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Emergency Engine 40 CFR 63 Subpart ZZZZ Compliance Test Report

EUEDG

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

March 8, 2024

Test Date: February 28, 2024

Test Performed by the Consumers Energy Company
Regulatory Compliance Testing Section
Air Emissions Testing Body
Laboratory Services Section
Work Order No. 42703219

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EXECUTIVE SUMMARY

Consumers Energy Regulatory Compliance Testing Section 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. 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 on February 28, 2024 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*, and Michigan Department of Environment, Great Lakes, and Energy Renewable Operating Permit MI-ROP-N6626-2019a. The previous test was completed less than 3 years ago on March 3, 2021, and at the start of this test, the engine had a total 1,815.4 operating hours.

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

The test was delayed from the originally scheduled test date of February 20, 2024 due to required engine maintenance. There were no deviations from the stack test protocol or associated USEPA Reference Methods. During testing, EUEDG was operated at the highest achievable load condition, which equated to 88% of peak load. 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	4.8	≤23
	CO Reduction Efficiency	%	93.2	≥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 both the CO exhaust concentration and reduction efficiency comply with applicable limits.

Detailed results are presented in the Appendix Table. 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 February 28, 2024 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 on February 28, 2024 at a stand-by diesel fired generator, EUEDG, installed and operated at the Jackson Generating Station in Jackson, Michigan.

A performance test notification was submitted to United States Environmental Protection Agency (USEPA) Region V and EGLE on December 7, 2023.

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* (RICE NESHAP) 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†	Applicable Regulation
Carbon monoxide	≤23 ppmvd @ 15% O_2 or ≥70% reduction efficiency	Table 2d (3) of 40 Part 63, Subpart ZZZZ - *Requirements for Existing Stationary RICE Located at Area Sources of HAP Emissions* 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 and 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. While the engine primarily serves in an emergency capacity, current USEPA 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
Test Program Contact Information

Program Role	Contact	Address
EPA Regional Contact	Carlo Demma 312-886-5890 demma.carlo@epa.gov	U.S. EPA Region 5 77 W. Jackson Blvd. Chicago, Illinois 60604
Regulatory Agency Representative	Jeremy Howe Technical Programs Unit Supervisor 231-878-6687 howej1@michigan.gov	EGLE, Air Quality Division Constitution Hall, 2nd Floor South 525 West Allegan Street Lansing, Michigan 48933
State Regulatory Inspector	Brian Carley Environmental Specialist 13 517-416-4631 carleyb@michigan.gov	EGLE, Jackson District Office State Office Building, 4th Floor 301 E. Louis B Glick Highway Jackson, Michigan 49201
Responsible Official	Norman Kapala VP Generation Operations 616-738-3200 norman.kapala@cmsenergy.com	Consumers Energy Company J.H. Campbell Annex 17000 Croswell Street West Olive, Michigan 49460
Authorized Representative	Janna Spitz Senior Manager Plant Operations 517-841-5710 janna.spitz@cmsenergy.com	Consumers Energy Company Jackson Generating Station 2219 Chapin Street Jackson, Michigan 49203
Corporate Air Quality Contact	Jason Prentice Principal Environmental Engineer 517-788-1467 jason.prentice@cmsenergy.com	Consumers Energy Company 1945 W Parnall Road Jackson, Michigan 49201
Test Facility	Nathan Parker Manager Plant Operations 989-316-6519 nathan.parker@cmsenergy.com	Consumers Energy Company Jackson Generating Station 2219 Chapin Street Jackson, Michigan 49203
Test Facility	Doug Mallory Sr. Engineering Technical Analyst 517-841-5723 douglas.mallory@cmsenergy.com	Consumers Energy Company Jackson Generating Station 2219 Chapin Street Jackson, Michigan 49203
Test Team Representative	Thomas Schmelter, QSTI Principal Lab Technical Analyst 616-738-3234 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 engine fired diesel fuel and operated at the highest achievable load. The engine generator system produced an average of 794 kilowatts (kW), or 88% of the maximum achievable load (900 kW), based on the manufacturer's design specifications. Due to elevated engine coolant temperatures, this load was the highest achievable load. 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 Appendix C for detailed operating data.

2.2 Applicable Permit Information

The Jackson Generating Station is 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 the RICE NESHAP.

