BTEC Inc.

Turbine 1100 VOC and PM Emissions Test Report

Prepared for:

Dearborn Industrial Generation

Dearborn, MI

Dearborn Industrial Generation
2400 Miller Road
Dearborn, MI 48121

Project No. 049AS-333240.00
April 9, 2018

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

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Dearborn Industrial Generation, LLC (DIG) to evaluate particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) and volatile organic compounds (VOC) emission rates from one (1) source at their facility located in Dearborn, Michigan. The source tested included one simple cycle turbine, EUCTG1 (Turbine 1100), that fires only natural gas (NG). The emissions testing on EUCTG1 was conducted February 5 through 9, 2018.

The testing was conducted to demonstrate compliance with Permit to Install (PTI) No. 8-17. The results of the emissions test program are summarized in Executive Summary Table E-1.

Table E-1
Overall Emission Rates Summary

Source	PM_{10} Emission Rate (lb/hr)	PM_{10} Emission Limit (lb/hr)	VOC Emission Rate (lb/hr)	VOC Emission Limit (lb/hr)
Turbine 1100	8.99	9	0.5	2.8

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1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Dearborn Industrial Generation, LLC (DIG) to evaluate particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) and volatile organic compounds (VOC) emission rates from one (1) source at the DIG facility located in Dearborn, Michigan. The source tested includes one simple cycle turbine, EUCTG1 (Turbine 1100), that fires only natural gas (NG). The emissions testing on EUCTG1 was conducted February 5 through 9, 2018.

BTEC personnel Todd Wessel, Steve Smith, Paul Molenda, and Dave Trahan performed the testing. Mr. Paul Snoes of DIG provided onsite coordination for the test program. Mr. Tom Gasloli and Mr. Jonathan Lamb with the Michigan Department of Environmental Quality (MDEQ) were onsite to witness a portion of the testing.

The testing was performed to demonstrate compliance with Permit to Install (PTI) No. 8-17. The purpose of this report is to document the results of the PM_{10} and VOC emissions compliance test program.

The Air Quality Division (AQD) of Michigan's Department of Environmental Quality has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). 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 the PM_{10} and VOC emissions compliance test program was conducted on February 5 through 9, 2018 at the DIG facility at 2400 Miller Road in Dearborn, Michigan. The emission test program included the evaluation of PM_{10} and VOC emission rates from one simple cycle turbine (EUCTG1).

1.b Purpose of Testing

MDEQ issued PTI No. 8-17 on April 5, 2017 that required testing of PM_{10} and VOC emission rates at EUCTG1 within 180 days of completion of the modifications. This permit specifies the following limits:

Table 1
Emission Limits Summary

Source	Pollutant	Emission Limit
EUCTG1	VOC	2.8 lb/hr
	PM_{10}	9 lb/hr

1.c Source Description

The DIG facility located in Dearborn, Michigan operates two combined-cycle turbines and one simple-cycle turbine that fire natural gas (NG) and three boilers that are capable of firing a mixture of NG and blast furnace gas (BFG), or NG only.

1.d Test Program Contact

The contact for the source and test plan is:

Facility Contact:
Mr. Paul Snoes
Dearborn Industrial Generation, LLC
2400 Miller Rd.
Dearborn, MI 48120
(313) 336-7189

Testing Team Contact:
Mr. Barry Boulianne
Source Testing Manager
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
Phone (313) 449-2361

1.e Testing Personnel

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

Table 2
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Paul Snoes Environmental Health & Safety Coordinator	Dearborn Industrial Generation LLC 2400 Miller Rd. Dearborn, MI 48120	(313) 336-7189
Mr. Todd Wessel Senior Client Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(616) 885-4013
Mr. Steve Smith Field Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Molenda Senior Field Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Dave Trahan Field Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Tom Gasloli Air Quality Division, MDEQ	525 West Allegan (Constitution Hall, 2nd Floor, South), Lansing, MI 48933	(517) 284-6778
Mr. Jonathan Lamb Air Quality Division, MDEQ	Cadillac Place, Suite 2-300 3058 West Grand Boulevard, Detroit, Michigan 48202	(313)-456-4683

2. Summary of Results

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

2.a Operating Data

The following information was collected during the performance test and can be found in Appendix E.

