Executive Summary

GRANGER ELECTRIC OF GRAND BLANC, LLC
CAT® G3520C LANDFILL GAS FUELED IC ENGINES
EMISSION TEST RESULTS

Energy Developments Limited (EDL) contracted Derenzo Environmental Services to conduct a performance demonstration for the determination of nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC) and sulfur dioxide (SO_2) concentrations and emission rates from two (2) Caterpillar (CAT®) Model No. G3520C landfill gas-fired reciprocating internal combustion engines (RICE) and electricity generator sets (EUENGINE6 and EUENGINE7) operated at the Granger Electric of Grand Blanc, LLC (Granger) renewable energy facility at the Citizens Disposal, Inc. Landfill in Grand Blanc, Genesee County, Michigan. **<u>SO_2 was added at the request of MDEQ in connection with a pending enforcement matter.</u>**

Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Renewable Operating Permit (ROP) No. MI-ROP-N5991-2016 requires that emission 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). The performance testing was conducted on November 28, 2018.

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

	NO_x Emissions		CO Emissions		VOC Emissions	SO_2 Emissions
Emission Unit	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(g/bhp-hr)	(lb/hr)
EUENGINE6	2.38	0.50	14.1	2.95	0.18	5.44
EUENGINE7	3.14	0.66	13.1	2.75	0.15	5.16
Permit Limits	--	1.0	--	3.0	1.0	1.7

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

Emission Unit	Generator Output (kW)	Engine Output (bhp)	LFG Fuel Use (scfm)	LFG CH_4 Content (%)	Exhaust Temp. (°F)
EUENGINE6	1,555	2,173	554	49.4	847
EUENGINE7	1,545	2,158	541	49.3	855

The data presented above indicates that EUENGINE6 and EUENGINE7 were tested while the units operated within 10% of 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 MI-ROP-N59917-2016 for NOx, CO, and VOC, but not for SO_2.

NSPS JJJJ (and the ROP) requires emission testing every 8,760 hours for NOx, CO and VOC. SO_2 was added at the request of MDEQ in connection with a pending enforcement matter. The results show that the engines were in compliance with NOx, CO and VOC emission limits of NSPS JJJJ and the ROP, but that an ROP limit for SO_2 was exceeded.

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 10, 2019
Test Date	November 28, 2018

Facility Information	
Name	Granger Electric of Grand Blanc, LLC
Street Address	2361 W. Grand Blanc Road
City, County	Grand Blanc, Genesee

Facility Permit Information	
Facility SRN :	N5991
Permit No.:	MI-ROP-N5991-2016
Emission Units:	EUENGINE6 and EUENGINE7

Testing Contractor	
Company	Derenzo Environmental Services
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1810004

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

GRANGER ELECTRIC OF GRAND BLANC, LLC

1.0 INTRODUCTION

Energy Developments Limited (EDL) owns and operates the Granger Electric of Grand Blanc, LLC (Granger) renewable energy facility at the Citizens Disposal, Inc. Landfill in Grand Blanc, Genesee County, Michigan. The EDL/Granger facility primarily consists of two (2) Caterpillar (CAT®) Model No. G3520C gas fueled reciprocating internal combustion engines and electricity generator sets (RICE gensets) that are identified as emission units EUENGINE6 and EUENGINE7 (collectively flexible emission group FGENGINES) in Section 2 of Michigan Renewable Operating Permit (ROP) No. MI-ROP-N5991-2016 issued by the Michigan Department of Environmental Quality – Air Quality Division (MDEQ-AQD).

The conditions of MI-ROP-N5991-2016:

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

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

In addition, sulfur dioxide (SO_2) emissions from the RICE gensets were measured as requested by the MDEQ-AQD, due to an investigation into the MDEQ-AQD Enforcement Notice dated April 19, 2018.

The compliance testing was performed by Derenzo Environmental Services (DES), a Michigan-based environmental consulting and testing company. DES representatives Tyler Wilson, Brad Thome, and Jory VanEss performed the field sampling and measurements November 28, 2018.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated October 23, 2018 that was reviewed and approved by the regulatory agency. MDEQ representatives Mr. David Patterson and Ms. Julie Brunner observed portions of the testing project.

