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# Engine 6 Formaldehyde Emissions Test Report

N5910

Prepared for:  
**North American Natural Resources, Inc.**

Lennon, Michigan

North American Natural Resources  
4516 Rathburn Rd  
Birch Run, Michigan 48415

Project No. 13-4404.00  
July 29, 2013

BT Environmental Consulting, Inc.  
4949 Fernlee Avenue  
Royal Oak, Michigan 48073  
(248) 548-8070

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## EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by North American Natural Resources (NANR) to evaluate formaldehyde (CH<sub>2</sub>O), oxides of nitrogen (NO<sub>x</sub>), and carbon monoxide (CO) emission rates from one engine. The engine is located at the NANR Venice Park Landfill facility in Lennon, Michigan. Field sampling for this emission test program was conducted on May 31, 2013. The purpose of this report is to document the results of the emission compliance test program.

The test program included triplicate 60-minute test runs for each pollutant as well as for oxygen, carbon dioxide, and water concentrations. The test program also included triplicate exhaust gas flowrate measurements. The results of the emissions test program are summarized by Table E-I.

**Table E-I**  
**North American Natural Resources**  
**Venice Park Landfill Facility**  
**Landfill Gas-Fired Reciprocating Engine 6**  
**Compliance Test Program Results Summary**

Source	Pollutant	Test Result	Emission Limitation
Engine 6	NO <sub>x</sub>	0.77 lb/hr	5.8 lb/hr
	CO	4.08 lb/hr	8.7 lb/hr
	Formaldehyde	0.65 lb/hr	0.68 lb/hr

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## **1. Introduction**

BT Environmental Consulting, Inc. (BTEC) was retained by North American Natural Resources (NANR) to evaluate formaldehyde (CH<sub>2</sub>O), oxides of nitrogen (NO<sub>x</sub>), and carbon monoxide (CO) emission rates from one engine. The engine is located at the NANR Venice Park Landfill facility in Lennon, Michigan. Field sampling for this emission test program was conducted on May 31, 2013. The purpose of this report is to document the results of the emission compliance test program.

The Air Quality Division (AQD) of Michigan's Department of Natural Resources and Environment has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (February 2008). The following is a summary of the emissions test program and results in the format outlined by the AQD document.

### **1.a Identification, Location, and Dates of Test**

Field-sampling for this emission test program was conducted on May 31, 2013 at the North American Natural Resources facility located at the Venice Park Landfill facility in Lennon, Michigan. The purpose of this report is to document the results of the compliance test program.

The emission test program included the evaluation of NO<sub>x</sub>, CO, and CH<sub>2</sub>O emission rates from one reciprocating engine.

### **1.b Purpose of Testing**

The purpose of the testing was to quantify formaldehyde emission rates in terms of lb/hr. These emission rates will be utilized to demonstrate compliance with AQD Permit to install No. 123-11 as well as the requirements of Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations (40 CFR 60, Subpart JJJJ).

### **1.c Source Description**

Engine 6 is a landfill gas-fired, spark-ignition, lean-burn reciprocating engine and is rated at 1148 bhp.

### **1.d Test Program Contact**

The contact for the source and test report is:

Mr. Richard Spranger  
Environmental Manager  
North American Natural Resources  
4516 Rathburn Road  
Birch Run, Michigan 48415  
(517) 719-1322

**1.e Test Personnel**

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

**Table 1  
Test Personnel**

<b>Name and Title</b>	<b>Affiliation</b>	<b>Telephone</b>
Mr. Richard Spranger Environmental Manager	North American Natural Resources - Lennon, Michigan	(517) 719-1322
Mr. Barry Boulianne Senior Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Molenda Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Phillip J. Kauppi Chemist / FTIR Specialist	PATI 2625 Denison Drive Mount Pleasant, MI 48858	(989) 621-1860
Tom Gasloli Technical Programs Unit	MDEQ Technical Programs Unit Air Quality Division	(517) 335-4861

**2. Summary of Results**

Sections 2.a through 2.d summarize the results of the emission compliance test program.

