Derenzo and Associates, Inc.
Environmental Consultants

EMISSIONS TEST REPORT

Title	Compliance Test Report for the FGICEENGINES Landfill Gas Fueled Internal Combustion Engines at the Granger Electric of Byron Center, LLC Facility
Report Date	August 23, 2012
Test Date(s)	August 9, 2012

Facility Information	
Name	Granger Electric of Byron Center, LLC
Street Address	10300 Clyde Park Avenue SW
City, County	Byron Township, MI 49315
Phone	(616) 336-4370

Facility Permit Information			
State Registration No.:	N1324	Permit No.:	PTI 212-08

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1206005

COMPLIANCE TEST REPORT FOR THE FGICEENGINES LANDFILL GAS FUELED INTERNAL COMBUSTION ENGINES AT THE GRANGER ELECTRIC OF BYRON CENTER, LLC FACILITY

1.0 INTRODUCTION

Granger Electric of Byron Center, LLC (Granger Electric), State Registration No. N1324 operates two (2) Caterpillar (CAT®) Model No. G3520C landfill gas-fueled internal combustion (IC) engines and electricity generator sets at the South Kent Landfill located in Byron Center, Kent County, Michigan.

Installation and operation of the IC engines are permitted by Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Permit to Install (PTI) No. 212-08, issued to Granger Electric on August 6, 2008.

Conditions of PTI 212-08 and 40 CFR Part 60 Subpart JJJJ (NSPS for spark ignition internal combustion engines) requires that performance testing be performed on the CAT® G3520C engines every 8,760 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 demonstration consisted of triplicate, one-hour test runs for the determination of nitrogen oxides (NO_X), carbon monoxide (CO), volatile organic compounds (VOC, as non-methane hydrocarbons), and formaldehyde (HCOH) concentrations and emission rates. Exhaust gas velocity, moisture, oxygen (O_2) content, and carbon dioxide (CO_2) content was determined for each test period to calculate volumetric exhaust gas flowrate and pollutant mass emission rates.

The compliance testing for Emission Units EUICEENGINE1 and EUICEENGINE2 (flexible emission group FGICENGINES) was performed on August 9, 2012, by Derenzo and Associates, Inc., an environmental consulting and testing company based in Livonia, Michigan. Michael Brack, Daniel Wilson, and Robert Bingham of Derenzo and Associates performed the Subpart JJJJ testing. Lindsey Wells with Prism Analytical Technologies, Inc. performed the formaldehyde testing. Process operations were coordinated by Dan Zimmerman of Granger Electric. Laura Brandt and Nathan Hude of the MDEQ-AQD Technical Programs Unit observed the testing.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Protocol dated June 20, 2012 and approved by the MDEQ-AQD by letter on June 27, 2012.

Questions regarding this emission test report should be directed to:

Mr. Michael Brack
Field Services Manager
Derenzo and Associates, Inc.
39395 Schoolcraft Road
Livonia, MI 48150
(734) 464-3880

Mr. Dan Zimmerman
Compliance Manager
Granger Energy
16980 Wood Road
Lansing, MI 48906-1044
(517) 371-9711

2.0 SUMMARY OF RESULTS

The exhaust gas for each LFG-fueled IC engine was monitored for at three (3) one-hour test periods during which the NO_X, CO, VOC, HCOH, O_2, and CO_2 concentrations were measured using instrumental analyzers. Exhaust gas flowrate was measured prior to and following each one-hour test period to calculate pollutant mass emission rates. Moisture determinations were conducted in conjunction with the instrumental analyzer measurements.

Testing was performed while the IC engines were operated at normal base load conditions (i.e., 1,600 kW peak electricity output +/- 10%).

The following table presents three-test summaries of the test results, and comparison of the results to the permitted pollutant emission rates for the Granger Electric of Byron Center, LLC engines.

Emission Unit ID	NO_X Emission Rate (lbs/hr)	NO_X Emission Factor (g/bhp-hr)	CO Emission Rate (lbs/hr)	CO Emission Factor (g/bhp-hr)	VOC Emission Factor (g/bhp-hr)	HCOH Emission Rate (lbs/hr)
EUICEENGINE1	3.81	0.76	15.19	3.05	0.12	1.65
EUICEENGINE2	2.67	0.53	15.06	3.00	0.15	N/A
Permit Limits	4.92	1.0	16.23	3.3	1.0	2.10

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

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

Landfill gas (LFG) is produced in the South Kent Landfill from the anaerobic decomposition of disposed waste materials. The LFG is collected from both active and capped landfill cells using a system of wells that are connected to a central header (gas collection system). The collected LFG is treated and then directed to the Byron Center facility where it is used as fuel for the IC engine generators that produce electricity for transfer to the local utility.

FGICENGINES consists of two (2) CAT® Model No.G3520C IC engines (EUICEENGINE1 and EUICEENGINE2) that are connected to individual electricity generators.

Figure 1 presents a process flow diagram for the LFG electricity generation facility.

Figure 2 presents an engine operation flow diagram

3.2 Rated Capacities, Type and Quantity of Raw Materials Used

The EUICEENGINE1 and EUICEENGINE2 engine generator sets have a design mechanical output of 2,233 brake horsepower (bhp) and a design electricity generation rate of 1,600 kilowatts (kW).

