IMPACT COMPLIANCE & TESTING

AIR EMISSION TEST REPORT

Title:	AIR EMISSION TEST REPORT FOR THE VERIFICATION OF AIR POLLUTANT EMISSIONS FROM LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES
Report Date:	July 18, 2019
Test Date(s):	June 3-5, 2019

Facility Information	
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Street Address:	36450 29 Mile Road
City, County:	Lenox Township, Macomb
Phone:	(586) 634-8085
SRN:	N5984

Facility Permit Information	
Renewable Operating Permit No.:	MI-ROP-N5984-201X
Emission Unit ID:	EU-ENGINE1 through EU-ENGINE7

Testing Contractor	
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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 by Sumpter Energy employees or representatives. This test report has been reviewed by Sumpter Energy representatives and approved for submittal to the EGLE-AQD.

I certify that the testing was conducted in accordance with the approved 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.

I certify that the facility operating conditions were in compliance with permit requirements or were at the maximum routine operating conditions for the facility. Based on information and belief formed after reasonable inquiry, the statements and information in this report are true, accurate and complete.

Responsible Official Certification:

Dennis Plaster
Vice President of Operations
Aria Energy

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FOR THE
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PINE TREE ACRES LANDFILL

1.0 INTRODUCTION

Sumpter Energy Associates (SEA) operates two (2) landfill gas (LFG) to energy facilities at the Pine Tree Acres (PTA) Landfill in Lenox Township, Macomb County, Michigan. The two Sumpter Energy facilities, referred to as SEA Phase I and SEA Phase II, have been issued a Working Draft of Renewable Operating Permit (ROP) No. MI-ROP-N5984-201X by the Michigan Department of Environment, Great Lakes, and Energy-Air Quality Division (EGLE-AQD).

The SEA Phase I facility consists of seven (7) Caterpillar (CAT®) Model No. 3516 LFG-fueled reciprocating internal combustion engines (RICE) that are identified in ROP No. MI-ROP-N5984-201X as Emission Unit ID: EU-ENGINE1 through EU-ENGINE7 (Flexible Group ID: FG-ENGINES).

Air emission compliance testing was performed pursuant to FG-ENGINES Special Condition No. V.3. of ROP No. MI-ROP-N5984-201X, which states:

> *The permittee shall verify the NOx, CO, HCl and NMOC emission rates from each engine in FG-ENGINES, at a minimum, every five years from the date of the last test.*

The compliance testing was performed by Impact Compliance & Testing, Inc. (ICT), a Michigan-based environmental consulting and testing company. ICT representatives Tyler Wilson and Jory VanEss performed the field sampling and measurements June 3-5, 2019.

The exhaust gas sampling and analysis was performed using procedures specified in the Stack Test Protocol that was reviewed and approved by the EGLE-AQD in the May 8, 2019 Test Plan Approval Letter. EGLE-AQD representatives Mr. Tom Gasloli and Mr. Robert Joseph observed portions of the testing project.

2.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

2.1 General Process Description

LFG containing methane is generated in the Pine Tree Acres 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 SEA Pine Tree LFGTE facility where it is treated and used as fuel for the seven (7) 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. 3516 RICE generator set has a rated output of 1,138 brake-horsepower (bhp) and the connected generator has a rated electricity output of 800 kilowatts (kW). The engine is designed to fire low-pressure, lean fuel mixtures (e.g., LFG) and employs lean-burn technology for efficient fuel combustion and to minimize emissions. The air-to-fuel ratio is set based on the gas quality (methane or heat content) of the treated fuel for the most efficient combustion. Exhaust gas is released directly to atmosphere through a noise muffler and vertical exhaust stack.

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.

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 seven (7) CAT® Model 3516 RICE exhaust stacks are identical.

The exhaust stack sampling ports for the CAT® Model 3516 engines (EU-ENGINE1 through EU-ENGINE7) are located in individual exhaust stacks with an inner diameter of 12.0 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 18.0 inches (1.5 duct diameters) upstream and 58.0 inches (4.8 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 the Working Draft of ROP No. MI-ROP-N5984-201X require Sumpter Energy to test each RICE (EU-ENGINE1 through EU-ENGINE7) for carbon monoxide (CO), nitrogen oxides (NO_X), non-methane organic compound (NMOC), and hydrogen chloride (HCl) emissions, at a minimum, every five (5) years from the last test. Measurements were performed for each RICE exhaust to determine CO, NO_X, NMOC, and HCl concentrations, diluent gas content (oxygen (O_2) and carbon dioxide (CO_2)) and volumetric flowrate.

