COMPLIANCE TEST REPORT
WOOLFOLK COMPRESSOR STATION
ENGINE APU

Prepared for:

TransCanada
In business to deliver

TransCanada's ANR Pipeline Company
Big Rapids, MI

Prepared by:

EQM

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PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at TransCanada in Big 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's Woolfolk Compressor Station in Big Rapids, MI

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Karl Mast
Test Supervisor

SUMMARY

The compliance emissions testing was performed on Engine APU to comply with the established NOx standards pursuant to testing requirements specified in Permit MI-ROP-B7220-2017a, section C, sub-section V, (R336.1213(3)). The testing was performed in accordance with the requirements of the Code of Federal Regulations, Title 40, Part 60, Subpart JJJJ [40 CFR 60 JJJJ].. A summary of the test results is given below:

Engine APU				
Measured Unit	**Rated Power (HP)**	**Permit Limit**	**Results**	**Pass/Fail**
NOx ppmvd @ 15% O_2	≥500	160 ppmvd @ 15% O_2	143.60	Pass
CO ppmvd @ 15%O_2		540 ppmvd @ 15%O_2	144.10	Pass
VOC ppmvd @ 15%O_2		86 ppmvd @ 15%O_2	85	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 TransCanada's ANR (ANR) Woolfolk Compressor Station, near Big Rapids, MI, which is located in Mecosta County. The primary purpose of this testing program was to conduct emissions testing to determine compliance with operating permit No. MI-ROP-B7220-2017, section C, sub-section V, (R336.1213(3)) for the Combustion Engine Unit APU at ANR Pipeline's gas compressor facility.

To ensure that compliance with the emission limits is maintained, the Air Compliance Team of TransCanada's ANR Pipeline Company (ANR) contracted Environmental Quality Management, Inc. (EQM) to perform source emissions testing on Engine APU. The primary purpose of this testing program was to conduct emissions testing to determine compliance with permit No. MI-ROP-B7220-2017 at ANR Pipeline Co.'s Woolfolk gas compressor facility.

EQM's responsibility was to conduct the compliance testing for the NO_x, CO, and VOC emission 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 TransCanada's process operations, and Compliance testing. The Compliance testing conducted on Engine APU was performed on November 30, 2018 from 9:25 A.M. to 12:57 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, O_2, CO, NO_x, and VOC test runs performed at the Engine APU pursuant to EPA Reference methods as described in 40 CFR, Part 60, Appendix A.
3. Process manufacturing operations maintained at 100% +/- 10 percent 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 O_2, CO, NO_x, and VOC, emissions determinations.
5. Stratification was found to be less than 5% in the engine exhaust.

The testing program was approved by and/or coordinated with Shawn Flannigan, TransCanada's ANR Pipeline Company. The emission testing was managed by Karl Mast, Manager Air Emissions, EQM and Zach Hill, Team Leader, EQM. Test Technician, EQM. The emission testing was observed by Jeremy Howe, MDEQ.

2. TEST RESULTS SUMMARY

The compliance testing was performed on Engine APU system in accordance with the requirements of the Code of Federal Regulations, Title 40, Part 60, Appendix A. A summary of the test results is given below:

Table 1. NO_x Test Results Summary -Engine APU

Engine APU				
Measured Unit	**Rated Power (HP)**	**Permit Limit**	**Results**	**Pass/Fail**
NOx ppmvd @ 15% O_2	≥500	160 ppmvd @ 15% O_2	143.60	Pass
CO ppmvd @ 15%O_2		540 ppmvd @ 15%O_2	144.10	Pass
VOC ppmvd @ 15%O_2		86 ppmvd @ 15%O_2	85	Pass

Based on the information provided above, the Engine 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 2-5.