Fuel (treated landfill gas) consumption is regulated to maintain the required heat input rate to support engine operations and is dependent on the fuel heat value (methane content) of the treated landfill gas. The average engine fuel consumption rate for each engine is typically between 510 and 540 standard cubic feet per minute (scfm) at full load.

Appendix B provides engine generator process data collected during the compliance test.

3.3 Emission Control System Description

The CAT® G3520 IC engine uses an electronic air-to-fuel ratio controller to fire lean fuel mixtures and produce low combustion by-product emissions. Emissions from the combustion of LFG are released into the ambient air through a stack connected to the IC engine exhaust manifold and noise muffler.

3.4 Sampling Locations (USEPA Method 1)

The exhaust stack sampling port for the Model G3520C IC engines tested satisfied the USEPA Method 1 criteria for a representative sample location. The inner diameter of the engine exhaust stack is 13.5 inches. The stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 8 inches (0.59 duct diameters) downstream and >40 feet (>35 duct diameters) upstream from any flow disturbance.

Velocity pressure traverse locations for the sampling points were determined in accordance with USEPA Method 1.

Figure 3 presents the performance test sampling and measurement locations.

4.0 <u>TEST RESULTS AND DISCUSSION</u>

4.1 Purpose and Objectives of the Tests

Compliance testing for FGICENGINES is required by PTI No. 212-08 and CFR Part 60 Subpart JJJJ every 8,760 hours of operation (as determined through the use of a non-resettable hour meter) or three years, whichever occurs first.

The exhaust from each LFG-fueled IC engine was monitored for three (3) one-hour test periods during which the NO_X, CO, VOC, HCOH, O_2, and CO_2 concentrations were measured using instrumental analyzers.

Exhaust gas moisture content was determined by gravimetric analysis of the weight gain in chilled impingers in accordance with USEPA Method 4. Velocity and volumetric flow rates were measured during pre-test and post-test times for the gaseous samples.

Testing was performed while the IC engines were operated at normal base load conditions (i.e., 1,600 kW electricity output +/- 10%).

4.2 Variations from Normal Sampling Procedures or Operating Conditions

The compliance tests for all pollutants were performed in accordance with the Test Protocol dated June 20, 2012; the MDEQ Approval Letter dated June 27, 2012, and the specified USEPA test methods.

Instrument calibrations and sampling period results satisfied the quality assurance verifications required by USEPA Methods 3A, 7E, 10, and 25A/ALT 078. No variations from the normal operating conditions of the IC engines occurred during the testing program.

4.3 Operating Conditions during Compliance Tests

The LFG-fueled IC engines were operated at base conditions load (within +/-10% of maximum design capacity) during the compliance testing. The average electricity generator output and fuel use values were recorded by the facility during each test event. Based on data provided by the facility operators, EUICEENGINE1 operated at an average electricity generation rate of 1,622 kW during the test periods and consumed an average of 512 scfm of treated LFG. EUICEENGINE2 operated at an average electricity generation rate of 1,634 kW during the test periods and consumed an average of 521 scfm of treated LFG.

The engine generator sets have a design mechanical output of 2,233 bhp and a corresponding design electricity generation rate of 1,600 kW. The mechanical output of the engine (bhp) cannot be directly measured. Therefore, it is calculated based on the generator output using the following equation:

$$\text{Engine Output (bhp)} = (kW_{avg}) / (0.961) / (0.7457\ kW/bhp)$$

Where: kW_{avg} = average recorded kW generation rate
0.961 = engine to generator efficiency (96.1%)
0.7457 = unit conversion of kW to bhp

4.4 Air Pollutant Sampling Results

The IC engines performance tests were conducted on August 9, 2012. The exhaust for each LFG-fueled IC engine (EUICEENGINE1 and EUICEENGINE2) was monitored for three (3) one-hour test periods during which the NO_X, CO, VOC, HCOH, O_2, and CO_2 concentrations were measured using instrumental analyzers. The measured pollutant concentrations were corrected for sampling system calibration and bias pursuant to equations in specified in the USEPA reference test methods.

Exhaust gas moisture content was determined by gravimetric analysis of the weight gain in chilled impingers in accordance with USEPA Method 4. Velocity and volumetric flow rate were measured near the beginning and end of each sampling period. NOx, CO, VOC, and HCOH mass emission rates were calculated from the pre-test and post-test flowrate averages for each 60-minute sampling periods.

The average measured exhaust gas volumetric flow rate for EUICENGINE1 was 4,080 dry standard cubic feet per minute (dscfm). The average measured exhaust gas NO_X concentration for EUICEENGINE1 was 130.4 parts per million by volume, dry basis (ppmvd) which corresponds to a mass emission rate of 3.81 pounds per hour (lb/hr) NO_2, and emission factor of 0.76 grams per bhp-hr (g/bhp-hr) NO_2.

The average measured exhaust gas CO concentration for EUICEENGINE1 was 853.4 ppmvd, which corresponds to a mass emission rate of 15.19 lb/hr and emission factor of 3.05 g/bhp-hr CO.

The average measured exhaust gas VOC concentration for EUICEENGINE1 was 19.18 ppmv, which corresponds to a mass emission rate of 0.58 lb/hr and emission factor of 0.12 g/bhp-hr VOC.

The average measured exhaust gas HCOH concentration for EUICEENGINE1 was 74.8 ppmv, which corresponds to a mass emission rate of 1.64 lb/hr and emission factor of 0.0.33 g/bhp-hr HCOH.

