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40 CFR Part 60 Subpart JJJJ
40 CFR Part 63 Subpart ZZZZ
Continuous Compliance Test Report

EUENGINE35

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

August 23, 2021

Test Date: July 13, 2021

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 38483901
Version No.: 0

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EXECUTIVE SUMMARY

Consumers Energy Company (Consumers Energy) Regulatory Compliance Testing Section (RCTS) conducted nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compound (VOC) testing upstream and/or downstream of the oxidation catalyst installed in the exhaust of EUENGINE35 operating at the Ray Compressor Station (RCS) a major source of hazardous air pollutant (HAP) emissions in Armada, Michigan. The 4- stroke, lean burn, (4SLB), spark ignited (SI), natural gas fired, reciprocating internal combustion engine (RICE) powers a compressor to maintain natural gas pipeline pressure for movement into and out of underground storage reservoirs and along the pipeline system. The engine is subject to federal air emission regulations and is part of FGENGINES3 described within the RCS Michigan Department of Environment, Great Lakes and Energy (EGLE), renewable operating permit (ROP) MI-ROP-B6636-2020.

The test program was performed on July 13, 2021 to evaluate continuous compliance with United States Environmental Protection Agency (USEPA) 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*** (NESHAP) ***for Stationary Reciprocating Internal Combustion Engines***, as noted in the Facility EGLE ROP MI-ROP-B6636-2020.

A test protocol was submitted to EGLE on April 9, 2021 and subsequently approved by Mr. Matthew Karl, Environmental Quality Analyst, in his letter dated June 11, 2021. Please note that the protocol describes testing at EUENGINE31 through EUENGINE35 during the June, 2021 timeframe, however EUENGINE35 was not available at that time due to unforeseen mechanical issues, thus this report is prepared and submitted separately.

The test program consisted of triplicate 60-minute test runs following the procedures in USEPA Reference Methods (RM) 1, 3A, 4 (Alt-008), 7E, 10, 18, 19, and 25A in 40 CFR Part 60, Appendix A. During testing, the engine operated within ± 10 percent of 100 percent peak (or the highest achievable) load, as specified in 40 CFR §60.4244(a). There were no deviations from the approved protocol or associated RM.

The EUENGINE35 NO_x, CO, and VOC test results (Table E-1) indicate the unit complies with the applicable emissions limits.

Table E-1
Summary of Average Test Results

Engine	NO_x (g/hp-hr)	CO (g/hp-hr)	CO (% reduction)	VOC[1] (g/hp-hr)	Catalyst Inlet Temperature[2] (°F)	Catalyst Pressure Drop (inches)	Initial Catalyst Pressure Drop (inches)
EUENGINE35	0.37	0.04	97.8	<0.02	846	2.2	2.1
JJJJ Limits	1.0	2.0		0.7			
ZZZZ Limits			≥93		450-1350	±2 (from initial)	
ROP Limits	0.5	0.2	≥93	0.19	450-1350	±2 (from initial)	

NO_x nitrogen oxides
CO carbon monoxide
VOC volatile organic compounds (non-methane, non-ethane organic compounds), as propane
g/HP-hr grams per horsepower hour
[1]40 CFR Part 60 Subpart JJJJ refers to volatile organic compounds as defined in 40 CFR §51.100(s)(1), which specifies a VOC definition including "*any compound of carbon...other than the following, which have been determined to have negligible photochemical reactivity: methane, ethane...*" Therefore, Subpart JJJJ exhaust gas VOC measurements reported herein include total *non-methane, non-ethane* (C_2H_6) organic compounds only.
[2]Compliance with the catalyst inlet temperature operating range is based on a 4-hour rolling average

Detailed results are presented in Appendix Table 1. Sample calculations, field data sheets, and laboratory data sheets are presented in Appendices A, B, and C. Engine operating data and supporting documentation are provided in Appendices D and E.

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1.0 INTRODUCTION

This report summarizes compliance air emission results from tests conducted at the Consumers Energy Ray Compressor Station (RCS) in Armada, Michigan.

1.1 Identification, Location, and Dates of Tests

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compound (VOC) tests on emission unit (EU) EUENGINE35, operating at the RCS facility, a major source of hazardous air pollutant (HAP) emissions in Armada, Michigan.

The test program was performed on July 13, 2021. A test protocol was submitted to EGLE on April 9, 2021 and subsequently approved by Mr. Matthew Karl, Environmental Quality Analyst, in his letter dated June 11, 2021. Please note that due to unforeseen mechanical issues, EUENGINE35 was not available during the June, 2021 test event on EUENGINE31-EUENGINE34. As such, this report from the June 2021 test event was prepared and submitted separately.

