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AIR EMISSION TEST REPORT

Title	AIR EMISSION TEST REPORT FOR THE LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES OPERATED AT PINE TREE ACRES LANDFILL
Report Date	June 2, 2014
Test Dates	April 8 – 10, 2014

Facility Information	
Name	Waste Management of Michigan, Inc. – Pine Tree Acres Landfill
Street Address	36600 29-Mile Rd.
City, County	Lenox Township, Macomb
SRN	N5984

Facility Permit Information			
Facility SRN.:	N5984	ROP No. :	MI-ROP-N5984-2013

Source Information – FGICENGINES, 8 CAT® Model G3520C IC Engines				
Emission Unit	EUICENGINE1	EUICENGINE2	EUICENGINE3	EUICENGINE4
Serial Number	GZJ00469	GZJ00464	GZJ00467	GZJ00466
Emission Unit	EUICENGINE5	EUICENGINE6	EUICENGINE7	EUICENGINE8
Serial Number	GZJ00462	GZJ00468	GZJ00463	GZJ00465

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1401101

AIR EMISSION TEST REPORT
FOR THE
LANDFILL GAS FUELED
INTERNAL COMBUSTION ENGINES
OPERATED AT
PINE TREE ACRES LANDFILL

1.0 INTRODUCTION

Waste Management of Michigan, Inc. (WM) operates eight (8) Caterpillar (CAT®) Model No. G3520C landfill gas (LFG) fueled reciprocating internal combustion engines (RICE) at the Pine Tree Acres (PTA) Landfill gas to energy facility (Facility SRN: N5984) in Lenox Township, Macomb County, Michigan. The facility has been issued Renewable Operating Permit (ROP) No. MI-ROP-N5984-2013 by the Michigan Department of Environmental Quality (MDEQ).

The CAT® Model No. G3520C engines are identified in ROP No. MI-ROP-N5984-2013 as Emission Unit ID: EUICENGINE1 through 8 (Flexible Group ID: FGICENGINES).

Air emission compliance testing was performed to demonstrate ongoing compliance with 40 CFR 60, Subpart JJJJ and FGICENGINES Special Condition No. V.2. of ROP No. MI-ROP-N5984-2013 which states:

> *...the permittee shall conduct an initial performance test for each engine in FGICENGINES within one year after startup of the engine and every 8,760 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 was performed by Derenzo and Associates, Inc. (Derenzo and Associates), a Michigan-based environmental consulting and testing company. Derenzo and Associates representatives Tyler Wilson, and Andrew Rusnak performed the field sampling and measurements April 8 – 10, 2014.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan that was reviewed and approved by the MDEQ in the March 11, 2014 test plan approval letter. MDEQ representatives Mr. Nathan Hund, Mr. David Patterson and Ms. Rebecca Loftus observed portions of the testing project.

Questions regarding this emission test report should be directed to:

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Report Certification

I certify under penalty of law that I believe the information provided in this document is true, accurate, and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for knowingly submitting false, inaccurate, or incomplete information.

Report Prepared By:

Andrew Rusnak, QSTI
Senior Environmental Engineer
Derenzo and Associates, Inc.

Responsible Official Certification:

Charles H. Cassie
Senior District Manager
Waste Management of Michigan, Inc.

2.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

2.1 General Process Description

LFG containing methane is generated in the PTA Landfill from the anaerobic decomposition of disposed waste materials. The LFG is collected from both active and capped landfill cells using a system of wells (gas collection system). The collected LFG is transferred to the PTA landfill gas-to-energy facility where it is treated and used as fuel for the eight (8) RICE. Each RICE is connected to an electricity generator that produces electricity that is transferred to the local utility.

2.2 Rated Capacities and Air Emission Controls

The CAT® Model No. G3520C RICE has a rated output of 2,233 brake-horsepower (bhp) and the connected generator has a rated electricity output of 1,600 kilowatts (kW). The engine is designed to fire low-pressure, lean fuel mixtures (e.g., LFG) and is equipped with an air-to-fuel ratio controller that monitors engine performance parameters and automatically adjusts the air-to-fuel ratio and ignition timing to maintain efficient fuel combustion.

The engine/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.

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.

2.3 Sampling Locations

The RICE exhaust gas is directed through mufflers and is released to the atmosphere through dedicated vertical exhaust stacks with vertical release points. The eight (8) CAT® Model G3520C RICE exhaust stacks are identical.

