# 40 CFR Part 60, Subpart JJJJ and 40 CFR Part 63 Subpart ZZZZ Continuous Compliance Demonstration Test Report

# EUENGINE31, EUENGINE32, EUENGINE 33, EUENGINE34, EUENGINE35

**Consumers Energy Company**
**Ray Compressor Station**
**69333 Omo Road**
**Armada, Michigan 48005**
**SRN: B6636**

**Test Dates: July 17 through 19, 2017**

**Report Submitted: September 11, 2017**

**Test Performed by the Consumers Energy Company**
**Regulatory Compliance Testing Section – Air Emissions Testing Body**
**Laboratory Services**
**Work Order No. 29763859**
**Revision 0**

## EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted nitrogen oxides ($NO_x$), carbon monoxide (CO), and volatile organic compound (VOC) testing of five natural gas fired, reciprocating internal combustion engines (RICE) EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4, and EUENGINE3-5 operating at the Ray Compressor Station in Armada, Michigan. Each engine is classified as a four-stroke lean burn (4SLB), spark ignited, 4,735 brake horsepower (BHP) engine, located at a major source of hazardous air pollutant (HAP) emissions. The engines are used to maintain pressure of natural gas in order to move it in and out of storage reservoirs and along the pipeline system. The test program was performed to satisfy the performance testing requirements and evaluate compliance with 40 CFR Part 60, Subpart JJJJ, "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines," and 40 CFR Part 63, Subpart ZZZZ, "National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines," (aka RICE MACT), as incorporated in Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B6636-2015a.

On July 17-19, 2017, triplicate 60-minute test runs were conducted on each engine. CO and oxygen ($O_2$) concentrations were measured at the exhaust of the engines (prior to the catalyst) and CO, $O_2$, $NO_x$, and VOC concentrations were measured at the outlets of oxidation catalysts following the procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 3A, 7E, 10 and 25A in 40 CFR 60, Appendix A. There were no deviations from the approved stack test protocol or the associated USEPA Reference Methods. During testing, the engines were operated at load conditions within ±10 percent of 100 percent load, as specified in 40 CFR 63.6620(b). The results of the emissions testing are summarized in the following table:

**Summary of Test Results**

| Engine | NOx (g/hp-hr) | CO (g/hp-hr) | CO Reduction Efficiency (%) | VOC (g/hp-hr) |
|---|---|---|---|---|
| EUENGINE31 | 0.4 | 0.01 | 99 | 0.07 |
| EUENGINE32 | 0.3 | 0.01 | 99 | 0.09 |
| EUENGINE33 | 0.3 | 0.01 | 99 | 0.14 |
| EUENGINE34 | 0.4 | 0.01 | 99 | 0.11 |
| EUENGINE35 | 0.4 | 0.01 | 99 | 0.13 |
| **JJJJ Limits** | **1.0** | **2.0** | | **0.7** |
| **ZZZZ Limits** | | | ≥93 | |
| **ROP Limits** | **0.5** | **0.2** | | **0.19** |

The results of the testing indicate each engine is operating in compliance with applicable limits.

Detailed results are presented in Appendix Tables 1 through 5. Sample calculations and field data sheets are presented in Appendices A and B. Laboratory data is provided in Appendix C. Engine operating data and supporting information are provided in Appendices D and E.

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AIR QUALITY DIVISION

# INTRODUCTION

This report summarizes the results of air emissions testing of EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4, and EUENGINE3-5 (collectively identified as FGENGINES3) operating at the Consumers Energy Ray Compressor Station.

Please note this document follows the Michigan Department of Environmental Quality (MDEQ) format described in the December 2013, Format for Submittal of Source Emission Test Plans and Reports and reproducing only a portion may omit critical substantiating documentation or cause information to be taken out of context. If any portion of this report is reproduced, please exercise due care in this regard.

## Identification, location, and dates of tests

On July 17-19, 2017, Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted nitrogen oxides ($NO_x$), carbon monoxide (CO), and volatile organic compound (VOC) testing of five natural gas fired, reciprocating internal combustion engines (RICE) EUENGINE3-1, EUENGINE3-2, EUENGINE3-3, EUENGINE3-4, and EUENGINE3-5 operating at the Ray Compressor Station in Armada, Michigan.

A test protocol was submitted to the MDEQ on May 15, 2017 and subsequently approved by Mr. Mark Dziadosz, Environmental Quality Analyst, in his letter dated July 5, 2017.

## Purpose of testing

The test program was performed to satisfy the performance testing requirements and evaluate compliance with 40 CFR Part 60, Subpart JJJJ, "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines," and 40 CFR Part 63, Subpart ZZZZ, "National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines," (aka RICE MACT), as incorporated in MDEQ Renewable Operating Permit (ROP) MI-ROP-B6636-2015a.

The testing evaluated compliance with the applicable emission limit options summarized in Table 1-1 and was performed to satisfy the testing requirements.

## Table 1-1
## FGENGINES3 Emission Limits

| Parameter | Emission Limit | Units | Underlying Applicable Requirements |
|---|---|---|---|
| $NO_x$ | 0.5 | g/hp-hr | Michigan Air Pollution Control Rules: R 336.2803, R 336.2804, R 336.2810; 40 CFR 52.21(c), (d) & (j); |
| | 1.0 | g/hp-hr | 40 CFR Part 60 Subpart JJJJ |
| CO | 93 | % removal efficiency | 40 CFR Part 63 Subpart ZZZZ |
| | 0.2 | g/hp-hr | Michigan Air Pollution Control Rules: R 336.2803, R 336.2804, R 336.2810; 40 CFR 52.21(c), (d) & (j) |
| VOC | 0.19 | g/hp-hr | Michigan Air Pollution Control Rules: R 336.1702(a), R 336.2810; 40 CFR 52.21(j), |
| | 0.7 | g/hp-hr | 40 CFR Part 60 Subpart JJJJ |

### Brief description of source

EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are classified as four stroke lean burn (4SLB) spark-ignited 4,735 brake horsepower (BHP) engines located at a major source of hazardous air pollutant (HAP) emissions. The engines are used to maintain pressure of natural gas in order to move it in and out of storage reservoirs and along the pipeline system.

### Contact Information

Table 1-2 presents the names, addresses, and telephone numbers of the contacts for information regarding the test and the test report, and names and affiliation of personnel involved in conducting the testing.

