AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS
FROM
LANDFILL GAS FIRED ENGINE – GENERATOR SETS

Prepared for:

Energy Developments Michigan, LLC
Brent Run Renewable Energy Facility
SRN N5987

ICT Project No.: 2200182
December 6, 2022

IMPACT COMPLIANCE & TESTING

Executive Summary

ENERGY DEVELOPMENTS MICHIGAN, LLC AT THE BRENT RUN LANDFILL
CAT® G3520 LANDFILL GAS FUELED IC ENGINE EMISSIONS TEST RESULTS

Energy Developments Michigan, LLC (EDL) contracted Impact Compliance & Testing, Inc. (ICT) to conduct a performance demonstration for the determination of carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOC) concentrations and emission rates from four (4) CAT® Model G3520 landfill gas-fired reciprocating internal combustion engines and electricity generator sets operated at the EDL Brent Run Renewable Energy Facility (Brent Run REF) in Montrose, Michigan.

The compliance emission testing was performed pursuant to conditions of Michigan Department of Environment, Great Lakes and Energy – Air Quality Division (EGLE-AQD) Renewable Operating Permit (ROP) No. MI-ROP-N5987-2015a, Permit to Install (PTI) No. 176-18 and the federal Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (the SI-RICE NSPS; 40 CFR Part 60 Subpart JJJJ), which requires that testing be performed every 8,760 operating hours or three years, whichever occurs first. The following table presents the emissions results and operating data from the performance demonstration.

Unit ID	Generator Output kW	CO lb/hr	CO g/bhp-hr	NOx lb/hr	NOx g/bhp-hr	VOC lb/hr	VOC g/bhp-hr
EUENGINE3	1,555	14.9	3.1	1.56	0.3	1.01	0.2
EUENGINE4	1,560	15.3	3.2	1.77	0.4	0.96	0.2
EUENGINE6	1,549	14.9	3.1	1.85	0.4	1.07	0.2
EUENGINE7	1,545	13.3	2.8	1.77	0.4	0.83	0.2
Permit Limit	-	*16.3*	*5.0*	*4.94*	*2.0*	*4.94*	*1.0*

kW=kilowatt, lb/hr = pounds per hour, g/bhp-hr = grams per brake horsepower hour

The data above indicate that all of the engines were tested while the units operated within 10% of their maximum capacity (1,600 kW) and are in compliance with the emission standards specified in MI-ROP-N5987-2015a and PTI No. 176-18.

Report Certification

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EDL Michigan, LLC – Brent Run REF
Montrose, Michigan

The material and data in this document were prepared under the supervision and direction of the undersigned.

Impact Compliance & Testing, Inc.

Andy Rusnak, QSTI
Technical Manager

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1.0 Introduction

EDL Michigan, LLC operates gas-fired reciprocating internal combustion engine (RICE), and electricity generator sets at the Brent Run REF in Montrose, Genesee County, Michigan. The RICE are fueled by landfill gas (LFG) that is recovered from the Brent Run Landfill and treated prior to use.

The State of Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division (EGLE-AQD) has issued to EDL PTI No. 176-18 and ROP No. MI-ROP-N5987-2015a for operation of the renewable electricity generation facility, which consists of:

- Four (4) Caterpillar (CAT®) Model No. G3520C RICE gensets identified as emission units EUENGINE3, EUENGINE4, EUENGINE6, and EUENGINE7 (Flexible Group ID FGICEENGINES).

The compliance emission testing was performed pursuant to conditions of PTI No. 176-18, ROP No. MI-ROP-N5987-2015a, and the federal Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (the SI-RICE NSPS; 40 CFR Part 60 Subpart JJJJ), which requires that testing be performed every 8,760 operating hours or three years, whichever occurs first (unless the engine has been certified by the manufacturer as specified in the SI-RICE NSPS). The limits presented in this report are the most stringent for each pollutant and may be less than the SI-RICE NSPS standards.

