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EMISSIONS TEST REPORT

Title	Compliance Test Report for the Landfill Gas-to- Energy IC Engine Generator Sets operated at the Waste Management of Michigan, Inc., Eagle Valley Landfill facility located in Orion, Michigan.
Report Date	October 28, 2013
Test Date(s)	October 15, 2013

Facility Information	
Name	Waste Management of Michigan, Inc. Eagle Valley Landfill
Street Address	3925 Giddings Road
City, County	Orion, Oakland
Phone	(800) 796-9696

Facility Permit Information	
State Registration No.: N3845	Permit No.: 116-10

Emission Unit ID	Description	Serial #
EUICENGINE1	CAT G3520C IC Engine	GZJ00471
EUICENGINE2	CAT G3520C IC Engine	GZJ00470

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1307004

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1.0 SOURCE INFORMATION

Waste Management of Michigan, Inc. (WMI) at Eagle Valley Landfill operates two (2) Caterpillar (CAT®) Model No. G3520C gas-fired reciprocating internal combustion (IC) engines and electricity generator sets at the Eagle Valley Landfill in Orion, Oakland County, Michigan. The treated landfill gas (LFG) fueled IC engine generator sets (Serial Numbers GZJ00471 & GZJ00470) are identified as emission unit EUICENGINE1 and EUICENGNE2 (Flexible Group ID: FGIENGINES) in Permit to Install (PTI) 116-10 issued by the Michigan Department of Environmental Quality-Air Quality Division (MDEQ-AQD).

The compliance demonstration consisted of triplicate, one-hour, test runs for the determination of nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC, as non-methane hydrocarbons). Exhaust gas velocity, moisture, oxygen (O_2) content, and carbon dioxide (CO_2) content was determined for each test period to calculate pollutant mass emission rates. Instrument analyzers were used for real time analysis of NOx, CO, VOC, O_2, and CO_2.

The performance testing for Emission Units EUICENGINE1 and EUICENGINE2 was conducted on October 15, 2013, by Derenzo and Associates, Inc., an environmental consulting and testing company in Livonia, MI. Mr. Michael Brack and Mr. Daniel Wilson of Derenzo and Associates performed the testing. Mr. James Dunn of Waste Management assisted with process coordination and operating parameter data acquisition. MDEQ-AQD representative Mark Dziadosz was on site to witness the test event.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Protocol dated August 7, 2013, and approved by DEQ on September 11, 2013.

Questions regarding this emission test report should be directed to:

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2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 General Process Description

Landfill gas (LFG) is produced in the Eagle Valley Landfill from the anaerobic decomposition of disposed waste materials. The LFG is collected from active 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 Eagle Valley electricity generation facility where it is used as fuel for the IC engine generator that produces electricity for transfer to the local utility.

The Eagle Valley facility currently consists of two (2) CAT Model No.G3520C IC engines.

2.2 Rated Capacities, Type and Quantity of Raw Materials Used

The Caterpillar G3520C engines are spark ignition, lean-burn, reciprocating internal combustion engines fueled by treated landfill gas. Each engine genset has an engine power rating of 2,233 hp at 100% load, and a generator power rating of 1,600 kW. Each CAT G3520C IC Engine was tested while operating at baseload conditions, within 10% (+/-) of the maximum electricity generation rate of 1,600 kW per engine. Fuel consumption is regulated to maintain the required heat input rate to support engine operations and is dependant on the fuel heat value (methane content).

The average engine fuel consumption rates for EUICENGINE1 and EUICENGINE2 during the test periods were 531.2 and 552.4 standard cubic feet per minute (scfm), respectively, based on data recorded from the fuel flow meter installed and operated by WMI-Eagle Valley.

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

2.3 Emission Control System Description

The engine incorporates state of the art technology in order to fire lean fuel mixtures and produce low combustion by-product emissions. Emissions from the combustion of LFG are released uncontrolled into the ambient air through a stack connected to the IC engine exhaust manifold and noise control system (noise muffler).