1.2 Purpose of Testing

The purpose of the test program was to evaluate continuous compliance with United States Environmental Protection Agency (USEPA) 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*** (NESHAP) ***for Stationary Reciprocating Internal Combustion Engines***, as incorporated in State of Michigan, Renewable Operating Permit (ROP) MI-ROP-B6636-2020. The applicable emission limits are shown in Table 1-1.

Table 1-1
FGENGINES3 Emission Limits

Parameter	Emission Limit	Units	Applicable Requirement
NO_x	0.5	g/HP-hr	MI-ROP-B6636-2020, Flexible Group Conditions: FGENGINES
	1.0	g/HP-hr	40 CFR Part 60, Subpart JJJJ, Table 1
	160	ppmvd at 15% O_2	40 CFR Part 60, Subpart JJJJ, Table 1
CO	0.2	g/HP-hr	MI-ROP-B6636-2020, Flexible Group Conditions: FGENGINES3
	2.0	g/HP-hr	40 CFR Part 60, Subpart JJJJ, Table 1
	540	ppmvd at 15% O_2	40 CFR Part 60, Subpart JJJJ, Table 1
	93	% Reduction across oxidation catalyst	MI-ROP-B6636-2020, Flexible Group Conditions: FGENGINES; 40 CFR §63.6300(b) – 40 CFR Part 63, Subpart ZZZZ, Table 2a
VOC	0.19	g/HP-hr	MI-ROP-B6636-2020, Flexible Group Conditions: FGENGINES
	0.7	g/HP-hr	40 CFR Part 60, Subpart JJJJ, Table 1
	86	ppmvd at 15% O_2	40 CFR Part 60, Subpart JJJJ, Table 1

1.3 Brief Description of Source

EUENGINE35 is a natural gas-fired, 4SLB SI RICE coupled to a compressor to transport natural gas into storage fields or into transmission lines. The engine is part of the FGENGINES3 group within MI-ROP-B6636-2020.

1.4 Contact Information

Table 1-2 contains the affiliated persons names, addresses and telephone numbers for further information regarding the test program.

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 Environment, Great Lakes and Energy 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State District Manager	Ms. Joyce Zhu Environmental Manager 586-606-2572 zhuj@michigan.gov	EGLE – Air Quality Division Warren District SE Michigan Office 27700 Donald Court Warren, Michigan 48092
State Technical Programs Field Inspector	Mr. Matt Karl Technical Programs Unit 517-282-2126 karlm@michigan.gov	EGLE – Air Quality Division 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Regulatory Inspector	Mr. Robert Elmouchi Environmental Quality Analyst 586-753-3736 elmouchir@michigan.gov	EGLE – Air Quality Division Warren District SE Michigan Office 27700 Donald Court Warren, Michigan 48092
Responsible Official	Mr. Avelock Robinson Director of Gas Compression 586-716-3326 avelock.robinson@cmsenergy.com	Consumers Energy Company St. Clair Compressor Station 10021 Marine City Highway Ira, Michigan 48023
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
Field Environmental Coordinator	Mr. Thomas Fox Senior Engineer II 989-667-5153 thomas.fox@cmsenergy.com	Consumers Energy Company Bay City Customer Service Center 4141 E. Wilder Road Bay City, MI 48706
Test Facility	Mr. William F. Harvey Gas Field Leader 586-784-2096 william.f.harvey@cmsenergy.com	Consumers Energy Company Ray Compressor Station 69333 Omo Road Armada, Michigan 48005
Test Team Representative	Mr. Joe Mason, QSTI Sr. Engineering Technical Analyst 231-720-4856 joe.mason@cmsenergy.com	Consumers Energy Company D.E. Karn Power Plant 2742 N. Weadock Hwy., ESD Trailer #4 Essexville, Michigan 48732

2.0 SUMMARY OF RESULTS

2.1 OPERATING DATA

During the performance test, the engine fired natural gas, and pursuant to §60.4244(a), operated within 10% of 100% peak (or the highest achievable) load. The average load was 101.5% torque at 95.6% horsepower, based on the maximum manufacturer's design capacity at engine and compressor site conditions. Refer to Appendix D for detailed operating data.

2.2 APPLICABLE PERMIT INFORMATION

RCS operates in accordance with MI-ROP- B6636-2020, which incorporates 40 CFR Part 60, Subpart JJJJ and 40 CFR Part 63, Subpart ZZZZ requirements specific to EUENGINE35 and FGENGINES3.

2.3 RESULTS

The test results (Table 2-1) indicate the engine and associated oxidation catalyst complies with applicable NO_x, CO and VOC emission and percent CO reduction limits in 40 CFR Part 60, Subpart JJJJ, 40 CFR Part 63, Subpart ZZZZ, and MI-ROP-B6636-2020.

