Consumers Energy
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# 40 CFR 63 Subpart ZZZZ Compliance Test Report

# EUEDG

Consumers Energy Company
Jackson Generating Station
2219 Chapin Street
Jackson, Michigan 49203
SRN: N6626

April 2, 2021

**Test Date: March 3, 2021**

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 38112104
Version No.: 0

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# EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section (RCTS) conducted carbon monoxide (CO) testing at a stand-by diesel-fired generator, EUEDG, installed and operated at the Jackson Generating Station, in Jackson, Michigan. The engine is classified as a non-emergency compression ignition existing stationary engine >500 horsepower located at an area source of hazardous air pollutants (HAP). EUEDG operates on a minimal basis for emergency purposes, maintenance and readiness testing, and as station power during periodic scheduled high voltage switchyard outages.

This test program was conducted March 3, 2021 to satisfy subsequent performance test requirements (every 3 years or 8,760 hours, whichever comes first), and evaluate compliance with the applicable emission limits specified in 40 CFR 63, Subpart ZZZZ, *National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines*, (RICE NESHAP) and Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-N6626-2019a. The previous test was completed less than 3 years ago on April 10, 2018, and at the start of the March 3, 2021 test, the engine had 1,497.5 run hours.

Three, 60-minute test runs were conducted at the engine catalyst inlet and outlet following procedures in the United States Environmental Protection Agency (USEPA), 40 CFR Part 60, Appendix A Reference Methods (RM) 1, 3A, and 10.

There were no deviations from the stack test protocol or associated USEPA Reference Methods. EUEDG was operated within plus or minus (±) 10 percent of 100 percent peak (or the highest achievable) load, as specified in 40 CFR 63.6610(d)(5) during the tests. The results of the emissions testing are summarized in Table E-1.

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

| Source | Parameter | Units | Average Result | Limit† |
|---|---|---|---|---|
| EUEDG | CO Exhaust Concentration | ppmvd @ 15% $O_2$ | 5.5 | ≤23 (or) |
| | CO Reduction Efficiency | % | 93.8 | ≥70 |

† 40 CFR 63, Subpart ZZZZ compliance may be achieved by limiting the carbon monoxide exhaust concentration **or** reducing carbon monoxide emissions
CO carbon monoxide
ppmvd @ 15% $O_2$ part per million by volume, dry basis, corrected to 15% oxygen

The EUEDG test results indicate the average carbon monoxide exhaust concentrations and oxidizing catalyst removal efficiency comply with applicable limits.

Detailed results are presented in Appendix Tables. 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 3, 2021 on EUEDG installed and operated at the Consumers Energy Jackson Generating Station in Jackson, Michigan.

This document follows the November 2019, *Format for Submittal of Source Emission Test Plans and Reports* format from the Michigan Department of Environment, Great Lakes and Energy (EGLE). Reproducing portions of this report may omit critical substantiating documentation, causing information to be taken out of context. If reproducing any portion of this report, 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) testing at a diesel fired generator, EUEDG, installed and operated at the Jackson Generating Station in Jackson, Michigan on March 3, 2021.

Consumers Energy mailed a December 11, 2020 performance test notification to the United States Environmental Protection Agency (USEPA) Region V and EGLE, who received it on December 17, 2020. Neither agency requested a site-specific Test Plan; the plan was completed 60 days prior to testing and maintained onsite and available for review.

## 1.2 Purpose of Testing

The test program was performed to satisfy subsequent performance test requirements (every 3 years or 8,760 hours whichever comes first), and evaluate compliance with the applicable emission limits specified in 40 CFR Part 63, Subpart ZZZZ, *National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines* and in EGLE Renewable Operating Permit (ROP) MI-ROP-N6626-2019a. The applicable emission limits are presented in Table 1-1.