Questions regarding this emission test report should be directed to:

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Report Certification

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

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:

Tyler J. Wilson
Livonia Office Supervisor
Derenzo Environmental Services

2.0 SUMMARY OF TEST RESULTS AND OPERATING CONDITIONS

2.1 Purpose and Objective of the Tests

The conditions of ROP No. MI-ROP-N5991-2016 and 40 CFR Part 60 Subpart JJJJ require EDL to test each engine contained in FGENGINES for carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOCs) every 8,760 hours of operation.

In addition, SO_2 emissions from the RICE gensets were measured as requested by the MDEQ-AQD, due to an investigation into the MDEQ-AQD Enforcement Notice dated April 19, 2018.

2.2 Operating Conditions During the Compliance Tests

The testing was performed while the EDL engine/generator sets were operated at maximum operating conditions (1,600 kW electricity output +/- 10%). EDL representatives provided the generator electricity output (kW) in 15-minute increments for each test period. The generator kW output ranged between 1,529 and 1,590 kW during the test periods.

Fuel flowrate (standard cubic feet per minute (scfm)) and fuel methane content (%) were also recorded by EDL representatives in 15-minute increments for each test period. The FGENGINES fuel consumption rate ranged between 450 and 575 scfm; fuel methane content ranged between 49.1 and 49.6%.

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 output (bhp) cannot be measured directly and was calculated based on the recorded electricity output, the calculated CAT® Model G3520C generator efficiency (96%), and the unit conversion factor for kW to horsepower (0.7457 kW/hp).

Engine output (bhp) = Electricity output (kW) / (0.96) / (0.7457 kW/hp)

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

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from the LFG fueled RICE (EUENGINE6 and EUENGINE7) were each sampled for three (3) one-hour test periods during the compliance testing performed November 28, 2018.

Table 2.2 presents the average measured CO, NO_X, VOC, and SO_2 emission rates for the engines (average of the three test periods for each engine).

Test results for each one-hour sampling period are presented in Section 6.0 of this report.

Table 2.1 Average engine operating conditions during the test periods

Engine Parameter	Engine No. 6	Engine No. 7
Generator output (kW)	1,555	1,545
Engine output (bhp)	2,173	2,158
Engine LFG fuel use (scfm)	554	541
LFG methane content (%)	49.4	49.3
Exhaust temperature (°F)	847	855

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

	CO Emissions		NOx Emissions		VOC Emissions		SO_2 Emissions[1]
Emission Unit	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)	(g/bhp-hr)	(lb/hr)
Engine No. 6	14.1	2.95	2.38	0.50	0.85	0.18	5.44
Engine No. 7	13.1	2.75	3.14	0.66	0.73	0.15	5.16
Permit Limit	--	3.0	--	1.0	--	1.0	1.7

1. SO_2 emissions from the RICE gensets were measured as requested by the MDEQ-AQD, due to an investigation into the MDEQ-AQD Enforcement Notice dated April 19, 2018.

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

Landfill gas (LFG) containing methane is generated in the Granger Citizens Disposal Landfill from the anaerobic decomposition of disposed waste materials. The LFG is collected from both active and capped landfill cells using a system of wells (gas collection system). The collected LFG is transferred to the Granger LFG power station facility where it is treated and used as fuel for the two (2) RICE. Each RICE is connected to an electricity generator that produces electricity that is transferred to the local utility.

3.2 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 generators have a rated electricity output of 1,600 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 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.

3.3 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 two (2) CAT® Model G3520C RICE exhaust stacks are identical.

The exhaust stack sampling ports for the CAT® Model G3520C engines (EUENGINE6 – EUENGINE7) are located in individual exhaust stacks with an inner diameter of 14.0 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location greater than 24.0 inches (1.71 duct diameters) upstream and greater than 168.0 inches (12.0 duct diameters) downstream from any flow disturbance and satisfies the USEPA Method 1 criteria for a representative sample location.

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

Appendix 1 provides diagrams of the emission test sampling location.

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 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 6C	Exhaust gas SO_2 concentrations were determined using an ultraviolet (UV) fluorescence instrumental analyzer.
USEPA Method 7E	Exhaust gas NOx concentration was determined using chemiluminescence instrumental analyzers.
USEPA Method 10	Exhaust gas CO concentration was measured using an NDIR instrumental analyzer.
USEPA Method 25A / ALT-096	Exhaust gas VOC (as NMHC) concentration was determined using a flame ionization analyzer equipped with methane separation column.

