



**Executive Summary**

**ENERGY DEVELOPMENTS PINCONNING AT THE WHITEFEATHER LANDFILL  
CAT® G3520C LANDFILL GAS FUELED IC ENGINES  
EMISSION TEST RESULTS**

Energy Developments Pinconning (EDL) contracted Impact Compliance & Testing, Inc. (ICT, formerly Derenzo Environmental Services) to conduct a performance demonstration for the determination of pollutant concentrations and emission rates from two (2) Caterpillar (CAT®) Model No. G3520C landfill gas-fired reciprocating internal combustion engines (RICE) and electricity generator sets EUCENGINE1 and EUCENGINE2 (collectively flexible emission group FGICENGINES) operated at the Whitefeather Landfill in Pinconning, Michigan.

Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Renewable Operating Permit (ROP) No. MI-ROP-N5985-2019 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 RICE) for nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), and volatile organic compounds (VOC). The performance testing was conducted on February 28, 2019.

APR 04 2019

The following table presents the emissions results from the performance demonstration

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Emission Unit	NO <sub>x</sub> Emissions		CO Emissions		VOC Emissions
	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(g/bhp-hr)
EUCENGINE1	3.72	0.77	13.1	2.73	0.13
EUCENGINE2	3.55	0.73	12.0	2.47	0.14
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 (lb/hr)	LFG CH <sub>4</sub> Content (%)	Exhaust Temp. (°F)
EUCENGINE1	1,563	2,182	2,209	54.6	775
EUCENGINE2	1,577	2,200	2,132	54.9	764

lb/hr=pounds per hour, kW=kilowatt, bhp=brake horse power

The data presented above indicates that EUCENGINE1 and EUCENGINE2 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-N5985-2019.



## AIR EMISSION TEST REPORT

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

AIR QUALITY DIVISION

Report Date March 22, 2019

APR 07 2019

Test Date February 28, 2019

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Facility Information	
Name	Energy Developments Pinconning at the Whitefeather Landfill
Street Address	2401 East Whitefeather Road
City, County	Pinconning, Bay

Facility Permit Information			
Permit No.:	MI-ROP-N5985-2019	Facility SRN :	N5985

Testing Contractor	
Company	Impact Compliance & Testing, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
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Project No.	1901048

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

ENERGY DEVELOPMENTS PINCONNING AT THE WHITEFEATHER LANDFILL

**1.0 INTRODUCTION**

Energy Developments Pinconning (EDL) owns and operates two (2) Caterpillar (CAT®) Model No. G3520C gas fueled reciprocating internal combustion engines (RICE) and electricity generator sets at the Whitefeather Landfill in Pinconning, Bay County, Michigan (Energy Developments of Pinconning, facility SRN: N5985). The two (2) landfill gas (LFG) fueled RICE-generator sets are identified as emission units EUCENGINE1 and EUCENGINE2 (FGICENGINES) in Renewable Operating Permit (ROP) No. MI-ROP-PN5985-2019 issued by the Michigan Department of Environmental Quality (MDEQ).

The conditions of MI-ROP-N5985-2019:

1. Allow for the installation and operation of two (2) spark ignition, lean burn reciprocating internal combustion engine and electricity generation sets (CAT® Model G3520C) that use treated landfill gas as fuel and have a rated horsepower (hp) output of 2,233 at full load.
2. Specify that ... *The permittee shall conduct an initial performance test for each engine in FGICENGINES, to verify NOx, CO, and VOC emission rates. The permittee shall conduct an initial performance test within 60 days after achieving the maximum production rate but not later than 180 days after initial startup of each engine in FGICENGINES and subsequent performance testing every 8760 hours of operation or three years, whichever occurs first, to demonstrate compliance. The performance tests shall be conducted according to 40 CFR 60.4244.*

The compliance testing was performed by Impact Compliance & Testing, Inc. (ICT, formerly Derenzo Environmental Services), a Michigan-based environmental consulting and testing company. ICT representatives Brad Thome and Jory VanEss performed the field sampling and measurements February 28, 2019.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan that was reviewed and approved by the MDEQ-AQD. Mr. Tom Gasloli of the MDEQ-AQD observed portions of the compliance testing.

