EMISSIONS TEST REPORT

Title	Compliance Emissions Testing Report for the Landfill Gas Fueled, Internal Combustion Engines, Operated at the Granger Electric of Pinconning, LLC Facility – Pinconning, Michigan
Report Date	October 7, 2013
Test Date(s)	September 5 & 6, 2013

Facility Information	
Name	Granger Electric of Pinconning, LLC
Street Address	2401 East Whitefeather Road
City, County	Pinconning, MI 48650
Phone	(517) 371-9711

Facility Permit Information			
State Registration No.:	N5985	Permit No.:	PTI 130-08A

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1305009

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GRANGER ELECTRIC OF PINCONNING, LLC
CAT® G3520C LANDFILL GAS FUELED IC ENGINES 2013 EMISSIONS RESULTS

Granger Energy and Electric contracted Derenzo and Associates, Inc., to conduct a performance demonstration for the determination of nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) concentrations and emission rates from two (2) Caterpillar (CAT®) Model No. G3520C landfill gas-fired reciprocating internal combustion engines and electricity generator sets operated at the Granger Electric of Pinconning facility located at the Whitefeather Landfill in Pinconning, Bay County.

Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) Permit to Install (PTI) No. 130-08A requires that performance testing be performed on the CAT® G3520C engines within 180 days of startup and every 8,760 hours of operation (or every three years) in accordance with the provisions of 40 CFR Part 60 Subpart JJJJ (NSPS for spark ignition internal combustion engines). The annual performance testing was conducted on September 5 - 6, 2013.

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

Emission Unit Identification	NOx Emission Rate (lbs/hr)	NOx Emission Factor (g/bhp-hr)	CO Emission Rate (lbs/hr)	CO Emission Factor (g/bhp-hr)	VOC Emission Rate (lbs/hr)	VOC Emission Factor (g/bhp-hr)
EUICEENGINE1	2.67	0.55	14.73	3.01	1.06	0.22
EUICEENGINE2	1.50	0.33	13.99	3.09	0.87	0.19
Permit Limits	4.92	1.00	16.23	3.3	-	1.0

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

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

Emission Unit Identification	Fuel Usage (scfm)	Fuel Quality (Btu/scf)	Electricity Generation (kW)	Engine Output (bHp-hr)	Exhaust Flowrate (scfm)	Exhaust Flowrate (dscfm)
EUICEENGINE1	547	497.9	1,585	2,220	4,922	4,365
EUICEENGINE2	519	513.3	1,464	2,051	4,770	4,216

scfm=standard cubic feet per minute, Btu/scf= British thermal unit per standard cubic foot, kW=kilowatt, bHp-hr=brake horse power hour, dscfm=dry standard cubic feet per minute

The data above indicates EUICEENGINE1 and EUICEENGINE2 operated at normal base load conditions and is in compliance with the emission standards presented in 40 CFR 60.4233(e) and MDEQ-AQD Permit to Install (PTI) No. 130-08A.

Compliance Emissions Testing Report
for the
Landfill Gas Fueled, Internal Combustion Engines,
operated at the
Granger Electric of Pinconning, LLC Facility
Pinconning, Michigan

1.0 INTRODUCTION

Granger Electric of Pinconning, LLC (Granger Electric), State Registration No. N5985, operates two (2) Caterpillar (CAT®) Model No. G3520C landfill gas-fueled internal combustion (IC) engines and electricity generator sets at the Granger Electrical Generation Station located in Pinconning, Bay County.

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. 130-08A, issued to Granger Electric on July 23, 2012.

Condition V.1.; of PTI 130-08A and 40 CFR Part 60 Subpart JJJJ (NSPS for spark ignition internal combustion engines), requires that:

The permittee shall conduct an initial performance test for each engine in FGENGINES, to verify NOx, CO, and VOC emission rates. The permittee shall conduct an initial performance test within 60 days after achieving the maximum production rate but not later than 180 days after initial startup of each engine in FGENGINES and subsequent performance testing every 8760 hours of operation or three years, whichever occurs first, to demonstrate compliance. The performance tests shall be conducted according to 40 CFR 60.4244.

