IMPACT
COMPLIANCE & TESTING

AIR EMISSION TEST REPORT

Title	TEST REPORT FOR THE VERIFICATION OF AIR POLLUTANT EMISSIONS FROM LANDFILL GAS-FUELED RECIPROCATING ENGINES
Report Date	February 28, 2019
Test Dates	February 12-14, 2019

Facility Information	
Name	Pine Tree Acres, Inc. (Landfill)
Street Address	36600 29-Mile Rd.
City, County	Lenox Township, Macomb
SRN	N5984

Permit Information	
Permit to Install No.:	MI-PTI-N5984-2013a
Operating Permit No.:	MI-ROP-N5984-2013a

Source Information			
Emission Unit	EUICENGINE1	EUICENGINE2	EUICENGINE3
Serial No.	GZJ00469	GZJ00464	GZJ00467
Emission Unit	EUICENGINE4	EUICENGINE6	EUICENGINE7
Serial No.	GZJ00466	GZJ00468	GZJ00463

Testing Contractor	
Company	Impact Compliance & Testing, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
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Project No.	1811006

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PINE TREE ACRES LANDFILL

1.0 INTRODUCTION

Pine Tree Acres, Inc. (PTA) operates eight (8) Caterpillar (CAT®) Model No. G3520C landfill gas (LFG) fueled reciprocating internal combustion engine (RICE) generator sets, two (2) enclosed flares and two open flares at the Pine Tree Acres Landfill (PTAL, Facility SRN: N5984) in Lenox Township, Macomb County, Michigan. The facility has been issued Renewable Operating Permit (ROP) No. MI-ROP-N5984-2013a and Permit to Install (PTI) No. MI-PTI-N5984-2013a by the Michigan Department of Environmental Quality (MDEQ).

Air emission testing was performed to demonstrate compliance with conditions of ROP No. MI-ROP-N5984-2013a, PTI No. MI-PTI-N5984-2013a, and 40 CFR Part 60 Subpart JJJJ.

Six (6) of the eight (8) RICE generator sets, identified as emission units EUICENGINE1, EUICENGINE2, EUICENGINE3, EUICENGINE4, EUICENGINE6, EUICENGINE7, and flexible group FGICENGINES, were tested for carbon monoxide (CO), nitrogen oxide (NO_x), and volatile organic compound (VOC) emissions. Two (2) of the eight (8) RICE generator sets, identified as emission units EUICENGINE5, EUICENGINE8, and flexible group FGICENGINES are in the process of being replaced and are scheduled to be tested on March 14, 2019 following installation and startup.

The compliance testing was performed by Impact Compliance & Testing, Inc. (ICT, formerly Derenzo Environmental Services), a Michigan-based environmental consulting and testing company. ICT representatives Tyler Wilson and Brad Thome performed the field sampling and measurements February 12 through 14, 2019. The engine performance tests were completed within 8,760 engine operating hours of the previous performance tests completed February 12-15, 2018.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan, dated January 4, 2019, that was reviewed and approved by the MDEQ in the February 1, 2019 test plan approval letter. MDEQ representatives Mr. David Patterson and Mr. Robert Joseph observed portions of the testing project.

Questions regarding this emission test report should be directed to:

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Report Certification

This test report was prepared by Impact Compliance & Testing, Inc. based on field sampling data collected by Impact Compliance & Testing, Inc. Facility process data were collected and provided Waste Management / Pine Tree Acres, Inc. employees or representatives. This test report has been reviewed by Waste Management / Pine Tree Acres, Inc. representatives and approved for submittal to the MDEQ.

I certify that the testing was conducted in accordance with the specified test methods and submitted test plan unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:

Tyler J. Wilson
Senior Project Manager
Impact Compliance & Testing, Inc.

Reviewed By:

Blake Beddow
Project Manager
Impact Compliance & Testing, Inc.

A Renewable Operating Permit Report Certification form signed by the source responsible official accompanies this report.