Table 1 presents measured exhaust gas conditions and air pollutant emission rates for EUICEENGINE1.

The average measured exhaust gas volumetric flow rate for EUICENGINE2 was 4,275 dscfm. The average measured exhaust gas NO_X concentration for EUICEENGINE2 was 89.5 ppmvd, which corresponds to a mass emission rate of 2.67 lb/hr NO_2, and emission factor of 0.53 g/bhp-hr NO_2.

The average measured exhaust gas CO concentration for EUICEENGINE2 was 800.6 ppmvd, which corresponds to a mass emission rate of 15.06 lb/hr and emission factor of 3.00 g/bhp-hr CO.

The average measured exhaust gas VOC concentration for EUICEENGINE2 was 22.0 ppmv, which corresponds to a mass emission rate of 0.73 lb/hr and emission factor of 0.15 g/bhp-hr VOC.

Table 2 presents measured exhaust gas conditions and air pollutant emission rates for EUICEENGINE2.

Appendix C provides computer calculated and field data sheets for the IC engine tests.

Appendix D provides raw instrumental analyzer response data for each test period.

5.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the compliance testing was prepared by Derenzo and Associates and reviewed by the MDEQ. This section provides a summary of the sampling and analytical procedures that were used during the test and presented in the test plan.

Appendix E presents sample procedures and diagrams for the USEPA sampling methods.

5.1 Exhaust Gas Velocity and Flowrate Determination (USEPA Method 2)

IC engine exhaust stack gas velocity was determined using USEPA Method 2 prior to and following each 60-minute sampling period. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were leak-checked to verify the integrity of the measurement system.

The absence of cyclonic flow for each sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at all of the velocity traverse points 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).

The calculated pre-test and post-test volumetric flowrate values were averaged and used for calculating the mass emission rate for each pollutant for that test period.

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

CO_2 and O_2 content in the IC engine exhaust gas stream was measured continuously throughout each one-hour test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a non-dispersive infrared (NDIR) gas analyzer. The O_2 content of the exhaust was monitored using a gas analyzer that utilizes a Zirconia Ion sensor.

During each one-hour sampling period, a continuous sample of the IC engine exhaust gas stream was extracted from the stack using a stainless steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzer. Therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. The instrument was calibrated using appropriate calibration gases to determine accuracy and system bias (described in Section 6.5 of this document).

Figure 4 presents a diagram of the instrument analyzer train.

Appendix E presents detailed gas sampling procedures for the USEPA sampling trains.

5.3 Exhaust Gas Moisture Content Determinations (Method 4)

Moisture content of the IC engine exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train, which was performed concurrently with the instrumental analyzer sampling methodologies. A non-heated probe was used for the moisture determinations as the engine exhaust temperature exceeded 800 ^{o}F. During each sampling period, a gas sample was extracted at a predetermined 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.

Figure 5 presents a diagram of the moisture sampling train.

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

NO_X and CO pollutant concentrations in the exhaust of the IC engine were determined using a chemiluminescence NO_X analyzer and NDIR CO analyzer.

Three (3) one-hour sampling periods were performed for the IC engine exhaust testing. Throughout each one-hour 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 described in Section 5.2 of this document, and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on a data logging 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 appropriate upscale calibration and zero gas to determine analyzer calibration error and system bias. Sampling times were recorded on field data sheets.

5.5 VOC Concentration Measurements (USEPA Method ALT 078)

The exhaust gas VOC concentrations were measured using a Flame Ionization Analyzer (FIA) instrumental analyzer in accordance with USEPA Alt 078 for direct measurement of VOC (non-methane organic compounds) concentrations. The TEI Model 55i methane, non-methane hydrocarbon analyzer has been approved by the USEPA for the measurement of IC engine exhaust gas VOC concentration when demonstrating compliance with NSPS Subpart JJJJ.

Samples of the exhaust gas were delivered to the instrument analyzer using an extractive gas sampling system that prevents condensation or contamination of the sample. The exhaust gas samples were delivered directly to the instrument analyzer. Therefore VOC measurements correspond to standard conditions with no moisture correction (wet basis).

The specified instrument analyzer was calibrated using certified propane concentrations in hydrocarbon-free air.

Appendix C presents the computer calculated and field data from the testing program.

5.6 Formaldehyde Concentration Measurements (USEPA Method 320)

The exhaust gas Formaldehyde concentrations were measured using a Fourier Transform Infrared (FTIR) spectroscopy analyzer.

FTIR data were collected using a MKS MultiGas 2030 FTIR spectrometer, serial number 016630515. The sampling system consisted of a 2 ft., 1/4 inch diameter, stainless steel probe; a 2-100 ft., 3/8 inch diameter, Teflon heated transfer line, maintained at 191°C; and a 0.01 μ glass filter for particulate matter removal.

The FTIR was equipped with a temperature-controlled, 5.11-meter multi-pass gas cell maintained at 191°C. Gas flows and sampling system pressures were monitored using a rotometer and pressure transducer. All data were collected at 0.5 cm-1 resolution. Each spectrum was derived from the co-addition of 64 scans, with a new data point generated approximately every one minute.

Direct FTIR measurements of N2, acetaldehyde, SF6, and ethylene gas standards were made daily to confirm concentrations. See the Engine 1 – FTIR QA/QC Data Appendix for results.

