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AIR EMISSION TEST REPORT

Title	AIR EMISSION TEST REPORT FOR THE VERIFICATION OF AIR POLLUTANT EMISSIONS FROM LANDFILL GAS FIRED ENGINE – GENERATOR SETS
Report Date	April 5, 2017
Test Date(s)	March 21-22, 2017

Facility Information	
Name:	North American Natural Resources Southeast Berrien County Landfill
Street Address:	3200 Chamberlain Road,
City, County, State:	Buchanan, Berrien, Michigan
Facility SRN:	N5432
Phone:	(269) 695-2500

Emission Unit and Permit Information	
Operating Permit No.:	MI-ROP-N5432-2021
Emission Unit ID Nos.	EUENGINE1-S2, EUENGINE2-S2, EUENGINE3-S2

Testing Contractor	
Company:	Derenzo Environmental Services
Mailing Address:	39395 Schoolcraft Rd. Livonia, MI 48150
Phone:	(734) 464-3880
Project No.:	1612012

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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: North American Natural Resources / SE Berrien LF   County: Berrien

Source Address: 3200 Chamberlain Road   City: Buchanan

AQD Source ID (SRN): N5432   ROP No.: N5432-2021   ROP Section No.: ______

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 3-21-2017 To 3-22-2017

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

Test report for CO, NOx, and VOC emissions from landfill gas fired CAT G3520C IC engines (EUENGINE1-S2, EUENGINE2-S2, and EUENGINE3-S2). The testing was conducted in accordance with MI-ROP-N5432-2021. The facility was operated in compliance with the permit conditions or at the maximum routine operating conditions.

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
Richard Spranger	Director of Operations	(517) 719-1322

Signature of Responsible Official: [signature]   Date: 4-5-17

* Photocopy this form as needed.

EQP 5736 (Rev 11-04)

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

NORTH AMERICAN NATURAL RESOURCES
SOUTHEAST BERRIEN COUNTY LANDFILL

1.0 INTRODUCTION

North American Natural Resources (NANR) operates gas-fired reciprocating internal combustion engine (RICE) and electricity generator sets at the Southeast Berrien County Landfill in Buchanan, Berrien County, Michigan. The RICE are fueled by landfill gas (LFG) that is recovered from the Southeast Berrien County Landfill. The recovered gas is transferred to NANR where it is treated and used as fuel.

The Michigan Department of Environmental Quality-Air Quality Division (MDEQ-AQD) has issued to NANR a Renewable Operating Permit (MI-ROP-N5432-2021) for operation of the renewable electricity generation facility, which consists of:

- Three (3) CAT® Model No. G3520C RICE-generator set identified as emission units EUENGINE1-S2, EUENGINE2-S2, and EUENGINE3-S2 (Flexible Group ID: FGENGINES-S2).

Air emission compliance testing was be performed pursuant to ROP No. MI-ROP-N5432-2021 and the federal Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (the SI-RICE NSPS; 40 CFR Part 60 Subpart JJJJ). The conditions of ROP No. MI-ROP-N5432-2021 state:

> *... The permittee must conduct performance testing every 8,760 hours or 3 years after the initial test, whichever comes first. ... to demonstrate compliance with the emission limits in 40 CFR 60.4233(e) ... If a performance test is required, the performance test shall be conducted according to 40 CFR 60.4244.*

The compliance testing presented in this report was performed by Derenzo Environmental Services (DES), a Michigan-based environmental consulting and testing company. DES representatives Tyler Wilson and Jeff Schlaf performed the field sampling and measurements March 21-22, 2017. The emission testing was performed within 8,760 operating hours of the previous test, which was performed on November 5, 2015.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan that was reviewed and approved by the MDEQ-AQD in the January 24, 2017 test plan approval letter. MDEQ-AQD representative Mr. Tom Gasloli observed portions of the testing project.

The engine emission performance tests consisted of triplicate, one-hour sampling periods for nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC, as non-methane hydrocarbons (NMHC)). Exhaust gas velocity, moisture content, oxygen (O_2) content, and carbon dioxide (CO_2) content were determined for each test period to calculate pollutant mass emission rates.

Questions regarding this emission test report should be directed to:

Tyler J. Wilson
Livonia Office Supervisor
Derenzo Environmental Services
39395 Schoolcraft Road
Livonia, MI 48150
Ph: (734) 464-3880

Mr. Richard Spranger
Director of Operations
North American Natural Resources
300 North 5th Street, Suite 100
Ann Arbor, MI 48104
Ph: (517) 719-1322

Report Certification

This test report was prepared by Derenzo Environmental Services based on field sampling data collected by Derenzo Environmental Services. Facility process data were collected and provided NANR employees or representatives. This test report has been reviewed by NANR representatives and approved for submittal to the MDEQ.