3.2 Operating Conditions During the Compliance Tests

The testing was performed while the engine/generator sets were operated within at least 10% of maximum rated capacity of 800 kW electricity output. Sumpter Energy representatives provided kW output data at 15-minute intervals for each test period. The RICE generator kW output ranged between 760 and 800 kW during the test periods (95% of maximum capacity or greater).

Facility fuel flowrate (cubic feet per minute) and fuel methane content (%) were also recorded by Sumpter Energy representatives in 15-minute increments for each test period. The RICE facility fuel consumption rate ranged between 1,815 and 2,181 scfm (259 and 312 scfm per individual RICE) and fuel methane content ranged between 50.9 and 52.3% during the test periods. A lower heating value of 910 Btu/scf was used to calculate the LFG heating value (Btu/scf LHV) based on the methane content.

Appendix B provides operating records provided by Sumpter Energy 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 3516 generator efficiency (93.9%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

$$\text{Engine output (bhp)} = \text{Electricity output (kW)} / (0.939) / (0.7457\ \text{kW/hp})$$

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 seven (7) LFG fueled RICE generator sets were each sampled for three (3) one-hour test periods during the compliance testing performed June 3-5, 2019.

Table 3.2 presents the average measured CO, NO_X, NMOC, and HCl 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 ROP No. MI-ROP-N5984-201X. Test results for each one-hour sampling period 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)	Facility Fuel Use (scfm)	RICE Fuel Use* (scfm)	LFG CH_4 Content (%)	LFG Btu Content (Btu/scf)	Exhaust Temp. (°F)
EU-ENGINE1	799	1,141	2,126	304	52.1	474	803
EU-ENGINE2	800	1,143	2,083	298	51.4	468	757
EU-ENGINE3	800	1,143	2,087	298	51.3	467	794
EU-ENGINE4	791	1,130	2,107	301	51.9	472	742
EU-ENGINE5	777	1,110	2,100	300	51.7	470	781
EU-ENGINE6	773	1,104	2,099	300	51.4	468	753
EU-ENGINE7	800	1,143	2,110	301	51.3	467	821

Note: Individual RICE fuel use cannot be measured, so total facility fuel use is divided by seven (7 engines total at the facility) for a best estimate of individual RICE fuel use.

Table 3.2 Average measured emission rates for each LFG-fueled RICE generator set (three-test average)

	CO Emission Rates	NO_X Emission Rates	NMOC Emission Rates	HCl Emission Rates
Emission Unit	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
EU-ENGINE1	7.68	1.92	0.56	0.091
EU-ENGINE2	5.74	1.94	0.40	0.091*
EU-ENGINE3	7.16	1.35	0.66	0.091*
EU-ENGINE4	6.71	2.17	0.57	0.091*
EU-ENGINE5	5.72	1.13	0.46	0.091*
EU-ENGINE6	7.16	0.97	0.71	0.087
EU-ENGINE7	7.33	1.18	0.82	0.094
Total	**47.5**	**10.7**	**4.18**	**0.63**
Emission Limit	*51.1*	*35.2*	*8.8*	*0.7*

Note: HCl testing was not performed on Engine Nos. 2, 3, 4, and 5. HCl emission rates for Engine Nos. 1, 6, and 7 were averaged and the result (0.091 lb/hr) was used for Engine Nos. 2, 3, 4, and 5 for calculating total HCl emissions for the entire facility to compare to the emission limit.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

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

4.1 Summary of Sampling Methods

USEPA Method 1	Exhaust gas velocity measurement locations were determined based on the physical stack arrangement and requirements in USEPA Method 1.
USEPA Method 2	Exhaust gas velocity pressure was determined using a Type-S Pitot tube connected to a red oil incline manometer; temperature was measured using a K-type thermocouple connected to the Pitot tube.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content was determined using paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	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 NMOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with an internal methane separation GC column.
USEPA Method 26A	Exhaust gas HCl concentration by single point (non-isokinetic) sampling and analysis by ion chromatography.

