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

Prepared for:

Sumpter Energy Associates, LLC
SRN N5984

Test Dates: May 13-16, 2024

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IMPACT COMPLIANCE & TESTING

Report Certification

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

Sumpter Energy Associates, LLC
at the Pine Tree Acres Landfill
Lenox Township, MI

Report Certification

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

Impact Compliance & Testing, Inc.

Tyler J. Wilson
Senior Project Manager

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1.0 Introduction

Sumpter Energy Associates, LLC (SEA) operates gas-fired reciprocating internal combustion engine (RICE) and electricity generator sets (gensets) at the Pine Tree Acres (PTA) Landfill located in Lenox Township, Macomb County, Michigan. The RICE are fueled by landfill gas (LFG) that is recovered from the PTA 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 SEA a Renewable Operating Permit (MI-ROP-N5984-2019) for operation of the renewable electricity generation facility (Phase I), which consists of:

- Seven (7) Caterpillar (CAT®) Model No. 3516 RICE gensets identified as emission units EU-ENGINE1 through EU-ENGINE7 (Flexible Group ID FG-ENGINES).

Air emission compliance testing was performed pursuant to MI-ROP-N5984-2019. Conditions of MI-ROP-N5984-2019 for FG-ENGINES state:

1. *Within 180 days of permit issuance or five years from the last test date, whichever is later, and then every five years thereafter, the permittee shall verify the NOx, CO, HCl, and NMOC emission rates from each engine in FG-ENGINES.*

The compliance testing presented in this report was performed by Impact Compliance & Testing, Inc. (ICT), a Michigan-based environmental consulting and testing company. ICT representatives Tyler Wilson and Renee Fromwiller performed the field sampling and measurements May 13-16, 2024.

The engine emission performance tests consisted of triplicate, one-hour sampling periods for nitrogen oxides (NOx), carbon monoxide (CO), non-methane organic compounds (NMOC, as non-methane hydrocarbons (NMHC)), and hydrogen chloride (HCl). 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 March 29, 2024, that was reviewed and approved by EGLE-AQD. Mr. Robert Joseph, Mr. Andrew Riley, and Ms. Amanda Battershell of EGLE-AQD observed portions of the compliance testing.

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-N5984-2019 require SEA to test each engine in FG-ENGINES for CO, NOx, NMOC, and HCl emissions. Engine Nos. 1 – 7 (EU-ENGINE1 – EU-ENGINE7, respectively) were tested during this compliance test event.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the SEA engine/generator sets were operated at maximum operating conditions (within 10% of 800-kilowatt (kW) electricity output). SEA representatives provided kW output in 15-minute increments for each test period.

Fuel flowrate (standard cubic feet per minute (scfm)), fuel methane (CH_4) content (%), and air-to-fuel ratio were also recorded by SEA representatives in 15-minute increments for each test period.

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

Average generator output (kW), fuel consumption, fuel methane content, and air-to-fuel ratio for each RICE is presented in Table 2.1 and Tables 6.1-6.7.

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled LFG fueled RICE (Engine Nos. 1 – 7 / EU-ENGINE1 – EU-ENGINE7) were each sampled for three (3) one-hour test periods during the compliance testing performed May 13-16, 2024.

Table 2.2 presents the average measured CO, NO_X, NMOC, and HCl 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

Emission Unit	Generator Output (kW)	LFG Fuel Use (scfm)	LFG CH_4 Content (%)	Air / Fuel Ratio
Engine No. 1	800	341	56.4	1.42
Engine No. 2	800	330	56.7	1.42
Engine No. 3	800	347	56.6	1.51
Engine No. 4	800	336	56.5	1.51
Engine No. 5	800	338	58.0	1.44
Engine No. 6	800	322	58.5	1.46
Engine No. 7	800	336	58.1	1.47