2.4 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 each engine exhaust stack is 16 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location 54 inches (3.4 duct diameters) downstream and 60 inches (3.8 duct diameters) upstream from any flow disturbance.

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

NOx, CO, and VOC results are calculated from the flowrates obtained before and after each 60-minute sampling period. Measured concentrations are drift and bias corrected as per current USEPA reference methods and the requirements of the MDEQ-AQD-TPU. Figure 1 presents the performance test sampling and measurement locations.

3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 Purpose and Objectives of the Tests

Permit to Install No. 116-10 and 40 CFR 60.4243(b)(2)(ii) (Subpart JJJJ) specifiy that owners and operators of new stationary spark-ignited IC engines with a power rating greater than 500 horsepower must conduct an initial performance test and conduct subsequent performance testing every 8,760 hours or 3 years, whichever comes first, thereafter to demonstrate compliance. This test event satisfied the second subsequent test event. The documented engine hours at the beginning of testing EUICENGINE1 and EUICENGINE2 were 18,635.9 and 18,568.9 hours respectively.

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 from the IC engines 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 before and after each test run.

Testing was performed while each IC engine was operated at normal base load conditions (i.e., 1600 kW peak electricity output +/- 10%).

3.2 Variations from Normal Sampling Procedures or Operating Conditions

The compliance tests for all pollutants were performed in accordance with the Test Protocol dated August 7, 2013; the USEPA Approval Letter dated November 8, 2012 (approval to perform Method ALT-096 for VOC determination), 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 ALT 096. No variations from the normal operating conditions of the IC engines occurred during the testing program.

3.3 Operating Conditions during Compliance Tests

Each LFG-fueled IC engine was operated at base load (100% capacity +/- 10%) conditions during the compliance testing. The average kilowatt (kW) output and fuel usage values were recorded by the facility during each test event. The average electrical output rates during the test events were 1,557 kW and 1,622 kW for EUICEENGINE1 and EUICENGINE2, respectively. LFG flowrate information was obtained from the facility fuel meter. The

average LFG consumption rate during the testing was 531.2 standard cubic feet per minute (scfm) and 552.4 scfm for EUICENGINE1 AND EUICENGINE 2, respectively.

3.4 Air Pollutant Sampling Results

The IC engine performance tests were performed on October 15, 2013. The testing included sampling for NOx, CO, and VOC. Test results and applicable emission limits are provided in the following table. Test results demonstrate compliance with emission limits specified in 40 CFR Part 60, Subpart JJJJ and Permit to Install No. 116-10.

Emission Parameter	**Test Result (g/bhp-hr)**	**Emission Limit (Specification)**
EUICENGINE1 CAT G3520, Output: 1,557 kW		
NOx	0.76	0.9 g/bhp (Permit No. 116-10) 2.0 g/bhp-hr (JJJJ*)
CO	2.65	4.13 g/bhp (Permit No. 116-10) 5.0 g/bhp-hr (JJJJ*)
VOC	0.10	1.0 g/bhp (Permit No. 116-10) 1.0 g/bhp-hr (JJJJ*)

Emission Parameter	**Test Result (g/bhp-hr)**	**Emission Limit (Specification)**
EUICENGINE2 CAT G3520, Output: 1,622 kW		
NOx	0.61	0.9 g/bhp (Permit No. 116-10) 2.0 g/bhp-hr (JJJJ*)
CO	2.49	4.13 g/bhp (Permit No. 116-10) 5.0 g/bhp-hr (JJJJ*)
VOC	0.11	1.0 g/bhp (Permit No. 116-10) 1.0 g/bhp-hr (JJJJ*)

*40 CFR Part 60 Subpart JJJJ

The diluents gases were measured at 7.68% O_2 and 12.1% CO_2 for EUICEENGINE1 and 7.68% O_2 and 12.1% CO_2 for EUICENGINE2.