4.2 Exhaust Gas Velocity Determination (USEPA Methods 1 and 2)

The RICE exhaust stack gas velocity and volumetric flow rate was 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 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 stream was measured continuously throughout each test period in accordance with USEPA Method 3A. The exhaust gas CO_2 content was monitored using a Servomex 1440D single beam single wavelength (SBSW) infrared gas analyzer. The exhaust gas O_2 content was monitored using a paramagnetic sensor within the Servomex 1440D gas analyzer.

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 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. For the RICE in which HCl sampling was performed, moisture content was measured as part of the USEPA sampling procedures for HCl (i.e., not as a separate measurement train), which was performed concurrently with the instrumental analyzer test periods. During each sampling period, a gas sample was extracted 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 48i infrared CO analyzer.

Throughout each test period, a continuous sample of the engine exhaust gas was extracted from the stack using the heated sample line and gas conditioning system described previously in this section. 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 NMOC (USEPA Method ALT-096)

The NMOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in the RICE 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 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, NMOC measurements correspond to standard conditions with no moisture correction (wet basis).

The instrumental analyzer was calibrated using certified propane concentrations in hydrocarbon-free air to demonstrate detector linearity and determine calibration drift and zero drift error.

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

4.7 HCl Emission Sampling (USEPA Method 26A)

HCl concentrations in the RICE exhaust gas were determined using USEPA Method 26A. A sample of the exhaust gas was drawn from the exhaust stack at a constant rate (i.e., non-isokinetic rate) using a glass lined probe and a quartz filter. The gas sample was bubbled through chilled impingers containing 0.1 normality sulfuric acid (0.1N H_2SO_4). The NaOH fraction of the Method 26A sampling train was replaced with a dry knockout impinger since chloride concentrations were not included in the analysis.

At the end of the one-hour test period, the impinger solutions were recovered and shipped to a third-party laboratory (Enthalpy Analytical in Durham, North Carolina) for HCl analysis by ion specific electrode analysis in accordance with USEPA Method 26A.

Appendix D provides NMOC calculation sheets. Appendix G provides a copy of the HCl laboratory report.

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 at least 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_2 concentration was 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.

The TEI Model 42c analyzer exhibited the longest system response time at 45 seconds (6/3/19), 59 seconds (6/4/19), and 40 seconds (6/5/19). 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 for that test day.

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 (NMOC) instrument was calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.6 Determination of Exhaust Gas Stratification

A stratification test was performed for each of the seven (7) identical RICE exhaust stacks. 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 all seven (7) RICE exhaust stacks indicate that the measured O_2 and CO_2 concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the RICE exhaust gas was considered to be unstratified and the compliance test sampling was performed at a single sampling location within each RICE exhaust stack.

5.7 Meter Box Calibrations

The Nutech Model 2010 sampling console, which was used for HCl testing and 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.

5.8 HCl Recovery and Analysis

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

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, probe assembly, scale, and barometer calibration records).

6.0 <u>RESULTS</u>

6.1 Test Results and Allowable Emission Limits

Engine operating data and air pollutant emission measurement results for each one-hour test period are presented in Tables 6.1 through 6.7. The serial number (SN) for each RICE is presented at the top of each table.

The measured total combined air pollutant concentrations and emission rates for Engine Nos. 1 through 7 (EU-ENGINE1 through EU-ENGINE7) are less than the allowable limits specified in ROP No. MI-ROP-N5984-201X for the engines:

- 35.2 lb/hr for NO_X;
- 51.1 lb/hr for CO;

- 8.8 lb/hr for NMOC; and
- 0.7 lb/hr for HCl.

The permit conditions do not specify individual engine emission limits.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with the approved Stack Test Protocol. The engine-generator sets operated within 10% of maximum output and no variations from the normal operating conditions of the RICE occurred during the engine test periods.

Exhaust gas HCl tests were performed for three (3) of the seven (7) identical RICE exhaust stacks. Mr. Tom Gasloli of the EGLE-AQD requested that one (1) of the RICE exhaust stacks be sampled for HCl per test day. The test event was performed over three (3) test days, therefore, three (3) RICE exhaust stacks were tested for HCl emissions (Engine Nos. 1, 6, and 7). HCl emission rates for Engine Nos. 1, 6, and 7 were averaged and the result (0.091 lb/hr) was used for Engine Nos. 2, 3, 4, and 5 for calculating total HCl emissions for the entire facility to compare to the emission limit.