Table 2-1
Summary of Average Test Results

Engine	NO_x (g/hp-hr)	CO (g/hp-hr)	CO (% reduction)	VOC[1] (g/hp-hr)	Catalyst Inlet Temperature[2] (°F)	Catalyst Pressure Drop (inches)	Initial Catalyst Pressure Drop (inches)
EUENGINE35	0.37	0.04	97.8	<0.02	846	2.2	2.1
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ROP Limits	0.5	0.2	≥93	0.19	450-1350	±2 (from initial)	

NO_x nitrogen oxides
CO carbon monoxide
VOC volatile organic compounds (non-methane, non-ethane organic compounds), as propane
g/hp-hr grams per horsepower hour

[1] 40 CFR Part 60 Subpart JJJJ refers to volatile organic compounds as defined in 40 CFR §51.100(s)(1), ,which specifies a VOC definition including "*any compound of carbon....other than the following, which have been determined to have negligible photochemical reactivity: methane, ethane...*" Therefore, Subpart JJJJ exhaust gas VOC measurements reported herein include total *non-methane (CH_4), non-ethane (C_2H_6)* organic compounds only.
[2] Compliance with the catalyst inlet temperature operating range is base on a 4-hour rolling average

Detailed results are presented in Appendix Tables 1 – 4, with further discussion in Section 5.0 of this report. Sample calculations, field data, laboratory data, engine operating data and supporting documentation are presented in Appendices A through E.

3.0 SOURCE DESCRIPTION

EUENGINE35 was constructed in 2013 and significant maintenance has not been performed on the engine or associated oxidation catalyst within the three months prior to the test. A summary of the engine specifications is presented in Table 3-1.

Table 3-1
Summary of Engine Specifications

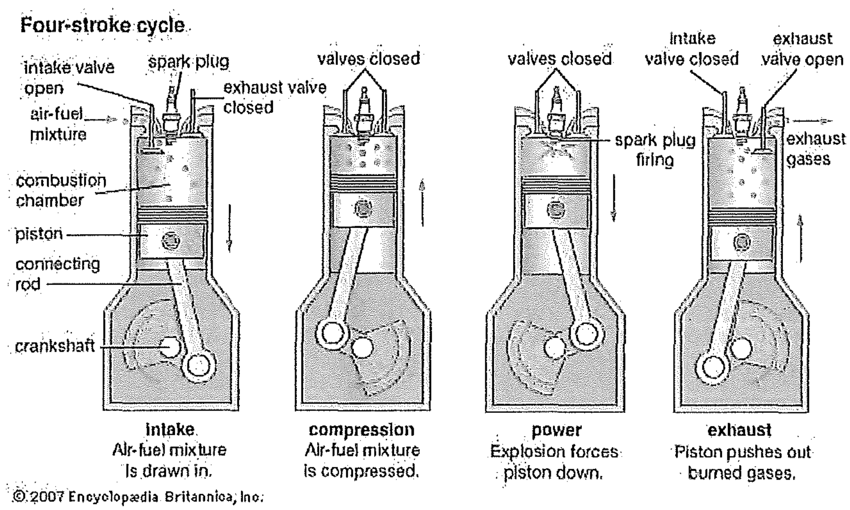
Parameter[1]	EUENGINE35
Make	Caterpillar
Model	G3616
Output (brake-horsepower)	4,735
Heat Input (mmBtu/hr)	32.0
Exhaust Flow Rate (ACFM, wet)	32,100
Exhaust Gas Temp.	856
Engine Outlet O_2 (Vol-%, dry)	12.00
Engine Outlet CO_2 (Vol-%, dry)	5.81
CO, Uncontrolled (ppmv, dry)	572.0
CO, Controlled (ppmv, dry)[2]	40.0

[1] Engine specifications are based upon vendor data for operation at 100% of rated engine capacity
[2] The controlled CO concentrations are based upon the vendor not to exceed CO concentrations at 100% load, and a reduction 93% by volume for the associated oxidation catalysts.

3.1 Process

The engine utilizes the four-stroke engine cycle (Figure 3-1) which begins with a downward air intake valve piston stroke, aspirating air into combustion chambers (cylinder). When the piston nears the cylinder bottom, fuel is injected and the intake valves close. As the piston travels upward, the air/fuel mixture compresses and ignites, forcing the piston downward into the power stroke. At the bottom of the power stroke, exhaust valves open and the upward traveling piston expels the combustion by-products.

