Executive Summary

GRANGER ELECTRIC AT THE SOUTH KENT LANDFILL
CAT® G3520C LANDFILL GAS FUELED IC ENGINE EMISSION RESULTS

Granger Electric contracted Derenzo and Associates, Inc., to conduct a performance demonstration for the determination of nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) concentrations and emission rates from two (2) Caterpillar (CAT®) Model No. G3520C landfill gas-fired reciprocating internal combustion engines and electricity generator sets (EUICEENGINE1 – 2) operated at the South Kent Landfill in Byron Center, Kent County, Michigan.

Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Renewable Operating Permit No. MI-ROP-N1324-2012 requires that performance testing be performed on the CAT® G3520C engines within 180 days of startup and every 8,760 hours of operation (or every three years) in accordance with the provisions of 40 CFR Part 60 Subpart JJJJ (NSPS for spark ignition internal combustion engines). The performance testing was conducted on January 15 and January 29, 2015.

The following table presents the emissions results from the performance demonstration.

Emission Unit	NOx Emission Rates (lb/hr)	(g/bhp-hr)	CO Emission Rates (lb/hr)	(g/bhp-hr)	VOC Emission Rate (g/bhp-hr)
EUICEENGINE1	2.19	0.45	14.49	2.96	0.13
EUICEENGINE2	2.51	0.51	13.15	2.66	0.16
Permit Limits	4.92	1.0	16.23	3.3	1.0

lb/hr = pounds per hour, g/bhp-hr = grams per brake horse power-hour

The following table presents the operating data recorded during the performance demonstration.

Emission Unit	Generator Output (kW)	Engine Output (bhp)	LFG Fuel Use (scfm)	LFG CH_4 Content (%)	Exhaust Temp. (^oF)
EUICEENGINE1	1,585	2,220	519	52.1	819
EUICEENGINE2	1,604	2,242	480	53.3	802

scfm=standard cubic feet per minute, kW=kilowatt, bHp-hr=brake horse power hour, psi=pounds per square inch

The data presented above indicate that EUICEENGINE1 and EUICEENGINE2 were tested while the units operated within 10% of its maximum capacity (2,233 bhp and 1,600 kW) and are in compliance with the emission standards specified in 40 CFR 60.4233(e) and MDEQ-AQD ROP No. MI-ROP-N1324-2012.

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 at the South Kent Landfill   County: Kent

Source Address: 10300 South Kent Drive SW   City: Byron Center

AQD Source ID (SRN): N1324   ROP No.: N1324-2012   ROP Section No.: 02

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 1-15-15 To 1-29-15

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

Test Report for a landfill gas fired IC engine (EUICEENGINE1 & EUICEENGINE2) for testing performed on 1-15-15 & 1-29-15. The testing was conducted in accordance with the approved Test Plan and the facility was operated in compliance with the permit conditions or at the maximum routine operating conditions for the facility.

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

Marc Pauley	Director of Operations	(517) 372-8330
Name of Responsible Official (print or type)	Title	Phone Number

[signature]
Signature of Responsible Official

2-26-15
Date

* Photocopy this form as needed.

Derenzo and Associates, Inc.
Environmental Consultants

AIR EMISSION TEST REPORT

Title	AIR EMISSION TEST REPORT FOR THE LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES OPERATED AT THE SOUTH KENT LANDFILL FACILITY
Report Date	February 19, 2015
Test Dates	January 15 & 29, 2015

Facility Information	
Name	Granger Electric at the South Kent Landfill
Street Address	10300 South Kent Drive SW
City, County	Byron Center, Kent

Facility Permit Information			
ROP No.:	MI-ROP-N1324-2012	Facility SRN :	N1324

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1409008

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

GRANGER ELECTRIC AT THE SOUTH KENT LANDFILL

1.0 INTRODUCTION

Granger Electric (Granger) operates two (2) Caterpillar (CAT®) Model No. G3520C gas fueled internal combustion (IC) engines and electricity generator sets at the South Kent Landfill in Byron Center, Kent County, Michigan. The two (2) landfill gas (LFG) fueled IC engine-generator sets are identified as emission units EUICEENGINE1 and EUICEENGINE2 (collectively flexible emission group FGICEENGINES) in Section 2 of Michigan Renewable Operating Permit (ROP) No. MI-ROP-N1324-2012 issued by the Michigan Department of Environmental Quality (MDEQ).