The compliance testing presented in this report was performed by ICT, a Michigan-based environmental consulting and testing company. ICT representatives Andy Rusnak and Max Fierro performed the field sampling and measurements November 29 – December 1, 2022. Mr. Trevor Drost and Ms. Michelle Lupow of EGLE-AQD were on-site to observe portions of the emissions testing.

The engine emission performance tests consisted of triplicate, one-hour sampling periods for nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC, as non-methane hydrocarbons (NMHC or NMOC)). Exhaust gas velocity, moisture, oxygen (O_2) content, and carbon dioxide (CO_2) content were determined for each test period to calculate pollutant mass emission rates.

The exhaust gas sampling and analysis was performed using procedures specified in the Stack Test Protocol dated September 13, 2022 that was reviewed and approved by EGLE-AQD.

Questions regarding this air emission test report should be directed to:

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2.0 Summary of Test Results and Operating Conditions

2.1 Purpose and Objective of the Tests

Conditions of MI-ROP-N5987-2015a, PTI No. 176-18 and the SI-RICE NSPS require EDL to test each engine in FGICEENGINES for CO, NOx and VOC emissions.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the EDL engine/generator sets were operated at maximum operating conditions (within 10% of rated capacity). The rated capacity for the CAT® Model G3520 engine generator sets is 1,600 kW electricity output. EDL representatives provided kW output in 15-minute increments for each test period.

Fuel flowrate (lb/hr), fuel methane content (%) and fuel oxygen content (%) were also recorded by EDL representatives in 15-minute increments for each test period.

Engine output (bhp) cannot be measured directly and was calculated based on the recorded electricity output, the calculated CAT® Model G3520C generator efficiency (95.7%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

Engine output (bhp) = Electricity output (kW) / (0.957) / (0.7457 kW/hp)

The facility records fuel use rate in units of pounds per hour. To convert to units of standard cubic feet of gas consumed per minute (scfm) the following equation was used:

Fuel Use (scfm) = Fuel Use (pph) / LFG MW (lb/lb-mol) * 385 scf LFG/lb-mol / 60 min/hr

A LFG MW of 30 lb/lb-mol was used.

Appendix 2 provides operating records provided by EDL representatives for the test periods.

Table 2.1 presents a summary of the average engine operating conditions during the test periods.

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled LFG fueled RICE (EUENGINE3, EUENGINE4, EUENGINE6 and EUENGINE7) were each sampled for three (3) one-hour test periods during the compliance testing performed November 29 – December 1, 2022.

Table 2.2 presents the average measured CO, NO_X and VOC emission rates for each engine (average of the three test periods).

Test results for each one-hour sampling period and comparison to the permitted emission rates are presented in Section 6.0 of this report.

Table 2.1 Average engine operating conditions during the test periods

Engine Parameter	EUENGINE3 CAT® G3520	EUENGINE4 CAT® G3520	EUENGINE6 CAT® G3520	EUENGINE7 CAT® G3520
Generator output (kW)	1,555	1,560	1,549	1,545
Engine output (bhp-hr)	2,187	2,178	2,171	2,165
Engine LFG fuel use (lb/hr)	2,766	2,732	2,518	2,870
Engine LFG fuel use (scfm)	592	584	539	614
LFG methane content (%)	44.5	47.2	48.8	44.8
LFG oxygen content (%)	1.13	0.89	0.62	0.99

Table 2.2 Average measured emission rates for each engine (three-test average)

Emission Unit	CO		NOx		VOC	
	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)
EUENGINE3	14.9	3.1	1.56	0.3	1.01	0.2
EUENGINE4	15.3	3.2	1.77	0.4	0.96	0.2
EUENGINE6	14.9	3.1	1.85	0.4	1.07	0.2
EUENGINE7	13.3	2.8	1.77	0.4	0.83	0.2
Permit Limit	***16.3***	***5.0***	***4.94***	***2.0***	***4.94***	***1.0***

3.0 Source and Sampling Location Description

3.1 General Process Description

EDL is permitted to operate four (4) CAT® Model G3520 RICE-generator sets at its facility. The units are fired exclusively with LFG that is recovered from the Brent Run Landfill and treated prior to use.