1. Date, time, MW
2. Natural gas flow

2.b Applicable Permit

The applicable permit for this emissions test program is PTI No. 8-17.

2.c Results

The overall results of the emissions compliance test program are summarized by Table 3 (see Section 5.a). Detailed results for each source are included as Tables 4-5.

2.d Emission Regulation Comparison

Emission limitations for DIG are summarized by Table 1.

3. Source Description

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

3.a Process Description

The simple cycle turbine is nominally rated at an output capacity of 181 Megawatts (MW) with a heat input of 1,638 million British thermal units per hour (MMBtu/hr) at ISO conditions. The turbine only fires natural gas. The turbine generator consists of a compressor, combustion turbine, and generator. Energy is generated at the combustion turbine by drawing in ambient air by means of burning fuel and expanding the hot combustion gases in a three-stage turbine. Low-NO_x combustors minimize the emissions of nitrogen oxides from the turbine, while the emissions of CO and SO_2 are minimized by the efficient combustion of low sulfur bearing clean-burning fuels.

3.b Raw and Finished Materials

The raw material supplied include NG.

3.c Process Capacity

The simple cycle turbine is nominally rated at an output capacity of 181 Megawatts (MW) with a heat input of 1,638 million British thermal unit per hour (MMBtu/hr) at ISO conditions.

3.d Process Instrumentation

The following information was collected during the performance test and can be found in Appendix E.

1. Date, time, MW
2. Natural gas flow

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.

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 3 - "Determination of Molecular Weight of Dry Stack Gas" (fyrite)
- Method 4 - "Determination of Moisture Content in Stack Gases"
- Method 5 - "Determination of Particulate Matter 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"

40 CFR 60, Appendix A, Method 5, *"Determination of Particulate Emissions from Stationary Sources"* and 40 CFR 51, Appendix M, Method 202, *"Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"* was used to measure total PM concentrations and calculate total PM emission rates (see Figure 1 for a schematic of the sampling train) for comparison to PM_{10} emission limits. Triplicate 240-minute test runs were conducted at EUCTG1.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) a glass-lined 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 of the three (3) test runs. After completion of the final leak test for the three (3) test runs, the filter was recovered, and the nozzle 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 Condensable Particulate Matter (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 as per section 9.9 of Method 202. 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 delivered to Enthalpy Analytical for analysis.

Volatile Organic compound (VOC) concentrations were measured according to 40 CFR 60, Appendix A, Method 25A. A sample of the gas stream was drawn through a 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 Labview® II data acquisition software. BTEC used a VIG Model 20 THC hydrocarbon analyzer to determine the VOC concentration (see Figure 2 for a schematic of the sampling train). Triplicate 60-minute test runs were conducted at EUCTG1.

The VIG THC hydrocarbon analyzer channels a fraction of the gas sample through a capillary tube that directs the sample to the flame ionization detector (FID), where the hydrocarbons present in the sample are ionized into carbon. The carbon concentration is then determined by the detector in parts per million (ppm). This concentration is transmitted to the data acquisition system (DAS) at 4-second intervals in the form of an analog signal, specifically voltage, to produce data that can be averaged over the duration of the testing program. This data is then used to determine the average ppm for total hydrocarbons (THC) using the equivalent units of propane (calibration gas). The analyzer was calibrated for a range of 0 to 100 ppm.

In accordance with Method 25A, a 3-point (zero, mid, and high) calibration check was performed on the THC analyzer. Calibration drift checks were performed at the completion of each run.

4.b Recovery and Analytical Procedures

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

4.c Sampling Ports

Sampling port and traverse point locations for the exhaust stacks are illustrated by Figure 3.

202. The maximum allowed blank correction of 2.0 mg is applied to the results, despite the laboratory analysis indicating 5.53 mg of particulate in the field train recovery blank. If the entire blank correction of 5.53 mg was applied, test results for total PM_{10} would be approximately 6.66 lb/hr. Guidance provided by U.S. EPA methodology 2014 suggests that field train proof blank corrections of 5.1 mg may be appropriate to reduce overestimation.

