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

Prepared for:

Pine Tree Acres, Inc.
SRN N5984

Test Dates: February 27, 2023-March 2, 2023

ICT Project No.: 2200226
April 18, 2023

IMPACT COMPLIANCE & TESTING

Report Certification

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

Pine Tree Acres, Inc.
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

Waste Management, Inc. (WM) operates gas-fired reciprocating internal combustion engine (RICE) and electricity generator sets (gensets) at the Pine Tree Acres, Inc. (PTA) facility located in Lenox Township, Macomb County, Michigan. The RICE are fueled by landfill gas (LFG) that is recovered from the Pine Tree Acres Landfill (PTAL) and treated prior to use.

The State of Michigan Department of Environment, Great Lakes, and Energy – Air Quality Division (EGLE-AQD) has issued to WM-PTA a Renewable Operating Permit (MI-ROP-N5984-2019) for operation of the renewable electricity generation facility, which consists of:

- Eight (8) Caterpillar (CAT®) Model No. G3520C RICE gensets identified as emission units EU-ICENGINE1 through EU-ICENGINE8 (Flexible Group ID FG-ICENGINES, FG-RICEMACT, and FG-RICENSPS).

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

1. *Except as provided in 40 CFR 60.4243(b), the permittee shall conduct an initial performance test for each engine in FG-RICENSPS within one year of startup of the engine and every 8760 hours of operation (as determined through the use of a non-resettable hour meter) or three years, whichever occurs first, to demonstrate compliance with the emission limits in 40 CFR 60.4233(e)...*

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 Nick Steinthal performed the field sampling and measurements February 27, 2023-March 2, 2023.

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 January 3, 2023, that was reviewed and approved by EGLE-AQD. Mr. Andrew Riley and Mr. Robert Joseph 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 and 40 CFR Part 60, Subpart JJJJ, Standards of Performance for New Stationary Sources for Stationary Spark Ignition Internal Combustion Engines require WM-PTA to test each engine in FG-ICENGINES / FG-RICEMACT / FG-RICENSPS for CO, NOx, and VOC emissions. Engine Nos. 1 – 8 (EU-ICENGINE1 – EU-ICENGINE8, respectively) were tested during this compliance test event.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the WM-PTA engine/generator sets were operated at maximum operating conditions (within 10% of 1,600-kilowatt (kW) electricity output). WM-PTA 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 WM-PTA representatives in 15-minute increments for each test period. In addition, WM-PTA representatives monitored LFG hydrogen sulfide (H_2S) content once per test day using Draeger® tubes.

Appendix 2 provides operating records provided by WM-PTA representatives for the test periods and photos of the H_2S Draeger® tubes.

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 6.1-6.8.

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled LFG fueled RICE (Engine Nos. 1 – 8 / EU-ICENGINE1 – EU-ICENGINE8) were each sampled for three (3) one-hour test periods during the compliance testing performed February 27, 2023-March 2, 2023.

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

Emission Unit	Generator Output (kW)	LFG Fuel Use (scfm)	LFG CH_4 Content (%)	Air / Fuel Ratio
Engine No. 1	1,624	586	50.3	6.8
Engine No. 2	1,640	630	50.1	7.2
Engine No. 3	1,640	606	49.8	7.3
Engine No. 4	1,635	588	49.9	7.1
Engine No. 5	1,629	584	50.7	7.3
Engine No. 6	1,637	584	51.3	7.3
Engine No. 7	1,633	607	51.4	7.2
Engine No. 8	1,648	598	51.3	7.2

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

	CO		NOx		VOC	
Emission Unit	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)
Engine No. 1	13.3	2.67	1.66	0.33	0.61	0.12
Engine No. 2	14.2	2.80	1.34	0.27	0.85	0.17
Engine No. 3	15.5	3.07	1.15	0.23	0.90	0.18
Engine No. 4	13.3	2.64	1.49	0.30	0.60	0.12
Engine No. 5	13.1	2.61	1.21	0.24	0.79	0.16
Engine No. 6	11.4	2.26	1.23	0.24	0.71	0.14
Engine No. 7	13.9	2.77	1.05	0.21	0.84	0.17
Engine No. 8	16.0	3.15	1.27	0.25	0.88	0.17
Permit Limit	***16.3***	***3.3***	***3.0***	***0.6***	***1.0***	***1.0***

3.0 Source and Sampling Location Description

3.1 General Process Description

WM-PTA is permitted to operate eight (8) RICE-generator sets (CAT® Model No. G3520C) at its facility. The units are fired exclusively with LFG that is recovered from the PTAL and treated prior to use.