The exhaust duct sampling ports for the CAT® Model G3520C engines (EUICENGINE1 through 8) 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). 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 A provides diagrams of the emission test sampling locations.

3.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

3.1 Purpose and Objective of the Tests

The conditions of ROP No. MI-ROP-N5984-2013 and 40 CFR Part 60 Subpart JJJJ require PTA Landfill to test each RICE (EUICENGINE1 through 8) for carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOCs) every 8,760 hours of operation. Therefore, each RICE (EUICEENGINE1 through 8) was sampled for CO, NO_X and VOC emissions and exhaust gas oxygen (O_2) and carbon dioxide (CO_2) content.

3.2 Operating Conditions During the Compliance Tests

The testing was performed while the engine/generator sets were operated at maximum operating conditions (1,600 kW electricity output +/- 10%). PTA Landfill representatives provided the kW output in 15-minute increments for each test period. The RICE generator kW output ranged between 1,594 and 1,655 kW during the test periods.

Fuel flowrate (cubic feet per minute) and fuel methane content (%) were also recorded by PTA Landfill representatives in 15-minute increments for each test period. The RICE fuel consumption rate ranged between 555 and 604 scfm and fuel methane content ranged between 48.4 and 49.4% during the test periods.

The MDEQ requested that the hydrogen sulfide content of the landfill gas after the treatment system be recorded once during each day of testing. Testing occurred over a three-day span and each day the measured LFG hydrogen sulfide content was 120 ppm.

Appendix B provides operating records provided by PTA Landfill representatives for 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 (96.1%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

Engine output (bhp) = Electricity output (kW) / (0.961) / (0.7457 kW/hp)

A lower heating value of 910 Btu/scf was used to calculate the LFG heating value.

Table 3.1 presents a summary of the average engine operating conditions during the test periods.

3.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled LFG fueled RICE were each sampled for three (3) one-hour test periods during the compliance testing performed April 8 – 10, 2014.

Table 3.2 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.

Results of the engine performance tests demonstrate compliance with emission limits specified in 40 CFR 60, Subpart JJJJ and ROP No. MI-ROP-N5984-2013.

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 3.1 Average engine operating conditions during the test periods

Emission Unit	Gen. Output (kW)	Engine Output (bHp)	Fuel Use (scfm)	LFG CH_4 Content (%)	LFG Btu Content (Btu/scf)	Exhaust Temp. (°F)	Air to Fuel Ratio	Inlet Press. (psi)
EUICENGINE1	1,633	2,279	583	48.9	445	932	8.14	2.32
EUICENGINE2	1,632	2,277	582	48.6	442	915	8.09	2.55
EUICENGINE3	1,634	2,280	595	48.7	443	941	8.14	2.36
EUICENGINE4	1,635	2,281	593	48.6	442	939	7.99	2.22
EUICENGINE5	1,625	2,267	587	49.2	448	933	8.19	2.31
EUICENGINE6	1,634	2,281	582	48.8	444	927	8.25	2.26
EUICENGINE7	1,625	2,268	574	49.2	448	926	8.21	2.29
EUICENGINE8	1,623	2,265	563	48.8	444	932	7.93	2.33

Table 3.2 Average measured emission rates for each tested PTA Landfill RICE (three-test average)

	CO Emission Rates		NOx Emission Rates		VOC Emission Rates	
Emission Unit	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)
EUICENGINE1	15.5	3.1	2.0	0.4	0.7	0.2
EUICENGINE2	13.7	2.7	1.9	0.4	0.8	0.2
EUICENGINE3	15.8	3.1	2.0	0.4	0.8	0.2
EUICENGINE4	16.1	3.2	2.1	0.4	0.7	0.2
EUICENGINE5	15.9	3.2	1.8	0.4	0.8	0.2
EUICENGINE6	15.9	3.2	2.4	0.5	0.7	0.1
EUICENGINE7	15.3	3.1	2.0	0.4	0.7	0.2
EUICENGINE8	14.5	2.9	2.5	0.5	0.7	0.1
Emission Limit	16.3	3.3	3.0	0.6	1.0	1.0

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Test protocols for the air emission testing were 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 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 NOx concentration was determined using chemiluminescence instrumental analyzers.
USEPA Method 10	Exhaust gas CO concentration was measured using NDIR instrumental analyzers.
USEPA Method ALT-096	Exhaust gas VOC (as NMHC) concentration was determined using flame ionization analyzers equipped with GC columns.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The RICE exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 prior to and after each test. 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 periodically leak-checked 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 C 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 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 4100 and 4900 single beam single wavelength (SBSW) infrared gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 4100 and 4900 gas analyzer that uses a paramagnetic sensor.

