COMPLIANCE TEST REPORT
ANR PIPELINE-COLD SPRINGS COMPRESSOR STATION
Engine EU CSCMPR-A and EU CSCMPR-C

May, 17, 2022

Prepared for:

TC Energy

TC Energy ANR Pipeline Company
Cold Springs Compressor Station
10000 Pflum Road
Mancelona, MI
Kalkaska County
Permit MI-ROP-B7198-2014a

Prepared by:

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June 2022

PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at TC Energy in Cold Springs, 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 Cold Springs Compressor Station located in Cold Springs, MI.

Karl Mast
Test Supervisor

SUMMARY

The compliance emissions testing program was performed on Unit EU BLCMPR-A in fulfillment of Michigan Department of Environment, Great Lakes, and Energy (MEGLE) permit no. MI-ROP-B7198-2014a, to 40 CFR Part 60, five (5) year test requirement. The testing was performed utilizing USEPA Methods 1, 3A, 7E, and 19 at the Exhaust Stack sampling locations. The results of the testing are detailed in the following tables. A summary of the test results is given below:

EU CS12CMPR-A Test Summary Results						
Parameter	**Run 1**	**Run 2**	**Run 3**	**Average**	**Limit**	**Pass/Fail**
NO_x lb/hr	38.9697	40.2178	39.6916	39.6264	99.2	PASS
NO_x g/hpr-hr	5.1792	5.2878	5.2613	5.2428	12	PASS

. EU CS12CMPR-C Test Summary Results						
Parameter	**Run 1**	**Run 2**	**Run 3**	**Average**	**Limit**	**Pass/Fail**
NO_x lb/hr	54.6125	53.9871	54.2578	54.2858	99.2	PASS
NO_x g/hpr-hr	7.2201	7.1983	7.2132	7.2105	12	PASS

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APPENDICES

1. INTRODUCTION

This report presents the results of the source emissions testing conducted by Environmental Quality Management, Inc. (EQM) for TC Energy's ANR (ANR) Cold Springs Compressor Station, near Kalkaska, MI in fulfillment of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-B7198-2014a. The testing was performed utilizing USEPA Methods 1, 3A, 7E, and 19 at the Exhaust Stack sampling locations to demonstrate NO_x emissions.

To ensure that compliance with the emission limits is maintained, the Air Compliance Team of TC Energy's ANR contracted Environmental Quality Management, Inc. (EQM) to perform source emissions testing on the Engines EU CS12CMPR-A (Unit A) and EU CS12CMPR-C (Unit C). The primary purpose of this testing program was to conduct emissions testing to determine compliance with the permit at ANR's gas compressor facility.

EQM's responsibility was to conduct and oversee the compliance testing for Nitrogen Oxide (NOx) 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 TC Energy's process operations, and Compliance testing. The Compliance testing conducted on EU CS12CMPR-A (Unit A) was performed on May 17, 2022 from 9:35 A.M. to 12:49 P.M. The Compliance testing conducted on EU CS12CMPR-c (Unit C) was performed on May 17, 2022 from 1:25 P.M. to 4:44 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 NOx and O2 test runs performed at the Unit A pursuant to EPA, Title 40, Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A.

3. Process operations conditions maintained within 10% rated load during the emissions testing periods.

4. All testing and analyses performed in accordance with current EPA test methodologies and analytical procedures for NOx and O2 emissions determinations.

The testing program was approved by and/or coordinated with Tyrah Lydia, TC Energy's ANR Pipeline. The emission testing was performed by Karl Mast, Project Manager, EQM, Zach Hill, Field Activitivies Lead, EQM, and Garrett Cox, Test Technician, EQM. The emission testing was observed by Jeremy Howe, BeckyRadulski, Daniel Droste and David Bowman, Michigan EGLE.

2. TEST RESULTS SUMMARY

The compliance testing was performed on Unit A system in accordance with the requirements of the Code of Federal Regulations, Title 40, Part 60, Appendix A, and the Permit MI-ROP-B7198-2014a requirements. A summary of the test results is given below:

Table 1. EU CS12CMPR-A Test Summary Results						
Parameter	**Run 1**	**Run 2**	**Run 3**	**Average**	**Limit**	**Pass/Fail**
NO_x lb/hr	38.9697	40.2178	39.6916	39.6264	99.2	PASS
NO_x g/hpr-hr	5.1792	5.2878	5.2613	5.2428	12	PASS

Table 2. EU CS12CMPR-C Test Summary Results						
Parameter	**Run 1**	**Run 2**	**Run 3**	**Average**	**Limit**	**Pass/Fail**
NO_x lb/hr	54.6125	53.9871	54.2578	54.2858	99.2	PASS
NO_x g/hpr-hr	7.2201	7.1983	7.2132	7.2105	12	PASS

Based on the information provided above, units EU CS12CMPR A and EU CS12CMPR-C 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 Tables 3-10.