2.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

2.1 Purpose and Objective of the Tests

Each LFG-fueled RICE (EUICENGINE1, EUICENGINE2, EUICENGINE3, EUICENGINE4, EUICENGINE6, and EUICENGINE7) was tested for CO, NO_x, and VOC emissions pursuant to the conditions of MI-ROP-N5984-2013a, MI-PTI-N5984-2013a, and 40 CFR Part 60 Subpart JJJJ, which require the SI-RICE to be tested every 8,760 hours of operation.

2.2 Operating Conditions During the Compliance Tests

The engine testing was performed while the RICE-generator sets were operated at maximum operating conditions (within 10% of the rated electricity output of 1,600 kW). PTAL representatives monitored and recorded the kW output at 15-minute intervals for each test period. The RICE generator kW output ranged between 1,597 and 1,646 kW during the test periods.

Fuel flowrate (cubic feet per minute) and fuel methane content (%) were also recorded during the RICE test periods by PTAL representatives at 15-minute intervals. The RICE fuel consumption rate ranged between 514 and 588 scfm and fuel methane content ranged between 51.4 and 55.7% during the test periods.

Engine output (bhp) cannot be measured directly and was calculated based on the recorded electricity output, the calculated CAT® Model G3520C generator efficiency (96%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

Engine output (bhp) = Electricity output (kW) / (0.96) / (0.7457 kW/hp)

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

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

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the treated LFG fueled RICE were sampled for three (3) one-hour test periods per unit during the compliance testing performed February 12 through 14, 2019.

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

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

2.4 Measured Emission Rates Compared to Permitted Emission Limits

Results of the RICE performance tests demonstrate compliance with emission standards specified in 40 CFR Part 60 Subpart JJJJ (SI RICE NSPS).

The measured RICE CO, NO_x, and VOC emissions demonstrate compliance with the applicable limits specified in MI-ROP-N5984-2013a, MI-PTI-N5984-2013a, and 40 CFR Part 60 Subpart JJJJ.

Table 2.1 Average engine operating conditions during the RICE test periods

Emission Unit	Generator Output (kW)	Engine Output (bHp)	Fuel Use (scfm)	LFG CH_4 Content (%)	LFG Btu Content (Btu/scf)	Exhaust Temp. (°F)
EUICENGINE1	1,611	2,251	537	53.3	485	968
EUICENGINE2	1,619	2,261	546	52.3	476	985
EUICENGINE3	1,615	2,257	519	55.5	505	953
EUICENGINE4	1,616	2,258	519	55.3	503	943
EUICENGINE6	1,626	2,272	582	51.9	472	960
EUICENGINE7	1,623	2,268	563	53.5	487	962

Table 2.2 Average measured CO, NO_x, and VOC emission rates for each RICE generator set (three-test average)

Emission Unit	CO Emission Rates		NO_x Emission Rates		VOC Emission Rates	
	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)
EUICENGINE1	14.1	2.84	1.75	0.35	0.77	0.16
EUICENGINE2	13.5	2.71	2.44	0.49	0.60	0.12
EUICENGINE3	13.9	2.80	1.81	0.36	0.66	0.13
EUICENGINE4	14.7	2.94	1.88	0.38	0.62	0.13
EUICENGINE6	15.3	3.05	1.66	0.33	0.68	0.14
EUICENGINE7	14.0	2.80	1.19	0.24	0.85	0.17
NSPS Standard	--	*5.0*	--	*2.0*	--	*1.0*
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

LFG recovered from the PTAL is treated and used as fuel in the renewable energy facility or combusted in flaring systems. The renewable energy facility consists of eight (8) Caterpillar (CAT®) Model No. G3520C RICE-generator sets identified as emission units EUICENGINE1 through EUICENGINE8 (FGICENGINES). Excess LFG (gas that is recovered but not used for electricity generation) is controlled in two (2) enclosed flares identified as EUFLARE4 and EUFLARE6.