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

	CO	NOx	NMOC	HCl
Emission Unit	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Engine No. 1	4.96	2.15	0.25	0.068
Engine No. 2	5.06	2.23	0.30	0.078
Engine No. 3	6.36	1.41	0.54	0.074
Engine No. 4	5.89	2.17	0.40	0.070
Engine No. 5	5.28	1.74	0.30	0.078
Engine No. 6	5.26	2.47	0.30	0.065
Engine No. 7	5.91	1.99	0.39	0.067
Total	**38.7**	**14.2**	**2.48**	**0.50**
Permit Limit	*51.1*	*35.2*	*8.8*	*0.7*

3.0 Source and Sampling Location Description

3.1 General Process Description

SEA is permitted to operate seven (7) RICE-generator sets (CAT® Model No. 3516) at its Phase I facility. The units are fired exclusively with LFG that is recovered from the PTA Landfill and treated prior to use.

Table 3.1 Engine Identification

Emission Unit	ROP Identification	Serial Number
Engine No. 1	EU-ENGINE1	4EK01498
Engine No. 2	EU-ENGINE2	4EK02485
Engine No. 3	EU-ENGINE3	4EK03329
Engine No. 4	EU-ENGINE4	3RC00386
Engine No. 5	EU-ENGINE5	4EK00605
Engine No. 6	EU-ENGINE6	CTL00644
Engine No. 7	EU-ENGINE7	4EK00283

3.2 Rated Capacities and Air Emission Controls

The CAT® 3516 engine generator sets each have a rated design capacity of:

- Engine Power: 1,138 brake horsepower (bhp)
- Electricity Generation: 800 kW

The LFG fueled RICE are not equipped with add-on emission control equipment. The engines employ lean-burn technology for efficient fuel combustion and to minimize emissions. The air-to-fuel ratio is set based on the gas quality (methane or heat content) of the treated fuel for the most efficient combustion. Exhaust gas is exhausted directly to atmosphere through a noise muffler and vertical exhaust stack for each engine.

3.3 Sampling Locations

Each 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 Engine Nos. 1 – 7 / EU-ENGINE1 – EU-ENGINE7 are identical. The exhaust stack sampling ports are located in individual vertical exhaust ducts, located after each engine muffler, with an inner diameter of 12.0 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location at least 0.5 duct diameters upstream and at least 2.0 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 a diagram of the emission test sampling locations with actual stack dimension measurements.

4.0 Sampling and Analytical Procedures

A Stack Test Protocol for the air emission testing was reviewed and approved by 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 4	Exhaust gas moisture was determined based on the water weight gain in chilled impingers.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content was determined using paramagnetic and infrared instrumental analyzers, respectively.
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 NMOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with methane separation column.
USEPA Method 26	Exhaust gas HCl concentration was determined using single point (non-isokinetic) sampling and analysis by ion chromatography.

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 once during 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 each 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 Content (USEPA Method 4)

Moisture content of each RICE exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. Exhaust gas moisture content was measured as part of the USEPA sampling procedures for HCl (i.e., not as a separate sampling train), which was performed concurrently with the instrumental analyzer sampling periods. 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 42i High Level chemiluminescence NO_X analyzer and a TEI 48i 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 NMOC (USEPA Method 25A / ALT-096)

The NMOC 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, NMOC 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 NMOC calculation sheets. Raw instrument response data for the NMHC analyzer is provided in Appendix 5.

4.7 HCl Emission Sampling (USEPA Method 26)

HCl concentrations in the RICE exhaust gas streams were determined using a modified version of USEPA Method 26 (see section 4.8 of this document). A sample of the exhaust gas was drawn from the exhaust stack at a constant rate (i.e., non-isokinetic rate) using a glass lined probe and a quartz filter. The gas sample was bubbled through chilled impingers containing 0.1 normality sulfuric acid (0.1N H_2SO_4). The NaOH fraction of the Method 26 sampling train was not used since halogen (Cl_2) concentrations were not included in the analysis.

The wetted portions of the sampling train were constructed of glass.
At the end of the one-hour test period, the impinger solutions and rinses were recovered, labeled, and transferred (picked up by) a third-party laboratory (Enthalpy Analytical in Durham, North Carolina) for HCl analysis by ion chromatography (IC) analysis in accordance with USEPA Method 26.