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 during the testing.

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

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

Table 4
Turbine 1100 Particulate Matter Emission Rates

Company	**DIG**			
Source Designation	**T-1100**			
Test Date	**2/5/2018**	**2/6/2018**	**2/7/2018**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	57.9	58.0	61.5	59.1
Meter Pressure - Pm (in. Hg)	29.6	29.7	29.6	29.7
Measured Sample Volume (Vm)	145.7	145.1	143.1	144.6
Sample Volume (Vm-Std ft3)	150.4	150.2	146.6	149.0
Sample Volume (Vm-Std m3)	4.26	4.25	4.15	4.22
Condensate Volume (Vw-std)	11.000	13.249	12.867	12.372
Gas Density (Ps(std) lbs/ft3) (wet)	0.0736	0.0733	0.0733	0.0734
Gas Density (Ps(std) lbs/ft3) (dry)	0.0756	0.0757	0.0757	0.0756
Total weight of sampled gas (m g lbs) (wet)	11.88	11.98	11.69	11.85
Total weight of sampled gas (m g lbs) (dry)	11.37	11.37	11.09	11.27
Nozzle Size - An (sq. ft.)	0.000241	0.000241	0.000241	0.000241
Isokinetic Variation - I	98.1	99.7	99.7	99.2
Stack Data				
Average Stack Temperature - Ts (F)	1123.6	1124.2	1114.2	1120.7
Molecular Weight Stack Gas- dry (Md)	29.2	29.3	29.3	29.3
Molecular Weight Stack Gas-wet (Ms)	28.5	28.4	28.4	28.4
Stack Gas Specific Gravity (Gs)	0.983	0.980	0.979	0.981
Percent Moisture (Bws)	6.82	8.11	8.07	7.66
Water Vapor Volume (fraction)	0.0682	0.0811	0.0807	0.0766
Pressure - Ps ("Hg)	29.6	29.7	29.6	29.6
Average Stack Velocity -Vs (ft/sec)	143.9	143.2	139.2	142.1
Area of Stack (ft2)	418.0	418.0	418.0	418.0
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	3,609,553	3,591,223	3,492,295	3,564,357
Flowrate ft^3 (Standard Wet)	1,191,124	1,187,267	1,157,995	1,178,795
Flowrate ft^3 (Standard Dry)	1,109,940	1,091,002	1,064,555	1,088,499
Flowrate m^3 (standard dry)	31,430	30,894	30,145	30,823
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	5.6	3.6	3.0	4.1
Organic Condensible Particulate	1.2	1.6	1.2	1.3
Inorganic Condensible Particulate	4.3	3.0	10.4	5.9
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	3.5	2.6	9.5	5.2
Total Filterable and Condensible Particulate	9.1	6.2	12.5	9.3
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.001	0.001
mg/dscm (dry)	1.3	0.8	0.7	1.0
gr/dscf	0.0006	0.0004	0.0003	0.0004
Filterable Particulate Emission Rate				
lb/ hr	5.49	3.47	2.89	3.95
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.001	0.000	0.002	0.001
lb/1000 lb (dry)	0.001	0.001	0.002	0.001
mg/dscm (dry)	0.8	0.6	2.3	1.2
gr/dscf	0.0004	0.0003	0.0010	0.0005
Condensible Particulate Emission Rate				
lb/ hr	3.41	2.51	9.19	5.04
Total Particulate Concentration				
lb/1000 lb (wet)	0.002	0.001	0.002	0.002
lb/1000 lb (dry)	0.002	0.001	0.002	0.002
mg/dscm (dry)	2.1	1.5	3.0	2.2
gr/dscf	0.0009	0.0006	0.0013	0.0010
Total Particulate Emission Rate				
lb/ hr	8.90	5.98	12.08	8.99

Table 5
Turbine 1100 VOC Emission Rates
Dearborn Industrial Generation
Dearborn, Michigan
BTEC Project No. 049AS-333240.00
Sampling Dates: February 5, 2018

