AIR EMISSION TEST REPORT

Title	AIR EMISSION TEST REPORT FOR LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES
Report Date	July 23, 2015
Test Dates	June 16 – 17, 2015

Facility Information	
Name	Adrian Energy Associates
Street Address	1900 North Ogden Highway
City, County	Adrian, Lenawee
SRN	P0426

Facility Permit Information	
ROP No. :	MI-ROP-P0426-2014
Emission Units :	EUICENGINE#1, EUICENGINE#2, EUICENGINE#3

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1412003

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 Adrian Energy Associates County Lenawee

Source Address 1900 North Ogden Highway City Adrian

AQD Source ID (SRN) P0426 ROP No. P0426-2014 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 ______ To ______

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

Emission verification Test Report for LFG-fired IC engines (EUICENGINE1-3).
The testing was conducted in accordance with the Test Plan dated May 9, 2015 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

Dennis Plaster	General Manager	(585) 948-8580
Name of Responsible Official (print or type)	Title	Phone Number

Signature of Responsible Official ______ Date ______

* Photocopy this form as needed.

AIR EMISSION TEST REPORT
FOR
LANDFILL GAS FUELED
INTERNAL COMBUSTION ENGINES

ADRIAN ENERGY ASSOCIATES

1.0 INTRODUCTION

Adrian Energy Associates (AEA) operates three (3) Caterpillar (CAT®) Model No. G3516 landfill gas (LFG) fueled reciprocating internal combustion engines (RICE) at its LFG gas to energy facility (Facility SRN: P0426) in Adrian, Lenawee County, Michigan. The facility has been issued Renewable Operating Permit (ROP) No. MI-ROP-P0426-2014 by the Michigan Department of Environmental Quality (MDEQ).

The CAT® Model No. G3516 engines are identified in ROP No. MI-ROP-P0426-2014 as Emission Unit ID: EUICENGINE#1 through 3 (Flexible Group ID: FGENGINES).

Air emission compliance testing was performed pursuant to ROP No. MI-ROP-P0426-2014, which states:

> *Within 12 months after the issuance of this permit, the permittee shall verify NO_X, CO and NMOC emission rates from EUICENGINE#1 through EUICENGINE#3, by testing at owner's expense, in accordance with the Department requirements.*

> *Within 12 months after the issuance of this permit, the permittee shall verify Formaldehyde emission rates from EUICENGINE#1 through EUICENGINE#3, by testing at owner's expense, in accordance with the Department requirements.*

Emission testing was performed on all three (3) engines to demonstrate compliance with the air pollutant emission limits for FGENGINES specified in MI-ROP-P0426-2014. The compliance testing was performed by Derenzo and Associates, Inc. (Derenzo and Associates) and Prism Analytical Technologies, Inc. (PATI). PATI representative Mr. Phil Kauppi and Derenzo and Associates representatives Tyler Wilson and Jeff Schlaf performed the field sampling and measurements June 16 – 17, 2015.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan that was reviewed and approved by the MDEQ in the May 22, 2015 test plan approval letter. MDEQ representatives Mr. Tom Gasloli and Ms. Diane Kavanaugh-Vetort observed portions of the testing project.

Questions regarding this emission test report should be directed to:

Tyler J. Wilson
Environmental Consultant
Derenzo and Associates, Inc.
39395 Schoolcraft Road
Livonia, MI 48150
Ph: (734) 464-3880
TWilson@derenzo.com

Mr. Rick Covell
Operations Maintenance Manager
Aria Energy
17036 Tall Timber
Clinton Township MI, 48036
(248) 380-3920
Rick.covell@ariaenergy.com

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 AEA employees or representatives.

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
Environmental Consultant
Derenzo and Associates, Inc.

Reviewed by:

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

This test report has been reviewed by AEA representatives and approved for submittal to the MDEQ. 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

Dennis Plaster
Vice President of Operations
Adrian Energy Associates / Aria Energy

2.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

2.1 General Process Description

LFG containing methane is generated at the Adrian Landfill facility 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 AEA landfill gas-to-energy facility where it is treated and used as fuel for the three (3) 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. G3516 RICE has a rated output of 1,138 brake-horsepower (bhp) and the connected generator has a rated electricity output of 800 kilowatts (kW). The engine is designed to fire low-pressure, lean fuel mixtures (e.g., LFG). 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.

