COMPLIANCE TEST REPORT
ANR Pipeline
Excelsior Compressor Station
Kalkaska, MI
Engine EUEXCOMP-A

Prepared for:

TransCanada
In business to deliver

TransCanada's ANR Pipeline Company
South Chester, MI

Prepared by:

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DEQ

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 Excelsior storage facility   County: Kalkaska

Source Address: 4936 State Road   City: Kalkaska

AQD Source ID (SRN): B7196   RO Permit No.: MI-ROP-B7196-2012   RO Permit Section No.: ______

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 1/20/2012 To 1/20/2017

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

Emissions testing per Operational Permit, Part D, section V.1

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.

Name of Responsible Official (print or type)	Title	Phone Number
Randy Schmidgall	VP Gas Pipeline Operations	(832) 320-5511

Signature of Responsible Official: [signature]   Date: 10/13/2014

* Photocopy this form as needed.

PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at Trans Canada in Kalkaska, 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
Project Manager

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 Trans Canada's Excelsior Compressor Station in Kalkaska, MI.

Karl Mast
Project Manager

SUMMARY

The compliance testing was performed on the Internal Combustion Reciprocating Engine EUEXCOMP-A (Unit 1) system in fulfillment of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-B7196-2012. The compliance testing was performed on the Combustion Engine in accordance with the requirements of the Code of Federal Regulations, Title 40, Part 60, Appendix A. The results of the testing are detailed in the following tables.

NO_x Test Results				
Reciprocating Engine	Rated Power (BHP)	Permit Limt	Measured Limt	Pass/Fail
Unit 1	3750	99.2 lb/hr	66.84	Pass

2. TEST RESULTS SUMMARY

The compliance testing was performed on the Unit No. 1 system in accordance with the requirements of the Title 40, Code of Federal Regulations, Part 60, Appendix A. A summary of the test results is given below:

Table 1. Test Results Summary-NO_x Results

NO_X Test Results				
Reciprocating Engine	Rated Power (BHP)	Permit Limt	Measured Limt	Pass/Fail
Unit 1	3750	99.2 lb/hr	66.84	Pass

Based on the information provided above, the Unit No. 1 system 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 2-3.

Additional testing information may be found in Appendix A.

Table 2. Operating Parameters –Unit No. 1

Run	1	2	3	AVERAGES
Date	08/19/14	08/19/14	08/19/14	
Time	11:34	12:52	14:03	
Condition	HS-HT	HS-HT	HS-HT	
Engine Operating Conditions				
Unit Horsepower from Control Panel	3,483.0	3,528.0	3,363.0	3,458.0
Unit Speed	345.0	347.0	352.0	348.0
Ignition Timing (^{O}BTDC)	12.2	12.9	13.4	12.8
Turbo RPM	13,163.0	13,183.0	13,388.0	13,244.7
Exhaust Temperature Average (^{O}F)	824.0	825.0	816.0	821.7
Air Manifold Pressure (PSIG)	20.0	20.0	20.0	20.0
Air Manifold Temperature (^{O}F)	119.0	120.0	124.0	121.0
Jacket Water Inlet Temperature (^{O}F)	170.0	178.0	173.0	173.7
Lube Oil Inlet Temperature (^{O}F)	169.0	160.0	163.0	164.0
Lube Oil Outlet Temperature (^{O}F)	155.0	155.4	155.5	155.3
Compressor Suction Pressure (PSIG)	697.0	705.0	784.0	728.7
Compressor Suction Temperature (^{o}F)	65.0	65.0	66.0	65.3
Compressor Discharge Pressure (PSIG)	3743.0	3747.0	3754.0	3,748.0
Compressor Discharge Temperature (^{o}F)	95.0	94.5	93.3	94.3
Compressor Flow (MMSCF/D)	34.8	33.9	34.5	34.4
Fuel Torque (%)	102.0	103.0	95.0	100.0
% Load	92.9	94.1	89.7	92.2
% Torque	94.2	94.9	89.2	92.8
Heat Rate (BTU/HP-hr)	7,269.0	7,442.0	7,134.3	7,281.8
Heat Rate (KJ/Watt-Hr)	10.280	10.525	10.090	10.3
Ambient Conditions				
Ambient Temperature (^{o}F)	74.00	74.00	74.00	74.00
Barometric Pressure ("Hg)	29.68	29.68	29.68	29.68
Ambient Relative Humidity (%)	64.00	64.00	64.00	64.00