4.2 Exhaust Gas Velocity Determination (USEPA Method 2)

The exhaust stack gas velocities and volumetric flowrates for each RICE were determined using USEPA Method 2 prior to 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 prior to the test event to verify the integrity of the measurement system.

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 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 each RICE exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train. The moisture sampling was performed concurrently with the instrumental analyzer sampling. During each sampling period, a gas sample was extracted at a constant rate from the source where moisture was removed from the sampled gas stream using impingers that were submersed in an ice bath. At the conclusion of each sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain.

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

The exhaust for the LFG-fueled 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, VOC measurements correspond to standard conditions with no moisture correction (wet basis).

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

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

4.7 SO_2 Concentration Measurements (USEPA Method 6C)

SO_2 content in each RICE exhaust gas stream was measured continuously throughout each test period in accordance with USEPA Method 6C. A Thermo Environmental, Inc. Model 43i pulsed ultraviolet fluorescence analyzer was used to determine SO_2 concentration.

Throughout each test period, a continuous sample of the exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system and delivered to the instrumental analyzer. Instrument response for the 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 instrument was calibrated using upscale calibration and zero gas to determine analyzer calibration error and system bias.

Appendix 4 provides SO_2 emission calculation sheets. Raw instrument response data is provided in Appendix 5.

5.0 QA/QC ACTIVITIES

5.1 Flow Measurement

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

The Pitot tube and connective tubing were leak-checked 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).

5.2 NO_x Converter Efficiency Test

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

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

5.3 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step 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, SO_2, O_2, and CO_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 2.5% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.5 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NO_x, CO, SO_2, 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, CO, and SO_2 in nitrogen and zeroed using hydrocarbon-free nitrogen. The NMHC (VOC) instrument was calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.6 Determination of Exhaust Gas Stratification

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

The recorded concentration data for the RICE exhaust stack indicated that the measured NOx concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the RICE exhaust gas was considered to be unstratified and the compliance test sampling was performed at a single sampling location within each RICE exhaust stack.

5.7 Meter Box Calibrations

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

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

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

6.0 RESULTS

6.1 Test Results and Allowable Emission Limits

Engine operating data and air pollutant emission measurement results for each one-hour test period are presented in Tables 6.1 and 6.2.

The measured air pollutant concentrations and emission rates for Engine Nos. 6 and 7 are less than the allowable limits specified in MI-ROP-N5991-2016 for Emission Unit Nos. EUENGINE6 and EUENGINE7:

- 1.0 g/bhp-hr for NO_X;
- 3.0 g/bhp-hr for CO; and
- 1.0 g/bhp-hr for VOC.

The measured air pollutant concentrations and emission rates for Engine Nos. 6 and 7 are above the allowable limit specified in MI-ROP-N5991-2016 for Emission Unit Nos. EUENGINE6 and EUENGINE7:

- 1.7 lb/hr for SO_2 (per engine).

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with USEPA methods and the approved test protocol with the exception noted below. The RICE-generator sets were operated within 10% of maximum output (1,600 kW generator output) during the engine test periods.

The first two (2) one-minute data averages for the USEPA Method 205 gas divider field certification are not shown in the raw data for setup day (11/27/18). This data was not exported correctly following the test event, and the data logger was cleared out prior to completing this

Air Emission Test Report. The handwritten field calibration data sheet with all USEPA Method 205 gas divider field certification data is included in Appendix 6 of this report.

Table 6.1 Measured exhaust gas conditions and NO_x, CO, and VOC air pollutant emission rates for Engine No. 6 (EUENGINE6)