Following startup of an engine (once the engine is at a steady-state condition) the process operates automatically. The engine will use an appropriate amount of fuel to maintain baseload operation. The air-to-fuel ratio is set based on the gas quality (methane or heat content) of the treated fuel for the most efficient combustion. Exhaust gas is released directly to atmosphere through a noise muffler and vertical exhaust stack.

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 G3516 RICE exhaust stacks are identical.

The exhaust stack sampling ports for the CAT® Model G3516 engines (EUICENGINE#1 through 3) are located in individual vertical exhaust stacks (located after the engine silencer) with an inner diameter of 12.0 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location greater than 9.0 inches (0.75 duct diameters) upstream and 35.5 inches (2.96 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 ROP No. MI-ROP-P0426-2014 require the AEA facility to test RICE (EUICENGINE#1 through 3) for carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), and formaldehyde.

3.2 Operating Conditions During the Compliance Tests

The testing was performed while the engine/generator sets were operated at maximum operating conditions (800 kW electricity output +/- 10%). AEA representatives provided the kW output in 15-minute increments for each test period. The RICE generator kW output was 760 kW during the test periods, which corresponds to an engine output of 1,085 bHp.

Fuel flowrate (cubic feet per minute) and fuel methane content (%) were also recorded by AEA representatives at 15-minute intervals for each test period. The RICE fuel consumption rate ranged between 893 and 986 scfm (total gas flow to all three engines) and fuel methane content ranged between 47.7 and 50.3% during the test periods. The lower heating value (LHV) for methane (910 Btu/scf) was used to calculate treated LFG heat content.

Air/fuel mixture at the after-cooler outlet temperature was monitored and recorded during each test period as required by ROP No. MI-ROP-P0426-2014 and requested in the test plan approval letter dated May 22, 2015. The temperature ranged between 117 and 137 during the test periods.

Appendix 2 provides operating records provided by AEA representatives for the test periods.

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

3.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the sampled LFG fueled RICE were each sampled for three (3) one-hour test periods during the NO_x, CO, VOC and formaldehyde compliance testing performed June 16-17, 2015.

Table 3.2 presents the average measured CO, NO_X, VOC, and formaldehyde emission rates for the engines (average of the three test periods for each engine) and applicable emission limits.

Results of the engine performance tests demonstrate compliance with emission limits specified in ROP No. MI-ROP-P0426-2014.

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

Table 3.1 Average engine operating conditions during the test periods

Emission Unit	Generator Output (kW)	Fuel Use (scfm)	LFG CH_4 Content (%)	LFG Btu Content (Btu/scf)	Exhaust Temp. (°F)
EUICENGINE#1	760	925	49.8	453	798
EUICENGINE#2	760	971	49.4	450	812
EUICENGINE#3	760	951	49.9	454	882

Notes:
Fuel use rates presented are for all three (3) IC engines combined.

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

	CO Emission Rates	NO_x Emission Rates	VOC Emission Rates	Formaldehyde Emission Rates
Emission Unit	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
EUICENGINE#1	5.33	1.37	0.37	0.74
EUICENGINE#2	6.57	0.97	0.46	0.97
EUICENGINE#3	5.90	0.62	0.53	1.00
ICE No. 1-3 Total	17.80	2.96	1.36	2.71
Emission Limit	21.25	15.38	6.73	

Notes:
VOC emission rate and permit limit includes emissions of formaldehyde.
Emission limits are total mass emissions for the combined operation of all three IC engines.

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 testing periods.

