IMPACT COMPLIANCE & TESTING

AIR EMISSION TEST REPORT

Title:	AIR EMISSION TEST REPORT FOR THE VERIFICATION OF AIR POLLUTANT EMISSIONS FROM LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES
Report Date:	January 31, 2020
Test Dates:	December 3-6, 2019

Facility Information	
Name:	Energy Developments Michigan, LLC
Street Address:	8247 Vienna Road (M-57)
City, County:	Montrose, Genesee
SRN:	N5987

Facility Permit Information	
Permit to Install No.:	176-18
Emission Units:	EUENGINE3 through EUENGINE7

Testing Contractor	
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Project No.:	1900208

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

ENERGY DEVELOPMENTS MICHIGAN, LLC

1.0 INTRODUCTION

Energy Developments Michigan, LLC (EDL) owns and operates a renewable energy facility located at the Brent Run Landfill in Montrose, Genesee County, Michigan. The EDL facility primarily consists of five (5) Caterpillar (CAT®) gas fueled reciprocating internal combustion engines and electricity generator sets (RICE gensets) that are identified as emission units EUENGINE3, EUENGINE4, EUENGINE5, EUENGINE6, and EUENGINE7 and flexible group FGICEENGINES in Permit to Install (PTI) No. 176-18.

The conditions of PTI No. 176-18 specify that:

1. *By December 31, 2019, the permittee shall verify emission rates for each engine in FGICEENGINES for NOx, CO, VOC, SO2, PM10, and PM2.5 and within every 5 years thereafter from the date of completion of the most recent stack test, by testing at owner's expense, in accordance with Department requirements.*

2. *By December 31, 2019, the permittee shall verify formaldehyde emission rates from the three engines EUENGINE3 or EUENGINE4, EUENGINE5, and EUENGINE7 of FGICEENGINES and within every 5 years from the date of completion of the most recent stack test, by testing at owner's expense, in accordance with Department requirements.*

3. *Except as provided in 40 CFR 60.4243(b), the permittee shall conduct an initial performance test for each engine in FGRICENSPS within one year after startup of the engine and every 8760 hours of operation (as determined through the use of a non-resettable hour meter) or three years, whichever occurs first, to demonstrate compliance with the emission limits in 40 CFR 60.4233(e)...*

The compliance testing was performed by Impact Compliance & Testing, Inc. (ICT). ICT representatives Tyler J. Wilson, Blake Beddow, Robert Harvey, Andy Rusnak, and Clay Gaffey performed the field sampling and measurements December 3-6, 2019.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Protocol dated October 24, 2019 that was reviewed and approved by the Michigan Department of Environment, Great Lakes and Energy (EGLE) Air Quality Divisions (AQD).

Questions regarding this emission test report should be directed to:

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Report Certification

This test report was prepared by ICT based on field sampling data collected by ICT. Facility process data were collected and provided by EDL employees or representatives. This test report has been reviewed by EDL representatives and approved for submittal to the EGLE-AQD.

A Report Certification signed by the facility's Responsible Official accompanies this report.

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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Reviewed By:

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2.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

2.1 Purpose and Objective of the Tests

The conditions of PTI No. 176-18 and 40 CFR Part 60 Subpart JJJJ require EDL to test EUENGINE4, EUENGINE3, EUENGINE6, EUENGINE7, and EUENGINE5 for carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compound (VOC), sulfur dioxide (SO_2), formaldehyde (HCOH), and particulate matter (PM10/PM2.5) emission rates.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the RICE generator sets were operated at maximum operating conditions or at least within 10% of rated electricity generation rate, which is 1,600 kW for EUENGINE4, EUENGINE3, EUENGINE6, and EUENGINE7, and 600 kW for EUENGINE5. EDL representatives recorded the generator electricity output (kW) at 15-minute intervals for each test period.

Fuel flowrate (pounds per hour (lb/hr or pph) and fuel methane content (%) were also recorded by EDL representatives every 15 minutes for each test period. 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 were recorded by the facility operators.

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

Engine horsepower output cannot be directly measured. However, it can be calculated based on a linear relationship with recorded generator output using the generator set efficiency:

CAT® G3520C HP = generator output (kW) / (0.7457 kW/hp) / generator efficiency (95.7%)

Using this equation, a generator output of 1,600 kW corresponds to an engine power output of approximately 2,242 hp.

CAT® G3512 HP = generator output (kW) / (0.7457 kW/hp) / generator efficiency (93.6%)

Using this equation, a generator output of 600 kW corresponds to an engine power output of approximately 860 hp.

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

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the LFG fueled RICE were each sampled for three (3) one-hour test periods during the compliance testing performed December 3-6, 2019.

Tables 2.2 and 2.3 present the average measured pollutant emission rates for EUENGINE4, EUENGINE3, EUENGINE6, EUENGINE7, and EUENGINE5 (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 2.1 Average engine operating conditions during the test periods

Engine Parameter	Engine No. 3	Engine No. 4	Engine No. 6	Engine No. 7	Engine No. 5
CAT® Model No.	G3520C	G3520C	G3520C	G3520C	G3512
Generator output (kW)	1,634	1,607	1,615	1,615	600
Engine output (bhp)	2,290	2,251	2,263	2,263	860
Engine LFG use (lb/hr)	2,285	2,292	2,338	2,353	--
Engine LFG use (scfm)	--	--	--	--	222
LFG methane content (%)	53.0	52.8	52.3	50.3	49.8
LFG LHV (Btu/scf)	482	480	476	458	453
Exhaust temperature (°F)	846	827	825	802	885

Table 2.2 Average measured emission rates for the CAT® G3520C engines (three-test average)

Pollutant	EUENGINE3	EUENGINE4	EUENGINE6	EUENGINE7	Permit Limit
NOx (lb/hr)	3.92	3.86	3.75	3.53	4.94
CO (lb/hr)	14.05	12.69	13.57	13.06	16.30
HCOH (lb/hr)	1.56	1.68	1.80	1.82	2.10
VOC (lb/hr)[1]	2.10	2.24	2.34	2.56	4.94
SO_2 (lb/hr)	3.79	3.64	3.76	3.56	3.56
$PM_{10/2.5}$ (lb/hr)	0.47	0.49	0.52	0.56	0.73
<u>NSPS</u>					
NOx (g/bhp-hr)	0.78	0.78	0.75	0.71	2.0
CO (g/bhp-hr)	2.80	2.56	2.72	2.62	5.0
VOC (g/bhp-hr)[2]	0.11	0.11	0.11	0.15	1.0

Table 2.3 Average measured emission rates for CAT® G3512 engine (three-test average)

Pollutant	EUENGINE5	Permit Limit
NOx (lb/hr)	0.65	5.10
CO (lb/hr)	3.97	7.84
HCOH (lb/hr)	0.54	0.75
VOC (lb/hr)[1]	0.95	1.04
SO_2 (lb/hr)	1.61	1.96
$PM_{10/2.5}$ (lb/hr)	0.20	0.40

<u>Notes</u>:
1. Formaldehyde is included in the lb/hr VOC limit.
2. Formaldehyde is not included in the NSPS VOC standard. The g/bhp-hr for VOC are based on non-methane hydrocarbon measurements without adding formaldehyde.

