



# Dearborn Industrial Generation CH<sub>2</sub>O Emissions Test Report

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AIR QUALITY DIVISION

*Prepared for:*

**Dearborn Industrial Generation**

Dearborn, MI

Dearborn Industrial Generation  
2400 Miller Road  
Dearborn, MI 48121

Project No. 049AS-455247  
October 11, 2018

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

**EXECUTIVE SUMMARY**

**AIR QUALITY DIVISION**

BT Environmental Consulting, Inc. (BTEC) was retained by Dearborn Industrial Generation LLC (DIG) to evaluate formaldehyde (CH<sub>2</sub>O) emission rates from 6 sources at the DIG facility located in Dearborn, Michigan. The sources tested included three boilers, two combined cycle turbines, and one simple cycle turbine. The boilers fired a mixture of blast furnace gas (BFG) and natural gas (NG) and are designated as EU-BOILER1 (Boiler 1100), EU-BOILER2 (Boiler 2100), and EU-BOILER3 (Boiler 3100). The two combined cycle turbines designated as EUCTG2 (Turbine 2100) and EUCTG3 (Turbine 3100) and simple cycle turbine EUCTG1 (Turbine 1100) fire NG only. The emissions testing was conducted on August 21<sup>st</sup> through August 23<sup>rd</sup>, 2018.

MDEQ issued permit to install (PTI) No. 163-17 to DIG on January 31, 2018 that contains a formaldehyde emission limit of 36 ton per year (tpy), applicable to "FGPLANT" on a 12-month rolling basis. "FGPLANT" includes DIG's three (3) turbines and three (3) boilers, as described in PTI No. 163-17. FGPLANT Special Condition V.1 requires DIG to perform formaldehyde emissions testing to verify emission factors two times by January 30, 2019, once in the summer and once in the winter. This testing constitutes the "summer" formaldehyde testing as required by SC V.1 of PTI No. 163-17.

The results of the emissions test program are summarized in Executive Summary Table E-1.

**Table E-1  
Overall Emission Rates Summary**

Source	CH <sub>2</sub> O (lb/MMBtu)
Boiler 1100	4.21E-05
Boiler 2100	3.30E-05
Boiler 3100	4.35E-05
Turbine 1100	6.72E-05
Turbine 2100	5.82E-05
Turbine 3100	5.41E-05



## **1. Introduction**

BT Environmental Consulting, Inc. (BTEC) was retained by Dearborn Industrial Generation LLC (DIG) to evaluate formaldehyde (CH<sub>2</sub>O) emission rates from 6 sources at the DIG facility located in Dearborn, Michigan. The sources tested included three boilers, two combined cycle turbines, and one simple cycle turbine. The boilers fired a mixture of blast furnace gas (BFG) and natural gas (NG) and are designated as EU-BOILER1 (Boiler 1100), EU-BOILER2 (Boiler 2100), and EU-BOILER3 (Boiler 3100). The two combined cycle turbines designated as EUCTG2 (Turbine 2100) and EUCTG3 (Turbine 3100) and simple cycle turbine EUCTG1 (Turbine 1100) fire NG only.

MDEQ issued permit to install (PTI) No. 163-17 to DIG on January 31, 2018 that contains a formaldehyde emission limit of 36 ton per year (tpy), applicable to "FGPLANT" on a 12-month rolling basis. "FGPLANT" includes DIG's three (3) turbines and three (3) boilers, as described in PTI No. 163-17. FGPLANT Special Condition V.1 requires DIG to perform formaldehyde emissions testing to verify emission factors two times by January 30, 2019, once in the summer and once in the winter. This testing constitutes the "summer" formaldehyde testing as required by SC V.1 of PTI No. 163-17.