Table 6.1 Measured exhaust gas conditions and NO_x, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 1 (EU-ENGINE1), SN: 3RC00663

Test No. Test date Test period (24-hr clock)	1 6/5/19 750-850	2 6/5/19 915-1015	3 6/5/19 1038-1138	Three Test Average
Facility fuel flowrate (scfm)	2,163	2,102	2,113	2,126
RICE fuel flowrate (scfm)	309	300	302	304
Generator output (kW)	796	800	800	799
Engine output (bhp)	1,137	1,143	1,143	1,141
LFG methane content (%)	51.9	52.2	52.1	52.1
LFG LHV heat content (Btu/scf)	472	475	474	474
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.9	11.8	11.7	11.8
O_2 content (% vol)	7.77	7.86	7.95	7.86
Moisture (% vol)	14.0	13.6	13.3	13.6
Exhaust gas temperature (^oF)	800	805	803	803
Exhaust gas flowrate (dscfm)	2,320	2,508	2,518	2,449
Exhaust gas flowrate (scfm)	2,698	2,904	2,906	2,836
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	118	110	101	110
NO_X emissions (g/bhp*hr)	0.78	0.78	0.72	0.76
NO_X emissions (lb/hr)	1.96	1.97	1.82	1.92
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	736	719	701	719
CO emissions (g/bhp*hr)	2.97	3.12	3.06	3.05
CO emissions (lb/hr)	7.45	7.87	7.71	7.68
<u>Non-Methane Organic Compounds</u>				
NMOC conc. (ppmv)	27.7	28.6	29.4	28.6
NMOC emissions (g/bhp*hr)	0.21	0.23	0.23	0.22
NMOC emissions (lb/hr)	0.51	0.57	0.59	0.56
<u>Hydrogen Chloride</u>				
HCl catch weight (µg)	11,527	11,361	11,203	11,364
HCl conc. (ppmvd)	6.56	6.55	6.45	6.52
HCl emissions (lb/hr)	0.086	0.093	0.092	0.091

Table 6.2 Measured exhaust gas conditions and NO_X, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 2 (EU-ENGINE2), SN: 4EK00952

Test No. Test date Test period (24-hr clock)	1 6/3/19 733-833	2 6/3/19 852-952	3 6/3/19 1010-1110	Three Test Average
Fuel flowrate (scfm)	2,096	2,094	2,060	2,083
RICE fuel flowrate (scfm)	299	299	294	298
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,143	1,143	1,143	1,143
LFG methane content (%)	51.2	51.5	51.4	51.4
LFG LHV heat content (Btu/scf)	466	469	468	468
Exhaust Gas Composition				
CO_2 content (% vol)	12.3	12.2	12.2	12.2
O_2 content (% vol)	7.28	7.45	7.41	7.38
Moisture (% vol)	12.7	11.2	11.7	11.9
Exhaust gas temperature (^{o}F)	760	757	755	757
Exhaust gas flowrate (dscfm)	2,348	2,516	2,563	2,476
Exhaust gas flowrate (scfm)	2,689	2,834	2,904	2,809
Nitrogen Oxides				
NO_X conc. (ppmvd)	126	98.2	105	110
NO_X emissions (g/bhp*hr)	0.84	0.70	0.77	0.77
NO_X emissions (lb/hr)	2.12	1.77	1.93	1.94
Carbon Monoxide				
CO conc. (ppmvd)	537	524	532	531
CO emissions (g/bhp*hr)	2.19	2.28	2.36	2.28
CO emissions (lb/hr)	5.51	5.75	5.95	5.74
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	19.9	20.8	21.7	20.8
NMOC emissions (g/bhp*hr)	0.15	0.16	0.17	0.16
NMOC emissions (lb/hr)	0.37	0.41	0.43	0.40

Table 6.3 Measured exhaust gas conditions and NO_x, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 3 (EU-ENGINE3), SN: 4EK02088