Table 3.1 Engine Identification

Emission Unit	ROP Identification	Serial Number
Engine No. 1	EU-ICENGINE1	GZJ00463
Engine No. 2	EU-ICENGINE2	GZJ00462
Engine No. 3	EU-ICENGINE3	GZJ00465
Engine No. 4	EU-ICENGINE4	GZJ00464
Engine No. 5	EU-ICENGINE5	GZJ00456
Engine No. 6	EU-ICENGINE6	GZJ00466
Engine No. 7	EU-ICENGINE7	GZJ00467
Engine No. 8	EU-ICENGINE8	GZJ00457

3.2 Rated Capacities and Air Emission Controls

The CAT® G3520C engine generator sets each have a rated design capacity of:

- Engine Power: 2,233 brake horsepower (bhp)
- Electricity Generation: 1,600 kW

Each engine is equipped with an air-to-fuel ratio (AFR) controller that automatically 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 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 – 8 / EU-ICENGINE1 – EU-ICENGINE8 are identical. The exhaust stack sampling ports are located in individual horizontal exhaust ducts, located before each engine muffler, with an inner diameter of 15.0 inches. After the engine muffler, each exhaust stack diameter is reduced to 14.0 inches as specified in MI-ROP-N5984-2019. 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 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 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 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 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 measurements were 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 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 VOC (USEPA Method 25A / ALT-096)

The VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC or NMOC) 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 (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 100.6% 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 NOx, 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.

Appendix E 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 6.8.

Engine Nos. 1 – 8 / EU-ICENGINE1 – EU-ICENGINE8 each have the following allowable emission limits specified in MI-ROP-N5984-2019:

- 16.3 pounds per hour (lb/hr) and 3.3 grams per brake horsepower hour (g/bhp-hr) for CO;
- 3.0 lb/hr and 0.6 g/bhp-hr for NOx; and
- 1.0 lb/hr and 1.0 g/bhp-hr for VOC.

The measured air pollutant concentrations and emission rates for Engine Nos. 1 – 8 / EU-ICENGINE1 – EU-ICENGINE8 are less than the allowable limits specified in MI-ROP-N5984-2019 and 40 CFR Part 60, Subpart JJJJ, Standards of Performance for New Stationary Sources for Stationary Spark Ignition Internal Combustion Engines.

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.

Table 6.1 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 1 (EU-ICENGINE1)

Test No. Test date Test period (24-hr clock)	1 3/2/2023 705-805	2 3/2/2023 821-921	3 3/2/2023 937-1037	Three Test Average
Fuel flowrate (scfm)	589	584	584	586
Generator output (kW)	1,634	1,616	1,622	1,624
Engine output (bhp)	2,282	2,258	2,266	2,269
LFG methane content (%)	49.9	50.2	50.9	50.3
Air-to-fuel ratio	6.8	6.8	6.8	6.8
Exhaust Gas Composition				
CO_2 content (% vol)	12.2	12.2	12.1	12.2
O_2 content (% vol)	8.05	8.10	8.11	8.09
Moisture (% vol)	10.7	11.7	12.0	11.5
Exhaust gas temperature (°F)	970	973	969	971
Exhaust gas flowrate (dscfm)	4,347	4,266	3,853	4,155
Exhaust gas flowrate (scfm)	4,870	4,833	4,376	4,693
Nitrogen Oxides				
NO_X conc. (ppmvd)	56.2	54.6	56.0	55.6
NO_X emissions (lb/hr)	1.75	1.67	1.55	1.66
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.35	0.34	0.31	0.33
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
Carbon Monoxide				
CO conc. (ppmvd)	728	739	740	735
CO emissions (lb/hr)	13.8	13.8	12.4	13.3
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.74	2.76	2.49	2.67
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
Volatile Organic Compounds				
NMHC conc. (ppmv)	18.9	18.7	19.6	19.1
NMHC emissions (lb/hr)	0.63	0.62	0.59	0.61
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.13	0.12	0.12	0.12
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.2 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 2 (EU-ICENGINE2)

