EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted continuous compliance testing on four (4) 4-stroke lean burn (4SLB) natural gas-fired, spark-ignition, reciprocating internal combustion engines (RICE) identified as EUENGINE1, EUENGINE2, EUENGINE3, and EUENGINE4 at the Consumers Energy White Pigeon Compressor Station in White Pigeon, Michigan. The facility is classified as a major source of hazardous air pollutants (HAP). The engines are natural gas-fired, four-stroke lean-burn (4SLB), spark ignited (SI), reciprocating internal combustion engines (RICE), >500 horsepower that power compressors used to maintain pressure in pipelines transporting natural gas from main lines to storage facilities located in Michigan or local distribution companies. The engines are collectively grouped as FGENGINES within Michigan Department of Environment, Great Lakes and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N5573-2018 and subject to federal air emissions regulations.

The test program was conducted March 4 and 5, 2020 to satisfy performance test requirements and evaluate compliance with 40 CFR Part 63, Subpart ZZZZ, *National Emission Standards for Hazardous Air Pollutants (NESHAP) for Stationary Reciprocating Internal Combustion Engines* §63.6620 and Table 4 and as specified in the facility ROP.

Three, 60-minute test runs for carbon monoxide (CO) and oxygen (O_2) were conducted at each RICE oxidation catalyst inlet and outlet following the procedures in United States Environmental Protection Agency (USEPA) Reference Methods (RM) 1, 3A, and 10 in 40 CFR Part 60, Appendix A. Percent CO reduction efficiency was calculated using 40 CFR 63, § 63.6620, Equation 1. There were no deviations from the approved stack test protocol or associated USEPA RM. During testing, the engines were operated at horsepower and torque conditions within plus or minus (±) 10 percent of 100 percent peak (or the highest achievable) load, as specified in 40 CFR 60.4244(a).

The Subpart ZZZZ test results summarized in Table E-1 indicate EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4 are operating in continuous compliance with the 40 CFR 63 Subpart ZZZZ RICE NESHAP, and as specified in the facility ROP.

Table E-1 Summary of 40 CFR Part 63 Subpart ZZZZ Test Results

Source	CO Reduction Efficiency (%)	Oxidation Catalyst Inlet Temperature (°F)	Oxidation Catalyst Pressure Drop Comparison (Inches Water Gauge)	
			Initial Test	2020 Results
	[Limit: ≥93%]	[Limit: ≥450°F & ≤1350°F]	[Limit: ±2" from Initial Test]	
EUENGINE1	99.4	722.2	3.5	3.98
EUENGINE2	98.9	738.9	3.2	2.94
EUENGINE3	99.0	721.0	2.9	2.72
EUENGINE4	99.1	740.9	3.0	3.45

Detailed results are presented in Appendix Tables 1, 2, 3 and 4. Sample calculations and field data sheets are presented in Appendices A and B. Engine operating data and supporting documentation are provided in Appendices C and D.

1.0 INTRODUCTION

This report summarizes the results of compliance air emissions testing conducted March 4 and 5, 2020 at the Consumers Energy White Pigeon Compressor Station (WPCS) in White Pigeon, Michigan.

This document follows the Michigan Department of Environment, Great Lakes and Energy (EGLE) format described in the November 2019, Format for Submittal of Source Emission Test Plans and Reports. Reproducing only a portion of this report 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 (CO) and oxygen (O_2) testing at the oxidation catalyst inlet and outlet of four, stationary, spark-ignition (SI), reciprocating internal combustion engines (RICE), identified as EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4 installed and operating at WPCS in White Pigeon, Michigan on March 4 and 5, 2020.

A test protocol submitted to EGLE on December 18, 2019 was subsequently approved by Ms. Lindsey Wells, EGLE Environmental Quality Analyst, in a letter dated February 18, 2020. There were no deviations from the approved stack test protocol or associated USEPA Reference Methods.

1.2 Purpose of Testing

The test program was conducted March 4 and 5, 2020 to satisfy performance testing requirements and evaluate compliance with 40 CFR Part 63, Subpart ZZZZ, *National Emission Standards for Hazardous Air Pollutants (NESHAP) for Stationary Reciprocating Internal Combustion Engines* §63.6620 and Table 4, and as specified in the facility ROP.

The RICE NESHAP CO requirement and equipment operating parameters are presented in Table 1-1.

Table 1-1 Summary of 40 CFR 63 Subpart ZZZZ Requirements

CO Reduction Efficiency (%)	**Oxidation Catalyst Inlet Temperature** (°F)	**Oxidation Catalyst Pressure Drop Change** (Inches Water Gauge)
≥93	≥450°F and ≤1350°F	±2” from Initial Performance Test

1.3 Brief Description of Source

WPCS operates one Caterpillar Model 3608 4SLB engine (EUENGINE1) and three Caterpillar Model 3616 4SLB engines (EUENGINE2 – 4) installed at Plant 3 to maintain pressure in the pipeline transporting natural gas from a main line to storage facilities located in Michigan or local distribution companies. The engines are collectively grouped as FGENGINES within MI-ROP-N5573-2018.