A calibration transfer standard (CTS), 100.0 ppm ethylene standard (Airgas Cylinder # CC124827) was analyzed before and after testing. The concentration determined for all CTS runs were within ± 5% of the certified value of the standard. The ethylene was passed through the entire system (system purge) to determine the sampling system response time and to ensure that the sampling system was leak-free at the stack location.

Nitrogen was purged through the sampling system daily to confirm the system was free of contaminants.

See Appendix A for the FTIR report presentation, which includes the HCOH results and associated qa/qc documentation for EUICEENGINE1.

6.0 INTERNAL QA/QC ACTIVITIES

6.1 NO_x Converter Efficiency Test

The NO_2 – NO conversion efficiency of the TEI Model 42C instrumental analyzer was verified prior to the commencement of the performance tests. The instrument analyzer NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. A USEPA Protocol 1 certified NO_2 calibration gas was used to verify the efficiency of the NO_2 – NO converter.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (the calculated NO_2 – NO conversion efficiency is greater than or equal to 90%).

6.2 Sampling System Response Time Determination

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

Sampling periods did not commence until the sampling probe had been in place for at least twice the system response time.

6.3 Determination of Exhaust Gas Stratification

A stratification test for EUICEENGINE1 exhaust stack was performed during the first 60-minute emissions test sampling period. 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 was recorded at each sample point for a minimum of twice the maximum system response time.

The recorded data for the IC engine exhaust stack gas indicated that the measured NOx concentrations did not vary by more than 5% of the mean across the stack diameter. Therefore, the stack gas was considered unstratified and the compliance test sampling was performed at a single sampling location which was closest to the mean concentration measured during the stratification test. EUICEENGINE2 stratification was considered identical to EUICEENGINE1.

6.4 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NOx, CO, O_2 and CO_2 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 3.0% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

6.5 Instrument Calibration and System Bias Checks

At the beginning of the test day, initial three-point instrument calibrations were performed by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were preformed prior to and at the conclusion of each sampling period by introducing the appropriate 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 verifying the instrument response against the initial instrument calibration readings. If the drift error is within 3% of the span over the period of the test run, the test run is considered acceptable.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NO_X, CO, Propane, and zeroed using pure nitrogen or hydrocarbon free air.

6.6 Meter Box Calibrations

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

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

Report Prepared By:

Daniel Wilson
Environmental Technician

Report Reviewed By:

Michael J. Brack
Field Services Manager

Table 1. Measured Exhaust Gas Conditions, Air Pollutant Emission Rates, and Emission Factors for the Granger Electric of Byron Center, LLC., CAT® G3520C Landfill Gas Fueled Internal Combustion Engine

Unit ID: **EUICEENGINE1**

Test Number: Test Date: Test Period (24-hr clock):	1 08/09/12 08:29-09:29	2 08/09/12 10:15-11:15	3 08/09/12 12:00 - 13:00	Three Test Average
Engine operating parameters				
Generator Output (kW)	1,621	1,622	1,622	1,622
Engine Horsepower (Hp)	2,263	2,264	2,263	2,263
Exhaust gas composition				
CO_2 content (% vol)	11.4	11.4	11.3	11.4
O_2 content (% vol)	7.77	7.91	7.99	7.89
Moisture (% vol)	11.5	13.6	14.3	13.1
Exhaust gas flowrate				
Standard conditions (scfm)	4,641	4,701	4,753	4,698
Dry basis (dscfm)	4,105	4,063	4,073	4,080
Nitrogen oxides emission rates				
NO_X concentration (ppmvd)*	137.0	132.4	121.7	130.4
NO_X emissions (lb/hr as NO_2)	4.03	3.86	3.55	3.81
NO_X permit limit (lb/hr)				*4.92*
NO_X emissions (g/bhp-hr)	0.81	0.77	0.71	0.76
NO_X permit limit (g/bhp-hr)				*1.00*
Carbon monoxide emission rates				
CO concentration (ppmvd)*	859.1	867.9	833.2	853.4
CO emissions (lb/hr)	15.39	15.39	14.81	15.19
CO permit limit (lb/hr)				*16.23*
CO emissions (g/bhp-hr)	3.09	3.08	2.97	3.05
CO permit limit (g/bhp-hr)				*3.30*
Volatile organic compound emission rates				
VOC concentration (ppmv C_3)*	16.9	17.7	18.9	17.8
VOC emissions (lb/hr)	0.54	0.57	0.62	0.58
VOC emissions (g/bhp-hr)	0.11	0.11	0.12	0.12
VOC permit limit (g/bhp-hr)				*1.0*
Formaldehyde emission rates				
HCOH concentration (ppmv)	73.4	74.3	76.7	74.8
HCOH emissions (lb/hr)	1.59	1.63	1.71	1.65
HCOH permit limit (lb/hr)				*2.10*
HCOH emissions (g/bhp-hr)	0.32	0.33	0.34	0.33

* Corrected for calibration bias.