During each sampling period, a continuous sample of the IC engine 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 D provides O_2 and CO_2 calculation sheets. Raw instrument response data are provided in Appendix E.

4.4 Exhaust Gas Moisture Content (USEPA Method 4)

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

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

NO_X and CO pollutant concentrations in the RICE exhaust gas streams were determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NO_X analyzer and a TEI Model 48c 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 D provides CO and NO_X calculation sheets. Raw instrument response data are provided in Appendix E.

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

VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in the exhaust gas for each RICE. NMHC pollutant concentration was determined using TEI Model 55i Methane / Nonmethane hydrocarbon analyzer.

Throughout each one-hour test period, a continuous sample of the IC engine exhaust gas was extracted from the stack using the Teflon® heated sample line described in Section 4.3 of this document, and delivered to the instrumental analyzer. The sampled gas was not conditioned prior to being introduced to the analyzer; therefore, the measurement of NMHC concentration corresponds to standard wet gas conditions. Instrument NMHC (VOC) response for the analyzer was recorded on an ESC Model 8816 data logging 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 instrument was calibrated using mid-range calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document).

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

5.0 QA/QC ACTIVITIES

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 within 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_2 concentration was -6.68% of the expected value, i.e., within 10% 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.

The TEI Model 42c analyzer exhibited the longest system response time at 74 seconds. 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 (on December 20, 2013) 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 (July 26, 2006, June 21, 2011 and April 3, 2012), 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 3.0% 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 for each IC engine exhaust stack was performed during the performance test sampling periods. 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 data for each IC engine exhaust stack gas indicate that the measured CO, O_2 and CO_2 concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the stack gas of each IC engine was considered to be unstratified and the compliance test sampling was performed at a single sampling location within each IC engine 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 F 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, stratification checks, cyclonic flow determinations sheets, Pitot tube and probe assembly 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.

The measured air pollutant concentrations and emission rates for Engine Nos. 1 through 8 (EUICENGINE1 through 8) are less than the allowable limits specified in ROP No. MI-ROP-N5984-2013 for the engines:

- 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 the approved test protocols. The engine-generator sets were operated within 10% of maximum output and no variations from the normal operating conditions of the RICE occurred during the engine test periods.

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

Test No. Test date Test period (24-hr clock)	1 4/9/14 1452 - 1552	2 4/9/14 1625 - 1725	3 4/9/14 1758 – 1858	Three Test Average
Fuel flowrate (scfm)	583	585	583	583
Generator output (kW)	1,628	1,632	1,639	1,633
Engine output (bhp)	2,272	2,278	2,287	2,279
LFG methane content (%)	48.8	49.0	49.0	48.9
LFG LHV heat content (Btu/scf)	444	446	446	445
Air / Fuel Ratio	8.10	8.18	8.14	8.14
Inlet Pressure (psi)	2.33	2.32	2.30	2.32
Exhaust Gas Composition				
CO_2 content (% vol)	11.4	11.4	11.4	11.4
O_2 content (% vol)	8.31	8.38	8.22	8.30
Moisture (% vol)	11.9	11.4	11.2	11.5
Exhaust gas temperature (°F)	933	931	930	932
Exhaust gas flowrate (dscfm)	4,220	4,193	4,189	4,201
Exhaust gas flowrate (scfm)	4,777	4,727	4,720	4,741
Nitrogen Oxides				
NO_X conc. (ppmvd)	65.9	66.5	64.2	65.6
NO_X emissions (g/bhp*hr)	0.4	0.4	0.4	0.4
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.0	2.0	1.9	2.0
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	848	849	846	848
CO emissions (g/bhp*hr)	3.1	3.1	3.1	3.1
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	15.6	15.5	15.5	15.5
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	23.2	22.4	22.8	22.8
VOC emissions (g/bhp*hr)	0.2	0.1	0.2	0.2
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.8	0.7	0.7	0.7
Permitted emissions (lb/hr)	-	-	-	1.0

