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40 CFR Part 63, Subpart ZZZZ Annual Compliance Demonstration Test Report

EUENGINE2-2 & EUENGINE2-4

Consumers Energy Company
St. Clair Compressor Station
10021 Marine City Highway
Ira, Michigan 48023
SRN: B6637

Test Dates: September 26 and October 2, 2017

November 15, 2017

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section – Air Emissions Testing Body
Laboratory Services
Work Order No. 30327218 and 30418272
Version 0

EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted carbon monoxide testing of natural gas fired, reciprocating internal combustion engines (RICE) EUENGINE2-2 and EUENGINE2-4 operating at the St. Clair Compressor Station in Ira, Michigan. EUENGINE2-2 and EUENGINE2-4 are spark-ignited (SI), four stroke lean burn (4SLB), 4,000 brake horsepower (BHP) engines located at an area 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 annual performance testing requirements and evaluate compliance with 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-B6637-2015.

One 20-minute test run was conducted on September 26 and October 2, 2017 that measured carbon monoxide and oxygen concentrations exhausted from each engine at the inlet and outlet of an oxidation catalyst following the procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 3A, and 10 in 40 CFR Part 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 plus or minus 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 tables.

Summary of EUENGINE2-2 and EUENGINE2-4 Test Results

Source	CO Exhaust Concentration (ppmvd @ 15% O_2)	CO Reduction Efficiency (%)
EUENGINE2-2	8.92	93.32
EUENGINE2-4	13.48	85.13
Limit†	**≤ 47**	**≥ 93**

† Compliance with 40 CFR Part 63, Subpart ZZZZ may be achieved by either limiting the exhaust concentration of carbon monoxide **or** reducing carbon monoxide emissions.
CO - carbon monoxide
ppmvd - parts per million by volume, dry basis
ppmvd @ 15% O_2 - parts per million by volume, dry basis, corrected to 15% oxygen

The results of the EUENGINE2-2 and EUENGINE2-4 testing indicate the carbon monoxide exhaust concentration and/or oxidizing catalyst removal efficiency are in compliance with applicable emission limits.

Detailed results are presented in Appendix Tables 1 and 2. Sample calculations and field data sheets are presented in Appendices A and B. Engine operating data and supporting information are provided in Appendices C and D.

1.0 INTRODUCTION

This report summarizes the results of compliance air emissions testing conducted on EUENGINE2-2 and EUENGINE2-4 at the Consumers Energy St. Clair Compressor Station on September 26 and October 2, 2017.

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.

1.1 IDENTIFICATION, LOCATION, AND DATES OF TESTS

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted carbon monoxide testing of natural gas fired, reciprocating internal combustion engines (RICE) EUENGINE2-2 and EUENGINE2-4 operating at the St. Clair Compressor Station in Ira, Michigan on September 26 and October 2, 2017.

A test protocol was submitted to the MDEQ on June 26, 2017 and subsequently approved by Mr. Tom Gasloli, Environmental Quality Analyst, in his letter dated August 28, 2017. EUENGINE2-3 testing was also originally scheduled to be completed the week of September 25, 2017; however, this engine has been removed from service and will no longer operate. Once the engine is cut/capped (i.e., fuel supply removed), an ROP modification will be submitted to remove the engine and associated requirements from the permit.

1.2 PURPOSE OF TESTING

The test program was performed to satisfy the annual performance testing requirements and evaluate compliance with 40 CFR Part 63, Subpart ZZZZ, "National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines," (aka RICE Area Source MACT) as incorporated in MDEQ ROP MI-ROP-B6637-2015.

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

Table 1-1

RICE Area Source MACT Emission Limits

Parameter	Emission Limit	Units	Applicable Requirement
CO	47	ppmvd at 15% O_2	Table 5 (13) and Table 6 (14) to Subpart ZZZZ of Part 63—Requirements for Existing Stationary RICE Located at Area Sources of HAP Emissions
	or		
	93	% removal efficiency	

ppmvd at 15% O_2: part per million by volume dry basis corrected to 15% oxygen

1.3 Brief Description of Source

EUENGINE2-2 and EUENGINE2-4 are spark-ignited (SI), four stroke lean burn (4SLB), 4,000 brake horsepower (BHP) engines located at an area 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.

