BTEC Inc.

VOC, CO, NOx, and PM Emissions Test Report

Prepared for:

North American Natural Resources, Inc.

Lennon, Michigan

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

Project No. 14-4570.00
October 17, 2014

BT Environmental Consulting, Inc.
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EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by North American Natural Resources (NANR) to conduct air emissions testing for compliance evaluation purposes. The sampling program included the evaluation of oxides of nitrogen (NOx), carbon monoxide (CO), volatile organic compounds (VOC), and filterable and condensable particulate matter (PM) emission rates from two reciprocating engines (7 and 8) and CO, VOC, and NOx emissions rates from two engines (9 and 10) located at the North American Natural Resources (NANR) Venice Park Generating Station in Lennon, Michigan. Field sampling for this emission test program was conducted on August 26 through 28, 2014. The purpose of this report is to document the results of the emissions compliance test program.

Testing consisted of triplicate 120-minute PM test runs on Engines 7 and 8 and triplicate 60-minute NOx, CO and VOC emission test runs on all four engines. The emissions test program is required by Michigan Permit No. PTI 123- 11A and Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations. The results of the emission test program are summarized by Table I.

Table I
North American Natural Resources – Venice Park Facility
Landfill Gas-Fired Reciprocating Engines 7, 8, 9, and 10
Test Program Results Summary

Source	Pollutant	Test Result	Emission Limitation
Reciprocating Engine 7	NOx	0.4 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.88 lbs/hr	2.97 lbs/hr
	CO	2.64 g/bhp-hr	3.30 g/bhp-hr
	CO	13.10 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
	$PM_{2.5/10}$	0.42 pph	0.74 pph
Reciprocating Engine 8	NOx	0.3 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.55 lbs/hr	2.97 lbs/hr
	CO	2.14 g/bhp-hr	3.30 g/bhp-hr
	CO	10.60 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
	$PM_{2.5/10}$	0.31 pph	0.74 pph
Reciprocating Engine 9	NOx	0.5 g/bhp-hr	2.0 g/bhp-hr
	NOx	2.50 lbs/hr	2.97 lbs/hr
	CO	2.69 g/bhp-hr	3.30 g/bhp-hr
	CO	13.35 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
Reciprocating Engine 10	NOx	0.5 g/bhp-hr	2.0 g/bhp-hr
	NOx	2.50 lbs/hr	2.97 lbs/hr
	CO	2.74 g/bhp-hr	3.30 g/bhp-hr
	CO	13.61 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr

Note: All VOC emissions were determined to be Methane (CH_4). Also, the PM result is for total particulate as determined by Methods 5 and 202.

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1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by North American Natural Resources (NANR) to conduct air emissions testing for compliance evaluation purposes. The sampling program included the evaluation of oxides of nitrogen (NOx), carbon monoxide (CO), volatile organic compounds (VOC), and filterable and condensable particulate matter (PM) emission rates from two reciprocating engines (7 and 8) and CO, VOC, and NOx emissions rates from two engines (9 and 10) located at the North American Natural Resources (NANR) Venice Park Generating Station in Lennon, Michigan. Field sampling for this emission test program was conducted on August 26 through 28, 2014. The purpose of this report is to document the results of the emissions 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" (December 2013, see Appendix A). 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 August 26 through 28, 2014 at the North American Natural Resources Venice Park Generating Station in Lennon, Michigan. The purpose of this report is to document the results of the emissions determined during compliance test program.

Testing consisted of triplicate 120-minute PM test runs on Engines 7 and 8 and triplicate 60-minute NOx, CO and VOC emission test runs on all four engines. The emissions test program is required by Michigan Permit No. PTI 123- 11A and Title 40, Part 60, Subpart JJJJ of the Code of Federal Regulations.

1.b Purpose of Testing

The purpose of the emissions test program was to demonstrate compliance with the emission limitations included in Permit No. 123-11 for which testing was required. Emission limitations are included in Table 1.

1.c Source Description

The Venice Park facility includes four landfill gas-fired, spark-ignition, lean-burn reciprocating engines. Each reciprocating engine produces approximately 1,600 kilowatts (kW) at 2,250 bhp. Normal operation of the engine includes operation at constant speed near 100% load conditions.

1.d Test Program Contact

The contact for the source and test plan is:

Mr. Richard Spranger
Environmental Manager
North American Natural Resources
4516 Rathburn Rd.
Birch Run, Michigan 48415
(517) 347-4048

1.e Testing Personnel

Names and affiliations for personnel who were present during the testing program are summarized by Table 2.

2. Summary of Results

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

2.a Operating Data

Inlet gas flowrate, exhaust temperature, methane content, and generator power load (kW) were monitored during the testing and are included in Appendix E.

2.b Applicable Permit

The applicable permit for this emissions test program is PTI 123- 11.

2.c Results

The overall results of the emissions compliance test program are summarized by Table 3.

2.d Emission Regulation Comparison

Emission limitations and corresponding test program results are summarized by Table 3

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 the main header where flowrate, 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

The engines produce approximately 1,600 kW with an inlet pressure of 225 kpa. If methane changes, the inlet pressure changes, and the operators adjust the engines fuel ratio to bring up boost or kPa to maintain an average of 9 % oxygen in the exhaust. Each engine is rated at 2,250 bhp-hr.

3.d Process Instrumentation

Engines 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 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"
- Method 5 - "Determination of Particulate Emissions from Stationary Sources"
- Method 7E - "Determination of Nitrogen Oxide Emissions from Stationary Sources"
- Method 10 - "Determination of Carbon Monoxide Emissions from Stationary Sources"
- Method 25A - "Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer"

- Method 202 - "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources Stationary Sources"

The NO_x content of the exhaust gas was measured using a TECO 42hi NO_x gas analyzer and the O_2, CO, & CO_2 content was measured using M&C and Teledyne analyzers. 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® 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 10-second intervals on a PC equipped with data acquisition software.