Test No. Test date Test period (24-hr clock)	1 2/28/2023 714-814	2 2/28/2023 828-928	3 2/28/2023 943-1043	Three Test Average
Fuel flowrate (scfm)	628	629	634	630
Generator output (kW)	1,647	1,638	1,637	1,640
Engine output (bhp)	2,300	2,288	2,287	2,292
LFG methane content (%)	50.3	50.2	49.7	50.1
Air-to-fuel ratio	7.3	7.2	7.2	7.2
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	12.0	12.0	12.0	12.0
O_2 content (% vol)	8.26	8.30	8.26	8.27
Moisture (% vol)	11.9	10.4	11.8	11.4
Exhaust gas temperature (°F)	955	958	968	960
Exhaust gas flowrate (dscfm)	3,993	4,049	4,202	4,081
Exhaust gas flowrate (scfm)	4,533	4,520	4,767	4,607
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	45.6	46.0	46.3	45.9
NO_X emissions (lb/hr)	1.30	1.33	1.39	1.34
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.26	0.26	0.28	0.27
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	800	790	795	795
CO emissions (lb/hr)	13.9	14.0	14.6	14.2
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.75	2.77	2.89	2.80
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
<u>Volatile Organic Compounds</u>				
NMHC conc. (ppmv)	26.7	26.9	26.5	26.7
NMHC emissions (lb/hr)	0.83	0.83	0.87	0.85
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.16	0.17	0.17	0.17
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.3 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 3 (EU-ICENGINE3)

Test No. Test date Test period (24-hr clock)	1 2/28/2023 1108-1208	2 2/28/2023 1221-1321	3 2/28/2023 1335-1435	Three Test Average
Fuel flowrate (scfm)	610	603	607	606
Generator output (kW)	1,646	1,634	1,640	1,640
Engine output (bhp)	2,299	2,282	2,291	2,291
LFG methane content (%)	49.7	49.8	49.8	49.8
Air-to-fuel ratio	7.3	7.3	7.3	7.3
Exhaust Gas Composition				
CO_2 content (% vol)	11.7	11.7	11.7	11.7
O_2 content (% vol)	8.57	8.59	8.60	8.59
Moisture (% vol)	10.1	13.0	11.1	11.4
Exhaust gas temperature (°F)	932	928	928	929
Exhaust gas flowrate (dscfm)	4,264	4,091	4,208	4,188
Exhaust gas flowrate (scfm)	4,746	4,702	4,731	4,726
Nitrogen Oxides				
NO_X conc. (ppmvd)	39.0	37.7	38.3	38.4
NO_X emissions (lb/hr)	1.19	1.11	1.16	1.15
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.24	0.22	0.23	0.23
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
Carbon Monoxide				
CO conc. (ppmvd)	852	844	853	849
CO emissions (lb/hr)	15.9	15.1	15.7	15.5
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	3.13	3.00	3.10	3.07
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
Volatile Organic Compounds				
NMHC conc. (ppmv)	27.6	27.6	27.9	27.7
NMHC emissions (lb/hr)	0.90	0.89	0.91	0.90
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.18	0.18	0.18	0.18
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.4 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 4 (EU-ICENGINE4)