Tables 1 and 2, following the text portion of this report, presents measured gas conditions and calculated pollutant emission rates and emission factors for the tested LFG-fueled IC engines.

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.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the compliance testing was prepared by Derenzo and Associates and reviewed by the MDEQ-AQD. 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 for the USEPA Methods sampling methods.

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

In order to determine air pollutant emission rates on a mass basis (e.g., pound per hour), IC engine exhaust stack gas velocities, and volumetric flow rates were determined using USEPA Method 2 during each 60-minute test. 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).

Exhaust gas velocity pressure and temperature were measured before and after each one-hour sampling period in accordance with USEPA Method 2.

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

CO_2 and O_2 content in the IC engine exhaust 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 5.5 of this document).

Figure 2 presents the instrument analyzer sampling train. Appendix E presents detailed gas sampling procedures for the USEPA sampling trains.

4.3 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. 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 3 presents the moisture sampling train schematic. Appendix E presents detailed gas sampling procedures for the USEPA sampling trains.

4.4 NOx and CO Concentration Measurements (USEPA Method 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 4.2 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.

Figure 2 presents the instrument analyzer train. Appendix E presents detailed gas sampling procedures for the USEPA sampling trains.

4.5 VOC Concentration Measurements (USEPA Method ALT 096)

The exhaust gas VOC concentrations were measured using a Flame Ionization Detector (FID) instrumental analyzer in accordance with USEPA Alt 096 for direct measurement of VOC (non-methane organic compounds) concentrations. The TECO model 55I methane, non-methane hydrocarbon analyzer has been approved by the USEPA on Subpart JJJJ sources for VOC measurements.

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.

Based on previous IC engine testing, the VOC concentrations measured with the FIA analyzer were expected to be approximately 10 to 50 ppmv for the exhaust, measured as propane. Therefore, the instrument analyzer VOC measurement span was set based on available calibration gases that satisfy minimum and maximum method requirements.

Figure 2 presents the instrument analyzer train. Appendix E presents detailed gas sampling procedures for the USEPA sampling trains.

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

5.0 INTERNAL QA/QC ACTIVITIES

5.1 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%).

5.2 Calibration Gas Divider Field Validation

In accordance with USEPA Method 205, a field evaluation of the calibration gas divider was performed prior to commencement of the compliance testing. Triplicate injections were performed at two separate dilution ratios (60% and 40%) through the gas divider, followed by triplicate injections of mid-level calibration gas into the instrument directly (bypassing the gas divider). Calculations were performed to verify the gas divider met all acceptable criteria presented in Method 205. The gas divider satisfied the method requirements and was used throughout the compliance demonstration.

5.3 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.

5.4 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.

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

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).

Conclusion

Results of the October 15, 2013 performance demonstration indicate continued compliance with the requirements of MDEQ-AQD PTI 116-10 and 40 CFR Part 60 Subpart JJJJ.

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Report Reviewed By:

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Derenzo and Associates, Inc.

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Table 1. Summary of EUICENGINE1 Test Results (CAT G3520C)
Waste Management of Michigan, Eagle Valley Landfill
Serial Number: GZJ00471