**2.a Operating Data**

A summary of engine operating data monitored during the emissions test program is provided in Appendix D.

**2.b Applicable Permit**

The applicable permits for this emissions test program are AQD Permit to Install No. 123-11 and AQD Renewable Operating Permit No. MI-ROP-N5910-2010.

**2.c Results**

The overall results of the emission compliance test program are summarized by Table 2 (see Section 5.a).

## **2.d Emission Regulation Comparison**

Emission limitations and corresponding test program results are summarized by Table 2.

## **3. Source Description**

Sections 3.a through 3.e provide a detailed description of the process.

### **3.a Process Description**

Landfill Gas is compressed, filtered, and chilled to 50 degrees Fahrenheit. Gas enters a main header where flow, temperature, and methane content are measured. The engines burn the landfill gas to produce electricity. As methane content fluctuates throughout the day, the engines gas jets are adjusted to minimize emissions.

### **3.b Raw and Finished Materials**

The raw material supplied to the engine includes landfill gas. The finished material is electricity.

### **3.c Process Capacity**

Engine 6 is rated at 1148 bhp.

### **3.d Process Instrumentation**

Engine performance is determined by methane input and kW output.

## **4. Sampling and Analytical Procedures**

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used to verify emission rates from the landfill gas engines.

### **4.a Sampling Train and Field Procedures**

Sampling and analysis procedures utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - "Sample and Velocity Traverses for Stationary Sources"
- Method 2 - "Determination of Stack Gas Velocity and Volumetric Flowrate"
- Method 3A - "Determination of Molecular Weight of Dry Stack Gas"
- Method 4 - "Determination of Moisture Content in Stack Gases"

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- Method 320 - "Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Technology"

The O<sub>2</sub> content of the gas stream was measured using an API Teledyne analyzer. A sample of the gas stream was drawn through an insulated stainless-steel probe with an in-line glass fiber filter to remove any particulate, a heated Teflon<sup>®</sup> sample line, and through a Universal Analyzers 3080PV electronic sample conditioner to remove the moisture from the sample before it entered the analyzer. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

FTIR data were collected using a MKS MultiGas 2030 FTIR spectrometer, serial number 016252291. The sampling system consisted of: 2 ft., 3/8 inch diameter, stainless steel probe; 100 ft., 3/8 inch diameter, Teflon heated transfer line, maintained at 191°C; and a 0.01µ glass filter for particulate matter removal.

The FTIR was equipped with a temperature-controlled, 5.11 meter multipass 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<sup>-1</sup> resolution. Each spectrum was derived from the coaddition of 32 scans, with a new data point generated approximately every thirty seconds.

Direct FTIR measurements of N<sub>2</sub>, acetaldehyde, SF<sub>6</sub>, CO, NO and ethylene gas standards were made to confirm concentrations.

A calibration transfer standard (CTS), 100.4 ppm ethylene standard, 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 measured directly at the FTIR and 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.

See the FTIR Report by Prism included in Appendix E for a more detailed explanation of the FTIR sampling train. See Figure 3 for a schematic of the sampling train

#### **4.b Recovery and Analytical Procedures**

Recovery and analytical procedures were described in Section 4.a.

#### **4.c Sampling Ports**

All sampling was completed at the engine exhaust ducts located outside the building. Two sampling ports positioned 90° apart were installed along the horizontal portion of the ductwork.

## 5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

### 5.a Results Tabulation

The results of the emissions test program are summarized by Table 2.

**Table 2**  
**North American Natural Resources**  
**Venice Park Landfill Facility**  
**Landfill Gas-Fired Reciprocating Engine 6**  
**Compliance Test Program Results Summary**

Source	Pollutant	Test Result	Emission Limitation
Engine 6	NOx	0.77 lb/hr	5.8 lb/hr
	CO	4.08 lb/hr	8.7 lb/hr
	Formaldehyde	0.65 lb/hr	0.68 lb/hr

Detailed data for each test run can be found in Table 3.

### 5.b Discussion of Results

Emission limitations for AQD Permit to install No. 123-11 along with results of the emissions test program are summarized by Table 2.