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

Landfill gas (LFG) containing methane is generated in the Brent Run 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 LFG power station facility where it is treated and used as fuel for the RICE. Each RICE is connected to an electricity generator that produces electricity that is transferred to the local utility.

3.2 Rated Capacities and Air Emission Controls

The CAT® Model No. G3520C RICE have a rated output of 2,242 brake-horsepower (bhp) and the connected generators have a rated electricity output of 1,600 kilowatts (kW). The CAT® Model No. G3512 RICE has a rated output of 860 brake-horsepower (bhp) and the connected generator has a rated electricity output of 600 kilowatts (kW). The engines are designed to fire low-pressure, lean fuel mixtures (e.g., LFG) and are 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 RICE generator sets are not equipped with an add-on emission control device. 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.

3.3 Sampling Locations

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

The exhaust stack sampling ports for EUENGINE4, EUENGINE3, and EUENGINE6 are located in the exhaust stack 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 300 inches (22.2 duct diameters) upstream and greater than 114 inches (8.44 duct diameters) downstream from any flow disturbance and satisfies the USEPA Method 1 criteria for a representative sample location.

The exhaust stack sampling ports for EUENGINE7 are located in the exhaust stack with an inner diameter of 12.25 inches. The stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location greater than 300 inches (24.5 duct diameters) upstream and greater than 114 inches (9.31 duct diameters) downstream from any flow disturbance and satisfies the USEPA Method 1 criteria for a representative sample location.

The exhaust stack sampling ports for EUENGINE5 are located in the exhaust stack with an inner diameter of 12.5 inches. The stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 50 inches (4.00 duct diameters) upstream and 105 inches (8.40 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.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the air emission testing was reviewed and approved by the EGLE-AQD. This section provides a summary of the sampling and analytical procedures that were used during the test 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 analyzer.
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.
USEPA Method 5/202	Exhaust gas PM10/PM2.5 concentration was measured using an isokinetic sample train for filterable and condensable particulate matter.
ASTM Method D6348	Exhaust gas SO_2 and HCOH was measured using Fourier transform infrared spectroscopy (FTIR instrumental analyzer).
ASTM Method D5504	Fuel gas sulfur analysis by gas chromatography and chemiluminescence.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The RICE exhaust stack gas velocities and volumetric flow rates were determined using USEPA Method 2 during the isokinetic sampling periods. 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.

Appendix 3 provides exhaust gas flowrate field data sheets (isokinetic PM10/PM2.5).

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

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

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

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

4.4 Exhaust Gas Moisture Content (USEPA Method 4)

Moisture content of the RICE exhaust gas stream was determined in accordance with USEPA Method 4 as a component of the particulate matter 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 a knockout impinger and 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.

Appendix 3 provides exhaust gas moisture gain field data sheets (isokinetic PM2.5/PM10).

4.5 NO_x and CO Concentration Measurements (USEPA Methods 7E and 10)

The exhaust for each RICE was monitored for three (3) one-hour test periods during which the NOx and CO concentrations were measured using a Thermo Environmental Instruments, Inc. (TEI) Model 42c High Level chemiluminescence NO_X analyzer and a TEI Model 48i infrared CO analyzer. The measured pollutant concentrations were adjusted based on instrument calibrations performed prior to and following each test period (drift and bias corrected pursuant to equations in specified in the USEPA reference test methods).

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

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

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

The VOC emission rate was determined by measuring the nonmethane hydrocarbon (NMHC) concentration in each RICE 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, 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 5.0 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 and Sulfur Dioxide (ASTM Method D6348)

Formaldehyde (HCOH) and sulfur dioxide (SO_2) concentrations in the RICE exhaust gas streams were determined using a MKS Multi-Gas 2030 Fourier transform infrared (FTIR) spectrometer.

Samples of the exhaust gas were delivered directly to the instrumental analyzer using a Teflon® heated sample line, heated head pump and heated filter to prevent condensation. The sample to the FTIR analyzer was not conditioned to remove moisture. Therefore, HCOH and SO_2 measurements correspond to standard conditions with no moisture correction (wet basis).

A calibration transfer standard (CTS), ethylene standard, and nitrogen zero gas were analyzed before and after each test run. Analyte spiking, of each engine, with acetaldehyde, sulfur hexafluoride, and sulfur dioxide was performed to verify the ability of the sampling system to quantitatively deliver a sample containing the compound of interest from the base of the probe to the FTIR. Data was collected at 0.5 cm^{-1} resolution. Instrument response was recorded using MKS data acquisition software.

Appendix 4 provides HCOH and SO_2 calculation sheets. Raw instrument response data for the FTIR instrument is provided in Appendix 5.

4.8 Measurement of Particulate Matter Emissions (USEPA Method 5/202)

The conditions of PTI No. 176-18 specify PM10/PM2.5 emission limits for the RICE generators sets. The testing was performed using a combined filterable and condensable particulate matter (PM) sampling train. The filterable and condensable fractions were added to calculate total PM10/PM2.5 emissions (i.e., all filterable and condensable PM emissions were assumed to be in the PM10/PM2.5 size range).

4.8.1 Filterable Particulate Matter Sample Train (USEPA Method 5)

Filterable PM was determined using USEPA Method 5. RICE exhaust gas was withdrawn from the exhaust stack at an isokinetic sampling rate using an appropriately-sized stainless steel sample nozzle and heated probe. The collected exhaust gas was passed through a pre-tared glass fiber filter that was housed in an independent heated filter box. The back half of the filter housing was connected to the condensable PM impinger train.