The conditions of MI-ROP-N1324-2012:

1. Allow for the installation and operation of two (2) spark ignition, lean burn reciprocating internal combustion (IC) engine and electricity generation sets (CAT® Model G3520C) that have a rated horsepower (hp) output of 2,233 at full load.

2. Specify that … *Except as provided in 40 CFR 60.4243, the permittee shall conduct an initial performance test for each engine in FGENGINES within one year after startup of the engine and every 8760 hours of operation or three years, whichever occurs first, to demonstrate compliance unless the engines have been certified by the manufacturer as required by 40 CFR Part 60 Subpart JJJJ and the permittee maintains the engine as required by 40 CFR 60.4243(a)(1). If a performance test is required, the performance tests shall be conducted according to 40 CFR 60.4244.*

The compliance testing was performed by Derenzo and Associates, Inc. (Derenzo and Associates), a Michigan-based environmental consulting and testing company. Derenzo and Associates representatives Dan Wilson, Kalan Briggs and Patrick Triscari performed the field sampling and measurements January 15 and 29, 2015.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated November 15, 2014 that was reviewed and approved by the Michigan Department of Environmental Quality (MDEQ). MDEQ representative Mr. Nathaniel Hude observed portions of the testing project.

Questions regarding this emission test report should be directed to:

Dan Wilson
Environmental Consultant
Derenzo and Associates, Inc.
39395 Schoolcraft Road
Livonia, MI 48150
Ph: (734) 464-3880

Mr. Dan Zimmerman
Director of Operations and Compliance
Granger Electric Company
16980 Wood Road
Lansing, MI 48906
Ph: (517) 371-9711

Report Certification

This test report was prepared by Derenzo, Associates, Inc. based on field sampling data collected by Derenzo and Associates, Inc. Facility process data were collected and provided by Granger employees or representatives. This test report has been reviewed by Granger 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:

Kalan M. Briggs
Environmental Consultant
Derenzo and Associates, Inc.

Reviewed By:

Robert L. Harvey, P.E.
General Manager
Derenzo and Associates, Inc.

I certify that the facility and emission units were operated at maximum routine operating conditions for the test event. Based on information and belief formed after reasonable inquiry, the statements and information in this report are true, accurate and complete.

Responsible Official Certification:

Marc Pauley
Operations Manager
Granger Electric Company

2.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

2.1 General Process Description

Landfill gas (LFG) containing methane is generated in the South Kent 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 two (2) 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 horizontal release points. The two (2) CAT® Model G3520C RICE exhaust stacks are identical.

The exhaust stack sampling ports for the CAT® Model G3520C engines (EUICEENGINE1 – EUICEENGINE2) 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 24.0 inches (1.71 duct diameters) upstream and greater than 168.0 inches (12.0 duct diameters) downstream from any flow disturbance and satisfies the USEPA Method 1 criteria for a representative sample location.

Individual traverse points were determined in accordance with USEPA Method 1.

Appendix 1 provides diagrams of the emission test sampling location.

3.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

3.1 Purpose and Objective of the Tests

The conditions of ROP No. MI-ROP-N1324-2012 and 40 CFR Part 60 Subpart JJJJ require Granger to test each engine contained in FGENGINES for carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOCs) every 8,760 hours of operation.

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 generator electricity output (kW) in 15-minute increments for each test period. The generator kW output ranged between 1,568 and 1,612 kW during the test periods.