# Table 1-2
## Contact Information

| Program Role | Contact | Address |
|---|---|---|
| State Regulatory Administrator | Karen Kajiya-Mills<br>Technical Programs Unit Manager<br>517-335-4874<br>Kajiya-Millsk@michigan.gov | Michigan Department of Environmental Quality<br>Technical Programs Unit<br>525 W. Allegan, Constitution Hall, 2nd Floor S<br>Lansing, Michigan 48933 |
| State Regulatory Inspector | Robert Elmouchi<br>Sr. Environmental Engineer<br>586-753-3731<br>Elmouchir@michigan.gov | Michigan Department of Environmental Quality<br>Southeast Michigan District<br>27700 Donald Court<br>Warren, Michigan 48092 |
| Responsible Official | Gregory Baustian<br>Executive Director-Natural Gas Compression and Storage<br>616-237-4009<br>Gregory.Baustian@cmsenergy.com | Consumers Energy Company<br>Zeeland Generation<br>425 N. Fairview Road<br>Zeeland, Michigan 49464 |
| Corporate Air Quality Contact | Amy Kapuga<br>Sr. Environmental Engineer II<br>517-788-2201<br>Amy.Kapuga@cmsenergy.com | Consumers Energy Company<br>Environmental Services Department<br>1945 West Parnall Road<br>Jackson, Michigan 49201 |
| Test Facility | Charles Kelly<br>Gas Field Lead III<br>586-784-2096<br>Charles.Kelly@cmsenergy.com | Consumers Energy Company<br>Ray Compressor Station<br>69333 Omo Road<br>Armada, Michigan 48005 |
| Test Team Representative | Mr. Dillon A. King, QSTI<br>Engineering Technical Analyst<br>989-891-5585<br>Dillon.King@cmsenergy.com | Consumers Energy Company<br>D.E. Karn Generating Station<br>2742 North Weadock Highway<br>ESD Trailer #4<br>Essexville, Michigan 48732 |

# SUMMARY OF RESULTS

## Operating Data

During the performance test, the engine fired natural gas and was operated near maximum operating load conditions. 40 CFR 63.6620(b) states that each performance test must be conducted at any load condition within ±10 percent of 100 percent load. The performance testing was conducted while the engines were operating between 98.57% and 106.31% of the maximum manufacturer's design capacity for torque at engine site conditions.

Refer to Attachment D for detailed operating data, which was recorded in Eastern Daylight Time. Note the time convention for the reference method (RM) testing was correlated to match facility operating data recordkeeping time.

## Applicable Permit Information

The Ray Compressor Station has been assigned State of Michigan Registration Number (SRN) B6636 and operates in accordance with air permit MI-ROP-B6636-2015a. EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are the emission unit source identifications in the permit and are included in the FGENGINES3 flexible group. Incorporated within the permit are the applicable requirements of 40 CFR Part 60, Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and 40 CFR Part 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines.

## Results

The results of the testing indicate EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are operating in compliance with applicable limits. Refer to Table 2-1 for a summary of test results.

**Table 2-1**
**Summary of Test Results**

| Engine | NOx (g/hp-hr) | CO (g/hp-hr) | CO Reduction Efficiency (%) | VOC (g/hp-hr) |
|---|---|---|---|---|
| EUENGINE31 | 0.4 | 0.01 | 99 | 0.07 |
| EUENGINE32 | 0.3 | 0.01 | 99 | 0.09 |
| EUENGINE33 | 0.3 | 0.01 | 99 | 0.14 |
| EUENGINE34 | 0.4 | 0.01 | 99 | 0.11 |
| EUENGINE35 | 0.4 | 0.01 | 99 | 0.13 |
| **JJJJ Limits** | **1.0** | **2.0** | | **0.7** |
| **ZZZZ Limits** | | | **≥93** | |
| **ROP Limits** | **0.5** | **0.2** | | **0.19** |

Detailed results are presented in Appendix Tables 1 through 5. Sample calculations and field data sheets are presented in Appendices A and B. Laboratory data is provided in Appendix C. Engine operating data and supporting information are provided in Appendices D and E.

## SOURCE DESCRIPTION

EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are natural gas fired RICE's used to maintain pressure of sweet natural gas in order to move it in and out of storage reservoirs and along the pipeline system. A summary of the engine specifications are provided in Table 3-1.

**Table 3-1**
**Summary of Engine Specifications**

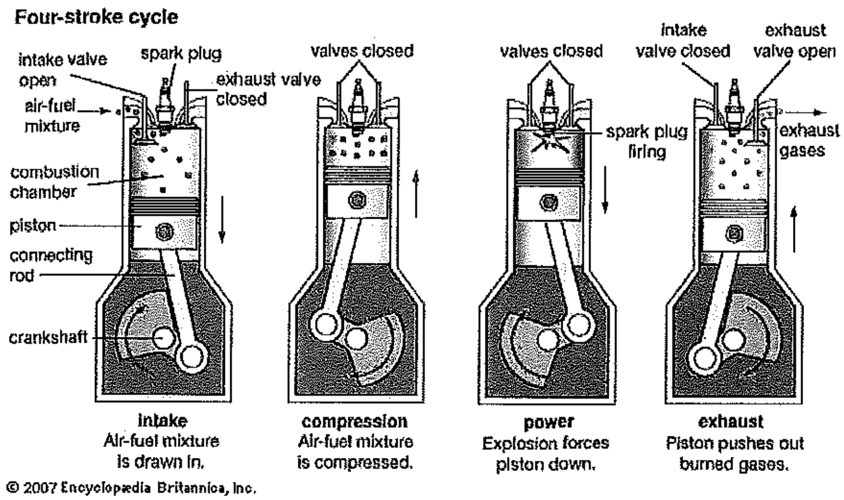
| Parameter | EUENGINE31 through EUENGINE35 |
|---|---|
| Make | Caterpillar |
| Model | B3616 |
| Output (bhp) | 4735 |
| Heat Input (mmBtu/hr) | 32.0 |
| Emission Control | Oxidation Catalyst |

### Description of Process

EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are natural gas-fired, spark ignited, 4-stroke lean-burn (4SLB) RICE's installed in 2013. In the four-stroke engine, air is aspirated into the cylinder during the downward travel of the piston on the intake stroke. The fuel charge is injected with the piston near the bottom of the intake stroke and the intake ports are then closed as the piston moves to the top of the cylinder, compressing the air/fuel mixture. The ignition and combustion of the air/fuel charge, begins the downward movement of the piston, called the power stroke. As the piston reaches the bottom of the power stroke, valves are opened to exhaust combustion products as the piston is driven upward, expelling the combustion products from the cylinder. A new air-to-fuel charge is injected as the piston moves downward in a new intake stroke.

The engine provides mechanical shaft power for compressors and/or pumps. The compressors and/or pumps are used to help inject natural gas into high pressure natural gas storage fields or to help move natural gas and maintain pressure within the natural gas pipeline transmission and distribution system to consumers. Refer to Figure 3-1 for a four-stroke engine process diagram.

## Figure 3-1
## Four-Stroke Engine Process Diagram




The flue gas generated through natural gas combustion is controlled through parametric controls (i.e., timing and operating at a lean air-to-fuel ratio) and by a post-combustion oxidizing catalyst installed on the engine exhaust system. As carbon monoxide passes through the Dresser Rand catalytic oxidation system containing eight modular catalyst elements with a specially formulated low-$NO_2$ coating, CO and VOCs are oxidized to $CO_2$ and water, while suppressing the conversion of NO to $NO_2$.

A continuous parameter monitoring system (CPMS) is installed to continuously monitor catalyst inlet temperature in accordance with the requirements specified in Table 5 (13) of 40 CFR Subpart ZZZZ. This parameter is monitored in accordance with the site-specific preventative maintenance / malfunction and abatement plan as a means to evaluate an efficient catalytic reaction and the performance of the pollution control equipment. Detailed operating data are provided in Appendix D.