4.8.2 Condensable Particulate Matter Sample Train (USEPA Method 202)

Condensable PM (CPM) concentrations were measured in accordance with USEPA Method 202. Following the Method 5 filter assembly, the sample gas travelled through the impinger train which consisted of a condenser, a knock-out impinger, a standard Greenberg-Smith (G-S) impinger (dry), a Teflon-coated CPM filter (with exhaust thermocouple), a modified G-S impinger containing 100 milliliters of deionized water, and a modified G-S impinger containing a known amount of indicating silica gel.

The CPM components of the Method 202 sampling train (dry knockout impinger and dry GS impinger) were placed in a tempered water bath and a pump was used to circulate water through the condenser. The temperature of the bath was maintained such that the CPM filter outlet temperature remained between 65 and 85°F. Crushed ice was placed around the last two impingers to chill the gas to below 68°F.

4.8.3 <u>Sample Recovery and Analysis (USEPA Method 5/202)</u>

At the conclusion of each one-hour test period, the sample train was leak-checked and disassembled. The sample nozzle, probe liner, and filter holder were brushed and rinsed with acetone. The recovered particulate filter and acetone rinses were stored in sealed containers and transferred to Enthalpy Analytical, Inc. (Durham, North Carolina) for gravimetric measurements.

The impingers were transported to the recovery area where they were weighed. The exhaust gas contained significant amounts of moisture. Therefore, prior to recovery, the CPM portion of the sample train underwent the nitrogen purge step of Method 202. The glassware (between the particulate filter and CPM filter) was rinsed with DI water, acetone, and hexane in accordance with the Method 202 sample recovery procedures. The CPM filter and recovered rinses were clearly and uniquely labeled and transferred to Enthalpy Analytical, Inc. for analysis.

Diluent gas content (Method 3A O_2 and CO_2) measurements were performed with each of the PM10/PM2.5 isokinetic sampling periods.

Appendix 4 provides PM10/PM2.5 calculation sheets. The PM10/PM2.5 laboratory report is provided in Appendix 7.

4.9 Fuel Gas Analysis for Sulfur (ASTM Method D5504)

The EGLE-AQD Test Protocol Approval Letter required the following additional process data to be recorded during the test program:

- *One fuel gas sample per test day, collected during active testing using a Draeger tube, for H2S determination; and*

- *One fuel gas sample per test program, collected during active testing, for determination of sulfur compounds in accordance with ASTM D5504.*

ICT satisfied the additional process data request by performing one Draeger tube measurement per test day (photos included in Appendix 7); and by performing one sulfur compounds measurement via tedlar bag per test event. A representative sample of the treated LFG was collected during the test event (December 5, 2019) using a tedlar bag. The sample Teflon tubing was connected to the fuel header at a location after the treatment system and gas blower. The tedlar bag was conditioned with treated LFG gas prior to collecting the gas sample.

The gas sample was analyzed by SPL (Traverse City, MI) for sulfur bearing compounds by ASTM D5504.

Appendix 7 provides a copy of the laboratory analytical report for the treated LFG tedlar bag sample and photos of the four (4) Draeger® tubes.

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_X concentration is greater than or equal to 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NO_X concentration was 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 delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.3 Instrumental Analyzer Interference Check

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

5.4 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO_x, CO, CO_2, and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings. At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the NMHC analyzer, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one-hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

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

5.5 Determination of Exhaust Gas Stratification

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

The recorded concentration data for each RICE exhaust stack indicated that the measured CO, O_2, and CO_2 concentrations did not vary by more than 5% of the mean across each stack diameter. Therefore, the RICE exhaust gas was considered to be unstratified and the analyzer portion of 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 the particulate matter and 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, Pitot tube, probe, nozzle, scale, and barometer calibration records; stratification checks).

5.7 Particulate Matter Recovery and Analysis

All recovered particulate matter samples were stored and picked up in pre-rinsed glass sample bottles with Teflon® lined caps. The liquid level on each bottle was marked with a permanent marker prior to pick-up and the caps were secured closed with tape. Samples of the reagents used in the test event (200 milliliters each of deionized high-purity water, acetone and hexane) were picked up by a laboratory representative for analysis to verify that the reagents used to recover the samples have low particulate matter residues.
The glassware used in the condensable PM impinger trains was washed and rinsed prior to use in accordance with the procedures of USEPA Method 202. The glassware was not baked prior to use; therefore, ICT used the field train proof blank option provided in USEPA Method 202. Analysis of the collected field train proof blank rinses (sample train rinse performed prior to use) indicated a total of 2.6 milligrams (mg) of recovered PM from the sample train. In addition, a field train recovery proof blank was performed following the second sampling period. Analysis of the field train recovery proof blank resulted in 2.6 mg of recovered PM from the sample train. The reported condensable PM test results were blank-corrected according to the method (USEPA Method 202 allows a blank correction of up to 2 mg).

5.8 Laboratory QA/QC Procedures

The particulate matter analyses were conducted by a qualified third-party laboratory according to the appropriate QA/QC procedures specified in the USEPA Methods 5 and 202 and are included in the final report provided by Enthalpy Analytical.

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 6.5.

The measured air pollutant emission rates for each LFG-fueled CAT® RICE genset are less than the allowable limits specified in PTI No. 176-18 except for SO_2 emissions for EUENGINE4, EUENGINE3, and EUENGINE6:

Emission Unit	CO (pph)	NOx (pph)	VOC[1] (pph)	HCOH (pph)	SO_2 (pph)	PM10/PM2.5 (pph)
EUENGINE3 EUENGINE4 EUENGINE6 EUENGINE7	16.30	4.94	4.94	2.10	3.56	0.73
EUENGINE5	7.84	5.10	1.04	0.75	1.96	0.40

Notes:
1. Formaldehyde is included in each VOC limit.

The measured air pollutant emission rates for each of the LFG-fueled CAT® G3520C RICE gensets are less than the allowable limits specified in 40 CFR 60.4233(e) Table 1 of 40 CFR Part 60 Subpart JJJJ:

Emission Unit	CO (g/bhp-hr)	CO (ppmvd)[1]	NOx (g/bhp-hr)	NOx (ppmvd)[1]	VOC[2] (g/bhp-hr)	VOC[2] (ppmvd)[1]
EUENGINE3 EUENGINE4 EUENGINE6 EUENGINE7	5.0	610	2.0	150	1.0	80

Notes:
1. ppmvd @ 15% O_2
2. Formaldehyde is not included in the NSPS VOC standard.
3. Each RICE must pass either the specified g/bhp-hr emission limit or the ppmvd @ 15% O_2 emission limit for each pollutant.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

Each RICE generator set was operated within 10% of maximum output during the engine test periods. The testing for all pollutants was performed in accordance with USEPA methods and the approved Test Protocol with any exceptions noted below.