The emissions testing was conducted on August 21<sup>st</sup> through August 23<sup>rd</sup>, 2018. BTEC personnel Todd Wessel, Paul Diven, and Shane Rabideau, and Prism personnel Blake Ericson, and Trevor Tilmann performed the testing. Mr. Paul Snoes of DIG provided onsite coordination for the test program. Mr. Mark Dziadosz, Mr. Jonathan Lamb, and Ms. Regina Hines with the MDEQ were onsite to witness a portion of the testing.

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" (March 2018). 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 emissions compliance test program was conducted on August 21<sup>st</sup> through the 23<sup>rd</sup>, 2018 at the DIG facility at 2400 Miller Road in Dearborn, Michigan. The emission test program included the evaluation of formaldehyde emissions from three boilers and three turbines.

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

DIG operates according to Michigan Renewable Operating Permit No. MI-ROP-N6631-2012a, PTI No. 8-17, and PTI No. 163-17. PTI No. 163-17 (issued on January 31, 2018) contains a formaldehyde limit of 36 tpy for flexible group "FGPLANT." FGPLANT consists of DIG's three (3) turbines and three (3) boilers, as described in Section 1.c.



Recordkeeping for the 36 tpy limit relies on emission factors from stack testing and actual 12-month rolling heat input to demonstrate compliance.

**Table 1**  
**Permitted Emission Limits**  
**Dearborn Industrial Generation LLC**

Source	Pollutant	Emission Limit
FGPLANT <sup>1</sup>	CH <sub>2</sub> O	36 ton/yr

<sup>1</sup> DIG's three boilers and three turbines comprise FGPLANT

PTI No. 163-17 lists emission factors for formaldehyde, as presented in Table 2 below. PTI No. 163-17 requires that DIG perform emissions testing to verify the factors for each equipment category listed in Table 2. PTI No. 163-17 specifies additional activities and reporting if a 3-run test average for a unit is greater than the emission factor for the particular equipment category listed in Table 2.

**Table 2**  
**PTI No. 163-17 Formaldehyde Emission Factors<sup>1</sup>**  
**Dearborn Industrial Generation LLC**

Equipment Category	Emission Factor (lb/MMBtu)
Boilers	1.12E-03
Simple-cycle Turbine	8.67E-04
Combined-cycle Turbine	1.36E-03

<sup>1</sup> These emission factors do not constitute emission limits; however, the results of emissions testing will be compared to these emission factors.

### 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 3.

**Table 3  
 Test Personnel**

<b>Name and Title</b>	<b>Affiliation</b>	<b>Telephone</b>
Mr. Paul Snoes Health & Safety Coordinator	Dearborn Industrial Generation LLC 2400 Miller Rd. Dearborn, MI 48120	(313) 336-7189
Mr. Todd Wessel Client Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(616) 885-4013
Mr. Paul Diven Field Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Shane Rabideau Field Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Blake Ericson Field Project Manager	Prism Analytical Technologies 2625 Denison Drive Mt. Pleasant, MI 48858	(989) 772-5088
Mr. Trevor Tilmann Field Technician	Prism Analytical Technologies 2625 Denison Drive Mt. Pleasant, MI 48858	(989) 772-5088
Mr. Mark Dziadosz Air Quality Division, MDEQ	Southeast Michigan District Office 27700 Donald Court Warren, MI 48092-2793	(586) 753-3745
Mr. Jonathan Lamb Air Quality Division, MDEQ	Detroit District (Wayne County) Cadillac Place, Suite 2-300 3058 West Grand Blvd. Detroit, MI 48202-6058	(313) 456-4683
Ms. Regina Hines Air Quality Division, MDEQ	Detroit District (Wayne County) Cadillac Place, Suite 2-300 3058 West Grand Blvd. Detroit, MI 48202-6058	(313) 418-0895



## **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, steam flow, heat input (MMBtu/hr),
2. MW generated (turbines)
3. Natural gas flow (Turbines and Boilers)
4. Blast Furnace gas flow (Boilers)
5. Ambient temperature and humidity

### **2.b Applicable Permit**

The applicable permit for this emissions test program is PTI No. 163-17.