40 CFR 60, Appendix A, Method 5, *"Determination of Particulate Emissions from Stationary Sources"* and 40 CFR 60, Appendix A, Method 202, *"Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"* were used to measure PM concentrations and calculate PM emission rates (see Figure 8 for a schematic of the sampling train). Triplicate 120-minute test runs were conducted on Engines 7 and 8.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) a glass probe, (3) a heated filter holder, (4) a vertical condenser, (5) an empty pot bellied impinger, (6) an empty modified Greenburg-Smith (GS) impinger, (7) unheated filter holder with a teflon filter, (8) a second modified GS impinger with 100 ml of deionized water, and a third modified GS impinger containing approximately 300 g of silica gel desiccant, (9) a length of sample line, and (10) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

A sampling train leak test was conducted before and after each test run. After completion of the final leak test for each test run, the filter was recovered, and the nozzle, probe, and the front half of the filter holder assembly were brushed and triple rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The impinger train was then purged with nitrogen for one hour at a flow rate of 18 liters per minute. The CPM filter was recovered and placed in a petri dish. The back half of the filter housing, the condenser, the pot bellied impinger, the moisture drop out impinger, and the front half of the CPM filter housing and all connecting glassware were triple rinsed with deionized water which was collected in a pre-cleaned sample container. The same glassware was then rinsed with acetone which was collected in a pre-cleaned sample container labeled as the organic fraction. The glassware was then double rinsed with hexane which was added to the same organic fraction sample bottle.

BTEC labeled each container with the test number, test location, and test date, and marked the level of liquid on the outside of the container. In addition, blank samples of the acetone, DI water, hexane, and filter were collected. BTEC personnel carried all samples to BTEC's laboratory (for filter and acetone gravimetric analysis) in Royal Oak, Michigan. DI water and organic samples were hand delivered to Maxxam for analysis.

The VOC content of the exhaust was measured using a J.U.M. Model 109A 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 and a heated Teflon® sample line to prevent the condensation of any moisture from the sample before it enters the analyzer. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

For analyzer calibrations, calibration gases were mixed to desired concentrations using an Environics Series 4040 Computerized Gas Dilution System. The Series 4040 consisting of a single chassis with four mass flow controllers. The mass flow controllers are factory-calibrated using a primary flow standard traceable to the United States' National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11 point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. Schematic drawings of the flow traverse points, continuous emission systems, and the moisture sampling train are provided as Figures 1 through 4.

USEPA Method 205 Verification of Gas Dilution Systems for Field Instrument Calibrations was performed. The results of this verification can be found in Appendix C.

4.b Recovery and Analytical Procedures

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

4.c Sampling Ports

Sampling port locations met the minimum criteria of Method 1.

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 3. Detailed data for each test run can be found in Tables 4 through 9.

5.b Discussion of Results

Emission limitations for the Michigan ROP No. PTI 123- 11 are summarized by Table 1. The results of the emissions test program are summarized by Table 3.

5.c Sampling Procedure Variations

It should be noted that, with the approval of the on-site MDEQ-AQD representative, exhaust gas O_2 and CO_2 content was measured using the Fyrite analysis procedures of Method 3 for the third test run conducted on August 26, 2014 and all three test runs conducted on August 28, 2014.

5.d Process or Control Device Upsets

No process upsets occurred during the emissions test.

5.e Control Device Maintenance

Only routine maintenance was conducted.

5.f Audit Sample Analyses

Audit samples are not applicable to this emissions test program.

5.g Calibration Sheets

Relevant equipment calibration documents are provided in Appendix C.

5.h Sample Calculations

Sample calculations are provided in Appendix D.

5.i Field Data Sheets

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

5.j Laboratory Data

Analytical results documents relevant to the emissions test program are provided in Appendix F.

Table 1
North American Natural Resources – Venice Park Facility
Landfill Gas-Fired Reciprocating Engines 7, 8, 9, and 10
Compliance Test Program Emission Limitations Summary

Source	Pollutant	Emission Limitation
Reciprocating Engine 7	NOx	2.0 g/bhp-hr
	NOx	2.97 lbs/hr
	CO	3.30 g/bhp-hr
	CO	16.30 lbs/hr
	VOC	0.63 g/bhp-hr
	$PM_{2.5/10}$	0.74 pph
Reciprocating Engine 8	NOx	2.0 g/bhp-hr
	NOx	2.97 lbs/hr
	CO	3.30 g/bhp-hr
	CO	16.30 lbs/hr
	VOC	0.63 g/bhp-hr
	$PM_{2.5/10}$	0.74 pph
Reciprocating Engine 9	NOx	2.0 g/bhp-hr
	NOx	2.97 lbs/hr
	CO	3.30 g/bhp-hr
	CO	16.30 lbs/hr
	VOC	0.63 g/bhp-hr
Reciprocating Engine 10	NOx	2.0 g/bhp-hr
	NOx	2.97 lbs/hr
	CO	3.30 g/bhp-hr
	CO	16.30 lbs/hr
	VOC	0.63 g/bhp-hr

Table 2
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Richard Spranger Environmental Manager	North American Natural Resources - Zeeland, Michigan	(269) 362-5546
Mr. Todd Wessel Senior Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Diven Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Draper Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Daniel McGreen Environmental Quality Analyst	MDEQ P.O. BOX 30242 Lansing, MI 48909	(517) 284-6638

Table 3
North American Natural Resources – Venice Park Facility
Landfill Gas-Fired Reciprocating Engines 7, 8, 9, and 10
Test Program Results Summary

Source	Pollutant	Test Result	Emission Limitation
Reciprocating Engine 7	NOx	0.4 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.88 lbs/hr	2.97 lbs/hr
	CO	2.64 g/bhp-hr	3.30 g/bhp-hr
	CO	13.10 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
	$PM_{2.5/10}$	0.42 pph	0.74 pph
Reciprocating Engine 8	NOx	0.3 g/bhp-hr	2.0 g/bhp-hr
	NOx	1.55 lbs/hr	2.97 lbs/hr
	CO	2.14 g/bhp-hr	3.30 g/bhp-hr
	CO	10.60 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
	$PM_{2.5/10}$	0.31 pph	0.74 pph
Reciprocating Engine 9	NOx	0.5 g/bhp-hr	2.0 g/bhp-hr
	NOx	2.50 lbs/hr	2.97 lbs/hr
	CO	2.69 g/bhp-hr	3.30 g/bhp-hr
	CO	13.35 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr
Reciprocating Engine 10	NOx	0.5 g/bhp-hr	2.0 g/bhp-hr
	NOx	2.50 lbs/hr	2.97 lbs/hr
	CO	2.74 g/bhp-hr	3.30 g/bhp-hr
	CO	13.61 lbs/hr	16.30 lbs/hr
	VOC	0.00 g/bhp-hr	0.63 g/bhp-hr

Note: All VOC emissions were determined to be Methane (CH_4). Also, the PM result is for total particulate as determined by Methods 5 and 202.