The test protocol indicated that SO_2 emissions would be measured with the a TEI Model 43i by USEPA Method 6C. However, ICT experienced issues with the SO_2 sampling system and SO_2 emissions for this test event were measured with the FTIR instrumental analyzer by Method ASTM D6348. EGLE-AQD representative Ms. Lindsey Wells approved this adjustment to the test procedures and recommended the SO_2 analyte spiking procedures presented in Section 4.7 of this report.

The PM10/2.5 portion of Test No. 1 for Engine No. 3 was discarded due to the PM10/PM2.5 sample train failing the post-test leak check. All collected data for Test No. 1 is still provided in this Test Report. An additional test period for PM10/2.5 (Test No. 4) was performed to satisfy the three-test average requirement for PM10/2.5 emissions and all other pollutant (except for SO_2 and HCOH) emission measurements are included for Test No. 4.

The exhaust gas moisture content for Test No. 1 for Engine No. 3 (11.4%) was measured with the FTIR instrumental analyzer since the isokinetic sampling system failed the post-test leak check.

Test No. 1 for Engine No. 5 was restarted because the manual air-to-fuel ratio set-point was in the wrong position upon beginning the test and the selected isokinetic sampling system nozzle was too small to collect adequate sample volume for the lower flowrate (the CAT® G3512 flowrate was approximately 41% of the CAT® G3520C flowrates). All analytical raw data for the discarded test is included in this report.

Table 6.1 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 3 (EUENGINE3)

Test No.	1	2	3	3	
Test date	12/4/19	12/4/19	12/4/19	12/4/19	Test
Test period (24-hr clock)	9:03-10:12	10:44-11:51	12:32-13:38	14:14-15:23	Average[4]
Fuel flowrate (lb/hr)	2,287	2,275	2,291	2,292	2,285
Generator output (kW)	1,646	1,632	1,624	1,619	1,634
Engine output (bhp)	2,306	2,286	2,276	2,268	2,290
LFG methane content (%)	53.0	53.1	52.8	52.7	53.0
LFG heat content (Btu/scf)	482	483	480	480	482
Exhaust Gas Composition					
CO_2 content (% vol)	11.6	11.6	11.6	11.6	11.6
O_2 content (% vol)	8.42	8.43	8.41	8.43	8.42
Moisture (% vol)	11.4	11.5	11.8	11.4	11.6
Exhaust gas temperature (^oF)	845	845	848	840	844
Exhaust gas flowrate (dscfm)	4,660	4,657	4,594	4,655	4,635
Exhaust gas flowrate (scfm)	5,262	5,263	5,207	5,256	5,242
Nitrogen Oxides					
NO_X conc. (ppmvd)	118	120	118	116	118
NO_X emissions (lb/hr)	3.94	4.00	3.89	3.87	3.92
Permitted emissions (lb/hr)	-	-	-	-	*4.94*
NO_X emissions (g/bhp*hr)	0.78	0.79	0.78	0.77	0.78
*Permitted emissions (g/bhp*hr)*	-	-	-	-	*2.0*
Carbon Monoxide					
CO conc. (ppmvd)	701	700	694	690	694
CO emissions (lb/hr)	14.3	14.2	13.9	14.0	14.0
Permitted emissions (lb/hr)	-	-	-	-	*16.30*
CO emissions (g/bhp*hr)	2.81	2.82	2.77	2.80	2.80
*Permitted emissions (g/bhp*hr)*	-	-	-	-	*5.0*
Volatile Organic Compounds					
VOC conc. (ppmv as C_3)[1]	15.1	15.1	15.4	15.7	15.4
VOC emissions (lb/hr)	0.55	0.55	0.55	0.57	0.56
VOC emissions (g/bhp*hr)	0.11	0.11	0.11	0.11	0.11
*Permitted emissions (g/bhp*hr)[3]*	-	-	-	-	*1.0*

Table 6.1 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 3 (EUENGINE3) [Continued]

Test No.	1	2	3	4	
Test date	12/4/19	12/4/19	12/4/19	12/4/19	Test
Test period (24-hr clock)	9:03-10:12	10:44-11:51	12:32-13:38	14:14-15:23	Average[4]
Particulate Matter					
Sampled volume (dscf)	-	48.6	48.9	47.3	48.3
Filterable catch (mg)	-	10.8	10.5	14.5	11.9
Condensable catch (mg)	-	31.4	22.6	20.2	24.7
Total PM10/PM2.5 catch (mg)	-	42.2	33.1	34.7	36.6
PM10/PM2.5 emissions (lb/hr)	-	0.53	0.41	0.45	0.47
Permitted emissions (lb/hr)	-	-	-	-	*0.73*
Formaldehyde					
HCOH conc. (ppmv)	63.0	63.3	63.8	-	63.4
HCOH emissions (lb/hr)	1.55	1.56	1.55	-	1.56
Permitted emissions (lb/hr)	-	-	-	-	*2.10*
VOC + HCOH emissions (lb/hr)	2.10	2.11	2.11	-	2.10
Permitted emissions (lb/hr)[2]	-	-	-	-	*4.94*
Sulfur Dioxide					
SO_2 conc. (ppmv)	72.7	72.7	71.6	-	72.3
SO_2 emissions (lb/hr)	3.82	3.82	3.72	-	3.79
Permitted emissions (lb/hr)	-	-	-	-	*3.56*

1. VOC measured as nonmethane hydrocarbons.
2. Formaldehyde is not included in the g/bhp*hr VOC limit.
3. Formaldehyde is included in the lb/hr VOC limit.
4. Run 1 for PM was discarded due to a train leak. FTIR data were not collected for the fourth test.