3.2 Rated Capacities and Air Emission Controls

The CAT® Model No. G3520C RICE have a rated output of 2,233 brake-horsepower (bhp) and the connected generators have a rated electricity output of 1,600 kilowatts (kW). The engines are designed to fire low-pressure, lean fuel mixtures (e.g., treated LFG) and are equipped with air-to-fuel ratio controllers that monitor engine performance parameters and automatically adjust the air-to-fuel ratio to maintain efficient fuel combustion. The fuel consumption rate is regulated automatically to maintain the heat input rate required to support engine operations and is dependent on the fuel heat value (methane content) of the treated LFG.

The RICE generator sets are not equipped with add-on emission control devices. Air pollutant emissions are minimized through the proper operation of the gas treatment system and efficient fuel combustion in the engines.

3.3 Sampling Locations

The RICE exhaust gas is directed through mufflers and is released to the atmosphere through dedicated vertical exhaust stacks. The eight (8) CAT® Model G3520C RICE exhaust stacks are identical. The exhaust sampling ports for the CAT® Model G3520C engines (EUICENGINE1 through EUICENGINE8) are located in individual horizontal exhaust ducts, located before the engine silencer, with an inner diameter of 15.0 inches. After the engine silencer the exhaust stack diameter is reduced to 14.0 inches as specified in the permit. Each duct is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 38.0 inches (2.5 duct diameters) upstream and 45.0 inches (3.0 duct diameters) downstream from any flow disturbance and satisfies 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.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the air emission testing was reviewed and approved by the MDEQ. 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 zirconia ion/paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Exhaust gas moisture was determined based on the water weight gain in chilled impingers.
USEPA Method 7E	Exhaust gas NO_x concentration was determined using a chemiluminescence instrumental analyzer.
USEPA Method 10	Exhaust gas CO concentration was measured using an NDIR instrumental analyzer.
USEPA Method 25A / ALT-096	Exhaust gas VOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with a GC column.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 once for each test. 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 onsite prior to the test event to verify the integrity of the measurement system.

The absence of significant cyclonic flow for the exhaust configuration 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 exhaust gas streams were measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 1440D single beam single wavelength (SBSW) infrared gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 1440D gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the 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 the exhaust gas streams were 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 exhaust gas streams were determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NO_x analyzer and a TEI Model 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 Volatile Organic Compounds (USEPA Method 25A/ALT-096)

VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in each 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 several alternate test methods approving the use of the TEI 55-series analyzer as an effective instrument for measuring NMOC from gas-fueled reciprocating internal combustion engines (RICE) in that it uses USEPA Method 25A and 18 (ALT-066, ALT-078 and 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 <u>QA/QC ACTIVITIES</u>

5.1 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_2 concentration is greater than or equal to 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_2 concentration was 97.7% of the expected value, i.e., greater than 90% of the expected value as required by Method 7E).

5.2 Sampling System Response Time Determination

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.

Results of the response time determinations were recorded on field data sheets. For each test period, test data were collected once the sample probe was in position for at least twice the maximum system response time.

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

5.7 Meter Box Calibrations

The Nutech Model 2010 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).

6.0 RESULTS

6.1 RICE NO_x, CO, and VOC Emissions

The six (6) RICE generator sets (EUICENGINE1, EUICENGINE2, EUICENGINE3, EUICENGINE4, EUICENGINE6, and EUICENGINE7) were tested for NO_x, CO, and VOC emission rates. The measured air pollutant concentrations and emission rates for each one-hour test period are presented in Tables 6.1 through 6.6.

The measured emission rates are less than 40 CFR Part 60 Subpart JJJJ (SI RICE NSPS) emission standards; 2.0 g/bhp-hr NO_x, 5.0 g/bhp-hr CO and 1.0 g/bhp-hr VOC.

The measured emission rates are less than the allowable rates specified in MI-ROP-N5984-2013a and MI-PTI-N5984-2013a:

- 3.0 lb/hr and 0.6 g/bhp-hr for NO_x;
- 16.3 lb/hr and 3.3 g/bhp-hr for CO; and
- 1.0 lb/hr and 1.0 g/bhp-hr for VOC.

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 test protocol. The engine-generator sets were operated within 10% of maximum output (1,600 kW generator output) during the engine test periods.