1.4 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	Ms. Karen Kajiya-Mills Technical Programs Unit Manager 517-335-4874 Kajiya-Millsk@michigan.gov	Michigan Department of Environmental Quality Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Technical Programs Field Inspector	Mr. Tom Gasloli Technical Programs Unit Field Operations Section 517-284-6778 gaslolit@michigan.gov	Michigan Department of Environmental Quality Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Regulatory Inspector	Mr. Sebastian Kallumkal Sr. Environmental Engineer 586-753-3738 Kallumkals@michigan.gov	Michigan Department of Environmental Quality Southeast Michigan District 27700 Donald Court Warren, Michigan 48092
Responsible Official	Mr. Gregory Baustian Executive Director-Natural Gas Compression and Storage 616-237-4009 Gregory.Baustian@cmsenergy.com	Consumers Energy Company Zeeland Generation 425 N. Fairview Road Zeeland, Michigan 49464
Corporate Air Quality Contact	Ms. Amy Kapuga Senior Engineer 517-788-2201 Amy.kapuga@cmsenergy.com	Consumers Energy Company Environmental Services Department 1945 West Parnall Road Jackson, Michigan 49201
Test Facility	Mr. Brian Mauzy Gas Field Lead III 586-716-3331 Brian.Mauzy@cmsenergy.com	Consumers Energy Company St. Clair Compressor Station 10021 Marine City Highway Ira, Michigan 48023
Test Team Representative	Mr. Thomas Schmelter, QSTI Engineering Technical Analyst 616-738-3334 Thomas.Schmelter@cmsenergy.com	Consumers Energy Company L&D Training Center 17010 Croswell Street West Olive, Michigan 49460

2.0 SUMMARY OF RESULTS

2.1 OPERATING DATA

During the performance test, the engines fired natural gas and were operated near maximum operating load conditions. 40 CFR 63.6620(b) states that each performance test must be conducted at any load condition within plus or minus 10 percent of 100 percent load. The performance testing was conducted while EUENGINE2-2 was operating at 96.3% and EUENGINE2-4 at 94.1% 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 sync with facility operating data recordkeeping time, which is approximately 14-minutes ahead of local clock time.

2.2 APPLICABLE PERMIT INFORMATION

The St. Clair Compressor Station has been assigned State of Michigan Registration Number (SRN) B6637 and operates in accordance with air permit MI-ROP-B6637-2015. EUENGINE2-2 and EUENGINE2-4 are the emission unit source identifications in the permit and are included in the FGENGINES-P2 flexible group. Incorporated within the permit are the applicable requirements of 40 CFR Part 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines.

2.3 RESULTS

The results of the EUENGINE2-2 and EUENGINE2-4 testing indicate the carbon monoxide exhaust concentration and/or oxidizing catalyst removal efficiency are in compliance with applicable emission limits. Refer to Table 2-1 for a summary of EUENGINE2-2 and EUENGINE2-4 test results.

Table 2-1
Summary of EUENGINE2-2 and EUENGINE2-4 Test Results

Source	CO Exhaust Concentration (ppmvd @ 15% O_2)	CO Reduction Efficiency (%)
EUENGINE2-2	8.92	93.32
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CO - carbon monoxide
ppmvd - parts per million by volume, dry basis
ppmvd @ 15% O_2 - parts per million by volume, dry basis, corrected to 15% oxygen

Detailed results are presented in Appendix Tables 1 and 2. Sample calculations and field data sheets are presented in Appendices A and B. Engine operating data and supporting information are provided in Appendices C and D.