3.2 Rated Capacities and Air Emission Controls

The CAT® G3520 engine generator set has a rated design capacity of:

- Engine Power: 2,242 bhp
- Electricity Generation: 1,600 kW

Each engine is equipped with an electronic air-to-fuel ratio (AFR) controller that blends the appropriate ratio of combustion air and treated LFG fuel.

The RICE are not equipped with add-on emission control devices. The AFR controller maintains efficient fuel combustion, which minimizes air pollutant emissions. Exhaust gas is exhausted directly to atmosphere through a noise muffler and vertical exhaust stack.

3.3 Sampling Locations

The RICE exhaust gas is directed through a muffler and is released to the atmosphere through a dedicated vertical exhaust stack with a vertical release point.

The exhaust stacks for EUENGINE3, EUENGINE4, and EUENGINE6 are identical. The exhaust stack for EUENGINE7 is similar, with a slightly smaller diameter. The exhaust stack sampling ports are located after the muffler in the vertical exhaust stacks, each with an inner diameter of 13.5 inches (EUENGINE7 has an inner diameter of 12.25 inches). Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location greater than 2.0 duct diameters upstream and greater than 8.0 duct diameters downstream from any flow disturbance.

All sample port locations satisfy the USEPA Method 1 criteria for a representative sample location. Individual traverse points were determined in accordance with USEPA Method 1.

Appendix 1 provides diagrams of the emission test sampling locations with actual stack dimension measurements.

4.0 Sampling and Analytical Procedures

A test protocol for the air emission testing was reviewed and approved by the EGLE-AQD. This section provides a summary of the sampling and analytical procedures that were used during the testing periods.

4.1 Summary of Sampling Methods

USEPA Method 1	Exhaust gas velocity measurement locations were determined based on the physical stack arrangement and requirements in USEPA Method 1
USEPA Method 2	Exhaust gas velocity pressure was determined using a Type-S Pitot tube connected to a red oil incline manometer; temperature was measured using a K-type thermocouple connected to the Pitot tube.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content was determined using paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Moisture determination by gravimetric water gain in chilled impingers
USEPA Method 7E	Exhaust gas NOx concentration was determined using chemiluminescence instrumental analyzers.
USEPA Method 10	Exhaust gas CO concentration was measured using an infrared instrumental analyzer
USEPA Method 25A / ALT-096	Exhaust gas VOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with methane separation column

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The RICE exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 prior to and after each test period. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were leak-checked periodically throughout the test periods to verify the integrity of the measurement system.

The absence of significant cyclonic flow at the sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each velocity traverse point with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

Appendix 3 provides exhaust gas flowrate calculations and field data sheets.

4.3 Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

CO_2 and O_2 content in the RICE exhaust gas stream was measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 4900 infrared gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 4900 gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the RICE exhaust gas stream was extracted from the stack using a stainless steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzers; therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. Instrument response data were recorded using an ESC Model 8816 data acquisition system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages.

Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document). Sampling times were recorded on field data sheets.

Appendix 4 provides O_2 and CO_2 calculation sheets. Raw instrument response data are provided in Appendix 5.

4.4 Exhaust Gas Moisture Determination (USEPA Method 4)

Moisture content of the engine exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. The moisture sampling was performed concurrently with the instrumental analyzer sampling. During each sampling period a gas sample was extracted at a constant rate from the source where moisture was removed from the sampled gas stream using impingers that were submersed in an ice bath. At the conclusion of each sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain.

4.5 NO_x and CO Concentration Measurements (USEPA Methods 7E and 10)

NO_X and CO pollutant concentrations in the RICE exhaust gas streams were determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NO_X analyzer and a Fuji ZRF infrared CO analyzer.

Throughout each test period, a continuous sample of the engine exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on an ESC Model 8816 data acquisition system that logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias.

Appendix 4 provides CO and NO_X calculation sheets. Raw instrument response data are provided in Appendix 5.