Test No. Test date Test period (24-hr clock)	1 6/3/19 1134-1234	2 6/3/19 1249-1349	3 6/3/19 1405-1505	Three Test Average
Fuel flowrate (scfm)	2,084	2,085	2,093	2,087
RICE fuel flowrate (scfm)	298	298	299	298
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,143	1,143	1,143	1,143
LFG methane content (%)	51.3	51.3	51.3	51.3
LFG LHV heat content (Btu/scf)	467	467	467	467
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.9	12.0	11.7	11.8
O_2 content (% vol)	7.81	7.65	8.02	7.83
Moisture (% vol)	10.5	15.6	12.6	12.9
Exhaust gas temperature (^oF)	791	794	795	793
Exhaust gas flowrate (dscfm)	2,557	2,404	2,439	2,466
Exhaust gas flowrate (scfm)	2,858	2,848	2,790	2,832
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	74.6	96.6	57.9	76.4
NO_X emissions (g/bhp*hr)	0.54	0.66	0.40	0.54
NO_X emissions (lb/hr)	1.37	1.66	1.01	1.35
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	661	687	648	666
CO emissions (g/bhp*hr)	2.93	2.86	2.74	2.84
CO emissions (lb/hr)	7.38	7.21	6.90	7.16
<u>Non-Methane Organic Compounds</u>				
NMOC conc. (ppmv)	33.6	31.9	36.3	33.9
NMOC emissions (g/bhp*hr)	0.26	0.25	0.28	0.26
NMOC emissions (lb/hr)	0.66	0.62	0.70	0.66

Table 6.4 Measured exhaust gas conditions and NO_x, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 4 (EU-ENGINE4), SN: 3RC00386

Test No. Test date Test period (24-hr clock)	1 6/4/19 1546-1646	2 6/4/19 1702-1802	3 6/4/19 1818-1918	Three Test Average
Fuel flowrate (scfm)	2,099	2,106	2,115	2,107
RICE fuel flowrate (scfm)	300	301	302	301
Generator output (kW)	792	794	788	791
Engine output (bhp)	1,131	1,134	1,125	1,130
LFG methane content (%)	51.8	52.0	51.9	51.9
LFG LHV heat content (Btu/scf)	471	473	472	472
Exhaust Gas Composition				
CO_2 content (% vol)	11.4	11.5	11.4	11.4
O_2 content (% vol)	8.24	8.20	8.30	8.25
Moisture (% vol)	12.4	12.9	9.1	11.5
Exhaust gas temperature (^oF)	748	740	738	742
Exhaust gas flowrate (dscfm)	2,234	2,296	2,410	2,313
Exhaust gas flowrate (scfm)	2,550	2,637	2,650	2,612
Nitrogen Oxides				
NO_X conc. (ppmvd)	138	140	115	131
NO_X emissions (g/bhp*hr)	0.89	0.92	0.80	0.87
NO_X emissions (lb/hr)	2.22	2.31	1.98	2.17
Carbon Monoxide				
CO conc. (ppmvd)	667	674	653	665
CO emissions (g/bhp*hr)	2.61	2.70	2.77	2.69
CO emissions (lb/hr)	6.51	6.76	6.87	6.71
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	30.7	32.1	32.4	31.8
NMOC emissions (g/bhp*hr)	0.22	0.23	0.24	0.23
NMOC emissions (lb/hr)	0.54	0.58	0.59	0.57

Table 6.5 Measured exhaust gas conditions and NO_x, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 5 (EU-ENGINE5), SN: 4EK02485

Test No. Test date Test period (24-hr clock)	1 6/4/19 1154-1254	2 6/4/19 1309-1409	3 6/4/19 1425-1525	Three Test Average
Fuel flowrate (scfm)	2,103	2,094	2,102	2,100
RICE fuel flowrate (scfm)	300	299	300	300
Generator output (kW)	786	776	770	777
Engine output (bhp)	1,123	1,108	1,100	1,110
LFG methane content (%)	51.6	51.7	51.8	51.7
LFG LHV heat content (Btu/scf)	470	470	471	470
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.2	11.7	11.8	11.8
O_2 content (% vol)	8.53	7.92	7.81	8.09
Moisture (% vol)	13.3	12.4	12.9	12.9
Exhaust gas temperature (^oF)	787	776	780	781
Exhaust gas flowrate (dscfm)	2,116	2,384	2,388	2,296
Exhaust gas flowrate (scfm)	2,439	2,720	2,740	2,633
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	71.2	61.5	73.6	68.8
NO_X emissions (g/bhp*hr)	0.44	0.43	0.52	0.46
NO_X emissions (lb/hr)	1.08	1.05	1.26	1.13
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	560	571	581	571
CO emissions (g/bhp*hr)	2.09	2.43	2.50	2.34
CO emissions (lb/hr)	5.17	5.94	6.06	5.72
<u>Non-Methane Organic Compounds</u>				
NMOC conc. (ppmv)	25.7	26.3	24.7	25.6
NMOC emissions (g/bhp*hr)	0.17	0.20	0.19	0.19
NMOC emissions (lb/hr)	0.43	0.49	0.47	0.46