2.3 Results

The EUEDG test results indicate both the CO exhaust concentrations and reduction efficiency comply with applicable 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	4.8	≤23
	CO Reduction Efficiency	%	93.2	≥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 the Appendix Table. 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

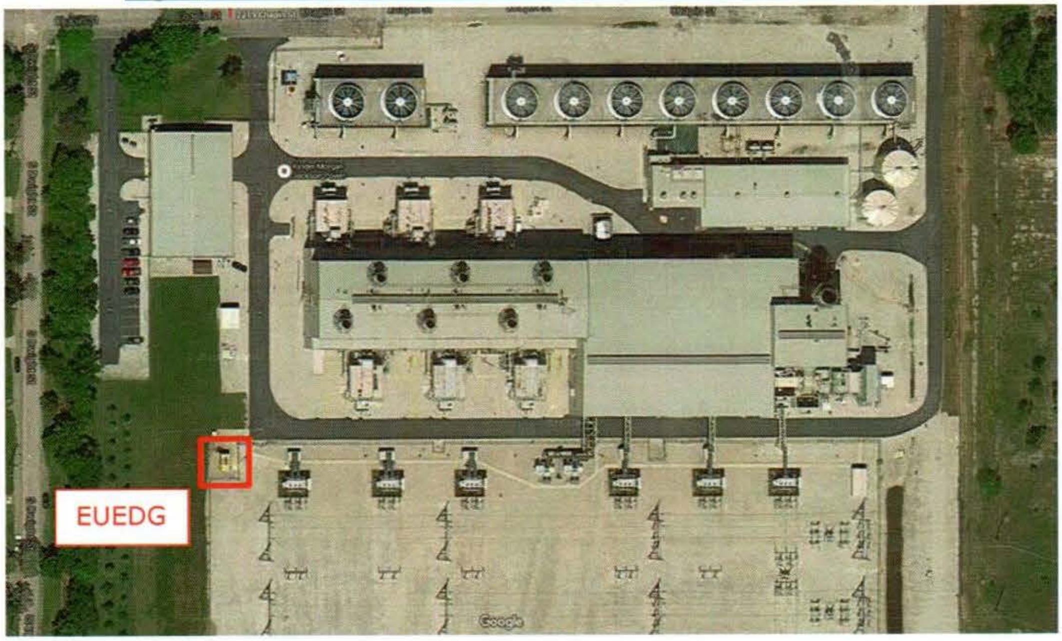
EUEDG provides mechanical shaft power to an electric generator capable of producing 900 kW. The electricity produced is used to power the facility during emergencies or during high voltage switchyard maintenance.

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 relative to the engine exhaust gas temperature. Detailed operating data from the test are provided in Appendix C.

3.2 Process Flow

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 for electricity production. 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 the Jackson Generating Station and location of EUEDG.

Figure 3-1. Jackson Generating Station EUEDG Location



3.3 Materials Processed

EUEDG utilizes diesel fuel 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

Consumers Energy personnel recorded the following engine parameters at 15-minute intervals:

- Catalyst differential pressure (in. H_2O)
- Catalyst inlet temperature (°F)
- Electrical output (kW)
- Engine speed (RPM)

Refer to Appendix C for operating data. Data was also continuously monitored (at 1-minute intervals) by the facility's 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.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

RCTS tested CO and oxygen (O_2) concentrations using the USEPA test methods presented in Table 4-1. The sampling and analytical procedures associated with each parameter are described in the following sections.

Table 4-1
Test Methods

Parameter	USEPA	
	Method	Title
Sample traverses	1	Sample and Velocity Traverses for Stationary Sources
Oxygen	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 (2024)	Run	Parameter	Start Time (EDT)	Stop Time (EDT)	Test Duration (min)	EPA Test Method	Comment
Feb. 20†	1	O_2 CO	10:45	11:44	60	1 3A 10	Testing halted after first run due to overheating of the engine/ tripping offline
Feb. 28	1		10:15	11:14	60		Engine hours @ test start: 1,815.4
	2		11:30	12:29	60		
	3		12:45	13:44	60		Engine hours @ test end: 1,818.9

† February 20 data were not included in the average calculations.

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.