Test No.	1	2	3	
Test date	10/15/13	10/15/13	10/15/13	Test
Test period (24-hr clock)	920-1020	1105-1205	1255-1355	Avg.
Generator output (kW)	1,567	1,545	1,560	1,557
Engine Horsepower (Hp)	2,195	2,165	2,185	2,182
Exhaust gas composition				
CO_2 content (% vol)	12.1	12.1	12.2	12.1
O_2 content (% vol)	7.71	7.68	7.64	7.68
Moisture (% vol)	13.6	12.5	12.4	12.9
Exhaust gas flowrate				
Standard conditions (scfm)	5,320	5,301	5,195	5,272
Dry basis (dscfm)	4,625	4,640	4,550	4,605
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	107.4	111.3	111.3	110.0
NO_X emissions (lb/hr NO_2)	3.56	3.70	3.63	3.63
NO_X emissions (g/bhp-hr)	0.74	0.78	0.75	0.76
NO_X permit limit (g/bhp-hr)				*0.90*
Carbon monoxide emission rates				
CO conc. (ppmvd)*	632.2	633.1	639.0	634.7
CO emissions (lb/hr)	12.8	12.8	12.7	12.8
CO emissions (g/bhp-hr)	2.64	2.69	2.63	2.65
CO permit limit (g/bhp-hr)				*4.13*
VOC/NMHC emission rates				
VOC conc. (ppmv C_3)*	13.0	13.5	13.5	13.4
VOC emissions (lb/hr)	0.47	0.49	0.48	0.48
VOC emissions (g/bhp-hr)	0.10	0.10	0.10	0.10
VOC permit limit (g/bhp-hr)				*1.0*

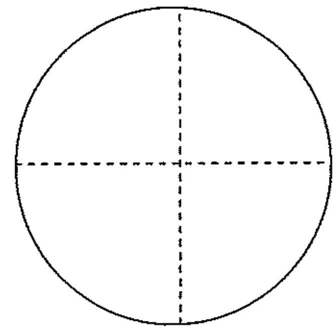
* Corrected for calibration bias.

Table 2. Summary of EUICENGINE2 Test Results (CAT G3520C)
Waste Management of Michigan, Eagle Valley Landfill
Serial Number: GZJ00470

Test No.	1	2	3	
Test date	10/15/13	10/15/13	10/15/13	Test
Test period (24-hr clock)	1500-1600	1645-1745	1830-1930	Avg.
Generator output (kW)	1,622	1,622	1,622	1,622
Engine Horsepower (Hp)	2,273	2,273	2,273	2,273
Exhaust gas composition				
CO_2 content (% vol)	12.1	12.1	12.2	12.1
O_2 content (% vol)	7.69	7.69	7.65	7.68
Moisture (% vol)	12.5	12.9	12.5	12.6
Exhaust gas flowrate				
Standard conditions (scfm)	5,526	5,437	5,419	5,461
Dry basis (dscfm)	4,823	4,746	4,742	4,770
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	89.1	88.1	89.5	88.9
NO_X corrected to 15% O_2	25.2	24.9	25.3	25.1
NO_X emissions (lb/hr NO_2)	3.08	3.00	3.04	3.04
NO_X emissions (g/bhp-hr)	0.62	0.60	0.61	0.61
NO_X permit limit (g/bhp-hr)				*0.90*
Carbon monoxide emission rates				
CO conc. (ppmvd)*	599.2	600.1	602.6	600.6
CO corrected to 15% O_2	264.1	264.0	264.5	264.2
CO emissions (lb/hr)	12.6	12.4	12.5	12.5
CO emissions (g/bhp-hr)	2.52	2.48	2.49	2.49
CO permit limit (g/bhp-hr)				*4.13*
VOC/NMHC emission rates				
VOC conc. (ppmv C_3)*	14.1	14.4	14.6	14.4
VOC corrected to 15% O_2	6.23	6.34	6.41	6.3
VOC emissions (lb/hr)	0.54	0.54	0.54	0.54
VOC emissions (g/bhp-hr)	0.11	0.11	0.11	0.11
VOC permit limit (g/bhp-hr)				*1.0*

* Corrected for calibration bias.