**Table 1-1**
**Applicable Emission Limits**

| Parameter | Emission Limit† | Units | Applicable Requirement |
|---|---|---|---|
| Carbon Monoxide | ≤23 | ppmvd @ 15 % $O_2$ | Table 2d (3) to Subpart ZZZZ of Part 63 -- *Requirements for Existing Stationary RICE Located at Area Sources of HAP Emissions* |
| | or | | |
| | ≥70 | % reduction efficiency | MI-ROP-N6626-2019a, Section C: EUEDG, Condition I.1 |

† 40 CFR 63, Subpart ZZZZ compliance may be achieved by limiting the carbon monoxide exhaust concentration **or** reducing carbon monoxide emissions
CO carbon monoxide
ppmvd @ 15% $O_2$ part per million by volume, dry basis, corrected to 15% oxygen

## 1.3 Brief Description of Source

EUEDG is a 1,332-horsepower diesel fuel fired engine connected to an electricity producing generator classified as a non-emergency compression ignition existing stationary engine

>500 horsepower at an area source of hazardous air pollutants (HAP). EUEDG operates on a minimal basis for emergency purposes, maintenance and readiness testing, and as station power during periodic scheduled high voltage switchyard outages. While the engine primarily serves in an emergency capacity, current EPA guidance suggests that use of the engine during scheduled high voltage switchyard outages (when power is still available from the grid) is not considered emergency operation.

## 1.4 Contact Information

Table 1-2 presents the contact names, addresses, and affiliations of personnel associated or directly involved with the test event.

**Table 1-2**
**Contact Information**

| Program Role | Contact | Address |
|---|---|---|
| Federal Regulatory Administrator | Mr. Brian Dickens<br>Stationary Engine Rule Lead<br>312-886-6073<br>dickens.brian@epa.gov | US EPA Region 5<br>Compliance Tracker (AE-17J)<br>77 West Jackson Blvd.<br>Chicago, Illinois 60604 |
| State Regulatory Administrator | Ms. Karen Kajiya-Mills<br>Technical Programs Unit Manager<br>517-256-0880<br>kajiya-millsk@michigan.gov | EGLE Technical Programs Unit<br>525 W. Allegan, Constitution Hall, 2nd Floor S<br>Lansing, Michigan 48933 |
| State Regulatory Inspector | Mr. Brian Carley<br>Environmental Specialist 13<br>517-416-4631<br>carleyb@michigan.gov | EGLE Jackson District Office<br>State Office Building, 4th Floor<br>301 E. Louis B Glick Highway<br>Jackson, Michigan 49201 |
| Responsible Official | Mr. John Broschak<br>VP Generation Operations and Compression<br>616-738-3718<br>john.broschak@cmsenergy.com | Consumers Energy Company<br>J.H. Campbell Annex<br>17000 Croswell Street<br>West Olive, Michigan 49460 |
| Corporate Air Quality Contact | Mr. Jason Prentice<br>Senior Engineer III<br>517-788-1467<br>jason.prentice@cmsenergy.com | Consumers Energy Company<br>Environmental Services Department<br>1945 West Parnall Road<br>Jackson, Michigan 49201 |
| Authorized Representative | Ms. Janna Spitz<br>Plant Manager<br>517-841-5714<br>janna.spitz@cmsenergy.com | Consumers Energy Company<br>Jackson Generating Station<br>2219 Chapin Street<br>Jackson, Michigan 49203 |
| Test Facility | Mr. Doug Mallory<br>Environmental Health & Safety /<br>NERC Compliance Coordinator<br>517-841-5723<br>doug.mallory@cmsenergy.com | Consumers Energy Company<br>Jackson Generating Station<br>2219 Chapin Street<br>Jackson, Michigan 49203 |
| Test Team Representative | Mr. Joe Mason, QSTI<br>Engineering Technical Analyst<br>616-738-3385<br>joe.mason@cmsenergy.com | Consumers Energy Company<br>L&D Training Center<br>17010 Croswell Street<br>West Olive, Michigan 49460 |

# 2.0 SUMMARY OF RESULTS

## 2.1 Operating Data

During the performance test, the engine fired diesel fuel and operated within 10% of 100 percent peak (or the highest achievable) load. The engine generator system produced an average of 841.3 kilowatts or 93.5% of the maximum achievable load (900 kW), based on the manufacturer's design specifications. It should be noted that for this category of engine, 40 CFR Part 63, Subpart ZZZZ does not require the tests be performed at a specified operating load condition. Refer to Attachment C for detailed operating data.