Definitions

kW - kilowatt
Hp - horsepower
% vol - percent by volume
lb/hr - pounds per hour
g/bhp-hr - grams per brake horsepower hour
scfm - standard cubic feet per minute
dscfm - dry standard cubic feet per minute
ppmv - parts per million by volume
ppmvd - parts per million by volume dry

Table 2. Measured Exhaust Gas Conditions, Air Pollutant Emission Rates, and Emission Factors for the Granger Electric of Byron Center, LLC., CAT® G3520C Landfill Gas Fueled Internal Combustion Engine

Unit ID: **EUICEENGINE2**

Test Number: Test Date: Test Period (24-hr clock):	1 08/09/12 14:00-15:00	2 08/09/12 15:40-16:40	3 08/09/12 17:23-18:23	Three Test Average
Engine operating parameters				
Generator Output (kW)	1,635	1,646	1,619	1,634
Engine Horsepower (Hp)	2,282	2,297	2,260	2,280
Exhaust gas composition				
CO_2 content (% vol)	11.5	11.4	11.4	11.4
O_2 content (% vol)	7.81	7.87	7.83	7.84
Moisture (% vol)	11.9	11.9	12.2	12.0
Exhaust gas flowrate				
Standard conditions (scfm)	4,860	4,883	4,838	4,860
Dry basis (dscfm)	4,279	4,301	4,246	4,275
Nitrogen oxides emission rates				
NO_X concentration (ppmvd)*	95.8	82.9	82.5	87.0
NO_X emissions (lb/hr NO_2)	2.94	2.56	2.51	2.67
NO_X permit limit (lb/hr)				*4.92*
NO_X emissions (g/bhp-hr)	0.58	0.50	0.50	0.53
NO_X permit limit (g/bhp-hr)				*1.00*
Carbon monoxide emission rates				
CO concentration (ppmvd)*	828.5	793.8	798.4	806.9
CO emissions (lb/hr)	15.48	14.90	14.80	15.06
CO permit limit (lb/hr)				*16.23*
CO emissions (g/bhp-hr)	3.08	2.94	2.97	3.00
CO permit limit (g/bhp-hr)				*3.30*
Volatile organic compound emission rates				
VOC concentration (ppmv C_3)*	21.4	22.2	22.3	22.0
VOC emissions (lb/hr)	0.71	0.75	0.74	0.73
VOC emissions (g/bhp-hr)	0.14	0.15	0.15	0.15
VOC permit limit (g/bhp-hr)				*1.0*

* Corrected for calibration bias.

Definitions

kW - kilowatt
Hp - horsepower
% vol - percent by volume
lb/hr - pounds per hour
g/bhp-hr - grams per brake horsepower hour
scfm - standard cubic feet per minute
dscfm - dry standard cubic feet per minute
ppmv - parts per million by volume
ppmvd - parts per million by volume dry

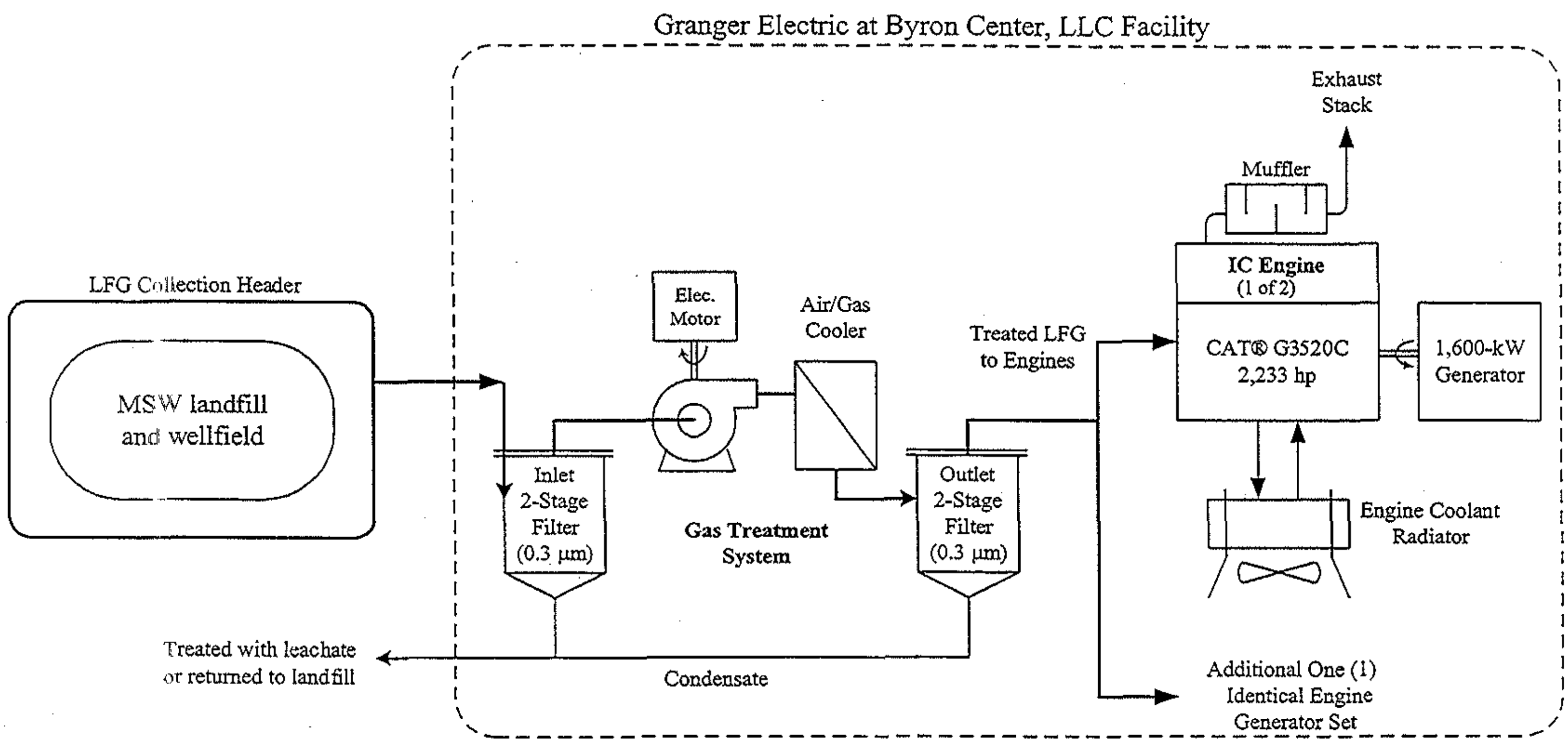

Figure 1.