Figure 3-1. Four-Stroke Engine Process Diagram



The flue gas generated by natural gas combustion is controlled through parametric controls (i.e., timing and operating at a lean air-to-fuel ratio) and by post-combustion oxidizing catalysts manufactured by EmeraChem, LLC (Part No. 28283.5-300CO). Four catalyst modules installed on the engine exhaust stack use proprietary materials to lower the oxidation temperature of CO and other organic compounds, thus maximizing the catalyst efficiency specific to the exhaust gas temperatures of the engines. As CO passes through the catalytic oxidation system, CO and VOC are oxidized to CO_2 and water, while suppressing the conversion of NO to NO_2.

Nitrogen oxides (NO_x) emissions from the engine is minimized through the use of lean-burn combustion technology. Lean-burn combustion refers to a high level of excess air (generally 50% to 100% relative to the stoichiometric amount) in the combustion chamber. The excess air absorbs heat during the combustion process, thereby reducing the combustion temperature and pressure resulting in lower NO_x emissions.

While the catalyst vendor guarantees 93% CO destruction efficiency, the catalyst also controls formaldehyde and non-methane, non-ethane hydrocarbons (NMNEHC). Estimated formaldehyde and NMNEHC destruction efficiencies are 85% and 75%, respectively.

A continuous parameter monitoring system (CPMS) monitors catalyst inlet temperature per Table 5 (1) of 40 CFR Part 63, Subpart ZZZZ requirements and in accordance with the site-specific preventative maintenance / malfunction and abatement plan which evaluates efficient catalytic reaction and pollution control equipment performance. Detailed operating data are provided in Appendix D.

3.2 Process Flow

Located in northern Macomb County, the Ray Compressor Station (Figure 3-2) helps maintain natural gas pressure along pipeline systems and for gas injection and withdrawal.

The engine exhaust stack is of non-typical design. Specifically, the bottom portion of the stack contains an outer and an inner circular stack (like a doughnut if viewed from the top of the stack). Engine exhaust from two horizontal exhaust ducts are directed downward through oxidation catalysts in the bottom of the outer stack and then into the inner stack through an opening near the stack base, traveling upwards approximately 95-feet to an unobstructed vertical discharge to ambient air.

Figure 3-2. Ray Compressor Station Natural Gas Process Flow

3.3 Materials Processed

The engine fuel utilized is exclusively natural gas, as defined in 40 CFR §72.2. Recent natural gas sample analyses reveal this composition is approximately 92.2% methane, 7.00% ethane, 0.25% propane, 0.4% nitrogen, and 0.22% carbon dioxide.

3.4 Rated Capacity

EUENGINE35 has a rated heat input of 32 mmBtu/hr and a maximum output of 4,735 horsepower, both of which are a function of facility and gas transmission extraction and/or storage demand.

3.5 Process Instrumentation

The following engine operating parameters were continuously monitored and collected in one-minute increments during the test:

- Discharge pressure (psi)
- Engine Load as Compressor Torque (% max)
- Engine speed (rpm)
- Power (BHP)
- Suction pressure (psi)
- Fuel use (scf/hr)
- Catalyst exhaust pressure (in. H_2O)
- Catalyst inlet / engine exhaust temperature (°F)

4.0 SAMPLING AND ANALYTICAL PROCEDURES

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

Table 4-1
Test Methods

Parameter	Method	USEPA Title
Sample traverses	1	Sample and Velocity Traverses for Stationary Sources
Oxygen	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Moisture content	4	Determination of Moisture Content in Stack Gases
Nitrogen oxides	7E	Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Carbon monoxide	10	Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Methane (CH_4)	18	Measurement of Gaseous Organic Compound Emissions by Gas Chromatography
Emission rates	19	Sulfur Dioxide Removal and Particulate, Sulfur Dioxide and Nitrogen Oxides from Electric Utility Steam Generators

4.1 Description of Sampling Train and Field Procedures

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

Table 4-2
Test Matrix

Date (2021)	Run	Sample Type	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
EUENGINE35							
July 13	1	O_2 NO_x CO Ethane VOC	8:10	9:09	60	1 3A 4 7E 10 18 19 25A	3-point traverse conducted at each sample location at 16.7, 50.0 & 83.3 % of the measurement line
	2		9:32	10:31	60		
	3		10:51	11:50	60		

4.2 Sample Location and Traverse Points (USEPA Method 1)

The number and location of traverse points for each sample location followed requirements in Table 4 of 40 CFR Part 63, Subpart ZZZZ, Table 2 of 40 CFR Part 60, Subpart JJJJ, and USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources*.