## 2.2 Applicable Permit Information

The Jackson Generating Station has been assigned State of Michigan Registration Number (SRN) N6626 and operates in accordance with ROP MI-ROP-N6626-2019a. EUEDG is the emission unit source identified in the permit that was evaluated during this test program. Incorporated within the permit are the applicable requirements of RICE NESHAP.

## 2.3 Results

The EUEDG test results indicate the CO exhaust concentrations, reduction efficiency and catalyst inlet temperature and pressure drop comply with MI-ROP-N6626-2019a and RICE NESHAP limits. Refer to Table 2-1 for the summary of test results.

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

| Source | Parameter | Units | Average Result | Limit† |
|---|---|---|---|---|
| EUEDG | CO Exhaust Concentration | ppmvd @ 15% $O_2$ | 5.5 | ≤23 (or) |
| | CO Reduction Efficiency | % | 93.8 | ≥70 |

† 40 CFR 63, Subpart ZZZZ compliance may be achieved by limiting the carbon monoxide exhaust concentration **or** reducing carbon monoxide emissions
CO carbon monoxide
ppmvd @ 15% $O_2$ part per million by volume, dry basis, corrected to 15% oxygen

Detailed results are presented in Appendix Tables. 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 information are provided in Appendices C and D.

# 3.0 SOURCE DESCRIPTION

EUEDG operates on a minimal basis for emergency purposes, maintenance and readiness testing, and as station power during periodic scheduled high voltage switchyard outages. A summary of the engine specifications is provided in Table 3-1.

**Table 3-1**
**Engine Specifications**

| Engine ID | Engine Description | | Site-Rated HP | Emission Control |
|---|---|---|---|---|
| | Manufacturer | Model | | |
| EUEDG | Caterpillar | 3508 | 1,332 | Oxidation catalyst |

## 3.1 PROCESS

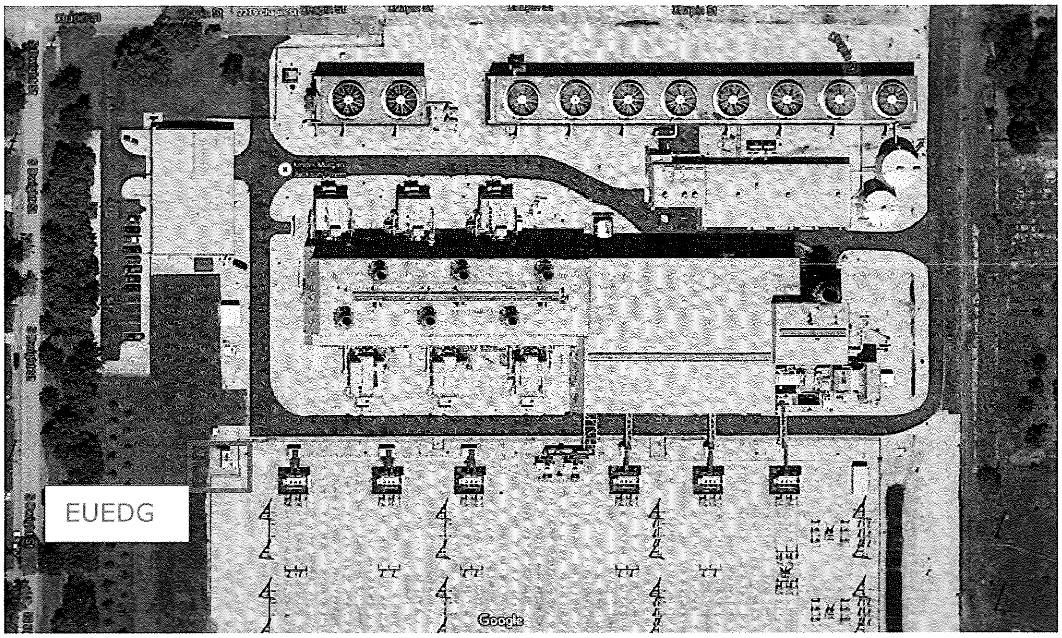
EUEDG is a diesel-fired 4-stroke, 34.5 Liter displacement, compression ignition engine constructed in 2001. The engine provides mechanical shaft power to an electric generator capable of producing 900 kilowatts. The electricity produced is used to power the facility during emergencies or during high voltage switchyard maintenance.