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 Environment, Great Lakes and Energy Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Technical Programs Field Inspector	Ms. Lindsey Wells Technical Programs Unit Field Operations Section 517-282-2345 wellsl8@michigan.gov	Michigan Department of Environment, Great Lakes and Energy Technical Programs Unit 525 W. Allegan, Constitution Hall, 2nd Floor S Lansing, Michigan 48933
State Regulatory Inspector	Mr. Chance Collins Environmental Quality Analyst 269-254-7119 collinsc21@michigan.gov/air	Michigan Department of Environment, Great Lakes and Energy Kalamazoo District Office 7953 Adobe Road Kalamazoo, Michigan 49009-5025
Responsible Official	Mr. Gregory Baustian Executive Director-Natural Gas Compression and Storage 616-638-8037 gregory.baustian@cmsenergy.com	Consumers Energy Company Traverse City Service Center 821 Hastings Street Traverse City, Michigan 49686
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. Gerald (Frank) Rand Jr. Senior Environmental Analyst 734-850-4209 frank.randjr@cmsenergy.com	Consumers Energy Company 7216 Crabb Road Temperance, Michigan 48182
Test Facility	Mr. Timothy Wolf Gas Field Leader III 269-483-2902 timothy.wolf@cmsenergy.com	Consumers Energy Company White Pigeon Compressor Station 68536 A Road, Route 1 White Pigeon, Michigan 49099
Test Team Representative	Mr. Gregg Koteskey, QSTI Engineering Technical Analyst II 616-738-3712 gregg.koteskey@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 pursuant to §60.4244(a), were operated within 10% of 100 percent peak (or the highest achievable) load. The performance test was conducted with the engines operating at an average load of 97.9% horsepower or greater, based on the maximum manufacturer's design capacity at engine and compressor site conditions. Refer to Appendix C for detailed operating data.

2.2 Applicable Permit Information

The White Pigeon Compressor Station operates in accordance with MI-ROP-N5573-2018. EUENGINE1, EUENGINE2, EUENGINE3, and EUENGINE4 are the emission unit sources identified in the permit. Collectively they are included within the FGENGINES flexible group. Incorporated within the permit are the applicable federal requirements of 40 CFR Part 63, Subpart ZZZZ.

2.3 Results

The CO reduction efficiency across the exhaust catalysts, when combined with engine parameter data, indicate FGENGINES are operating in continuous compliance with the applicable RICE NESHAP and ROP limits. Refer to Table 2-1 for the summary of test results.

Table 2-1 Summary of 40 CFR Part 63 Subpart ZZZZ Test Results

Source	CO Reduction Efficiency (%)	Oxidation Catalyst Inlet Temperature (°F)	Oxidation Catalyst Pressure Drop Comparison (Inches Water Gauge)	
			Initial Test	2020 Results
	[Limit: ≥93%]	[Limit: ≥450°F & ≤1350°F]	[Limit: ±2" from Initial Test]	
EUENGINE1	99.4	722.2	3.5	3.98
EUENGINE2	98.9	738.9	3.2	2.94
EUENGINE3	99.0	721.0	2.9	2.72
EUENGINE4	99.1	740.9	3.0	3.45

Detailed results are presented in Appendix Tables 1 - 4. A discussion of the results is presented in Section 5.0. Sample calculations and field data sheets are presented in Appendices A and B. Engine operating data and supporting documentation are provided in Appendices C and D.

3.0 SOURCE DESCRIPTION

EUENGINE1, EUENGINE2, EUENGINE2, and EUENGINE4 are operated as needed to maintain natural gas pressure along the natural gas pipeline system. A summary of the engine specifications is presented in Table 3-1.

Table 3-1
Engine Specifications

Parameter[1]	EUENGINE1	EUENGINE2, EUENGINE3, and EUENGINE3
Purchase Year	2008	2008
Installation Date	June 15, 2010	June 15, 2010
Make	Caterpillar	Caterpillar
Model	G3608	G3616
Cylinders	8	16
Output (brake-horsepower)	2,370	4,735
Heat Input (mmBtu/hr)	16.1	32.0
Exhaust Flow Rate (acfm, wet)	16,144	32,100
Exhaust Gas Temp. (°F)	857	856
Engine Outlet O_2 (Vol-%, dry)	12.00	12.00
Engine Outlet CO_2 (Vol-%, dry)	5.81	5.81
CO, uncontrolled (ppmvd)	570.0	572.0
CO, controlled[2] (ppmvd)	39.9	40.0