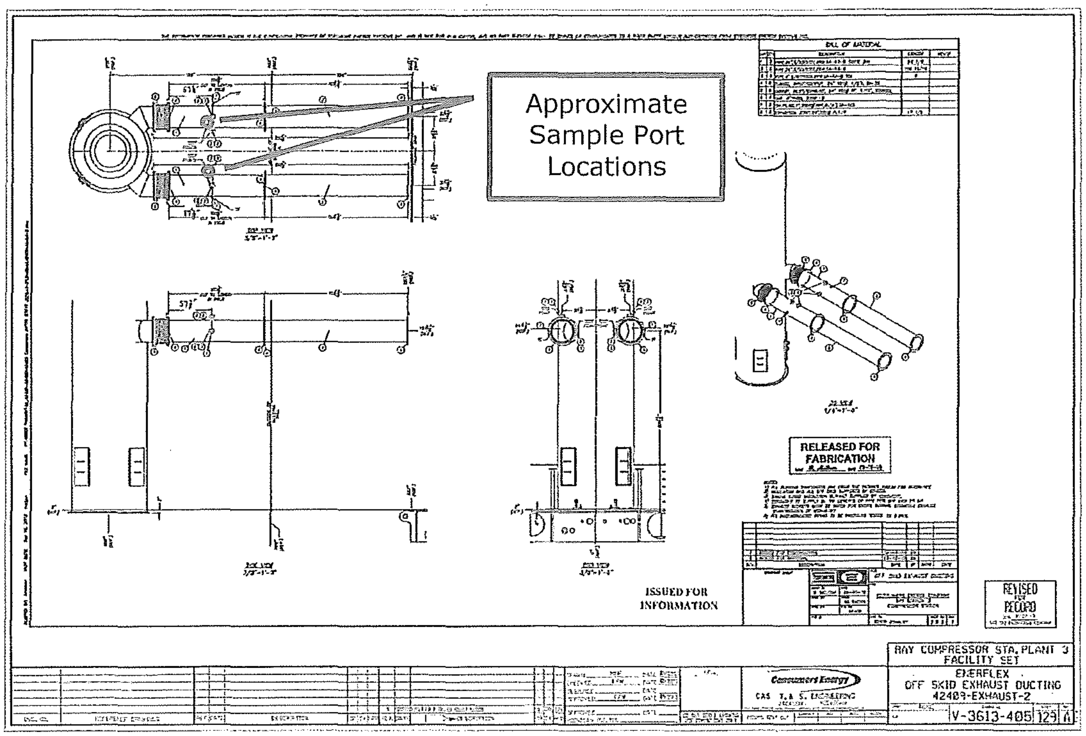
Pre-catalyst Sampling Ports

The engine is equipped with two 24-inch horizontal exhaust ducts exiting the engine and building. Each duct has two pre-catalyst test ports located

1. At least 208 inches (8.7 duct diameters) downstream of a duct bend disturbance at the engine exhaust, and
2. At least 57 inches (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 4-inch in diameter and extend approximately 2-inches beyond the stack wall (Figure 4-1).