3.0 SOURCE DESCRIPTION

EUENGINE2-2 and EUENGINE2-4 are natural gas fired RICE 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

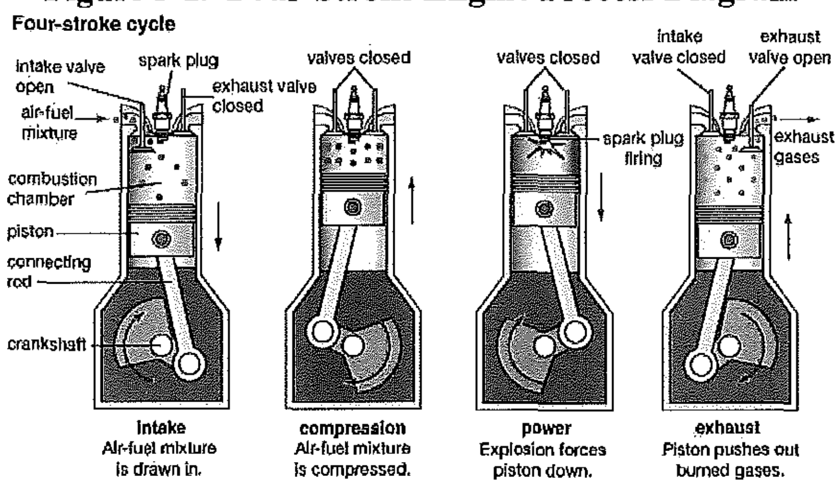
Engine ID	Engine Description		Site-Rate HP	Emission Control
	Manufacturer	Model		
EUENGINE2-2	Delaval	HVC-16C	4,000	Oxidation Catalyst
EUENGINE2-4	Delaval	HVC-16C	4,000	Oxidation Catalyst

3.1 DESCRIPTION OF PROCESS

EUENGINE2-2 and EUENGINE2-4 are SI 4SLB RICE installed in 1973. 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



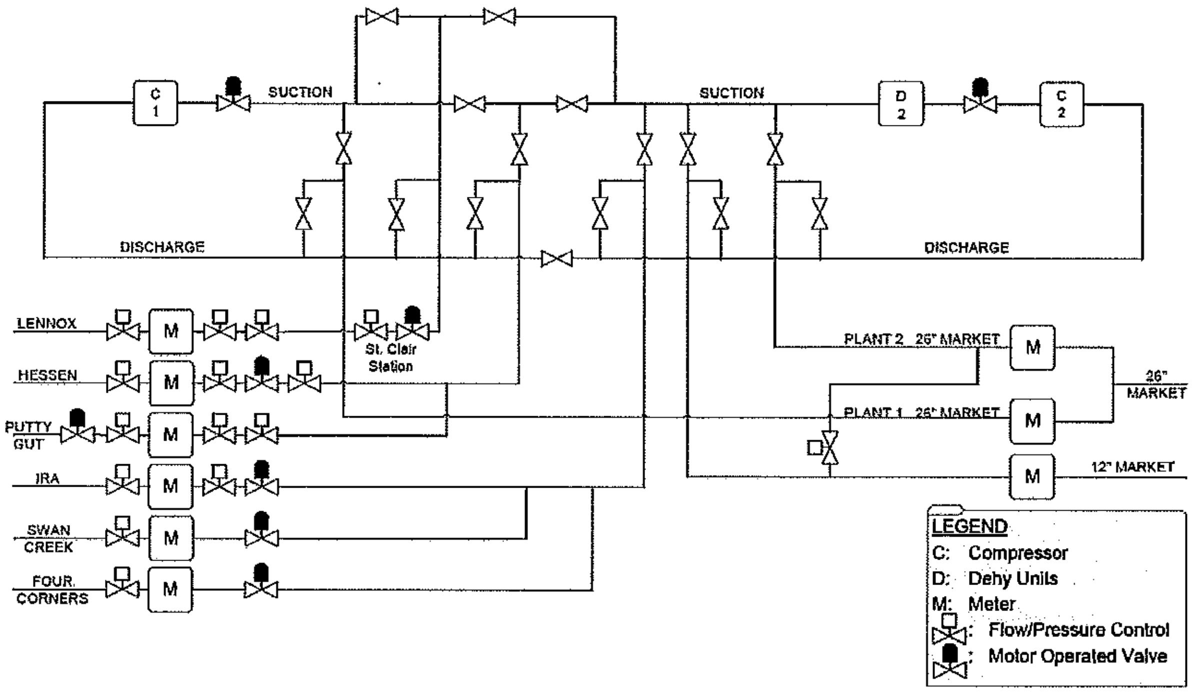
The flue gas generated through natural gas combustion is controlled through parametric controls (i.e., timing and operating at a lean air-to-fuel ratio) and by a post-combustion oxidizing catalyst installed on the engine exhaust system. As carbon monoxide passes through the Dresser Rand catalytic oxidation systems 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. The catalyst vendor has guaranteed a CO emission concentration of ≤ 47 ppmvd @ 15% O_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 Part 63, 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 C.