Traverse/Sampling Point	Distance from Port nipple (inches)
1	8.51
2	9.68
3	11.10
4	13.17
5	18.83
6	20.90
7	22.32
8	23.49



Diameter = 16"

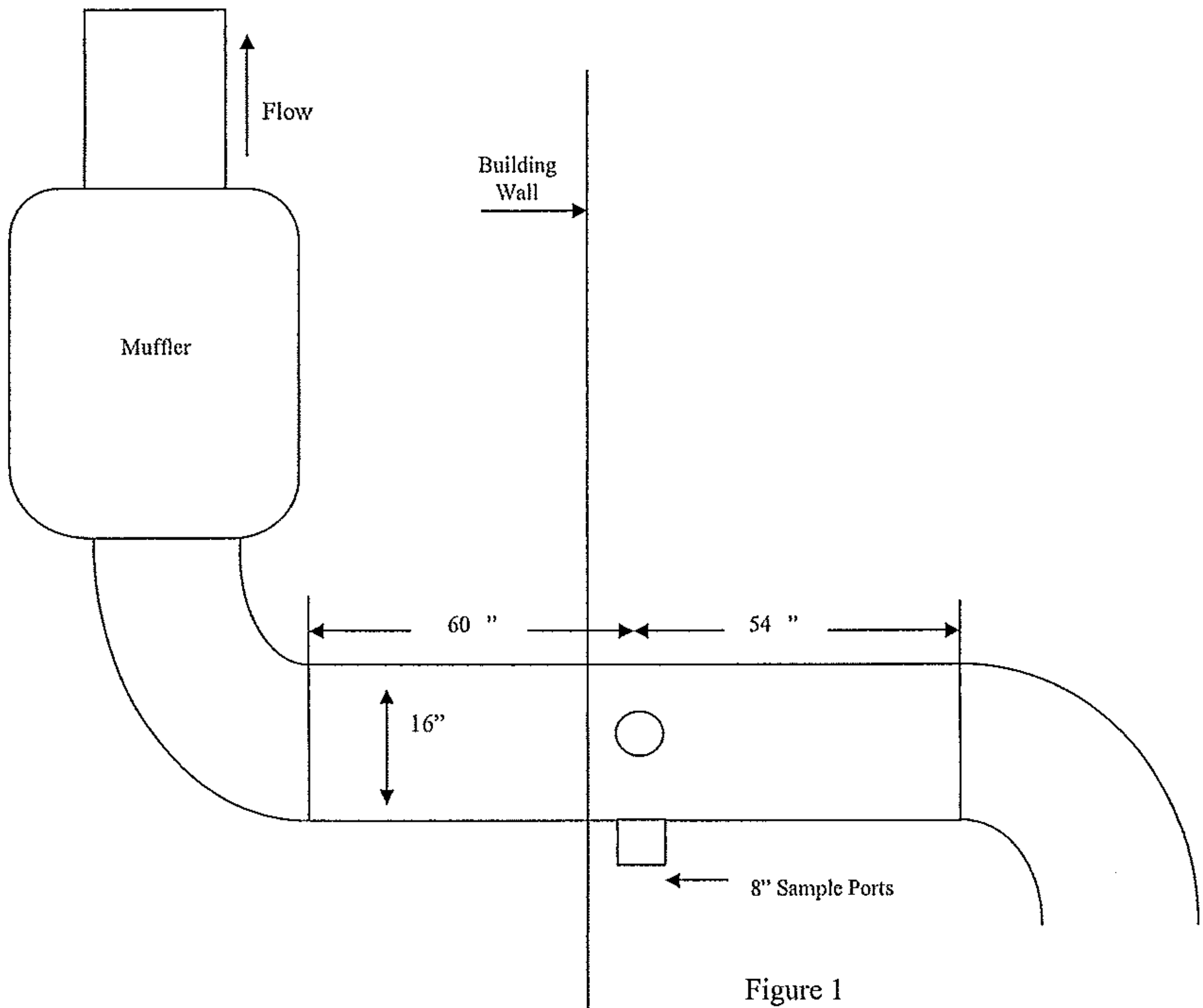


Figure 1

Eagle Valley Landfill
Exhaust Sample Locations