Figure 4-1. Pre-Catalyst Sampling Port Location



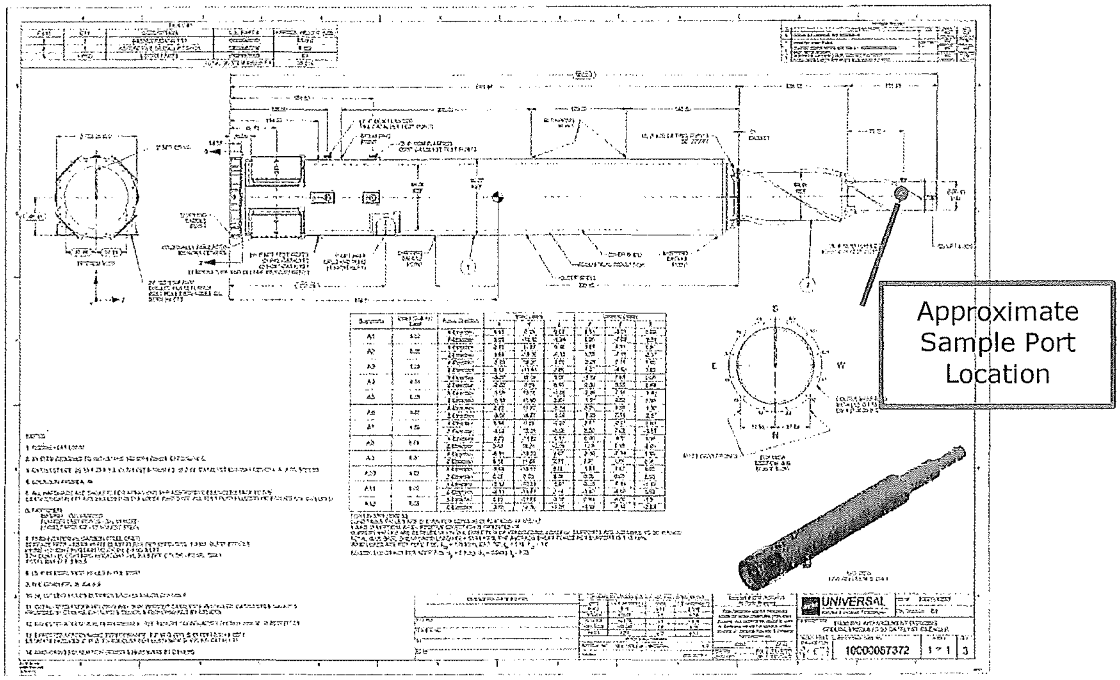
Post-catalyst Sampling Ports

The engine is equipped with a 36-inch vertical exhaust duct exiting the engine and oxidation catalyst. The duct has two test ports located

1. Approximately 72 inches or 2.0 duct diameters downstream of a duct diameter change/flow disturbance, and
2. 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 (Figure 4-2).

Figure 4-2. Post-Catalyst Sampling Port Location

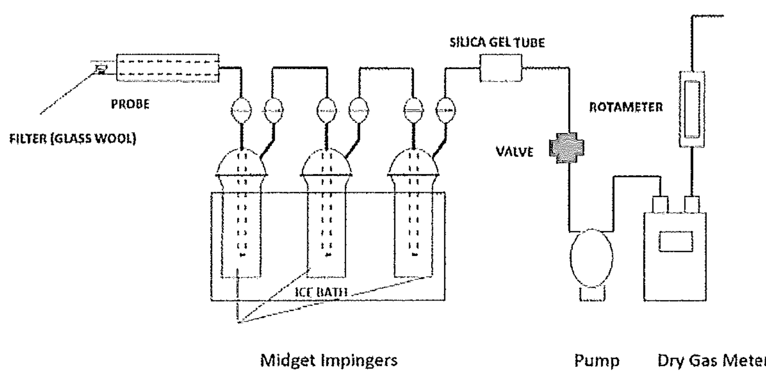


Because the ducts are >12 inches in diameter and the sample locations meet the 40 CFR Part 60, Appendix A-1, Method 1, Section 11.1.1 two and half-diameter criterion, the ducts were sampled at equal time intervals from each of three traverse points located at 16.7, 50.0, and 83.3% of the measurement line ('3-point long line') during each test.

4.3 Moisture Content (USEPA ALT-008)

Exhaust gas moisture content was determined following specifications in USEPA Method 4, *Determination of Moisture Content in Stack Gases*, or equivalent alternate moisture methodology, such as ALT - 008, to convert wet-basis volatile organic compound measurements to a dry basis. Exhaust gas is drawn from the stack into impingers immersed in an ice-bath, condensing any water therein, after which the condensed water is measured gravimetrically to calculate the percent moisture content (Figure 4-3).

Figure 4-3. Alternative Method 008 Moisture Sample Apparatus



The silica gel tube depicted in this figure was replaced with a midget impinger (bubbler) with a straight tube insert, as allowed in ALT-008, §1

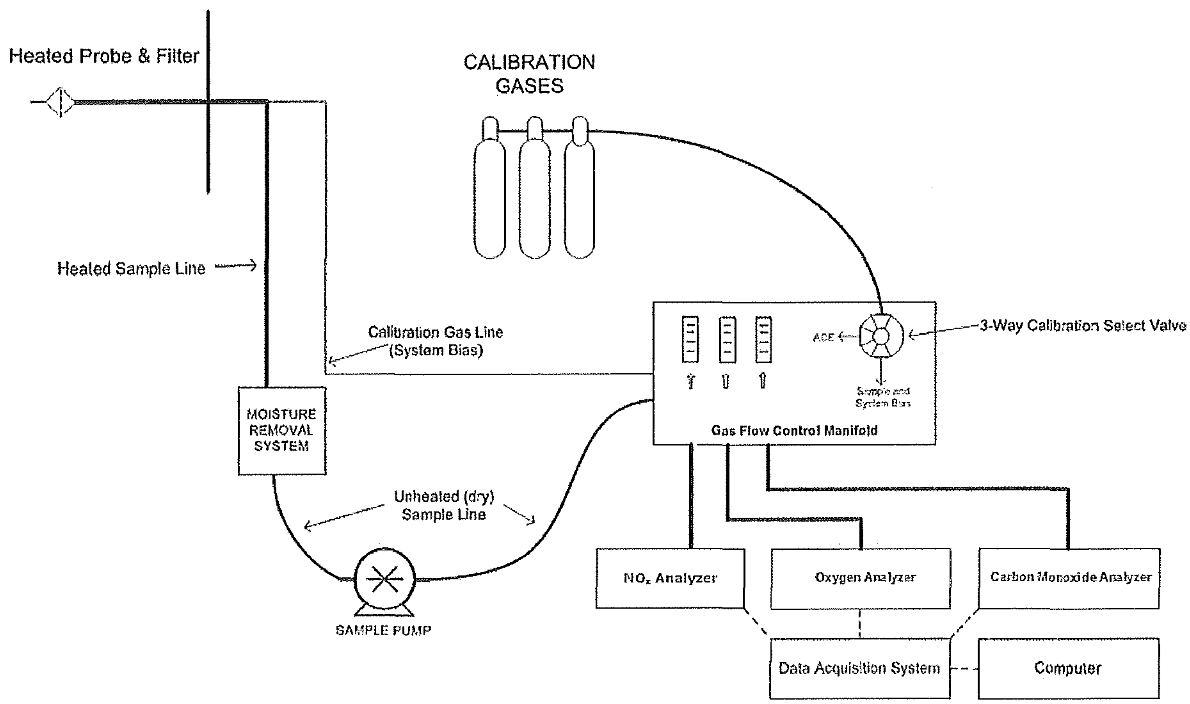
4.4 O_2, NO_X, and CO (USEPA Methods 3A, 7E, and 10)