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

Test No. Test date Test period (24-hr clock)	1 4/9/14 1033 - 1133	2 4/9/14 1159 - 1259	3 4/9/14 1328 - 1428	Three Test Average
Fuel flowrate (scfm)	583	582	580	582
Generator output (kW)	1,629	1,632	1,634	1,632
Engine output (bhp)	2,273	2,278	2,281	2,277
LFG methane content (%)	48.5	48.6	48.7	48.6
LFG LHV heat content (Btu/scf)	441	442	443	442
Air / Fuel Ratio	8.08	8.08	8.10	8.09
Inlet Pressure (psi)	2.55	2.55	2.55	2.55
Exhaust Gas Composition				
CO_2 content (% vol)	11.2	11.2	11.2	11.2
O_2 content (% vol)	8.55	8.57	8.56	8.56
Moisture (% vol)	11.2	11.6	10.8	11.2
Exhaust gas temperature (°F)	915	917	916	915
Exhaust gas flowrate (dscfm)	4,183	4,271	4,288	4,247
Exhaust gas flowrate (scfm)	4,722	4,810	4,809	4,780
Nitrogen Oxides				
NO_X conc. (ppmvd)	61.0	61.7	60.3	61.0
NO_X emissions (g/bhp*hr)	0.4	0.4	0.4	0.4
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	1.8	1.9	1.9	1.9
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	745	740	738	741
CO emissions (g/bhp*hr)	2.7	2.8	2.8	2.7
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	13.6	13.8	13.8	13.7
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	25.4	25.5	25.6	25.5
VOC emissions (g/bhp*hr)	0.2	0.2	0.2	0.2
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.8	0.8	0.9	0.8
Permitted emissions (lb/hr)	-	-	-	1.0

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

Test No. Test date Test period (24-hr clock)	1 4/8/14 1245 - 1345	2 4/8/14 1416 - 1516	3 4/8/14 1544 – 1644	Three Test Average
Fuel flowrate (scfm)	595	596	595	595
Generator output (kW)	1,635	1,627	1,639	1,634
Engine output (bhp)	2,281	2,270	2,287	2,280
LFG methane content (%)	48.7	48.8	48.7	48.7
LFG LHV heat content (Btu/scf)	443	444	443	443
Air / Fuel Ratio	8.14	8.14	8.14	8.14
Inlet Pressure (psi)	2.39	2.34	2.34	2.36
Exhaust Gas Composition				
CO_2 content (% vol)	11.6	11.2	11.2	11.3
O_2 content (% vol)	8.22	8.25	8.25	8.24
Moisture (% vol)	11.6	11.1	11.7	11.5
Exhaust gas temperature (°F)	941	941	940	941
Exhaust gas flowrate (dscfm)	4,267	4,305	4,307	4,293
Exhaust gas flowrate (scfm)	4,813	4,860	4,877	4,850
Nitrogen Oxides				
NO_X conc. (ppmvd)	65.9	64.4	66.3	65.5
NO_X emissions (g/bhp*hr)	0.4	0.4	0.4	0.4
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.0	2.0	2.1	2.0
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	845	848	835	842
CO emissions (g/bhp*hr)	3.1	3.2	3.1	3.1
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	15.7	15.9	15.7	15.8
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	22.1	22.3	23.1	22.5
VOC emissions (g/bhp*hr)	0.2	0.2	0.2	0.2
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.7	0.8	0.8	0.8
Permitted emissions (lb/hr)	-	-	-	1.0