**Impact Compliance & Testing, Inc.**

Energy Developments Pinconning (Whitefeather Landfill)  
Air Emission Test Report

March 22, 2019  
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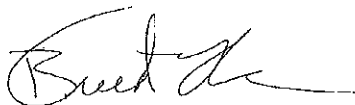
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**Report Certification**

This test report was prepared by Impact Compliance & Testing, Inc. based on field sampling data collected by ICT. Facility process data was collected and provided by EDL employees or representatives. This test report has been reviewed by EDL 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.

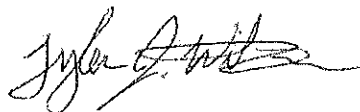
Report Prepared By:



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Brad Thome  
Environmental Consultant  
Impact Compliance & Testing, Inc.

Reviewed by:



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Tyler J. Wilson  
Senior Project Manager  
Impact Compliance & Testing, 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:

---

Dan Zimmerman  
Director of North America HSE & Compliance  
EDL Energy

## **2.0 SOURCE AND SAMPLING LOCATION DESCRIPTION**

### **2.1 General Process Description**

Landfill gas (LFG) containing methane is generated in the Whitefeather 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 EDL 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. The two (2) CAT® Model G3520C RICE exhaust stacks are identical. These exhaust stacks have been replaced since the previous emissions testing event, therefore, the stack dimensions in this test report are different from the stack dimensions in the last test report for this facility.

The exhaust stack sampling ports for the CAT® Model G3520C engines (EUIENGINE1 and EUIENGINE2) are located in individual exhaust stacks with an inner diameter of 14.25 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 240 inches (16.8 duct diameters) upstream and 120 inches (8.4 duct diameters) downstream from any flow disturbance and satisfies the USEPA Method 1 criteria for a representative sample location.

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

Appendix A provides diagrams of the emission test sampling locations.

### **3.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS**

#### **3.1 Purpose and Objective of the Tests**

The conditions of Renewable Operating Permit (ROP) No. MI-ROP-N5985-2019 and 40 CFR Part 60 Subpart JJJJ require EDL to test each engine (FGICENGINES) 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 EDL RICE-generator sets were operated at maximum operating conditions (1,600 kW electricity output +/- 10%). EDL representatives provided the kW output in 15-minute intervals for each test period. The FGICENGINES generator electricity output ranged between 1,550 and 1,590 kW for each test period.

Fuel flowrate (pounds per hour (lb/hr)), fuel methane content (%), and inlet pressure (psi) were also recorded by EDL representatives in 15-minute intervals for each test period. The FGICENGINES fuel consumption rate ranged between 2,100 and 2,221 lb/hr, fuel methane content ranged between 54.4 and 56.3%, and inlet pressure was 6.0 psi. There was no fuel flow to the flare or leachate evaporator during the test periods. Fuel heat value was calculated using a lower heating value of 910 Btu/scf for methane.

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

Appendix B provides operating records provided by EDL representatives for the test periods.

Engine output (bhp) cannot be measured directly and was calculated based on the recorded electricity output, the calculated CAT® Model G3520C generator efficiency (96.1%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

$$\text{Engine output (bhp)} = \text{Electricity output (kW)} / (0.961) / (0.7457 \text{ kW/hp})$$

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

#### **3.3 Summary of Air Pollutant Sampling Results**

The gases exhausted from each LFG-fueled RICE (EUCENGINE1 and EUCENGINE2) were sampled for three (3) one-hour test periods during the compliance testing performed February 28, 2019.