Oxygen, nitrogen oxides, and carbon monoxide concentrations were measured using the following sampling and analytical procedures:

- USEPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure),*
- USEPA Method 7E, *Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)*, and
- USEPA Method 10, *Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure).*

Each cited method sampling is procedurally similar apart from the analyzer and analytical technique used. Engine exhaust gas was extracted from the stacks or ducts 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, flow control manifold, and gas analyzers (Figure 4-4).

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



Prior to sampling engine exhaust gas, the analyzers are 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 is 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 is then 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% of span.

A NO_2 to NO conversion efficiency test is performed on the NO_X analyzer prior to beginning the test program to evaluate the ability of the instrument to convert NO_2 to NO before analyzing for NO_X.

Upon successful completion of the calibration error and initial system bias tests, sample flow rate and component temperatures are verified, and the probes inserted into the ducts at the appropriate traverse point. After confirming the engine is operating at established conditions, the test run is initiated. Gas concentrations are recorded at 1-minute intervals throughout each 60-minute test run. Oxygen concentrations are measured to adjust the pollutant concentrations to 15% O_2 and calculate pollutant emission rates.

At the conclusion of each test run, a post-test system bias check is performed to compare analyzer bias and drift relative to pre-test system bias checks, ensuring analyzer bias is within ±5.0% of span and drift is within ±3.0%. The analyzer response is also used to correct measured gas concentrations for analyzer drift.

4.5 Emission Rates (USEPA Method 19)

USEPA Method 19, *Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates*, was used to calculate exhaust gas flowrate. The default natural gas fuel factor from Method 19 is used to calculate the emission flow rate with the corresponding equation (Figure 4-5). The flow rate was used in calculations to present emissions in units of g/HP-hr.

Figure 4-5. USEPA Method 19 Emission Flow Rate Equation

$$E = C_d F_d \frac{20.9}{(20.9 - \%O_{2d})}$$

Where:

E	=	Pollutant emission rate (lb/mmBtu)
C_d	=	Pollutant concentration, dry basis (lb/dscf)
F_d	=	Volumes of combustion components per unit of heat content, 8,710 dscf/mmBtu for natural gas (F_d from fuel analysis was used)
$\%O_{2d}$	=	Concentration of oxygen on a dry basis (%, dry)

4.6 Volatile Organic Compounds (ALT-096: USEPA Methods 18/25A)

VOC concentrations were not measured using ALT-096 and/or Methods 18/25A in the field as described in the test protocol due to un-resolvable quality assurance issues with the VOC sample system. In lieu of conducting field measurements, RCTS contacted EGLE representative Mr. Matthew Karl to propose the collection and shipment of exhaust gas bag samples for analysis by an outside contracted laboratory for non-methane, non-ethane, organic compounds (NMNEOC) using U.S. EPA Method 18, *Measurement of Gaseous Organic Compound Emission By Gas Chromatography*.

Based on the unusual issues quality assuring the VOC instruments, Mr. Karl gave "Limited Approval" for this test plan modification only, while indicating for future emission testing, the EGLE approved test protocol must be followed.

Therefore, duplicate bags, manufactured using polyvinyl fluoride (PVF) film, also known as Tedlar film, were collected for each VOC run in the field from the engine exhaust.

At the laboratory, Method 18 was used to measure the gaseous organic mixture in each bag 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 also 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 each compound, the spike recovery (R)- value must fall between 70% <R < 130%.

The recovery study in the laboratory report in Attachment 5, indicates the Tedlar bag exhaust gas samples met the R-value criteria, and that R-value was applied to the reported methane, ethane and VOC as propane concentrations.