### 5.c Sampling Procedure Variations

There were no sampling variations used during the emission compliance test program.

### 5.d Process or Control Device Upsets

No upset conditions occurred during testing.

### 5.e Control Device Maintenance

No control device maintenance was performed.

### 5.f Audit Sample Analyses

No audit samples were collected as part of the test program.

### 5.g Calibration Sheets

All relevant equipment calibration documents are provided as Appendix B.



**5.h Sample Calculations**

Sample calculations are provided in Appendix C.

**5.i Field Data Sheets**

Field documents relevant to the emissions test program are presented in Appendix A.

**5.j Laboratory Data**

There are no laboratory results for this test program.

**Table 3**  
**Engine 6 CH<sub>2</sub>O, NO<sub>x</sub>, and CO Emission Rates**  
**North American Natural Resources**  
**Venice Park**  
**BTEC Project No. 13-4404.00**  
**Sampling Dates: 5-31-2013**

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	5/31/2013	5/31/2013	5/31/2013	
Test Run Time	8:07-9:07	9:32-10:32	10:54-11:54	
Outlet Flowrate (dscfm)	2,254	2,265	2,246	<b>2,255</b>
Outlet Flowrate (scfm)	2,612	2,619	2,595	<b>2,609</b>
Oxygen Concentration (%. dry)	7.32	7.61	7.62	<b>7.52</b>
Oxygen Concentration (%. dry, drift corrected as per USEPA 7E)	7.30	7.60	7.60	<b>7.50</b>
Carbon Dioxide Concentration (%. wet)	9.91	9.78	9.79	<b>9.83</b>
Formaldehyde Concentration (ppmv, wet)	53.7	53.0	54.1	<b>53.6</b>
<b>Formaldehyde Emission Rate (lb/hr)</b>	<b>0.65</b>	<b>0.65</b>	<b>0.65</b>	<b>0.65</b>
Oxides of Nitrogen Concentration (ppmv, wet)*	52.3	35.5	36.1	<b>41.3</b>
<b>Oxides of Nitrogen Emission Rate (lb/hr)</b>	<b>0.98</b>	<b>0.66</b>	<b>0.67</b>	<b>0.77</b>
Carbon Monoxide Concentration (ppmv, wet)	363.8	357.7	358.4	<b>360.0</b>
<b>Carbon Monoxide Emission Rate (lb/hr)</b>	<b>4.13</b>	<b>4.07</b>	<b>4.04</b>	<b>4.08</b>

\* NO and NO<sub>2</sub> measurements from FTIR report are added together to obtain NO<sub>x</sub> concentrations.

scfm = standard cubic feet per minute  
dscfm = dry standard cubic feet per minute  
ppmv = parts per million on a volume-to-volume basis  
lb/hr = pounds per hour  
MW = molecular weight (CH<sub>2</sub>O = 30.031, NO<sub>x</sub> = 46.01, CO = 28.01)  
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)  
35.31 = ft<sup>3</sup> per m<sup>3</sup>  
453600 = mg per lb

**Equations**

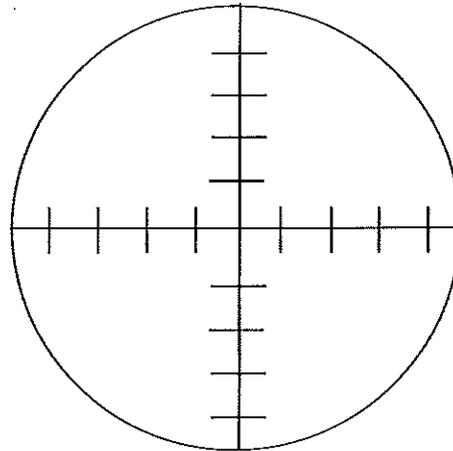
lb/hr = ppmv \* MW/24.14 \* 1/35.31 \* 1/453,600 \* scfm \* 60