Test No. Test date Test period (24-hr clock)	1 2/28/2023 1450-1550	2 2/28/2023 1603-1703	3 2/28/2023 1716-1816	Three Test Average
Fuel flowrate (scfm)	589	585	588	588
Generator output (kW)	1,634	1,634	1,638	1,635
Engine output (bhp)	2,282	2,283	2,288	2,284
LFG methane content (%)	49.6	50.0	50.1	49.9
Air-to-fuel ratio	7.0	7.1	7.1	7.1
Exhaust Gas Composition				
CO_2 content (% vol)	12.2	12.2	12.2	12.2
O_2 content (% vol)	8.03	8.03	8.04	8.04
Moisture (% vol)	12.7	12.0	10.6	11.8
Exhaust gas temperature (°F)	961	964	961	962
Exhaust gas flowrate (dscfm)	3,726	3,784	3,778	3,763
Exhaust gas flowrate (scfm)	4,266	4,302	4,226	4,265
Nitrogen Oxides				
NO_X conc. (ppmvd)	55.1	55.7	55.3	55.4
NO_X emissions (lb/hr)	1.47	1.51	1.50	1.49
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.29	0.30	0.30	0.30
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
Carbon Monoxide				
CO conc. (ppmvd)	803	813	816	811
CO emissions (lb/hr)	13.1	13.4	13.5	13.3
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.60	2.67	2.67	2.64
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
Volatile Organic Compounds				
NMHC conc. (ppmv)	20.2	20.3	20.8	20.4
NMHC emissions (lb/hr)	0.59	0.60	0.61	0.60
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.12	0.12	0.12	0.12
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.5 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 5 (EU-ICENGINE5)

Test No. Test date Test period (24-hr clock)	1 2/27/2023 750-850	2 2/27/2023 904-1004	3 2/27/2023 1018-1118	Three Test Average
Fuel flowrate (scfm)	587	584	582	584
Generator output (kW)	1,628	1,632	1,628	1,629
Engine output (bhp)	2,274	2,280	2,274	2,276
LFG methane content (%)	50.6	50.7	50.8	50.7
Air-to-fuel ratio	7.3	7.3	7.3	7.3
Exhaust Gas Composition				
CO_2 content (% vol)	11.7	11.7	11.7	11.7
O_2 content (% vol)	8.58	8.64	8.67	8.63
Moisture (% vol)	10.4	11.2	11.1	10.9
Exhaust gas temperature (°F)	940	942	943	942
Exhaust gas flowrate (dscfm)	4,096	4,017	4,108	4,074
Exhaust gas flowrate (scfm)	4,571	4,522	4,619	4,571
Nitrogen Oxides				
NO_X conc. (ppmvd)	42.0	41.1	41.4	41.5
NO_X emissions (lb/hr)	1.23	1.18	1.22	1.21
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.25	0.24	0.24	0.24
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
Carbon Monoxide				
CO conc. (ppmvd)	746	732	730	736
CO emissions (lb/hr)	13.3	12.8	13.1	13.1
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.66	2.55	2.61	2.61
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
Volatile Organic Compounds				
NMHC conc. (ppmv)	24.7	25.0	25.6	25.1
NMHC emissions (lb/hr)	0.78	0.78	0.81	0.79
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.15	0.15	0.16	0.16
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.6 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 6 (EU-ICENGINE6)

Test No. Test date Test period (24-hr clock)	1 3/1/2023 654-754	2 3/1/2023 809-909	3 3/1/2023 922-1022	Three Test Average
Fuel flowrate (scfm)	584	584	583	584
Generator output (kW)	1,634	1,643	1,634	1,637
Engine output (bhp)	2,283	2,295	2,282	2,286
LFG methane content (%)	51.3	51.4	51.3	51.3
Air-to-fuel ratio	7.3	7.4	7.3	7.3
Exhaust Gas Composition				
CO_2 content (% vol)	11.9	11.8	11.9	11.9
O_2 content (% vol)	8.37	8.46	8.43	8.42
Moisture (% vol)	11.3	11.4	11.1	11.3
Exhaust gas temperature (°F)	930	934	941	935
Exhaust gas flowrate (dscfm)	3,869	3,838	3,942	3,883
Exhaust gas flowrate (scfm)	4,360	4,334	4,432	4,376
Nitrogen Oxides				
NO_X conc. (ppmvd)	44.2	44.2	44.2	44.2
NO_X emissions (lb/hr)	1.23	1.22	1.25	1.23
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.24	0.24	0.25	0.24
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
Carbon Monoxide				
CO conc. (ppmvd)	667	670	679	672
CO emissions (lb/hr)	11.3	11.2	11.7	11.4
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.24	2.22	2.32	2.26
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
Volatile Organic Compounds				
NMHC conc. (ppmv)	23.6	23.7	23.5	23.6
NMHC emissions (lb/hr)	0.71	0.71	0.72	0.71
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.14	0.14	0.14	0.14
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