**Impact Compliance & Testing, Inc.**

Tables 3.2 and 3.3 present the average measured pollutant emission rates for EUCENGINE1 and EUCENGINE2, respectively (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	EUCENGINE1	EUCENGINE2
Generator output (kW)	1,563	1,577
Engine output (bhp)	2,182	2,200
Engine LFG fuel use (lb/hr)	2,209	2,132
LFG methane content (%)	54.6	54.9
LFG lower heating value (Btu/scf)	497	500
Inlet Pressure (psi)	6.0	6.0
Exhaust temperature (°F)	775	764

Table 3.2 Average measured emission rates for EUCENGINE1 (three-test average)

Emission Unit	CO		NOx		VOC
	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(g/bhp-hr)
Engine No. 1 Measured Rates	13.1	2.73	3.72	0.77	0.13
Permit Limit	16.23	3.3	4.92	1.0	0.65

Table 3.3 Average measured emission rates for EUCENGINE2 (three-test average)

Emission Unit	CO		NOx		VOC
	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(g/bhp-hr)
Engine No. 2 Measured Rates	12.0	2.47	3.55	0.73	0.14
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 EDL 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 <sub>2</sub> and CO <sub>2</sub> 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 NO <sub>x</sub> 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 velocity and volumetric flowrate was determined using USEPA Method 2 once for each test. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure at each traverse point across the stack cross section. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were leak-checked onsite, prior to the test event, to verify the integrity of the measurement system.

The absence of significant cyclonic flow for the exhaust configuration was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each velocity traverse point with the planes of the face openings of the Pitot tube perpendicular to the

stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

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

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

CO<sub>2</sub> and O<sub>2</sub> content in the RICE exhaust gas was measured continuously throughout each test period in accordance with USEPA Method 3A. The CO<sub>2</sub> content of the exhaust was monitored using a Servomex 1440D single beam single wavelength (SBSW) infrared gas analyzer. The O<sub>2</sub> 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<sub>2</sub> and CO<sub>2</sub> content correspond to standard dry gas conditions. Instrument response data were recorded using an ESC Model 8816 data acquisition system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages.

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

Appendix D provides O<sub>2</sub> and CO<sub>2</sub> calculation sheets. Raw instrument response data are provided in Appendix E.

#### **4.4 Exhaust Gas Moisture Content (USEPA Method 4)**

Moisture content of the RICE exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. 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<sub>x</sub> and CO Concentration Measurements (USEPA Methods 7E and 10)**

NO<sub>x</sub> 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<sub>x</sub> 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 D provides CO and NO<sub>x</sub> calculation sheets. Raw instrument response data are provided in Appendix E.

#### **4.6 Measurement of Volatile Organic Compounds (USEPA Method 25A and 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 NMHC 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 D provides VOC calculation sheets. Raw instrument response data for the NMHC analyzer is provided in Appendix E.

### **5.0 QA/QC ACTIVITIES**

#### **5.1 NO<sub>x</sub> Converter Efficiency Test**

The NO<sub>2</sub> – NO conversion efficiency of the Model 42c analyzer was verified prior to the testing program. A USEPA Protocol 1 certified concentration of NO<sub>2</sub> was injected directly into the analyzer, following the initial three-point calibration, to verify the analyzer's conversion efficiency. The analyzer's NO<sub>2</sub> – NO converter uses a catalyst at high temperatures to convert the NO<sub>2</sub> to NO for measurement. The conversion efficiency of the

analyzer is deemed acceptable if the measured NO<sub>x</sub> concentration is greater than or equal to 90% of the expected value.

The NO<sub>2</sub> – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO<sub>x</sub> concentration was 94.9% of the expected value, i.e., greater than 90% 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 delivers calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

## **5.3 Instrumental Analyzer Interference Check**

The instrumental analyzers used to measure NO<sub>x</sub>, CO, O<sub>2</sub> and CO<sub>2</sub> have had an interference response test performed 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.

## **5.4 Instrument Calibration and System Bias Checks**

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO<sub>x</sub>, CO, CO<sub>2</sub> and O<sub>2</sub> 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<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub>, 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 each RICE exhaust stack indicate that the measured CO, O<sub>2</sub> and CO<sub>2</sub> 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, 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 console was calibrated using a NIST traceable Omega<sup>®</sup> Model CL 23A temperature calibrator.

### **5.7 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.

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.