Table 6.2 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 4 (EUENGINE4)

Test No. Test date Test period (24-hr clock)	1 12/3/19 11:44-12:54	2 12/3/19 14:33-15:40	3 12/3/19 16:25-17:32	Three Test Average
Fuel flowrate (lb/hr)	2,278	2,293	2,305	2,292
Generator output (kW)	1,605	1,606	1,609	1,607
Engine output (bhp)	2,249	2,251	2,255	2,251
LFG methane content (%)	53.0	52.7	52.7	52.8
LFG heat content (Btu/scf)	482	480	480	480
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	11.5	11.5	11.5	11.5
O_2 content (% vol)	8.55	8.57	8.57	8.56
Moisture (% vol)	11.1	11.8	11.4	11.5
Exhaust gas temperature (^{o}F)	819	828	834	827
Exhaust gas flowrate (dscfm)	4,562	4,680	4,666	4,636
Exhaust gas flowrate (scfm)	5,131	5,308	5,267	5,236
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	129	107	112	116
NO_X emissions (lb/hr)	4.23	3.58	3.75	3.86
Permitted emissions (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp*hr)	0.85	0.72	0.76	0.78
*Permitted emissions (g/bhp*hr)*	-	-	-	*2.0*
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	632	633	616	627
CO emissions (lb/hr)	12.6	12.9	12.6	12.7
Permitted emissions (lb/hr)	-	-	-	*16.30*
CO emissions (g/bhp*hr)	2.54	2.61	2.52	2.56
*Permitted emissions (g/bhp*hr)*	-	-	-	*5.0*
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv as C_3)[1]	15.6	15.8	15.4	15.6
VOC emissions (lb/hr)	0.55	0.58	0.56	0.56
VOC emissions (g/bhp*hr)	0.11	0.12	0.11	0.11
*Permitted emissions (g/bhp*hr)*[2]	-	-	-	*1.0*

Table 6.2 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 4 (EUENGINE4) [Continued]

Test No. Test date Test period (24-hr clock)	1 12/3/19 11:44-12:54	2 12/3/19 14:33-15:40	3 12/3/19 16:25-17:32	Three Test Average
Particulate Matter				
Sampled volume (dscf)	50.5	51.3	50.8	50.9
Filterable catch (mg)	11.0	10.8	14.3	12.1
Condensable catch (mg)	27.0	26.6	25.6	26.4
Total PM10/PM2.5 catch (mg)	38.0	37.4	39.9	38.5
PM10/PM2.5 emissions (lb/hr)	0.48	0.47	0.52	0.49
Permitted emissions (lb/hr)	-	-	-	*0.73*
Formaldehyde				
HCOH conc. (ppmv)	68.2	69.0	68.2	68.5
HCOH emissions (lb/hr)	1.64	1.71	1.68	1.68
Permitted emissions (lb/hr)	-	-	-	*2.10*
VOC + HCOH emissions (lb/hr)	2.19	2.29	2.24	2.24
Permitted emissions (lb/hr)[3]	-	-	-	*4.94*
Sulfur Dioxide				
SO_2 conc. (ppmv)	70.8	69.9	68.2	69.6
SO_2 emissions (lb/hr)	3.63	3.70	3.59	3.64
Permitted emissions (lb/hr)	-	-	-	*3.56*

1. VOC measured as nonmethane hydrocarbons.
2. Formaldehyde is not included in the g/bhp*hr VOC limit.
3. Formaldehyde is included in the lb/hr VOC limit.

Table 6.3 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 6 (EUENGINE6)

Test No. Test date Test period (24-hr clock)	1 12/4/19 16:47-18:05	2 12/4/19 18:40-19:45	3 12/4/19 20:14-21:20	Three Test Average
Fuel flowrate (lb/hr)	2,339	2,339	2,335	2,338
Generator output (kW)	1,612	1,611	1,621	1,615
Engine output (bhp)	2,259	2,258	2,272	2,263
LFG methane content (%)	52.5	52.2	52.1	52.3
LFG heat content (Btu/scf)	478	475	474	476
Exhaust Gas Composition				
CO_2 content (% vol)	11.6	11.6	11.6	11.6
O_2 content (% vol)	8.51	8.50	8.50	8.51
Moisture (% vol)	11.3	11.3	11.4	11.3
Exhaust gas temperature (°F)	831	821	823	825
Exhaust gas flowrate (dscfm)	4,711	4,661	4,577	4,650
Exhaust gas flowrate (scfm)	5,309	5,254	5,164	5,242
Nitrogen Oxides				
NO_X conc. (ppmvd)	113	112	112	112
NO_X emissions (lb/hr)	3.83	3.76	3.66	3.75
Permitted emissions (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp*hr)	0.77	0.76	0.73	0.75
*Permitted emissions (g/bhp*hr)*	-	-	-	*2.0*
Carbon Monoxide				
CO conc. (ppmvd)	670	672	665	669
CO emissions (lb/hr)	13.8	13.7	13.3	13.6
Permitted emissions (lb/hr)	-	-	-	*16.30*
CO emissions (g/bhp*hr)	2.77	2.74	2.65	2.72
*Permitted emissions (g/bhp*hr)*	-	-	-	*5.0*
Volatile Organic Compounds				
VOC conc. (ppmv as C_3)[1]	14.7	15.2	15.1	15.0
VOC emissions (lb/hr)	0.54	0.55	0.54	0.54
VOC emissions (g/bhp*hr)	0.11	0.11	0.11	0.11
*Permitted emissions (g/bhp*hr)*[3]	-	-	-	*1.0*

Table 6.3 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 6 (EUENGINE6) [Continued]

Test No. Test date Test period (24-hr clock)	1 12/4/19 16:47-18:05	2 12/4/19 18:40-19:45	3 12/4/19 20:14-21:20	Three Test Average
Particulate Matter				
Sampled volume (dscf)	50.5	50.3	50.8	50.5
Filterable catch (mg)	12.9	12.2	12.2	12.4
Condensable catch (mg)	27.2	26.4	30.4	28.0
Total PM10/PM2.5 catch (mg)	40.1	38.6	42.7	40.5
PM10/PM2.5 emissions (lb/hr)	0.52	0.50	0.54	0.52
Permitted emissions (lb/hr)	-	-	-	*0.73*
Formaldehyde				
HCOH conc. (ppmv)	73.6	73.3	73.2	73.4
HCOH emissions (lb/hr)	1.83	1.80	1.77	1.80
Permitted emissions (lb/hr)	-	-	-	*2.10*
VOC + HCOH emissions (lb/hr)	2.37	2.35	2.30	2.34
Permitted emissions (lb/hr)[2]	-	-	-	*4.94*
Sulfur Dioxide				
SO_2 conc. (ppmv)	71.3	72.1	72.0	71.8
SO_2 emissions (lb/hr)	3.78	3.78	3.71	3.76
Permitted emissions (lb/hr)	-	-	-	*3.56*

1. VOC measured as nonmethane hydrocarbons.
2. Formaldehyde is not included in the g/bhp*hr VOC limit.
3. Formaldehyde is included in the lb/hr VOC limit.

