Derenzo Environmental Services
Consulting and 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	April 25, 2016
Test Dates	March 21 & 22, 2016

RECEIVED
MAY 1 0 2016
AIR QUALITY DIV.

Facility Information	
Name	Granger Electric at the Lansing Wood Street Landfill
Street Address	16980 Wood Rd
City, County	Lansing, Ingham

Facility Permit Information			
ROP No.:	MI-ROP-N5997-2013	Facility SRN :	N5997

Testing Contractor	
Company	Derenzo Environmental Services
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1508008

DEQ

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating Permit (ROP) program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as specified in Rule 213(3)(b)(ii), and be made available to the Department of Environmental Quality, Air Quality Division upon request.

Source Name: Granger Electric Company - Granger Wood St. Landfill — County: Ingham

Source Address: 16980 Wood Rd. — City: Lansing

AQD Source ID (SRN): N5997 — ROP No.: MI-ROP-N5997-2013 — ROP Section No.: Section 1

Please check the appropriate box(es):

☐ **Annual Compliance Certification (Pursuant to Rule 213(4)(c))**

Reporting period (provide inclusive dates): From ________ To ________

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the ROP.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the ROP, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))**

Reporting period (provide inclusive dates): From ________ To ________

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From 3/21/2016 To 3/22/2016

Additional monitoring reports or other applicable documents required by the ROP are attached as described:

Certification for Air Emissions Test Report associated with compliance testing of emission units FGICEENGINES-S1 as specifed by Renewable Operating Permit No. MI-ROP-N5997-2013. Testing was performed March 21 - 22, 2016.

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete

Name of Responsible Official (print or type)	Title	Phone Number
Todd Davlin	Director of Operations	(517) 372-2800

Signature of Responsible Official: [signature] — Date: 4/29/16

* Photocopy this form as needed.

AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF AIR POLLUTANT EMISSIONS
FROM
LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES

GRANGER ELECTRIC AT THE LANSING WOOD STREET LANDFILL

1.0 INTRODUCTION

Granger Electric Company (Granger) (Facility SRN: N5997) owns and operates four (4) Caterpillar (CAT®) Model No. G3516 landfill gas (LFG) fueled reciprocating internal combustion engines (RICE) and three (3) CAT® Model No. G3520C LFG fueled RICE at the Granger Wood St. Landfill in Lansing, Clinton County, Michigan. The CAT® Model No. G3516 engines are identified as Emission Unit ID: EUICE1-S1 – EUICE4-S1 (FGICE-S1) and the CAT® Model No. G3520C engines are identified as Emission Unit ID: EUICEENGINE1-S1 – EUICEENGINE3-S1 (FGICEENGINES-S1) in Renewable Operating Permit (ROP) No. MI-ROP-N5997-2013. EUICEENGINE1-S1 through EUICEENGINE3-S1 are also referred to as Engine Nos. 5 through 7, respectively, in this report and by facility representatives.

Air emission compliance testing was performed to satisfy the following requirements contained in ROP No. MI-ROP-N5997-2013:

- Test air pollutant emissions for FGICEENGINES-S1 in accordance with 40 CFR Part 60 Subpart JJJJ;

The compliance testing was performed by Derenzo Environmental Services, a Michigan-based environmental consulting and testing company. Derenzo Environmental Services representatives Blake Beddow and Andrew Rusnak performed the field sampling and measurements March 21 – 22, 2016.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated October 30, 2015 that was reviewed and approved by the Michigan Department of Environmental Quality (MDEQ). MDEQ representatives Mr. Thomas Gasloli and Ms. Michelle Luplow observed portions of the testing project.

2.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

2.1 General Process Description

Landfill gas (LFG) containing methane is generated in the Granger Wood Street 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 Granger LFG power station 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. 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 three (3) CAT® Model G3520C RICE exhaust stacks are identical.