Appendix F presents test equipment quality assurance data for the emission test equipment (NO<sub>2</sub> – 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 through 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-N5985-2019 for Emission Unit Nos. EUCENGINE1 and EUCENGINE2:

- 4.92 lb/hr and 1.0 g/bhp-hr for NO<sub>x</sub>;
- 16.23 lb/hr and 3.3 g/bhp-hr for CO; and
- 1.0 g/bhp-hr for VOC.

### **6.2 Variations from Normal Sampling Procedures or Operating Conditions**

The testing for all pollutants was performed in accordance with the approved test protocol. The engine-generator sets were operated within 10% of maximum output (1,600 kW generator output) and no variations from the normal operating conditions of the RICE occurred during the engine test periods.

Following Test No. 1 on Engine No. 2, the NO<sub>x</sub> instrument was re-calibrated since it was approaching the bias and drift limits. This was discussed with and approved by MDEQ-AQD representative Mr. Tom Gasloli.

Table 6.1 Measured exhaust gas conditions and NO<sub>x</sub>, CO, and VOC air pollutant emission rates for Engine No. 1 (EUIENGINE1)

Test No.	1	2	3	Three Test
Test date	2/28/19	2/28/19	2/28/19	Average
Test period (24-hr clock)	1351-1451	1517-1617	1640-1740	
Fuel flowrate (lb/hr)	2,211	2,205	2,210	2,209
Generator output (kW)	1,562	1,567	1,561	1,563
Engine output (bhp)	2,179	2,187	2,179	2,182
LFG methane content (%)	54.6	54.7	54.6	54.6
Inlet pressure (psi)	6.0	6.0	6.0	6.0
<u>Exhaust Gas Composition</u>				
CO <sub>2</sub> content (% vol)	10.5	10.5	10.5	10.5
O <sub>2</sub> content (% vol)	8.86	8.88	8.86	8.87
Moisture (% vol)	7.0	11.8	10.6	9.8
Exhaust gas temperature (°F)	775	776	775	775
Exhaust gas flowrate (dscfm)	4,745	4,502	4,599	4,615
Exhaust gas flowrate (scfm)	5,101	5,105	5,144	5,117
<u>Nitrogen Oxides</u>				
NO <sub>x</sub> conc. (ppmvd)	110	112	115	112
NO <sub>x</sub> emissions (g/bhp*hr)	0.78	0.75	0.79	0.77
Permitted emissions (g/bhp*hr)	-	-	-	1.0
NO <sub>x</sub> emissions (lb/hr)	3.75	3.62	3.78	3.72
Permitted emissions (lb/hr)	-	-	-	4.92
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	648	646	660	651
CO emissions (g/bhp*hr)	2.79	2.63	2.76	2.73
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	13.4	12.7	13.2	13.1
Permitted emissions (lb/hr)	-	-	-	16.23
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv as C <sub>3</sub> )	17.0	17.4	17.3	17.3
VOC emissions (g/bhp*hr)	0.12	0.13	0.13	0.13
Permitted emissions (g/bhp*hr)	-	-	-	1.0