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

Report Prepared By:

Tyler J. Wilson
Livonia Office Supervisor
Derenzo Environmental Services

Reviewed By:

Andy Rusnak, QSTI
Technical Manager
Derenzo Environmental Services

2.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

2.1 Purpose and Objective of the Tests

The conditions of MI-ROP-N5432-2021 and 40 CFR Part 60 Subpart JJJJ require NANR to test engines EUENGINE1-S2, EUENGINE2-S2, and EUENGINE3-S2 for CO, NOx, and VOC emissions every 8,760 hours of operation or three (3) years, whichever comes first.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the NANR engine/generator sets were operated at maximum operating conditions (within 10% of rated capacity). The rated capacity for the CAT® G3520C engine generator sets are 1,600 kW electricity output. NANR representatives provided kW output in 15-minute increments for each test period. The FGENGINES-S2 generator electricity output ranged between 1,600 and 1,605 kW for each test period.

Fuel flowrate (standard cubic feet per minute), fuel methane content (%), and air-to-fuel ratio were also recorded by NANR representatives in 15-minute increments for each test period. The FGENGINES-S2 fuel consumption rate ranged between 544 and 580 scfm, fuel methane content ranged between 48.0 and 49.3%, and air-to-fuel ratio ranged from 7.4 to 7.8.

Appendix 1 provides operating records provided by NANR 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 (95.7%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

$$\text{Engine output (bhp)} = \text{Electricity output (kW)} / (0.957) / (0.7457 \text{ kW/hp})$$

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

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled LFG fueled RICE (EUENGINE1-S2, EUENGINE2-S2, and EUENGINE3-S2) were sampled for three (3) one-hour test periods during the compliance testing performed March 21-22, 2017.

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

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

Table 2.1 Average engine operating conditions during the test periods

Engine Parameter	EUENGINE1-S2 CAT® G3520C	EUENGINE2-S2 CAT® G3520C	EUENGINE3-S2 CAT® G3520C
Generator output (kW)	1,602	1,602	1,602
Engine output (bhp)	2,245	2,244	2,245
Engine LFG fuel use (scfm)	555	563	575
LFG methane content (%)	48.5	48.2	48.0
Exhaust temperature (°F)	951	949	952
Air-to-fuel ratio	7.6	7.7	7.4

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

Emission Unit	CO Emission Rates		NOx Emission Rates		VOC Emission Rates	
	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)
EUENGINE1-S2	9.46	1.91	2.33	0.47	0.43	0.09
EUENGINE2-S2	13.1	2.66	2.41	0.49	0.47	0.10
EUENGINE3-S2	11.8	2.37	2.19	0.44	0.56	0.11
Permit Limit	-	*2.8*	-	*0.62*	-	*1.0*

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

NANR operates three (3) CAT® Model No. G3520C RICE-generator sets at its Southeast Berrien County Generating station. The units are fired exclusively with LFG that is recovered from the Southeast Berrien County Landfill solid waste disposal facility and is treated prior to use.

3.2 Rated Capacities and Air Emission Controls

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

- Engine Power; 2,242 bhp
- Electricity Generation; 1,600 kW

Each RICE is equipped with an electronic air-to-fuel ratio (AFR) controller that blends the appropriate ratio of combustion air and treated LFG fuel. The electronic AFR controller monitors engine performance parameters and automatically adjusts the AFR and ignition timing to maintain efficient fuel combustion.

The RICE are not equipped with add-on emission control devices. The AFR controller maintains efficient fuel combustion, which minimizes air pollutant emissions. Exhaust gas is exhausted directly to atmosphere through a noise muffler and vertical exhaust stack.

3.3 Sampling Locations

The RICE exhaust gas is directed through a muffler and is released to the atmosphere through a dedicated vertical exhaust stack with a vertical release point.

The exhaust stack sampling ports for the CAT® Model G3520C engines (EUENGINE1-S2, EUENGINE2-S2, and EUENGINE3-S2) are located before the muffler in a horizontal exhaust duct with an inner diameter of 13.0 inches. The duct is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 28 inches (2.15 duct diameters) upstream and 144 inches (11.1 duct diameters) downstream from any flow disturbance.

All sample port locations satisfy the USEPA Method 1 criteria for a representative sample location. Individual traverse points were determined in accordance with USEPA Method 1.

