# COMPLIANCE TEST REPORT
## ANR-Blue Lake Compressor Station
## Heaters EGBLHTR-A and EGBLHTR-B

Prepared for:

TransCanada
*In business to deliver*

TC Energy's ANR Pipeline Company
Mancelona, MI

Prepared by:

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## PREFACE

I, Karl Mast, do hereby certify that the source emissions testing conducted at TC Energy in Mancelona, 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 Blue Lake Compressor Station in Mancelona, MI.

Karl Mast
Test Supervisor

## SUMMARY

The compliance emissions testing was performed on heaters EGBLHTR-A (A) and EGBLHTR-B (B) to comply with the established $NO_x$ and CO standards pursuant to of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-B7198-2014a. The testing was performed utilizing USEPA Methods 1-4, 3A, 7E and 10 at the Exhaust Stack sampling location. The results of the testing are detailed in the following tables.

| Heater A $NO_x$ Emission Test Results | | |
|---|---|---|
| **Run No.** | **$NO_x$ Emissions (lbs/hr)** | **$NO_x$ Emissions (lbs/mmbtu)** |
| 1 | 0.35 | 0.04 |
| 2 | 0.35 | 0.04 |
| 3 | 0.31 | 0.04 |
| Average | 0.34 | 0.04 |
| Emission Limit | 2.8 | 0.14 |

| Heater A CO Emission Test Results | | |
|---|---|---|
| **Run No.** | **CO Emissions (lbs/hr)** | **CO Emissions (lbs/mmbtu)** |
| 1 | 0.12 | 0.01 |
| 2 | 0.12 | 0.01 |
| 3 | 0.10 | 0.01 |
| Average | 0.11 | 0.01 |
| Emission Limit | 0.7 | 0.035 |

| Heater B $NO_x$ Emission Test Results | | |
|---|---|---|
| **Run No.** | **$NO_x$ Emissions (lbs/hr)** | **$NO_x$ Emissions (lbs/mmbtu)** |
| 1 | 0.60 | 0.07 |
| 2 | 0.59 | 0.07 |
| 3 | 0.60 | 0.07 |
| Average | 0.60 | 0.07 |
| Emission Limit | 2.8 | 0.14 |

| Heater B CO Emission Test Results | | |
|---|---|---|
| **Run No.** | **CO Emissions (lbs/hr)** | **CO Emissions (lbs/mmbtu)** |
| 1 | 0.20 | 0.02 |
| 2 | 0.20 | 0.02 |
| 3 | 0.21 | 0.02 |
| Average | 0.21 | 0.02 |
| Emission Limit | 0.7 | 0.035 |

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# 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) Blue Lake Compressor Station, near Mancelona, MI. Testing was conducted to comply with the established $NO_x$ and CO standards pursuant to of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-B7198-2014a.

To ensure that compliance with the emission limits is maintained, the Air Compliance Team of TC Energy's ANR Pipeline Company contracted Environmental Quality Management, Inc. (EQM) to perform source emissions testing on Heaters EGBLHTR-A (A) and EGBLHTR-B (B). The primary purpose of this testing program was to conduct emissions testing of the Sivalls withdrawal gas heaters, with an emission limit of 2.8 lbs/hr of $NO_x$, 0.14 lbs/mmbtu of $NO_x$, 0.7 lbs/hr of CO, and 0.035 lbs/mmbtu of CO.

EQM's responsibility was to conduct the compliance testing for the $NO_x$ and CO emissions rates, perform data reduction for conformance evaluation, and record process data. 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 Heater A was performed on February 20, 2020 from 11:00 A.M. to 2:07 P.M. The Compliance testing conducted on Heater B was performed on February 20, 2020 from 2:50 P.M. to 5:49 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, $NO_x$, CO, and $O_2$ test runs performed at the each heater pursuant to EPA Reference methods as described in 40 CFR, Part 60, Appendix A.
3. Process manufacturing operations maintained at 100% 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 $NO_x$, CO, and $O_2$, emissions determinations.

The testing program was approved by and/or coordinated with Tyrah Lydia, TC Energy's ANR Pipeline Company. The emission testing program was overseen by Karl Mast, Manager Air Emissions, EQM. The emission testing was performed by Zach Hill, Lead Field Activities' Test Technician, EQM and Kameron King, Test Technician, EQM. The emission testing was observed by Robert Dickman and Rebbecca Radulski, Michigan EGLE.