4.1 Summary of Sampling Methods

USEPA Method 2	Exhaust gas velocity pressure was determined using a Type-S Pitot tube connected to a red oil incline manometer; temperature was measured using a K-type thermocouple connected to the Pitot tube.
USEPA Method 3A	Exhaust gas O_2 and CO_2 content was determined using zirconia ion/paramagnetic and infrared instrumental analyzers, respectively.
USEPA Method 4	Exhaust gas moisture was determined based on the water weight gain in chilled impingers and FTIR spectrometer analyzer.
USEPA Method 7E	Exhaust gas NOx concentration was determined using a chemiluminescence instrumental analyzer.
USEPA Method 10	Exhaust gas CO concentration was measured using a NDIR instrumental analyzer.
USEPA Method 320	Exhaust gas formaldehyde concentration was measured using a FTIR spectrometer analyzer.
USEPA Method 25A / ALT-096	Exhaust gas VOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with a GC 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 instrumental analyzer test (for NO_x, CO, VOC and formaldehyde mass emission calculations). An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were periodically leak-checked to verify the integrity of the measurement system.

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

Appendix 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 streams were measured continuously throughout each test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a Servomex 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 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 an FTIR spectrometer analyzer, but during the first emission test (Test No. 1 for Engine No. 3) a chilled impinger sampling train was also used to verify accurate moisture content results. The moisture sampling was performed concurrently with the instrumental analyzer sampling. During the first 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 the first sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain, and the results were compared to FTIR moisture content results.

Following Test No. 1 for Engine No. 3, moisture content results from the chilled impinger sampling train method (13.7%) were compared to the moisture content results determined by the FTIR spectrometer analyzer (13.5%) and Mr. Tom Gasloli (MDEQ-AQD) approved the use of FTIR moisture content results for all subsequent tests.

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 NMHC (USEPA Method 25A/ALT-096)

The nonmethane hydrocarbon (NMHC) concentration in the engine exhaust gas was measured using an instrumental analyzer. 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 NMHC 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, NMHC 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 5.5 of this document).

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

4.7 Measurement of Formaldehyde Emissions (USEPA Method 320)

The concentration of formaldehyde in the RICE exhaust gas was determined by Extractive Fourier Transform Infrared (FTIR) using a MKS Multi-Gas 2030 FTIR spectrometer. Formaldehyde measurements were performed by Mr. Phil Kauppi of Prism Analytical Technologies, Inc.

Throughout each one-hour test period, a continuous sample of the engine exhaust gas was extracted from the stack using a Teflon® heated sample line and heated particulate filter, and delivered to the instrumental analyzer. The sampled gas was not conditioned prior to being introduced to the analyzer; therefore, the measurement of formaldehyde concentration corresponds to standard wet gas conditions. Instrument formaldehyde response for the analyzer was recorded with a data logging system that monitored the analog output of the instrumental analyzer continuously and logged data as one-minute averages. Prior to, and at the conclusion of each test, analyte spiking was performed to verify the ability of the sampling system to quantitatively deliver a sample from the base of the probe to the FTIR (described in Appendix 7).

Appendix 4 provides formaldehyde calculation sheets. The formaldehyde report prepared by PATI is provided in Appendix 7.

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 -0.96% of the expected value, i.e., within 10% of the expected value as required by Method 7E).

5.2 Sampling System Response Time Determination

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.
The TEI Model 42c analyzer exhibited the longest system response time at 56 seconds. Results of the response time determinations were recorded on field data sheets. For each test period, test data

were collected once the sample probe was in position for at least twice the maximum system response time.

5.3 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.4 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NO_X, CO, O_2 and CO_2 have had an interference response test preformed prior to their use in the field (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 3.0% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.5 Instrument Calibration and System Bias Checks

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

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

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

5.6 Determination of Exhaust Gas Stratification

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

The recorded data for each IC engine exhaust stack gas indicate that the measured CO, NO_x, O_2 and CO_2 concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the stack gas of each IC engine was considered to be unstratified and the compliance test sampling was performed at a single sampling location within each IC engine exhaust stack.

5.7 Meter Box Calibrations

The Nutech Model 2010 sampling console, which was used for exhaust gas moisture content sampling, was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5. The metering console calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

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

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. 1 through 3 (EUICENGINE#1 through 3) are less than the allowable limits specified in ROP No. MI-ROP-P0426-2014 for the engines:

- 15.38 lb/hr for NO_X;
- 21.25 lb/hr for CO; and
- 6.73 lb/hr for VOC (including formaldehyde).