4.6 Measurement of Volatile Organic Compounds (USEPA Method 25A/ALT-096)

The VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in the engine exhaust gas. NMHC pollutant concentration was determined using a TEI Model 55i Methane / Nonmethane hydrocarbon analyzer. The TEI 55i analyzer contains an internal gas chromatograph column that separates methane from non-methane components. The concentration of NMHC in the sampled gas stream, after separation from methane, is determined relative to a propane standard using a flame ionization detector in accordance with USEPA Method 25A.

The USEPA Office of Air Quality Planning and Standards (OAQPS) has issued an alternate test method approving the use of the TEI 55i-series analyzer as an effective instrument for measuring NMOC from gas-fueled RICE (ALT-096).

Samples of the exhaust gas were delivered directly to the instrumental analyzer using the Teflon® heated sample line to prevent condensation. The sample to the NHMC analyzer was not conditioned to remove moisture. Therefore, VOC measurements correspond to standard conditions with no moisture correction (wet basis).

Prior to, and at the conclusion of each test, the instrument was calibrated using mid-range calibration (propane) and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document).

Appendix 4 provides VOC calculation sheets. Raw instrument response data for the NMHC analyzer is provided in Appendix 5.

5.0 QA/QC Activities

5.1 Flow Measurement Equipment

Prior to arriving onsite, the instruments used during the source test to measure exhaust gas properties and velocity (barometer and Pitot tube) were calibrated to specifications in the sampling methods.

The absence of cyclonic flow for each sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each of the velocity traverse points with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

5.2 NO_x Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42c analyzer was verified prior to the testing program. A USEPA Protocol 1 certified concentration of NO_2 was injected directly into the analyzer, following the initial three-point calibration, to verify the analyzer's conversion efficiency. The analyzer's NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. The conversion efficiency of the analyzer is deemed acceptable if the measured NO_x concentration is within 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_x concentration was 90.5% of the expected value).

5.3 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.4 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NO_X, CO, O_2 and CO_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 2.5% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.5 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO_x, CO, CO_2 and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings.

At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the NMHC analyzer, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NO_x, and CO in nitrogen and zeroed using hydrocarbon free nitrogen. The NMHC (VOC) instrument was calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.6 Determination of Exhaust Gas Stratification

A stratification test was performed for each RICE exhaust stack. The stainless steel sample probe was positioned at sample points correlating to 16.7, 50.0 (centroid) and 83.3% of the stack diameter. Pollutant concentration data were recorded at each sample point for a minimum of twice the maximum system response time.

The recorded concentration data for the RICE exhaust stacks indicated that the measured CO, O_2 and CO_2 concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the RICE exhaust gas was considered to be unstratified and the compliance test sampling was performed at a single sampling location within each RICE exhaust stack.

5.7 System Response Time

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

Sampling periods did not commence until the sampling probe had been in place for at least twice the greatest system response time.

5.8 Meter Box Calibrations

The dry gas meter sampling console, which was used for exhaust gas moisture content sampling, was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5. The metering console calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

The digital pyrometer in the Nutech metering consoles were calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix 6 presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results, meter box calibration records, Pitot tube calibration records and stratification checks).

6.0 Results

6.1 Test Results and Allowable Emission Limits

Engine operating data and air pollutant emission measurement results for each one-hour test period are presented in Tables 6.1 through 6.4.

EUENGINE3, EUENGINE4, EUENGINE6, and EUENGINE7 each have the following allowable emission limits specified in PTI No. 176-18 and MI-ROP-N5987-2015a:

- 16.3 pounds per hour (lb/hr) and 5.0 grams per brake horsepower hour (g/bhp-hr) for CO;
- 4.94 lb/hr and 2.0 g/bhp-hr for NOx; and
- 4.94 lb/hr and 1.0 g/bhp-hr for VOC.

The measured air pollutant concentrations and emission rates for each RICE are less than the allowable limits specified in PTI No. 176-18 and MI-ROP-N5987-2015a.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with USEPA methods and the approved Stack Test Protocol. The engine-generator sets were operated within 10% of maximum output (1,600 kW generator output for CAT® G3520C RICE) and no variations from normal operating conditions occurred during the engine test periods.