3.2 Process Flow

Located in southern St. Clair County, the St. Clair Compressor Station helps maintain natural gas pressures in southeast Michigan. The Hessen, Puttygut, Swan Creek, Four Corners, Ira, and Lenox gas storage fields are located in the Niagaran geologic formation and used to store and supply a capacity of 45.6 billion cubic feet of natural gas. The station connects to these six underground storage fields, which provide enough natural gas to serve up to 20 percent of the supply to Consumers Energy's 1.7 million gas customers in winter.

Figure 3-2. St. Clair Compressor Station Natural Gas Process Flow



EUENGINE2-2 and EUENGINE2-4 are two of the 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 serving these engines are a non-typical design. Specifically, the bottom portion of the stack incorporates a columnar annulus that contains the oxidation catalysts. The exhaust gases from the engine enter the annulus and flow downwards through the oxidization catalysts. After passing through the catalysts, the exhaust gases enter the interior of the annulus through an opening located near the base of the free standing stack. The exhaust gases then travel unobstructed vertically upwards through the approximate 47-feet high stack to atmosphere.

3.3 MATERIALS PROCESSED

The fuel utilized in EUENGINE2-2 and EUENGINE2-4 is exclusively natural gas, as defined in 40 CFR Part 72.2. The units are classified as existing stationary RICE located at an area source of HAP emissions, non-emergency, non-black start 4SLB stationary RICE >500 HP that are not remote stationary RICE and that operate more than 24 hours per calendar year as described in Table 2d (9) to Subpart ZZZZ.

3.4 Maximum and Normal Rated Capacity

EUENGINE2-2 and EUENGINE2-4 are limited to a maximum output of approximately 4,000 horsepower. At this achievable output, the heat input rating is approximately 27 mmBtu/hr. However, the engines normally operate at lower horsepower to maximize the torque required to turn the compressor shaft. Gas conditions, such as pressure, temperature, and density affect the amount of torque needed to compress or extract the gas from the storage field or pipeline. Torque is therefore used as a measure of the engines maximum capacity.

3.5 Process Instrumentation

The process was continuously monitored by operators and data acquisition systems during testing. Data were collected at 3-minute intervals during each test for the following parameters: speed (rpm), torque (%), horsepower (HP), fuel flow (scf/hr), suction pressure (psi), discharge pressure (psi), catalyst inlet temperature (°F), pressure drop across catalyst (ΔP), air/fuel ratio, ambient temperature (°F), barometric pressure (in Hg), and Btu content of fuel (Btu/ft^3). The time convention for the reference method (RM) testing was correlated to match facility operating data recordkeeping time, which is approximately 14-minutes ahead of local clock time. Refer to Appendix C for operating data.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy RCTS tested for oxygen and carbon monoxide 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) and CO_2	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Carbon monoxide (CO)	10	Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)

4.1 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

Source Date (2017)	Run	Sample Type	Start Time (EDT)	Stop Time (EST)	Test Duration (min)	EPA Test Method	Comment
EUENGINE2-2 September 26	1	CO	8:37	8:57	20	1 3A 10	Catalyst inlet temperature was 887.7°F
EUENGINE2-4 October 2	1	CO	11:45	12:45	20	1 3A 10	Catalyst inlet temperature was 741.1°F

4.1.1 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 Part 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 26-inch horizontal exhaust duct exiting the engine and building. The pre-catalyst sampling ports are situated:

- At least 52 inches or 2 duct diameters downstream of a duct bend disturbance at the engine exhaust, and
- At least 13 inches or 0.5 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 32-inch vertical exhaust duct exiting the engine and oxidation catalyst. The post-catalyst sampling ports are situated:

- Approximately 64 inches or 2.0 duct diameters downstream of a duct diameter change flow disturbance, and
- Approximately 56 inches or 1.75 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 locations meet the two and half-diameter criterion of Section 11.1.1 of Method 1 of 40 CFR Part 60, Appendix A-1, the exhaust 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 20 minute tests. Due to access limitations at the inlet sampling location, the design and dimensions of the inlet ducts preclude the use of multiple traverse points. Therefore RCTS, with approval from the MDEQ, conducted the sampling from a single traverse point for the catalyst inlet locations. Drawings of the EUENGINE2-2 and EUENGINE 2-4 pre- post-catalyst sampling locations are presented as Figures 4-1 and 4-2.