**Table 3. Emissions Concentrations, Calculated Mass Emissions & Fuel Flows
Unit No. 1**

Run	1	2	3	AVERAGES
Date	08/19/14	08/19/14	08/19/14	
Time	11:34	12:52	14:03	
Condition	HS-HT	HS-HT	HS-HT	
Emissions Concentrations & Calculated Mass Emissions				
NO_x ppm (BIAS Corrected)	1130.62	1128.34	1115.07	1124.68
NO_X g/BHP-HR	8.747	8.954	8.595	8.77
NO_X LB/HR	67.16	69.64	63.72	66.84
NO_X (ppm @ 15% O_2)	650.80	650.75	641.22	647.59
Nox Tons/Year	294.17	305.04	279.10	292.77
Nox lbs/scf fuel	0.002487	0.002487	0.002451	0.00248
NOx LB/MMBTU	2.40	2.40	2.36	2.39
CO ppm (BIAS Corrected) Outlet	322.44	311.75	318.83	317.67
CO g/BHP-HR	1.518	1.506	1.496	1.51
CO LB/HR	11.66	11.71	11.09	11.49
CO LB/MMBTU **	0.42	0.40	0.41	0.41
CO (ppm @ 15% O_2)	185.60	179.80	183.34	182.91
% O_2 (BIAS Corrected)	10.65	10.67	10.64	10.65
Calculated Flows				
Fuel Flow - (SCFM)	450.0	466.7	433.3	450.0
Fuel Flow - (SCFH)	27,000.0	28,000.0	26,000.0	27,000.0
Fuel Flow (LB/HR)	1,227.3	1,657.0	1,663.3	1,515.9
Exhaust Flow (LB/HR)	37,514.9	38,981.9	36,089.6	37,528.8
Exhaust Flow (WSCFM)	9,587.4	9,942.5	9,232.3	9,587.4
Exhaust Flow (DSCFM)	8,275.1	8,598.4	7,960.9	8,278.2
Exhaust Gas Volume (ACFM)	23,858.7	24,761.7	22,831.9	23,817.4
Air Flow (WSCFM)	8,022.2	8,335.5	7,717.6	8,025.1
BSAC, #/BHP-hr	10.5	10.8	10.5	10.6
Fuel Flow Measurements				
Fuel Gas Differential Pressure ("H_2O)	33.0	82.9	83.4	66.43
Fuel Gas Static Pressure (PSIG)	94.0	65.0	65.4	74.80
Fuel Gas Temperature (°F)	70.0	75.9	77.7	74.53

** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION
* BASED ON CARBON BALANCE (STOICH. + O2)
- A/F IS TOTAL MASS RATIO

Table 4. Gas Composition-AGA Standard Conditions-Unit No. 1

GAS COMPOSITION (Based on AGA standard conditions of 14.73 psia and 60 F)

Constituent	Mol. Fraction	MW	weighted MW	DENSITY	Weighted Density
NITROGEN	0.0054441	28.0134	0.1525	0.07399	0.00040
CARBON DIOX	0.0112284	44.01	0.4942	0.11624	0.00131
METHANE	0.9360315	16.04315	15.0169	0.04237	0.03966
ETHANE	0.0405860	30.0703	1.2204	0.07942	0.00322
PROPANE	0.0054070	44.0975	0.2384	0.11647	0.00063
I-BUTANE	0.0004511	58.1246	0.0262	0.15352	0.00007
N-BUTANE	0.0005667	58.1246	0.0329	0.15352	0.00009
I-PENTANE	0.0001708	72.1518	0.0123	0.19057	0.00003
N-PENTANE	0.0000000	72.1518	0.0000	0.19057	0.00000
HEXANE +	0.0000642	95.958	0.0062	0.32000	0.00002
	0.9999	17.2001	17.2001		0.04543