Appendix 4 provides HCl calculation sheets. Appendix 6 provides a copy of the HCl laboratory report.

4.8 Test Method Exception (USEPA Method 26)

A modified version of USEPA Method 26 was used to measure HCl for each RICE.

Standard Greenberg-Smith (G-S) and modified G-S impingers were used instead of midget impingers for the sampling train.

A calibrated dry gas meter was used to measure the total sample volume.

These were the same procedures that were performed during the June 2019 compliance test event at this facility.

5.0 QA/QC Activities

5.1 Flow Measurement Equipment

Prior to arriving onsite (or onsite prior to beginning compliance testing), the instruments used during the source test to measure exhaust gas properties and velocity (pyrometer, Pitot tube, and scale) were calibrated to specifications in the sampling methods.

5.2 NO_x Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42i 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 at least 90% of the expected value (within 10%).

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_X concentration was 100.5% 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 the 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 (NMOC) 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 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 used for moisture testing 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 metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

5.9 HCl Recovery and Analysis

All recovered Method 26 impinger solutions and rinses were stored in appropriate HDPE bottles with Teflon® lined caps. The liquid level on each bottle was marked with a permanent marker and the caps were securely sealed with tape, prior to pick-up. A blank solution was prepared using 0.1 N H_2SO_4 and the high-purity deionized (DI) water used for recovery and analyzed by the laboratory with the sample train solutions. QA/QC procedures used by the laboratory are included in the final report provided by Enthalpy Analytical.

Appendix 7 presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas certifications, interference test results, meter box calibration records, and field equipment calibration records).

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 6.7.

Engine Nos. 1 – 7 / EU-ENGINE1 – EU-ENGINE7 have the following combined allowable emission limits specified in MI-ROP-N5984-2019:

- 51.1 pounds per hour (lb/hr) for CO;
- 35.2 lb/hr for NOx;
- 8.8 lb/hr for NMOC; and
- 0.7 lb/hr for HCl.

The measured combined air pollutant emission rates for Engine Nos. 1 – 7 / EU-ENGINE1 – EU-ENGINE7 are less than the allowable limits specified in MI-ROP-N5984-2019.

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 (800 kW generator output for CAT® 3516 RICE) throughout the compliance testing and no variations from normal operating conditions occurred during the engine test periods.

Table 6.1 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 1 (EU-ENGINE1)

Test No. Test date Test period (24-hr clock)	1 5/14/2024 710-810	2 5/14/2024 835-935	3 5/14/2024 1005-1105	Three Test Average
Fuel flowrate to plant (scfm)	2,405	2,395	2,360	2,387
Fuel flowrate to engine (scfm)	344	342	337	341
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	56.7	56.2	56.2	56.4
Air-to-fuel ratio	1.41	1.43	1.42	1.42
Exhaust Gas Composition				
CO_2 content (% vol)	14.3	14.3	14.3	14.3
O_2 content (% vol)	6.32	6.30	6.34	6.32
Moisture (% vol)	13.9	13.9	13.9	13.9
Exhaust gas temperature (°F)	795	795	795	795
Exhaust gas flowrate (dscfm)	2,014	1,949	2,036	2,000
Exhaust gas flowrate (scfm)	2,340	2,264	2,365	2,323
Nitrogen Oxides				
NO_X conc. (ppmvd)	142	149	158	150
NO_X emissions (lb/hr)	2.05	2.09	2.30	2.15
Carbon Monoxide				
CO conc. (ppmvd)	565	568	571	568
CO emissions (lb/hr)	4.97	4.83	5.08	4.96
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	16.1	16.1	15.8	16.0
NMOC emissions (lb/hr)	0.26	0.25	0.26	0.25
Hydrogen Chloride				
HCl catch weight (µg)	10,882	11,149	11,007	11,013
HCl conc. (ppmvd)	5.88	6.04	6.00	5.98
HCl emissions (lb/hr)	0.067	0.067	0.069	0.068