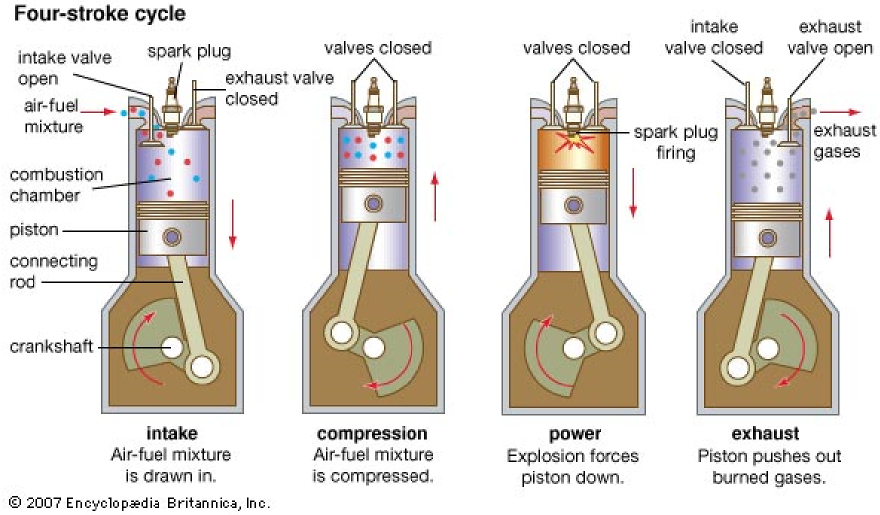
1 All engine specifications are based upon vendor data for operation at 100% of rated engine capacity.
2 The controlled CO concentrations are based upon the vendor not to exceed CO concentrations at 100% load, and a reduction of 93% by volume for the associated oxidation catalysts.

3.1 PROCESS

EUENGINE1, EUENGINE2, EUENGINE3, and EUENGINE4 are natural gas-fired 4SLB SI RICEs constructed in 2010. In a 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 when the piston is near the bottom of the intake stroke; the intake ports close 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, and combustion products are expelled from the cylinder as the piston travels upward. A new air-to-fuel charge is injected as the piston moves downward with a new intake stroke.

The engines provide mechanical shaft power to a gas compressor. The compressors are used to maintain pressure within the natural gas pipeline transmission and distribution system. Refer to Figure 3-1 for a four-stroke engine process diagram.

Figure 3-1. Four-Stroke Engine Process Diagram



The natural gas-fired engine flue gas is controlled through parametric controls (i.e., timing and air-to-fuel ratio), lean burn combustion technology, and oxidation catalysts. The Caterpillar engines includes an Advanced Digital Engine Management (ADEM) III electronic control system. The ADEM III electronic controls integrate governing (engine sensing and monitoring, air/fuel ratio control, ignition timing, and detonation control) into one comprehensive engine control system for optimum performance and reliability.

The NO_x emissions from each of the engines are minimized using 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 and resulting in lower NO_x emissions.

The engines are also equipped with oxidation catalysts. Pollution Control Associates, Inc. (PCA) manufacturers the model ADCAT CO catalysts (part number 28283.5-300CO) that are installed on each engine exhaust stack. The catalysts are designed in a modular manner where each Caterpillar Model G3616 engine is equipped with four catalyst modules, while the Caterpillar Model 3608 engine is equipped with two catalyst modules. The catalyst uses proprietary materials to lower the oxidation temperature of CO and other organic compounds, thus maximizing the catalyst efficiency specific to the exhaust gas temperatures generated by the engines. The catalyst vendor has guaranteed a CO removal efficiency of 93%. The catalysts also provide control of formaldehyde, as well as non-methane and non-ethane hydrocarbons with the estimated destruction efficiency of 85% and 75%, respectively.