Table 6.7 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 7 (EU-ICENGINE7)

Test No. Test date Test period (24-hr clock)	1 3/1/2023 1043-1143	2 3/1/2023 1156-1256	3 3/1/2023 1314-1414	Three Test Average
Fuel flowrate (scfm)	608	607	608	607
Generator output (kW)	1,630	1,632	1,638	1,633
Engine output (bhp)	2,277	2,279	2,288	2,281
LFG methane content (%)	51.3	51.4	51.5	51.4
Air-to-fuel ratio	7.2	7.2	7.3	7.2
Exhaust Gas Composition				
CO_2 content (% vol)	11.7	11.7	11.7	11.7
O_2 content (% vol)	8.58	8.64	8.61	8.61
Moisture (% vol)	10.3	11.0	11.8	11.0
Exhaust gas temperature (°F)	958	960	962	960
Exhaust gas flowrate (dscfm)	4,546	4,460	4,475	4,494
Exhaust gas flowrate (scfm)	5,068	5,012	5,075	5,052
Nitrogen Oxides				
NO_X conc. (ppmvd)	32.7	31.9	33.0	32.5
NO_X emissions (lb/hr)	1.07	1.02	1.06	1.05
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.21	0.20	0.21	0.21
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
Carbon Monoxide				
CO conc. (ppmvd)	711	711	711	711
CO emissions (lb/hr)	14.1	13.9	13.9	13.9
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	2.81	2.76	2.75	2.77
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
Volatile Organic Compounds				
NMHC conc. (ppmv)	23.8	24.2	24.3	24.1
NMHC emissions (lb/hr)	0.83	0.83	0.85	0.84
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.17	0.17	0.17	0.17
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

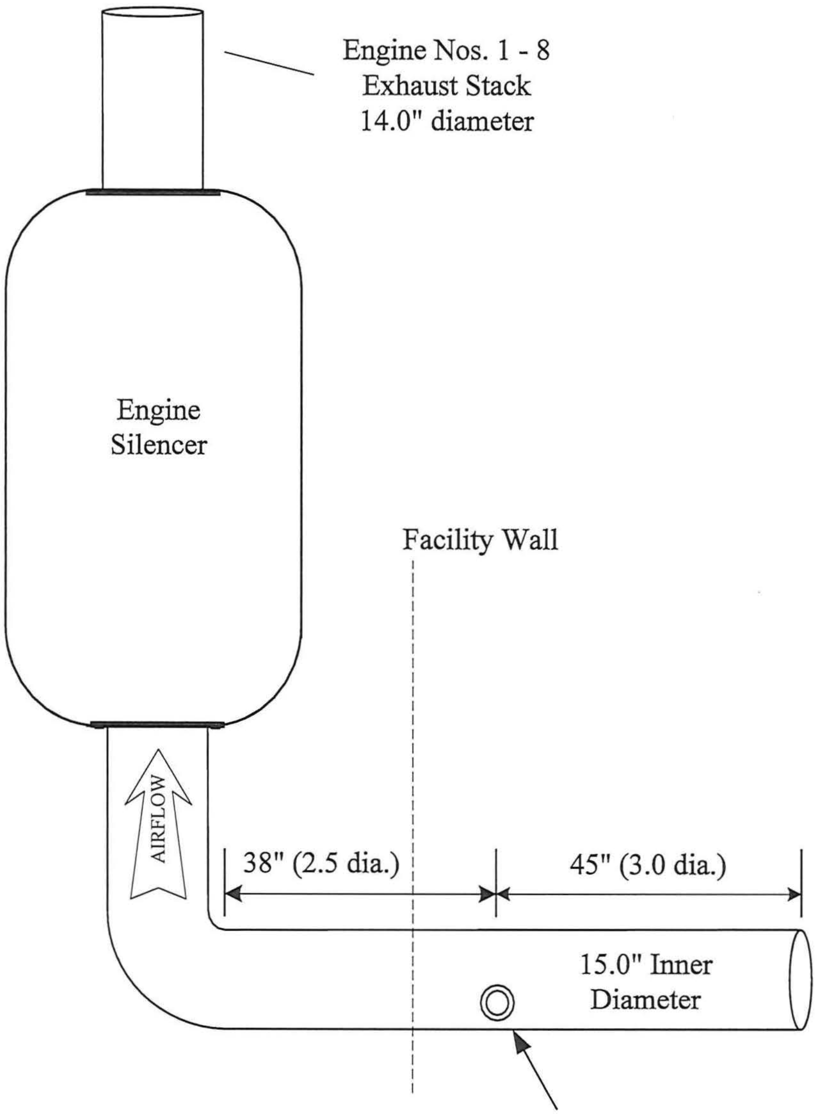
Table 6.8 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 8 (EU-ICENGINE8)