Table 4
Engine 7 NOx, VOC, and CO Emission Rates
North American Natural Resources
Lennon, MI
BTEC Project No. 14-4570.00
Sampling Date: 8/28/14

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	8/28/2014	8/28/2014	8/28/2014	
Test Run Time	9:20-10:20	11:19-12:19	12:52-13:52	
Outlet Flowrate (dscfm)	5,345	5,280	5,281	**5,302**
Outlet Flowrate (scfm)	6,093	6,024	6,025	**6,047**
bhp	2,250	2,250	2,250	
Outlet Oxides of Nitrogen Concentration (ppmv)	49.7	46.1	50.9	**48.9**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	51.4	46.5	50.7	**49.5**
NOx Emission Rate (lb/hr)	**1.90**	**1.74**	**1.92**	**1.85**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**1.96**	**1.75**	**1.91**	**1.88**
Outlet Carbon Monoxide Concentration (ppmv)	565.0	561.6	574.6	**567.1**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	568.8	561.1	575.8	**568.6**
CO Emission Rate (lb/hr)	**13.13**	**12.89**	**13.19**	**13.07**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**13.21**	**12.88**	**13.22**	**13.10**
Outlet VOC Concentration (ppmv as propane)	567.8	560.2	573.6	**567.2**
Outlet Methane Concentration (ppmv as methane)	1326.1	1368.1	1511.5	**1401.9**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	573.6	568.2	570.2	**570.7**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1320.4	1356.7	1483.7	**1386.9**
Outlet VOC Concentration (-Methane)	0.0	0.0	0.0	**0.0**
Outlet Methane Concentration (-Methane, corrected as per USEPA 7E)	0.0	0.0	0.0	**0.0**
VOC Emission Rate as Propane (lb/hr)	**0.0**	**0.0**	**0.0**	**0.0**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**0.0**	**0.0**	**0.0**	**0.0**
NOX (g/bhp-hr)	0.40	0.35	0.39	**0.38**
CO (g/bhp-hr)	2.66	2.60	2.66	**2.64**
VOC (g/bhp-hr)	0.00	0.00	0.00	**0.00**

VOC Correction			
Co	-0.68	-0.10	-0.49
Cma	500	500	500
Cm	494.88	492.96	502.95

Methane Correction			
Co	-10.80	-8.13	-8.98
Cma	1000	1000	1000
Cm	1001.71	1006.25	1015.86

response factor = 2.15
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 (CO = 28.01, NOx = 46.01, C_3H_8 = 44.10)
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
g/bhp-hr = grams per brake horse power hour

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *scfm* * 60 *for* VOC
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *dcfm* * 60

Table 5
Engine 8 NOx, VOC, and CO Emission Rates
North American Natural Resources
Lennon, MI
BTEC Project No. 14-4570.00
Sampling Date: 8/27/14

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	8/27/2014	8/27/2014	8/27/2014	
Test Run Time	8:38-9:38	10:15-11:15	12:11-13:11	
Outlet Flowrate (dscfm)	4,461	4,457	4,447	**4,455**
Outlet Flowrate (scfm)	5,122	5,141	5,113	**5,125**
bhp	2,250	2,250	2,250	
Outlet Oxides of Nitrogen Concentration (ppmv)	46.6	44.4	51.3	**47.4**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	48.7	45.3	52.1	**48.7**
NOx Emission Rate (lb/hr)	**1.48**	**1.41**	**1.63**	**1.51**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**1.55**	**1.44**	**1.65**	**1.55**
Outlet Carbon Monoxide Concentration (ppmv)	532.2	528.8	566.7	**542.6**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	541.3	535.9	564.5	**547.2**
CO Emission Rate (lb/hr)	**10.32**	**10.25**	**10.95**	**10.51**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**10.49**	**10.38**	**10.91**	**10.60**
Outlet VOC Concentration (ppmv as propane)	498.1	573.7	556.4	**542.7**
Outlet Methane Concentration (ppmv as methane)	1247.0	1425.7	1445.3	**1372.7**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	494.7	566.4	546.7	**535.9**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1242.0	1420.0	1407.8	**1356.6**
Outlet VOC Concentration (-Methane)	0.0	0.0	0.0	**0.0**
Outlet Methane Concentration (-Methane, corrected as per USEPA 7E)	0.0	0.0	0.0	**0.0**
VOC Emission Rate as Propane (lb/hr)	**0.0**	**0.0**	**0.0**	**0.0**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**0.0**	**0.0**	**0.0**	**0.0**
NOX (g/bhp-hr)	0.31	0.29	0.33	**0.31**
CO (g/bhp-hr)	2.12	2.09	2.20	**2.14**
VOC (g/bhp-hr)	0.00	0.00	0.00	**0.00**

VOC Correction			
Co	-2.97	-2.34	-2.21
Cma	500	500	500
Cm	503.55	506.17	508.67

Methane Correction			
Co	-6.73	-4.18	-5.74
Cma	1000	1000	1000
Cm	1002.76	1002.80	1025.01

response factor = 2.16
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 (CO = 28.01, NOx = 46.01, C_xH_8 = 44.10)
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
g/bhp-hr = grams per brake horse power hour

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *scfm* * 60 *for* VOC
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *dcfm* * 60

Table 6
Engine 9 NOx, VOC, and CO Emission Rates
North American Natural Resources
Lennon, MI
BTEC Project No. 14-4570.00
Sampling Date: 8/26/14