The annual performance test compliance demonstration consisted of triplicate, one-hour test runs for the determination of nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC, as non-methane hydrocarbons) emission rates from both engines identified in the PTI. 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 September 5 & 6, 2013, by Derenzo and Associates, Inc., an environmental consulting and testing company based in Livonia, Michigan. Michael Brack, QSTI, and Daniel Wilson of Derenzo and Associates performed the testing.

Process operations were coordinated by Mr. Dan Zimmerman of Granger Electric. Mr. Tom Gasloli of the MDEQ-AQD-TPU observed portions of the testing.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Protocol dated June 24, 2013 and approved by the MDEQ-AQD by letter on July 1, 2013. Questions regarding this emission test report should be directed to:

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2.0 SUMMARY OF RESULTS

The exhaust gas for the LFG-fueled IC engines was monitored for three (3) one-hour test periods during which the NOx, CO, VOC, O_2, and CO_2 concentrations were measured using instrumental analyzers. Exhaust gas flowrate measurements were conducted prior to and following each one-hour test period to calculate average flowrates for each engine, and ultimately pollutant mass emission rates.

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 Pinconning, LLC.

Emission Unit ID	NOx Emission Rate (lbs/hr)	NOx Emission Factor (g/bhp-hr)	CO Emission Rate (lbs/hr)	CO Emission Factor (g/bhp-hr)	VOC Emission Factor (g/bhp-hr)
EUICEENGINE1	2.67	0.55	14.73	3.01	0.22
EUICEENGINE2	1.50	0.33	13.99	3.09	0.19
Permit Limits	4.92	1.0	16.23	3.3	1.0

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

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

Landfill gas (LFG) is produced in the Pinconning 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 Granger Electrical Generation Station 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 2,242 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 530 and 560 standard cubic feet per minute (scfm) at full load.

Appendix A 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 >25 feet (>21.4 duct diameters) downstream and 126 inches (9 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. 130-08A and 40 CFR Part 60 Subpart JJJJ initially and every 8,760 hours of operation (as determined through the use of a non-

resettable hour meter) or three years, whichever occurs first. This compliance demonstration satisfied the subsequent performance testing event.
The exhaust from each LFG-fueled IC engine was monitored for three (3) one-hour test periods during which the NOx, CO, VOC, 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 24, 2013; the MDEQ Approval Letter dated July 1, 2013, 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 096. 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 1,585 kW during the test periods and consumed an average of 545.1 scfm of treated LFG. EUICEENGINE2 operated at an average electricity generation rate of 1,464 kW during the test periods and consumed an average of 519.1 scfm of treated LFG.

The engine generator sets have a design mechanical output of 2,242 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:

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 performed on September 5 & 6, 2013. 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, 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, and VOC mass emission rates were calculated from the pre-test and post-test flowrate averages for each 60-minute sampling period.

The average measured exhaust gas volumetric flow rate for EUICENGINE1 was 4,365 dry standard cubic feet per minute (dscfm). The average measured exhaust gas NO_X and CO concentrations for EUICEENGINE1 were 85.3 parts per million by volume, dry basis (ppmvd) and 773.4 ppmvd, respectively. Based on the measured exhaust gas flowrate, these concentrations correspond to a mass emission rate of 2.67 pounds per hour (lb/hr) NO_2, which is equivalent to 0.55 grams per bhp-hr (g/bhp-hr) NO_2, and 14.73 lb/hr CO, which is equivalent to 3.01 g/bhp-hr CO.

Exhaust gas VOC concentrations, measured as NMHC, were determined to be 31.4 ppmv (as propane) for EUICEENGINE1. The measured exhaust gas flowrate for EUICEENGINE1 was 4,922 scfm, which resulted in calculated VOC mass emission rates of 1.06lb/hr which is equivalent to 0.22 g/bhp-hr.

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

The average measured exhaust gas volumetric flow rate for EUICEENGINE2 was 4,216 dscfm. The average measured exhaust gas NO_X and CO concentrations for EUICEENGINE2 were 49.6 ppmvd and 760.0 ppmvd, respectively. Based on the measured exhaust gas flowrate, these concentrations correspond to a mass emission rate of 1.50 lb/hr NO_2, which is equivalent to 0.33 g/bhp-hr NO_2, and 13.99 lb/hr CO, which is equivalent to 3.09 g/bhp-hr CO.