Figure 4-1. Pre-Catalyst Sampling Port Location

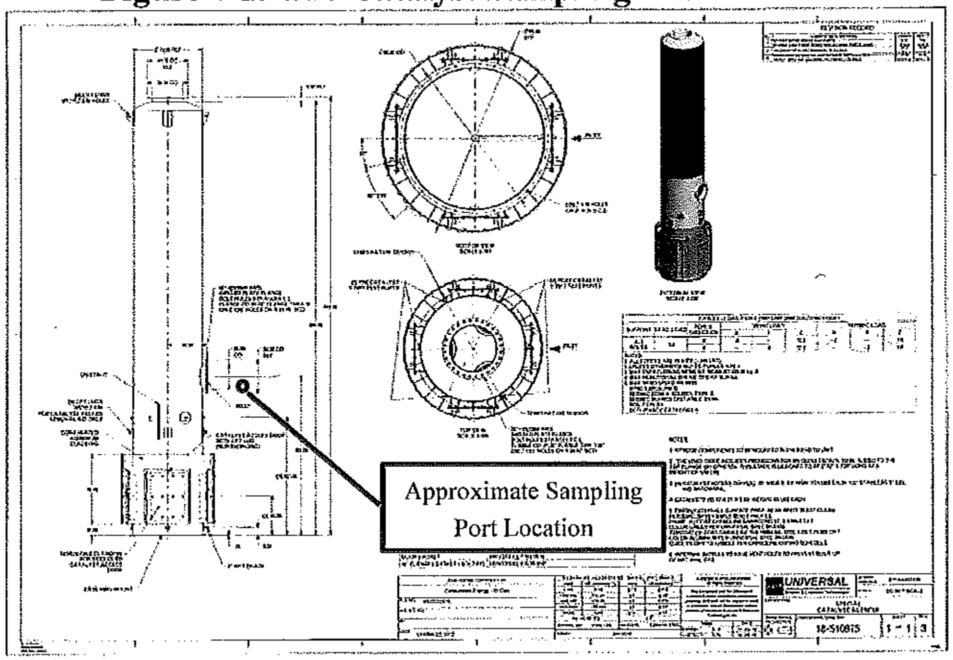
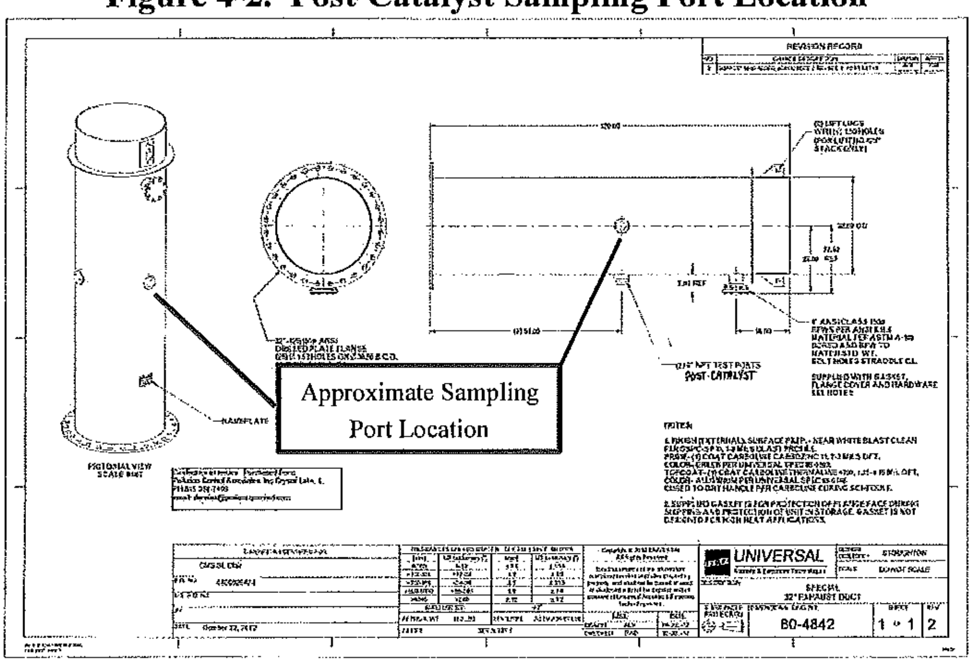