Table 6.4 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 7 (EUENGINE7)

Test No. Test date Test period (24-hr clock)	1 12/5/19 9:44-10:55	2 12/5/19 11:25-12:30	3 12/5/19 12:58-14:02	Three Test Average
Fuel flowrate (lb/hr)	2,349	2,359	2,351	2,353
Generator output (kW)	1,623	1,613	1,609	1,615
Engine output (bhp)	2,275	2,260	2,254	2,263
LFG methane content (%)	50.3	50.3	50.3	50.3
LFG heat content (Btu/scf)	458	458	458	458
Exhaust Gas Composition				
CO_2 content (% vol)	11.2	11.2	11.2	11.2
O_2 content (% vol)	9.00	8.97	8.96	8.98
Moisture (% vol)	10.3	10.8	10.4	10.5
Exhaust gas temperature (°F)	802	804	801	802
Exhaust gas flowrate (dscfm)	4,825	4,681	4,748	4,751
Exhaust gas flowrate (scfm)	5,378	5,250	5,300	5,310
Nitrogen Oxides				
NO_X conc. (ppmvd)	103	103	104	104
NO_X emissions (lb/hr)	3.57	3.46	3.55	3.53
Permitted emissions (lb/hr)	-	-	-	*4.94*
NO_X emissions (g/bhp*hr)	0.71	0.69	0.72	0.71
*Permitted emissions (g/bhp*hr)*	-	-	-	*2.0*
Carbon Monoxide				
CO conc. (ppmvd)	629	630	630	629
CO emissions (lb/hr)	13.2	12.9	13.1	13.1
Permitted emissions (lb/hr)	-	-	-	*16.30*
CO emissions (g/bhp*hr)	2.64	2.58	2.63	2.62
*Permitted emissions (g/bhp*hr)*	-	-	-	*5.0*
Volatile Organic Compounds				
VOC conc. (ppmv as C_3)[1]	20.5	20.3	20.3	20.4
VOC emissions (lb/hr)	0.76	0.73	0.74	0.74
VOC emissions (g/bhp*hr)	0.15	0.15	0.15	0.15
*Permitted emissions (g/bhp*hr)*[3]	-	-	-	*1.0*

Table 6.4 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 7 (EUENGINE7) [Continued]

Test No. Test date Test period (24-hr clock)	1 12/5/19 9:44-10:55	2 12/5/19 11:25-12:30	3 12/5/19 12:58-14:02	Three Test Average
<u>Particulate Matter</u>				
Sampled volume (dscf)	62.2	60.9	62.2	61.8
Filterable catch (mg)	19.5	17.9	17.2	18.2
Condensable catch (mg)	37.4	33.8	34.8	35.3
Total PM10/PM2.5 catch (mg)	56.9	51.7	52.0	53.5
PM10/PM2.5 emissions (lb/hr)	0.60	0.55	0.55	0.56
Permitted emissions (lb/hr)	-	-	-	*0.73*
<u>Formaldehyde</u>				
HCOH conc. (ppmv)	73.3	74.5	71.9	73.2
HCOH emissions (lb/hr)	1.84	1.83	1.78	1.82
Permitted emissions (lb/hr)	-	-	-	*2.10*
VOC + HCOH emissions (lb/hr)	2.60	2.56	2.52	2.56
Permitted emissions (lb/hr)[2]	-	-	-	*4.94*
<u>Sulfur Dioxide</u>				
SO_2 conc. (ppmv)	67.0	67.3	67.4	67.2
SO_2 emissions (lb/hr)	3.60	3.53	3.57	3.56
Permitted emissions (lb/hr)	-	-	-	*3.56*

1. VOC measured as nonmethane hydrocarbons.
2. Formaldehyde is not included in the g/bhp*hr VOC limit.
3. Formaldehyde is included in the lb/hr VOC limit.

Table 6.5 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 5 (EUENGINE5)

Test No. Test date Test period (24-hr clock)	1 12/6/19 11:20-12:23	2 12/6/19 12:57-13:59	3 12/6/19 14:30-15:34	Three Test Average
Fuel flowrate (scfm)	225	221	221	222
Generator output (kW)	863	864	852	860
Engine output (bhp)	2,286	2,280	2,277	2,281
LFG methane content (%)	50.0	49.9	49.6	49.8
LFG heat content (Btu/scf)	455	454	451	453
<u>Exhaust Gas Composition</u>				
CO_2 content (% vol)	12.3	12.3	12.2	12.3
O_2 content (% vol)	7.53	8.01	7.98	7.84
Moisture (% vol)	11.5	11.6	10.5	11.2
Exhaust gas temperature (°F)	886	885	884	885
Exhaust gas flowrate (dscfm)	1,952	1,904	2,003	1,953
Exhaust gas flowrate (scfm)	2,204	2,154	2,238	2,199
<u>Nitrogen Oxides</u>				
NO_X conc. (ppmvd)	55.0	47.0	37.7	46.6
NO_X emissions (lb/hr)	0.77	0.64	0.54	0.65
Permitted emissions (lb/hr)	-	-	-	*5.10*
NO_X emissions (g/bhp*hr)	0.40	0.34	0.29	0.34
*Permitted emissions (g/bhp*hr)*	-	-	-	-
<u>Carbon Monoxide</u>				
CO conc. (ppmvd)	470	463	465	466
CO emissions (lb/hr)	4.00	3.85	4.07	3.97
Permitted emissions (lb/hr)	-	-	-	*7.84*
CO emissions (g/bhp*hr)	2.10	2.02	2.16	2.10
*Permitted emissions (g/bhp*hr)*	-	-	-	-
<u>Volatile Organic Compounds</u>				
VOC conc. (ppmv as C_3)[1]	27.3	26.9	28.0	27.4
VOC emissions (lb/hr)	0.41	0.40	0.43	0.41
VOC emissions (g/bhp*hr)	0.22	0.21	0.23	0.22
*Permitted emissions (g/bhp*hr)*	-	-	-	-

Table 6.5 Measured exhaust gas conditions and air pollutant emission rates for Engine No. 5 (EUENGINE5) [Continued]