Table 6.6 Measured exhaust gas conditions and NO_x, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 6 (EU-ENGINE6), SN: 4EK01551

Test No. Test date Test period (24-hr clock)	1 6/3/19 1545-1645	2 6/3/19 1730-1830	3 6/3/19 1900-2000	Three Test Average
Fuel flowrate (scfm)	2,044	2,119	2,135	2,099
RICE fuel flowrate (scfm)	292	303	305	300
Generator output (kW)	776	780	764	773
Engine output (bhp)	1,108	1,114	1,091	1,104
LFG methane content (%)	51.3	51.4	51.4	51.4
LFG LHV heat content (Btu/scf)	467	468	468	468
Exhaust Gas Composition				
CO_2 content (% vol)	11.3	11.3	11.2	11.3
O_2 content (% vol)	8.43	8.46	8.54	8.47
Moisture (% vol)	12.6	12.0	11.9	12.2
Exhaust gas temperature (^oF)	752	752	753	752
Exhaust gas flowrate (dscfm)	2,468	2,452	2,494	2,471
Exhaust gas flowrate (scfm)	2,825	2,788	2,831	2,814
Nitrogen Oxides				
NO_X conc. (ppmvd)	63.1	55.7	45.7	54.8
NO_X emissions (g/bhp*hr)	0.46	0.40	0.34	0.40
NO_X emissions (lb/hr)	1.12	0.98	0.82	0.97
Carbon Monoxide				
CO conc. (ppmvd)	674	668	648	663
CO emissions (g/bhp*hr)	2.97	2.91	2.93	2.94
CO emissions (lb/hr)	7.26	7.15	7.06	7.16
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	35.9	36.8	37.3	36.7
NMOC emissions (g/bhp*hr)	0.29	0.29	0.30	0.29
NMOC emissions (lb/hr)	0.70	0.70	0.73	0.71
Hydrogen Chloride				
HCl catch weight (µg)	10,997	11,055	10,955	11,002
HCl conc. (ppmvd)	6.15	6.25	6.23	6.21
HCl emissions (lb/hr)	0.086	0.087	0.088	0.087

Table 6.7 Measured exhaust gas conditions and NO_x, CO, NMOC, and HCl air pollutant emission rates PTA Landfill Engine No. 7 (EU-ENGINE7), SN: CTL00644

Test No. Test date Test period (24-hr clock)	1 6/4/19 730-830	2 6/4/19 850-950	3 6/4/19 1022-1122	Three Test Average
Fuel flowrate (scfm)	2,129	2,102	2,099	2,110
RICE fuel flowrate (scfm)	304	300	300	301
Generator output (kW)	800	800	800	800
Engine output (bhp)	1,143	1,143	1,143	1,143
LFG methane content (%)	51.3	51.1	51.4	51.3
LFG LHV heat content (Btu/scf)	467	465	468	467
Exhaust Gas Composition				
CO_2 content (% vol)	12.0	12.1	11.9	12.0
O_2 content (% vol)	7.58	7.43	7.76	7.59
Moisture (% vol)	13.1	13.2	12.7	13.0
Exhaust gas temperature (^oF)	816	826	820	821
Exhaust gas flowrate (dscfm)	2,460	2,509	2,509	2,493
Exhaust gas flowrate (scfm)	2,831	2,889	2,872	2,864
Nitrogen Oxides				
NO_X conc. (ppmvd)	64.7	79.1	54.8	66.2
NO_X emissions (g/bhp*hr)	0.45	0.57	0.39	0.47
NO_X emissions (lb/hr)	1.14	1.42	0.99	1.18
Carbon Monoxide				
CO conc. (ppmvd)	670	685	666	674
CO emissions (g/bhp*hr)	2.86	2.98	2.90	2.91
CO emissions (lb/hr)	7.20	7.51	7.29	7.33
Non-Methane Organic Compounds				
NMOC conc. (ppmv)	40.5	38.9	45.3	41.6
NMOC emissions (g/bhp*hr)	0.31	0.31	0.36	0.32
NMOC emissions (lb/hr)	0.79	0.77	0.89	0.82
Hydrogen Chloride				
HCl catch weight (µg)	11,857	11,848	11,415	11,707
HCl conc. (ppmvd)	6.64	6.74	6.49	6.62
HCl emissions (lb/hr)	0.093	0.096	0.093	0.094