The Stack Test Protocol dated January 4, 2019, submitted to and approved by MDEQ-AQD, stated that all eight (8) RICE generator sets, identified as emission units EUICENGINE1-EUICENGINE8, and flexible group FGICENGINES, would be tested for carbon monoxide (CO), nitrogen oxide (NO_x), and volatile organic compound (VOC) emissions during this test event. Following submittal of the Stack Test Protocol, but prior to completing the test event, Waste Management / Pine Tree Acres, Inc. representatives decided to postpone testing of two (2) of the RICE generator sets, identified as emission units EUICENGINE5 and EUICENGINE8 of flexible group FGICENGINES due to a scheduled replacement of those engines. Waste Management / Pine Tree Acres, Inc. and Impact Compliance & Testing, Inc. scheduled testing for those two (2) RICE generator sets (EUICENGINE5 and EUICENGINE8) for March 14, 2019, following installation and startup. This was discussed with and approved by MDEQ-AQD representative Mr. David Patterson.

Table 6.1 Measured exhaust gas conditions and NO_x, CO, and VOC emission rates
Engine No. 1 (EUICENGINE1, SN: GZJ00469)

Test No. Test date Test period (24-hr clock)	1 2/13/19 1147 - 1247	2 2/13/19 1302 - 1402	3 2/13/19 1417 - 1517	Three Test Average
Fuel flowrate (scfm)	534	539	539	537
Generator output (kW)	1,612	1,612	1,610	1,611
Engine output (bhp)	2,251	2,252	2,248	2,251
LFG methane content (%)	53.4	53.3	53.2	53.3
LFG LHV heat content (Btu/scf)	486	485	484	485
Exhaust Gas Composition				
CO_2 content (% vol)	11.4	11.4	11.4	11.4
O_2 content (% vol)	8.38	8.27	8.29	8.31
Moisture (% vol)	11.7	11.8	11.3	11.6
Exhaust gas temperature (^oF)	967	967	970	968
Exhaust gas flowrate (dscfm)	3,826	3,896	4,084	3,935
Exhaust gas flowrate (scfm)	4,333	4,420	4,603	4,452
Nitrogen Oxides				
NO_x conc. (ppmvd)	61.2	62.8	62.4	62.1
NO_x emissions (g/bhp*hr)	0.34	0.35	0.37	0.35
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_x emissions (lb/hr)	1.68	1.75	1.83	1.75
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	813	827	825	822
CO emissions (g/bhp*hr)	2.73	2.83	2.97	2.84
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	13.6	14.1	14.7	14.1
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	25.7	24.7	25.3	25.2
VOC emissions (g/bhp*hr)	0.15	0.15	0.16	0.16
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.76	0.75	0.80	0.77
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.2 Measured exhaust gas conditions and NO_x, CO, and VOC emission rates
Engine No. 2 (EUICENGINE2, SN: GZJ00464)

Test No. Test date Test period (24-hr clock)	1 2/14/19 1117 - 1217	2 2/14/19 1239 - 1339	3 2/14/19 1357 - 1457	Three Test Average
Fuel flowrate (scfm)	547	546	545	546
Generator output (kW)	1,620	1,618	1,618	1,619
Engine output (bhp)	2,263	2,260	2,260	2,261
LFG methane content (%)	52.2	52.4	52.4	52.3
LFG LHV heat content (Btu/scf)	475	477	477	476
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.8	11.8	11.8	11.8
O_2 content (% vol)	7.85	7.81	7.85	7.84
Moisture (% vol)	12.1	11.9	10.0	11.3
Exhaust gas temperature (°F)	987	987	980	985
Exhaust gas flowrate (dscfm)	3,715	3,574	3,983	3,757
Exhaust gas flowrate (scfm)	4,228	4,058	4,424	4,237
<u>Nitrogen Oxides</u>				
NO_x conc. (ppmvd)	91.1	91.3	89.4	90.6
NO_x emissions (g/bhp*hr)	0.49	0.47	0.51	0.49
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_x emissions (lb/hr)	2.43	2.34	2.55	2.44
Permitted emissions (lb/hr)	-	-	-	3.0
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	822	830	815	822
CO emissions (g/bhp*hr)	2.67	2.60	2.85	2.71
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	13.3	13.0	14.2	13.5
Permitted emissions (lb/hr)	-	-	-	16.3
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv)	20.8	20.6	20.6	20.7
VOC emissions (g/bhp*hr)	0.12	0.12	0.13	0.12
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.61	0.58	0.63	0.60
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.3 Measured exhaust gas conditions and NO_x, CO, and VOC emission rates
Engine No. 3 (EUICENGINE3, SN: GZJ00467)