Granger Electric LFG Electricity Generation Facility		
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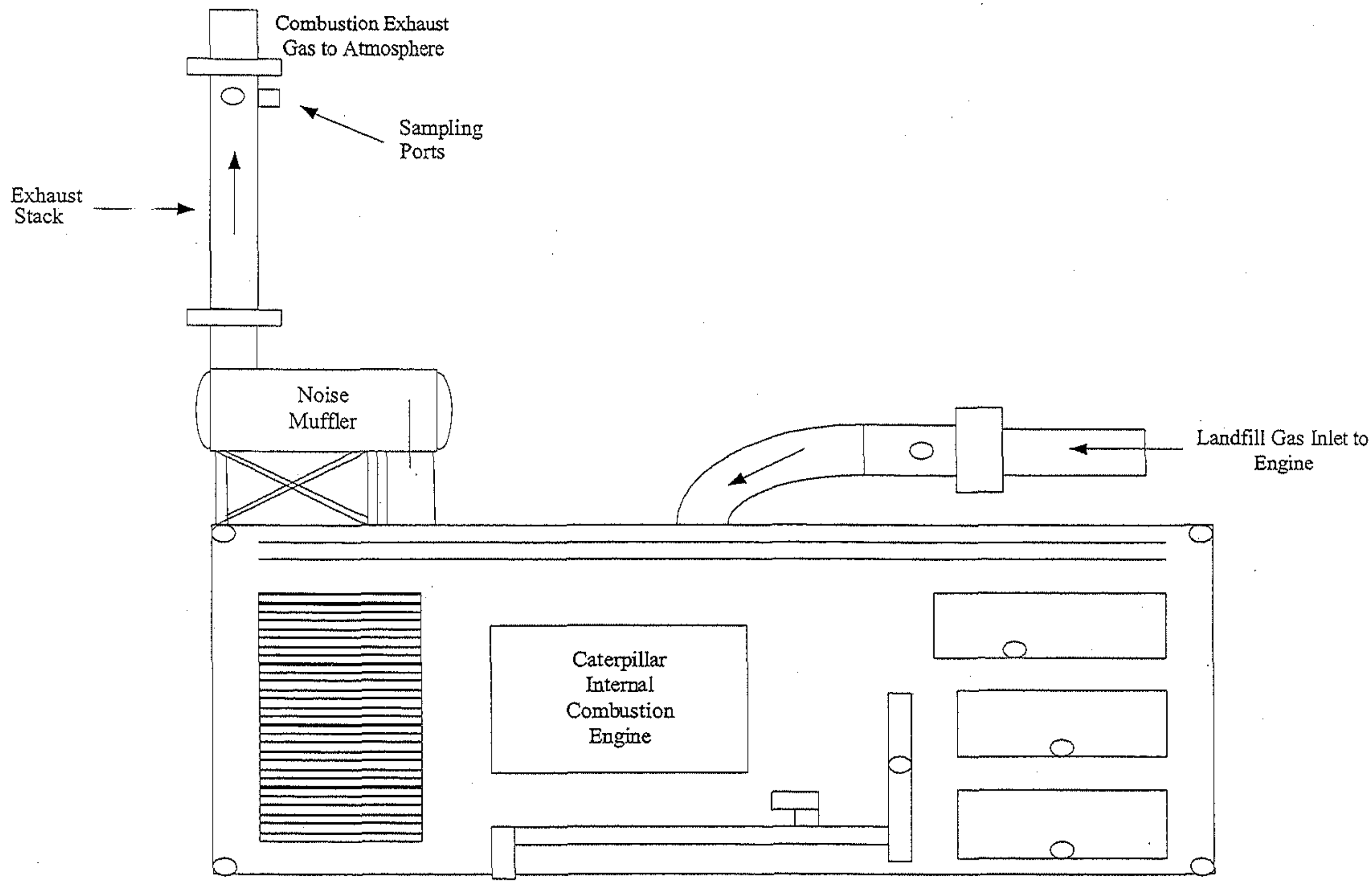