Appendix 2 provides diagrams of the emission test sampling locations.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the air emission testing was reviewed and approved by the MDEQ-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 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 during each test period. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were leak-checked prior to each traverse to verify the integrity of the measurement system.

The absence of significant cyclonic flow at the sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each velocity traverse point with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

Appendix 3 provides exhaust gas flowrate calculations and field data sheets.

4.3 Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

CO_2 and O_2 content in the RICE exhaust gas stream was measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 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 RICE exhaust gas stream was extracted from the stack using a stainless steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzers; therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. Instrument response data were recorded using an ESC Model 8816 data acquisition system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages.

Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias (described in Section 5.0 of this document). Sampling times were recorded on field data sheets.

Appendix 4 provides O_2 and CO_2 calculation sheets. Raw instrument response data are provided in Appendix 5.

4.4 Exhaust Gas Moisture Content (USEPA Method 4)

Moisture content of 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 48i infrared CO analyzer.

Throughout each test period, a continuous sample of the engine exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on an ESC Model 8816 data acquisition system that logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias.

Appendix 4 provides CO and NO_X calculation sheets. Raw instrument response data are provided in Appendix 5.

4.6 Measurement of Volatile Organic Compounds (USEPA Method 25A/ALT-096)

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 RICE (ALT-096).

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

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

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

5.0 QA/QC ACTIVITIES

5.1 Flow Measurement Equipment

Prior to arriving onsite, the instruments used during the source test to measure exhaust gas properties and velocity (barometer, pyrometer and Pitot tube) were calibrated to specifications in the sampling methods.

The absence of cyclonic flow for each sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each of the velocity traverse points 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).

5.2 NO_x Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42c analyzer was verified prior to the testing program. A USEPA Protocol 1 certified concentration of NO_2 was injected directly into the analyzer, following the initial three-point calibration, to verify the analyzer's conversion efficiency. The analyzer's NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. The conversion efficiency of the analyzer is deemed acceptable if the measured NO_2 concentration is greater than or equal to 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_2 concentration was 97.5% of the expected value, i.e., greater than 90% of the expected value as required by Method 7E).

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

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STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.4 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NO_X, CO, O_2, and CO_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 2.5% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.5 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO_x, CO, CO_2, and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings.

At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the NMHC analyzer, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one-hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NO_x, and CO in nitrogen and zeroed using hydrocarbon free nitrogen. The NMHC (VOC) instrument was calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.6 Determination of Exhaust Gas Stratification

A stratification test was performed for each RICE exhaust stack. The stainless steel sample probe was positioned at sample points correlating to 16.7, 50.0 (centroid) and 83.3% of the stack diameter. Pollutant concentration data were recorded at each sample point for a minimum of twice the maximum system response time.

The recorded concentration data for the RICE exhaust stacks indicated that the measured 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 dry gas meter and 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 <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 6.3.

The measured air pollutant concentrations and emission rates for EUENGINE1-S2, EUENGINE2-S2, and EUENGINE3-S2 are less than the allowable limits specified in MI-ROP-N5432-2021:

- 2.8 g/bhp-hr for CO;
- 0.62 g/bhp-hr for NOx; 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 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. 1 (EUENGINE1-S2)

Test No. Test date Test period (24-hr clock)	1 3/21/17 0805-0905	2 3/21/17 0932-1032	3 3/21/17 1056-1156	Three Test Average
Fuel flowrate (scfm)	553	553	560	555
Generator output (kW)	1,602	1,601	1,602	1602
Engine output (bhp)	2,245	2,244	2,245	2,245
LFG methane content (%)	48.6	48.8	48.2	48.5
Air-to-fuel ratio	7.6	7.6	7.5	7.6
Exhaust Gas Composition				
CO_2 content (% vol)	11.3	11.3	11.3	11.3
O_2 content (% vol)	8.04	8.07	8.08	8.07
Moisture (% vol)	11.2	11.7	11.1	11.3
Exhaust gas temperature (^oF)	950	954	949	951
Exhaust gas flowrate (dscfm)	3,952	4,077	4,114	4,048
Exhaust gas flowrate (scfm)	4,451	4,619	4,626	4,565
Nitrogen Oxides				
NO_X conc. (ppmvd)	82.4	78.5	79.7	80.2
NO_X emissions (lb/hr)	2.33	2.30	2.35	2.33
NO_X emissions (g/bhp*hr)	0.47	0.46	0.47	0.47
*Permitted emissions (g/bhp*hr)*	-	-	-	*0.62*
Carbon Monoxide				
CO conc. (ppmvd)	545	525	537	536
CO emissions (lb/hr)	9.41	9.35	9.64	9.46
CO emissions (g/bhp*hr)	1.90	1.89	1.95	1.91
*Permitted emissions (g/bhp*hr)*	-	-	-	*2.8*
Volatile Organic Compounds				
VOC conc. (ppmv)	13.5	13.9	13.8	13.7
VOC emissions (lb/hr)	0.41	0.44	0.44	0.43
VOC emissions (g/bhp*hr)	0.09	0.09	0.09	0.09
*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. 2 (EUENGINE2-S2)