Figure 4-2. Post-Catalyst Sampling Port Location

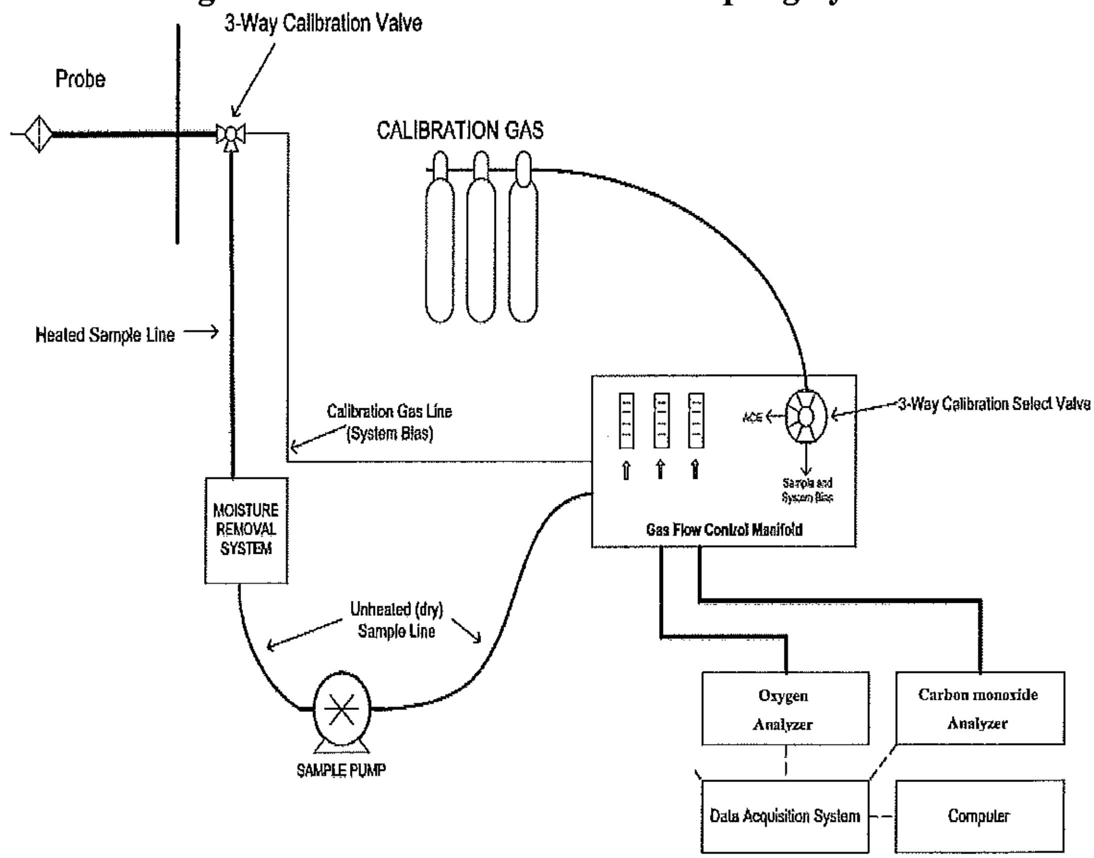


4.1.2 Oxygen and Carbon Monoxide (USEPA Methods 3A and 10)

Oxygen, carbon dioxide, 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)* and 10, *Determination of Carbon Monoxide.* The sampling procedures of the methods are similar with the exception of the analyzers and analytical technique used to quantify the parameters of interest. Oxygen concentrations measured from EUENGINE2-2 were used to adjust the carbon monoxide concentrations to 15% O_2, while carbon dioxide measured from EUENGINE2-4 was used as allowed by Subpart ZZZZ, by developing O_2 to CO_2 fuel factor ratios described in §63.6620 (e)(2)(ii)(Eq.3).