The exhaust stack sampling ports for the CAT® Model G3520C engines (Engine Nos. 5, 6 and 7) are located in individual exhaust stacks with an inner diameter of 13.5 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location greater than 120 inches (>9 duct diameters) upstream and greater than 120.0 inches (>9 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.

3.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

3.1 Purpose and Objective of the Tests

The conditions of MI-ROP-N5997-2013 and 40 CFR Part 60 Subpart JJJJ require Granger to test each engine contained in FGICEENGINES-S1 for carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOCs) every 8,760 hours of operation. Therefore, each engine contained in FGICEENGINES-S1 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 Granger engine/generator sets were operated at maximum operating conditions (1,600 kW electricity output +/- 10%). Granger representatives provided the kW output in 15-minute increments for each test period. The FGICEENGINES-S1 generator kW output ranged between 1,495 and 1,640 kW for each test period.

Fuel flowrate (pounds per hour), fuel methane content (%), fuel inlet pressure (psi) and the air to fuel ratio were also recorded by Granger representatives in 15-minute increments for each test period. The FGICEENGINES-S1 fuel consumption rate ranged between 2,151 and 2,314 pph, fuel methane content ranged between 52.6 and 54.9%, fuel inlet pressure was 3.0 psi and the air to fuel ratio ranged from 7.5 to 7.9 during the test periods.

Appendix 2 provides operating records provided by Granger 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)

The facility records fuel use rate in units of pounds per hour. To convert to units of standard cubic feet of gas consumed per minute (scfm) the following equation was used:

Fuel Use (scfm) = Fuel Use (pph) / LFG MW (lb/lb-mol) * 385 scf LFG/lb-mol / 60 min/hr

A lower heating value of 909 Btu/ft^3 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 (Engine Nos. 5, 6 and 7) were each sampled for three (3) one-hour test periods during the compliance testing performed March 21 through March 22, 2016.

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).

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

Table 3.1 Average engine operating conditions during the test periods

Engine Parameter	Engine No. 5	Engine No. 6	Engine No. 7
Generator output (kW)	1,514	1,618	1,618
Engine output (bhp)	2,113	2,258	2,257
Engine LFG fuel use (pph)	2,172	2,297	2,266
Engine LFG fuel use (scfm)	485	514	501
LFG methane content (%)	54.6	54.7	53.6
LFG lower heating value (Btu/ft^3)	496	497	487
Exhaust temperature (^{o}F)	780	764	767
Inlet fuel pressure (psi)	3.0	3.0	3.0
Air to fuel ratio	7.5	7.9	7.8

Table 3.2 Average measured emission rates for each engine (three-test average)

	CO Emission Rates		NOx Emission Rates		VOC Emission Rates
Emission Unit	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(g/bhp-hr)
Engine No. 5	12.4	2.65	3.05	0.66	0.12
Engine No. 6	13.5	2.71	3.14	0.63	0.11
Engine No. 7	13.4	2.68	3.32	0.67	0.14
Permit Limit	16.23	3.30	4.92	1.0	1.0

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 Granger 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 analyzer.
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 an infrared instrumental analyzer
USEPA Method 25A / ALT-096	Exhaust gas VOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with methane separation column

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The RICE exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 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 leak-checked prior to each traverse 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 RICE exhaust gas stream was measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 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 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 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 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 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)

The VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in the engine exhaust gas. NMHC pollutant concentration was determined using a TEI Model 55i Methane / Nonmethane hydrocarbon analyzer. The TEI 55i analyzer contains an internal gas chromatograph column that separates methane from non-methane components. The concentration of NMHC in the sampled gas stream, after separation from methane, is determined relative to a propane standard using a flame ionization detector in accordance with USEPA Method 25A.

The USEPA Office of Air Quality Planning and Standards (OAQPS) has issued an alternate test method approving the use of the TEI 55i-series analyzer as an effective instrument for measuring NMOC from gas-fueled reciprocating internal combustion engines (RICE) in that it uses USEPA Method 25A and 18 (ALT-096).