Table 6.2 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 2 (EU-ENGINE2)

Test No. Test date Test period (24-hr clock)	1 5/14/2024 1145-1245	2 5/14/2024 1315-1415	3 5/14/2024 1445-1545	Three Test Average
Fuel flowrate to plant (scfm)	2,340	2,284	2,301	2,308
Fuel flowrate to engine (scfm)	334	326	329	330
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	56.6	56.8	56.8	56.7
Air-to-fuel ratio	1.43	1.42	1.40	1.42
Exhaust Gas Composition				
CO_2 content (% vol)	14.4	14.3	14.4	14.4
O_2 content (% vol)	6.22	6.24	6.17	6.21
Moisture (% vol)	14.0	13.9	14.1	14.0
Exhaust gas temperature (°F)	784	781	779	781
Exhaust gas flowrate (dscfm)	2,188	2,151	2,263	2,201
Exhaust gas flowrate (scfm)	2,545	2,499	2,634	2,559
Nitrogen Oxides				
NO_X conc. (ppmvd)	142	134	147	141
NO_X emissions (lb/hr)	2.22	2.07	2.39	2.23
Carbon Monoxide				
CO conc. (ppmvd)	524	523	533	526
CO emissions (lb/hr)	5.00	4.91	5.26	5.06
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	17.2	17.5	16.9	17.2
NMOC emissions (lb/hr)	0.30	0.30	0.31	0.30
Hydrogen Chloride				
HCl catch weight (µg)	11,411	10,909	11,114	11,145
HCl conc. (ppmvd)	6.28	6.12	6.28	6.23
HCl emissions (lb/hr)	0.078	0.075	0.081	0.078

Table 6.3 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 3 (EU-ENGINE3)

Test No. Test date Test period (24-hr clock)	1 5/16/2024 705-805	2 5/16/2024 835-935	3 5/16/2024 1005-1105	Three Test Average
Fuel flowrate to plant (scfm)	2,425	2,439	2,433	2,432
Fuel flowrate to engine (scfm)	346	348	348	347
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	56.5	56.5	56.7	56.6
Air-to-fuel ratio	1.50	1.51	1.50	1.51
Exhaust Gas Composition				
CO_2 content (% vol)	13.6	13.5	13.7	13.6
O_2 content (% vol)	7.04	7.16	6.97	7.05
Moisture (% vol)	13.5	13.6	14.0	13.7
Exhaust gas temperature (°F)	825	829	829	828
Exhaust gas flowrate (dscfm)	2,251	2,282	2,318	2,284
Exhaust gas flowrate (scfm)	2,602	2,641	2,696	2,646
Nitrogen Oxides				
NO_X conc. (ppmvd)	92.1	73.0	93.1	86.0
NO_X emissions (lb/hr)	1.49	1.19	1.55	1.41
Carbon Monoxide				
CO conc. (ppmvd)	653	608	655	638
CO emissions (lb/hr)	6.41	6.05	6.63	6.36
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	29.1	30.2	29.2	29.5
NMOC emissions (lb/hr)	0.52	0.55	0.54	0.54
Hydrogen Chloride				
HCl catch weight (μg)	10,754	10,250	10,760	10,588
HCl conc. (ppmvd)	5.79	5.47	5.90	5.72
HCl emissions (lb/hr)	0.074	0.071	0.078	0.074

Table 6.4 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 4 (EU-ENGINE4)