Table 2. Measured & Calculated Data-Engine APU

Summary of Stack Gas Parameters and Test Results
APU
Woolfolk
US EPA Test Method 2- Velocity
Outlet
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	RUN NUMBER	O-1	O-2	O-3	
	RUN DATE	11/30/2018	11/30/2018	11/30/2018	Average
	RUN TIME	810-910	915-1015	1020-1120	
	MEASURED DATA				
P_{static}	Stack Static Pressure, inches H_2O	0.17	0.17	0.17	0.17
P_{bar}	Barometric Pressure, inches Hg	28.75	28.75	28.75	28.75
CO_2	Carbon Dioxide content, % by volume	7.6	7.6	7.6	7.6
O_2	Oxygen content, % by volume	7.9	7.9	7.9	7.9
N_2	Nitrogen content, % by volume	84.5	84.5	84.5	84.5
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:	12.00	12.00	12.00	12.00
	CALCULATED DATA				
P_s	Stack Pressure, inches Hg	28.76	28.76	28.76	28.76
B_{ws}	Moisture, % by volume	9.8	9.3	9.6	9.6
M_d	Molecular Weight (d.b.), lb/lb•mole	29.53	29.53	29.53	29.53
A	Stack Area, ft^2	0.785	0.785	0.785	0.79

Table 3. Emissions Test Results-Engine APU

	Oxygen				
O_2	Concentration PPM Dry	7.61	7.63	7.57	7.60
	Nitrogen Oxides				
NO_x	Concentration PPM Dry	334.14	316.2	320.53	323.62
NO_x	Concentration PPM Dry @ 15% O_2	148.34	140.59	141.87	143.60
	Carbon Monoxide				
CO	Concentration PPM Dry	324.94	324.59	324.72	324.75
CO	Concentration PPM Dry @ 15% O_2	144.25	144.32	143.72	144.10
	Total Hydrocarbons				
THC	Concentration PPM Wet C1	515.94	541.35	515.86	524.38
THC	Concentration PPM Wet C3	171.98	180.45	171.95	174.79
THC	Concentration PPM Dry C3	188.81	197.29	188.54	191.55
THC	Concentration PPM Dry @ 15% O_2	83.82	87.72	83.45	85.00

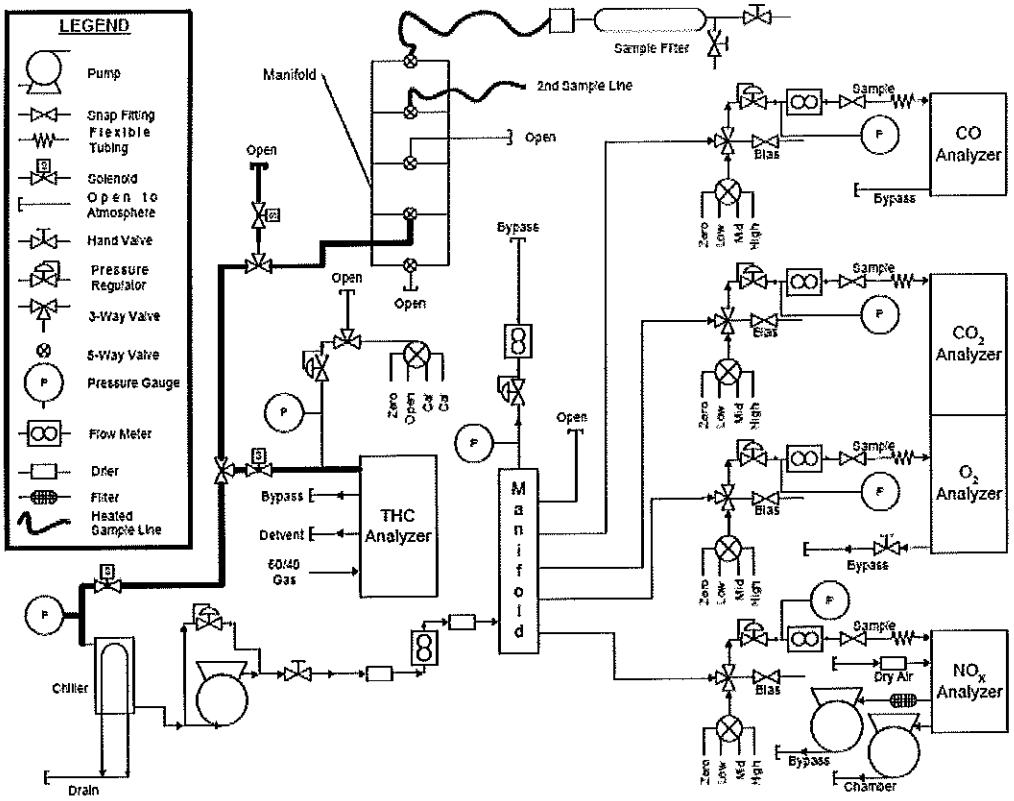
TransCanada's ANR Woolfolk Compressor Station (ANR) is located in Big Rapids, MI and operates a natural gas fired compressor station. The plant is located at 11039 150th Avenue, Big Rapids, MI. The Engine APU replaces the emergency generators (EUWLGEN001 and EUWLGEN002), which was scheduled to be removed from the site on September 5, 2017. The new emergency generator (APU) was installed to replace the two older generators.