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	8/26/2014	8/26/2014	8/26/2014	
Test Run Time	13:04-14:04	14:41-15:41	16:11-17:11	
Outlet Flowrate (dscfm)	4,690	4,675	4,679	**4,681**
Outlet Flowrate (scfm)	5,142	5,143	5,130	**5,139**
bhp	2,250	2,250	2,250	
Outlet Oxides of Nitrogen Concentration (ppmv)	71.9	75.2	69.0	**72.0**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	74.9	78.2	71.2	**74.7**
NOx Emission Rate (lb/hr)	**2.41**	**2.51**	**2.30**	**2.41**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**2.51**	**2.61**	**2.38**	**2.50**
Outlet Carbon Monoxide Concentration (ppmv)	641.7	663.7	653.1	**652.8**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	643.0	667.2	658.2	**656.1**
CO Emission Rate (lb/hr)	**13.08**	**13.49**	**13.28**	**13.28**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**13.11**	**13.56**	**13.39**	**13.35**
Outlet VOC Concentration (ppmv as propane)	532.2	393.5	549.8	**491.8**
Outlet Methane Concentration (ppmv as methane)	1553.0	1275.2	1539.5	**1455.9**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	522.5	377.2	526.1	**475.3**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1519.5	1234.6	1494.2	**1416.1**
Outlet VOC Concentration (-Methane)	0.0	0.0	0.0	**0.0**
Outlet Methane Concentration (-Methane, corrected as per USEPA 7E)	0.0	0.0	0.0	**0.0**
VOC Emission Rate as Propane (lb/hr)	**0.0**	**0.0**	**0.0**	**0.0**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**0.0**	**0.0**	**0.0**	**0.0**
NOX (g/bhp-hr)	0.51	0.53	0.48	**0.50**
CO (g/bhp-hr)	2.64	2.73	2.70	**2.69**
VOC (g/bhp-hr)	0.00	0.00	0.00	**0.00**

VOC Correction			
Co	-1.75	-2.22	-2.35
Cma	500	500	500
Cm	509.19	522.25	522.47

Methane Correction			
Co	-3.36	-4.58	-4.97
Cma	1000	1000	1000
Cm	1020.87	1031.96	1028.70

response factor = 2.26
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 (CO = 28.01, NOx = 46.01, C_3H_8 = 44.10)
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
g/bhp-hr = grams per brake horse power hour

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *scfm* * 60 *for* VOC
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *dcfm* * 60

Table 7
Engine 10 NOx, VOC, and CO Emission Rates
North American Natural Resources
Lennon, MI
BTEC Project No. 14-4570.00
Sampling Date: 8/26/14

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	8/26/2014	8/26/2014	8/26/2014	
Test Run Time	8:48-9:48	10:13-11:13	11:39-12:39	
Outlet Flowrate (dscfm)	4,589	4,684	4,648	**4,640**
Outlet Flowrate (scfm)	5,286	5,275	5,294	**5,285**
bhp	2,250	2,250	2,250	
Outlet Oxides of Nitrogen Concentration (ppmv)	69.9	71.9	75.2	**72.3**
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	73.4	75.3	78.0	**75.6**
NOx Emission Rate (lb/hr)	**2.29**	**2.40**	**2.49**	**2.40**
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	**2.41**	**2.52**	**2.59**	**2.50**
Outlet Carbon Monoxide Concentration (ppmv)	659.1	668.3	659.8	**662.4**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	677.1	679.7	667.5	**674.7**
CO Emission Rate (lb/hr)	**13.15**	**13.61**	**13.33**	**13.36**
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	**13.50**	**13.84**	**13.49**	**13.61**
Outlet VOC Concentration (ppmv as propane)	470.9	509.8	482.4	**487.7**
Outlet Methane Concentration (ppmv as methane)	1186.1	1321.3	1284.2	**1263.8**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	462.6	488.1	461.8	**470.8**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1177.1	1281.3	1236.3	**1231.6**
Outlet VOC Concentration (-Methane)	0.0	0.0	0.0	**0.0**
Outlet Methane Concentration (-Methane, corrected as per USEPA 7E)	0.0	0.0	0.0	**0.0**
VOC Emission Rate as Propane (lb/hr)	**0.0**	**0.0**	**0.0**	**0.0**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**0.0**	**0.0**	**0.0**	**0.0**
NOX (g/bhp-hr)	0.49	0.51	0.52	**0.50**
CO (g/bhp-hr)	2.72	2.79	2.72	**2.74**
VOC (g/bhp-hr)	0.00	0.00	0.00	**0.00**

VOC Correction			
Co	-1.75	-2.22	-2.35
Cma	500	500	500
Cm	509.19	522.25	522.47

Methane Correction			
Co	-5.13	-9.01	-5.77
Cma	1000	1000	1000
Cm	1006.85	1029.21	1037.65

response factor = 2.15
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 (CO = 28.01, NOx = 46.01, C_3H_8 = 44.10)
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
35.31 = ft^3 per m^3
453600 = mg per lb
g/bhp-hr = grams per brake horse power hour

Equations
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *scfm* * 60 *for* VOC
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *dcfm* * 60