5.0 TEST RESULTS AND DISCUSSION

The EUENGINE35 test program performed on July 13 satisfies the continuous compliance evaluation requirements in 40 CFR Part 60, Subpart JJJJ, *Standards of Performance for Stationary Spark Ignition Internal Combustion Engines*, 40 CFR Part 63, Subpart ZZZZ, *National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines* and MI-ROP-B6636-2020. The test results also indicate the NO_x, CO, and VOC engine emissions are compliant with the applicable emissions limits summarized in Table 2-1 of this report.

5.1 Tabulation of Results

Appendix Table 1 contains detailed tabulation of results, process operating conditions, and exhaust gas conditions for each respective RICE.

5.2 Significance of Results

The test results indicate EUENGINE35 is achieving continuous compliance requirements and meeting applicable emissions limits.

5.3 Variations from Sampling or Operating Conditions

As stated in Section 4.6 above, a protocol variance occurred where instead of conducting field measurements, exhaust gas samples were collected in Tedlar bags and sent to an outside contracted laboratory to verify the NMNEOC content using Method 18 analysis.

Please note that the laboratory reported NMNEOC ppmv concentrations are derived by subtracting total hydrocarbons as propane from the sum of methane and ethane as propane, which for each of the three samples collected, resulted in negative NMNEOC concentrations.

Therefore, as suggested in Section 2.2 of the laboratory report, the EUENGINE35 VOC emission rate is calculated using the laboratory derived detection limit, or Limit of Quantitation (LOQ) value of 2.02 ppmv.

5.4 Process or Control Equipment Upset Conditions

EUENGINE35 and its associated gas compressor operated under maximum routine conditions during the test and no upsets were encountered.

5.5 Air Pollution Control Device Maintenance

No major air pollution control device maintenance was performed during the three-month period prior to the test event. Engine optimization is continuously performed to ensure lean-burn combustion and ongoing compliance with regulatory emission limits.

5.6 Re-Test Discussion

Based on the test program results, a re-test is not required. Subsequent air emissions testing on the engine will be performed:

- annually to evaluate the reduction of CO emissions across the oxidation catalyst in accordance with 40 CFR Part 63 Subpart ZZZZ and the facility ROP; and
- every 8,760 engine operating hours or 3 years (2024), whichever is first, thereafter, to evaluate compliance with NO_x, CO, and VOC emission limits in 40 CFR Part 60, Subpart JJJJ and the ROP. The engine hours on July 1st were:
    - EUENGINE35: 11,972.6 hours

5.7 Results of Audit Samples

Audit samples for the reference methods utilized during this test program are not available from USEPA Stationary Source Audit Sample Program providers.

The USEPA RM performed state reliable results are obtained by persons equipped with a thorough knowledge of the techniques associated with each method. Factors with the potential to cause measurement errors are minimized by implementing quality control (QC) and assurance (QA) programs into the applicable components of field testing. QA/QC components were included in this test program (Table 5-1). Refer to Appendix E for supporting documentation.

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
M1: Sampling Location	Evaluates sampling location suitability	Measure upstream and downstream disturbance distances from ports	Pre-test	≥2 diameters downstream; ≥0.5 diameter upstream.
M1: Duct diameter/ dimensions	Verifies stack area is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings
M3A, M7E, M10, M25A: Calibration gas standards	Ensures accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty ≤2.0%
M3A, M7E, M10: Calibration Error	Evaluates analyzer operation	Calibration gases introduced directly into analyzers	Pre-test	±2.0% of calibration span
M3A, M7E, M10: System Bias and Analyzer Drift	Evaluates analyzer/sample system integrity and accuracy over test duration	Calibration gas introduced at sample probe tip, HSL, and into analyzers	Pre-test and Post-test	Bias: ±5.0% of calibration span Drift: ±3.0% of calibration span
M4 (ALT-008): Field balance calibration	Verifies moisture measurement accuracy	Class 6 weight used to check balance accuracy	Daily before use	Balance must measure within ±0.5 gram of certified mass
M7E: NO_2-NO converter efficiency	Evaluates NO_2-NO converter operation	NO_2 calibration gas introduced directly into analyzer	Pre-test or Post-test	NO_x response ≥90% of certified NO_2 calibration gas

5.8 Calibration Sheets

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

5.9 Sample Calculations

Sample calculations and formulas used to compute 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

The method specific quality assurance and quality control procedures in each method employed during this test program were followed, without deviation.

5.12 QA/QC Blanks

The Method 3A, 7E, and 10 calibration gases described in Table 5-1 and in Appendix E were the only QA/QC media employed during the test event.