During the second test run for EUENGINE6, high wind conditions caused the sample probe to fall out of the exhaust stack. Data from the time when the probe was out of the stack was removed from the test average and the test period was extended for an appropriate amount of time so that 60 minutes of data was recorded.

Sampling on November 30, 2022 was suspended after the first test run on EUENGINE3 due to high wind conditions. Wind gusts exceeded 40 mph which exceeded the safe operating range of the aerial manlift used to access the exhaust stack. Sampling was resumed on December 1, 2022 under favorable weather conditions.

Table 6.1 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 3 (EUENGINE3)

Test No. Test date Test period (24-hr clock)	1 11/30/22 801-901	2 12/1/22 907-1007	3 12/1/22 1025-1125	Three Test Average
Fuel flowrate (lb/hr)	2,651	2,835	2,811	2,766
Fuel flowrate (scfm)	567	606	601	592
Generator output (kW)	1,562	1,547	1,557	1,555
Engine output (bhp)	2,189	2,167	2,182	2,179
LFG methane content (%)	46.9	43.3	43.4	44.5
LFG oxygen content (%)	0.93	1.25	1.22	1.13
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.3	11.5	11.5	11.4
O_2 content (% vol)	8.97	8.58	8.57	8.71
Moisture (% vol)	10.5	11.6	11.4	11.2
Exhaust gas flowrate (dscfm)	4,620	4,553	4,589	4,587
Exhaust gas flowrate (scfm)	5,159	5,152	5,181	5,164
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	36.4	53.2	52.4	47.4
NO_X emissions (lb/hr)	1.21	1.74	1.73	1.56
Permit Limit (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp-hr)	0.3	0.4	0.4	0.3
Permit Limit (g/bhp-hr)	-	-	-	*2.0*
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	730	753	755	745
CO emissions (lb/hr)	14.7	15.0	15.1	14.9
Permit Limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	3.0	3.1	3.1	3.1
Permit Limit (g/bhp-hr)	-	-	-	*5.0*
<u>Volatile Organic Compounds</u>				
NMHC conc. (ppmv)	30.7	27.0	27.3	28.3
VOC emissions (lb/hr)	1.09	0.96	0.97	1.01
Permit Limit (lb/hr)	-	-	-	*4.94*
VOC emissions (g/bhp-hr)	0.2	0.2	0.2	0.2
Permit Limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.2 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 4 (EUENGINE4)

Test No. Test date Test period (24-hr clock)	1 11/29/22 803-903	2 11/29/22 920-1020	3 11/29/22 1037-1137	Three Test Average
Fuel flowrate (lb/hr)	2,738	2,741	2,718	2,732
Fuel flowrate (scfm)	586	586	581	584
Generator output (kW)	1,554	1,559	1,568	1,560
Engine output (bhp)	2,178	2,185	2,197	2,187
LFG methane content (%)	46.9	47.1	47.5	47.2
LFG oxygen content (%)	0.94	0.90	0.84	0.89
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.0	11.1	11.0	11.0
O_2 content (% vol)	9.19	9.17	9.18	9.18
Moisture (% vol)	10.2	10.8	11.4	10.8
Exhaust gas flowrate (dscfm)	4,701	4,639	4,527	4,622
Exhaust gas flowrate (scfm)	5,233	5,202	5,110	5,182
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	58.2	51.7	50.5	53.5
NO_X emissions (lb/hr)	1.96	1.72	1.64	1.77
Permit Limit (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp-hr)	0.4	0.4	0.3	0.4
Permit Limit (g/bhp-hr)	-	-	-	*2.0*
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	759	757	753	757
CO emissions (lb/hr)	15.6	15.3	14.9	15.3
Permit Limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	3.3	3.2	3.1	3.2
Permit Limit (g/bhp-hr)	-	-	-	*5.0*
<u>Volatile Organic Compounds</u>				
NMHC conc. (ppmv)	27.3	27.2	26.6	27.0
VOC emissions (lb/hr)	0.98	0.97	0.93	0.96
Permit Limit (lb/hr)	-	-	-	*4.94*
VOC emissions (g/bhp-hr)	0.2	0.2	0.2	0.2
Permit Limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.3 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 6 (EUENGINE6)