Test No. Test date Test period (24-hr clock)	1 11/28/18 1339 - 1439	2 11/28/18 1518 - 1618	3 11/28/18 1652 - 1752	Three Test Average
Fuel flowrate (scfm)	560	560	543	554
Generator output (kW)	1,559	1,550	1,557	1,555
Engine output (bhp)	2,177	2,165	2,175	2,173
LFG methane content (%)	49.5	49.4	49.2	49.4
Exhaust Gas Composition				
CO_2 content (% vol)	11.4	11.4	11.4	11.4
O_2 content (% vol)	8.53	8.54	8.52	8.53
Moisture (% vol)	10.1	11.3	11.0	10.8
Exhaust gas temperature (°F)	851	845	846	847
Exhaust gas flowrate (dscfm)	4,928	4,856	4,833	4,872
Exhaust gas flowrate (scfm)	5,479	5,473	5,432	5,461
Nitrogen Oxides				
NO_X conc. (ppmvd)	69.7	66.6	68.3	68.2
NO_X emissions (lb/hr)	2.46	2.32	2.37	2.38
NO_X emissions (g/bhp*hr)	0.51	0.49	0.49	0.50
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Carbon Monoxide				
CO conc. (ppmvd)	665	659	667	664
CO emissions (lb/hr)	14.3	14.0	14.1	14.1
CO emissions (g/bhp*hr)	2.98	2.93	2.93	2.95
Permitted emissions (g/bhp*hr)	-	-	-	3.0
Volatile Organic Compounds				
VOC conc. (ppmv C_3)	22.4	22.7	22.7	22.6
VOC emissions (lb/hr)	0.84	0.86	0.85	0.85
VOC emissions (g/bhp*hr)	0.18	0.18	0.18	0.18
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Sulfur Dioxide[1]				
SO_2 conc. (ppmvd)	113	113	109	112
SO_2 emissions (lb/hr)	5.57	5.48	5.28	5.44
Permitted emissions (lb/hr)	-	-	-	1.7

1. SO_2 emissions from the RICE gensets were measured as requested by the MDEQ-AQD, due to an investigation into the MDEQ-AQD Enforcement Notice dated April 19, 2018.

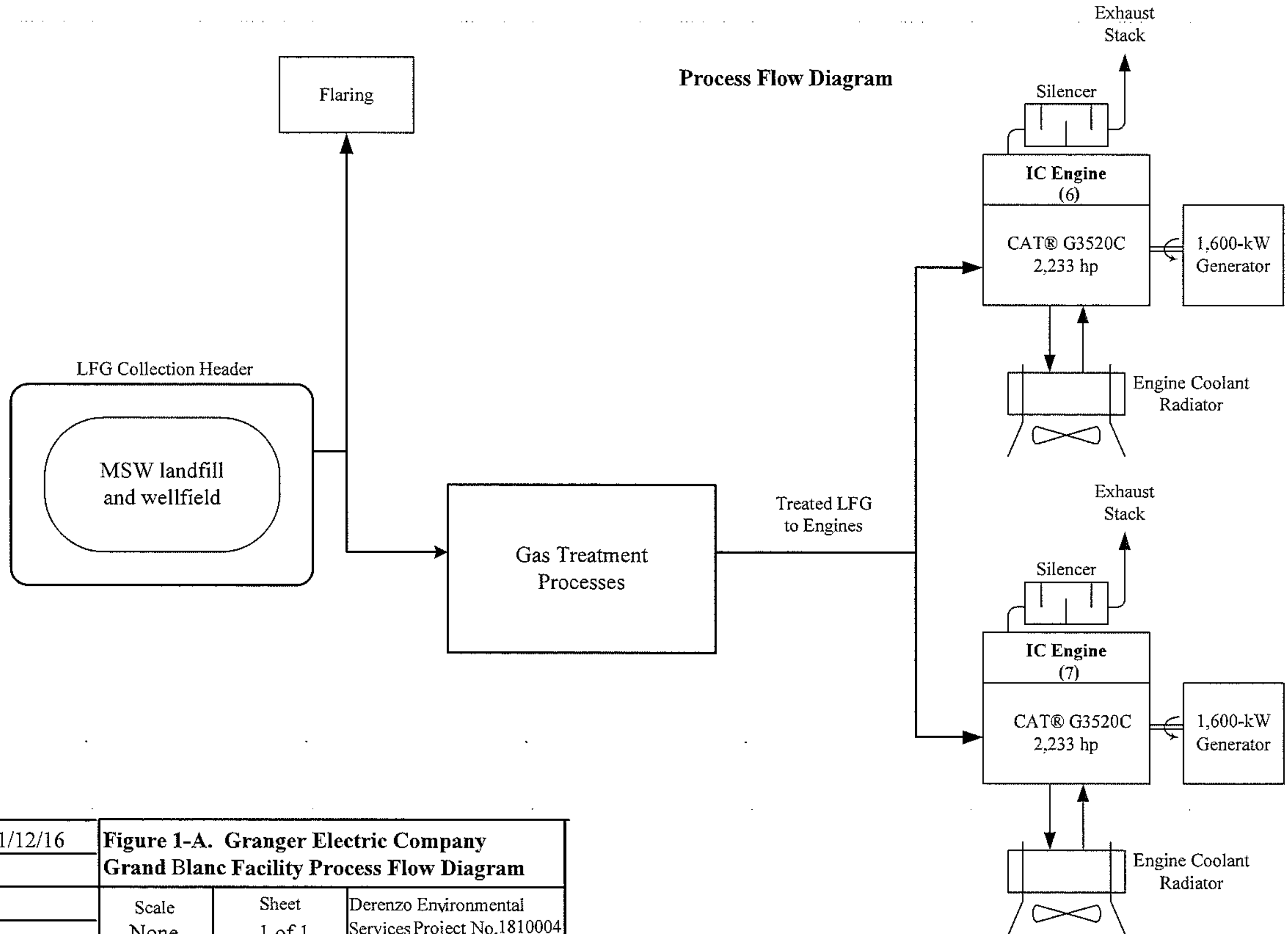
Table 6.2 Measured exhaust gas conditions and NO_x, CO, and VOC air pollutant emission rates for Engine No. 7 (EUENGINE7)