Scale	Sheet	Derenzo and Associates
None	1 of 1	Project No. 1307004

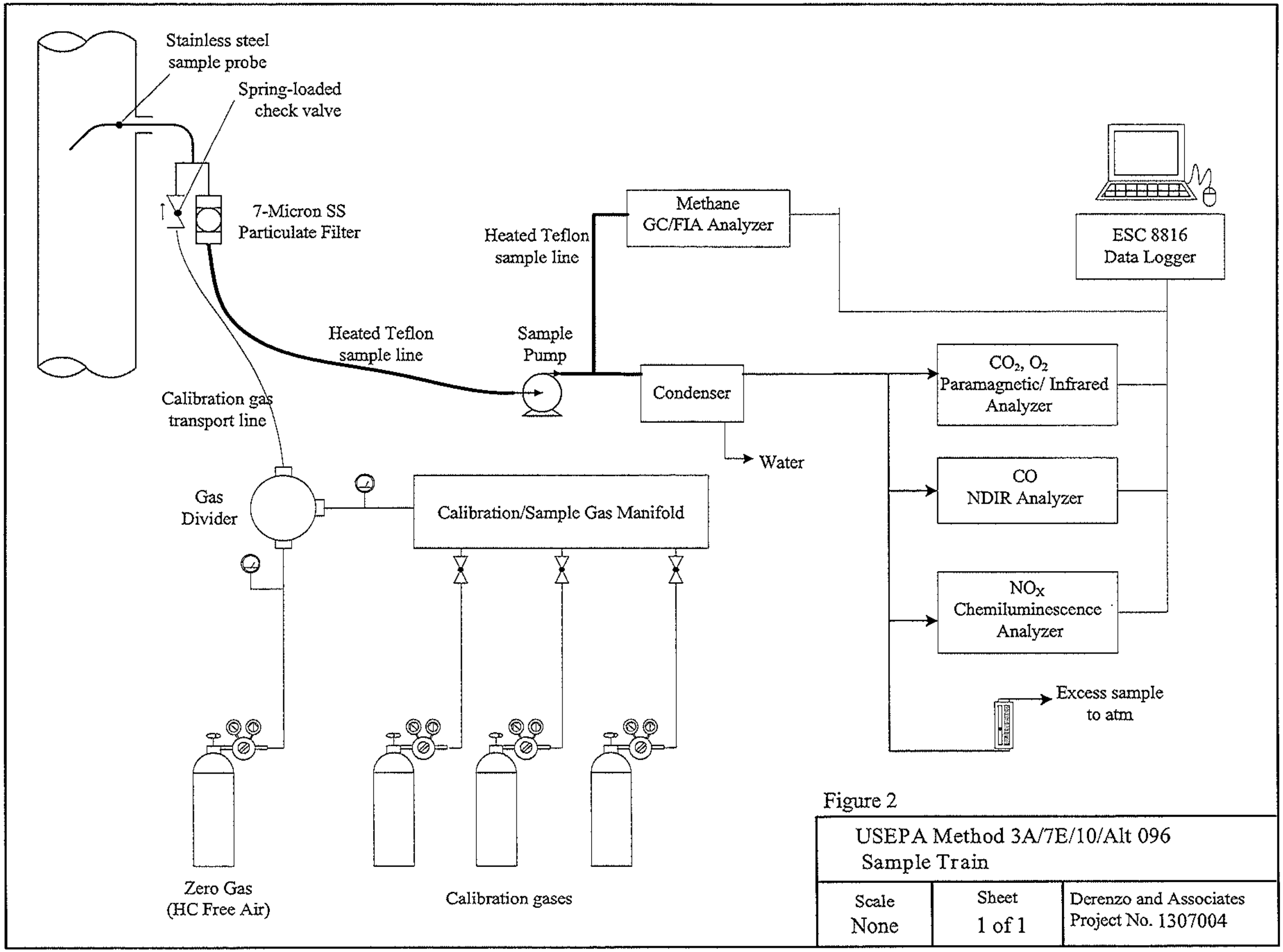


Figure 2

USEPA Method 3A/7E/10/Alt 096 Sample Train		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1307004