Exhaust gas VOC concentrations, measured as NMHC, were determined to be 26.6 ppmv (as propane) for EUICEENGINE2. The measured exhaust gas flowrate for EUICEENGINE2 was 4,770 scfm, which resulted in calculated VOC mass emission rates of 0.87 lb/hr which is equivalent to 0.19 g/bhp-hr.

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

Appendix B provides computer calculated and field data sheets for the IC engine tests.
Appendix C 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, and approved by the MDEQ-AQD-TPU. This section provides a summary of the sampling and analytical procedures that were used during the test and presented in the test plan.

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

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

The 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 Paramagnetic 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 6.4 of this document).

Figure 4 presents a diagram of the instrument analyzer train.

Appendix D 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 700 °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.

Appendix D presents detailed gas sampling procedures for the USEPA moisture sampling train.

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

NOx and CO pollutant concentrations in the exhaust of the IC engine were determined using a chemiluminescence NOx 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 Methods 25A and ALT 096)

The exhaust gas VOC concentrations were measured using a Flame Ionization Analyzer (FIA) instrumental analyzer in accordance with USEPA Methods 25A and Alt 096 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 B presents the computer calculated and field data from the testing program.

6.0 INTERNAL QA/QC ACTIVITIES

6.1 NOx 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 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.

6.4 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, NOx, CO, Propane, and zeroed using pure nitrogen or hydrocarbon free air.

6.5 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 E 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).

<u>Report Certification</u>

I certify under penalty of law that I believe the information provided in this document is true, accurate, and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine, imprisonment or both, for knowingly submitting false, inaccurate, or incomplete information.

Report Prepared By:

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Environmental Consultant
Derenzo and Associates, Inc.

Report Reviewed By:

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Derenzo and Associates, Inc.

Responsible Official Certification:

Marc Pauley
Operations Manager
Granger Electric of Pinconning

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

Unit ID: **EUICEENGINE1**

Test Number:	1	2	3	Three
Test Date:	09/05/13	09/05/13	09/05/13	Test
Test Period (24-hr clock):	8:30-9:30	10:10-11:10	11:50-12:50	Average
Engine operating parameters				
Generator Output (kW)	1,577	1,592	1,584	1,585
Engine Horsepower (Hp)	2,210	2,231	2,220	2,220
Exhaust gas composition				
CO_2 content (% vol)	10.8	10.7	10.6	10.7
O_2 content (% vol)	8.75	8.77	8.83	8.78
Moisture (% vol)	10.5	11.5	11.9	11.3
Exhaust gas flowrate				
Standard conditions (scfm)	4,909	4,918	4,938	4,922
Dry basis (dscfm)	4,393	4,351	4,350	4,365
Nitrogen oxides emission rates				
NO_X concentration (ppmvd)*	86.0	85.8	84.1	85.3
NO_X emissions (lb/hr as NO_2)	2.71	2.68	2.62	2.67
NO_X permit limit (lb/hr)				*4.92*
NO_X emissions (g/bhp-hr)	0.56	0.54	0.54	0.55
NO_X permit limit (g/bhp-hr)				*1.00*
Carbon monoxide emission rates				
CO concentration (ppmvd)*	770.0	777.6	772.6	773.4
CO emissions (lb/hr)	14.76	14.76	14.67	14.73
CO permit limit (lb/hr)				*16.23*
CO emissions (g/bhp-hr)	3.03	3.00	3.00	3.01
CO permit limit (g/bhp-hr)				*3.30*
Volatile organic compound emission rates				
VOC concentration (ppmv C_3)*	31.7	31.3	31.2	31.4
VOC emissions (lb/hr)	1.07	1.06	1.06	1.06
VOC emissions (g/bhp-hr)	0.22	0.22	0.22	0.22
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