## 2. TEST RESULTS SUMMARY

The compliance testing was performed on Heater A and Heater B to with the established $NO_x$ and CO standards pursuant to of Michigan Department of Environmental Quality, Air Quality Division, permit no. MI-ROP-B7198-2014a. A summary of the test results is given below:

**Table 1. Test Results Summary-NOx Test Results-Heater A**

| Heater A $NO_x$ Emission Test Results | | |
|---|---|---|
| **Run No.** | **$NO_x$ Emissions (lbs/hr)** | **$NO_x$ Emissions (lbs/mmbtu)** |
| 1 | 0.35 | 0.04 |
| 2 | 0.35 | 0.04 |
| 3 | 0.31 | 0.04 |
| Average | 0.34 | 0.04 |
| Emission Limit | 2.8 | 0.14 |

**Table 2. Test Results Summary-CO Test Results-Heater A**

| Heater A CO Emission Test Results | | |
|---|---|---|
| **Run No.** | **CO Emissions (lbs/hr)** | **CO Emissions (lbs/mmbtu)** |
| 1 | 0.12 | 0.01 |
| 2 | 0.12 | 0.01 |
| 3 | 0.10 | 0.01 |
| Average | 0.11 | 0.01 |
| Emission Limit | 0.7 | 0.035 |

**Table 3. Test Results Summary-NOx Test Results-Heater B**

| Heater B $NO_x$ Emission Test Results | | |
|---|---|---|
| **Run No.** | **$NO_x$ Emissions (lbs/hr)** | **$NO_x$ Emissions (lbs/mmbtu)** |
| 1 | 0.60 | 0.07 |
| 2 | 0.59 | 0.07 |
| 3 | 0.60 | 0.07 |
| Average | 0.60 | 0.07 |
| Emission Limit | 2.8 | 0.14 |

**Table 4. Test Results Summary-CO Test Results-Heater B**

| Heater B CO Emission Test Results | | |
|---|---|---|
| **Run No.** | **CO Emissions (lbs/hr)** | **CO Emissions (lbs/mmbtu)** |
| 1 | 0.20 | 0.02 |
| 2 | 0.20 | 0.02 |
| 3 | 0.21 | 0.02 |
| Average | 0.21 | 0.02 |
| Emission Limit | 0.7 | 0.035 |

Based on the information provided above, the Heater A and Heater B 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 5-12.

Additional testing information may be found in Appendix A.

## Table 5. Emission Test Data- Heater A

| Run | 1 | 2 | 3 | AVERAGES |
|---|---|---|---|---|
| Date | 02/20/20 | 02/20/20 | 02/20/20 | |
| Time | 11:00-11:59 | 12:08-13:07 | 13:08-14:07 | |
| Condition | High | High | High | |
| **Ambient Conditions** | | | | |
| Ambient Temperature (°F) | 16.00 | 16.00 | 19.00 | 17.00 |
| Barometric Pressure ("Hg) | 29.10 | 29.08 | 29.06 | 29.08 |
| Ambient Relative Humidity (%) | 78.00 | 78.00 | 67.00 | 74.33 |
| **Emissions Concentrations & Calculated Mass Emissions** | | | | |
| $NO_x$ ppm (BIAS Corrected) | 16.92 | 17.27 | 17.42 | 17.20 |
| $NO_X$ g/BHP-HR | 0.020 | 0.020 | 0.018 | 0.02 |
| $NO_X$ LB/HR 2.8 Limit | 0.35 | 0.35 | 0.31 | 0.34 |
| $NO_X$ (ppm @ 15% $O_2$) | 10.84 | 11.03 | 9.53 | 10.47 |
| Nox Tons/Year | 1.52 | 1.55 | 1.35 | 1.47 |
| Nox lbs/scf fuel | 0.000041 | 0.000042 | 0.000036 | 0.00004 |
| NOx LB/MMBTU .14 Limit | 0.04 | 0.04 | 0.04 | 0.04 |
| CO ppm (BIAS Corrected) Outlet | 9.39 | 9.41 | 9.56 | 9.45 |
| CO g/BHP-HR | 0.007 | 0.007 | 0.006 | 0.01 |
| CO LB/HR .7 Limit | 0.12 | 0.12 | 0.10 | 0.11 |
| CO LB/MMBTU ** .035 Limit | 0.01 | 0.01 | 0.01 | 0.01 |
| CO (ppm @ 15% $O_2$) | 6.02 | 6.01 | 5.23 | 5.75 |
| % $O_2$ (BIAS Corrected) | 11.69 | 11.66 | 10.12 | 11.16 |
| **Calculated Flows** | | | | |
| Fuel Flow - (SCFM) | 140.0 | 140.7 | 141.3 | 140.7 |
| Fuel Flow - (SCFH) | 8,400.0 | 8,440.0 | 8,480.0 | 8,440.0 |
| Fuel Flow (LB/HR) | 376.4 | 378.2 | 380.0 | 378.2 |
| Exhaust Flow (LB/HR) | 13,044.9 | 13,063.3 | 11,174.0 | 12,427.4 |
| Exhaust Flow (WSCFM) | 2,976.6 | 2,990.8 | 3,005.0 | 2,990.8 |
| Exhaust Flow (DSCFM) | 2,858.0 | 2,862.3 | 2,465.0 | 2,728.4 |
| Exhaust Gas Volume (ACFM) | 7,032.4 | 7,075.8 | 7,014.3 | 7,040.8 |
| Air Flow (WSCFM) | 2,762.9 | 2,767.1 | 2,385.1 | 2,638.3 |
| BSAC, #/BHP-hr | 1.6 | 1.6 | 1.4 | 1.5 |
| **Fuel Flow Measurements** | | | | |
| Fuel Flow (SCFH) | 8400.00 | 8440.00 | 8480.00 | 8440.00 |
| ** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION | | | | |
| * BASED ON CARBON BALANCE (STOICH. + O2) | | | | |
| - A/F IS TOTAL MASS RATIO | | | | |