Test No. Test date Test period (24-hr clock)	1 2/12/19 1202 - 1302	2 2/12/19 1320 - 1420	3 2/12/19 1436 - 1536	Three Test Average
Fuel flowrate (scfm)	521	518	520	519
Generator output (kW)	1,618	1,612	1,616	1,615
Engine output (bhp)	2,260	2,252	2,258	2,257
LFG methane content (%)	55.4	55.6	55.5	55.5
LFG LHV heat content (Btu/scf)	504	506	505	505
Exhaust Gas Composition				
CO_2 content (% vol)	11.1	11.1	11.2	11.1
O_2 content (% vol)	8.56	8.57	8.51	8.55
Moisture (% vol)	12.6	12.7	8.4	11.2
Exhaust gas temperature (^oF)	953	953	953	953
Exhaust gas flowrate (dscfm)	4,160	4,121	4,157	4,146
Exhaust gas flowrate (scfm)	4,760	4,718	4,539	4,672
Nitrogen Oxides				
NO_x conc. (ppmvd)	61.5	60.9	60.2	60.9
NO_x emissions (g/bhp*hr)	0.37	0.36	0.36	0.36
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_x emissions (lb/hr)	1.83	1.80	1.79	1.81
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	768	768	771	769
CO emissions (g/bhp*hr)	2.80	2.78	2.81	2.80
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	13.9	13.8	14.0	13.9
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	20.8	20.9	20.4	20.7
VOC emissions (g/bhp*hr)	0.14	0.14	0.13	0.13
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.68	0.68	0.63	0.66
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.4 Measured exhaust gas conditions and NO_x, CO, and VOC emission rates
Engine No. 4 (EUICENGINE4, SN: GZJ00466)

Test No. Test date Test period (24-hr clock)	1 2/12/19 0800 - 0900	2 2/12/19 0922 - 1022	3 2/12/19 1044 - 1144	Three Test Average
Fuel flowrate (scfm)	521	518	518	519
Generator output (kW)	1,617	1,614	1,617	1,616
Engine output (bhp)	2,259	2,255	2,259	2,258
LFG methane content (%)	55.4	55.2	55.3	55.3
LFG LHV heat content (Btu/scf)	504	502	503	503
Exhaust Gas Composition				
CO_2 content (% vol)	11.2	11.2	11.2	11.2
O_2 content (% vol)	8.39	8.38	8.43	8.40
Moisture (% vol)	11.6	12.0	9.3	11.0
Exhaust gas temperature (^oF)	942	943	945	943
Exhaust gas flowrate (dscfm)	3,952	3,857	4,158	3,989
Exhaust gas flowrate (scfm)	4,468	4,385	4,586	4,479
Nitrogen Oxides				
NO_x conc. (ppmvd)	67.9	64.6	64.9	65.8
NO_x emissions (g/bhp*hr)	0.39	0.36	0.39	0.38
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_x emissions (lb/hr)	1.92	1.79	1.94	1.88
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	843	839	842	841
CO emissions (g/bhp*hr)	2.92	2.84	3.07	2.94
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	14.5	14.1	15.3	14.7
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	19.6	20.1	21.2	20.3
VOC emissions (g/bhp*hr)	0.12	0.12	0.13	0.13
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.60	0.61	0.67	0.62
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.5 Measured exhaust gas conditions and NO_x, CO, and VOC emission rates
Engine No. 6 (EUICENGINE6, SN: GZJ00468)