Fuel flowrate (cubic feet per minute) and fuel methane content (%), were also recorded by Granger representatives in 15-minute increments for each test period. The FGENGINES fuel consumption rate ranged between 475 and 523 scfm and fuel methane content ranged between 51.8 and 53.9%

In addition, the engine serial number and operating hours at the beginning of test No. 1 were recorded by the facility operators.

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 (96.0%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

Engine output (bhp) = Electricity output (kW) / (0.960) / (0.7457 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 sampled LFG fueled RICE (EUICEENGINE1 and EUICEENGINE2) were each sampled for three (3) one-hour test periods during the compliance testing performed January 15 and 29, 2015.

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 are presented in Section 6.0 of this report.

Table 3.1 Average engine operating conditions during the test periods

Engine Parameter	Engine No. 1	Engine No. 2
Generator output (kW)	1,585	1,604
Engine output (bhp)	2,220	2,242
Engine LFG fuel use (scfm)	519	480
LFG methane content (%)	52.1	53.3
LFG lower heating value (Btu/scf)	473	482
Exhaust temperature (°F)	819	802

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)	(lb/hr)	(g/bhp-hr)
Engine No. 1	14.49	2.96	2.19	0.45	0.62	0.13
Engine No. 2	13.15	2.66	2.51	0.51	0.78	0.16
Permit Limit	16.23	3.3	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 zirconia ion/paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Exhaust gas moisture was determined based on the water weight gain in chilled impingers.
USEPA Method 7E	Exhaust gas NOx concentration was determined using chemiluminescence instrumental analyzers.
USEPA Method 10	Exhaust gas CO concentration was measured using an NDIR 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 periodically 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 and a Servomex 4900 paramagnetic sensor gas analyzer. The O_2 content of the exhaust was monitored using a Servomex 1440D gas analyzer that uses a paramagnetic sensor and a Servomex 4900 paramagnetic sensor gas analyzer.

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 NOx and CO Concentration Measurements (USEPA Methods 7E and 10)

NOx and CO pollutant concentrations in the RICE exhaust gas streams were determined using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NOx analyzer, a TEI Model 48c infrared CO analyzer and a Fuji ZRF non-dispersion infra-red absorption 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 NOx 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 several alternate test methods approving the use of the TEI 55-series analyzer as an effective instrument for measuring NMOC from gas-fueled reciprocating internal combustion engines (RICE) in that it uses USEPA Method 25A and 18 (ALT-066, ALT-078 and ALT-096).

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

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

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

5.0 QA/QC ACTIVITIES

5.1 NOx 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 5.6% 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 NOx, 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 , April 3, 2012, June 6, 2013 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 3.0% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.4 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 NOx, 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, NOx, 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 the 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 stack indicated that the measured CO, O_2 and CO_2 concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the 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 and the Clean Air Model 3080, which was used for exhaust gas moisture content sampling, was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5. The metering console calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

The digital pyrometer in the Nutech metering consoles were calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix 6 presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results, meter box calibration records, Pitot tube calibration records).

6.0 RESULTS

6.1 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 and 6.2.

The measured air pollutant concentrations and emission rates for Engine Nos. 1 and 2 are less than the allowable limits specified in MI-ROP-N1324-2012 for Emission Unit Nos. EUICEENGINE1 and EUICEENGINE2:

- 1.0 g/bhp-hr and 4.92 lb/hr for NO_X;
- 3.3 g/bhp-hr and 16.23 lb/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 tests for EUICEENGINE2 were performed on January 15, 2015 as originally planned. EUICEENGINE1 was not operating properly on the originally scheduled test date. The test event for EUICEENGINE1 was postponed and performed on January 29, 2015. Mr. David Patterson of the MDEQ-AQD was notified of the scheduling change.

