Emissions Test Report

Units EUWL001 to EUWL005, Five Ingersoll Rand KVG-103 Gas Fired Internal Combustion Reciprocating Engines and Units EUWL006 to EUWL009, Four Ingersoll Rand KVG-123 Gas Fired Internal Combustion Reciprocating Engines

Permit No.: MI-ROP-B7220-2012a

ANR Pipeline Company
Woolfolk Compressor Station
Big Rapids, Michigan.

Date:	**June 16, 2015**
Prepared for:	**Michigan Department of Environmental Quality. Air Quality Division.**
Prepared by:	**Pedro Amieva.** **Plant Reliability (832) 320-5839**

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating (RO) Permit program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as described in General Condition No. 22 in the RO Permit and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name: ANR Pipeline Company, Woolfolk Compressor Station — County: Mecosta

Source Address: 11750 150th Avenue — City: Big Rapids

AQD Source ID (SRN): B7220 — RO Permit No.: MI-ROP-B7220-2012a — RO Permit Section No.: 1

Please check the appropriate box(es):

☐ **Annual Compliance Certification (General Condition No. 28 and No. 29 of the RO Permit)**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the RO Permit.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the RO Permit, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the RO Permit, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (General Condition No. 23 of the RO Permit)**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the RO Permit were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From 5/1/2015 To 9/30/2015

Additional monitoring reports or other applicable documents required by the RO Permit are attached as described:

Ozone Season Monitoring per R336.1818(4)(a)(ii)

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete.

Randall Schmidgall	Vicepresident Operations US	(832) 320-5511
Name of Responsible Official (print or type)	Title	Phone Number
Signature of Responsible Official		7/17/2015 Date

* Photocopy this form as needed.

EQP 5736 (Rev 9/01)

1. Introduction

1.1. The Plant Reliability Department of TransCanada's US Pipelines Central conducted monitoring at ANR Woolfolk Compressor Station (SRN: B7220) pursuant to the Compliance Plan ANR submitted to comply with R336.1818(3)(a). The Compliance Plan has been approved by the MDEQ.

1.2. The purpose of the monitoring was to comply with the ozone season monitoring requirement in the ANR Compliance Plan and is in accordance with R336.1818(4)(a)(ii)(A)(2). The monitoring demonstrates compliance with the projected NOx emission rate in the ANR Compliance Plan. As such, the following parameter was determined:

1.2.1. Woolfolk Units #20011 to #20099: ***20.5 g/bhp-hr of NOx***

1.3. Facilities Information:

ANR Woolfolk Compressor Station
11750 150th Avenue
Big Rapids, MI 49307

Environmental Contact
Melinda Holdsworth
717 Texas Street, Suite 24155B
Houston, TX 77002
(832) 320-5665

2. Process Description

2.1. Woolfolk compressor station operates nine NOx SIP affected engines; 2001 through 2005 are Ingersoll-Rand KVG-103, 1,000 HP each and 2006 through 2009 are Ingersoll-Rand KVG-123, 1,320 HP each. All engines are natural gas fired, reciprocating internal combustion engine used in Natural Gas Transmission. More specifically, the engine is used in the compression of natural gas from an initial "suction" pressure to a final "discharge" pressure, which creates the pressure gradient necessary to transport natural gas through ANR Pipeline's interstate pipeline system

3. Methodology

3.1. American Society of Testing and Materials test method D6522-00: Standard Test Method for Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Concentrations in Emissions from Natural Gas-Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers was employed for determination of compliance with Section 1.2.1.

4. Sample System

4.1. Sample system components, as outlined in Method D6522-00, were utilized for monitoring. These components include, but are not limited to, sample probe, heated sample line, sample transport lines, calibration assembly, moisture removal system, particulate filter, sample pump, sample flow rate control, gas analyzer, data recorder, and external interference gas scrubber.

5. Sample Location

5.1. Sampling location was selected as specified in sections 10.1.1 and 10.1.2 of Method D6522-00 at a location of five duct diameters downstream of any flow disturbance and three duct diameters upstream of the discharge to atmosphere.

5.2. All the stratification sampling for all the units showed a variance in concentration of less of 5%, therefore, as per section 10.1.4 of Method D6522-00, sampling was taken from a single point located in the center of the stack.

6. Sample Time

6.1. Monitoring was conducted during normal engine operation, i.e. not during periods of startup, shutdown, or malfunction. Each engine was monitored at the maximum load achievable based upon pipeline and ambient conditions.

6.2. Each engine was sampled at three 30-minutes test runs. Samples were taken at a frequency of once per minute.

7. Results

7.1. Results of the monitoring demonstrated that all units tested below the permitted levels of 20.5 g/BHP-hr. Detailed emissions summaries and calibration records can be found in the following pages.