The limits are total mass emissions for the combined operation of all three (3) CAT® 3516 engine generator sets.

The air pollutant mass emission rates (lb/hr) were converted to grams per brake-horsepower hour (g/bHp-hr) values for use in the facility's monthly emission records. This information is presented in Tables 6.1 through 6.3.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with the USEPA reference test methods and approved test protocol except as noted below. The engine-generator sets were operated within 10% of maximum output and no variations from the normal operating conditions of the RICE occurred during the engine test periods.

During Test No. 1 on Engine No. 1, NOx emissions briefly spiked over the calibration span value (119 ppmv) for the NOx instrument (the recorded concentrations, however, were well within the measurement range of the instrument). NOx emissions decreased to under the span value for the remainder of the test period. Mr. Tom Gasloli (MDEQ-AQD) witnessed and approved the continuance and acceptance of Test No. 1. Prior to commencing Test No. 2, the observed RICE exhaust gas NOx concentration again spiked over the calibration span value of 119 ppmv. The test crew consulted with Tom Gasloli and it was decided to re-calibrate the NOx instrument to a span value of 178.6 ppmv to avoid additional exceedances of the calibration span value. The remaining tests were performed based on the calibration span value of 178.6. A NOx concentration of 119 ppmv was used for the upscale system bias check following each test period.

Engine exhaust gas moisture content was measured using an FTIR spectrometer analyzer rather than the usual USEPA Method 4 impinger sampling train. A chilled impinger sampling train was operated concurrently with the FTIR instrument during the first emission test to verify that that two methods resulted in comparable measured moisture content. See section 4.4 of this report for more information.

Table 6.1 Measured exhaust gas conditions and NO_x, CO, VOC and formaldehyde air pollutant emission rates Adrian Energy Associates Engine No. 1 (EUICENGINE#1)

Test No. Test date Test period (24-hr clock)	1 6/16/15 1235 - 1335	2 6/16/15 1430 - 1530	3 6/16/15 1555 - 1655	Three Test Average
Fuel flowrate (scfm)	941	918	915	925
Generator output (kW)	760	760	760	760
LFG methane content (%)	49.3	50.0	50.2	49.8
LFG LHV heat content (Btu/scf)	449	455	457	453
Aftercooler temperature (°F)	123	124	124	124
Exhaust Gas Composition				
CO_2 content (% vol)	12.0	12.1	12.0	12.0
O_2 content (% vol)	7.27	7.21	7.31	7.26
Moisture (% vol)	13.5	13.5	13.3	13.4
Exhaust gas temperature (°F)	789	804	808	798
Exhaust gas flowrate (dscfm)	2,248	2,438	2,317	2,334
Exhaust gas flowrate (scfm)	2,593	2,809	2,666	2,689
Nitrogen Oxides				
NO_X conc. (ppmvd)	59.9	112	72.5	81.4
NO_X emissions (lb/hr)	0.97	1.95	1.20	1.37
NO_X emissions (g/bHp*hr)	0.40	0.82	0.50	0.57
Carbon Monoxide				
CO conc. (ppmvd)	516	529	524	523
CO emissions (lb/hr)	5.07	5.63	5.30	5.33
CO emissions (g/bHp*hr)	2.12	2.35	2.21	2.23
Volatile Organic Compounds				
NMHC conc. (ppmv C_3)	20.5	19.9	20.4	20.3
NMHC emissions (lb/hr)	0.37	0.38	0.37	0.37
HCOH conc. (ppmv)	58.0	58.8	59.0	58.6
HCOH emissions (lb/hr)	0.70	0.77	0.74	0.74
Total VOC emissions (lb/hr)	1.07	1.15	1.11	1.11
Total VOC emissions (g/bHp*hr)	0.44	0.48	0.47	0.47

Table 6.2 Measured exhaust gas conditions and NO_x, CO, VOC and formaldehyde air pollutant emission rates Adrian Energy Associates Engine No. 2 (EUICENGINE#2)