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diameter = 9.5 inches

Points	Distance "
1	0.3
2	1.0
3	1.8
4	3.1
5	6.4
6	7.7
7	8.5
8	9.2



Not to Scale

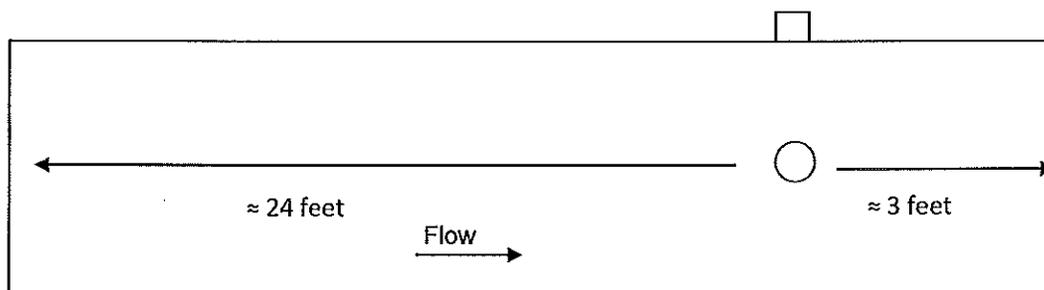


Figure No. 1

Site:  
Engines #6 Exhaust  
North American Natural Resources  
Lennon, Michigan

Sampling Date:  
May 31, 2013

BT Environmental Consulting, Inc.  
4949 Fernlee Avenue  
Royal Oak, Michigan 48073