Test Summary

General Information

Company: TransCanada US Pipelines

Station: ANR Woolfolk

Unit Information

Unit No.: 2001 to 2005

Manufacturer: INGERSOLL RAND

Model: KVG-103

Rated BHP: 1,000

Rated RPM: 330

General Data					
Unit	**2001**	**2002**	**2003**	**2004**	**2005**
Test Date	6/17/15	6/17/15	6/18/15	6/19/15	6/19/15
Operating Data					
Horsepower	915	932	944	957	954
Speed	325	329	330	331	330
% Load	91.5%	93.2%	94.4%	95.7%	95.4%
% Torque	92.8%	93.4%	94.6%	95.4%	95.4%
Fuel Use (scfh)	8,546	8,660	8,688	9,267	8,620
Emissions Data					
NOx Limit	**20.5 g/bhp-hr**				
NOx (ppm)	1559.7	2659.7	1625.4	2748.3	1711.2
NO_X (ppm@ 15% O_2)	558.0	917.9	643.0	915.5	598.0
NO_X (lb/hr)	18.8	31.3	22.0	33.5	20.4
NO_X (g/bhp-hr)	9.3	15.2	10.6	15.9	9.7
NO_X (TPY)	82.2	137.1	96.3	146.8	89.3
O_2 (%)	4.4	3.8	6.0	3.4	4.0

Test Summary

General Information

Company: TransCanada US Pipelines

Station: ANR Woolfolk

Unit Information

Unit No.: 2006 to 2009

Manufacturer: INGERSOLL RAND

Model: KVG-123

Rated BHP: 1,320

Rated RPM: 330

General Data				
Unit	**2006**	**2007**	**2008**	**2009**
Test Date	6/23/15	6/23/15	6/24/15	6/25/15
Operating Data				
Horsepower	1,265	1,266	1,242	1,258
Speed	331	330	330	328
% Load	95.9%	95.9%	94.1%	95.3%
% Torque	95.6%	95.9%	94.0%	95.9%
Fuel Use (scfh)	11,721	11,393	11,201	11,582
Emissions Data				
NOx Limit	**20.5 g/bhp-hr**			
NOx (ppm)	1,162.4	1,348.9	1,115.2	1,340.4
NO_X (ppm@ 15% O_2)	461.9	506.7	440.6	494.4
NO_X (lb/hr)	21.4	22.8	19.5	22.5
NO_X (g/bhp-hr)	7.7	8.2	7.1	8.1
NO_X (TPY)	93.8	100.0	85.2	98.4
O_2 (%)	6.0	5.2	6.0	4.9

Unit 2001

Emissions Data Sheet Summary
Sample Calculations
General Information
Linearity Check
NO Stability Check
NO_2 Stability Check
Calibration Error
Engine Operating Data
Run 1 – 3

Data Summary

General Information

Start Date: 6/17/2015

Company: ANR

Station: Woolfolk

Unit Information

Unit No.: 2001

Manufacturer: I/R

Model: KVG 103

Rated BHP: 1000

Rated RPM: 330

Gas Analysis

Nitrogen:	1.5306	I - Butane:	0.112
Carbon Dioxide:	0.7633	N - Butane:	0.1756
Methane:	89.5604	I - Pentane:	0.0275
Ethane:	6.5561	N - Pentane:	0.0222
Propane:	1.2353	Hexane +:	0.0171

Total: 100.000

Test Data

General Data				
Run	**1**	**2**	**3**	**Averages**
Date	6/17/15	6/17/15	6/17/15	
Time	8:56:50 AM	10:18:19 AM	2:22:37 PM	
Operating Data				
Horsepower	926	921	898	**915**
Speed	325	326	326	**325**
% Load	92.6%	92.1%	89.8%	**91.5%**
% Torque	94.1%	93.4%	90.9%	**92.8%**
Fuel Use (scfh)	8,650	8,593	8,395	**8,546**
UDHV (BTU/dscf)	1,068.7	1,068.7	1,068.7	**1,068.7**
Curve	1	1	1	**1**
AMP (psig)				
AMT (^{o}F)				
Suct. Press. (psig)	383	380	262	**342**
Suct. Temp. (^{o}F)	58.2	61.6	58.3	**59.3**
Disc. Press. (psig)	680	673	606	**653**
Disc. Temp. (^{o}F)	72.9	74.9	77.8	**75.2**
Emissions Data				
NO (ppm)	1365.34	1467.61	1466.82	**1433.26**
NO Bias corrected (ppm)	1396.88	1502.15	1501.31	**1466.78**
NO_2 (ppm)	85.98	91.31	92.89	**90.06**
NO_2 Bias corrected (ppm)	88.73	94.23	95.85	**92.94**
NO_X (ppm)	1485.61	1596.38	1597.16	**1559.72**
NO_X (ppm@ 15% O_2)	534.15	571.64	568.29	**558.03**
NO_X (lb/hr)	18.19	19.34	18.78	**18.77**
NO_X (g/bhp-hr)	8.9	9.5	9.5	**9.3**
NO_X (TPY)	79.7	84.7	82.3	**82.2**
O_2 (%)	4.49	4.42	4.32	**4.41**