APPENDIX A

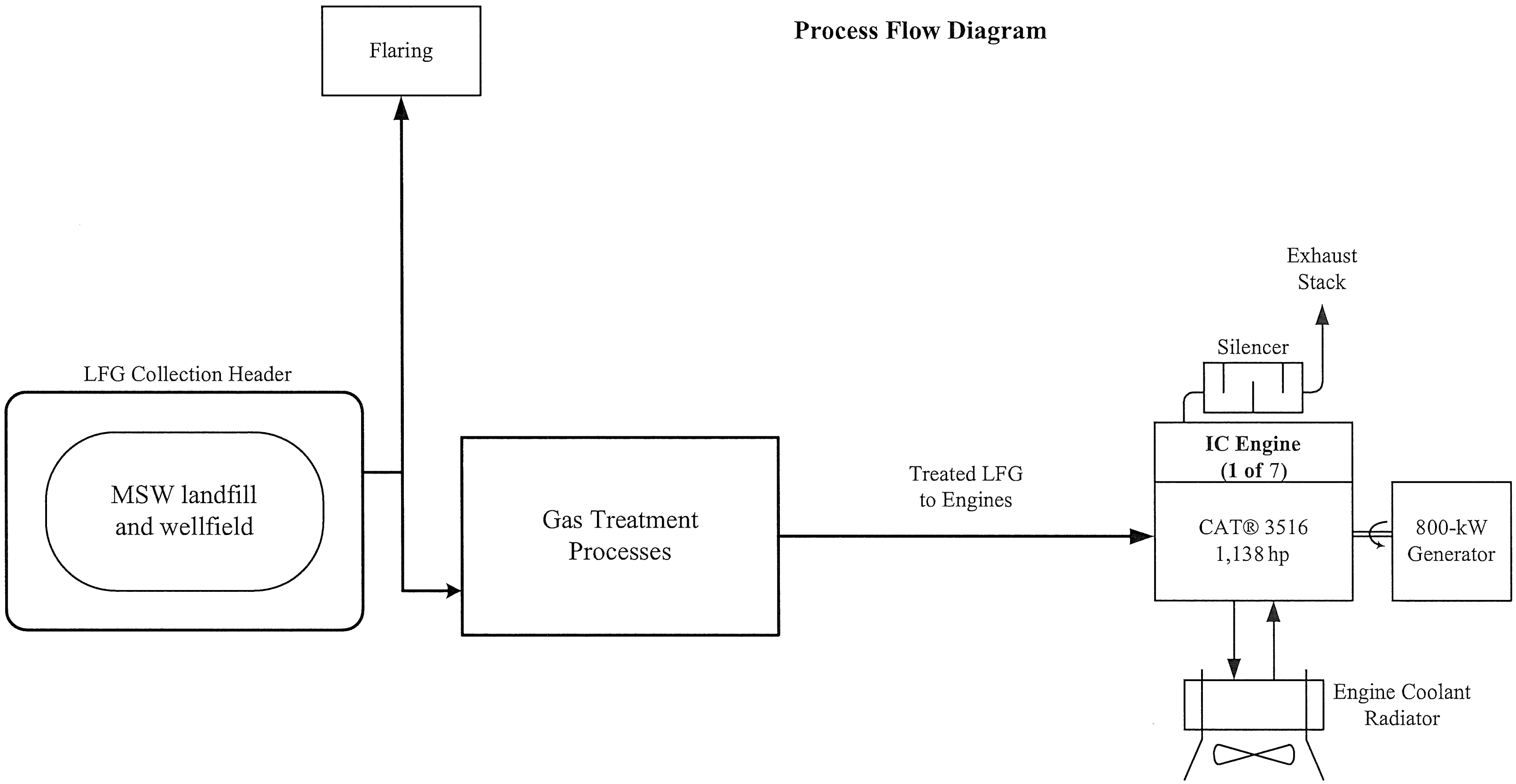
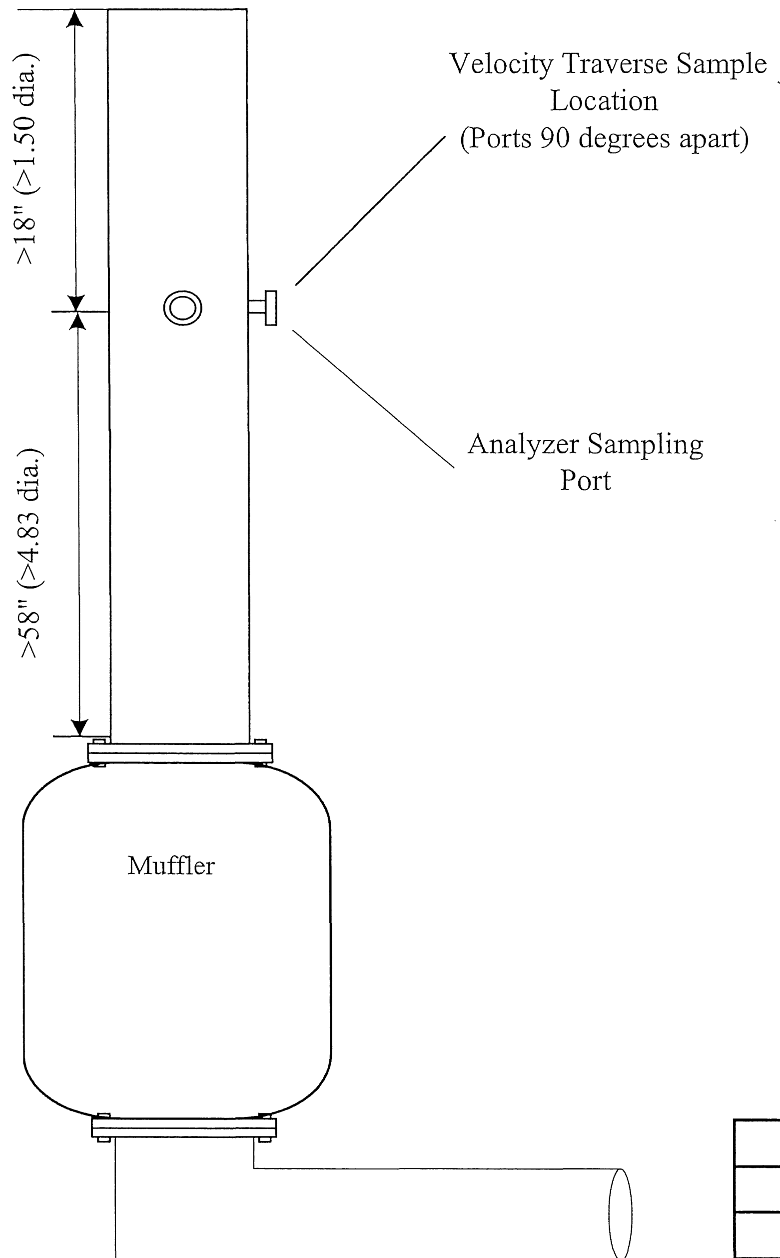
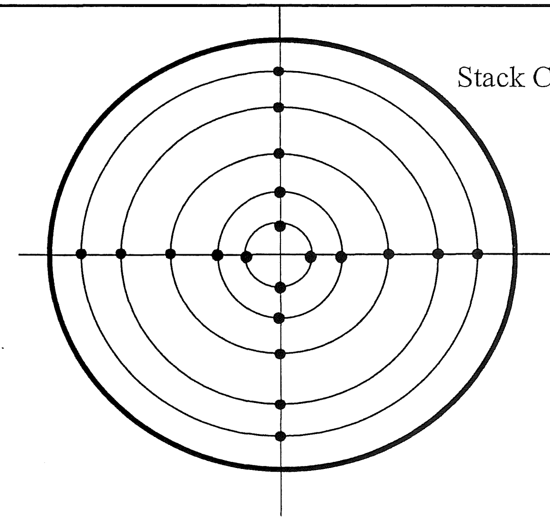


Figure A-1. SEA Facility Process Flow Diagram

Scale	Sheet	
None	1 of 1	ICT

Engine Nos. 1-7
Exhaust Stacks
12" diameter+2.5"
nipple





Velocity sample locations
(not including 2.5" sampling port nipple)

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

Figure A-2. Sumpter Energy-Pine Tree Acres Engine Nos. 1-7 Exhaust Sampling Locations

Scale	Sheet	
None	1 of 1	ICT