The engine-generator sets were operated within 10% of maximum output (1,600 kW generator output) 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 (EUICEENGINE1)

Test No. Test date Test period (24-hr clock)	1 1/29/15 1128 - 1228	2 1/29/15 1330 - 1430	3 1/29/15 1509 – 1609	Three Test Average
Fuel flowrate (scfm)	518	518	521	519
Generator output (kW)	1,579	1,587	1,588	1,585
Engine output (bhp)	2,213	2,223	2,225	2,220
LFG methane content (%)	52.3	52.1	51.8	52.1
LFG heat content (Btu/scf (lhv))	473	473	473	473
Exhaust Gas Composition				
CO_2 content (% vol)	10.7	11.7	11.1	11.1
O_2 content (% vol)	9.4	7.9	8.9	8.7
Moisture (% vol)	11.3	10.9	9.0	10.4
Exhaust gas temperature (^oF)	820	820	813	817
Exhaust gas flowrate (dscfm)	4,516	4,470	4,522	4,503
Exhaust gas flowrate (scfm)	5,093	5,016	4,967	5,025
Nitrogen Oxides				
NO_X conc. (ppmvd)	64.3	71.8	67.6	67.9
NO_X emissions (lb/hr)	2.08	2.30	2.19	2.19
Permitted emissions (lb/hr)	-	-	-	4.92
NO_X emissions (g/bhp*hr)	0.43	0.47	0.45	0.45
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Carbon Monoxide				
CO conc. (ppmvd)	727.6	747.0	738.7	737.8
CO emissions (lb/hr)	14.34	14.57	14.58	14.49
Permitted emissions (lb/hr)	-	-	-	16.23
CO emissions (g/bhp*hr)	2.94	2.97	2.97	2.96
Permitted emissions (g/bhp*hr)	-	-	-	3.3
Volatile Organic Compounds				
VOC conc. (ppmv)	26.0	27.6	27.2	26.9
VOC emissions (lb/hr)	0.91	0.95	0.93	0.93
VOC emissions (g/bhp*hr)	0.19	0.19	0.19	0.19
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 (EUICEENGINE2)

Test No. Test date Test period (24-hr clock)	1 1/15/15 932 - 1032	2 1/15/15 1110 – 1210	3 1/15/15 1250 – 1350	Three Test Average
Fuel flowrate (scfm)	478	480	484	480
Generator output (kW)	1,605	1,604	1,603	1,604
Engine output (bhp)	2,242	2,242	2,242	2,242
LFG methane content (%)	53.4	53.4	53.2	53.3
LFG heat content (Btu/scf (lhv))	482	482	482	482
Exhaust Gas Composition				
CO_2 content (% vol)	10.9	11.0	11.0	11.0
O_2 content (% vol)	9.1	9.1	9.1	9.1
Moisture (% vol)	9.9	9.7	8.7	9.5
Exhaust gas temperature (^oF)	800	804	802	802
Exhaust gas flowrate (dscfm)	4,594	4,579	4,618	4,597
Exhaust gas flowrate (scfm)	5,100	5,072	5,059	5,077
Nitrogen Oxides				
NO_X conc. (ppmvd)	79.8	70.6	78.4	76.2
NO_X emissions (lb/hr)	2.63	2.32	2.59	2.51
Permitted emissions (lb/hr)	-	-	-	4.92
NO_X emissions (g/bhp*hr)	0.53	0.47	0.52	0.51
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Carbon Monoxide				
CO conc. (ppmvd)	653.3	655.5	657.4	655.4
CO emissions (lb/hr)	13.10	13.10	13.25	13.15
Permitted emissions (lb/hr)	-	-	-	16.23
CO emissions (g/bhp*hr)	2.65	2.65	2.68	2.66
Permitted emissions (g/bhp*hr)	-	-	-	3.3
Volatile Organic Compounds				
VOC conc. (ppmv)	22.7	21.5	22.9	22.4
VOC emissions (lb/hr)	0.80	0.75	0.79	0.78
VOC emissions (g/bhp*hr)	0.16	0.15	0.16	0.16
Permitted emissions (g/bhp*hr)	-	-	-	1.0