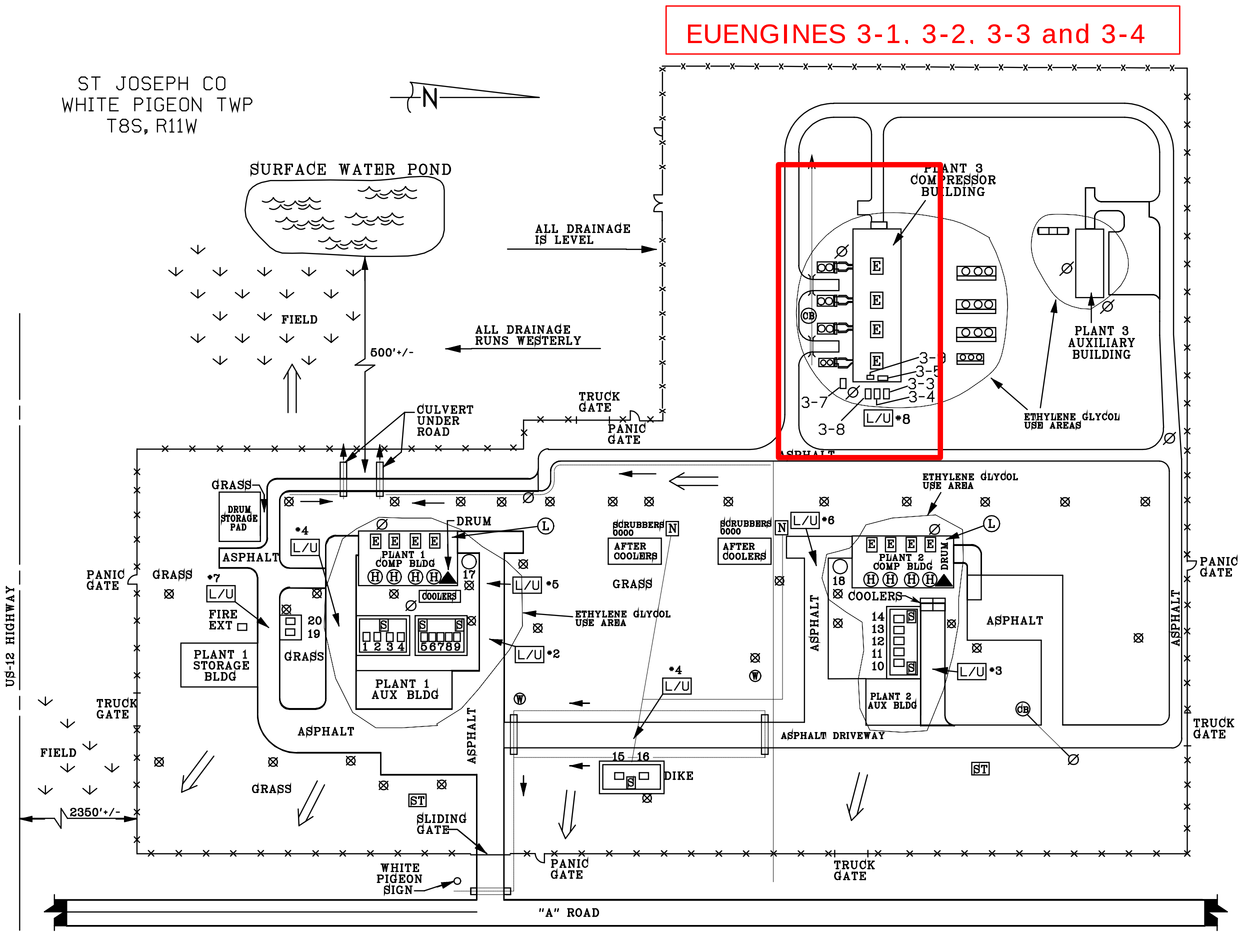
Detailed operating data recorded during testing are provided in Appendix C.

3.2 Process Flow

Located in southwestern St. Joseph County, the White Pigeon Compressor Station helps maintain natural gas pressures in the natural gas pipeline transmission system. The station receives natural gas from the ANR and Trunk Line interstate pipeline sources and provides adequate system pressure to support customer load and injection operations at other compressor stations. The Plant 3 compressor engines have the capacity to pump 800 million cubic feet of natural gas a day.

The facility is divided into three plants comprising natural gas reciprocating compressor engines, emergency generators, and associated equipment to maintain pressure in natural gas transmission system. The Plant 3 natural gas compressor engines were the focus of this test program. Refer to Figure 3-2 for the White Pigeon Compressor Station Plant 3 Site Map.

Figure 3-2. White Pigeon Compressor Station Plant 3 Site Map



3.3 Materials Processed

The fuel utilized in EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4 is exclusively natural gas, as defined in 40 CFR 72.2. During testing, the natural gas combusted within the engines was comprised of approximately 92% methane, 6% ethane, 2% nitrogen, and 0.3% carbon dioxide.

3.4 Rated Capacity

EUENGINE1 has a maximum power output of approximately 2,370 horsepower while EUENGINE2-4 are rated at 4,735 horsepower. The engines have a rated heat input of 16.1 and 32.0 million British thermal units per hour (mmBtu/hour), respectively. The normal rated capacities of the engines are a function of facility and gas transmission demand. The engine operating parameters were recorded and averaged for each test run. Refer to Appendix C for operating data recorded during testing.