The engine emissions are controlled by an oxidation catalyst manufactured by DCL International Inc. One catalyst module model DC64-16 CC is installed on the engine. The catalyst contains propriety materials to lower the oxidation temperature of CO and other organic compounds, thus maximizing the catalyst efficiency specific to the engine exhaust gas temperatures. Detailed operating data from the test are provided in Appendix C.

## 3.2 PROCESS FLOW

Located in Jackson, Michigan, the Jackson Generating Station burns natural gas to power seven General Electric combustion turbines. The turbines use heat-recovery steam generators that create steam to run two steam turbine generators to produce electricity. The 542-megawatt generating station provides electricity to the electrical grid and Consumers Energy customers. EUEDG is used for facility power during emergencies and for maintenance purposes. Refer to Figure 3-1 for an aerial photograph depicting Jackson Generating Station and location of EUEDG.

**Figure 3-1. Jackson Generating Station EUEDG Location**




## 3.3 Materials Processed

The fuel utilized in EUEDG is diesel, as defined in 40 CFR 63.6675. During testing, the diesel fuel combusted in the engine was a low-sulfur fuel containing a maximum of 15-parts per million sulfur and high cetane index meeting the requirements of 40 CFR 63.6604(a) and 40 CFR 1090.305 for ultra low-sulfur diesel fuel.

## 3.4 Rated Capacity

The engine has a maximum power output of approximately 1,332 horsepower. When operated at 100% load, the engine generator set is rated at 900 kW. The normal electrical output of the engine is a function of facility electricity demand and site conditions.

## 3.5 Process Instrumentation

The engine processes were monitored by Consumers Energy personnel at 15-minute intervals, and continuously (at 1-minute intervals) with the facility distributed control system (DCS) and continuous parameter monitoring system (CPMS). A CAT EMPC 4.2 Generator Set Control was used to provide kW readout directly from the engine meter. CAT maintains true RMS sensing ensures AC metering accuracy is 0.5% for AC volts, amps, and power parameters, and maintains metering accuracy from -40°F to 158°F. Operating load, percent, was calculated using the electricity produced divided by the generator rated capacity of 900 kW. Data were recorded during each test for the following parameters:

- Catalyst differential pressure (in. $H_2O$)
- Catalyst inlet temperature (°F)
- Electricity generated (kW, kVa, KWH)
- Engine speed (RPM)
- Engine run hours (hours)

Note that there was no difference in time convention for the CPMS and DCS historian (Eastern Standard Time) and RCTS data acquisition time convention, as Eastern Daylight Savings Time was not yet in effect. Refer to Appendix C for operating data. When comparing the start and stop times between the RM test runs and the CEMS data, note that the last minute of the CEMS run average data is one minute ahead of the RM run end time. This is due to a difference in reporting convention, where the end minute recorded for each RM run reflects when the last reading was taken, but not the last minute during which sampling occurred. For example, the times for RM Run 1 are listed as 9:41-10:40. While the last RM Run 1 value was recorded at 10:40, the last full minute of sampling was 10:41.

# 4.0 SAMPLING AND ANALYTICAL PROCEDURES

Consumers Energy RCTS tested for CO and oxygen ($O_2$) 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 | USEPA | |
|---|---|---|
| | Method | 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) |
| Carbon monoxide | 10 | Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure) |

## 4.1 Description of Sampling Train and Field Procedures

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

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

| Date (2021) | Run | Sample Type | Start Time (EDT) | Stop Time (EDT) | Test Duration (min) | EPA Test Method | Comment |
|---|---|---|---|---|---|---|---|
| EUEDG | | | | | | | |
| March 3 | 1 | $O_2$ CO | 9:41 | 10:40 | 60 | 1 3A 10 | Engine hours @ test start: 1,497.5 |
| | 2 | | 10:55 | 11:54 | 60 | | |
| | 3 | | 12:06 | 13:05 | 60 | | Engine hours @ test end: 1,501.0 |

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

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

**Catalyst Inlet**

A ½-inch diameter test port protrudes approximately 1-inch beyond an approximate 20-inch diameter, conical shaped engine exhaust duct into the oxidizing catalyst. The sample port is located:

- Approximately 8 inches or 0.4 duct diameters downstream from an exhaust duct expansion, and
- Approximately 4 inches or 0.2 duct diameters upstream of the oxidization catalyst.