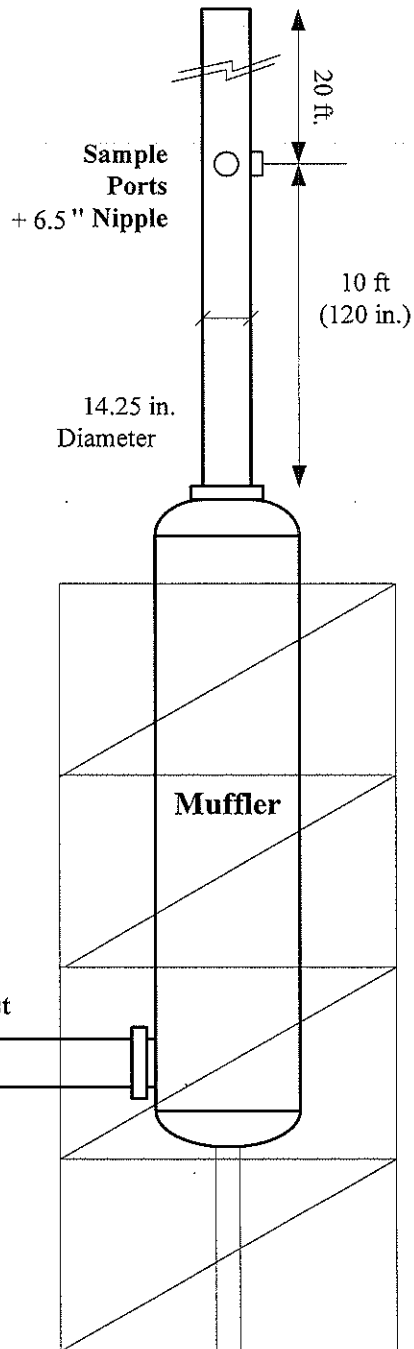


Table 6.2 Measured exhaust gas conditions and NO<sub>x</sub>, CO, and VOC air pollutant emission rates for Engine No. 2 (EUCENGINE2)

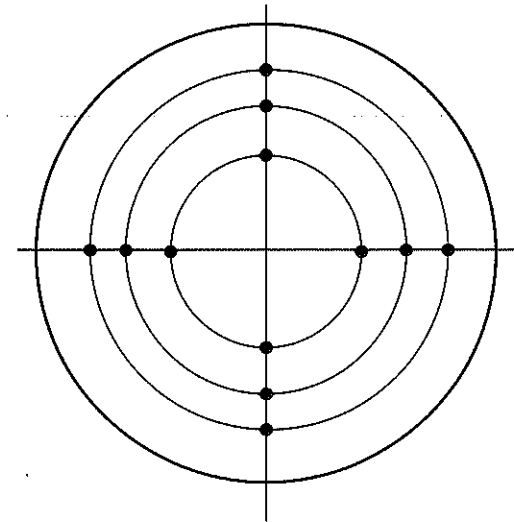
Test No.	1	2	3	Three Test
Test date	2/28/19	2/28/19	2/28/19	Average
Test period (24-hr clock)	0857-0957	1049-1149	1221-1321	
Fuel flowrate (lb/hr)	2,121	2,134	2,140	2,132
Generator output (kW)	1,576	1,579	1,576	1,577
Engine output (bhp)	2,199	2,203	2,200	2,200
LFG methane content (%)	55.3	54.9	54.5	54.9
Inlet pressure (psi)	6.0	6.0	6.0	6.0
<u>Exhaust Gas Composition</u>				
CO <sub>2</sub> content (% vol)	10.4	10.4	10.4	10.4
O <sub>2</sub> content (% vol)	9.02	9.00	9.02	9.01
Moisture (% vol)	12.0	11.3	11.4	11.6
Exhaust gas temperature (°F)	765	763	764	764
Exhaust gas flowrate (dscfm)	4,655	4,628	4,737	4,673
Exhaust gas flowrate (scfm)	5,289	5,217	5,349	5,285
<u>Nitrogen Oxides</u>				
NO <sub>x</sub> conc. (ppmvd)	109	105	104	106
NO <sub>x</sub> emissions (g/bhp*hr)	0.75	0.72	0.73	0.73
Permitted emissions (g/bhp*hr)	-	-	-	1.0
NO <sub>x</sub> emissions (lb/hr)	3.65	3.48	3.52	3.55
Permitted emissions (lb/hr)	-	-	-	4.92
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	585	588	590	588
CO emissions (g/bhp*hr)	2.45	2.45	2.52	2.47
Permitted emissions (g/bhp*hr)	-	-	-	3.3
CO emissions (lb/hr)	11.9	11.9	12.2	12.0
Permitted emissions (lb/hr)	-	-	-	16.23
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv as C <sub>3</sub> )	18.2	18.3	19.1	18.5
VOC emissions (g/bhp*hr)	0.14	0.14	0.14	0.14
Permitted emissions (g/bhp*hr)	-	-	-	1.0

**APPENDIX A**

- Figure A-1 – IC Engine Nos. 1 – 2 Sample Port Diagram
- Figure A-2 – USEPA Method 3A/7E/10/Alt096 Sampling Train Diagram
- Figure A-3 – USEPA Method 4 Sampling Train Diagram