Sample Calculation

1) 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)

Example: Run 1 - NO

C_R:	1365.34	ppmvd
C_O:	8.375	ppmvd
C_M:	2456.38	ppmvd
C_{MA}:	2520	ppmvd

C_{GAS} = 1396.88 ppmvd

2) NO Interference Response

$$I_{NO} = \left[\left(\frac{R_{NO-NO2}}{C_{NO2G}} \times \frac{C_{NO2S}}{C_{NOxS}}\right)\right] \times 100$$

Where:

I_{NO}: NO interference response (%)
R_{NO-NO2}: NO response to NO_2 span gas (ppm NO)
C_{NO2G}: Concentration of NO_2 span gas (ppm NO_2)
C_{NO2S}: Concentration of NO_2 in stack gas (ppm NO_2)
C_{NOxS}: Concentration of NO_x in stack gas (ppm NO_x)

Example:

R_{NO-NO2}:	4.0	ppm NO
C_{NO2G}:	101.0	ppm NO_2
C_{NO2S}:	90.1	ppm NO_2
C_{NOxS}:	1523.3	ppm NO_x

I_{NO} = 0.23 %

General Information

General Information

Start Date: 6/17/2015

Company: ANR

Station: Woolfolk

Unit Information

Unit No.: 2001

Manufacturer: I/R

Model: KVG 103

Rated BHP: 1000

Rated RPM: 330

Analyzer Information

Manufacturer: ECOM

Model: EN2F

Serial Number: 5169 OCNX

Calibration Gas Selection Criteria

Pollutant	Expected Concentration	Gas Ranges	Must be greater than	Must be less than	Calibration Concentration	Bottle Number
NO (ppm)	2000	Span Gas	1600	8000	2520	CC70218
		Mid Gas	1008	1512	995	ALM004704
NO2 (ppm)	60	Span Gas	48	240	101	AAL67757
		Mid Gas	40.4	60.6	50.7	CC61265
O2 (%)	5.5	Span Gas	0	15.5	12.2	BAL4245
		Mid Gas	4.88	7.32	6.02	ALM040227

Emissions Permit Limit

Pollutant	Applicable Permit Limits	
	ppm @15% O_2	g/bhp-hr
NO_x		20.5

Linearity Check

General Information

Date: 6/17/2015

Company: ANR

Station: Woolfolk

Unit: 2001

Analyzer Information

Manufacturer: ECOM

Model Number: EN2F

Serial Number: 5169 OCNX

Calculations

	Standard Concentration	Analyzer Response	Absolute Difference	Percent Difference	Allowable Difference
NO Zero	0.00	0.00	0.00	**0.00%**	2.50%
NO Span	2520.00	2527.25	7.25	**0.29%**	2.50%
NO Mid	995.00	993.00	2.00	**0.08%**	2.50%
NO_2 Zero	0.00	0.00	0.00	**0.00%**	3.00%
NO_2 Span	101.00	99.00	2.00	**1.98%**	3.00%
NO_2 Mid	50.70	52.75	2.05	**2.03%**	3.00%
O_2 Zero	0.00	0.00	0.00	**0.00%**	2.50%
O_2 Span	12.20	12.20	0.00	**0.00%**	2.50%
O_2 Mid	6.02	6.00	0.02	**0.16%**	2.50%

NO Stability Check

General Information

Date: 6/17/2015

Company: ANR

Station: Woolfolk

Unit: 2001

Analyzer Information

Manufacturer: ECOM

Model Number: EN2F

Serial Number: 5169 OCNX

Span Gas Conc.: 2520

Data Entry

Elapsed Time (Minutes)	Analyzer Response	Elapsed Time (Minutes)	Analyzer Response	Elapsed Time (Minutes)	Analyzer Response
1	2531	16		31	
2	2530	17		32	
3	2530	18		33	
4	2530	19		34	
5	2530	20		35	
6	2530	21		36	
7	2531	22		37	
8	2530	23		38	
9	2531	24		39	
10	2531	25		40	
11	2531	26		41	
12	2530	27		42	
13	2530	28		43	
14	2530	29		44	
15	2531	30		45	

Calculations

Stability Time: 10 minutes

Stability Period	Maximum Response	Minimum Response	Maximum Deviation	Allowable Deviation
15 Minutes	2531.00	2530.00	**0.04%**	1.00%