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

Unit ID: **EUICEENGINE2**

Test Number:	1	2	3	Three
Test Date:	09/06/13	09/06/13	09/06/13	Test
Test Period (24-hr clock):	09:10-10:10	10:50-11:50	12:30-13:30	Average
Engine operating parameters				
Generator Output (kW)	1,459	1,466	1,466	1,464
Engine Horsepower (Hp)	2,045	2,054	2,054	2,051
Exhaust gas composition				
CO_2 content (% vol)	10.8	10.7	10.6	10.7
O_2 content (% vol)	8.72	8.80	8.89	8.81
Moisture (% vol)	11.9	11.7	11.2	11.6
Exhaust gas flowrate				
Standard conditions (scfm)	4,745	4,799	4,765	4,770
Dry basis (dscfm)	4,179	4,238	4,231	4,216
Nitrogen oxides emission rates				
NO_X concentration (ppmvd)*	51.9	49.1	47.9	49.6
NO_X emissions (lb/hr NO_2)	1.55	1.49	1.45	1.50
NO_X permit limit (lb/hr)				*4.92*
NO_X emissions (g/bhp-hr)	0.34	0.33	0.32	0.33
NO_X permit limit (g/bhp-hr)				*1.00*
Carbon monoxide emission rates				
CO concentration (ppmvd)*	762.5	760.7	756.7	760.0
CO emissions (lb/hr)	13.91	14.07	13.98	13.99
CO permit limit (lb/hr)				*16.23*
CO emissions (g/bhp-hr)	3.09	3.11	3.09	3.09
CO permit limit (g/bhp-hr)				*3.30*
Volatile organic compound emission rates				
VOC concentration (ppmv C_3)*	26.4	26.4	26.9	26.6
VOC emissions (lb/hr)	0.86	0.87	0.88	0.87
VOC emissions (g/bhp-hr)	0.19	0.19	0.19	0.19
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