### Process Flow

Located in southern Ray County, the Ray Compressor Station helps maintain natural gas pressures in southeast Michigan. The station is used to compress and store natural gas into the Ray gas storage field. This field can store up to 43 billion cubic feet of natural gas which provide enough natural gas to serve up to 40 percent of the supply to Consumers Energy's 1.7 million gas customers in winter.

EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are natural gas reciprocating compressor engines used at the facility to maintain pressure and move natural gas in and out of the storage reservoirs. The exhaust stacks are of non-typical design. Specifically, the bottom portion of the stack has an outer stack and an inner circular stack (the shape is like a doughnut as viewed looking down from the top of the stack). The exhaust gases from the engine enter the outer stack via two horizontal ducts running from the engine to the free standing stack. Once the gases enter the outer stack, they flow downwards through the oxidation catalysts placed in the bottom of the outer stack. After passing through the catalysts, the exhaust gases enter the inner stack through an opening located near the base of the free standing stack. The exhaust gases then travel upwards, through the free standing stack, (via the inner stack) until they are discharged unobstructed vertically upwards through the approximately 75-feet high stack to the ambient air.

### Materials Processed

The fuel utilized in the engines is exclusively natural gas, as defined in 40 CFR 72.2. The units are classified as new stationary RICE located at an major source of HAP emissions, non-emergency, non-black start 4SLB stationary RICE >500 HP that is not remote stationary RICE and that operates more than 24 hours per calendar year as described in Table 2d (9) to Subpart ZZZZ.

### Maximum and Normal Rated Capacity

EUENGINE31, EUENGINE32, EUENGINE33, EUENGINE34 and EUENGINE35 are each limited to a maximum output of approximately 4,735 horsepower. At this achievable output, the heat input rating is approximately 32 mmBtu/hr.

### Process Instrumentation

The process was continuously monitored by operators and data acquisition systems during testing. Data were collected at 1-minute intervals during each test for the following parameters: speed (rpm), torque (%), horsepower (HP), fuel flow (mscf/hr), suction pressure (psi), discharge pressure (psi), pressure drop across catalyst ($\Delta P$), exhaust temperature (°F), ambient temperature (°F) and barometric pressure (in Hg). The time convention for the reference method (RM) testing was correlated to match facility operating data recordkeeping time. Refer to Appendix D for operating data.

# SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy RCTS tested for $NO_x$, VOCs, CO and $O_2$ concentrations using the USEPA test methods presented in Table 4-1. The sampling and analytical procedures associated with each parameter are described in the following sections.

**Table 4-1**
**Test Methods**

| Parameter | USEPA | |
|---|---|---|
| | Method | Title |
| Sample traverses | 1 | Sample and Velocity Traverses for Stationary Sources |
| Oxygen ($O_2$ concentration) | 3A | Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure) |
| Nitrogen oxides ($NO_x$) | 7E | Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrument Analyzer Procedure) |
| Carbon monoxide (CO) | 10 | Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure) |
| Volatile Organic Compounds (VOC as NMVOC) | 25A | Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer (FIA) |

## Description of Sampling Train and Field Procedures

The test matrix presented in Table 4-2 summarizes the sampling and analytical methods performed for the specified parameters during this test program.

**Table 4-2**
**Test Matrix**

| Date (2017) | Engine | Run | Start Time (EDT) | Stop Time (EST) | Test Duration (min) | EPA Test Method | Comment |
|---|---|---|---|---|---|---|---|
| July 17 | 3-1 | 1 | 15:25 | 16:25 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 2 | 16:49 | 17:49 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 3 | 18:16 | 19:16 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |

**Table 4-2**
**Test Matrix**

| Date (2017) | Engine | Run | Start Time (EDT) | Stop Time (EST) | Test Duration (min) | EPA Test Method | Comment |
|---|---|---|---|---|---|---|---|
| July 18 | 3-2 | 1 | 10:10 | 11:10 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 2 | 11:37 | 12:37 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 3 | 12:57 | 13:57 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| July 19 | 3-3 | 1 | 9:00 | 10:00 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 2 | 10:20 | 11:20 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 3 | 11:40 | 12:40 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| July 19 | 3-4 | 1 | 13:25 | 14:25 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 2 | 14:44 | 15:44 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 3 | 16:19 | 17:19 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| July 18 | 3-5 | 1 | 15:40 | 16:40 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 2 | 16:58 | 17:58 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |
| | | 3 | 18:16 | 19:16 | 60 | 1, 3A, 7E, 10, 25A | 3 traverse points |

### Sample Location and Traverse Points (USEPA Method 1)

The number and location of traverse points was evaluated according to the requirements in Table 4 of 40 CFR 63, Subpart ZZZZ and USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources.*

#### Pre-catalyst Sampling Ports

Two test ports are located in a 24-inch horizontal exhaust duct exiting the engine and building. The pre-catalyst sampling ports are situated:

- At least 208 inches or 8.7 duct diameters downstream of a duct bend disturbance at the engine exhaust, and

- At least 57 inches or 2.4 duct diameters upstream of flow disturbance caused by a change in duct diameter and flow direction as it enters the oxidation catalyst.

The pre-catalyst sample ports are 1-inch in diameter and extend approximately 1-inch beyond the stack wall.

**Post-catalyst Sampling Ports**

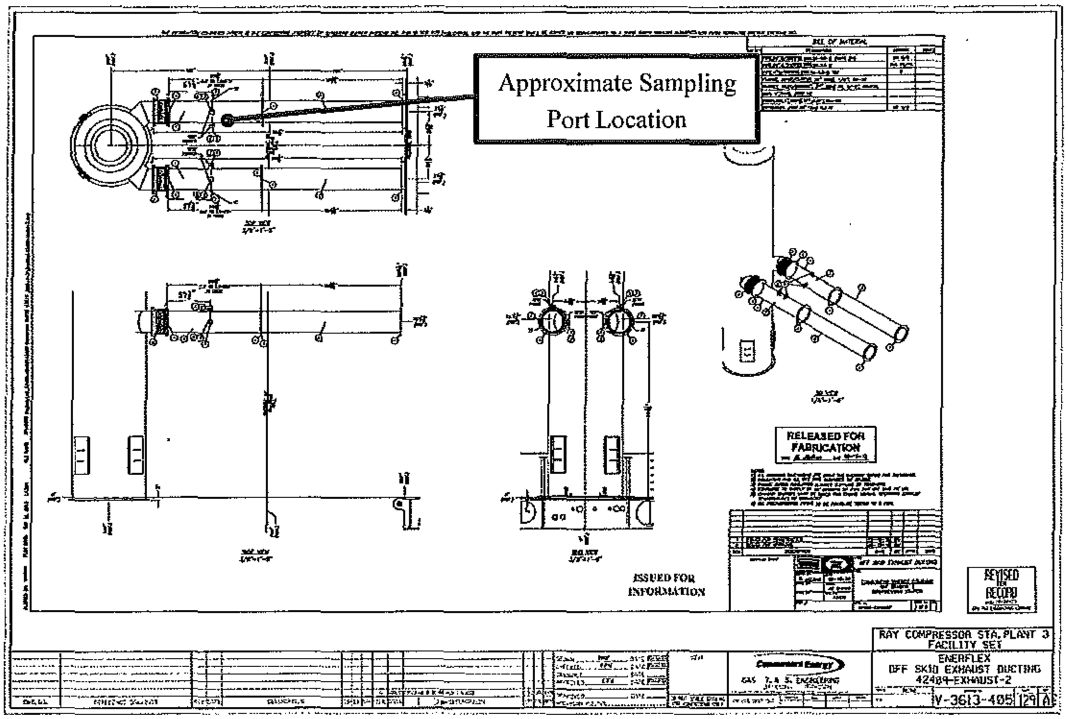
Two test ports are located in a 36-inch vertical exhaust duct exiting the engine and oxidation catalyst. The post-catalyst sampling ports are situated:

- Approximately 72 inches or 2.0 duct diameters downstream of a duct diameter change flow disturbance, and
- Approximately 43 inches or 1.2 duct diameters upstream of the stack exit.

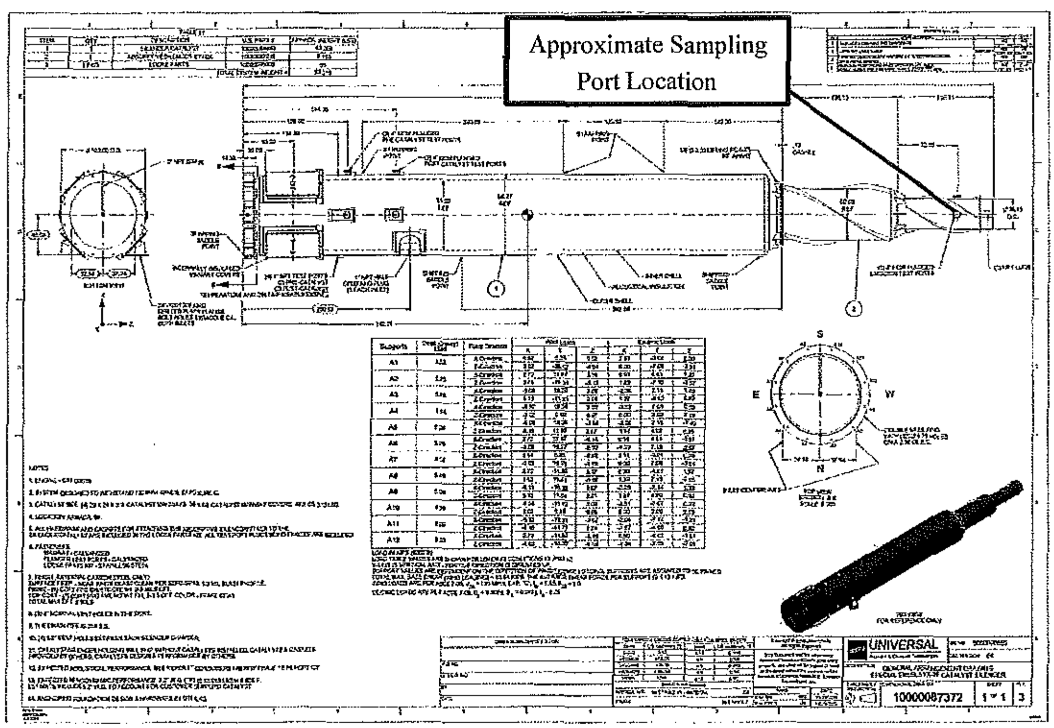
The post-catalyst sample ports are 4-inch in diameter and extend approximately 4-inches beyond the stack wall.

Because the ducts are >12 inches in diameter and the sampling port location meets the two and half-diameter criterion of Section 11.1.1 of Method 1 of 40 CFR Part 60, Appendix A-1, the duct was sampled at 3 traverse points located at 16.7, 50.0, and 83.3% of the measurement line ('3-point long line'). The flue gas was sampled from the three traverse points at approximately equal intervals during the tests. Pre-catalyst and post-catalyst sampling port location drawings are presented as Figures 4-1 and 4-2.

# Figure 4-1
# Pre-Catalyst Sampling Port Location




# Figure 4-2
# Post-Catalyst Sampling Port Location

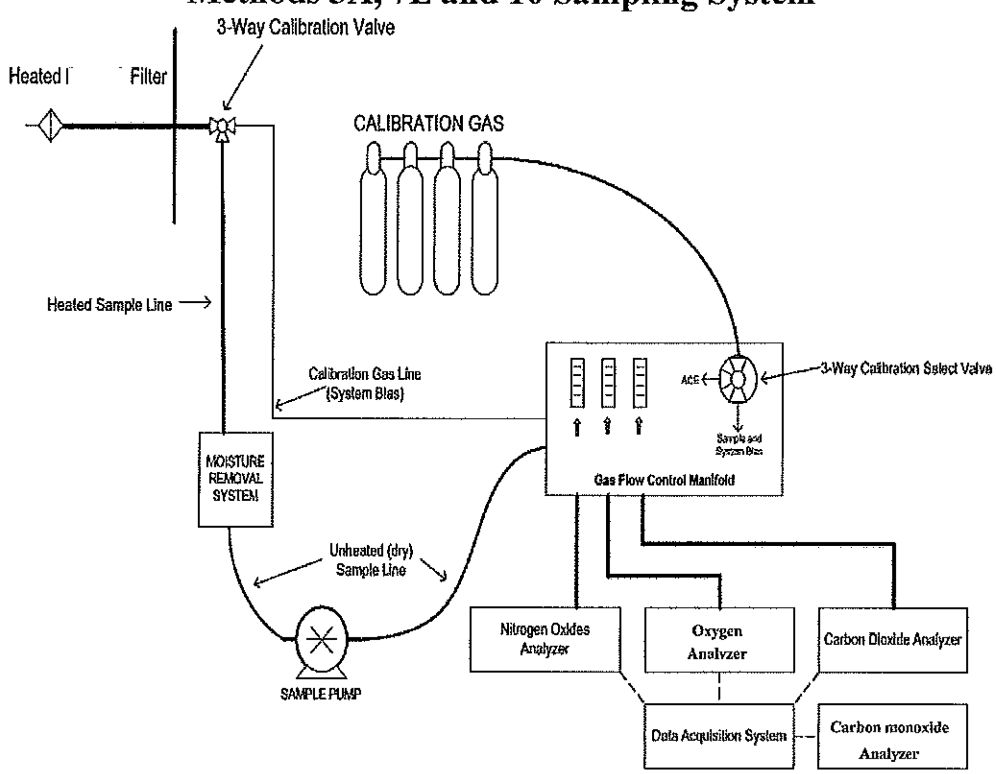


**OXYGEN, NITROGEN OXIDES, AND CARBON MONOXIDE (USEPA METHODS 3A, 7E AND 10)**

Oxygen, nitrogen oxides and carbon monoxide concentrations were measured using the sampling and analytical procedures of USEPA Methods 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)*, 7E, *Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)* and 10, *Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure).* The sampling procedures of the methods are similar with the exception of the analyzers and analytical technique used to quantify the parameters of interest. The measured oxygen concentrations were used to adjust the carbon monoxide concentrations to 15% $O_2$.