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	2/5/2018	2/5/2018	2/5/2018	
Test Run Time	10:23-11:22	11:34-12:33	12:41-13:40	
Outlet Flowrate (scfm)	1,221,127	1,191,124	1,218,527	**1,210,259**
Outlet VOC Concentration (ppmv as propane)	0.28	0.17	0.19	**0.21**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E) [1]	0.13	0.05	***0.00***	**0.06**
VOC Emission Rate as Propane (lb/hr)	**2.34**	**1.39**	**1.58**	**1.77**
VOC Emission Rate as Propane(lb/hr) (corrected as per USEPA 7E)	**1.11**	**0.39**	**0.00**	**0.50**

VOC Correction			
Co	0.15	0.13	0.23
Cma	29.99	29.99	29.99
Cm	29.47	28.64	29.13

Flow 2 is taken from PM Run 1. Flows 1 and 3 are from independent flow measurements.
1: VOC Run 3 drift correction resulted in a negative number which has been replaced with zero for calculations.

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 (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

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

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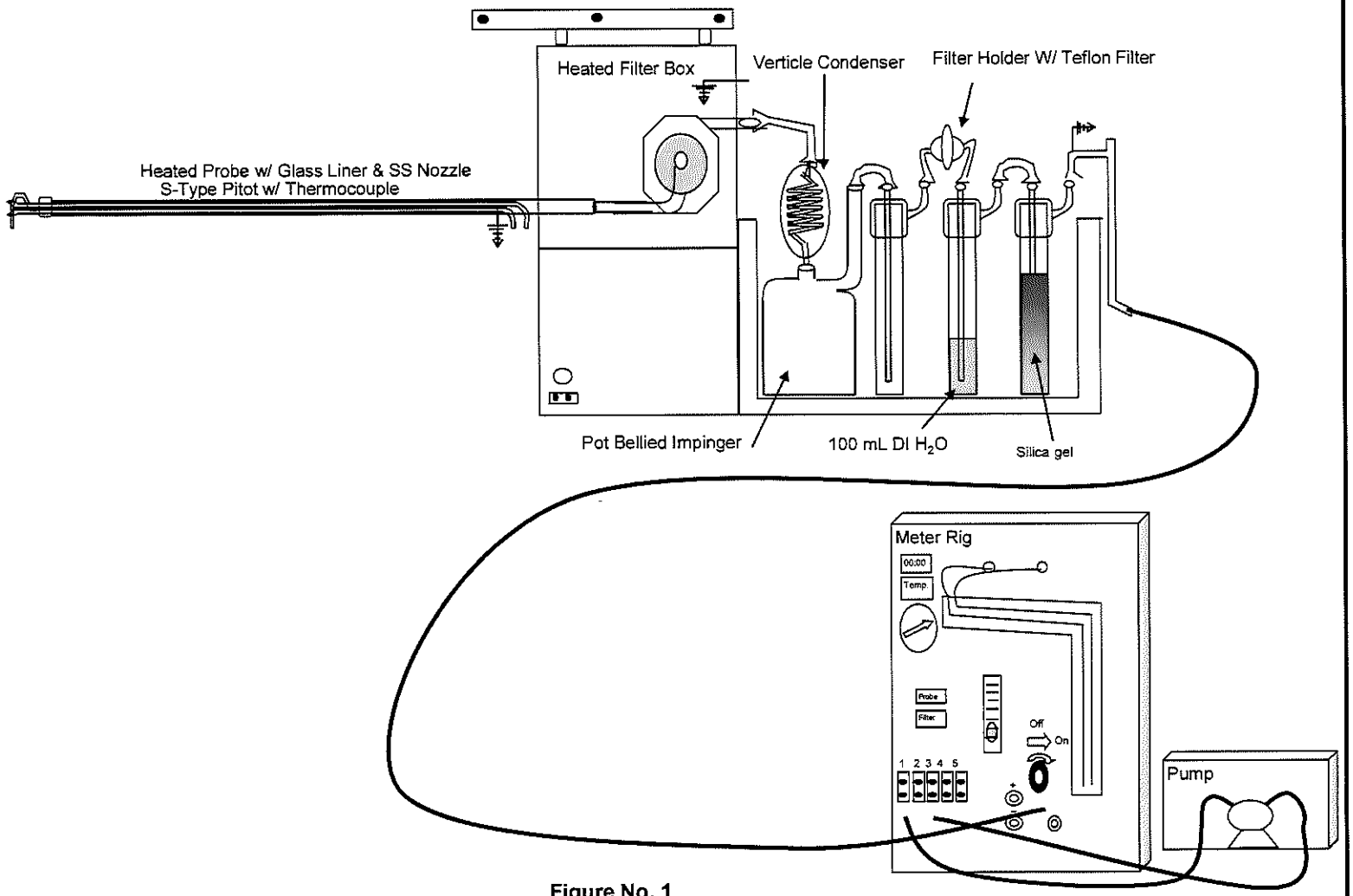