Table 3 . Engine Operating and Ambient Conditions -Unit A

Run	1	2	3	
Date	05/17/22	05/17/22	05/17/22	
Time	9:35	10:42	11:50	
Engine Operating Conditions	HS-HT	HS-HT	HS-HT	Averages
Unit Horsepower from Control Panel	3,413.0	3,450.0	3,422.0	3,428.3
Unit Speed (rpm)	333.0	333.0	333.0	333.0
Compressor Suction Pressure (PSIG)	682.0	689.0	683.0	684.7
Compressor Suction Temperature (°F)	47.2	47.8	47.9	47.6
Compressor Discharge Pressure (PSIG)	1221.0	1233.0	1223.0	1,225.7
Compressor Discharge Temperature (°F)	165.0	163.5	166.0	164.8
Compressor Flow (MMSCF/D)	66.2	67.4	66.2	66.6
% Load	91.0	92.0	91.3	91.4
% Torque	95.7	96.7	95.9	96.1
Heat Rate (BTU(LHV)/HP-hr)	6,824.6	6,840.4	6,826.3	6,830.4
Ambient Conditions				
Ambient Temperature (°F)	98.90	99.20	100.10	99.40
Barometric Pressure (psi)	14.03	14.04	14.04	14.04
Ambient Relative Humidity (%)	53.00	49.00	49.00	50.33
Absolute Humidity (grains/LB)	331.40	307.37	316.26	318.35

Table 4. Emissions Concentrations, Calculated Mass Emissions, Concentrations & Flows -Unit A

Run	1	2	3	
Date	05/17/22	05/17/22	05/17/22	
Time	9:35	10:42	11:50	
Emissions Concentrations & Calculated Mass Emissions				
NO_x ppm (BIAS Corrected)	713.10	725.65	722.10	720.28
NO_X g/BHP-HR	5.1792	5.2878	5.2613	5.2428
NO_X LB/HR	38.9697	40.2178	39.6916	39.6264
NO_X (ppm @ 15% O_2)	410.8682	418.5078	417.2762	415.5507
NOx LB/MMBTU	1.5130	1.5411	1.5366	1.5302
NO_X Tons/Year	170.6871	176.1542	173.8494	173.5636
NO_X LB/SCF Fuel	1.610E-03	1.640E-03	1.635E-03	0.00
NO_X LB/MMSCF Fuel	1.6096E+03	1.6395E+03	1.6347E+03	1.6279E+03
% O_2 (BIAS Corrected)	10.66	10.67	10.69	10.67
Calculated Flows				
Fuel Flow - (SCFM)	404.33333	409.66667	405.50000	406.50000
Fuel Flow - (SCFH)	24260.00	24580.00	24330.00	24390.00
Fuel Flow (LB/HR)	1109.3003	1123.9324	1112.5010	1115.2446
Fuel Flow (MMcf/hr)	2.4260E-02	2.4580E-02	2.4330E-02	2.4390E-02
Exhaust Flow Method 19 (scfm)	7,612.7760	7,720.7316	7,657.1751	7,663.5609
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	24.26	24.58	24.33	24.39
** 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				

Table 5 . Engine Operating and Ambient Conditions -Unit C

Run	1	2	3	
Date	05/17/22	05/17/22	05/17/22	
Time	13:25	14:32	15:50	
Engine Operating Conditions	HS-HT	HS-HT	HS-HT	Averages
Unit Horsepower from Control Panel	3,431.0	3,402.0	3,412.0	3,415.0
Unit Speed (rpm)	334.0	334.0	334.0	334.0
Compressor Suction Pressure (PSIG)	676.0	677.0	677.0	676.7
Compressor Suction Temperature (°F)	49.1	48.9	49.1	49.0
Compressor Discharge Pressure (PSIG)	1203.0	1205.0	1204.0	1,204.0
Compressor Discharge Temperature (°F)	154.5	156.5	155.5	155.5
Compressor Flow (MMSCF/D)	67.2	66.4	66.7	66.8
% Load	91.5	90.7	91.0	91.1
% Torque	95.9	95.1	95.3	95.4
Heat Rate (BTU(LHV)/HP-hr)	6,805.6	6,846.6	6,846.3	6,832.8
Ambient Conditions				
Ambient Temperature (°F)	86.40	85.10	86.60	86.03
Barometric Pressure (psi)	14.04	14.05	14.04	14.04
Ambient Relative Humidity (%)	43.00	41.00	38.00	40.67
Absolute Humidity (grains/LB)	176.26	160.61	156.05	164.31

Table 6. Emissions Concentrations, Calculated Mass Emissions, Concentrations & Flows -Unit C