Test No. Test date Test period (24-hr clock)	1 6/17/15 745 - 845	2 6/17/15 910 - 1010	3 6/17/15 1035 - 1135	Three Test Average
Fuel flowrate (scfm)	967	972	972	971
Generator output (kW)	760	760	760	760
LFG methane content (%)	49.4	49.5	49.3	49.4
LFG LHV heat content (Btu/scf)	450	450	449	450
Aftercooler temperature (°F)	117	119	120	119
Exhaust Gas Composition				
CO_2 content (% vol)	11.8	11.8	11.8	11.8
O_2 content (% vol)	7.33	7.40	7.42	7.38
Moisture (% vol)	13.3	13.3	13.1	13.2
Exhaust gas temperature (°F)	811	811	812	812
Exhaust gas flowrate (dscfm)	2,401	2,400	2,405	2,402
Exhaust gas flowrate (scfm)	2,761	2,759	2,765	2,761
Nitrogen Oxides				
NO_X conc. (ppmvd)	57.4	54.2	57.7	56.4
NO_X emissions (lb/hr)	0.99	0.93	0.99	0.97
NO_X emissions (g/bHp*hr)	0.41	0.39	0.42	0.41
Carbon Monoxide				
CO conc. (ppmvd)	625	625	630	627
CO emissions (lb/hr)	6.55	6.54	6.62	6.57
CO emissions (g/bHp*hr)	2.74	2.73	2.77	2.75
Volatile Organic Compounds				
NMHC conc. (ppmv C_3)	23.6	24.4	24.2	24.1
NMHC emissions (lb/hr)	0.45	0.46	0.46	0.46
HCOH conc. (ppmv)	74.1	74.4	75.9	74.8
HCOH emissions (lb/hr)	0.96	0.96	0.98	0.97
Total VOC emissions (lb/hr)	1.41	1.43	1.43	1.42
Total VOC emissions (g/bHp*hr)	0.59	0.59	0.60	0.59

Table 6.3 Measured exhaust gas conditions and NO_x, CO, VOC and formaldehyde air pollutant emission rates Adrian Energy Associates Engine No. 3 (EUICENGINE#3)

Test No. Test date Test period (24-hr clock)	1 6/16/15 753 - 853	2 6/16/15 920 - 1020	3 6/16/15 1045 - 1145	Three Test Average
Fuel flowrate (scfm)	956	939	957	951
Generator output (kW)	760	760	760	760
LFG methane content (%)	49.9	49.9	49.8	49.9
LFG LHV heat content (Btu/scf)	454	454	453	454
Aftercooler temperature (°F)	130	133	136	133
Exhaust Gas Composition				
CO_2 content (% vol)	11.9	11.9	11.7	11.8
O_2 content (% vol)	7.36	7.45	7.58	7.46
Moisture (% vol)	13.1	13.0	13.0	13.0
Exhaust gas temperature (°F)	879	885	886	882
Exhaust gas flowrate (dscfm)	2,364	2,362	2,356	2,361
Exhaust gas flowrate (scfm)	2,733	2,727	2,717	2,726
Nitrogen Oxides				
NO_X conc. (ppmvd)	43.1	35.0	31.1	36.4
NO_X emissions (lb/hr)	0.73	0.59	0.52	0.62
NO_X emissions (g/bHp*hr)	0.31	0.25	0.22	0.26
Carbon Monoxide				
CO conc. (ppmvd)	585	568	566	573
CO emissions (lb/hr)	6.04	5.86	5.82	5.90
CO emissions (g/bHp*hr)	2.52	2.45	2.43	2.47
Volatile Organic Compounds				
NMHC conc. (ppmv C_3)	27.2	28.2	28.8	28.1
NMHC emissions (lb/hr)	0.51	0.53	0.54	0.53
HCOH conc. (ppmv)	77.6	78.1	78.5	78.1
HCOH emissions (lb/hr)	0.99	1.00	1.00	1.00
Total VOC emissions (lb/hr)	1.50	1.53	1.53	1.52
Total VOC emissions (g/bHp*hr)	0.62	0.64	0.64	0.64