Test No. Test date Test period (24-hr clock)	1 5/15/2024 710-810	2 5/15/2024 850-950	3 5/15/2024 1030-1130	Three Test Average
Fuel flowrate to plant (scfm)	2,357	2,355	2,349	2,354
Fuel flowrate to engine (scfm)	337	336	336	336
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	56.5	56.1	56.8	56.5
Air-to-fuel ratio	1.49	1.52	1.52	1.51
Exhaust Gas Composition				
CO_2 content (% vol)	13.7	13.4	13.5	13.6
O_2 content (% vol)	6.94	7.20	7.16	7.10
Moisture (% vol)	13.2	13.4	13.8	13.5
Exhaust gas temperature (°F)	772	771	770	771
Exhaust gas flowrate (dscfm)	2,205	2,289	2,261	2,252
Exhaust gas flowrate (scfm)	2,539	2,642	2,622	2,601
Nitrogen Oxides				
NO_X conc. (ppmvd)	168	116	119	135
NO_X emissions (lb/hr)	2.66	1.91	1.93	2.17
Carbon Monoxide				
CO conc. (ppmvd)	627	584	589	600
CO emissions (lb/hr)	6.03	5.83	5.81	5.89
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	21.5	22.6	22.5	22.2
NMOC emissions (lb/hr)	0.37	0.41	0.41	0.40
Hydrogen Chloride				
HCl catch weight (µg)	10,286	9,977	10,440	10,234
HCl conc. (ppmvd)	5.48	5.34	5.66	5.49
HCl emissions (lb/hr)	0.069	0.069	0.073	0.070

Table 6.5 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 5 (EU-ENGINE5)

Test No. Test date Test period (24-hr clock)	1 5/15/2024 1210-1310	2 5/15/2024 1340-1440	3 5/15/2024 1510-1610	Three Test Average
Fuel flowrate to plant (scfm)	2,350	2,387	2,353	2,363
Fuel flowrate to engine (scfm)	336	341	336	338
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	57.9	58.1	58.1	58.0
Air-to-fuel ratio	1.42	1.47	1.43	1.44
Exhaust Gas Composition				
CO_2 content (% vol)	14.4	13.9	14.6	14.3
O_2 content (% vol)	6.23	6.72	6.00	6.32
Moisture (% vol)	14.5	14.1	14.6	14.4
Exhaust gas temperature (°F)	835	834	833	834
Exhaust gas flowrate (dscfm)	2,289	2,383	2,098	2,257
Exhaust gas flowrate (scfm)	2,679	2,774	2,456	2,636
Nitrogen Oxides				
NO_X conc. (ppmvd)	113	65.2	151	110
NO_X emissions (lb/hr)	1.85	1.11	2.27	1.74
Carbon Monoxide				
CO conc. (ppmvd)	540	495	577	537
CO emissions (lb/hr)	5.39	5.15	5.28	5.28
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	16.3	18.3	15.2	16.6
NMOC emissions (lb/hr)	0.30	0.35	0.26	0.30
Hydrogen Chloride				
HCl catch weight (µg)	10,604	11,139	10,837	10,860
HCl conc. (ppmvd)	5.90	6.28	6.14	6.11
HCl emissions (lb/hr)	0.077	0.085	0.073	0.078

Table 6.6 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 6 (EU-ENGINE6)

Test No. Test date Test period (24-hr clock)	1 5/13/2024 1330-1430	2 5/13/2024 1505-1605	3 5/13/2024 1640-1740	Three Test Average
Fuel flowrate to plant (scfm)	2,119	2,328	2,312	2,253
Fuel flowrate to engine (scfm)	303	333	330	322
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	58.4	58.7	58.4	58.5
Air-to-fuel ratio	1.44	1.46	1.48	1.46
Exhaust Gas Composition				
CO_2 content (% vol)	14.1	14.0	13.9	14.0
O_2 content (% vol)	6.48	6.51	6.68	6.55
Moisture (% vol)	14.2	14.0	14.0	14.1
Exhaust gas temperature (°F)	768	766	767	767
Exhaust gas flowrate (dscfm)	2,024	1,901	1,966	1,964
Exhaust gas flowrate (scfm)	2,358	2,211	2,286	2,285
Nitrogen Oxides				
NO_X conc. (ppmvd)	178	190	158	175
NO_X emissions (lb/hr)	2.59	2.59	2.23	2.47
Carbon Monoxide				
CO conc. (ppmvd)	616	625	599	613
CO emissions (lb/hr)	5.44	5.19	5.14	5.26
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	19.1	18.9	19.4	19.1
NMOC emissions (lb/hr)	0.31	0.29	0.30	0.30
Hydrogen Chloride				
HCl catch weight (μg)	9,901	10,748	10,331	10,327
HCl conc. (ppmvd)	5.62	6.12	5.88	5.87
HCl emissions (lb/hr)	0.065	0.066	0.066	0.065