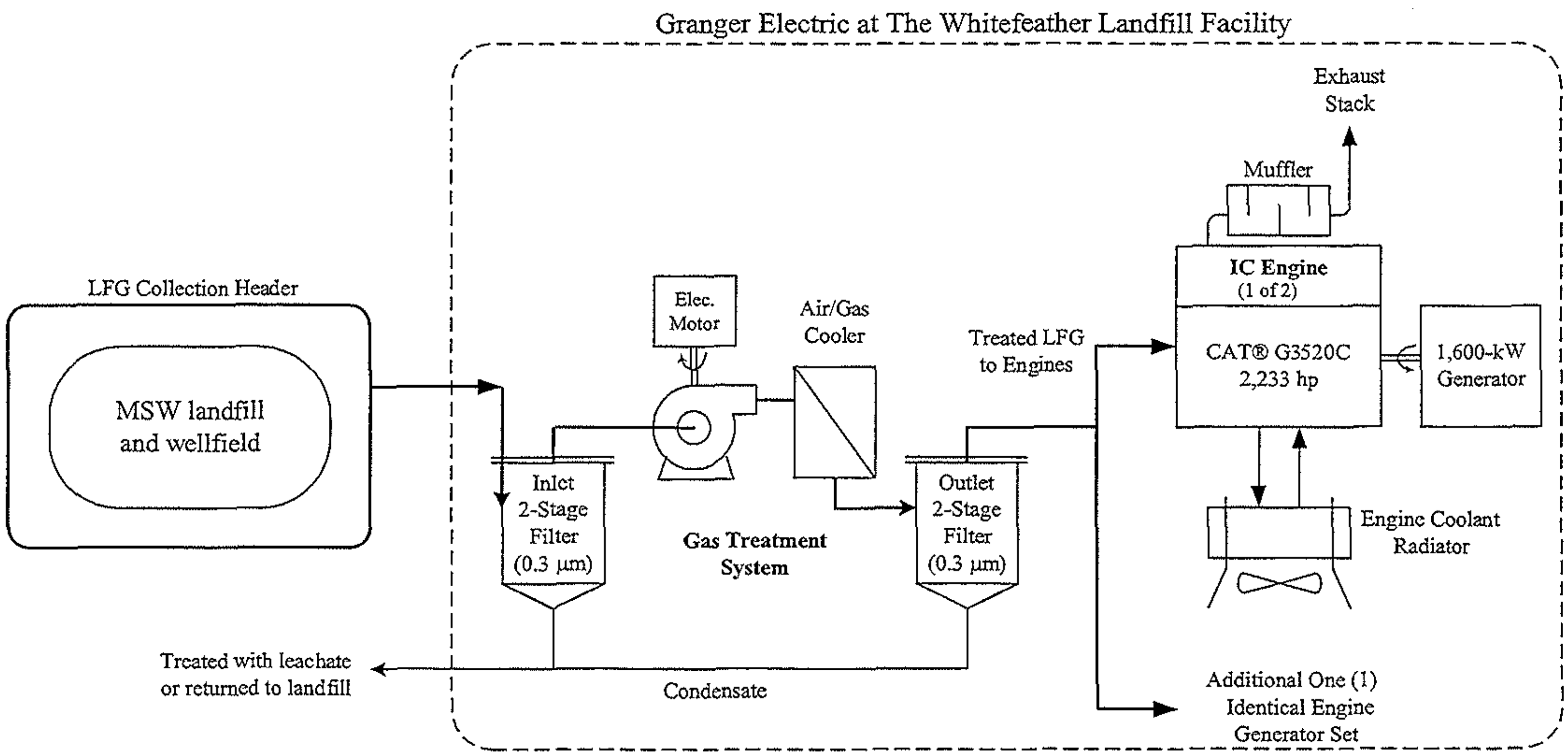

Figure 1.

Granger Electric LFG Electricity Generation Facility		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1305009