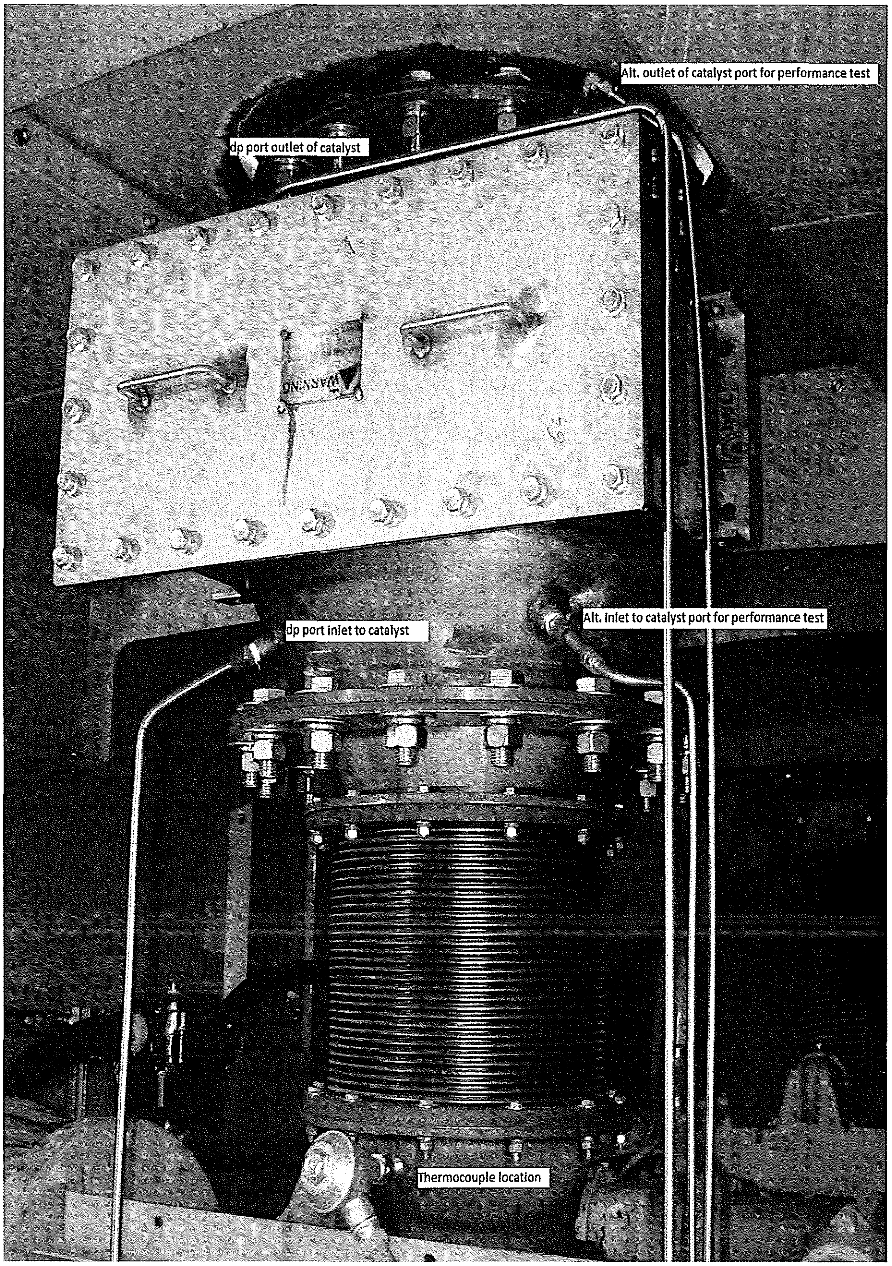
**Catalyst Exhaust**

A ½-inch diameter test port protrudes approximately 1-inch beyond an approximate 20-inch diameter conical shaped duct exiting the oxidation catalyst. The sample port is located:

- Approximately 4 inches or 0.2 duct diameters downstream from the oxidization catalyst, and
- Approximately 8 inches or 0.4 duct diameters upstream of a bend in exhaust ductwork.