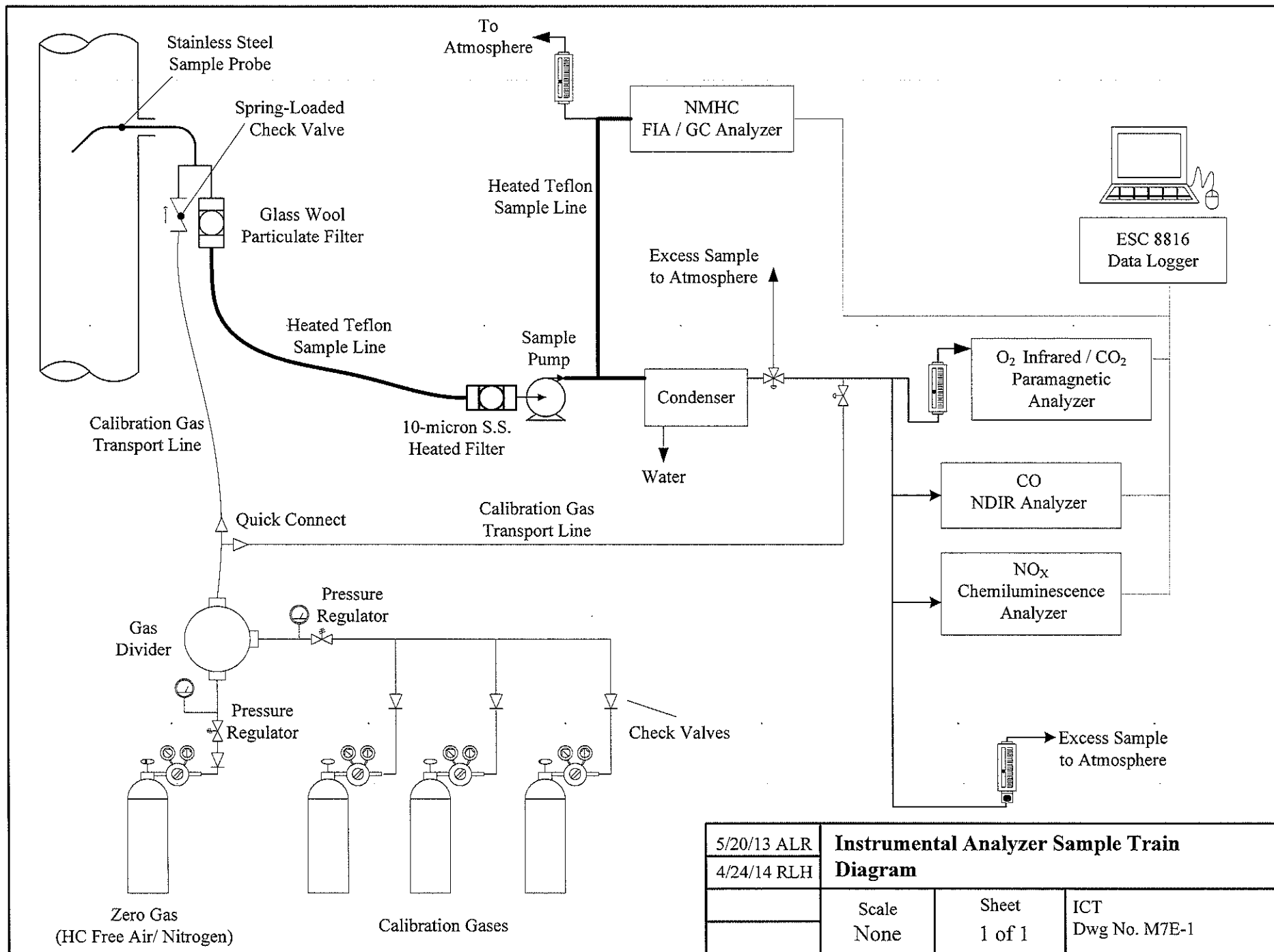
Exhaust Stack  
Cross-Section with  
Traverse Points