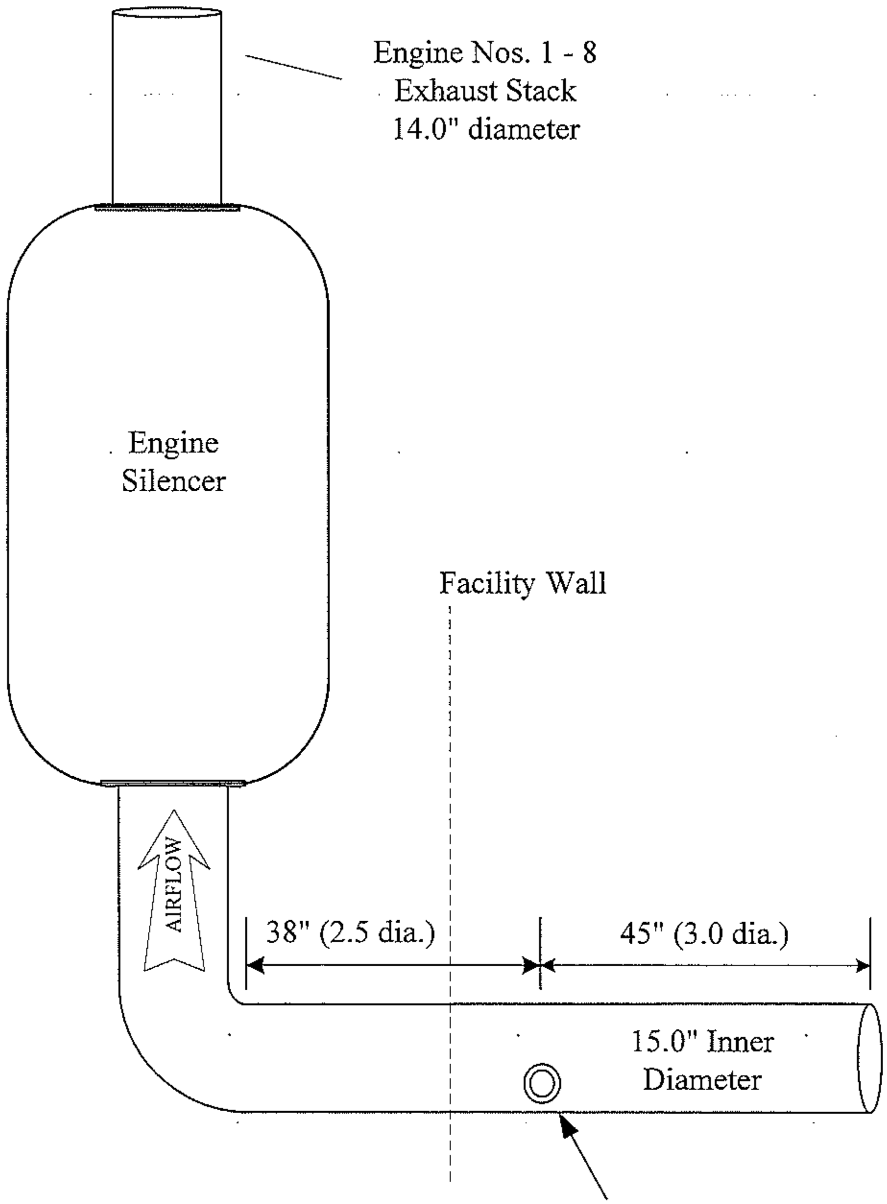
Test No. Test date Test period (24-hr clock)	1 2/14/19 0709 - 0809	2 2/14/19 0832 - 0932	3 2/14/19 0952 - 1052	Three Test Average
Fuel flowrate (scfm)	583	582	580	582
Generator output (kW)	1,626	1,629	1,624	1,626
Engine output (bhp)	2,272	2,276	2,268	2,272
LFG methane content (%)	51.7	51.9	52.2	51.9
LFG LHV heat content (Btu/scf)	470	472	475	472
Exhaust Gas Composition				
CO_2 content (% vol)	11.5	11.5	11.4	11.5
O_2 content (% vol)	8.14	8.16	8.24	8.18
Moisture (% vol)	10.8	13.5	11.3	11.9
Exhaust gas temperature (^oF)	963	963	954	960
Exhaust gas flowrate (dscfm)	4,174	4,082	4,154	4,137
Exhaust gas flowrate (scfm)	4,678	4,716	4,681	4,692
Nitrogen Oxides				
NO_x conc. (ppmvd)	55.4	56.2	56.1	55.9
NO_x emissions (g/bhp*hr)	0.33	0.33	0.33	0.33
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_x emissions (lb/hr)	1.66	1.64	1.67	1.66
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	841	855	843	846
CO emissions (g/bhp*hr)	3.06	3.03	3.06	3.05
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	15.3	15.2	15.3	15.3
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	21.6	21.1	20.7	21.1
VOC emissions (g/bhp*hr)	0.14	0.14	0.13	0.14
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.69	0.68	0.67	0.68
Permitted emissions (lb/hr)	-	-	-	1.0