Test No. Test date Test period (24-hr clock)	1 2/27/2023 1145-1245	2 2/27/2023 1259-1359	3 2/27/2023 1413-1513	Three Test Average
Fuel flowrate (scfm)	594	600	599	598
Generator output (kW)	1,642	1,653	1,650	1,648
Engine output (bhp)	2,294	2,309	2,305	2,303
LFG methane content (%)	51.2	51.2	51.5	51.3
Air-to-fuel ratio	7.2	7.2	7.2	7.2
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.8	11.9	11.9	11.9
O_2 content (% vol)	8.46	8.46	8.46	8.46
Moisture (% vol)	11.3	11.7	11.9	11.6
Exhaust gas temperature (°F)	964	964	956	961
Exhaust gas flowrate (dscfm)	4,378	4,169	4,377	4,308
Exhaust gas flowrate (scfm)	4,937	4,720	4,969	4,875
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	40.7	40.9	41.6	41.1
NO_X emissions (lb/hr)	1.28	1.22	1.31	1.27
NO_X permit limit (lb/hr)	-	-	-	*3.0*
NO_X emissions (g/bhp-hr)	0.25	0.24	0.26	0.25
NO_X permit limit (g/bhp-hr)	-	-	-	*0.6*
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	843	852	854	850
CO emissions (lb/hr)	16.1	15.5	16.3	16.0
CO permit limit (lb/hr)	-	-	-	*16.3*
CO emissions (g/bhp-hr)	3.18	3.05	3.21	3.15
CO permit limit (g/bhp-hr)	-	-	-	*3.3*
<u>Volatile Organic Compounds</u>				
NMHC conc. (ppmv)	26.0	26.3	26.0	26.1
NMHC emissions (lb/hr)	0.88	0.85	0.89	0.88
NMHC permit limit (lb/hr)	-	-	-	*1.0*
NMHC emissions (g/bhp-hr)	0.17	0.17	0.17	0.17
NMHC permit limit (g/bhp-hr)	-	-	-	*1.0*

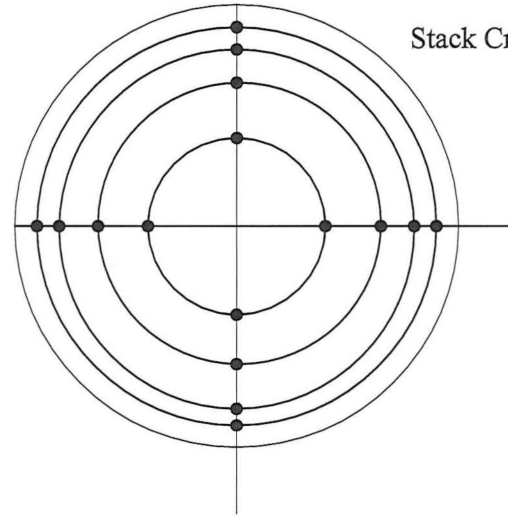
APPENDIX 1

- RICE Engine Sample Port Diagram

Impact Compliance & Testing, Inc.



Stack Cross Section



Velocity sample locations
(as measured from stack wall)

1	0.5"
2	1.6"
3	2.9"
4	4.8"
5	10.2"
6	12.1"
7	13.4"
8	14.5"

6/2/14 ALR 4/15/16 RLH	**PTA Landfill IC Engine Nos. 1-8 Exhaust Sample Locations**		
	Scale None	Sheet 1 of 1	IMPACT COMPLIANCE & TESTING