Engine exhaust gas was extracted from the stacks through a stainless steel probe, heated Teflon® sample line, and through a gas conditioning system to remove water and dry the sample before entering a sample pump, gas flow control manifold, and paramagnetic, chemiluminescent, and infrared gas filter correlation gas analyzers. Figure 4-3 depicts the Methods 3A, 7E and 10 sampling system.

**Figure 4-3**
**Methods 3A, 7E and 10 Sampling System**



Prior to sampling engine exhaust gas, the analyzers were calibrated by performing a calibration error test where zero-, mid-, and high-level calibration gases are introduced directly to the back of the analyzers. The calibration error check was performed to evaluate if the analyzers response was within ±2.0% of the calibration gas span or high calibration gas concentration. An initial system-bias test was performed where the zero- and mid- or high- calibration gases are introduced at the sample probe to measure the ability of the system to respond accurately to within ±5.0 percent of span.

Upon successful completion of the calibration error and initial system bias tests, sample flow rates and component temperatures were verified and the probes were inserted into the ducts at the appropriate traverse point. After confirming the engine was operating at established conditions the test run was initiated. Oxygen and carbon monoxide concentrations were recorded at 1-minute intervals throughout the 20-minute test duration.

At the conclusion of the test run, a post-test system bias check was performed to evaluate analyzer bias and drift from the pre- and post-test system bias checks. The system-bias checks evaluate if the analyzers bias is within 5.0% of span and drift is within ±3.0%. The analyzers response was used to correct the measured oxygen, nitrogen oxides and carbon monoxide concentrations for analyzer drift. Refer to Appendix E for analyzer calibration supporting documentation.

### VOLATILE ORGANIC COMPOUNDS AS NMNEOC (USEPA METHODS 18 AND 25A)

VOC concentrations were monitored at each engine exhaust using a Thermo Model 55i Direct Methane and Non-methane Analyzer following the guidelines of U.S. EPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer (FIA)*. The instrument uses a flame ionization detector (FID) to measure the exhaust gas total hydrocarbon concentration in conjunction with a gas chromatographic column which separates the methane from other organic compounds. Sample gas is injected into the column. Due to methane's low molecular weight and high volatility, the compound moves through the column more quickly than other existing organic compounds and exits the column to be analyzed in the FID. The column is then flushed with inert carrier gas and the remaining non-methane organic compounds are analyzed in the FID. This analytical technique allows separate measurements for methane and non-methane organic compounds via the use of a single FID.
The field VOC instrument was calibrated with zero air and three propane and methane in air gases following U.S. EPA Method 25A specifications at the zero level, low (25 to 35 percent of calibration span), mid (45 to 55 percent of calibration span) and high (equivalent to instrument span). Please note that since the field VOC instrument measures on a wet basis, exhaust gas moisture content was estimated for each VOC run for converting wet VOC concentrations to a

dry basis until moisture content results determined from daily natural gas fuel samples collected as required by 40 CFR Part 60 Subpart JJJJ were applied to the final VOC concentrations and emission rates.

VOC as NMNEOC concentrations were determined by an outside contracted laboratory using U.S. EPA Method 18, Measurement of Gaseous Organic Compound Emission By Gas Chromatography. Triplicate bags manufactured from polyvinyl fluoride (PVF) film, also known as Tedlar film, were collected in the field directly from each engine exhaust. The gaseous organic mixture in each bag was measured by separating the major organic components using a gas chromatograph (GC) and measuring them with a suitable detector. To identify and quantify the major components, the retention times of each separated component were compared with those of known compounds under identical conditions. The approximate concentrations of the organic emission components were identified beforehand and standard mixtures prepared so the GC was calibrated under physical conditions identical to those used for the samples. Method 18 requires the sample results to be corrected based on results obtained from a spike recovery study. For the bag sampling technique to be considered valid for a compound, the recovery must be between $70\% < R < 130\%$. The recovery study performed on the Ray Compressor engine Tedlar bag samples successfully achieved the R value requirement and that value was applied to the reported methane, ethane and VOC as propane concentrations as shown in Appendix E of this report.

# TEST RESULTS AND DISCUSSION

The test program was performed to satisfy the continuous performance test requirements and evaluate compliance with 40 CFR Part 60, Subpart JJJJ, "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines," and 40 CFR Part 63, Subpart ZZZZ, "National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines," (aka RICE MACT) as incorporated in the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) MI-ROP-B6636-2015a.

## Tabulation of Results

The results of the testing indicate the individual and 3-run average CO removal efficiency, as well as CO, NOx, and NMNEOC emission rate results are in compliance with applicable limits. The results are summarized in Table 2-1. Tables 1 through 5 in the Appendix contain detailed tabulation of results, process operating conditions, and exhaust gas conditions.

## Significance of Results

The results of the testing indicate compliance with the applicable engine operating parameters and emission regulation.

## Variations from Sampling or Operating Conditions

The analysis of the natural gas sample taken on July 19, 2017 for the EUENGINE33 and EUENGINE34 testing could not determine water content results via ASTM D4D4 due to standing free water in the gas cylinder. This may have been due to a lack of purging the sample cylinder prior to taking the natural gas sample. The average water content of the July 17 and 18, natural gases was used to calculate moisture for EUENGINE33 and EUENGINE34 to correct the NMNEOC measurements to a dry basis. No other sampling procedure deviations or operating conditions were encountered during the test program.

## Upset Conditions

The process and control equipment were operating under maximum routine conditions and no upsets were encountered.

## Air Pollution Control Device Maintenance

No significant pollution control device maintenance occurred during the three months prior to the test. Engine optimization and continuous parametric monitoring of the air pollution control device are monitored to ensure compliance with regulatory emission limits.

### Re-Test Discussion

No significant changes to the process or air pollution control device occurred since the last performance test. Based on the results of this test program, a re-test is not required.

### Results of Audit Samples

Audit samples for the reference methods utilized during this test program are not available from EPA Stationary Source Audit Sample Program providers. Table 5-1 summarizes the primary field quality assurance and quality control activities required by the reference method that were performed. Refer to Appendix E for supporting documentation.