3.5 Process Instrumentation

The engine operating parameters were continuously monitored by a distributed control system for the Caterpillar engines, data acquisition systems, and by Consumers Energy operations personnel during testing. Data were collected at 1-minute intervals during each test for the following parameters:

- Discharge pressure (psi)
- Suction pressure (psi)
- Catalyst differential pressure (in. H_2O)
- Catalyst inlet temperature (°F)
- Catalyst exhaust temperature (°F)
- Power (BHP)
- Engine speed (rpm)
- Compressor Torque (% max)
- Compressor Load Step (unit less)
- Fuel use (1,000 scf/hr)

Refer to Appendix C for operating data.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy RCTS tested for CO and O_2 concentrations using the United States Environmental Protection Agency (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	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)
Nitrogen Oxides	7E [1]	*Determination of Nitrogen Oxides Emissions From Stationary Sources (Instrumental Analyzer Procedure)*
Carbon monoxide (CO)	10	Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)

[1] The Method 7E NO_x parameter was not measured, however Method 3A and 10 analyzers followed Method 7E quality assurance procedural and sample traverse point guidance.

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

Date (2020)	Run	Sample Type	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
EUENGINE1							
March 5	1	O_2 CO	12:38	13:37	60	1 3A 10	Sampling performed at three traverse points
	2		13:51	14:50	60		
	3		15:06	16:07	62		RM data logger disconnect for two-minute duration, run extended
EUENGINE2							
March 5	1	O_2 CO	8:14	9:13	60	1 3A 10	Sampling performed at three traverse points
	2		9:29	10:28	60		
	3		10:42	11:41	60		
EUENGINE3							
March 4	1	O_2 CO	13:00	13:59	60	1 3A 10	Sampling performed at three traverse points
	2		14:15	15:14	60		
	3		15:30	16:29	60		
EUENGINE4							
March 4	1	O_2 CO	9:00	9:59	60	1 3A 10	Sampling performed at three traverse points
	2		10:15	11:14	60		
	3		11:30	12:29	60		

4.2 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*. The engine sampling locations are presented in the following section. Pre-catalyst and post-catalyst sampling port location drawings are presented as Figures 4-1 (EUENGINE1) and 4-2 (EUENGINE2-4).

EUENGINE1

Sample Port Location Upstream of Oxidation Catalyst in 26-inch diameter duct:

- Approximately 60-inches or 2.3 duct diameters downstream of a flow disturbance where the engine exhaust enters the exhaust stack, and
- Approximately 85-inches or 3.3 duct diameters upstream of the catalysts.

Sample Port Location Downstream of Oxidation Catalyst in 26-inch diameter duct:

- Approximately 52-inches or 2 duct diameters downstream of a flow disturbance, and
- Approximately 573-inches or 22 duct diameters upstream of the stack exit.

EUENGINE2, EUENGINE3 and EUENGINE4

Sample Port Location Upstream of Oxidation Catalyst in 34.5-inch equivalent diameter duct (note sample port is within the duct annulus):

- Approximately 127-inches or 3.7 duct diameters downstream of a flow disturbance where the engine exhaust enters the exhaust stack, and
- Approximately 41-inches or 1.2 duct diameters upstream of the catalysts.

Sample Port Location Downstream of Oxidation Catalyst in 36-inch diameter duct:

- Approximately 72-inches or 2 duct diameters downstream of a flow disturbance, and
- Approximately 679-inches or 18.9 duct diameters upstream of the stack exit.

The sample ports are 0.5 to 1-inch in diameter and extend 3 inches beyond the stack wall. Because the ducts are >12 inches in diameter and the port locations meet the two and one-half diameter criterion of Section 11.1.1 of Method 1 of 40 CFR Part 60, Appendix A-1, the exhaust ducts were sampled at approximately equal intervals at 3 traverse points located at 16.7, 50.0, and 83.3% of the measurement line ('3-point long line'). The sample port upstream of the oxidation catalyst was not traversed at EUENGINE2-4 and flue gas concentrations were measured at a single sample location due to duct configuration.