Samples of the exhaust gas were delivered directly to the instrumental analyzer using the Teflon® heated sample line to prevent condensation. The sample to the NHMC analyzer was not conditioned to remove moisture. Therefore, VOC measurements correspond to standard conditions with no moisture correction (wet basis).

Prior to, and at the conclusion of each test, the instrument was calibrated using mid-range calibration (propane) and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document).

Appendix 4 provides VOC calculation sheets. Raw instrument response data for the NMHC analyzer is provided in Appendix 5.

5.0 QA/QC ACTIVITIES

5.1 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 90.57% of the expected value, i.e., within 10% of the expected value as required by Method 7E).

5.2 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.

5.3 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 June 12, 2014), 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.

5.4 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.

5.5 Determination of Exhaust Gas Stratification

A stratification test was performed for each RICE exhaust stack. The stainless steel sample probe was positioned at sample points correlating to 16.7, 50.0 (centroid) and 83.3% of each 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 RICE exhaust stack indicated that the measured CO, O_2 and CO_2 concentrations did not vary by more than 5% of the mean across each 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 the RICE exhaust stack.

5.6 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 and stratification checks).

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 6.3.

The measured air pollutant concentrations and emission rates for Engine Nos. 5 – 7 are less than the allowable limits specified in Permit to Install No. MI-ROP-N5997-2013 for Emission Unit Nos. EUICEENGINE1-S1 through EUICEENGINE3-S1:

- 4.92 lb/hr and 1.0 g/bhp-hr for NO_X;
- 16.23 lb/hr and 3.3 g/bhp-hr for CO; 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) and no variations from normal operating conditions occurred during the engine test periods.

Table 6.1 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates for Engine No. 5 (EUICEENGINE1-S1)

Test No. Test date Test period (24-hr clock)	1 3/21/16 0820 – 0920	2 3/21/16 0956 – 1056	3 3/21/16 1126 - 1226	Three Test Average
Fuel flowrate (scfm)	486	485	484	485
Generator output (kW)	1,508	1,510	1,524	1,514
Engine output (bhp)	2,104	2,107	2,126	2,113
LFG methane content (%)	54.7	54.5	54.5	54.6
LFG heat content (Btu/scf)	497	495	495	496
Fuel inlet pressure (psi)	3.0	3.0	3.0	3.0
Air to fuel ratio	7.5	7.5	7.5	7.5
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.0	11.0	11.0	11.0
O_2 content (% vol)	8.81	8.81	8.79	8.80
Moisture (% vol)	11.7	10.5	10.5	10.9
Exhaust gas temperature (°F)	781	787	772	780
Exhaust gas flowrate (dscfm)	4,219	4,288	4,342	4,283
Exhaust gas flowrate (scfm)	4,745	4,790	4,851	4,796
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	102	97.8	98.3	99.4
NO_X emissions (lb/hr)	3.08	3.01	3.06	3.05
Permitted emissions (lb/hr)	-	-	-	4.92
NO_X emissions (g/bhp*hr)	0.66	0.65	0.65	0.66
Permitted emissions (g/bhp*hr)	-	-	-	1.0
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	659	662	661	661
CO emissions (lb/hr)	12.1	12.4	12.5	12.4
Permitted emissions (lb/hr)	-	-	-	16.23
CO emissions (g/bhp*hr)	2.62	2.67	2.67	2.65
Permitted emissions (g/bhp*hr)	-	-	-	3.30
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv)	17.1	17.4	17.5	17.3
VOC emissions (g/bhp*hr)	0.12	0.12	0.12	0.12
Permitted emissions (g/bhp*hr)	-	-	-	1.0

Table 6.2 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates for Engine No. 6 (EUICEENGINE2-S1)