**Table 5-1**
**Quality Control Procedures**

| EPA Method QC Specification | Purpose | Procedure | Frequency | Acceptance Criteria |
|---|---|---|---|---|
| EPA 1: Sampling Location | Evaluate if the sampling location is suitable for sampling | Measure distance from ports to downstream and upstream disturbance | Pre-test | ≤2 diameters downstream; ≤0.5 diameter upstream. |
| EPA 1: Duct diameter | Verify major of stack is accurately measured | Review as-built drawings and field measurement | Pre-test | Field measurement agreement with as-built drawings |
| EPA 3A, 7E, 10 and 25A: Calibration gas standards | Ensure accurate calibration standards | Traceability protocol of calibration gases | Pre-test | Calibration gas uncertainty ≤2.0% |
| EPA 3A, 7E and 10: Calibration Error | Evaluates operation of analyzers | Calibration gases introduced directly into analyzers | Pre-test | ±2% of the calibration span |
| EPA 25A: Calibration Error | Evaluates operation of analyzers | Cal gases introduced at inlet of sampling system and into analyzers | Pre-test | ±5% of the calibration gas |
| EPA 3A, 7E, 10 and 25A: System Bias and Analyzer Drift | Evaluates ability of sampling system to delivery stack gas to analyzers | Cal gases introduced at inlet of sampling system and into analyzers | Pre-test and Post-test | ±5% of the analyzer calibration span for bias and ±3% of analyzer calibration span for drift |
| EPA 3A, 7E, 10 and 25A: Duct traverse | Ensure representative sample collection | Insert probe into stack and traverse duct | During test | Collect samples from 3-point long line |

## Calibration Sheets

Calibration sheets, including gas protocol sheets and analyzer quality control and assurance checks are presented in Appendix E.

## Sample Calculations

Sample calculations for formulas used to calculate emissions data are presented in Appendix A.

## Field Data Sheets

Field data sheets are presented in Appendix B.

## Laboratory Quality Assurance / Quality Control Procedures

Laboratory data is presented in Appendix C.

## Ray Compressor Station
### AVERAGE
### EUENGINE31 NESHAP DATA
### July 17, 2017

| | INLET | OUTLET |
|---|---|---|
| Catalyst Exhaust Gas Moisture Content, Percent: | 10.2 | |
| O2 Concentration, Percent, Dry: | 11.83 | 11.79 |
| **Carbon Monoxide (CO) Concentrations, Reduction Efficiency and Emissions** | | |
| CO Concentration, PPM, Dry: | 397.02 | 4.69 |
| CO Concentration@15% O2, PPM, Dry: | 258.24 | 3.04 |
| CO Percent Reduction Efficiency, Percent: | **98.82** | |
| CO Emission Rate, Lb/mmBtu: | 0.0036 | |
| CO Emission Rate, Lb/Hr: | 0.12 | |
| CO Emission Rate, Ton/Yr: | 0.54 | |
| CO Concentration, Gram/BHPHR: | **0.012** | |
| **Nitrogen Oxides (NOx) Concentrations and Emissions** | | |
| NOx Concentration, PPM, DRY: | 54.77 | |
| NOx Concentration, PPM, DRY, @ 15% O2: | 35.46 | |
| NOx Emission Rate, Lb/mmBtu: | 0.1306 | |
| NOx Emission Rate, Lb/Hr: | 4.47 | |
| NOx Emission Rate, Ton/Yr: | 19.58 | |
| NOx Concentration, Gram/BHPHR: | **0.435** | |
| **Non-Methane Organic Compounds (NMOC), Field Analysis [1]** | | |
| NMOC Concentration, Wet, PPM as propane: | 46.4 | |
| NMOC Concentration, Dry, PPM, as propane: | 51.7 | |
| NMOC Emission Rate, Lb/mmBtu: | 0.1182 | |
| NMOC Emission Rate, Lb/Hr: | 4.0 | |
| NMOC Emission Rate, Ton/Yr: | 17.7 | |
| NMOC Concentration, Gram/BHPHR: | 0.393 | |
| **Ethane Laboratory Analysis [1]** | | |
| Ethane Concentration, Wet, PPM: | 56.7 | |
| Ethane Concentration, Wet, PPM as propane: | 37.8 | |
| Ethane Concentration, Dry, PPM, as propane: | 42.1 | |
| **Non-Methane, Non-Ethane Organic Compounds (NMNEOC) Concentrations and Emissions** | | |
| NMNEOC Concentration, Dry, PPM, as propane: | 9.6 | |
| NMNEOC Emission Rate, Lb/mmBtu: | 0.0193 | |
| NMNEOC Emission Rate, Lb/Hr: | 0.67 | |
| NMNEOC Emission Rate, Ton/Yr: | 2.93 | |
| NMNEOC Concentration, Gram/BHPHR: | **0.065** | |
| **Continuous Parameter Monitoring System Engine Data** | | |
| Natural Gas Fuel Factor, BTU/Ft$^3$: | 1037.50 | |
| Natural Gas Fuel Factor, Fc: | 1040.0 | |
| Engine Fuel Flow Rate, Ft$^3$/Min: | 549.91 | |
| Engine Speed, RPM: | 959.74 | |
| Engine Torque, Percent: | 102.67 | |
| Engine Brake Horsepower: | 4666.32 | |

[1] While the U.S. EPA does not classify methane and ethane as volatile organic compounds (VOC), field measured VOC may contain both compounds, depending on test methods employed, instrumentation used and/or fuel combusted. During the Ray Compressor test program, methane and non-methane concentrations were quantified separately and independently using a Thermo Environmental Model 55I. With the methane contribution removed, non-methane VOC concentrations at each Plant 3 engine exhaust appeared to be greater than allowed by the facility ROP limit. Further investigation revealed the engines were firing natural gas obtained from shale sources, wih an unknown ethane content, which the Thermo 55I includes as non-methane, so additional samples were collected for ethane analysis at an outside contracted laboratory. The resulting ethane contribution reported (as propane) was then subtracted from the non-methane field measurement.

## Ray Compressor Station
### AVERAGE
### EUENGINE32 NESHAP DATA
### July 18, 2017

| | INLET | OUTLET |
|---|---|---|
| Catalyst Exhaust Gas Moisture Content, Percent: | 10.4 | |
| O2 Concentration, Percent, Dry: | 11.86 | 11.80 |
| **Carbon Monoxide (CO) Concentrations, Reduction Efficiency and Emissions** | | |
| CO Concentration, PPM, Dry: | 423.87 | 3.11 |
| CO Concentration@15% O2, PPM, Dry: | 276.70 | 2.02 |
| CO Percent Reduction Efficiency, Percent: | **99.27** | |
| CO Emission Rate, Lb/mmBtu: | 0.0024 | |
| CO Emission Rate, Lb/Hr: | 0.08 | |
| CO Emission Rate, Ton/Yr: | 0.35 | |
| CO Concentration, Gram/BHPHR: | **0.008** | |
| **Nitrogen Oxides (NOx) Concentrations and Emissions** | | |
| NOx Concentration, PPM, DRY: | 39.75 | |
| NOx Concentration, PPM, DRY, @ 15% O2: | 25.76 | |
| NOx Emission Rate, Lb/mmBtu: | 0.0949 | |
| NOx Emission Rate, Lb/Hr: | 3.20 | |
| NOx Emission Rate, Ton/Yr: | 13.99 | |
| NOx Concentration, Gram/BHPHR: | **0.311** | |
| **Non-Methane Organic Compounds (NMOC), Field Analysis** [1] | | |
| NMOC Concentration, Wet, PPM as propane: | 53.14 | |
| NMOC Concentration, Dry, PPM, as propane: | 59.32 | |
| NMOC Emission Rate, Lb/mmBtu: | 0.1357 | |
| NMOC Emission Rate, Lb/Hr: | 4.57 | |
| NMOC Emission Rate, Ton/Yr: | 20.02 | |
| NMOC Concentration, Gram/BHPHR: | 0.445 | |
| **Ethane Laboratory Analysis** [1] | | |
| Ethane Concentration, Wet, PPM: | 64.0 | |
| Ethane Concentration, Wet, PPM as propane: | 42.7 | |
| Ethane Concentration, Dry, PPM, as propane: | 47.6 | |
| **Non-Methane, Non-Ethane Organic Compounds (NMNEOC) Concentrations and Emissions** | | |
| NMNEOC Concentration, Dry, PPM, as propane: | 11.7 | |
| NMNEOC Emission Rate, Lb/mmBtu: | 0.0268 | |
| NMNEOC Emission Rate, Lb/Hr: | 0.90 | |
| NMNEOC Emission Rate, Ton/Yr: | 3.95 | |
| NMNEOC Concentration, Gram/BHPHR: | **0.088** | |
| **Continuous Parameter Monitoring System Engine Data** | | |
| Natural Gas Fuel Factor, BTU/$Ft^3$: | 1036.5 | |
| Natural Gas Fuel Factor, Fc: | 1040.0 | |
| Engine Fuel Flow Rate, $Ft^3$/Min: | 541.38 | |
| Engine Speed, RPM: | 925.80 | |
| Engine Torque, Percent: | 106.31 | |
| Engine Brake Horsepower: | 4659.72 | |