Test No. Test date Test period (24-hr clock)	1 11/28/18 841 - 941	2 11/28/18 1018 - 1118	3 11/28/18 1203 - 1303	Three Test Average
Fuel flowrate (scfm)	544	544	535	541
Generator output (kW)	1,545	1,542	1,547	1,545
Engine output (bhp)	2,158	2,155	2,161	2,158
LFG methane content (%)	49.2	49.2	49.6	49.3
Exhaust Gas Composition				
CO_2 content (% vol)	11.4	11.4	11.4	11.4
O_2 content (% vol)	8.52	8.56	8.56	8.55
Moisture (% vol)	13.7	13.0	12.4	13.0
Exhaust gas temperature (°F)	854	851	861	855
Exhaust gas flowrate (dscfm)	4,538	4,600	4,675	4,604
Exhaust gas flowrate (scfm)	5,258	5,290	5,335	5,294
Nitrogen Oxides				
NO_X conc. (ppmvd)	103	92.4	90.6	95.2
NO_X emissions (lb/hr)	3.34	3.05	3.04	3.14
NO_X emissions (g/bhp*hr)	0.70	0.64	0.64	0.66
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Carbon Monoxide				
CO conc. (ppmvd)	660	644	649	651
CO emissions (lb/hr)	13.1	12.9	13.2	13.1
CO emissions (g/bhp*hr)	2.75	2.72	2.78	2.75
Permitted emissions (g/bhp*hr)	-	-	-	3.0
Volatile Organic Compounds				
VOC conc. (ppmv C_3)	19.4	20.1	20.9	20.1
VOC emissions (lb/hr)	0.70	0.73	0.77	0.73
VOC emissions (g/bhp*hr)	0.15	0.15	0.16	0.15
Permitted emissions (g/bhp*hr)	-	-	-	1.0
Sulfur Dioxide[1]				
SO_2 conc. (ppmvd)	112	112	113	112
SO_2 emissions (lb/hr)	5.05	5.15	5.26	5.16
Permitted emissions (lb/hr)	-	-	-	1.7