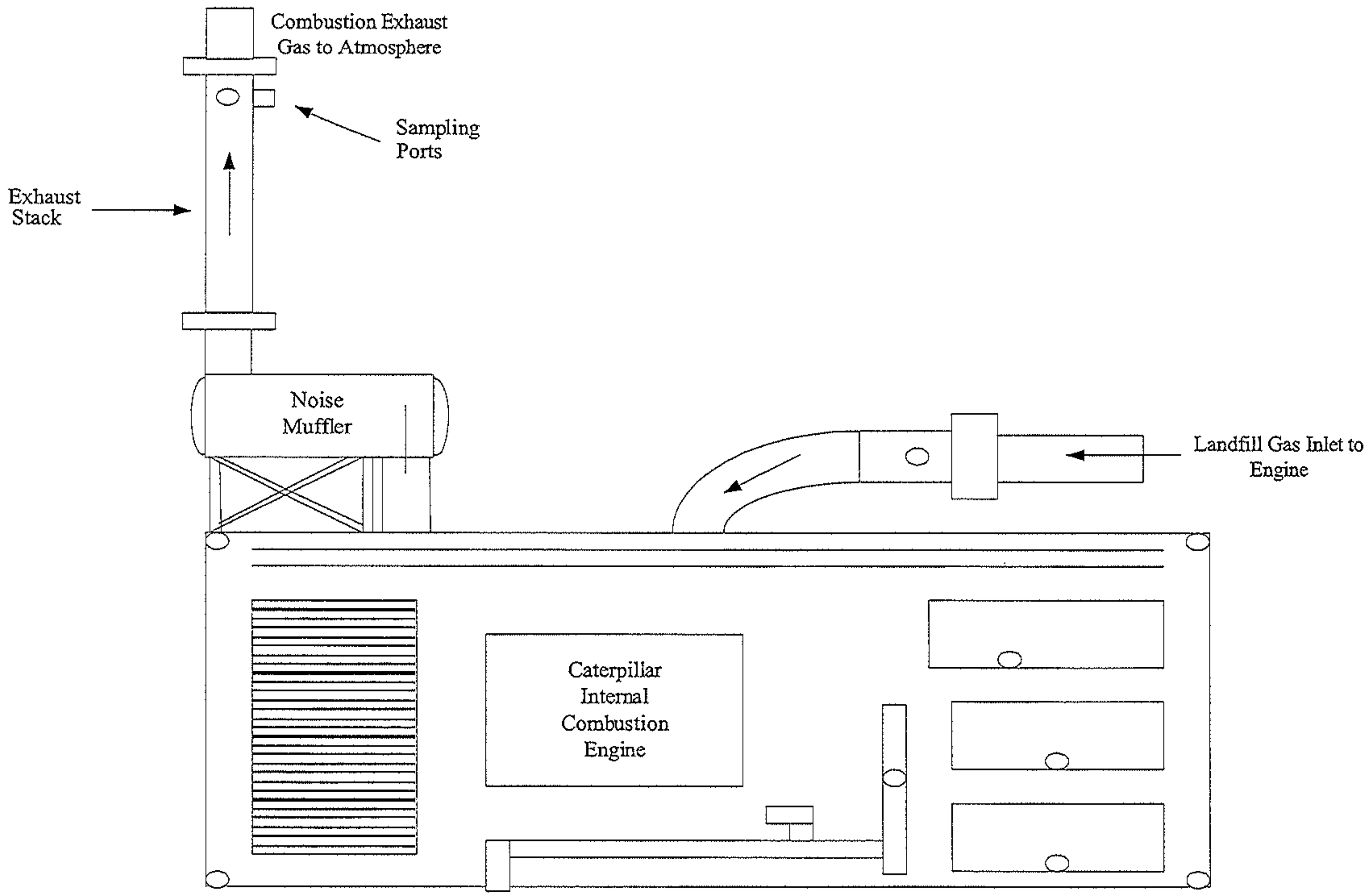

Figure 2

9/4/13	**Granger Electric General Engine Operation Flow Diagram**		
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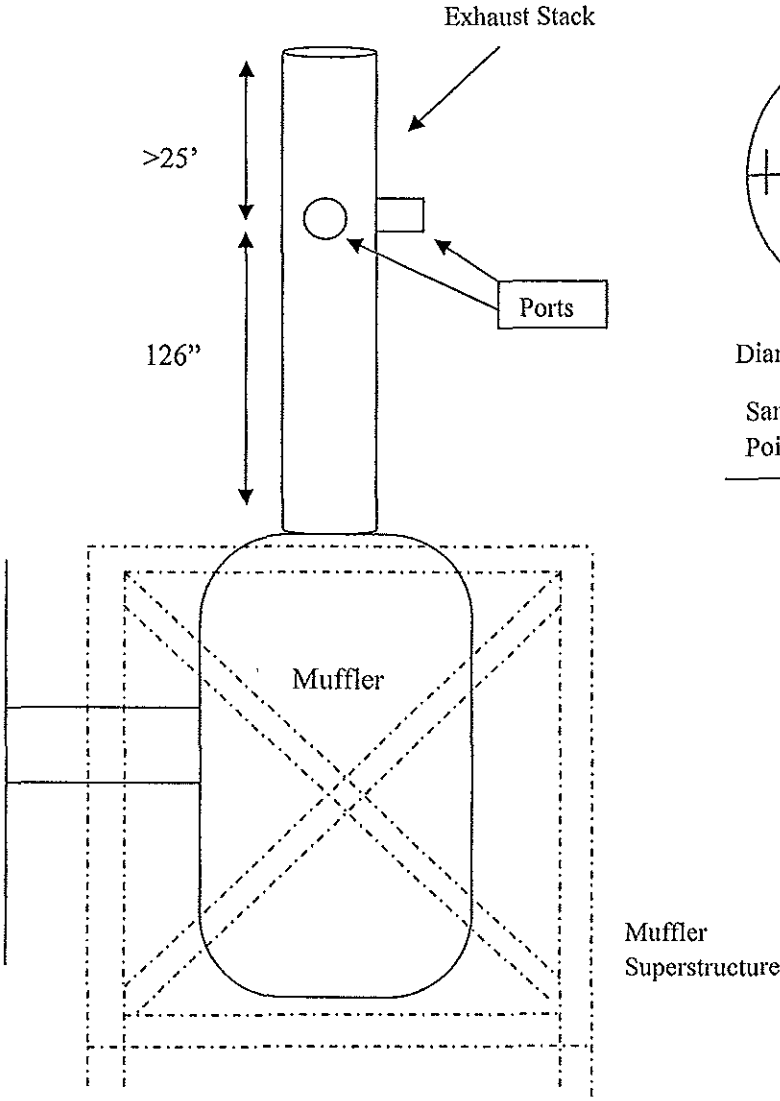

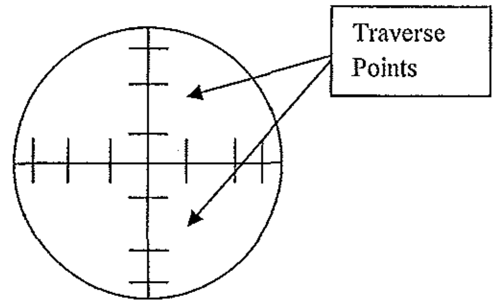

Diameter = 13.5" + 2.75" nipple

Sampling Point	Distance from nipple
1	3.34
2	4.72
3	6.75
4	12.25
5	14.28
6	15.66

Diagram not to scale

All measurements were verified prior to testing

Figure 3. Sampling and measurement locations for the internal combustion engines emission testing program that was conducted at the Granger Electric at Pinconning, LLC facility in Bay County, Michigan.	Sampling Date(s): September 5-6, 2013
	Derenzo and Associates, Inc.