Figure No. 1

Site: **USEPA Method 5/202** **Dearborn Industrial Generation** **Dearborn, Michigan**	**Sampling Date:** **February 5-7, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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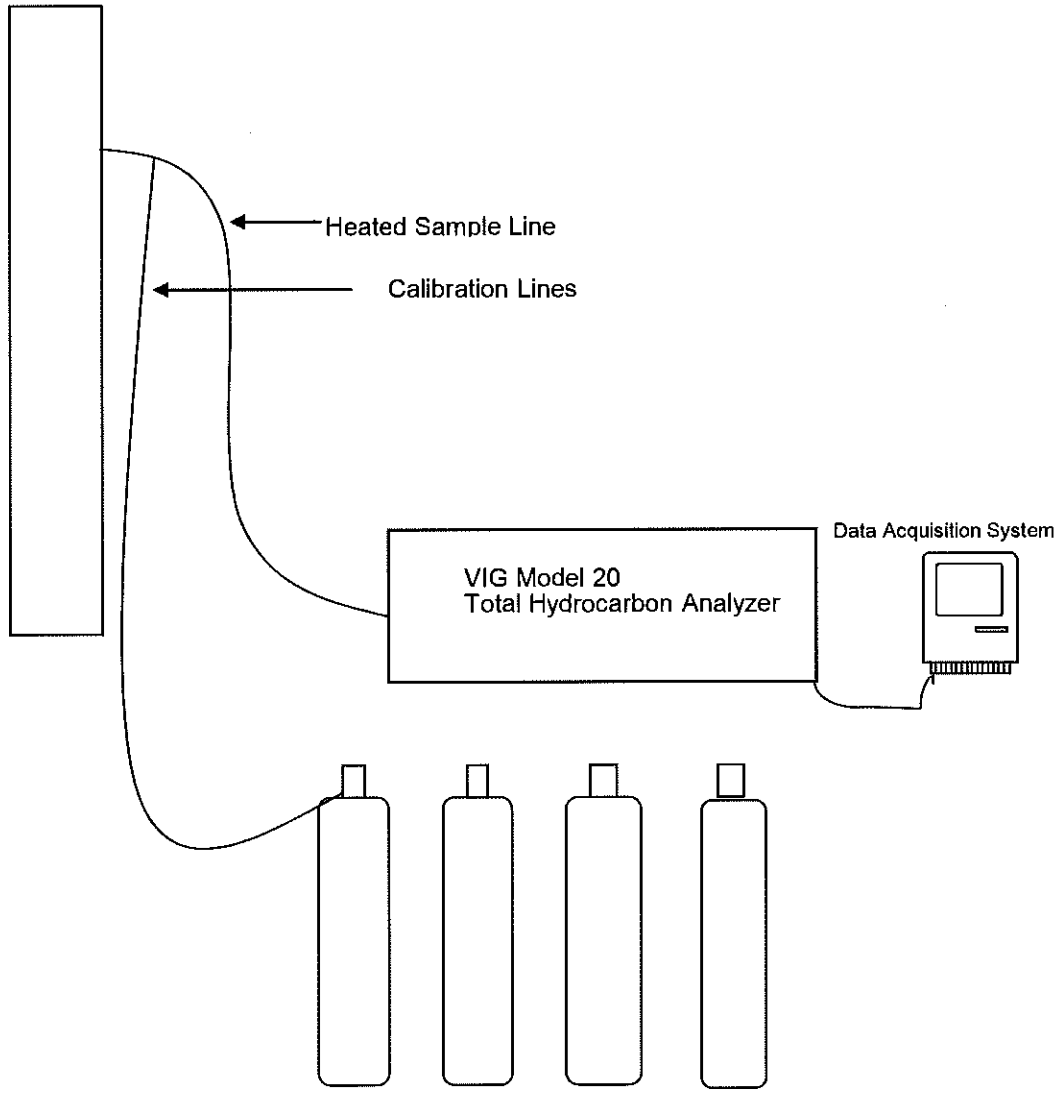