Test No. Test date Test period (24-hr clock)	1 11/29/22 1203-1303	2 11/29/22 1324-1434	3 11/29/22 1453-1553	Three Test Average
Fuel flowrate (lb/hr)	2,533	2,527	2,495	2,518
Fuel flowrate (scfm)	542	540	534	539
Generator output (kW)	1,561	1,537	1,549	1,549
Engine output (bhp)	2,187	2,154	2,171	2,171
LFG methane content (%)	48.5	48.6	49.2	48.8
LFG oxygen content (%)	0.68	0.63	0.53	0.62
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	10.8	11.1	11.1	11.0
O_2 content (% vol)	9.43	9.13	9.15	9.24
Moisture (% vol)	11.2	11.1	12.1	11.5
Exhaust gas flowrate (dscfm)	4,511	4,598	4,513	4,541
Exhaust gas flowrate (scfm)	5,078	5,175	5,135	5,129
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	56.7	55.7	58.5	57.0
NO_X emissions (lb/hr)	1.83	1.84	1.89	1.85
Permit Limit (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp-hr)	0.4	0.4	0.4	0.4
Permit Limit (g/bhp-hr)	-	-	-	*2.0*
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	736	755	760	750
CO emissions (lb/hr)	14.5	15.2	15.0	14.9
Permit Limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	3.0	3.2	3.1	3.1
Permit Limit (g/bhp-hr)	-	-	-	*5.0*
<u>Volatile Organic Compounds</u>				
NMHC conc. (ppmv)	29.9	31.0	30.3	30.4
VOC emissions (lb/hr)	1.04	1.10	1.07	1.07
Permit Limit (lb/hr)	-	-	-	*4.94*
VOC emissions (g/bhp-hr)	0.2	0.2	0.2	0.2
Permit Limit (g/bhp-hr)	-	-	-	*1.0*

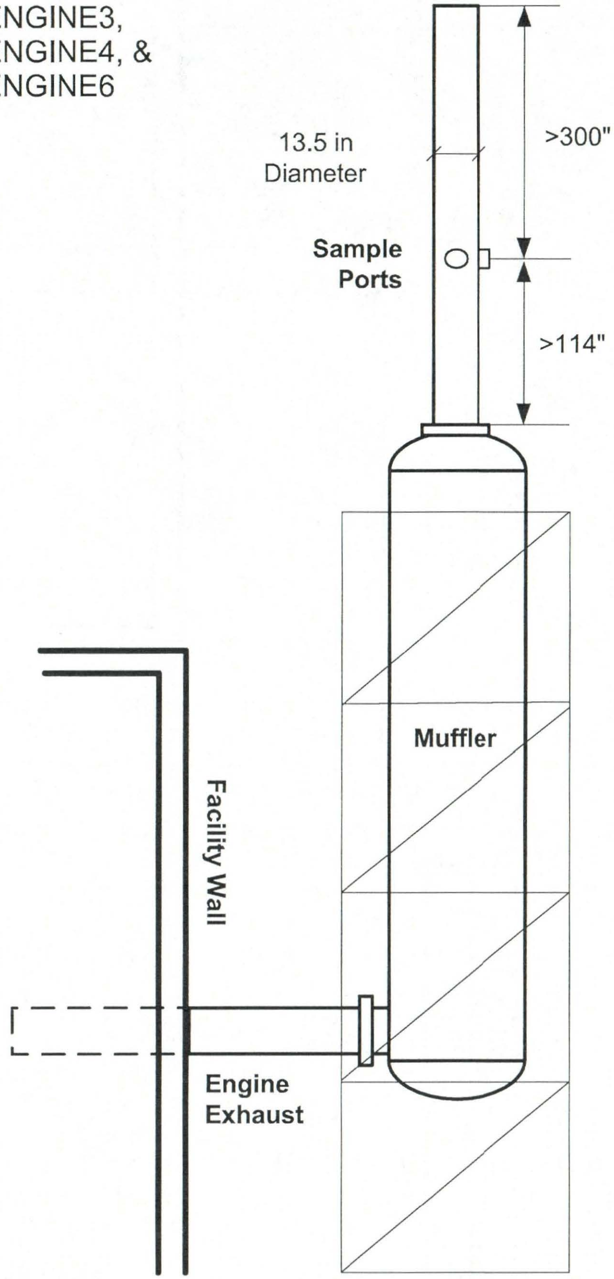
Table 6.4 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 7 (EUENGINE7)