Test No. Test date Test period (24-hr clock)	1 3/21/16 1306 – 1406	2 3/21/16 1437 – 1537	3 3/21/16 1604 - 1704	Three Test Average
Fuel flowrate (scfm)	516	513	513	514
Generator output (kW)	1,618	1,618	1,617	1,618
Engine output (bhp)	2,258	2,258	2,257	2,258
LFG methane content (%)	54.6	54.8	54.8	54.7
LFG heat content (Btu/scf)	496	498	498	497
Fuel inlet pressure (psi)	3.0	3.0	3.0	3.0
Air to fuel ratio	7.9	7.9	7.9	7.9
Exhaust Gas Composition				
CO_2 content (% vol)	11.2	11.2	11.2	11.2
O_2 content (% vol)	8.50	8.62	8.55	8.56
Moisture (% vol)	10.7	11.5	10.1	10.8
Exhaust gas temperature (^oF)	782	753	756	764
Exhaust gas flowrate (dscfm)	4,455	4,520	4,472	4,482
Exhaust gas flowrate (scfm)	5,011	5,066	4,972	5,016
Nitrogen Oxides				
NO_X conc. (ppmvd)	99.5	98.1	95.8	97.8
NO_X emissions (lb/hr)	3.18	3.18	3.07	3.14
Permitted emissions (lb/hr)	-	-	-	4.92
NO_X emissions (g/bhp*hr)	0.64	0.64	0.62	0.63
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Carbon Monoxide				
CO conc. (ppmvd)	689	689	690	689
CO emissions (lb/hr)	13.4	13.6	13.5	13.5
Permitted emissions (lb/hr)	-	-	-	16.23
CO emissions (g/bhp*hr)	2.69	2.73	2.71	2.71
Permitted emissions (g/bhp*hr)	-	-	-	3.30
Volatile Organic Compounds				
VOC conc. (ppmv)	15.9	15.8	15.6	15.8
VOC emissions (g/bhp*hr)	0.11	0.11	0.11	0.11
Permitted emissions (g/bhp*hr)	-	-	-	1.0

Table 6.3 Measured exhaust gas conditions and NO_x, CO and VOC air pollutant emission rates for Engine No. 7 (EUICEENGINE3-S1)

Test No. Test date Test period (24-hr clock)	1 3/22/16 0818 – 0918	2 3/22/16 953 – 1053	3 3/22/16 1123 - 1223	Three Test Average
Fuel flowrate (scfm)	501	502	501	501
Generator output (kW)	1,624	1,615	1,614	1,618
Engine output (bhp)	2,266	2,253	2,253	2,257
LFG methane content (%)	53.5	53.6	53.7	53.6
LFG heat content (Btu/scf)	486	487	488	487
Fuel inlet pressure (psi)	3.0	3.0	3.0	3.0
Air to fuel ratio	7.7	7.8	7.8	7.8
Exhaust Gas Composition				
CO_2 content (% vol)	10.9	10.9	10.9	10.9
O_2 content (% vol)	8.93	8.92	9.00	8.95
Moisture (% vol)	12.1	11.3	10.9	11.4
Exhaust gas temperature (°F)	745	778	777	767
Exhaust gas flowrate (dscfm)	4,409	4,546	4,570	4,508
Exhaust gas flowrate (scfm)	4,994	5,113	5,128	5,078
Nitrogen Oxides				
NO_X conc. (ppmvd)	103	103	103	103
NO_X emissions (lb/hr)	3.26	3.36	3.36	3.32
Permitted emissions (lb/hr)	-	-	-	4.92
NO_X emissions (g/bhp*hr)	0.65	0.68	0.68	0.67
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Carbon Monoxide				
CO conc. (ppmvd)	677	679	680	678
CO emissions (lb/hr)	13.0	13.5	13.6	13.4
Permitted emissions (lb/hr)	-	-	-	16.23
CO emissions (g/bhp*hr)	2.61	2.71	2.73	2.68
Permitted emissions (g/bhp*hr)	-	-	-	3.30
Volatile Organic Compounds				
VOC conc. (ppmv)	19.3	19.5	19.6	19.5
VOC emissions (g/bhp*hr)	0.13	0.14	0.14	0.14
Permitted emissions (g/bhp*hr)	-	-	-	1.0