Note that sample port access is limited, and sample port proximity to engine/generator components is a safety concern. Consistent with the test protocol, RCTS based the number of sample points used for this 2021 test program on 12-point stratification test results obtained by Airtech Environmental Services, Inc. (AES) on May 5, 2015. At that time, oxidation catalyst inlet and outlet stratification test results indicated concentration differences at each traverse point of less than 5% from the mean, thus AES used a single sample point at each location. Therefore, since the engine exhaust duct configuration is unchanged, RCTS assumed the 2015 stratification test result is unchanged, and sampled from a single point near the centroid of each duct at each sample location. A photograph of the sample locations is shown in Figure 4-1.

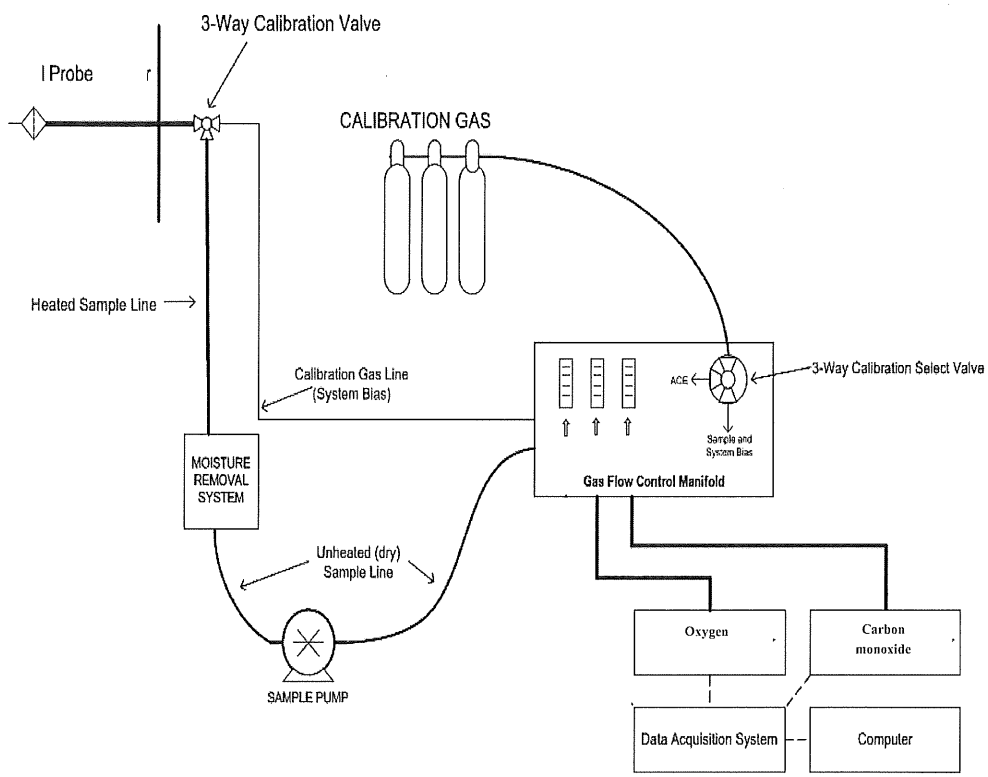
**Figure 4-1. Sample Port Locations**




## 4.3 CO AND $O_2$ CONCENTRATIONS (USEPA METHODS 3A AND 10)

Oxygen 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 Emissions from Stationary Sources (Instrumental Analyzer Procedure).* The two method sampling procedures are similar, apart from the analyzers and analytical technique used to quantify the parameters of interest. Engine exhaust upstream and downstream from the oxidation catalyst were extracted simultaneously from the ducts through stainless steel probes, heated sample lines, and gas conditioning systems to remove water and dry the samples before entering sample pumps, gas flow control manifolds, and Thermo Scientific 410i paramagnetic, and Thermo Scientific 48i infrared gas filter correlation gas analyzers. The CO concentrations were adjusted to 15% $O_2$ using the diluent ($O_2$) concentrations. Exhaust gas moisture content for normalizing CO results to 15% $O_2$, dry basis wasn't necessary, since the CO and $O_2$ were measured on a dry basis. Figure 4-2 depicts the Methods 3A and 10 sampling system.