Test No. Test date Test period (24-hr clock)	1 12/6/19 11:20-12:23	2 12/6/19 12:57-13:59	3 12/6/19 14:30-15:34	Three Test Average
Particulate Matter				
Sampled volume (dscf)	47.4	46.4	48.1	47.3
Filterable catch (mg)	18.1	16.8	14.5	16.4
Condensable catch (mg)	19.0	15.0	23.4	19.1
Total PM10/PM2.5 catch (mg)	37.0	31.8	37.9	35.6
PM10/PM2.5 emissions (lb/hr)	0.21	0.18	0.22	0.20
Permitted emissions (lb/hr)	-	-	-	*0.40*
Formaldehyde				
HCOH conc. (ppmv)	52.3	51.9	52.1	52.1
HCOH emissions (lb/hr)	0.54	0.52	0.55	0.54
Permitted emissions (lb/hr)	-	-	-	*0.75*
VOC + HCOH emissions (lb/hr)	0.95	0.92	0.98	0.95
Permitted emissions (lb/hr)[2]	-	-	-	*1.04*
Sulfur Dioxide				
SO_2 conc. (ppmv)	74.6	73.6	72.4	73.5
SO_2 emissions (lb/hr)	1.64	1.58	1.62	1.61
Permitted emissions (lb/hr)	-	-	-	*1.96*

1. VOC measured as nonmethane hydrocarbons.
2. Formaldehyde is not included in the g/bhp*hr VOC limit.
3. Formaldehyde is included in the lb/hr VOC limit.

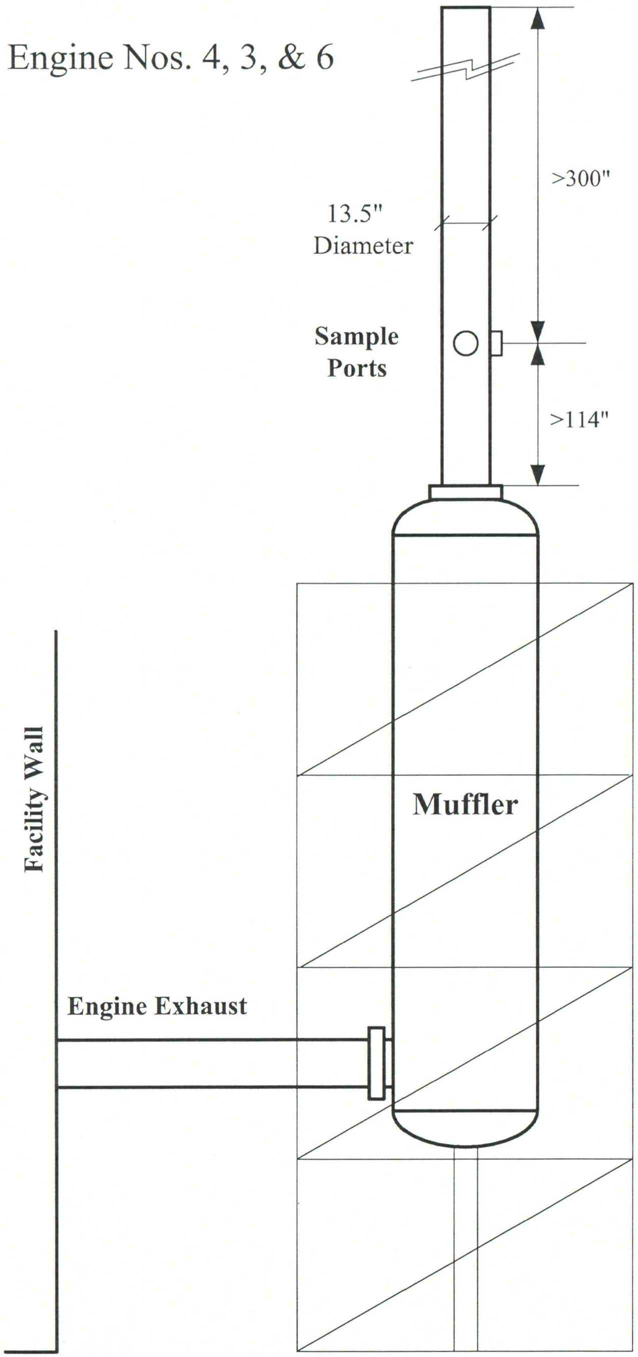
Table 6.6 Summary of LFG fuel sulfur content analysis

Test No.	12/3/19	12/4/19	12/5/19	12/6/19
Draeger® tube[1] (ppm H_2S)	650	525	600	610
Lab result (ppm H_2S)	--	--	--	545
Lab result[2] (ppm TRS)	--	--	--	564
SO_2 emission factor (lb/MMcf)	--	--	--	93.7
Engine No. 7 fuel use rate[3] (scfm)	--	--	--	555
Engine No. 7 SO_2 emissions[4] (lb/hr)	--	--	--	3.12