Upper Dry Heat Value	1039.56	btu/dscf
Low Dry Heat Value	938	btu/dscf
Specific Gravity	0.5950	
DENSITY	0.0454	lb/cf

Total Carbons	1.050007884	Total H	4.044023958

Constituent	LHV ideal	LHV(i) ideal	LHV(i) real	HHV ideal	HHV(i) ideal	HHV(i) real
NITROGEN		0.00	0.00		0	0
CARBON DIOX		0.00	0.00		0	0
METHANE	911.5	853.19	855.11	1012	947.26383	949.39
ETHANE	1622.4	65.85	65.99	1773.7	71.98744421	72.15
PROPANE	2320.3	12.55	12.57	2522.1	13.63707435	13.67
I-BUTANE	3007.3	1.36	1.36	3260.5	1.470931667	1.47
N-BUTANE	3017.8	1.71	1.71	3270.1	1.853010765	1.86
I-PENTANE	3707.6	0.63	0.63	4011.1	0.68509588	0.69
N-PENTANE	3715.5	0.00	0.00	4018.2	0	0.00
HEXANE +	4900.5	0.31	0.32	5288.8	0.339318249	0.34
		LHV real	937.70		HHV real	1039.56

Constituent	SG	SG(i) ideal	b	b(i)
NITROGEN	0.96723	0.005265697	0.0044	2.3954E-05
CARBON DIOX	1.51955	0.017062176	0.0197	0.0002212
METHANE	0.55392	0.518486542	0.0116	0.010857965
ETHANE	1.03824	0.042138041	0.0239	0.000970006
PROPANE	1.52256	0.00823253	0.0344	0.000186002
I-BUTANE	2.00684	0.000905359	0.0458	2.06621E-05
N-BUTANE	2.00684	0.001137181	0.0478	2.7086E-05
I-PENTANE	2.49115	0.000425488	0.0581	9.92348E-06
N-PENTANE	2.49115	0	0.0631	0
HEXANE +	3.3127	0.000212536	0.0802	5.14546E-06
	SG real	0.594952655		0.012321944

Compressibility
0.99776354

Table 5. Gas Composition-EPA Standard Conditions-Unit No. 1

GAS COMPOSITION (Based onEPA standard conditions of 14.696 psia and 68 F)

Constituent	Mol. Fraction	MW	weighted MW
NITROGEN	0.0054	28.0134	0.1525
CARBON DIOX.	0.0112	44.01	0.4942
METHANE	0.9360	16.04315	15.0169
ETHANE	0.0406	30.0703	1.2204
PROPANE	0.0054	44.0975	0.2384
I-BUTANE	0.0005	58.1246	0.0262
N-BUTANE	0.0006	58.1246	0.0329
I-PENTANE	0.0002	72.1518	0.0123
N-PENTANE	0.0000	72.1518	0.0000
HEXANE +	0.0001	95.958	0.0062
	0.9999	MW	17.2001

Upper Dry Heat Value	1037	btu/dscf	Mole Weight	17.2001	btu/dscf
Low Dry Heat Value	939	btu/dscf	A F-Factor (calc)	8693	dscf/MMbtu
Specific Gravity	0.5950				
Density	0.0456	lb/scf			
Total Carbons	1.0500	Total H	4.0441		

Constituent	LHV ideal	LHV(i) ideal	LHV(i) real	HHV ideal	HHV(i) ideal	HHV(i) real
NITROGEN		0.00	0.00		0	0
CARBON DIOX.		0.00	0.00		0	0
METHANE	913	854.60	856.51	1010	945.3917671	947.51
ETHANE	1624	65.91	66.06	1769.6	71.82104148	71.98
PROPANE	2322	12.56	12.58	2516.1	13.60463216	13.64
I-BUTANE	3010	1.36	1.36	3251.9	1.46705189	1.47
N-BUTANE	3020	1.71	1.72	3262.3	1.848590875	1.85
I-PENTANE	3711	0.63	0.64	4000.9	0.68335372	0.68
N-PENTANE	3718	0.00	0.00	4008.9	0	0.00
HEXANE +	4904	0.31	0.32	5278	0.338625343	0.34
		LHV real	939.18		HHV real	1037.48