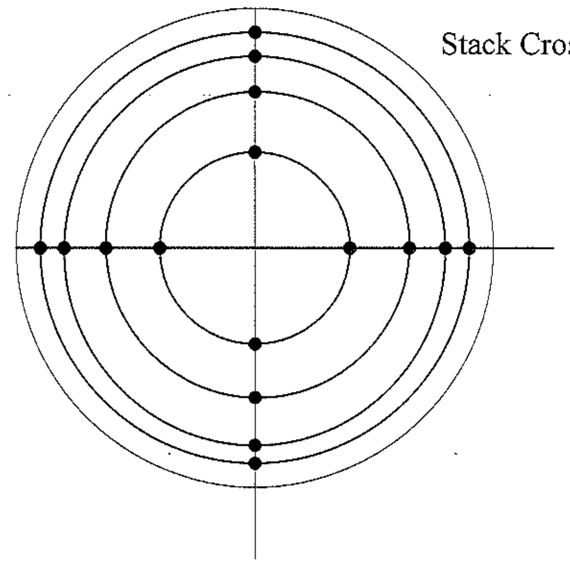
Table 6.6 Measured exhaust gas conditions and NO_x, CO, and VOC emission rates
Engine No. 7 (EUICENGINE7, SN: GZJ00463)

Test No. Test date Test period (24-hr clock)	1 2/13/19 0756 - 0856	2 2/13/19 0912 - 1012	3 2/13/19 1028 - 1128	Three Test Average
Fuel flowrate (scfm)	564	564	562	563
Generator output (kW)	1,630	1,620	1,620	1,623
Engine output (bhp)	2,277	2,263	2,263	2,268
LFG methane content (%)	53.4	53.6	53.6	53.5
LFG LHV heat content (Btu/scf)	486	488	488	487
Exhaust Gas Composition				
CO_2 content (% vol)	11.3	11.3	11.3	11.3
O_2 content (% vol)	8.45	8.45	8.48	8.46
Moisture (% vol)	13.5	11.1	12.2	12.3
Exhaust gas temperature (^oF)	964	960	963	962
Exhaust gas flowrate (dscfm)	4,232	4,387	4,339	4,319
Exhaust gas flowrate (scfm)	4,892	4,934	4,940	4,922
Nitrogen Oxides				
NO_x conc. (ppmvd)	40.2	37.8	37.4	38.5
NO_x emissions (g/bhp*hr)	0.24	0.24	0.23	0.24
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_x emissions (lb/hr)	1.22	1.19	1.16	1.19
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	745	739	744	743
CO emissions (g/bhp*hr)	2.74	2.84	2.82	2.80
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	13.8	14.2	14.1	14.0
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	25.0	25.0	25.4	25.1
VOC emissions (g/bhp*hr)	0.17	0.17	0.17	0.17
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.84	0.85	0.86	0.85
Permitted emissions (lb/hr)	-	-	-	1.0

APPENDIX 1

Sample Port Diagrams





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	ICT