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 and infrared gas filter correlation gas analyzers. Figure 4-3 depicts the Methods 3A and 10 sampling system.

Figure 4-3. Methods 3A 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, carbon dioxide 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 and carbon monoxide concentrations for analyzer drift. Refer to Appendix D for analyzer calibration supporting documentation.

5.0 TEST RESULTS AND DISCUSSION

The test program was performed to satisfy the annual performance test requirements and evaluate compliance with the RICE MACT as incorporated in the MDEQ ROP MI-ROP-B6637-2015.

5.1 Tabulation of Results

The results of the testing indicate the carbon monoxide exhaust concentration and/or oxidizing catalyst removal efficiency results are in compliance with applicable limits. The results are summarized in Table 2-1. Tables 1 and 2 in the Appendix contain detailed tabulation of results, process operating conditions, and exhaust gas conditions.

5.2 Significance of Results

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

5.3 Variations from Sampling or Operating Conditions

No sampling procedure deviations or operating conditions were encountered during the test program.

5.4 Upset Conditions

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

5.5 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.

5.6 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.

5.7 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 methods that were performed. Refer to Appendix D for supporting documentation.

Table 5-1
Quality Control Procedures

EPA Method QC Specification	Purpose	Procedure	Frequency	Acceptance Criteria
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.
1: Duct diameter	Verify area of stack is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings
3A and 10: Calibration gas standards	Ensure accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty ≤ 2.0%
3A and 10: Calibration Error	Evaluates operation of analyzers	Calibration gases introduces directly into analyzers	Pre-test	±2% of the calibration span
3A and 10: 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
3A and 10: Duct traverse	Ensure representative sample collection	Insert probe into stack and traverse duct	During test	Collect samples from 3-point long line

5.8 CALIBRATION SHEETS

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

5.9 Sample Calculations

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

5.10 Field Data Sheets

Field data sheets are presented in Appendix B.

5.11 Laboratory Quality Assurance / Quality Control Procedures

Because the sampling and analysis of the parameters of interest were performed onsite, laboratory quality assurance and quality control procedures are not applicable to this test program.

Table 1
EUENGINE2-2 Emissions Test Results
St. Clair Compressor Station
September 26, 2017

Parameter	Run 1
	8:37-8:57
Process Conditions	
Engine Speed, RPM:	505.0
Engine Torque, %	96.3
Engine Brake Horsepower, bhp	3248.3
Fuel Flow, SCFH	27.9
Catalyst Inlet Temperature, °F	887.7
Inlet Gas Conditions	
Drift Corrected Oxygen Concentration, %, dry	8.92
Drift Corrected Carbon Monoxide Concentration, ppmvd	271.43
Corrected Carbon Monoxide Concentration, ppmvd @ 15% O_2	133.55
Outlet Gas Conditions	
Drift Corrected Oxygen Concentration, %, dry	8.91
Drift Corrected Carbon Monoxide Concentration, ppmvd	18.11
Corrected Carbon Monoxide Concentration, ppmvd @ 15% O_2	**8.92**
CO Reduction Efficiency, %	**93.32**

Table 2
EUENGINE2-4 Emissions Test Results
St. Clair Compressor Station
October 2, 2017

Parameter	Run 1
	11:45-12:45
Process Conditions	
Engine Speed, RPM:	455.1
Engine Torque, %	94.1
Engine Brake Horsepower, bhp	2856.0
Fuel Flow, SCFH	21.1
Catalyst Inlet Temperature, °F	741.1
Inlet Gas Conditions	
Drift Corrected Carbon Dioxide Concentration, %, dry	6.36
Drift Corrected Carbon Monoxide Concentration, ppmvd	171.02
Corrected Carbon Monoxide Concentration, ppmvd @ 15% O_2	90.65
Outlet Gas Conditions	
Drift Corrected Carbon Dioxide Concentration, %, dry	6.40
Drift Corrected Carbon Monoxide Concentration, ppmvd	25.61
Corrected Carbon Monoxide Concentration, ppmvd @ 15% O_2	**13.48**
CO Reduction Efficiency, %	**85.13**