The APU is expected to meet the exemption R 336.1285(g). The new emergency generator is subject to the New Source Review Standards (NSPS) of Performance for Stationary Spark Ignition Internal Combustion Engines (40 CFR Part 60, Subpart JJJJ) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Stationary Reciprocating Internal Combustion Engines (40 CFR Part 63, Subpart ZZZZ). The Conditions relevant to the NSPS and NESHAP will be incorporated into the ROP during the next Renewal.

Table 4. Engine APU Production Data (Horse Power)

Engine APU Production Data (HP)	
Run No.	Horse Power
1	799.6
2	796.8
3	797.4
Average	797.9

Figure 1. Engine APU 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 2 – Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
- U.S. EPA Method 3A – Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S EPA Method 4 – Determination of Moisture Content in Stack Gases
- 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 1, 2 and 4 were performed at the Exhaust Stack sampling location utilizing an Apex Instruments, Model 522, control unit and sampling train incorporating an 8'effective length, stainless-steel probe with a heated, borosilicate glass liner, stainless-steel nozzle and Type S, stainless-steel pitot tube, ¼" O.D., stainless-steel static pressure/gas sampling tube and Type K (Chromel/Alumel) thermocouples; an aluminum filter oven and borosilicate glass filter holders with Teflon filter supports with Viton-O-Rings, and 0.3 micron (99.9% retention), Whatman 8.2 cm, Type 934-AH, glass microfiber filters; foam insulated, aluminum impinger units with two (2) Greenburg-Smith and two (2) modified Greenburg-Smith glass impinger bottles, and a stainless-steel umbilical adapter with Type K (Chromel/Alumel) gas exit thermocouple; and a 90' umbilical with various interconnecting fittings, plugs and connectors.

USEPA Methods 3A, 7E, 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 for the Engine APU 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

NO_x Gr/bhp/hr

$$NOx_{\frac{g}{bhp\text{-}hr}} = C_d \times F_d \times \frac{20.9}{20.9 - \%O_2} \times Q_h \times \frac{GCV}{10^6} \times \frac{4536}{Bhp}$$

Where:

Cd:	Pollutant concentration, lb/scf
Fd:	Fuel specific F-factor, dscf/MMBtu
Qh:	Fuel flow, scf/hr
$\%O2$:	Oxygen concentration in percent, measured on a dry basis
GCV:	Upper dry heating value of fuel, Btu/dscf

Mass Emissions 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:

Cd: Pollutant concentration, lb/scf
Fd: Fuel specific F-factor, dscf/MMBtu
Qh: Fuel flow, scf/hr
%O2: 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 APU at TransCanada's ANR Pipeline Company's Woolfolk Compressor Station located in Big Rapids, Michigan. The testing was conducted on November 30, 2018.

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

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