Figure 4-1. EUENGINE1 Sampling Locations

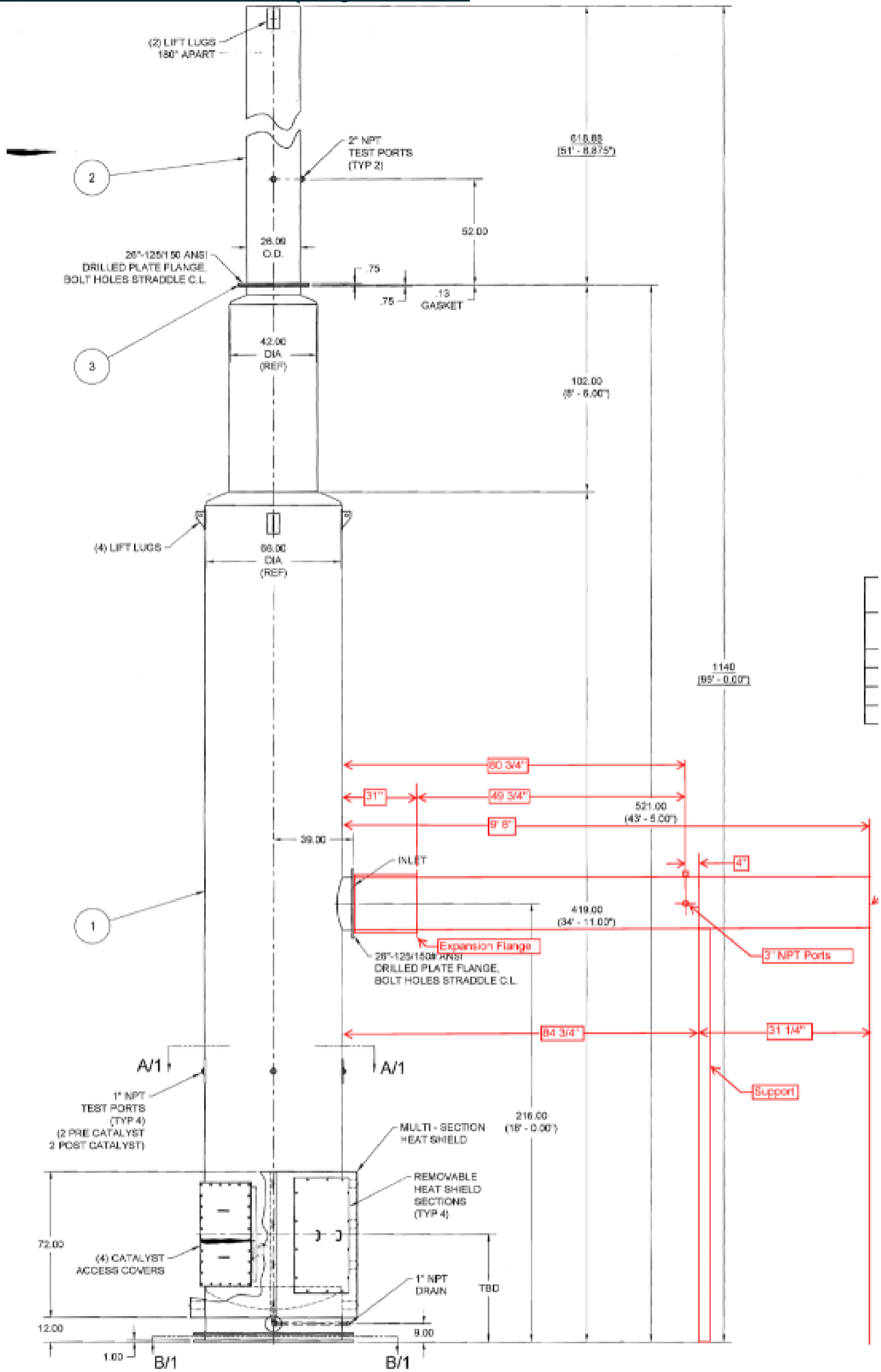
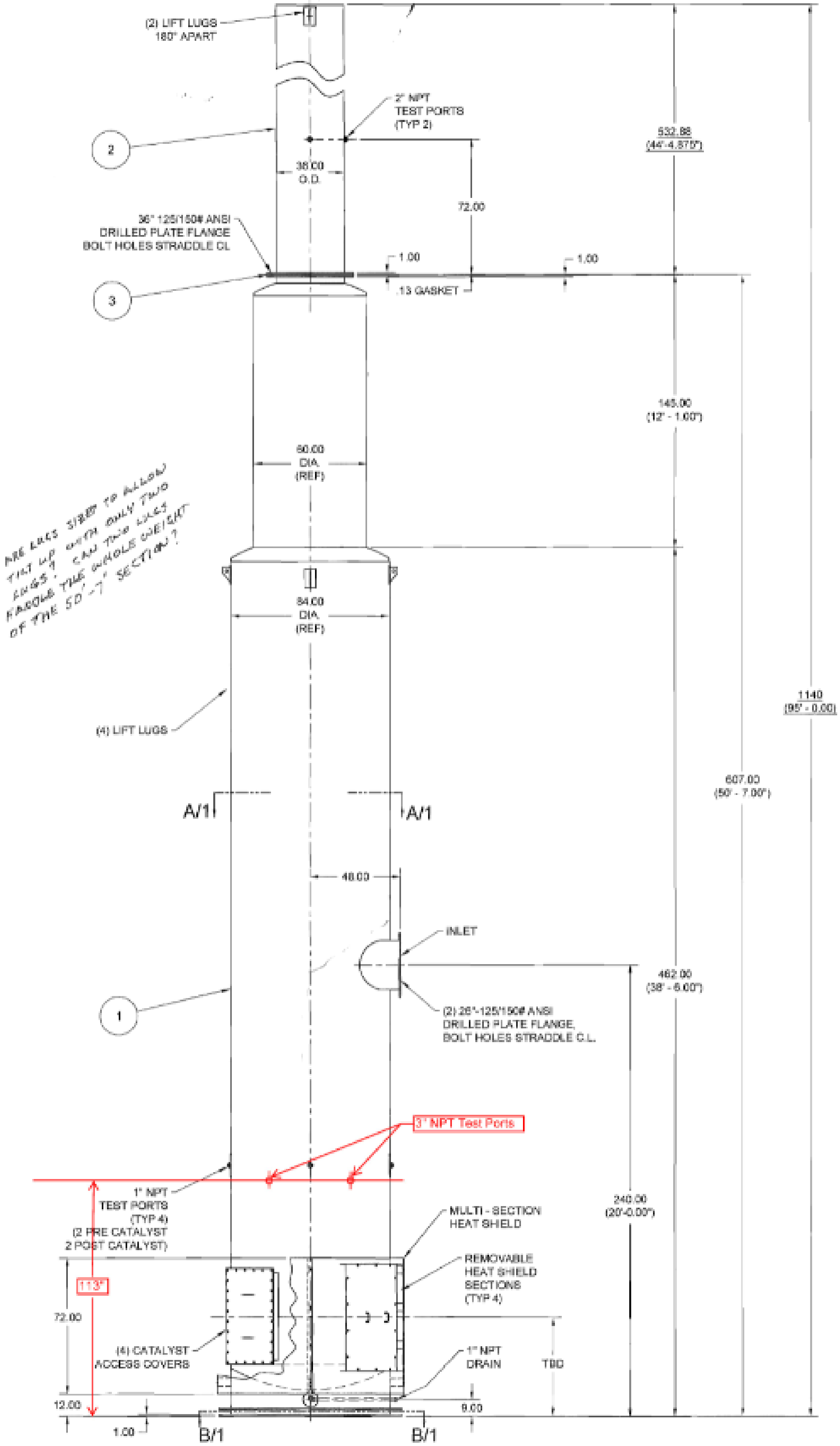