## Table 6. Emission Test Data-Heater B

| Run | 1 | 2 | 3 | AVERAGES |
|---|---|---|---|---|
| Date | 02/20/20 | 02/20/20 | 02/20/20 | |
| Time | 14:50-15:49 | 15:50-16:49 | 16:50-17:49 | |
| Condition | High | High | High | |
| **Ambient Conditions** | | | | |
| Ambient Temperature (°F) | 19.00 | 19.00 | 17.00 | 18.33 |
| Barometric Pressure ("Hg) | 29.05 | 29.05 | 29.04 | 29.05 |
| Ambient Relative Humidity (%) | 70.00 | 71.00 | 71.00 | 70.67 |
| **Emissions Concentrations & Calculated Mass Emissions** | | | | |
| $NO_x$ ppm (BIAS Corrected) | 40.91 | 41.55 | 41.15 | 41.20 |
| $NO_X$ g/BHP-HR | 0.035 | 0.034 | 0.035 | 0.03 |
| $NO_X$ LB/HR 2.8 Limit | 0.60 | 0.59 | 0.60 | 0.60 |
| $NO_X$ (ppm @ 15% $O_2$) | 18.26 | 18.79 | 18.60 | 18.55 |
| Nox Tons/Year | 2.62 | 2.60 | 2.64 | 2.62 |
| Nox lbs/scf fuel | 0.000069 | 0.000071 | 0.000071 | 0.00007 |
| NOx LB/MMBTU .14 Limit | 0.07 | 0.07 | 0.07 | 0.07 |
| CO ppm (BIAS Corrected) Outlet | 22.92 | 23.54 | 23.82 | 23.43 |
| CO g/BHP-HR | 0.012 | 0.012 | 0.012 | 0.01 |
| CO LB/HR .7 Limit | 0.20 | 0.20 | 0.21 | 0.21 |
| CO LB/MMBTU ** .035 Limit | 0.02 | 0.02 | 0.02 | 0.02 |
| CO (ppm @ 15% $O_2$) | 10.23 | 10.64 | 10.77 | 10.55 |
| % $O_2$ (BIAS Corrected) | 7.68 | 7.85 | 7.85 | 7.79 |
| **Calculated Flows** | | | | |
| Fuel Flow - (SCFM) | 143.3 | 138.3 | 141.7 | 141.1 |
| Fuel Flow - (SCFH) | 8,600.0 | 8,300.0 | 8,500.0 | 8,466.7 |
| Fuel Flow (LB/HR) | 385.4 | 371.9 | 380.9 | 379.4 |
| Exhaust Flow (LB/HR) | 9,214.8 | 9,013.2 | 9,230.4 | 9,152.8 |
| Exhaust Flow (WSCFM) | 3,047.5 | 2,941.2 | 3,012.0 | 3,000.2 |
| Exhaust Flow (DSCFM) | 2,038.5 | 1,993.0 | 2,041.0 | 2,024.2 |
| Exhaust Gas Volume (ACFM) | 7,211.0 | 6,965.6 | 7,035.9 | 7,070.8 |
| Air Flow (WSCFM) | 1,974.4 | 1,930.2 | 1,976.8 | 1,960.5 |
| BSAC, #/BHP-hr | 1.2 | 1.1 | 1.1 | 1.1 |
| **Fuel Flow Measurements** | | | | |
| Fuel Flow (SCFH) | 8600.00 | 8300.00 | 8500.00 | 8466.67 |
| ** BASED ON FUEL SPECIFIC DRY F-FACTOR CALCULATION<br>* BASED ON CARBON BALANCE (STOICH. + O2)<br>- A/F IS TOTAL MASS RATIO | | | | |

## 3. PROCESS DESCRIPTION

TC Energy's ANR Blue Lake Compressor Station (ANR) is located in Mancelona, Michigan and operates two Sivalls withdrawal gas heaters labeled Unit EGBLHTR-A and Unit EGBLHTR-B. The plant is located at 10000 Pflum Road, Mancelona, Michigan.