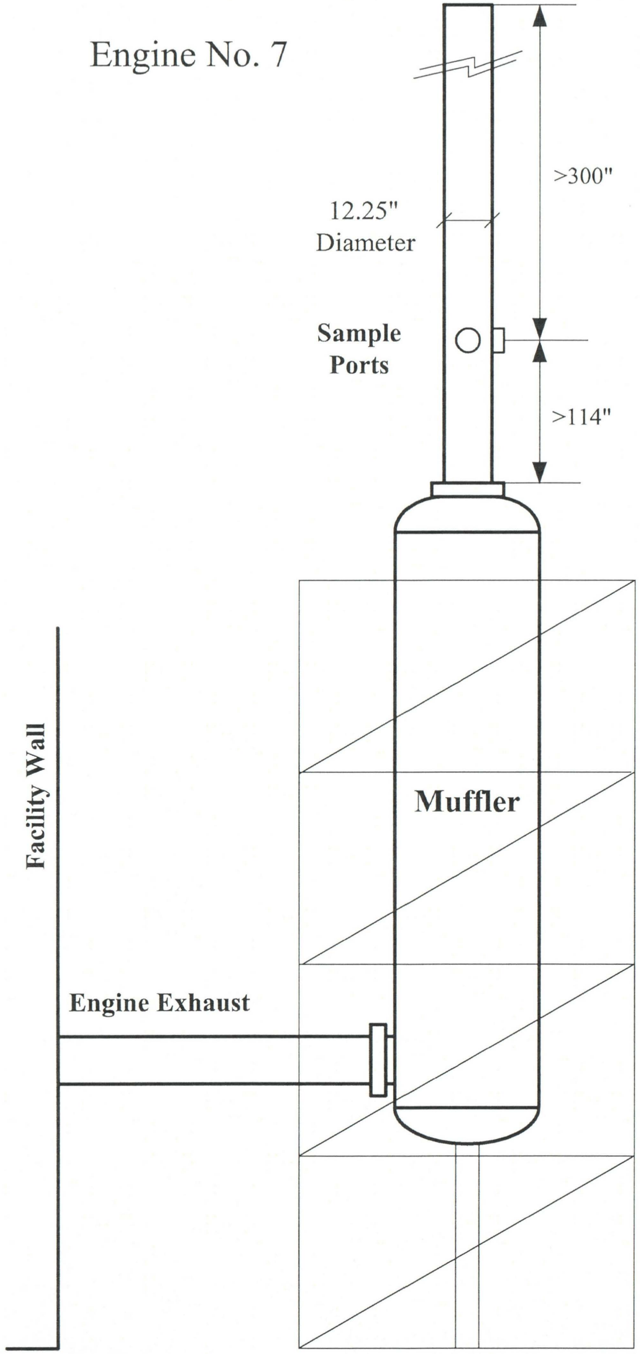
1. Estimated from observation of Draeger® tubes. Photos are provided in Appendix 7.
2. TRS concentration based on the total of all sulfur-bearing compounds detected in the sample. See laboratory report in Appendix 7.
3. The fuel gas sample was collected on December 5, 2019. The average fuel use rate recorded for Engine No. 7 on December 5, 2019 was used for the calculation.
4. SO_2 emission rate calculated using the fuel use rate and emission factor derived from the laboratory analysis.

APPENDIX 1

Engine Nos. 4, 3, & 6

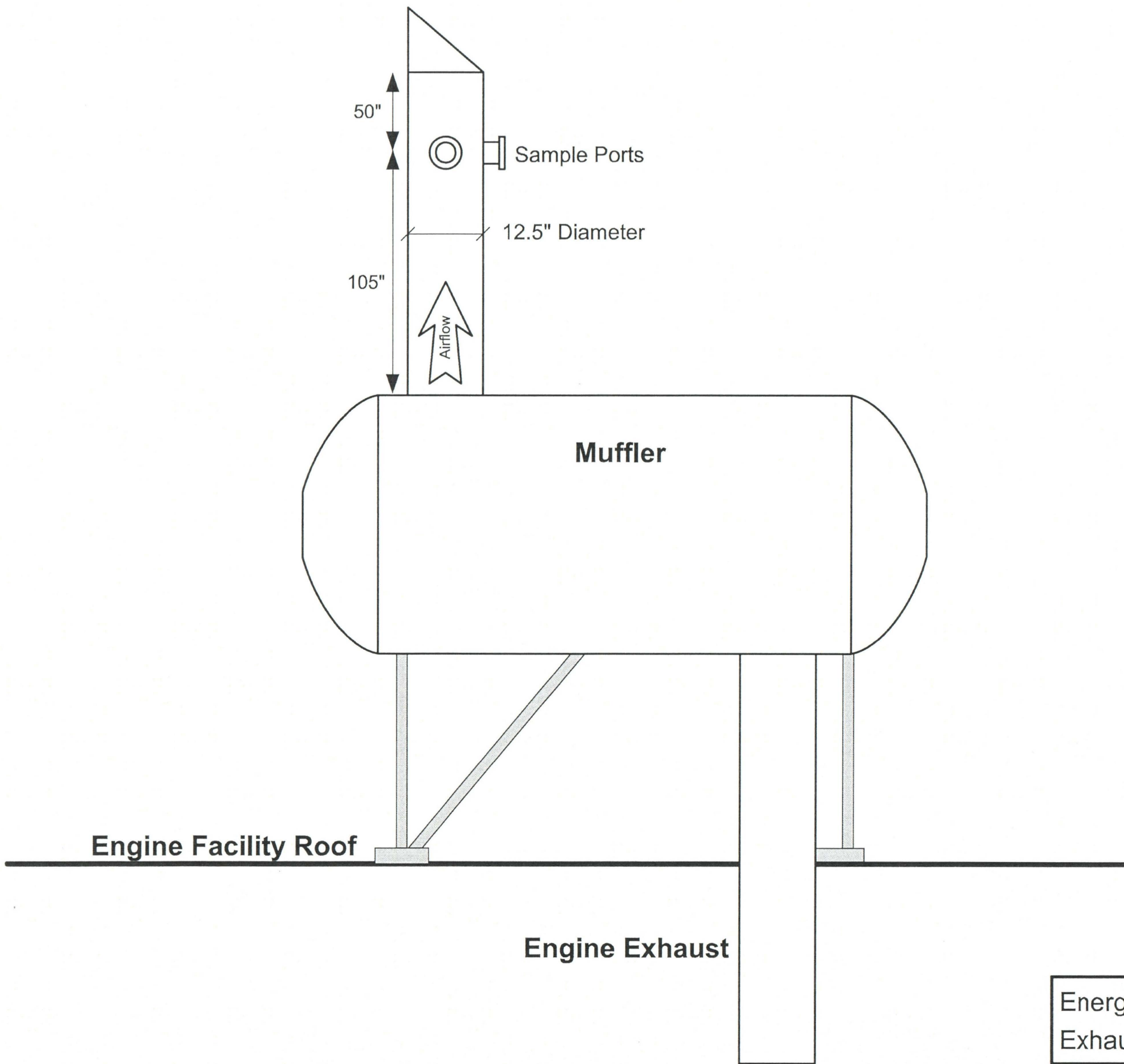


10/23/19	Energy Developments - Brent Run Exhaust Sample Location, CAT® G3520C RICE		
	Scale None	Sheet 1 of 1	IMPACT COMPLIANCE & TESTING



10/23/19	Energy Developments - Brent Run Exhaust Sample Location, CAT® G3520C RICE		
	Scale None	Sheet 1 of 1	IMPACT COMPLIANCE & TESTING

Engine No. 5



Energy Developments - Brent Run
Exhaust Sample Location, CAT® G3512 RICE

Scale	Sheet	
None	1 of 1	IMPACT COMPLIANCE & TESTING