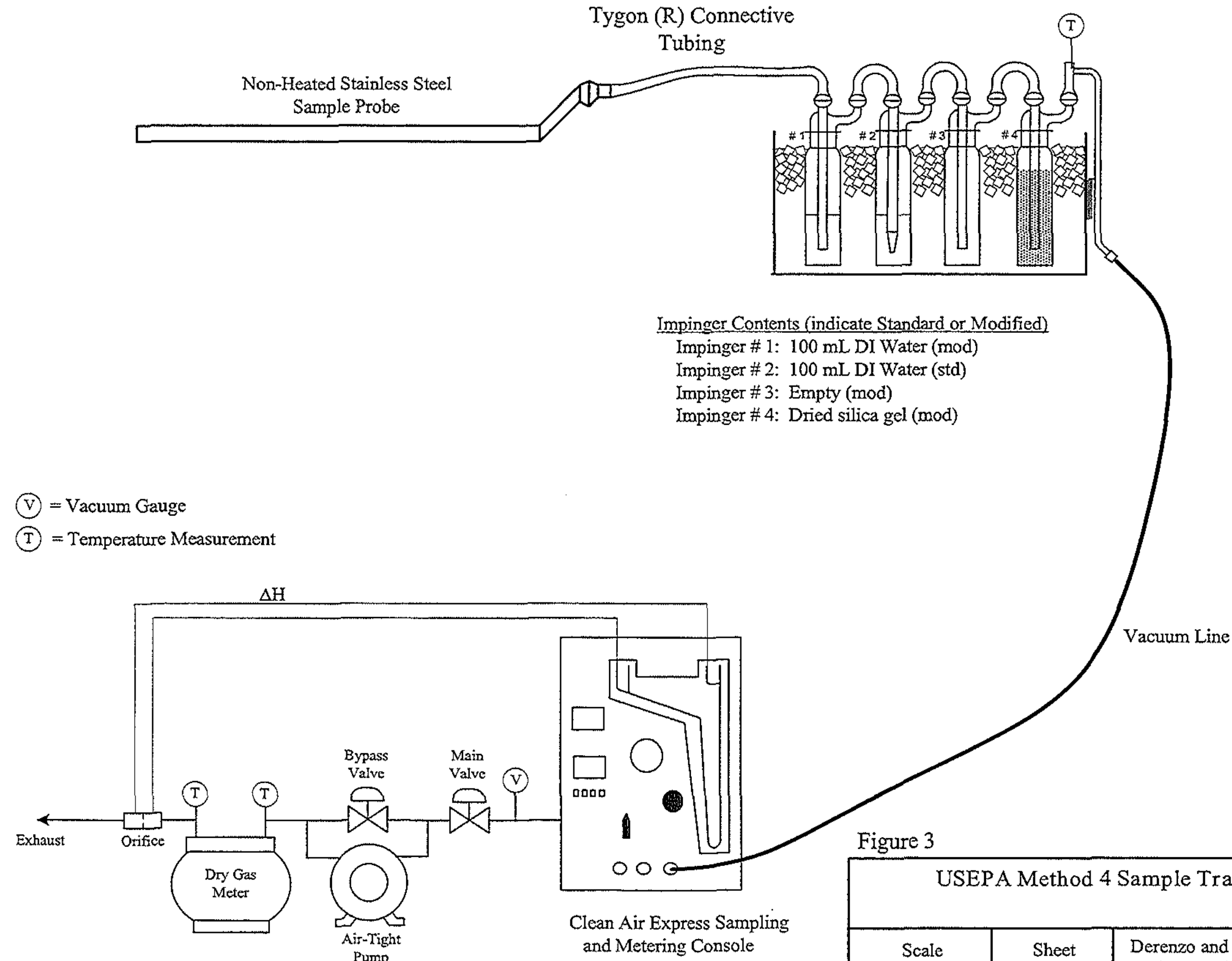


Figure 3

USEPA Method 4 Sample Train		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1307004