Constituent	SG	SG(i) ideal	b	b(i)	
NITROGEN	0.96723	0.005265697	0.0044	2.3954E-05	
CARBON DIOX.	1.51955	0.017062176	0.0197	0.0002212	Compressibility
METHANE	0.55392	0.518486542	0.0116	0.010857965	0.99776354
ETHANE	1.03824	0.042138041	0.0239	0.000970006	
PROPANE	1.52256	0.00823253	0.0344	0.000186002	
I-BUTANE	2.00684	0.000905359	0.0458	2.06621E-05	
N-BUTANE	2.00684	0.001137181	0.0478	2.7086E-05	
I-PENTANE	2.49115	0.000425488	0.0581	9.92348E-06	
N-PENTANE	2.49115	0	0.0631	0	
HEXANE +	3.3127	0.000212536	0.0802	5.14546E-06	
	SG real	0.594952655		0.012321944	

Table 6. Orifice Flow Calculations –Unit No. 1

ORIFICE FLOW CALCULATIONS				
Run Number	1	2	3	AVERAGES
Supply Pressure	94.0	65.0	65.4	74.8
Differential	33.0	82.9	83.4	66.4
Temperature	70.0	75.9	77.7	74.5
Fuel Flow (scfh)	27016	36474	36613	34630
Fuel Flow (scfm)	450.3	607.9	610.2	577.2
PIPE I.D.	2.067	2.067	2.067	2.067
ORIFICE I.D.	1.25	1.25	1.25	1.25
PRESS TAP? (1-UP,2-DN)	2	2	2	2
SP. GRAVITY	0.583817634	0.5838176	0.5838176	0.583817634
BETA	0.604741171	0.6047412	0.6047412	0.604741171
K	0.658439831	0.6584398	0.6584398	0.658439831
K1	0.658439831	0.6584398	0.6584398	0.658439831
Bc	368.6426941	368.64269	368.64269	368.6426941
E	671.8343196	671.83432	671.83432	671.8343196
kflang	0.648675828	0.6486758	0.6486758	0.648675828
Ko	0.653173935	0.6531739	0.6531739	0.653173935
Fb	345.1391483	345.13915	345.13915	345.1391483
BB	0.064554807	0.0645548	0.0645548	0.064554807
Fr	1.001080386	1.000797	1.0007926	1.000839727
Fpb	1	1	1	1
Ftb	1	1	1	1
Ftf	0.990515179	0.9850442	0.983393	0.986303391
FG	1.308764167	1.3087642	1.3087642	1.308764167
Fpv	1.007786191	1.005466	1.0054236	1.006201841
R	0.011008774	0.0378041	0.0378409	0.026952632
QY	1.001642034	1.0056868	1.0056924	1.00404086
C	452.1334634	450.28494	449.51177	450.4713502
Qfh	27016	36474	36613	34630
Qfm	450.3	607.9	610.2	577.2

3. PROCESS DESCRIPTION

TransCanada's ANR Pipeline's Excelsior Compressor Station is located in Kalkaska, Michigan and runs an Ingersoll Rand KVR-412 natural gas fired internal combustion reciprocating engine labeled EUEXCOMP-A (Unit 1).