Run	1	2	3	
Date	05/17/22	05/17/22	05/17/22	
Time	13:25	14:32	15:50	
Emissions Concentrations & Calculated Mass Emissions				
NO_x ppm (BIAS Corrected)	1010.51	991.76	998.70	1000.32
NO_X g/BHP-HR	7.2201	7.1983	7.2132	7.2105
NO_X LB/HR	54.6125	53.9871	54.2578	54.2858
NO_X (ppm @ 15% O_2)	574.3747	569.2008	570.4095	571.3283
NOx LB/MMBTU	2.1151	2.0960	2.1005	2.1039
NO_X Tons/Year	239.2028	236.4633	237.6492	237.7718
NO_X LB/SCF Fuel	2.2501E-03	2.2299E-03	2.2346E-03	2.2382E-03
NO_X LB/MMSCF Fuel	2250.1225	2229.8537	2234.5889	2238.1884
% O_2 (BIAS Corrected)	10.52	10.62	10.57	10.57
Calculated Flows				
Fuel Flow - (SCFM)	405.3333	404.3333	405.5000	405.0556
Fuel Flow - (SCFH)	24320.00	24260.00	24330.00	24303.3333
Fuel Flow (LB/HR)	1112.0438	1109.3003	1112.5010	1111.2817
Fuel Flow (MMcf/hr)	2.4320E-02	2.4260E-02	2.4330E-02	2.4303E-02
Exhaust Flow Method 19 (scfm)	7528.6729	7583.1543	7568.2243	7560.0172
Fuel Flow Measurements				
Fuel Flow From Screen(MSCFH)	24.32	24.26	24.33	24.30
** 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. FACILITY AND PROCESS DESCRIPTION

TC Energy's ANR Cold Springs Compressor Station is located in Maneclona, MI and operates a natural gas fired compressor station. The plant is located at 10000 Pflum Road, Mancelona, MI, which is located in Kalkaska County.

The two units areIngersoll Rand KVR-410 natural gas fired internal combustion reciprocating engines. The Ingersoll Rand KVR-410 is a four stroke, 3,750 horsepower, 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 inject or withdraw natural gas from a natural gas storage field.

The following tables provide a summary of the production rates for the Unit A during the tests

Table 7. EU CS12CMPR-A Process Data

Parameter	Run 1	Run 2	Run 3	Average	Rated	% Load
Horsepower	3,413.0	3,450.0	3,422.0	3,428.3	3,750	91.4
RPM	333.0	333.0	333.0	333.0	350	95.1

Table 8. EU CS12CMPR-C Process Data

Parameter	Run 1	Run 2	Run 3	Average	Rated	% Load
Horsepower	3,431.0	3,402.0	3,412.0	3,415.0	3,750	91.1
RPM	334.0	334.0	334.0	334.0	350	95.4

Table 9. Unit A General Information

General Information

Date:	17-May-22
Company:	TC Energy
Station:	Cold Springs
Unit:	A
Engine Type:	INGEROLL RAND
Serial Number:	410KVR-154A
Bore:	18 in.
Stroke:	20 in.
Rated RPM:	350 RPM
Rated BHP:	3750 BHP
Number of Cylinders:	10
Rod Length:	45 in.
2 or 4 Stroke ?:	2

Permit Limits

	ppm@15%	g/Bhp-Hr	lb/hr	TPY
NOx:		12	99.2	
CO:				
VOC:				
H2CO:				

Limits are actuallly listed as average values

Fuel Gas Analysis

Constituent	Mole Percent
Nitrogen	0.414
Carbon Dioxide	0.496
Methane	91.948
Ethane	6.690
Propane	0.369
I-Butane	0.033
N-Butane	0.033
I-Pentane	0.009
N-Pentane	0.003
Hexane +	0.006
Total	100.000

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

Table 10. Unit C General Information

General Information

Date:	17-May-22
Company:	TC Energy
Station:	Cold Springs
Unit:	C
Engine Type:	Ingersal rand
Serial Number:	410KVR156A
Bore:	18 in.
Stroke:	20 in.
Rated RPM:	350 RPM
Rated BHP:	3750 BHP
Number of Cylinders:	10
Rod Length:	45 in.
2 or 4 Stroke ?:	2

Permit Limits

	ppm@15%	g/Bhp-Hr	lb/hr	TPY
NOx:		12	99.2	
CO:				
VOC:				
H2CO:				

Limits are actuallly listed as average values

Fuel Gas Analysis

Constituent	Mole Percent
Nitrogen	0.414
Carbon Dioxide	0.496
Methane	91.948
Ethane	6.690
Propane	0.369
I-Butane	0.033
N-Butane	0.033
I-Pentane	0.009
N-Pentane	0.003
Hexane +	0.006
Total	100.000

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

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 Oxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)
- U.S. EPA Method 19– Determination of Volumetric Flow Rate From Stationary Sources

USEPA Methods 3 and 7E, 10 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 A 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

NOx Mass Emissions Calculations g/bhr/hr

$$NOx_{\frac{g}{bhp-hr}} = C_d \times F_d \times \frac{20.9}{20.9 - \%O_2} \times Q_h \times \frac{GCV}{10^6} \times \frac{453.6}{Bhp}$$

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

NOx 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

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 Interference Response

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

Where:

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

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. 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 compressor engines labeled Unit EU CS12CMPR-A and CS12CMPR-C at TC Energy's ANR Pipeline Company's Cold Springs Compressor Station located in Cold Springs, Michigan. The testing was conducted on May 17, 2022..

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

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