NO_2 Stability Check

General Information

Date: 6/17/2015

Company: ANR

Station: Woolfolk

Unit: 2001

Analyzer Information

Manufacturer: ECOM

Model Number: EN2F

Serial Number: 5169 OCNX

Span Gas Conc.: 101

Data Entry

Elapsed Time (Minutes)	Analyzer Response	Elapsed Time (Minutes)	Analyzer Response	Elapsed Time (Minutes)	Analyzer Response
1	101	16		31	
2	101	17		32	
3	101	18		33	
4	101	19		34	
5	101	20		35	
6	101	21		36	
7	101	22		37	
8	101	23		38	
9	101	24		39	
10	101	25		40	
11	101	26		41	
12	101	27		42	
13	101	28		43	
14	101	29		44	
15	101	30		45	

Calculations

Stability Time: 4 minutes

Stability Period	Maximum Response	Minimum Response	Maximum Deviation	Allowable Deviation
15 Minutes	101.00	101.00	**0.00%**	1.00%

Calibration Error

General Information

Date: 17-Jun-15

Company: ANR

Station: Woolfolk

Unit: 2001

Analyzer Information

Manufacturer: ECOM

Model Number: EN2F

Serial Number: 5169 OCNX

NO Cell Temperature Monitoring

Initial NO Cell Temperature (°F): **79.9**

Final NO Cell Temperature (°F): **92.8**

Pre-test Calibration Error Check

	Gas Concentration	Analyzer Response	Absolute Difference	Percent Difference	Allowable Difference
NO Zero	0.00	0.00	0.00	**0.00%**	3.00%
NO Span	2520.00	2448.25	71.75	**2.85%**	5.00%
NO_2 Zero	0.00	0.00	0.00	**0.00%**	3.00%
NO_2 Span	101.00	98.25	2.75	**2.72%**	5.00%
O_2 Zero	0.00	0.00	0.00	**0.00%**	0.3%
O_2 Span	12.20	12.3	0.10	**0.10%**	0.5%

Post Test Calibration Error Check

	Gas Concentration	Analyzer Response	Absolute Difference	Percent Difference	Allowable Difference
NO Zero	0.00	16.75	16.75	**0.66%**	3.00%
NO Span	2520.00	2464.60	55.40	**2.20%**	5.00%
NO_2 Zero	0.00	0.00	0.00	**0.00%**	3.00%
NO_2 Span	101.00	97.50	3.50	**3.47%**	5.00%
O_2 Zero	0.00	0.00	0.00	**0.00%**	0.3%
O_2 Span	12.20	12.3	0.08	**0.08%**	0.5%

NO Interference Verification

	NO Response
NO_2 Span	4

NO Interference Response: **0.23%**

Allowable: **5.00%**

Engine Operating Data

Run 1 Data Entry	1-1	1-2	1-3	1-4	AVG
Horsepower	933	925	927	920	**926**
Speed (RPM)	326.0	324.0	327.0	322.0	**324.8**
Fuel Use (scfh)	8,700	8,630	8,650	8,620	**8,650.0**
Curve	1	1	1	1	**1**
AMP ("HG)					
AMT (^{O}F)					
Suct. Press. (psig)	384	383	383	382	**383**
Suct. Temp. (^{O}F)	57.3	57.9	58.4	59.0	**58.2**
Disc. Press. (psig)	681	680	679	678	**680**
Disc. Temp. (^{O}F)	71.9	72.6	73.2	73.9	**72.9**

Run 2 Data Entry	2-1	2-2	2-3	2-4	AVG
Horsepower	930	922	918	915	**921**
Speed (RPM)	326.0	324.0	325.0	327.0	**325.5**
Fuel Use (scfh)	8,660	8,620	8,590	8,500	**8,592.5**
Curve	1	1	1	1	**1**
AMP ("HG)					
AMT (^{O}F)					
Suct. Press. (psig)	382	381	379	379	**380**
Suct. Temp. (^{O}F)	59.5	59.9	60.6	66.2	**61.6**
Disc. Press. (psig)	677	675	672	668	**673**
Disc. Temp. (^{O}F)	74.3	74.6	75.0	75.5	**74.9**

Run 3 Data Entry	3-1	3-2	3-3	3-4	AVG
Horsepower	895	905	902	889	**898**
Speed (RPM)	324.0	327.0	327.0	326.0	**326.0**
Fuel Use (scfh)	8,430	8,430	8,390	8,330	**8,395.0**
Curve	1	1	1	1	**1**
AMP ("HG)					
AMT (^{O}F)					
Suct. Press. (psig)	285	256	254	253	**262**
Suct. Temp. (^{O}F)	57.3	57.9	59.0	59.1	**58.3**
Disc. Press. (psig)	612	608	603	601	**606**
Disc. Temp. (^{O}F)	77.5	77.7	77.9	78.0	**77.8**