Table 8
Particulate Matter Emission Rates

Company	Nanar Lennon			
Source Designation	Engine 7			
Test Date	8/28/2014	8/28/2014	8/28/2014	
BHP	2,250	2,250	2,250	2,250
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	84.2	89.6	92.6	88.8
Meter Pressure - Pm (in. Hg)	29.6	29.6	29.6	29.6
Measured Sample Volume (Vm)	119.2	122.9	123.5	121.9
Sample Volume (Vm-Std ft3)	112.8	115.1	115.1	114.3
Sample Volume (Vm-Std m3)	3.19	3.26	3.26	3.24
Condensate Volume (Vw-std)	15.776	16.220	16.215	16.070
Gas Density (Ps(std) lbs/ft3) (wet)	0.0739	0.0739	0.0739	0.0739
Gas Density (Ps(std) lbs/ft3) (dry)	0.0778	0.0778	0.0778	0.0778
Total weight of sampled gas (m g lbs) (wet)	9.50	9.71	9.71	9.64
Total weight of sampled gas (m g lbs) (dry)	8.77	8.95	8.95	8.89
Nozzle Size - An (sq. ft.)	0.000171	0.000171	0.000171	0.000171
Isokinetic Variation - I	102.2	105.6	105.6	104.5
Stack Data				
Average Stack Temperature - Ts (F)	898.3	929.7	929.4	919.1
Molecular Weight Stack Gas- dry (Md)	30.1	30.1	30.1	30.1
Molecular Weight Stack Gas-wet (Ms)	28.6	28.6	28.6	28.6
Stack Gas Specific Gravity (Gs)	0.988	0.987	0.987	0.988
Percent Moisture (Bws)	12.27	12.35	12.35	12.32
Water Vapor Volume (fraction)	0.1227	0.1235	0.1235	0.1232
Pressure - Ps ("Hg)	31.2	31.2	31.2	31.2
Average Stack Velocity -Vs (ft/sec)	252.0	255.0	255.0	254.0
Area of Stack (ft2)	1.0	1.0	1.0	1.0
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	15,024	15,200	15,198	15,141
Flowrate ft^3 (Standard Wet)	6,093	6,024	6,025	6,047
Flowrate ft^3 (Standard Dry)	5,345	5,280	5,281	5,302
Flowrate m^3 (standard dry)	151	150	150	150
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	15.5	12.3	12.4	13.4
Organic Condensible Particulate	58.0	50.0	53.0	53.7
Inorganic Condensible Particulate	2.6	2.2	2.7	2.5
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	58.6	50.2	53.7	54.2
Total Filterable and Condensible Particulate	74.1	62.5	66.1	67.6
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.004	0.003	0.003	0.003
lb/1000 lb (dry)	0.004	0.003	0.003	0.003
mg/dscm (dry)	4.9	3.8	3.8	4.1
gr/dscf	0.0021	0.0016	0.0017	0.0018
Filterable Particulate Emission Rate				
lb/ hr	0.098	0.075	0.076	0.083
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.014	0.011	0.012	0.012
lb/1000 lb (dry)	0.015	0.012	0.013	0.013
mg/dscm (dry)	18.4	15.4	16.5	16.7
gr/dscf	0.0080	0.0067	0.0072	0.0073
Condensible Particulate Emission Rate				
lb/ hr	0.4	0.3	0.3	0.3
Total Particulate Concentration				
lb/1000 lb (wet)	0.017	0.014	0.015	0.015
lb/1000 lb (dry)	0.019	0.015	0.016	0.017
mg/dscm (dry)	23.2	19.2	20.3	20.9
gr/dscf	0.0101	0.0084	0.0089	0.0091
Total Particulate Emission Rate				
lb/ hr	0.466	0.381	0.403	0.417
g/bhp*Hr	0.09	0.08	0.08	0.08

Table 9
Particulate Matter Emission Rates

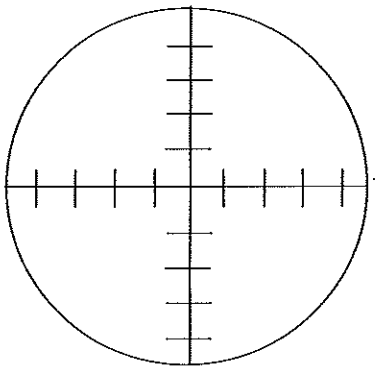
Company	NANR			
Source Designation	Engine 8			
Test Date	8/27/2014	8/27/2014	8/27/2014	
BHP	2,250	2,250	2,250	2,250
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	87.1	98.2	99.1	94.8
Meter Pressure - Pm (in. Hg)	29.5	29.5	29.5	29.5
Measured Sample Volume (Vm)	100.7	101.1	100.9	100.9
Sample Volume (Vm-Std ft3)	94.4	92.9	92.6	93.3
Sample Volume (Vm-Std m3)	2.67	2.63	2.62	2.64
Condensate Volume (Vw-std)	14.008	14.253	13.857	14.040
Gas Density (Ps(std) lbs/ft3) (wet)	0.0738	0.0726	0.0738	0.0734
Gas Density (Ps(std) lbs/ft3) (dry)	0.0778	0.0767	0.0778	0.0774
Total weight of sampled gas (m g lbs) (wet)	8.00	7.79	7.85	7.88
Total weight of sampled gas (m g lbs) (dry)	7.35	7.12	7.21	7.23
Nozzle Size - An (sq. ft.)	0.000171	0.000171	0.000171	0.000171
Isokinetic Variation - I	102.6	101.0	100.9	101.5
Stack Data				
Average Stack Temperature - Ts (F)	932.9	946.5	938.8	939.4
Molecular Weight Stack Gas- dry (Md)	30.1	29.7	30.1	30.0
Molecular Weight Stack Gas-wet (Ms)	28.6	28.1	28.5	28.4
Stack Gas Specific Gravity (Gs)	0.986	0.971	0.986	0.981
Percent Moisture (Bws)	12.92	13.30	13.02	13.08
Water Vapor Volume (fraction)	0.1292	0.1330	0.1302	0.1308
Pressure - Ps ("Hg)	31.2	31.2	31.2	31.2
Average Stack Velocity -Vs (ft/sec)	217.6	220.6	218.2	218.8
Area of Stack (ft2)	1.0	1.0	1.0	1.0
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	12,974	13,149	13,005	13,043
Flowrate ft^3 (Standard Wet)	5,122	5,141	5,113	5,125
Flowrate ft^3 (Standard Dry)	4,461	4,457	4,447	4,455
Flowrate m^3 (standard dry)	126	126	126	126
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	12.5	11.4	11.1	11.7
Organic Condensible Particulate	39.0	35.0	36.0	36.7
Inorganic Condensible Particulate	1.9	2.4	2.6	2.3
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	38.9	35.4	36.6	37.0
Total Filterable and Condensible Particulate	51.4	46.8	47.7	48.6
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.003	0.003	0.003	0.003
lb/1000 lb (dry)	0.004	0.004	0.003	0.004
mg/dscm (dry)	4.7	4.3	4.2	4.4
gr/dscf	0.0020	0.0019	0.0019	0.0019
Filterable Particulate Emission Rate				
lb/ hr	0.078	0.073	0.071	0.074
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.011	0.010	0.010	0.010
lb/1000 lb (dry)	0.012	0.011	0.011	0.011
mg/dscm (dry)	14.5	13.5	14.0	14.0
gr/dscf	0.0064	0.0059	0.0061	0.0061
Condensible Particulate Emission Rate				
lb/ hr	0.2	0.2	0.2	0.2
Total Particulate Concentration				
lb/1000 lb (wet)	0.014	0.013	0.013	0.014
lb/1000 lb (dry)	0.015	0.014	0.015	0.015
mg/dscm (dry)	19.2	17.8	18.2	18.4
gr/dscf	0.0084	0.0078	0.0080	0.0080
Total Particulate Emission Rate				
lb/ hr	0.322	0.298	0.304	0.308
g/bhp*Hr	0.065	0.060	0.061	0.062