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

Test No. Test date Test period (24-hr clock)	1 4/8/14 1711 - 1811	2 4/8/14 1830 - 1930	3 4/8/14 1950 – 2050	Three Test Average
Fuel flowrate (scfm)	588	594	597	593
Generator output (kW)	1,631	1,636	1,638	1,635
Engine output (bhp)	2,276	2,283	2,285	2,281
LFG methane content (%)	48.7	48.6	48.5	48.6
LFG LHV heat content (Btu/scf)	443	442	441	442
Air / Fuel Ratio	8.02	7.96	7.98	7.99
Inlet Pressure (psi)	2.26	2.25	2.14	2.22
Exhaust Gas Composition				
CO_2 content (% vol)	11.3	11.3	11.4	11.3
O_2 content (% vol)	8.20	8.22	8.22	8.21
Moisture (% vol)	11.7	11.5	11.6	11.6
Exhaust gas temperature (°F)	938	939	940	939
Exhaust gas flowrate (dscfm)	4,227	4,229	4,187	4,215
Exhaust gas flowrate (scfm)	4,783	4,782	4,736	4,767
Nitrogen Oxides				
NO_X conc. (ppmvd)	72.4	66.5	67.6	68.8
NO_X emissions (g/bhp*hr)	0.4	0.4	0.4	0.4
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.2	2.0	2.0	2.1
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	875	871	877	874
CO emissions (g/bhp*hr)	3.2	3.2	3.2	3.2
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	16.1	16.1	16.0	16.1
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	22.6	22.8	22.5	22.6
VOC emissions (g/bhp*hr)	0.2	0.2	0.2	0.2
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.7	0.8	0.7	0.7
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.5 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates PTA Landfill Engine No. 5 (EUICENGINE5) (SN: GZJ00462)

Test No. Test date Test period (24-hr clock)	1 4/10/14 745 - 845	2 4/10/14 919 - 1019	3 4/10/14 1058 - 1158	Three Test Average
Fuel flowrate (scfm)	586	587	588	587
Generator output (kW)	1,621	1,628	1,625	1,625
Engine output (bhp)	2,262	2,272	2,268	2,267
LFG methane content (%)	49.0	49.3	49.3	49.2
LFG LHV heat content (Btu/scf)	446	449	449	448
Air / Fuel Ratio	8.10	8.22	8.24	8.19
Inlet Pressure (psi)	2.33	2.32	2.29	2.31
Exhaust Gas Composition				
CO_2 content (% vol)	11.6	11.5	11.4	11.5
O_2 content (% vol)	8.14	8.38	8.44	8.32
Moisture (% vol)	12.1	11.4	11.6	11.7
Exhaust gas temperature (°F)	937	934	930	933
Exhaust gas flowrate (dscfm)	4,207	4,223	4,275	4,235
Exhaust gas flowrate (scfm)	4,767	4,772	4,835	4,791
Nitrogen Oxides				
NO_X conc. (ppmvd)	66.6	58.6	55.4	60.2
NO_X emissions (g/bhp*hr)	0.4	0.4	0.3	0.4
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.0	1.8	1.7	1.8
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	857	856	861	858
CO emissions (g/bhp*hr)	3.2	3.2	3.2	3.2
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	15.7	15.8	16.1	15.9
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	23.3	26.6	26.7	25.5
VOC emissions (g/bhp*hr)	0.2	0.2	0.2	0.2
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.8	0.9	0.9	0.8
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.6 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates PTA Landfill Engine No. 6 (EUICENGINE6) (SN: GZJ00468)

Test No. Test date Test period (24-hr clock)	1 4/8/14 824 - 924	2 4/8/14 949 - 1049	3 4/8/14 1114 – 1214	Three Test Average
Fuel flowrate (scfm)	582	582	584	582
Generator output (kW)	1,639	1,632	1,632	1,634
Engine output (bhp)	2,287	2,278	2,277	2,281
LFG methane content (%)	48.8	48.8	48.7	48.8
LFG LHV heat content (Btu/scf)	444	444	443	444
Air / Fuel Ratio	8.28	8.26	8.22	8.25
Inlet Pressure (psi)	2.25	2.26	2.28	2.26
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.9	11.4	11.1	11.4
O_2 content (% vol)	8.30	8.25	8.24	8.26
Moisture (% vol)	12.4	11.2	12.1	11.9
Exhaust gas temperature (°F)	927	927	928	927
Exhaust gas flowrate (dscfm)	4,194	4,252	4,250	4,232
Exhaust gas flowrate (scfm)	4,754	4,814	4,835	4,801
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	79.8	80.8	79.2	79.9
NO_X emissions (g/bhp*hr)	0.5	0.5	0.5	0.5
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.4	2.5	2.4	2.4
Permitted emissions (lb/hr)	-	-	-	3.0
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	854	872	858	861
CO emissions (g/bhp*hr)	3.1	3.2	3.2	3.2
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	15.6	16.2	15.9	15.9
Permitted emissions (lb/hr)	-	-	-	16.3
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv)	21.9	21.7	21.4	21.7
VOC emissions (g/bhp*hr)	0.1	0.1	0.1	0.1
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.7	0.7	0.7	0.7
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.7 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates PTA Landfill Engine No. 7 (EUICENGINE7) (SN: GZJ00463)