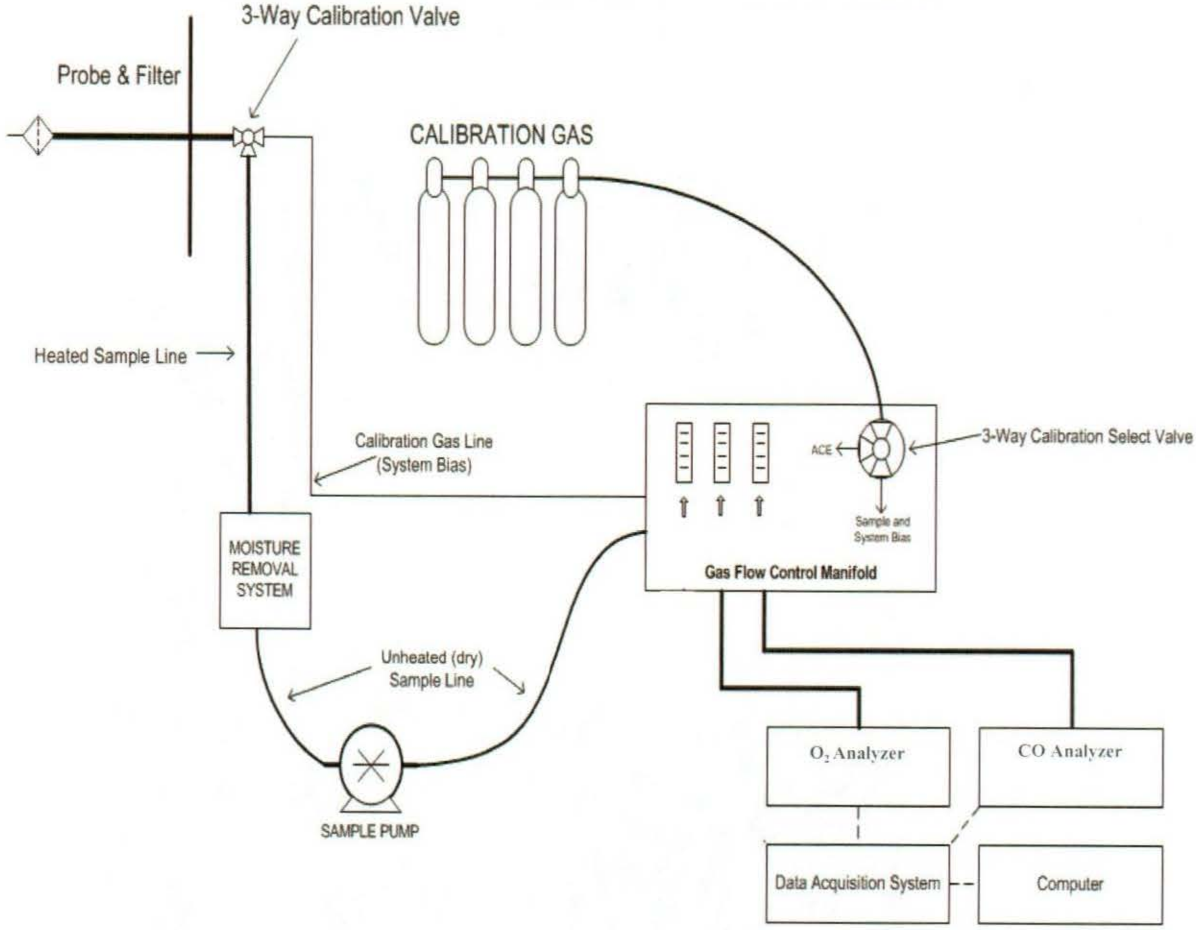
Note that sample port access is limited, and sample port proximity to engine/generator components is a safety concern. Consistent with the test protocol, RCTS based the number of sample points used for this test program on the 12-point stratification test results obtained by Airtech Environmental Services, Inc. (AES) on May 5, 2015. At that time, oxidation catalyst inlet and outlet stratification test results indicated concentrations at each traverse point differed by less than 5% from the mean. 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 O_2 AND CO 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 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 gas analyzers. The CO concentrations were adjusted to 15% O_2 using the diluent (O_2) concentrations. 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 were calibrated by performing an analyzer calibration error (ACE) test where zero-, mid-, and high-level calibration gases were introduced directly to the analyzers. The ACE verified the analyzer response was within 2.0% of the calibration gas span (i.e., high calibration gas concentration). An initial system-bias test was performed where zero- and mid-level calibration gases were introduced at the sample probe to verify the measurement system responses were within 5.0% of span.

After completing the ACE and initial system bias tests, 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. 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 and analyzer drift was less than 3.0% of span. 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 February 28, 2024 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.

Testing was originally scheduled for and attempted on February 20, 2024, but was abandoned due to an issue with the engine coolant system as further described in Section 5.4.

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. The single test run conducted on February 20, 2024 is not included in the average results.