Figures

BTEC Inc.

diameter = 13.5 inches

Points	Distance "
1	0.6
2	2.0
3	4.0
4	9.5
5	11.5
6	12.9



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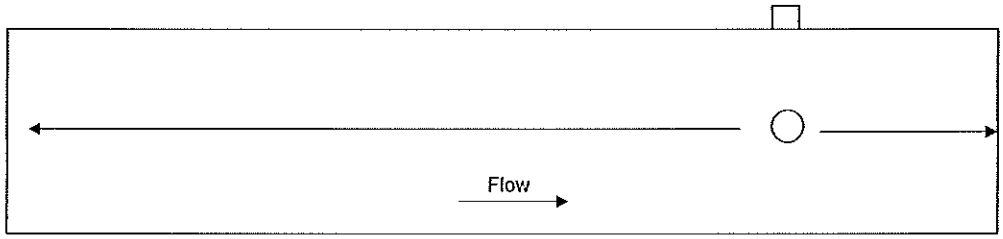

Figure 1

Site:	Sampling Date:	
Engines #7, #8, #9 and #10 Exhaust North American Natural Resources Lennon, Michigan	August 25 to 28, 2014	BT Environmental Consulting, Inc. 4949 Fernlee Avenue Royal Oak, Michigan 48073

BTEC Inc.

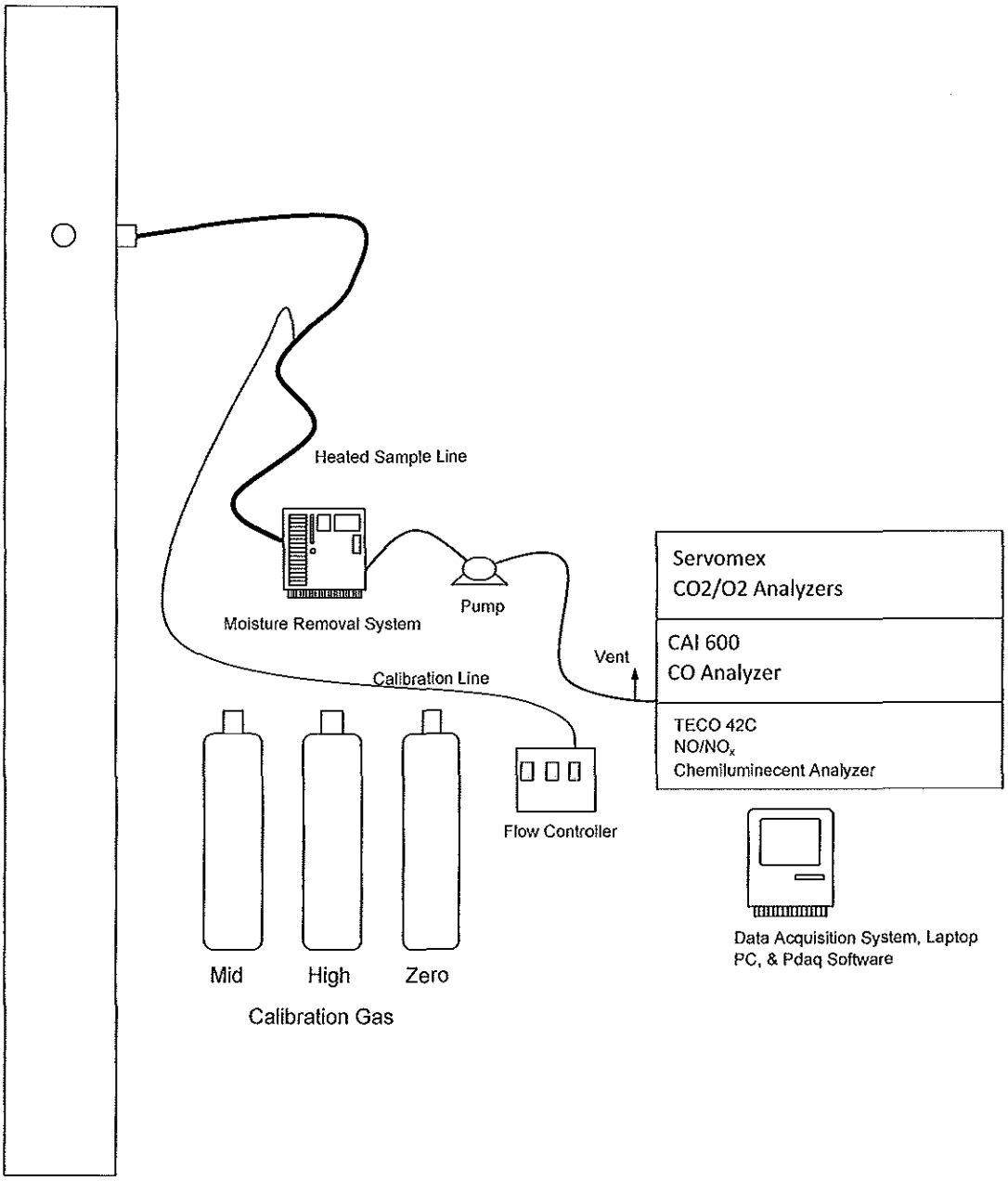

Figure 2

Site: **USEPA Method 3A/7E/10** **North American Natural Resources** **Lennon, Michigan**	**Sampling Date:** **August 25 to 28, 2014**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