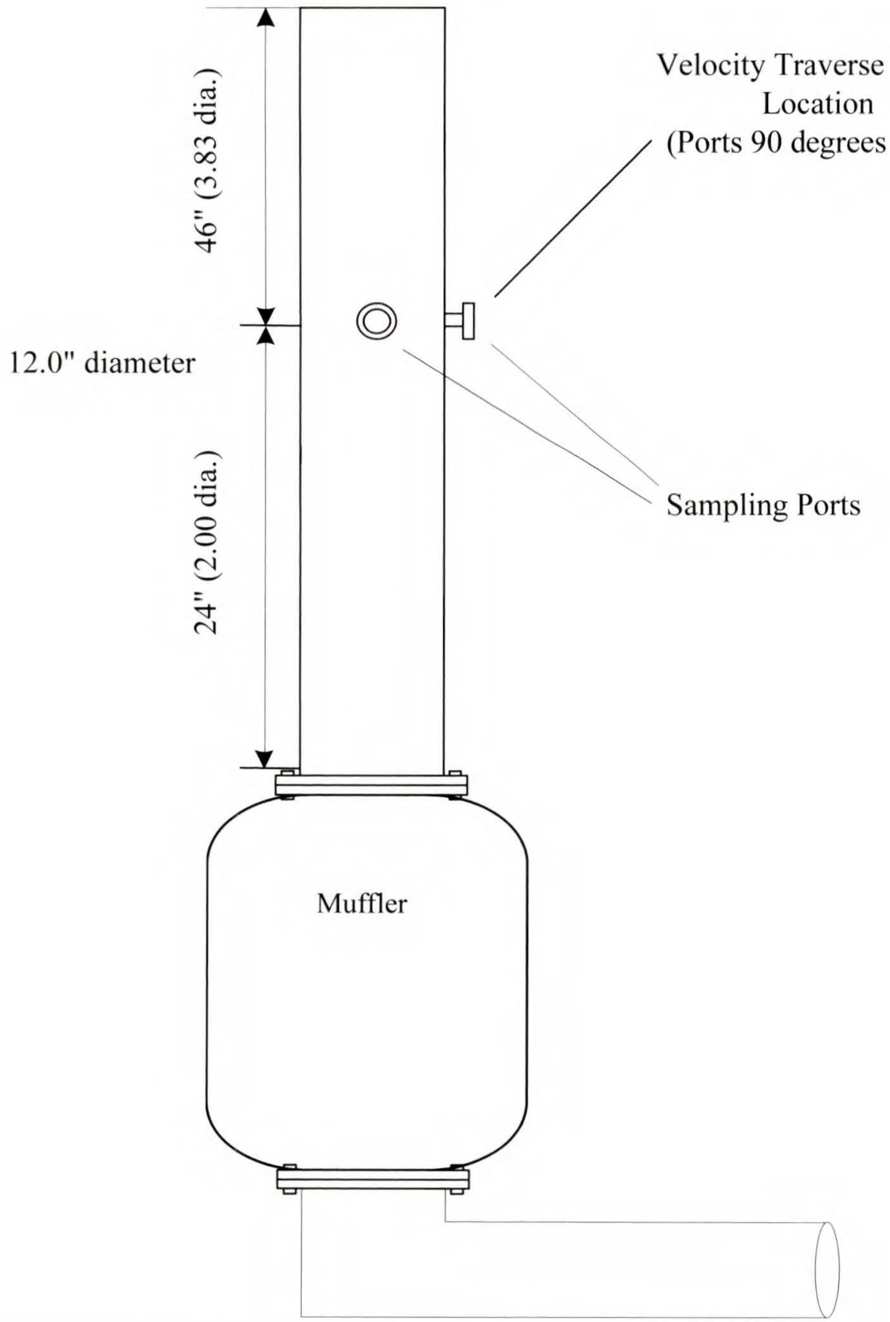
Table 6.7 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 7 (EU-ENGINE7)