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

After the completion of one test run on February 20, 2024, the engine shut down due to a trip alarm for elevated coolant temperature. After inspection, the facility's maintenance representative from Caterpillar discovered a pinhole leak in the top metal coolant line from the radiator to the engine block. Testing was postponed until the engine could be repaired. A letter regarding the delayed testing was sent to USEPA and EGLE on February 22, 2024, and is attached in Appendix D. Repairs were conducted February 26 and 27, 2024, and the performance testing was conducted on February 28, 2024.

Data collected during the first run completed on February 20, 2024 is presented in Appendix B and indicates that engine and oxidation catalyst performance were normal, with CO reduction efficiency and outlet CO concentrations below the Subpart ZZZZ limitations.

The engine and generator operated under maximum achievable conditions of approximately 88% load and no further upsets were encountered during testing on February 28, 2024. When operating outside of maintenance and readiness testing, the engine does not operate at 100% load and reduced load is deemed more representative of normal operations.

It should be noted that 40 CFR Part 63, Subpart ZZZZ only stipulates a testing load requirement for specific engines, as follows.

> 63.6620(b) Each performance test must be conducted according to the requirements that this subpart specifies in Table 4 to this subpart. If you own or operate a non-operational stationary RICE that is subject to performance testing, you do not need to start up the engine solely to conduct the performance test. Owners and operators of a non-operational engine can conduct the performance test when the engine is started up again. The test must be conducted at any load condition within plus or minus 10 percent of 100 percent load for the stationary RICE listed in paragraphs (b)(1) through (4) of this section.
>
> (1) Non-emergency 4SRB stationary RICE with a site rating of greater than 500 brake HP located at a major source of HAP emissions.
>
> (2) New non-emergency 4SLB stationary RICE with a site rating of greater than or equal to 250 brake HP located at a major source of HAP emissions.
>
> (3) New non-emergency 2SLB stationary RICE with a site rating of greater than 500 brake HP located at a major source of HAP emissions.
>
> (4) New non-emergency CI stationary RICE with a site rating of greater than 500 brake HP located at a major source of HAP emissions.

AS EUEDG is neither a new engine nor located at a major source of HAP emissions, the performance tests need not be conducted at 100%±10% load. This concept is further supported by a 2013 EPA Implementation Question and Answer Document[1] for engines, with the following stated on Page 9 of the document:

> 31) Must the performance test be conducted at 100% load ±10%?
>
> Subpart ZZZZ specifies that performance testing must be conducted at any load condition within plus or minus 10% of 100% load for existing 4SRB non-emergency engines above 500 HP at a major source of HAP, new non-emergency engines above 500 HP at a major source of HAP, and new SI 4SLB engines 250-500 HP at a major source of HAP. Subpart ZZZZ does not specify that performance testing must be conducted at 100% load ±10% for existing non-emergency engines of 500 HP or less at major sources of HAP, existing non-emergency CI engines above 500 HP at major sources of HAP, and existing nonemergency CI engines at area sources of HAP. However, for these engines, 40 CFR 63.7(e) requires performance tests to be conducted under such conditions as the EPA specifies to the owner or operator based on representative performance (i.e. performance based on normal operating conditions) of the affected source.

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. The CPMS system records the catalyst inlet temperature. A differential pressure transmitter displays the pressure

[1] https://www.epa.gov/sites/default/files/2014-03/documents/4_2_2013_qa_stationary_rice_neshap_nsps_stationaryci_si_ice.pdf

differential across the oxidation catalyst which averaged 2.46 inches of water, suggesting the catalyst is working efficiently and does not require maintenance at this time. Detailed operating parameter data are provided in Appendix C.

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 operating hours at the conclusion of testing were 1,818.9, and it is fully expected that the next test will be due in three years as the engine is not expected to accumulate an additional 8,760 hours of run time before then.

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 performed. Refer to Appendices B and D for supporting documentation.

Table 5-1
QA/QC Procedures

QA/QC Activity	Purpose	Procedure	Frequency	Acceptance Criteria
Stratification Check	Evaluates if the sampling location is suitable for sampling	Conduct stratification testing according to Section 8.1.2 of USEPA Method 7E	Pre-test[2]	Concentration at each traverse point ≤5.0% difference from mean
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
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	Bias: ±5.0% of the analyzer calibration span Drift: ±3.0% of analyzer calibration span

5.8 Calibration Sheets

Calibration sheets, including gas protocol sheets and analyzer QA/QC checks are presented in Appendix D.

[2] Conducted by Airtech Environmental Services, Inc. (AES) on May 5, 2015

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 QA/QC 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.