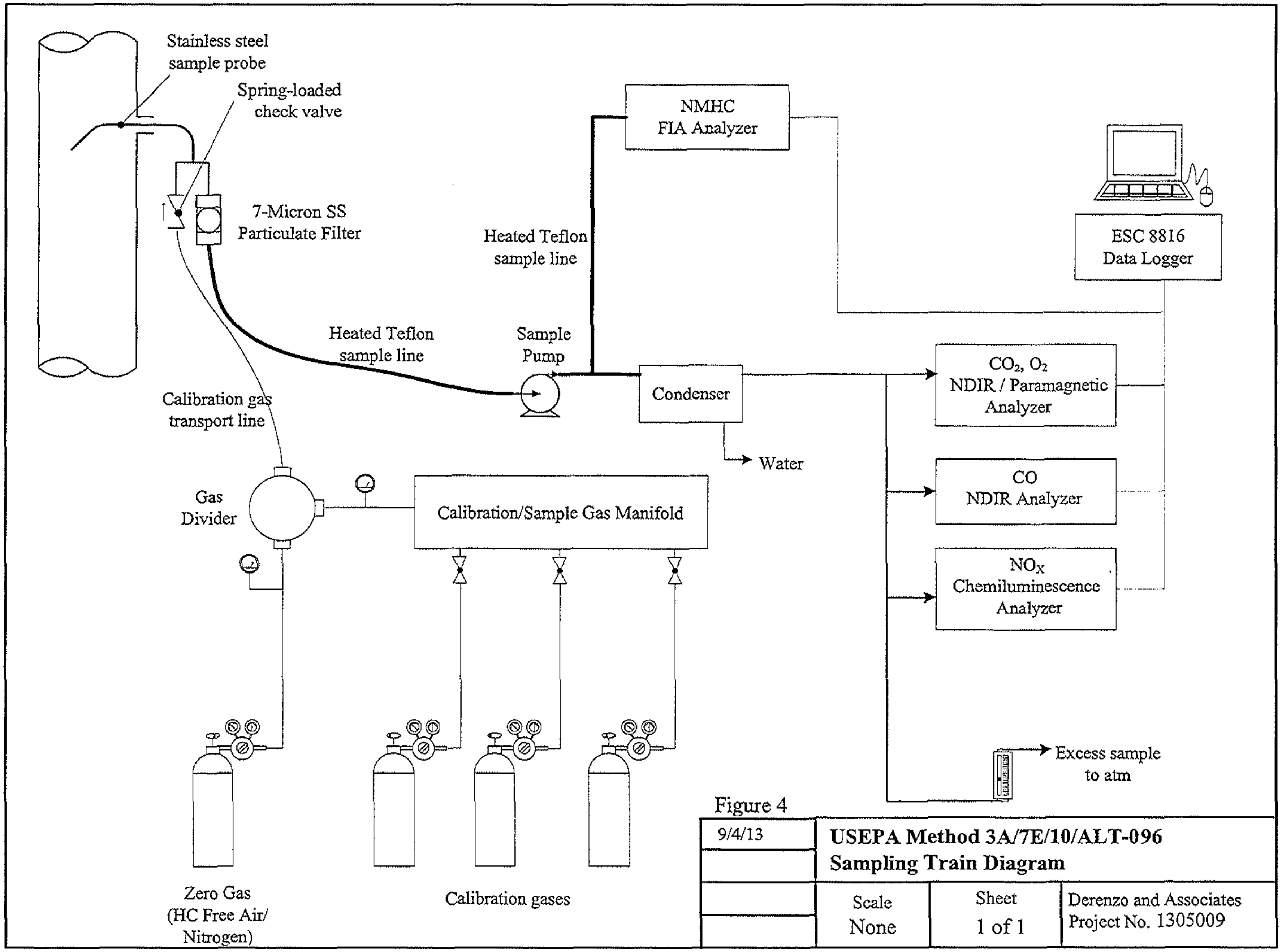

Figure 4

9/4/13	**USEPA Method 3A/7E/10/ALT-096 Sampling Train Diagram**		
	Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1305009