More specifically, The Ingersoll Rand KVR-412 is a four stroke lean burn, 3,750 HP rated, 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 table provides a summary of rated information for each engine and the production rates for the Unit No. 1 during the test:

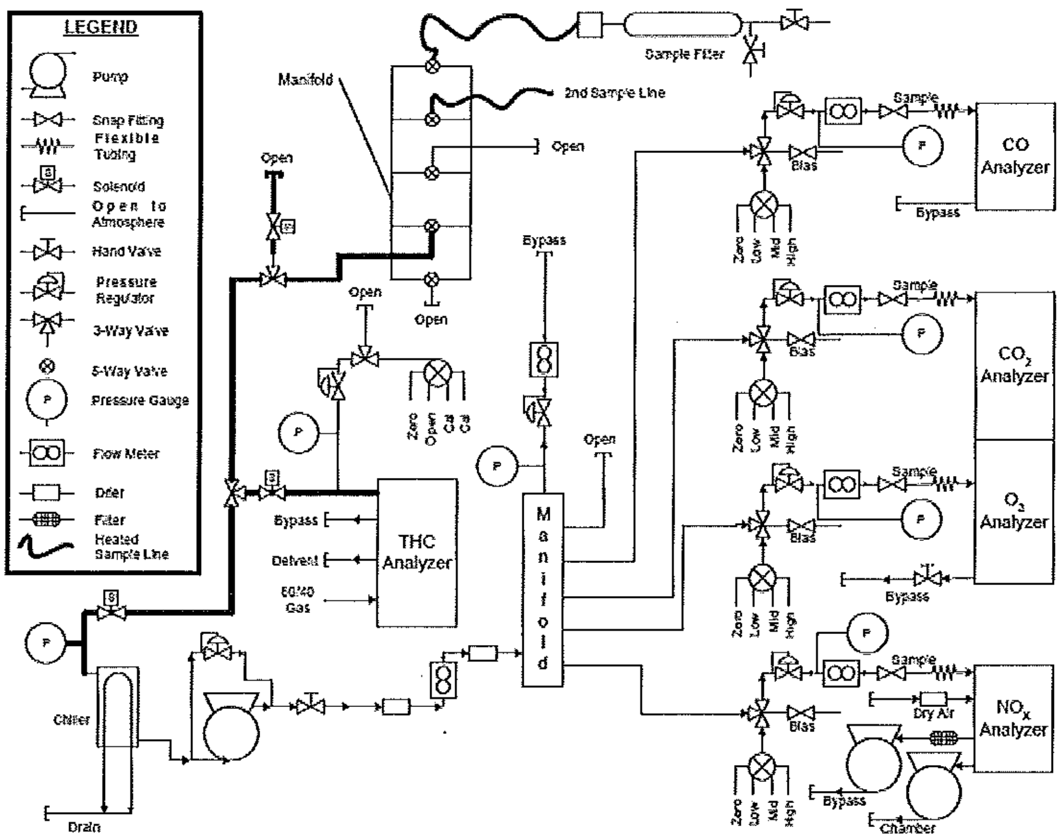
Table 7. Unit No. 1 Rated Information

		# of Cylinders:	10	
		Stroke:	4	
		Fuel Orifice ID.:	1.25	in.
		Fuel Pipe ID.:	2.067	in.
		AGA UDHV :	1,040	btu/dscf
		AGA LDHV :	939	btu/dscf
Company:	ANR	Rated RPM:	350	RPM
Station:	Excelsior	Bore:	17.00	inches
Unit:	Unit 1	Stroke:	22	Inches
Engine Type	I R KVR-412	Rated BHP:	3,750	BHP
Date:	19-Aug-14	Rated BEMP:	250	psi

Table 8. Unit No. 1-Production Data-Horse Power (HP)

Unit No. 1 Horse Power (HP)	
Run No.	**Unit No. 1**
1	3,483
2	3,528
3	3,363
Average	3,458
Rated HP	3,750

Figure 1. Flow Schematic



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

4. TEST PROCEDURES

EQ and EQ'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

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

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

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. EQ and EQ'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

A Compliance Test was conducted on Combustion Engine Unit No. 1 at ANR Excelsior Compressor Station near Kalkask, MI. The Compliance testing was conducted on August 19, 2014.

During the course of the testing, the Combustion Engine Unit No. 1 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 Combustion Engine Unit No. 1 emissions shall be determined by others.

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

A. FIELD TEST DATA