265.12	261.89
NO_X LB/SCF Fuel	0.0024	0.0024	0.0024	0.0024
CO ppm (raw measured dry)	196.93	191.32	193.62	193.96
CO g/BHP-HR	0.88	0.85	0.87	0.87
CO LB/HR	6.67	6.45	6.55	6.56
CO LB/MMBTU **	0.25	0.24	0.25	0.25
CO (ppm @ 15% O_2)	112.15	108.43	110.16	110.25
CO (ppm @ 15% O_2, ISO)	176.31	165.38	169.22	170.31
CO Tons/Year	29.22	28.25	28.70	28.73
% O_2 (BIAS Corrected)	10.54	10.49	10.53	10.52
Calculated Emissions Concentrations				
% CO_2 (Wet) *	5.28	5.30	5.28	5.29
%CO_2 (Dry) *	5.92	5.94	5.92	5.93
% H_2O *	10.82	10.81	10.84	10.82
% O_2 (Wet) *	9.40	9.36	9.39	9.38
% N_2 + CO (Wet) *	74.51	74.54	74.49	74.51
Calculated Flows				
Fuel Flow - (SCFM)	416.67	416.67	416.67	416.67
Fuel Flow - (SCFH)	25,000	25,000	25,000	25,000
Exhaust Flow (LB/HR)	32,085.3	31,729.8	31,866.1	31,894
Exhaust Flow (WSCFM)	8,373.7	8,342.6	8,367.5	8,361
Air Flow (WSCFM)	7,507	7,471	7,500	7,493
Exhaust Flow Method 19 (wscfm)	7,753	7,716	7,746	7,739
Exhaust Flow Method 19 (lbm/min)	360	359	360	360
Exhaust Flow Carbon Balance (lbm/min)	613.71	610.94	613.16	613
Air flow Beshouri (scfm)	7,980.51	7,944.41	7,973.26	7,966
BSAC, #/BHP-hr	9.97	9.91	10.01	10
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	25.00	25.00	25.00	25.00
** 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. PROCESS DESCRIPTION

TC Energy's ANR Rapid River Compressor Station is located in Kalkaska, Michigan and operates an affected engines. Units EURRCOMP-A (serial number 410KVR152A) is an Ingersoll Rand 410-KVRTEnatural gas fired internal combustion reciprocating engine rated at 3,750 hp and 350 rpm.

The Ingersoll Rand KVR-410-TE 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 move it toward another compressor gas station, into or out of the gas storage facility, or the final user.

The following tables provide a summary of the production rates for the Unit A and Unit B during the test:

Table 4. Unit A Plant Data-Horse Power	
Run No.	**Horse Power**
1	3,432
2	3,435
3	3,414
Average	3,427
Rated HP	3,750

Table 5. Unit A General Information

General Information

Date:	14-Apr-20
Company:	ANR
Station:	Rapid River
Unit:	Unit A
Engine Type:	KVR-410-TE
Serial Number:	410KVR152A
Rated RPM:	350 RPM
Rated BHP:	3750 BHP

Permit Limits

	ppm@15%	g/Bhp-Hr	lb/hr	TPY
NOx:			99.2	
CO:				
VOC:				
H2CO:				

Limits are actuallly listed as average values

Fuel Gas Analysis

Constituent	Mole Percent
Nitrogen	0.821
Carbon Dioxide	0.815
Methane	90.821
Ethane	6.887
Propane	0.525
I-Butane	0.032
N-Butane	0.046
I-Pentane	0.012
N-Pentane	0.004
Hexane +	0.039
Total	100.00

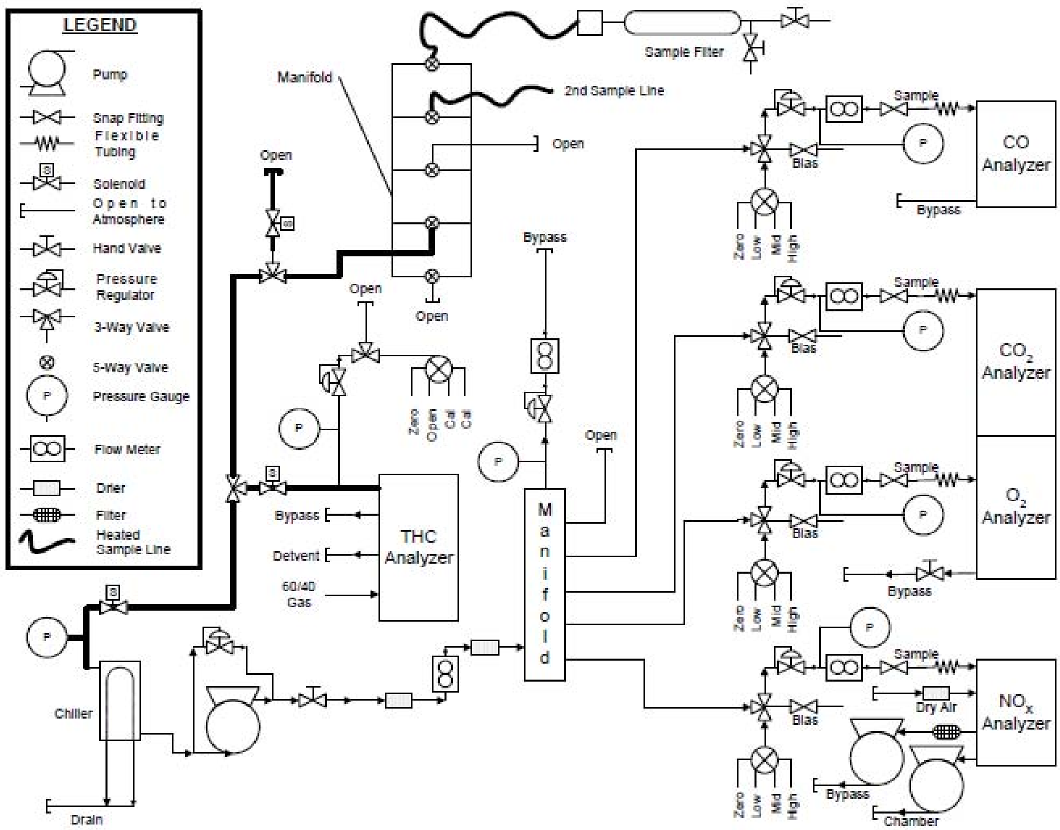
Fuel Meter Type

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. 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)

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 Unit No. 1 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

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

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 Lb/Hr

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

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

To Convert from:	To	Multiply by:
ppm NO_x	lb/scf	1.194×10^{-7}

NO_x Corrected to 15% O_2

$$Em = NO_X\left(\frac{5.9}{20.9 - \%O_2}\right)$$

Where:

$E_{m:}$ Pollutant concentration corrected to 15% O_2, ppm
NO_x: Pollutant concentration, ppm
$\%O_2$: Oxygen concentration in percent, measured on a dry basis

No testing or sample recovery procedure deviations or errors occurred during the onsite sampling phase of the testing program.

No significant process deviations or upsets occurred during the emissions testing periods.

The emissions test data and supporting data collected during the field sampling can be found in Appendix A of this report.

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 Unit A at TC Energy's ANR Pipeline Company's Rapid River Compressor Station located in Kalkaska, MI. The testing was conducted on April 14, 2020

During the course of the testing, the Engine Unit A 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 Unit A emissions shall be determined by others.

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