Figure No. 2

Site: **Sampling Date:** **USEPA Method 25A** **February 5, 2018** **Dearborn Industrial Generation** **Dearborn, Michigan**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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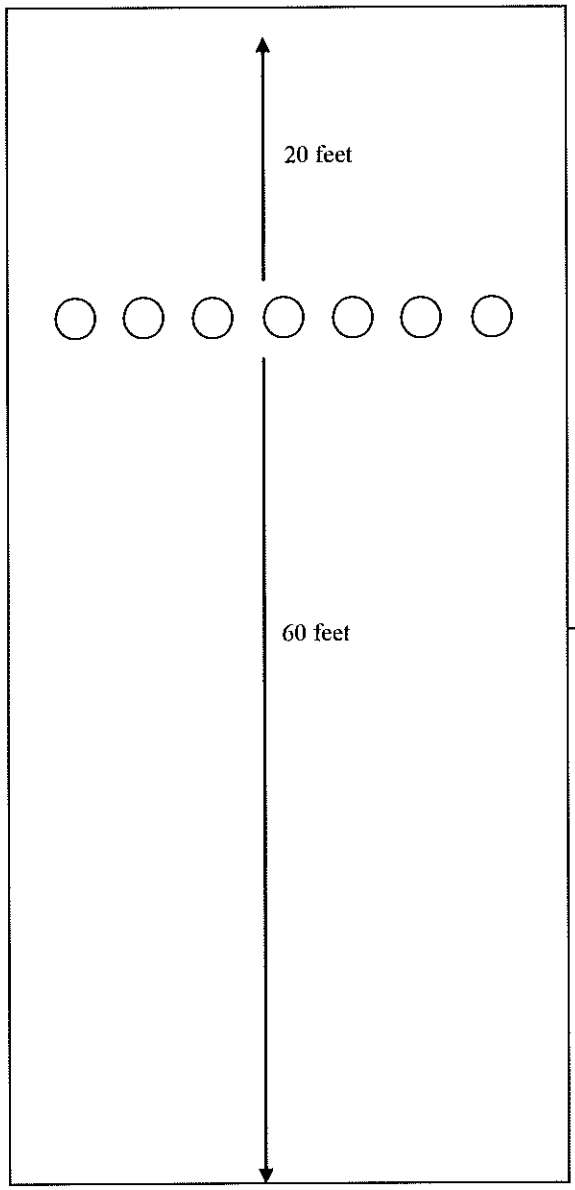
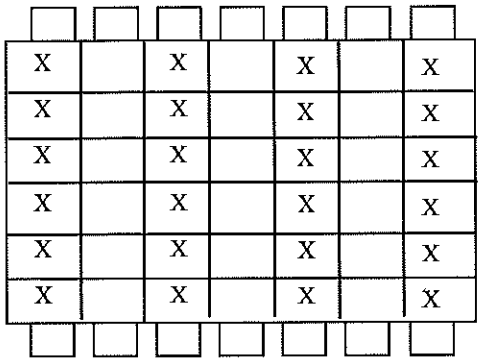
Stack Dimensions: 19' Deep X 22' Wide





X = sample point

Not to Scale

Points	Distance "
1	19.0
2	57.0
3	95.0

Figure No. 3

Site: **Turbine 1100 (EUCTG1)** **Dearborn Industrial Generation** **Dearborn, Michigan**	**Sampling Date:** **February 5-7, 2018**

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