Test No.	1	2	3	
Test date	3/22/17	3/22/17	3/22/17	Three Test
Test period (24-hr clock)	0725-0825	0854-0954	1017-1117	Average
Fuel flowrate (scfm)	560	563	567	563
Generator output (kW)	1,602	1,602	1,601	1,602
Engine output (bhp)	2,245	2,244	2,243	2,244
LFG methane content (%)	48.2	48.2	48.1	48.2
Air-to-fuel ratio	7.8	7.7	7.7	7.7
Exhaust Gas Composition				
CO_2 content (% vol)	11.2	11.2	11.2	11.2
O_2 content (% vol)	8.23	8.22	8.32	8.26
Moisture (% vol)	9.0	11.5	11.0	10.5
Exhaust gas temperature (°F)	947	950	950	949
Exhaust gas flowrate (dscfm)	4,200	4,199	4,128	4,176
Exhaust gas flowrate (scfm)	4,617	4,744	4,637	4,666
Nitrogen Oxides				
NO_X conc. (ppmvd)	81.1	80.6	79.4	80.3
NO_X emissions (lb/hr)	2.44	2.43	2.35	2.41
NO_X emissions (g/bhp*hr)	0.49	0.49	0.47	0.49
*Permitted emissions (g/bhp*hr)*	-	-	-	*0.62*
Carbon Monoxide				
CO conc. (ppmvd)	720	725	718	721
CO emissions (lb/hr)	13.2	13.3	12.9	13.1
CO emissions (g/bhp*hr)	2.67	2.68	2.62	2.66
*Permitted emissions (g/bhp*hr)*	-	-	-	*2.8*
Volatile Organic Compounds				
VOC conc. (ppmv)	14.7	14.6	14.7	14.7
VOC emissions (lb/hr)	0.47	0.48	0.47	0.47
VOC emissions (g/bhp*hr)	0.09	0.10	0.09	0.10
*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. 3 (EUENGINE3-S2)

Test No. Test date Test period (24-hr clock)	1 3/21/17 1223-1323	2 3/21/17 1347-1447	3 3/21/17 1512-1612	Three Test Average
Fuel flowrate (scfm)	574	575	577	575
Generator output (kW)	1,603	1,602	1,602	1,602
Engine output (bhp)	2,246	2,245	2,245	2,245
LFG methane content (%)	48.1	48.1	47.9	48.0
Air-to-fuel ratio	7.5	7.4	7.4	7.4
Exhaust Gas Composition				
CO_2 content (% vol)	11.2	11.2	11.2	11.2
O_2 content (% vol)	8.22	8.24	8.29	8.25
Moisture (% vol)	11.2	11.5	10.5	11.1
Exhaust gas temperature (°F)	948	948	960	952
Exhaust gas flowrate (dscfm)	4,313	4,295	4,417	4,342
Exhaust gas flowrate (scfm)	4,855	4,855	4,935	4,882
Nitrogen Oxides				
NO_X conc. (ppmvd)	72.1	71.0	68.4	70.5
NO_X emissions (lb/hr)	2.23	2.19	2.17	2.19
NO_X emissions (g/bhp*hr)	0.45	0.44	0.44	0.44
*Permitted emissions (g/bhp*hr)*	-	-	-	*0.62*
Carbon Monoxide				
CO conc. (ppmvd)	629	622	610	620
CO emissions (lb/hr)	11.8	11.7	11.8	11.8
CO emissions (g/bhp*hr)	2.39	2.35	2.37	2.37
*Permitted emissions (g/bhp*hr)*	-	-	-	*2.8*
Volatile Organic Compounds				
VOC conc. (ppmv)	16.4	16.6	17.0	16.7
VOC emissions (lb/hr)	0.55	0.55	0.58	0.56
VOC emissions (g/bhp*hr)	0.11	0.11	0.12	0.11
*Permitted emissions (g/bhp*hr)*	-	-	-	*1.0*