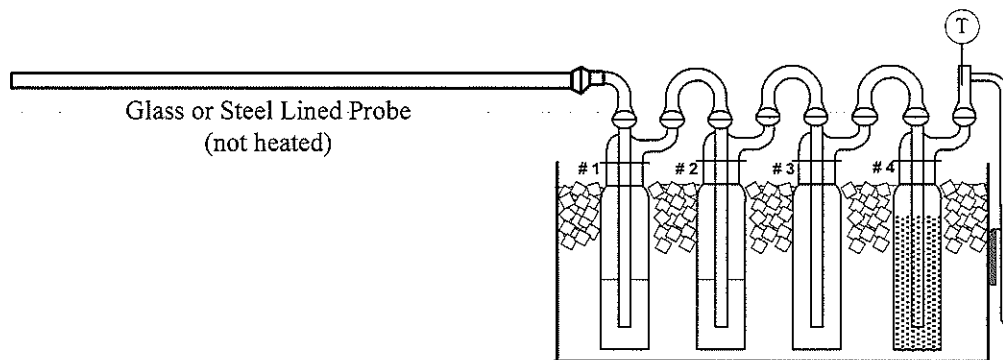
Velocity sample locations as  
measured from stack wall

Pt. #	in.
1	0.63
2	2.08
3	4.22
4	10.03
5	12.17
6	13.62

3/29/18 TJW	<b>Energy Developments Pinconning Exhaust Sample Location, CAT® G3520 ICE</b>		
	Scale None	Sheet 1 of 1	ICT



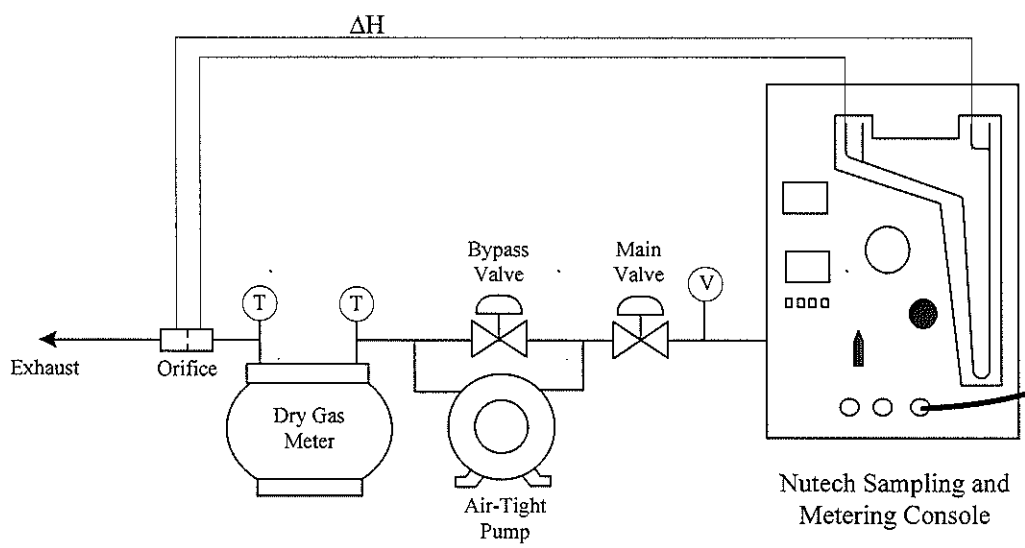
5/20/13 ALR	<b>Instrumental Analyzer Sample Train</b>		
4/24/14 RLH	<b>Diagram</b>		
	Scale None	Sheet 1 of 1	ICT Dwg No. M7E-1



Impinger Contents (indicate Standard or Modified)

- Impinger # 1: 100 mL Water (std).
- Impinger # 2: 100 mL Water (mod)
- Impinger # 3: Empty (std)
- Impinger # 4: Dried silica gel (mod)

(V) = Vacuum Gauge  
 (T) = Temperature Measurement



3/1/10	<b>USEPA Method 4 Sample Train</b>		
	Scale	Sheet	ICT
	None	1 of 1	Dwg No. M4-03