Figure 2

8/23/12	**Granger Electric General Engine Operation Flow Diagram**		
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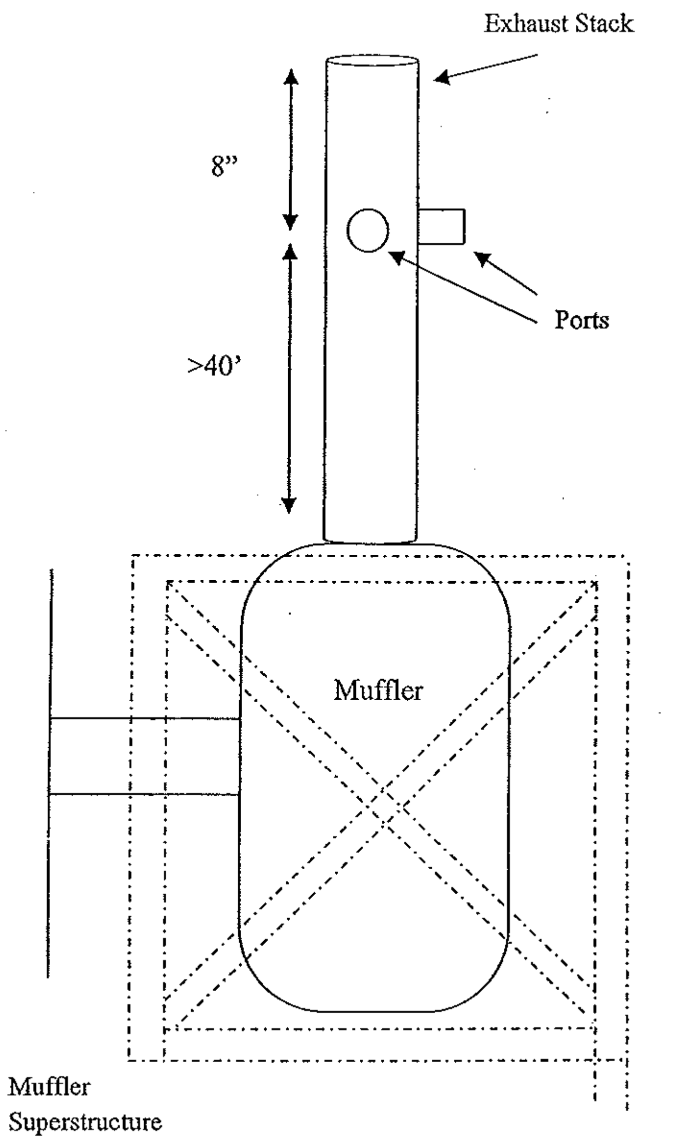

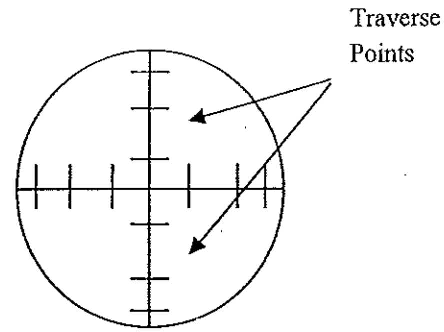

Diameter = 13.5" + 1.25" nipple

Sampling Point	Distance from stack wall
1	0.50
2	1.42
3	2.62
4	4.36
5	9.14
6	10.88
7	12.08
8	13.00

Diagram not to scale

Figure 3. Sampling and measurement locations for the internal combustion engines emissions testing program that was conducted at the Granger Electric at Byron Center, LLC facility in Kent County, Michigan.	Sampling Date(s): August 9, 2012
	Derenzo and Associates, Inc.