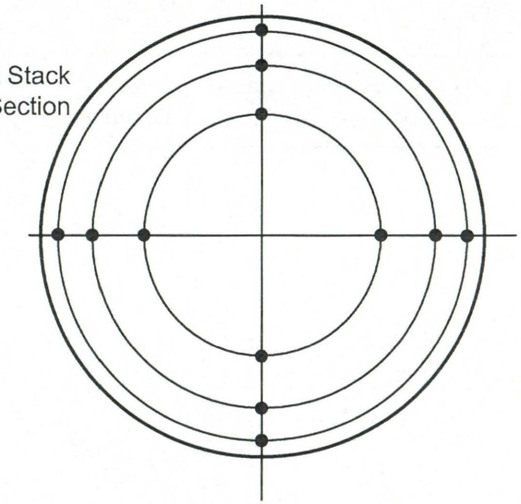
Test No. Test date Test period (24-hr clock)	1 12/1/22 1150-1250	2 12/1/22 1310-1410	3 12/1/22 1426-1526	Three Test Average
Fuel flowrate (lb/hr)	2,900	2,872	2,839	2,870
Fuel flowrate (scfm)	620	614	607	614
Generator output (kW)	1,551	1,551	1,531	1,545
Engine output (bhp)	2,174	2,174	2,146	2,165
LFG methane content (%)	44.2	44.9	45.3	44.8
LFG oxygen content (%)	1.08	0.97	0.90	0.99
Exhaust Gas Composition				
CO_2 content (% vol)	11.5	11.5	11.5	11.5
O_2 content (% vol)	8.67	8.65	8.67	8.67
Moisture (% vol)	9.7	11.4	9.8	10.3
Exhaust gas flowrate (dscfm)	4,596	4,466	4,531	4,531
Exhaust gas flowrate (scfm)	5.090	5,039	5,022	5,051
Nitrogen Oxides				
NO_X conc. (ppmvd)	55.7	53.9	53.4	54.4
NO_X emissions (lb/hr)	1.84	1.73	1.74	1.77
Permit Limit (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp-hr)	0.4	0.4	0.4	0.4
Permit Limit (g/bhp-hr)	-	-	-	*2.0*
Carbon Monoxide				
CO conc. (ppmvd)	674	673	676	674
CO emissions (lb/hr)	13.5	13.1	13.4	13.3
Permit Limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.8	2.7	2.8	2.8
Permit Limit (g/bhp-hr)	-	-	-	*5.0*
Volatile Organic Compounds				
NMHC conc. (ppmv)	24.0	23.2	24.1	23.8
VOC emissions (lb/hr)	0.84	0.81	0.83	0.83
Permit Limit (lb/hr)	-	-	-	*4.94*
VOC emissions (g/bhp-hr)	0.2	0.2	0.2	0.2
Permit Limit (g/bhp-hr)	-	-	-	*1.0*