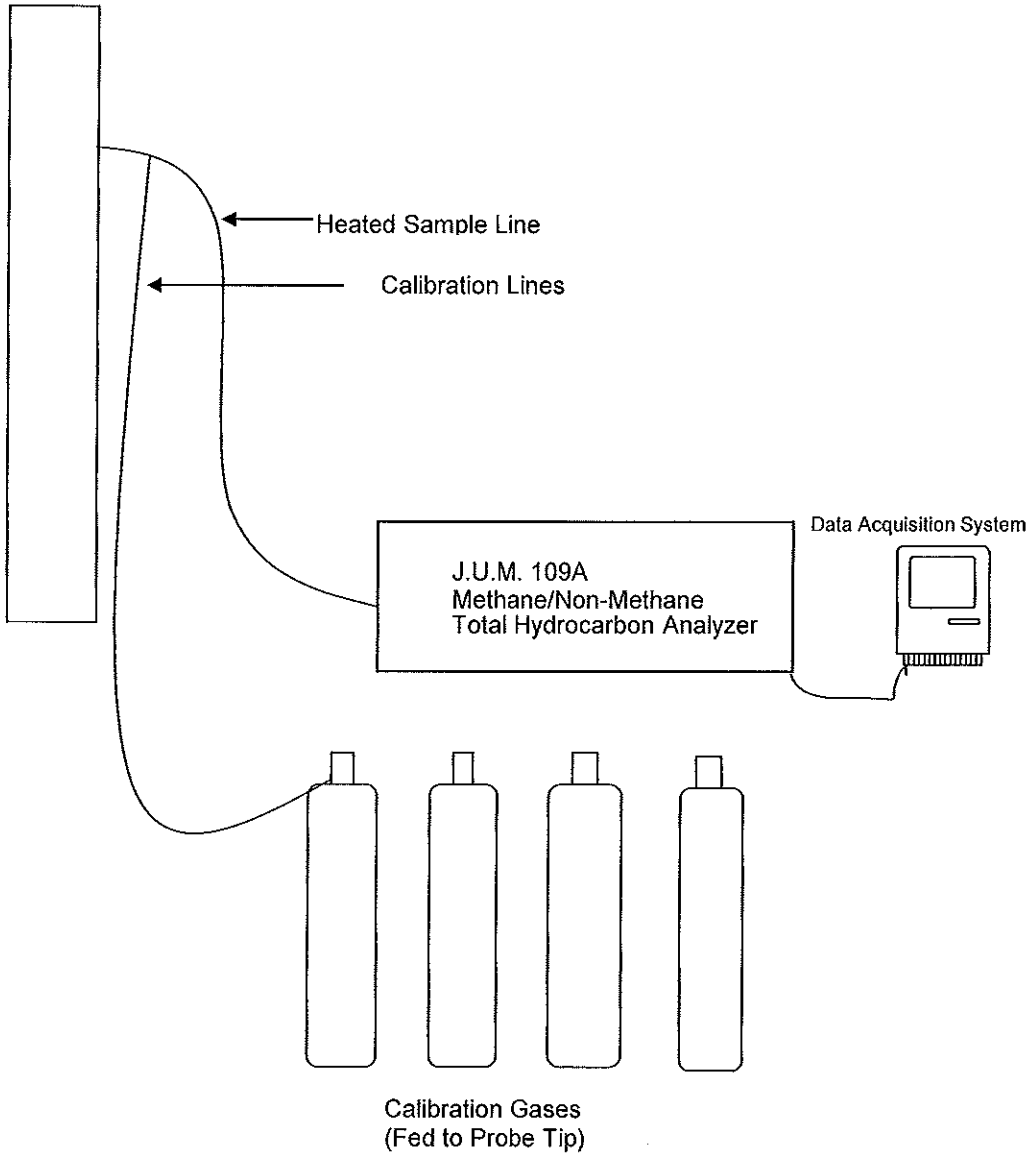

Figure 3

Site: **USEPA Method 25A** **North American Natural Resources** **Lennon, Michigan**	**Sampling Date:** **August 25 to 28, 2014**
	BT Environmental Consulting, Inc. **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