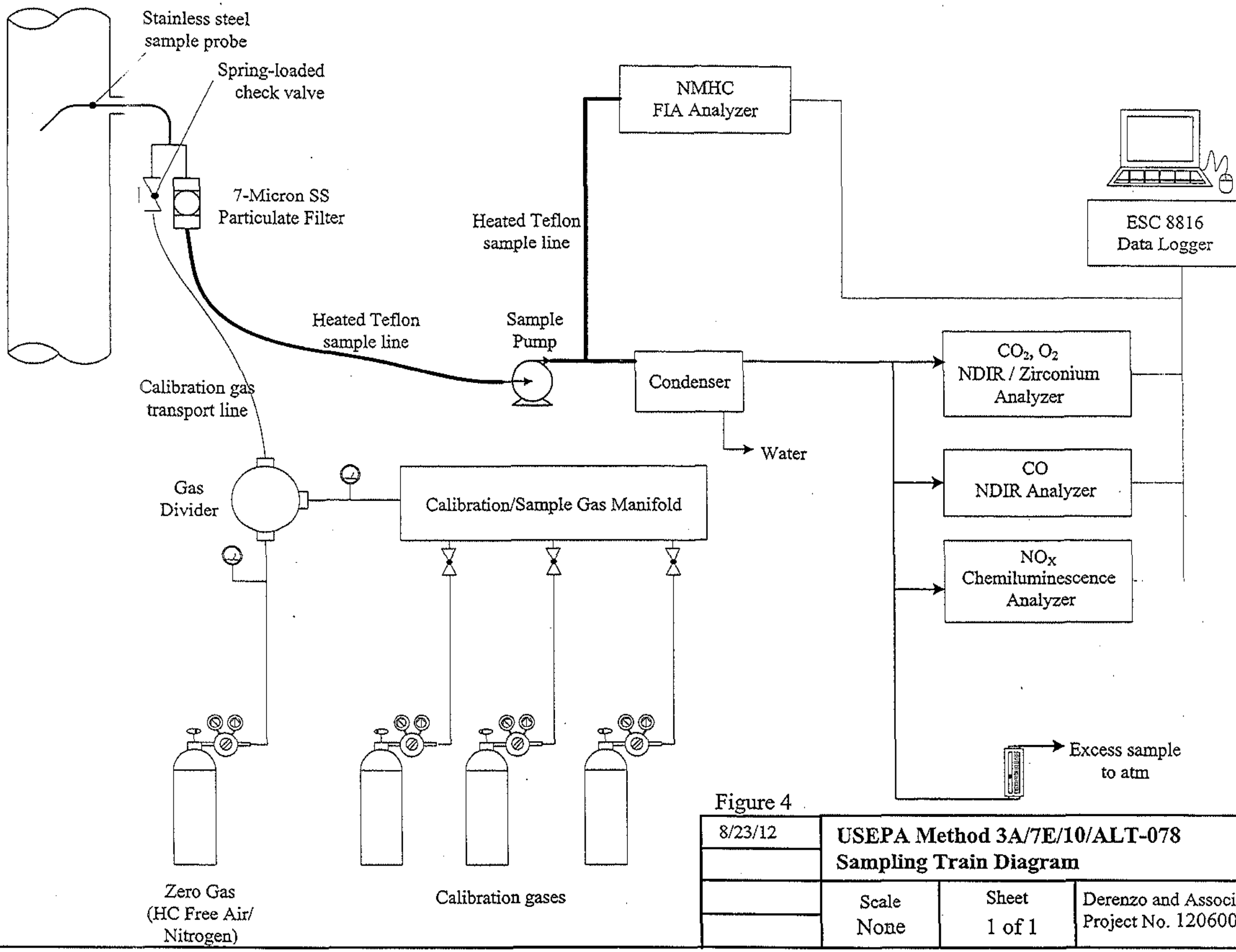

Figure 4

8/23/12	**USEPA Method 3A/7E/10/ALT-078 Sampling Train Diagram**		
	Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1206005

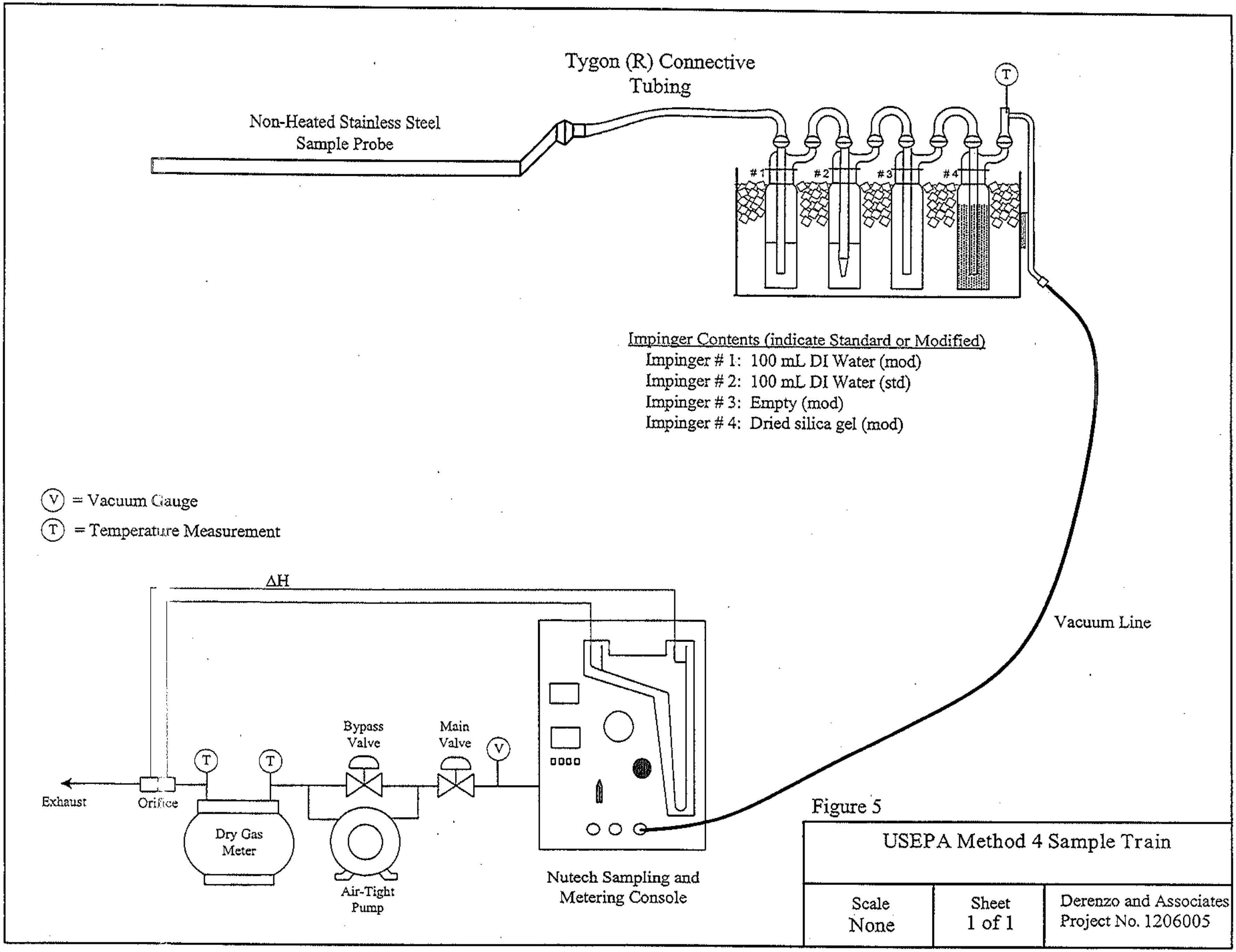

Figure 5

USEPA Method 4 Sample Train		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1206005