[1] While the U.S. EPA does not classify methane and ethane as volatile organic compounds (VOC), field measured VOC may contain both compounds, depending on test methods employed, instrumentation used and/or fuel combusted. Therefore during the Ray Compressor test program, methane and non-methane concentrations were quantified separately and independently using a Thermo Environmental Model 55I. With the methane contribution removed, non-methane VOC concentrations at each Plant 3 engine exhaust appeared to be greater than allowed by the facility ROP limit. Further investigation revealed the engines were firing natural gas obtained from shale sources, wih an unknown ethane content. Since the Thermo 55I includes ethane in the non-methane analysis, additional samples were collected for ethane analysis at an outside contracted laboratory.

## Ray Compressor Station
### AVERAGE
### EUENGINE33 NESHAP DATA
### July 19, 2017

| | INLET | OUTLET |
|---|---|---|
| Catalyst Exhaust Gas Moisture Content, Percent: | 10.3 | |
| O2 Concentration, Percent, Dry: | 12.00 | 11.99 |
| **Carbon Monoxide (CO) Concentrations, Reduction Efficiency and Emissions** | | |
| CO Concentration, PPM, Dry: | 421.24 | 3.79 |
| CO Concentration@15% O2, PPM, Dry: | 279.39 | 2.51 |
| CO Percent Reduction Efficiency, Percent: | **99.10** | |
| CO Emission Rate, Lb/mmBtu: | 0.0029 | |
| CO Emission Rate, Lb/Hr: | 0.10 | |
| CO Emission Rate, Ton/Yr: | 0.42 | |
| CO Concentration, Gram/BHPHR: | **0.009** | |
| **Nitrogen Oxides (NOx) Concentrations and Emissions** | | |
| NOx Concentration, PPM, DRY: | 39.57 | |
| NOx Concentration, PPM, DRY, @ 15% O2: | 26.19 | |
| NOx Emission Rate, Lb/mmBtu: | 0.0965 | |
| NOx Emission Rate, Lb/Hr: | 3.16 | |
| NOx Emission Rate, Ton/Yr: | 13.85 | |
| NOx Concentration, Gram/BHPHR: | **0.311** | |
| **Non-Methane Organic Compounds (NMOC), Field Analysis**[1] | | |
| NMOC Concentration, Wet, PPM as propane: | 60.84 | |
| NMOC Concentration, Dry, PPM, as propane: | 67.79 | |
| NMOC Emission Rate, Lb/mmBtu: | 0.1584 | |
| NMOC Emission Rate, Lb/Hr: | 5.19 | |
| NMOC Emission Rate, Ton/Yr: | 22.73 | |
| NMOC Concentration, Gram/BHPHR: | 0.511 | |
| **Ethane Laboratory Analysis**[1] | | |
| Ethane Concentration, Wet, PPM: | 66.0 | |
| Ethane Concentration, Wet, PPM as propane: | 44.0 | |
| Ethane Concentration, Dry, PPM, as propane: | 49.4 | |
| **Non-Methane, Non-Ethane Organic Compounds (NMNEOC) Concentrations and Emissions** | | |
| NMNEOC Concentration, Dry, PPM, as propane: | 18.4 | |
| NMNEOC Emission Rate, Lb/mmBtu: | 0.043 | |
| NMNEOC Emission Rate, Lb/Hr: | 1.410 | |
| NMNEOC Emission Rate, Ton/Yr: | 6.18 | |
| NMNEOC Concentration, Gram/BHPHR: | **0.139** | |
| **Continuous Parameter Monitoring System Engine Data** | | |
| Natural Gas Fuel Factor, BTU/Ft$^3$: | 1044.7 | |
| Natural Gas Fuel Factor, Fc: | 1040.0 | |
| Engine Fuel Flow Rate, Ft$^3$/Min: | 522.84 | |
| Engine Speed, RPM: | 921.98 | |
| Engine Torque, Percent: | 105.52 | |
| Engine Brake Horsepower: | 4607.15 | |

[1] While the U.S. EPA does not classify methane and ethane as volatile organic compounds (VOC), field measured VOC may contain both compounds, depending on test methods employed, instrumentation used and/or fuel combusted. During the Ray Compressor test program, methane and non-methane concentrations were quantified separately and independently using a Thermo Environmental Model 55I. With the methane contribution removed, non-methane VOC concentrations at each Plant 3 engine exhaust appeared to be greater than allowed by the facility ROP limit. Further investigation revealed the engines were firing natural gas obtained from shale sources, wih an unknown ethane content, which the Thermo 55I includes as non-methane, so additional samples were collected for ethane analysis at an outside contracted laboratory. The resulting ethane contribution reported (as propane) was then subtracted from the non-methane field measurement.