Figure 4-2. EUENGINE2, EUENGINE3 and EUENGINE4 Sampling Locations



4.3 O_2 AND CO (USEPA METHODS 3A AND 10)

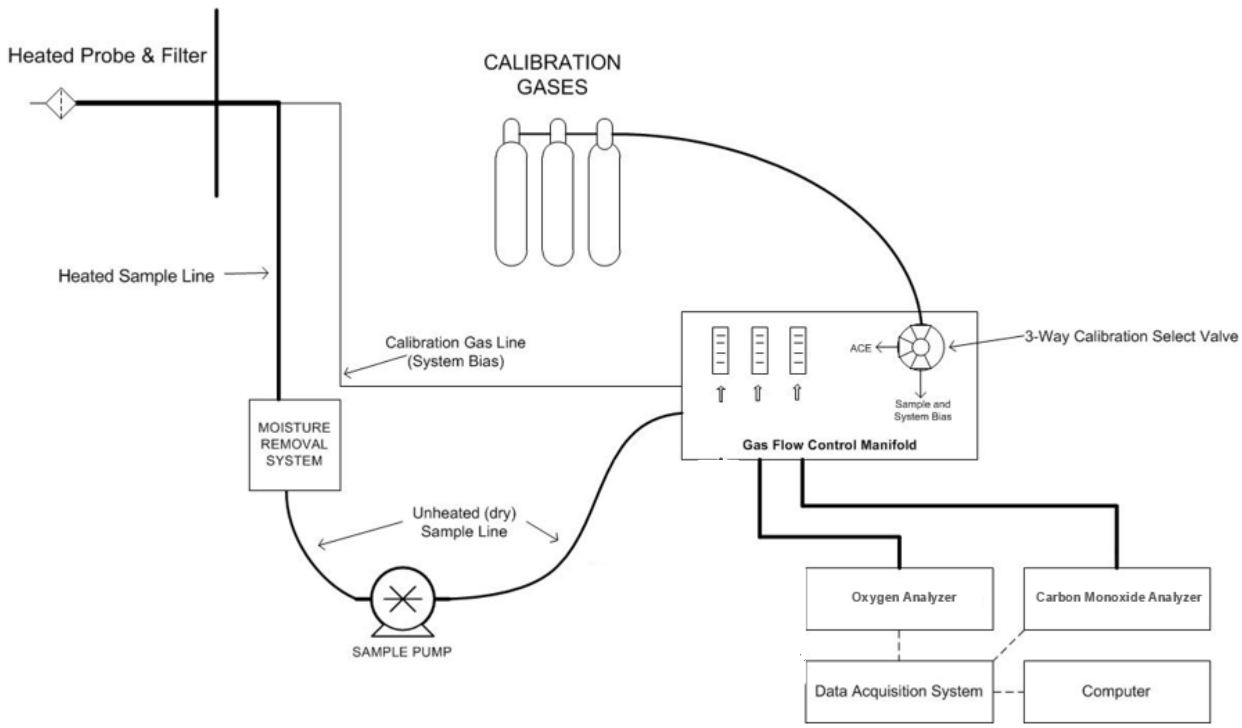
Oxygen, nitrogen oxides, and/or carbon monoxide concentrations were measured using the following sampling and analytical procedures:

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

Apart from the analyzers and analytical technique used, the sampling procedures of each method are similar. The measured oxygen concentrations were used to adjust the pollutant concentrations to 15% O_2 and calculate pollutant emission rates.

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 4-3 depicts a drawing of the Methods 3A and 10 sampling system.

Figure 4-3. USEPA 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 were 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 were introduced at the sample probe to measure the ability of the system to respond accurately to within ±5.0% of span.

Upon successful completion of the calibration error and initial system bias tests, sample flow rate and component temperatures were verified, and the probes were inserted into the ducts at the appropriate traverse point. After confirming the engine was operating within established conditions, the test run was initiated. Gas concentrations were recorded at 1-minute intervals throughout each 60-minute test run.

After the conclusion of each 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 evaluated if the analyzers bias was within ±5.0% of span and drift was within ±3.0%. The analyzers responses were used to correct the measured gas concentrations for analyzer drift.

5.0 TEST RESULTS AND DISCUSSION

The test program was conducted March 4 and 5, 2020 to satisfy performance testing requirements and evaluate compliance with 40 CFR Part 63, Subpart ZZZZ, *National Emission Standards for Hazardous Air Pollutants (NESHAP) for Stationary Reciprocating Internal Combustion Engines* and MI-ROP-N5573-2018.

5.1 Tabulation of Results

The EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4 test results indicate the engines are operating in continuous compliance with the applicable RICE NESHAP and ROP limits as summarized in Table 2-1. Appendix Tables 1 – 4 contain detailed tabulation of results, process operating conditions, and exhaust gas conditions for each respective RICE.

5.2 Significance of Results

The results of the testing indicate compliance with the applicable emission limits.

5.3 Variations from Sampling or Operating Conditions

No operating condition variations were observed during the test program. During testing of EUENGINE1 on March 5, 2020, the reference method (RM) data logger lost connection with the analyzers at approximately 15:22. The connection was restored and data logging resumed during the minute of 15:23. Due to the two minute sample data loss, the test run was extended two minutes (15:06 to 16:07) in order to log the necessary 60 minutes of data.

5.4 Process or Control Equipment Upset Conditions

The engines and gas compressors were operating under maximum routine conditions and no upsets were encountered during testing.

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

- annually to evaluate the reduction of CO emissions across the oxidation catalyst in accordance with 40 CFR 60 Subpart JJJJ and the ROP
- every 8,760 engine operating hours or 3 years (2022), whichever is first, thereafter to evaluate compliance with NO_x, CO, and VOC emission limits in 40 CFR Part 63, Subpart ZZZZ and the ROP

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 reference methods 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 summarizes the primary field quality assurance and quality control activities that were performed. 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 suitability of sample location	Measure distance from ports to downstream and upstream flow disturbances	Pre-test	≥2 diameters downstream; ≥0.5 diameter upstream.
M1: Duct diameter/ dimensions	Verifies area of stack is accurately measured	Review as-built drawings and field measurement	Pre-test	Field measurement agreement with as-built drawings
M3A, M10: Calibration gas standards	Ensures accurate calibration standards	Traceability protocol of calibration gases	Pre-test	Calibration gas uncertainty ≤2.0%
M3A, M10: Calibration Error	Evaluates operation of analyzers	Calibration gases introduced directly into analyzers	Pre-test	±2.0% of the calibration span
M3A, M10: System Bias and Analyzer Drift	Evaluates analyzer and sample system integrity and accuracy over test duration	Calibration gases introduced at sample probe tip, heated sample line, and into analyzers	Pre and Post-test	±5.0% of the analyzer calibration span for bias and ±3.0% of analyzer calibration span for drift

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 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

Laboratory analysis was not required for this compliance demonstration.

5.12 QA / QC BLANKS

Other than Method 3A and 10 QA/QC and calibration gases used for zero calibrations, no other reagent or media blanks were used. QA/QC data are presented in Appendix D.