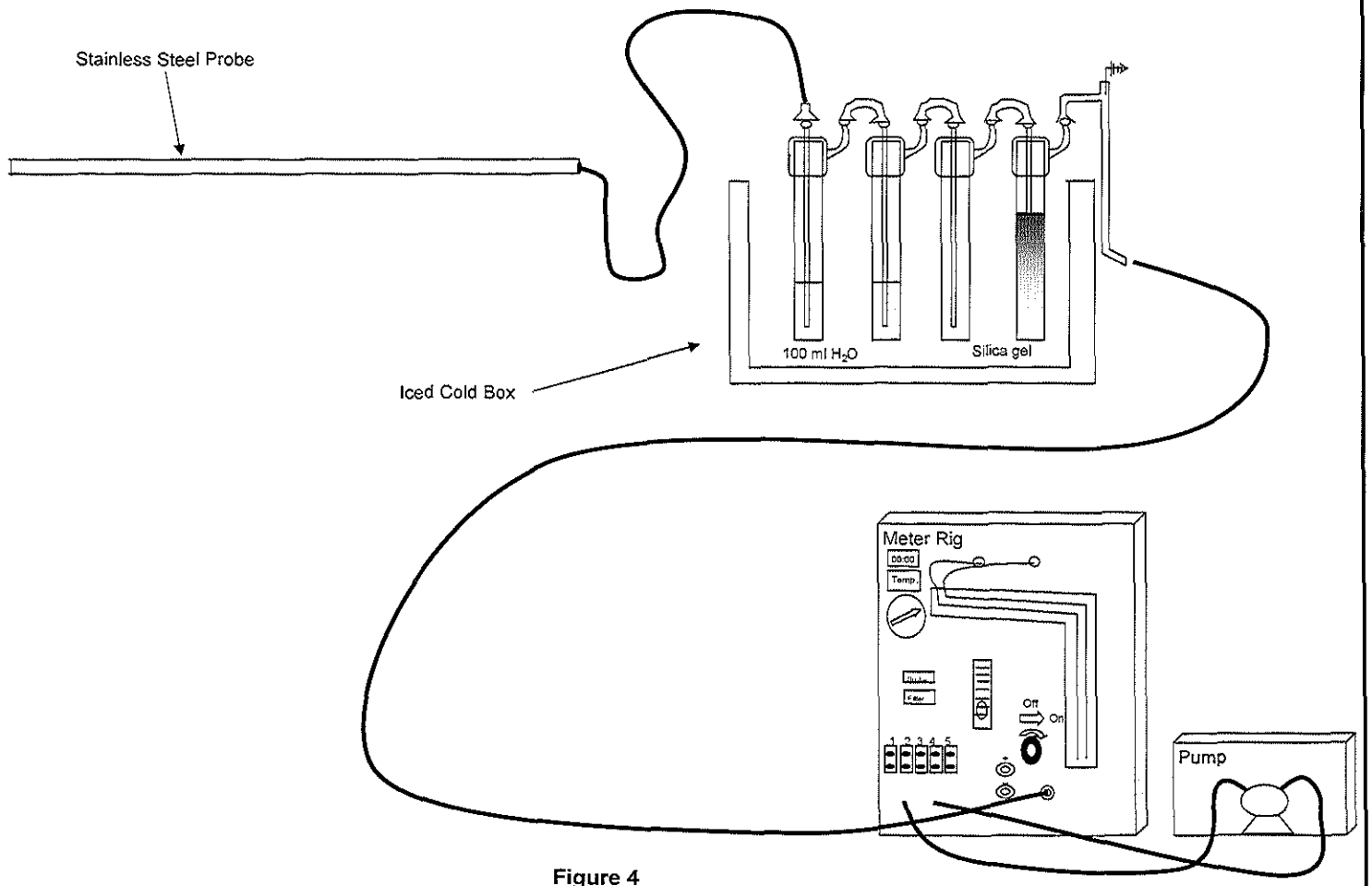

Figure 4

Site:	Sampling Date:	
USEPA Method 4 North American Natural Resources Lennon, Michigan	August 25 to 28, 2014	BT Environmental Consulting, Inc. 4949 Fernlee Avenue Royal Oak, Michigan 48073

BTEC Inc.

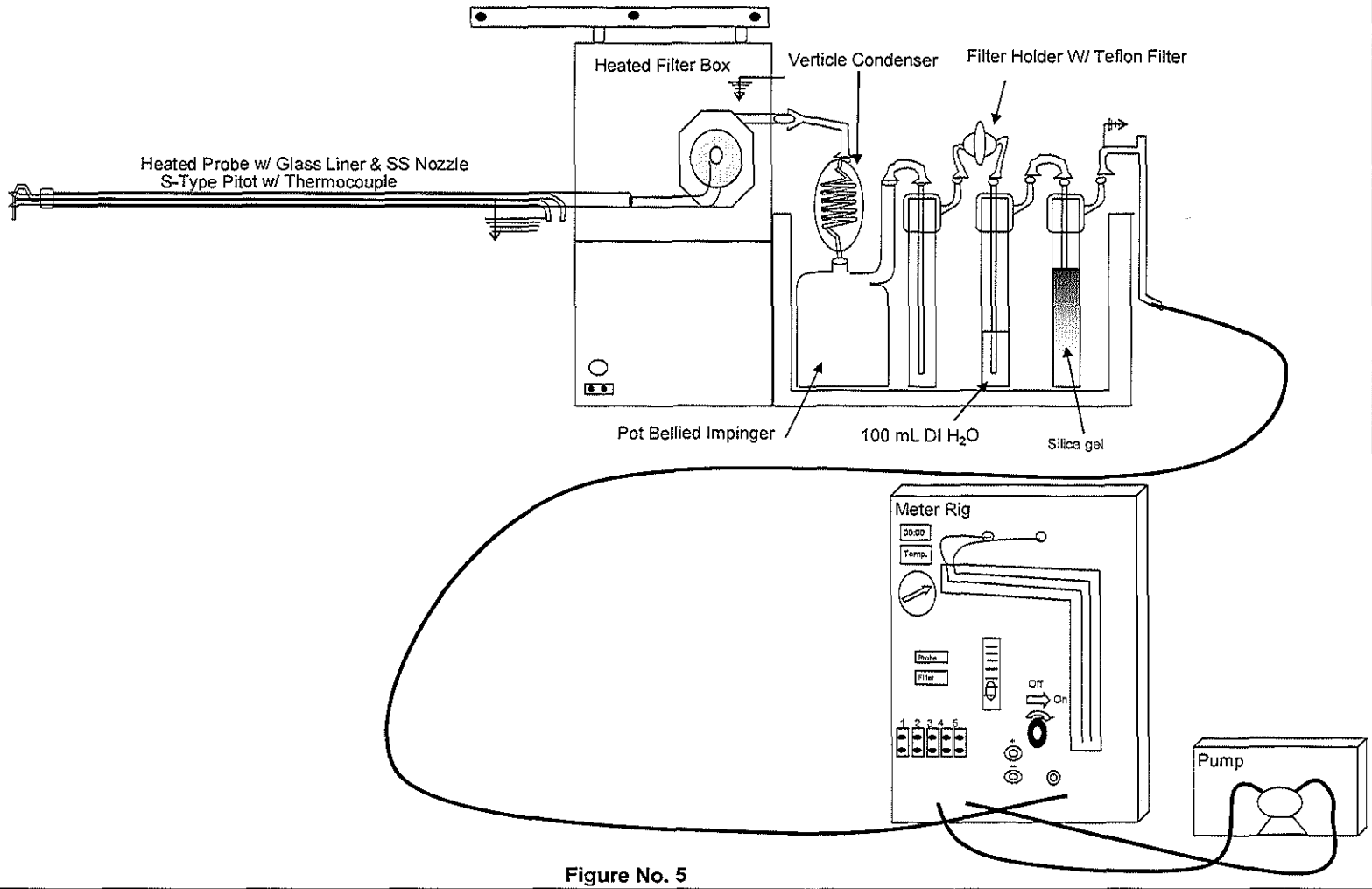

Figure No. 5

Site: **USEPA Method 5/202** **North American Natural Resources** **Lennon, Michigan**	**Sampling Date:** **August 27 and 28, 2014**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**