| Ray Compressor Station<br>AVERAGE<br>EUENGINE34 NESHAP DATA<br>July 19, 2017 | INLET | OUTLET |
|---|---|---|
| Catalyst Exhaust Gas Moisture Content, Percent: | 10.1 | |
| O2 Concentration, Percent, Dry: | 11.67 | 11.69 |
| **Carbon Monoxide (CO) Concentrations, Reduction Efficiency and Emissions** | | |
| CO Concentration, PPM, Dry: | 399.34 | 5.85 |
| CO Concentration@15% O2, PPM, Dry: | 255.49 | 3.75 |
| CO Percent Reduction Efficiency, Percent: | **98.53** | |
| CO Emission Rate, Lb/mmBtu: | 0.0044 | |
| CO Emission Rate, Lb/Hr: | 0.15 | |
| CO Emission Rate, Ton/Yr: | 0.64 | |
| CO Concentration, Gram/BHPHR: | **0.014** | |
| **Nitrogen Oxides (NOx) Concentrations and Emissions** | | |
| NOx Concentration, PPM, DRY: | 48.09 | |
| NOx Concentration, PPM, DRY, @ 15% O2: | 30.81 | |
| NOx Emission Rate, Lb/mmBtu: | 0.1135 | |
| NOx Emission Rate, Lb/Hr: | 3.77 | |
| NOx Emission Rate, Ton/Yr: | 16.51 | |
| NOx Concentration, Gram/BHPHR: | **0.372** | |
| **Non-Methane Organic Compounds (NMOC), Field Analysis[1]** | | |
| NMOC Concentration, Wet, PPM as propane: | 56.96 | |
| NMOC Concentration, Dry, PPM, as propane: | 63.33 | |
| NMOC Emission Rate, Lb/mmBtu: | 0.1432 | |
| NMOC Emission Rate, Lb/Hr: | 4.76 | |
| NMOC Emission Rate, Ton/Yr: | 20.84 | |
| NMOC Concentration, Gram/BHPHR: | 0.469 | |
| **Ethane Laboratory Analysis [1]** | | |
| Ethane Concentration, Wet, PPM: | 65.00 | |
| Ethane Concentration, Wet, PPM as propane: | 43.33 | |
| Ethane Concentration, Dry, PPM, as propane: | 48.48 | |
| **Non-Methane, Non-Ethane Organic Compounds (NMNEOC) Concentrations and Emissions** | | |
| NMNEOC Concentration, Dry, PPM, as propane: | 14.61 | |
| NMNEOC Emission Rate, Lb/mmBtu: | 0.033 | |
| NMNEOC Emission Rate, Lb/Hr: | 1.099 | |
| NMNEOC Emission Rate, Ton/Yr: | 4.81 | |
| NMNEOC Concentration, Gram/BHPHR: | **0.109** | |
| **Continuous Parameter Monitoring System Engine Data** | | |
| Natural Gas Fuel Factor, BTU/Ft$^3$: | 1044.70 | |
| Natural Gas Fuel Factor, Fc: | 1040.0 | |
| Engine Fuel Flow Rate, Ft$^3$/Min: | 529.99 | |
| Engine Speed, RPM: | 952.02 | |
| Engine Torque, Percent: | 102.00 | |
| Engine Brake Horsepower: | 4598.45 | |

1 While the U.S. EPA does not classify methane and ethane as volatile organic compounds (VOC), field measured VOC may contain both compounds, depending on test methods employed, instrumentation used and/or fuel combusted. During the Ray Compressor test program, methane and non-methane concentrations were quantified separately and independently using a Thermo Environmental Model 55I. With the methane contribution removed, non-methane VOC concentrations at each Plant 3 engine exhaust appeared to be greater than allowed by the facility ROP limit. Further investigation revealed the engines were firing natural gas obtained from shale sources, wih an unknown ethane content, which the Thermo 55I includes as non-methane, so additional samples were collected for ethane analysis at an outside contracted laboratory. The resulting ethane contribution reported (as propane) was then subtracted from the non-methane field measurement.

| Ray Compressor Station<br>AVERAGE<br>EUENGINE35 NESHAP DATA<br>July 18, 2017 | INLET | OUTLET |
|---|---|---|
| Catalyst Exhaust Gas Moisture Content, Percent: | 10.3 | |
| O2 Concentration, Percent, Dry: | 11.87 | 11.66 |
| **Carbon Monoxide (CO) Concentrations, Reduction Efficiency and Emissions** | | |
| CO Concentration, PPM, Dry: | 388.73 | 3.81 |
| CO Concentration@15% O2, PPM, Dry: | 252.07 | 2.44 |
| CO Percent Reduction Efficiency, Percent: | **99.04** | |
| CO Emission Rate, Lb/mmBtu: | 0.0027 | |
| CO Emission Rate, Lb/Hr: | 0.09 | |
| CO Emission Rate, Ton/Yr: | 0.39 | |
| CO Concentration, Gram/BHPHR: | **0.009** | |
| **Nitrogen Oxides (NOx) Concentrations and Emissions** | | |
| NOx Concentration, PPM, DRY: | 54.54 | |
| NOx Concentration, PPM, DRY, @ 15% O2: | 34.84 | |
| NOx Emission Rate, Lb/mmBtu: | 0.1284 | |
| NOx Emission Rate, Lb/Hr: | 4.26 | |
| NOx Emission Rate, Ton/Yr: | 18.65 | |
| NOx Concentration, Gram/BHPHR: | **0.426** | |
| **Non-Methane Organic Compounds (NMOC), Field Analysis [1]** | | |
| NMOC Concentration, Wet, PPM as propane: | 47.12 | |
| NMOC Concentration, Dry, PPM, as propane: | 52.54 | |
| NMOC Emission Rate, Lb/mmBtu: | 0.1185 | |
| NMOC Emission Rate, Lb/Hr: | 3.93 | |
| NMOC Emission Rate, Ton/Yr: | 17.21 | |
| NMOC Concentration, Gram/BHPHR: | 0.393 | |
| **Ethane Laboratory Analysis [1]** | | |
| Ethane Concentration, Wet, PPM: | 47.0 | |
| Ethane Concentration, Wet, PPM as propane: | 31.3 | |
| Ethane Concentration, Dry, PPM, as propane: | 34.9 | |
| **Non-Methane, Non-Ethane Organic Compounds (NMNEOC) Concentrations and Emissions** | | |
| NMNEOC Concentration, Dry, PPM, as propane: | 17.60 | |
| NMNEOC Emission Rate, Lb/mmBtu: | 0.040 | |
| NMNEOC Emission Rate, Lb/Hr: | 1.321 | |
| NMNEOC Emission Rate, Ton/Yr: | 5.78 | |
| NMNEOC Concentration, Gram/BHPHR: | **0.132** | |
| **Continuous Parameter Monitoring System Engine Data** | | |
| Natural Gas Fuel Factor, BTU/$Ft^3$: | 1036.50 | |
| Natural Gas Fuel Factor, Fc: | 1040.0 | |
| Engine Fuel Flow Rate, $Ft^3$/Min: | 533.30 | |
| Engine Speed, RPM: | 945.92 | |
| Engine Torque, Percent: | 101.30 | |
| Engine Brake Horsepower: | 4534.55 | |

[1] While the U.S. EPA does not classify methane and ethane as volatile organic compounds (VOC), field measured VOC may contain both compounds, depending on test methods employed, instrumentation used and/or fuel combusted. During the Ray Compressor test program, methane and non-methane concentrations were quantified separately and independently using a Thermo Environmental Model 55I. With the methane contribution removed, non-methane VOC concentrations at each Plant 3 engine exhaust appeared to be greater than allowed by the facility ROP limit. Further investigation revealed the engines were firing natural gas obtained from shale sources, wih an unknown ethane content, which the Thermo 55I includes as non-methane, so additional samples were collected for ethane analysis at an outside contracted laboratory. The resulting ethane contribution reported (as propane) was then subtracted from the non-methane field measurement.