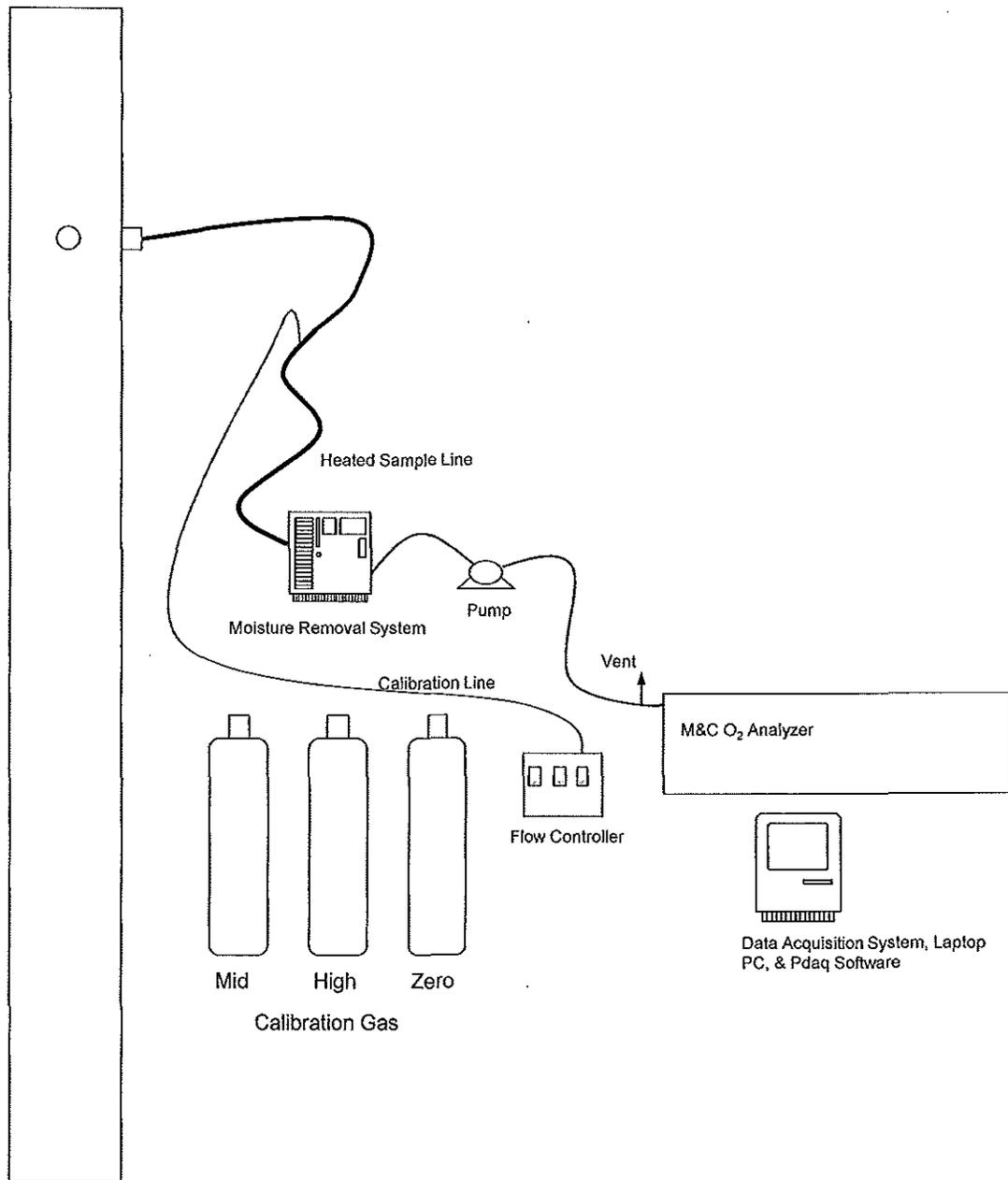


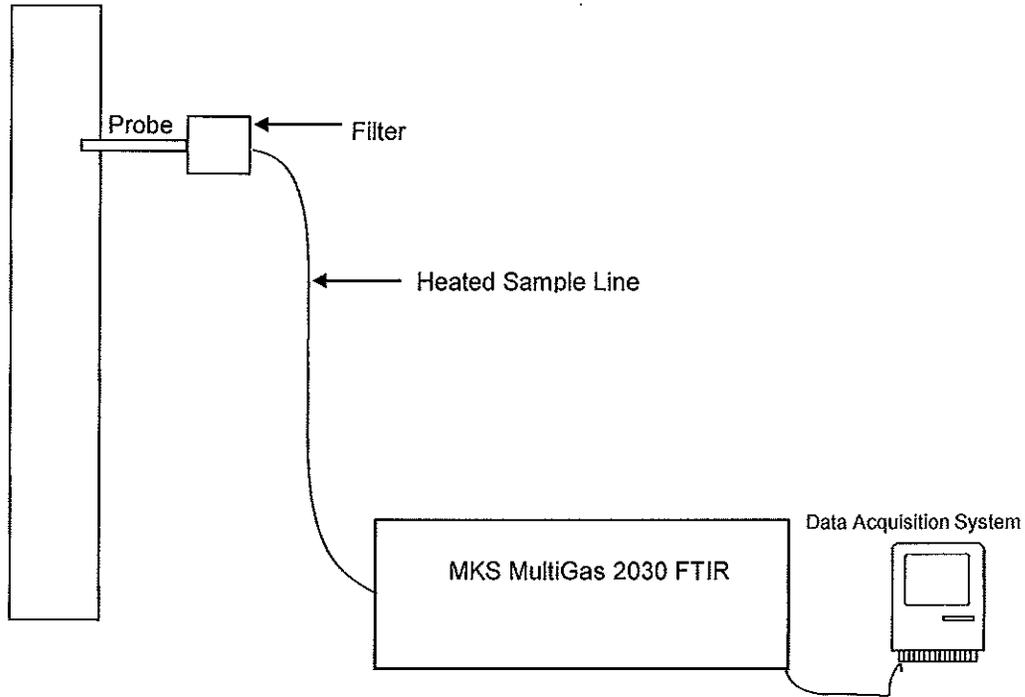
Figure No. 2

Site:  
USEPA Method 3A  
North American Natural Resources  
Lennon, Michigan

Sampling Date:  
May 31, 2013

BT Environmental Consulting Inc.  
4949 Fernlee Avenue  
Royal Oak, MI 48073

**BTEC Inc.**



**Figure No. 3**

Site:  
USEPA Method 320  
North American Natural Resources  
Lennon, Michigan

Sampling Date:  
May 31, 2013

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Royal Oak, Michigan 48073