APPENDIX 1

- RICE Engine Sample Port Diagram

EUENGINE3,
EUENGINE4, &
EUENGINE6



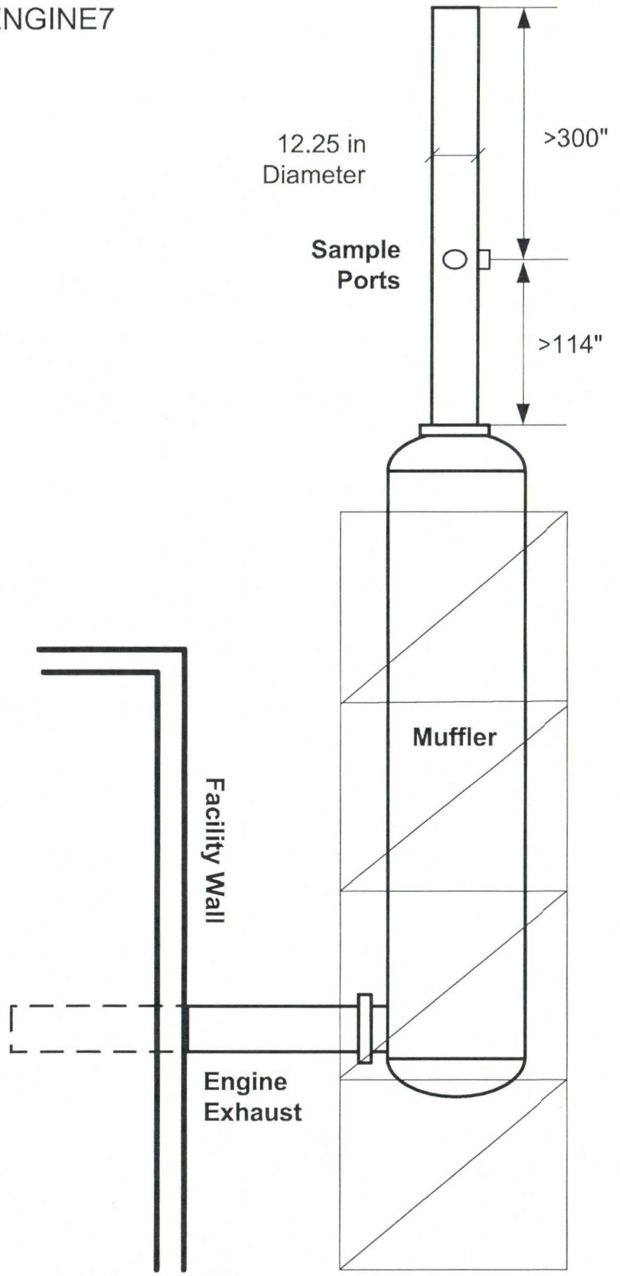


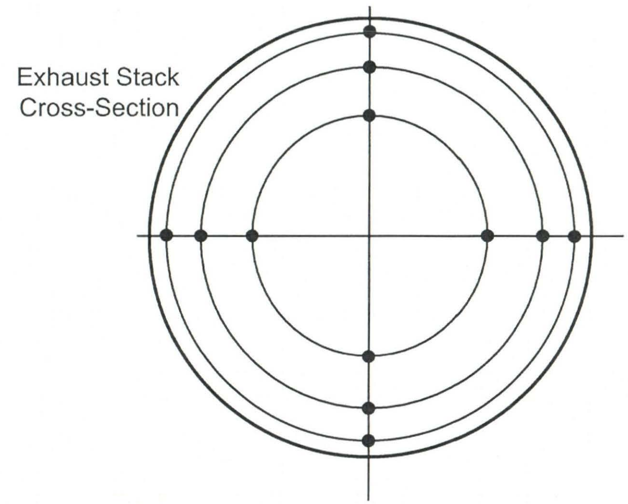
Velocity sample locations as measured from stack wall

Pt. #	in.
1	0.6
2	2.0
3	4.0
4	9.5
5	11.5
6	12.9

8-17-20	Energy Developments – Brent Run Exhaust Sample Locations, CAT® G3520C RICE		
	Scale None	Sheet 1 of 1	IMPACT COMPLIANCE & TESTING

EUENGINE7





Velocity sample locations as measured from stack wall

Pt. #	in.
1	0.6
2	1.8
3	3.6
4	8.6
5	10.5
6	11.7

8-17-20	**Energy Developments – Brent Run** **Exhaust Sample Location, CAT® G3520C RICE**		
	Scale None	Sheet 1 of 1	IMPACT COMPLIANCE & TESTING