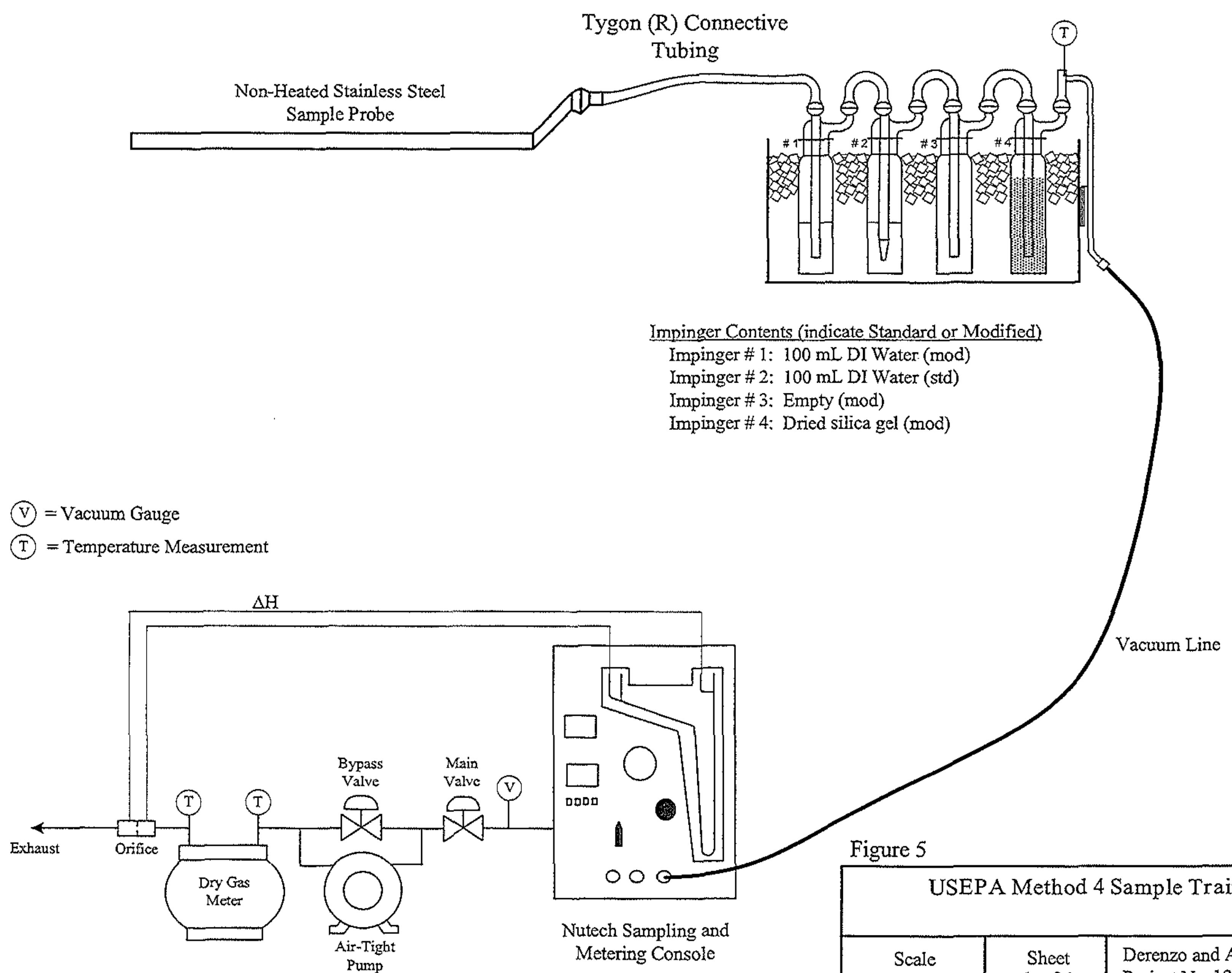

Figure 5

USEPA Method 4 Sample Train		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1305009