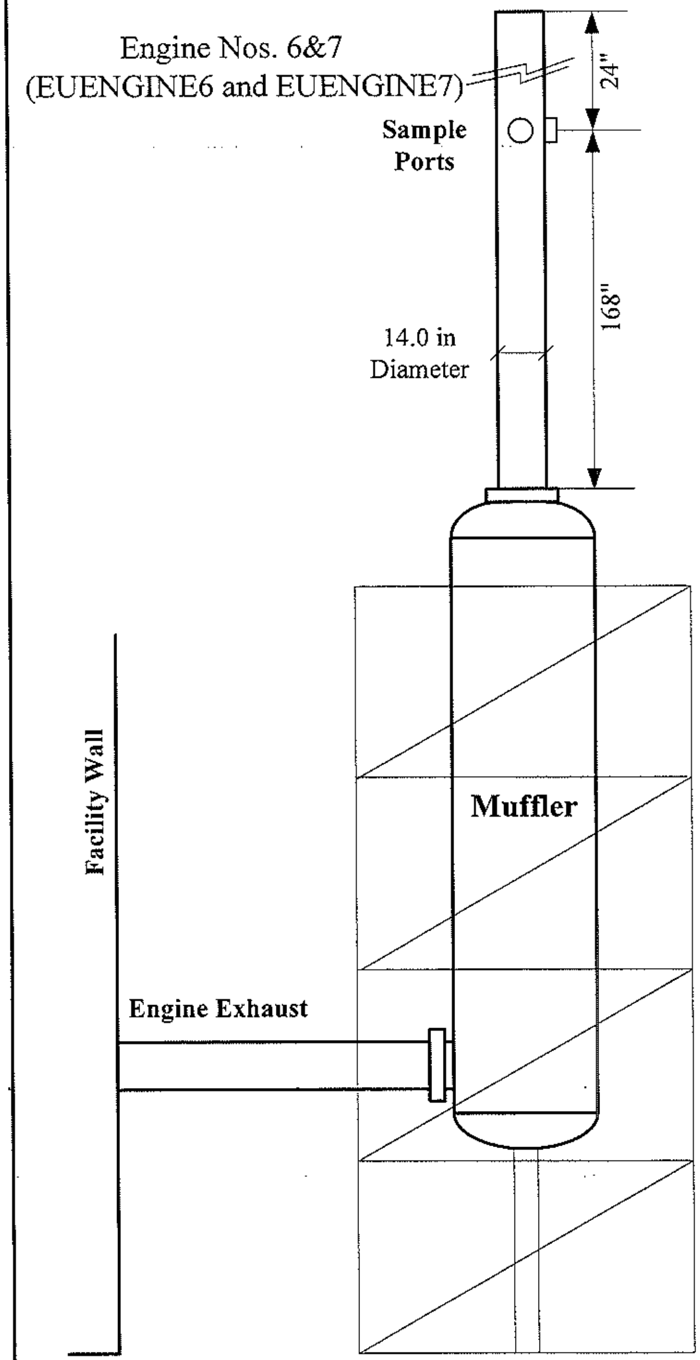
1. SO_2 emissions from the RICE gensets were measured as requested by the MDEQ-AQD, due to an investigation into the MDEQ-AQD Enforcement Notice dated April 19, 2018.

APPENDIX 1

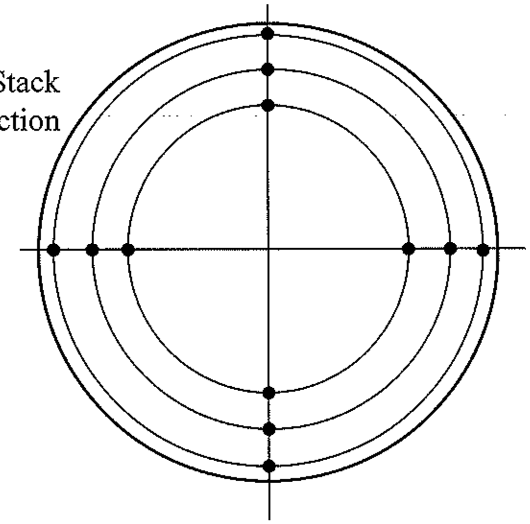
- Figure 1-A – Process Flow Diagram
- Figure 1-B – IC Engine Nos. 6 & 7 Sample Port Diagram



1/12/16	**Figure 1-A. Granger Electric Company Grand Blanc Facility Process Flow Diagram**		
	Scale None	Sheet 1 of 1	Derenzo Environmental Services Project No.1810004



Exhaust Stack
Cross-Section



Velocity sample locations as
measured from stack wall
(not including 1.5" sampling port nipple)

Pt. #	in.
1	0.62
2	2.04
3	4.14
4	9.86
5	12.0
6	13.4

01/06/15	**Granger Electric – Grand Blanc** **Exhaust Sample Location, CAT G3520 ICE**		
	Scale None	Sheet 1 of 1	Derenzo Environmental Services Project No. 1810004