**Figure 4-2. Methods 3A and 10 Sampling System**




Prior to sampling, the analyzers are calibrated by performing an analyzer calibration error (ACE) test where zero-, mid-, and high-level calibration gases are introduced directly to the analyzers. The ACE verifies the analyzer response is within ±2.0% of the calibration gas span or high calibration gas concentration or ≤0.5 ppmv (for CO) and ±0.5% (for $O_2$) absolute difference to be acceptable. An initial system-bias test is then performed where zero- and mid- or high-level calibration gases are introduced at the sample probe to verify the measurement system response is within ±5.0 percent of span or ≤0.5 ppmv (for CO) and ±0.5% (for $O_2$) absolute difference.

After completing the ACE and initial system bias', sample flow rates and component temperatures were verified and the probes were inserted into the ducts. After confirming the engine was operating at required conditions, the test run began. CO and $O_2$ concentrations were recorded at 1-minute intervals throughout each 60-minute test duration.

At the conclusion of each test run, a post-test system bias check was performed to verify measurement system bias remained within ±5.0% of span or ≤0.5 ppmv (for CO) and ±0.5% (for $O_2$) absolute difference and analyzer drift remained within 3.0% or ≤0.5 ppmv (for CO) and ±0.5% (for $O_2$) absolute difference. The analyzer responses were used to correct the measured run concentrations for analyzer drift. Refer to Appendix B for measured concentrations and Appendix D for supporting analyzer calibration and interference check documentation.

# 5.0 TEST RESULTS AND DISCUSSION

The test program was conducted March 3, 2021 to evaluate compliance with the RICE NESHAP and satisfy 40 CFR Part 63, Subpart ZZZZ Subsequent performance testing requirements, along with MI-ROP-N6626-2019a requirements.

## 5.1 Tabulation of Results

The EUEDG test results indicate the average carbon monoxide exhaust concentration and oxidizing catalyst removal efficiency comply with applicable limits as summarized in Table 2-1. Appendix Table 1 contains 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 RICE NESHAP and MI-ROP-N6626-2019a limits.

## 5.3 Variations from Sampling or Operating Conditions

No operating condition variations were encountered during the test program.

## 5.4 Process or Control Equipment Upset Conditions

The engine and generator operated under maximum routine conditions and no upsets were encountered during testing. Note that the engine load was reduced from 95% to 90% after test run 2 to prevent automatic shutdown from elevated coolant temperature.

## 5.5 Air Pollution Control Device Maintenance

Engine optimization and continuous parametric monitoring are performed to ensure efficient combustion and compliance with regulatory emission limits is achieved. The CPMS system records the catalyst inlet temperature. A differential pressure transmitter displays the pressure differential across the oxidation catalyst which averaged 2.65 inches of water, suggesting the catalyst is working efficiently and does not require maintenance at this time.

## 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 engine will be performed every 8,760 engine operating hours or 3 years, whichever is first, thereafter, to demonstrate compliance. The EUEDG engine hours at the conclusion of testing were 1,501.0.

## 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 Appendices B and D for supporting documentation.

**Table 5-1**
**QA/QC Procedures**

| QA/QC Activity | Purpose | Procedure | Frequency | Acceptance Criteria |
|---|---|---|---|---|
| M3A and M10: Calibration gas standards | Ensures accurate calibration standards | Traceability protocol of calibration gases | Pre-test | Calibration gas uncertainty ≤2.0% |
| M3A and M10: Calibration Error | Evaluates analyzer operation | Calibration gases introduced directly into analyzers | Pre-test | ±2.0% of calibration span or ±0.5% or ±0.5 ppmv absolute difference |
| M3A and M10: System Bias and Analyzer Drift | Evaluates analyzer and measurement system over test duration | Calibration gases introduced at sample probe tip, heated sample line, and into analyzers | Pre-test and Post-test | ±5.0% of the analyzer calibration span or ±0.5% or ±0.5 ppmv absolute difference for bias and ±3.0% of analyzer calibration span or ±0.5% or ±0.5 ppmv 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

The method specific quality assurance and quality control procedures in each method employed during this test program were followed, without deviation. No samples were submitted to a laboratory for analysis.

## 5.12 QA/QC Blanks

No reagent, media, or other QA/QC blanks were required to complete this test program.

# Appendix Tables