In the process of withdrawing the gas from its underground storage facilities during winter time, and while depressurizing it to pipeline conditions (from around 4,000 psi to 800-900 psi), the reduction in pressure implies also a reduction in the temperature of the gas. To prevent the gas to reach temperatures below the minimum temperature rating of the pipe, the gas heaters preheat the gas using burners before the pressure cut.

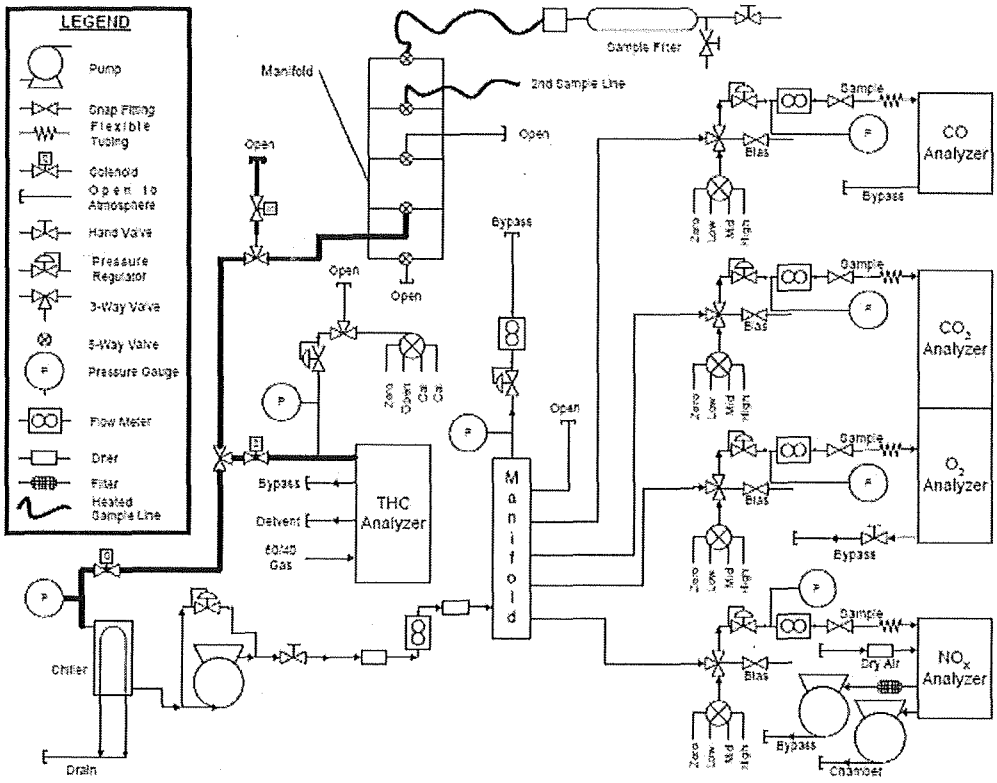
The following tables provide a summary of the production rates for the Heaters A and B during the tests:

**Table 7. Heaters A & B- Fuel Flow (SCFH)**

| Fuel Flow (SCFH) | | |
|---|---|---|
| **Run No.** | **Heater A** | **[1]Heater B** |
| 1 | 8,400 | 8,600 |
| 2 | 8,440 | 8,300 |
| 3 | 8,480 | 8,500 |
| Average | 8,440 | 8,467 |

[1]Unit B's plant data's fuel flow printouts are labeled incorrectly as MMCFD, and should have been labeled MMSCFH located in Appendix B.

**Figure 1. Heaters A and B-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 1 – Sample and Velocity Traverses for Stationary Sources
- 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)
- U.S. EPA Method 10 – Determination of Carbon Monoxide Emissions From Stationary Sources (Instrumental Analyzer Procedure)

USEPA Methods 3A, 7E and 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 Engine 1110 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

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

**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 |

Mass Emissions Calculations g/bhp-hr

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

**Where:**

*Em:* Pollutant emissions rate
$C_d$: 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 CO | lb/scf | $7.268 \times 10^{-8}$ |
| ppm $NO_x$ | lb/scf | $1.194 \times 10^{-7}$ |

## 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 Heaters A and Heater B at TC Energy's ANR Pipeline Company's Blue Lake Compressor Station located in Mancelona, MI. The testing was conducted on February 20, 2020.

During the course of the testing, the Heater A and Heater B conformed to the requirements of Code of Federal Regulations, Title 40, Part 60, Appendix A, National Emission Standards for Hazardous Air Pollutants for withdrawal gas heaters.

The usefulness and/or significance of the emissions values presented in this document as they relate to the compliance status of the Heater A and Heater B emissions shall be determined by others.

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