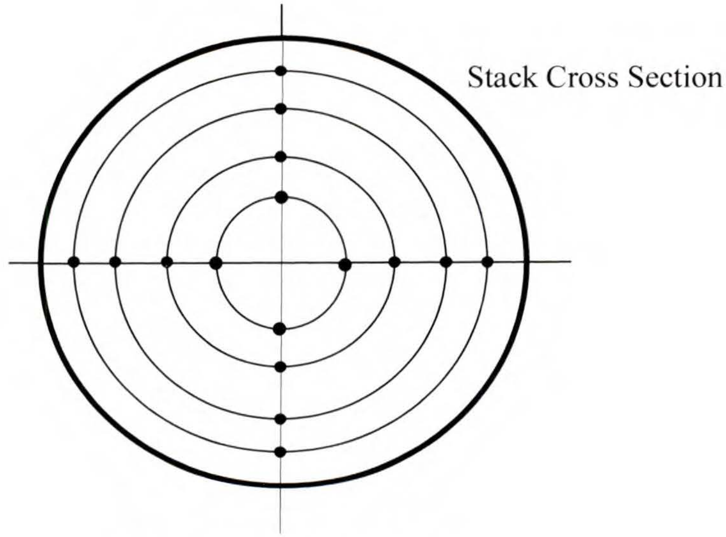
Test No. Test date Test period (24-hr clock)	1 5/13/2024 815-915	2 5/13/2024 1000-1100	3 5/13/2024 1135-1235	Three Test Average
Fuel flowrate to plant (scfm)	2,362	2,362	2,341	2,355
Fuel flowrate to engine (scfm)	337	337	334	336
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,129	1,129	1,129	1,129
LFG methane content (%)	58.1	57.9	58.3	58.1
Air-to-fuel ratio	1.45	1.48	1.46	1.47
Exhaust Gas Composition				
CO_2 content (% vol)	13.6	13.7	13.8	13.7
O_2 content (% vol)	7.03	6.89	6.75	6.89
Moisture (% vol)	14.2	14.4	13.9	14.2
Exhaust gas temperature (°F)	768	770	766	768
Exhaust gas flowrate (dscfm)	2,213	2,170	2,179	2,187
Exhaust gas flowrate (scfm)	2,581	2,534	2,529	2,548
Nitrogen Oxides				
NO_X conc. (ppmvd)	101	124	156	127
NO_X emissions (lb/hr)	1.60	1.94	2.43	1.99
Carbon Monoxide				
CO conc. (ppmvd)	587	615	656	619
CO emissions (lb/hr)	5.67	5.83	6.24	5.91
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	23.2	22.0	21.5	22.2
NMOC emissions (lb/hr)	0.41	0.38	0.37	0.39
Hydrogen Chloride				
HCl catch weight (µg)	9,689	9,963	9,950	9,867
HCl conc. (ppmvd)	5.21	5.44	5.53	5.39
HCl emissions (lb/hr)	0.065	0.067	0.068	0.067

APPENDIX 1

- RICE Engine Sample Port Diagram

Engine Nos. 1-7 (EU-ENGINE1 through EU-ENGINE7) Exhaust Stacks





Velocity sample locations
(as measured from stack wall)

1	0.50”
2	1.26”
3	2.33”
4	3.86”
5	8.12”
6	9.67”
7	10.74”
8	11.50”

SEA-PTA Phase I Facility
Engine Exhaust Sample Locations

Scale	Sheet
None	1 of 1

IMPACT COMPLIANCE & TESTING