Test No. Test date Test period (24-hr clock)	1 4/10/14 1238 - 1338	2 4/10/14 1404 - 1504	3 4/10/14 1526 – 1626	Three Test Average
Fuel flowrate (scfm)	572	575	576	574
Generator output (kW)	1,625	1,624	1,627	1,625
Engine output (bhp)	2,268	2,266	2,270	2,268
LFG methane content (%)	49.3	49.2	49.0	49.2
LFG LHV heat content (Btu/scf)	449	448	446	448
Air / Fuel Ratio	8.20	8.20	8.22	8.21
Inlet Pressure (psi)	2.33	2.27	2.27	2.29
Exhaust Gas Composition				
CO_2 content (% vol)	11.6	11.5	11.5	11.5
O_2 content (% vol)	8.09	8.21	8.44	8.25
Moisture (% vol)	11.5	11.7	12.1	11.8
Exhaust gas temperature (°F)	932	924	919	926
Exhaust gas flowrate (dscfm)	4,316	4,283	4,285	4,295
Exhaust gas flowrate (scfm)	4,881	4,862	4,878	4,874
Nitrogen Oxides				
NO_X conc. (ppmvd)	64.7	65.1	63.8	64.5
NO_X emissions (g/bhp*hr)	0.4	0.4	0.4	0.4
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.0	2.0	2.0	2.0
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	818	814	810	814
CO emissions (g/bhp*hr)	3.1	3.1	3.0	3.1
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	15.4	15.2	15.2	15.3
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	21.4	21.9	22.4	21.9
VOC emissions (g/bhp*hr)	0.1	0.2	0.2	0.2
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.7	0.7	0.8	0.7
Permitted emissions (lb/hr)	-	-	-	1.0

Table 6.8 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates PTA Landfill Engine No. 8 (EUICENGINE8) (SN: GZJ00465)

Test No. Test date Test period (24-hr clock)	1 4/10/14 1649 - 1749	2 4/10/14 1808 - 1908	3 4/10/14 1927 – 2027	Three Test Average
Fuel flowrate (scfm)	559	564	566	563
Generator output (kW)	1,621	1,621	1,628	1,623
Engine output (bhp)	2,262	2,261	2,271	2,265
LFG methane content (%)	48.9	48.8	48.6	48.8
LFG LHV heat content (Btu/scf)	445	444	442	444
Air / Fuel Ratio	7.98	7.90	7.90	7.93
Inlet Pressure (psi)	2.33	2.33	2.34	2.33
Exhaust Gas Composition				
CO_2 content (% vol)	11.7	11.5	11.8	11.7
O_2 content (% vol)	8.05	7.71	7.83	7.86
Moisture (% vol)	11.7	12.2	12.2	12.0
Exhaust gas temperature (^oF)	930	934	934	932
Exhaust gas flowrate (dscfm)	4,139	4,085	4,078	4,101
Exhaust gas flowrate (scfm)	4,700	4,654	4,647	4,667
Nitrogen Oxides				
NO_X conc. (ppmvd)	81.8	89.0	88.7	86.5
NO_X emissions (g/bhp*hr)	0.5	0.5	0.5	0.5
Permitted emissions (g/bhp*hr)	-	-	-	0.6
NO_X emissions (lb/hr)	2.4	2.6	2.6	2.5
Permitted emissions (lb/hr)	-	-	-	3.0
Carbon Monoxide				
CO conc. (ppmvd)	808	812	811	810
CO emissions (g/bhp*hr)	2.9	2.9	2.9	2.9
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	14.6	14.5	14.4	14.5
Permitted emissions (lb/hr)	-	-	-	16.3
Volatile Organic Compounds				
VOC conc. (ppmv)	20.6	20.0	19.8	20.1
VOC emissions (g/bhp*hr)	0.1	0.1	0.1	0.1
Permitted emissions (g/bhp*hr)	-	-	-	1.0
VOC emissions (lb/hr)	0.7	0.6	0.6	0.7
Permitted emissions (lb/hr)	-	-	-	1.0