### **2.c Results**

The overall results of the emissions compliance test program are summarized by Table 4 (see Section 5.a). Detailed results for each source are included as Tables 6-11.

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

The emission limitation for "FGPLANT" at DIG is summarized in Table 1. The emission factors (in lb/MMBtu) from this emission test are compared to the emission factors presented in Table 2, as required by PTI No. 163-17.

## **3. Source Description**

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

### **3.a Process 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.

The simple cycle turbine is nominally rated at an output capacity of approximately 181 Megawatts (MW) and 1,638 million British thermal unit per hour (MMBtu/hr) heat input, and the combined-cycle turbines are each nominally rated at an output capacity of

approximately 179 MW and 1,626 MMBtu/hr heat input. The turbines use natural gas as fuel. 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. The hot exhaust gases from the combined-cycle combustion turbines are directed to a multi-pressure heat recovery steam generator (HRSG) to produce steam. Low-NO<sub>x</sub> combustors minimize the emissions of nitrogen oxides from the turbines, while the emissions of CO and SO<sub>2</sub> are minimized by the efficient combustion of low sulfur bearing clean-burning fuels.

Each boiler is nominally rated at an output capacity of 500,000 pounds per hour of superheated steam at a minimum pressure of 1,350 psig and temperature of 960°F. The input capacity of the boilers while firing NG and BFG is 746 MMBtu/hr and 763 MMBtu/hr while burning natural gas only. The steam from the boilers is dispatched to a steam turbine for electrical generation and or utilized as process steam.

The boilers at DIG are designed to burn a mixture of BFG and NG or natural gas only. The BFG to NG ratio is approximately 95% BFG to 5% NG, based upon the heat inputs of the fuels.

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

The raw material supplied includes BFG and NG.

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

The simple cycle turbine is nominally rated at an output capacity of approximately 181 Megawatts (MW) and 1,638 million British thermal unit per hour (MMBtu/hr) heat input. The combined-cycle turbines are each nominally rated at an output capacity of approximately 179 MW and 1,626 MMBtu/hr heat input. The turbines operated at approximately 100% of load at the ambient conditions during testing.

Each boiler is nominally rated at an output capacity of 500,000 pounds per hour of superheated steam at a minimum pressure of 1,350 psig and temperature of 960°F. The input capacity of the boilers while firing NG and BFG is 746 MMBtu/hr and 763 MMBtu/hr while burning natural gas only. The boilers were operated in co-firing mode at maximum normal operating load based on available BFG supply during the testing.

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

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

1. Date, time, steam flow, heat input (MMBtu/hr),
2. MW generated (turbines)
3. Natural gas flow (Turbines and Boilers)
4. Blast Furnace gas flow (Boilers)



5. Ambient temperature and humidity

#### 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 3A - "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)"
- Method 4 - "Determination of Moisture Content in Stack Gases"

USEPA Methods 1, 2, and 4 were not performed at the turbines, as Method 19 was used to determine emission factors for the combustion turbines.

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2. S-type pitot tubes with thermocouple assemblies, calibrated in accordance with Method 2, were used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions outlined in Sections 2-6 through 2-8 are within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) is assigned.

Cyclonic flow checks were performed at each sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. The average of the absolute values of the flow angles is less than 20 degrees; therefore cyclonic flow does not exist.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the moisture sampling train and passed through (i) two impingers, each with 100 ml deionized water, (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content is then determined gravimetrically.





## Oxygen and Carbon Dioxide (USEPA Method 3A)

Measurement of oxygen and carbon dioxide content was conducted using the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 3A - *“Determination of Oxygen and Carbon Dioxide Concentration in Emissions From Stationary Sources (Instrumental Analyzer Procedure)”*

The O<sub>2</sub> and CO<sub>2</sub> content of the gas stream is measured using a Servomex 4100 O<sub>2</sub>/CO<sub>2</sub> gas analyzer. The gas stream is drawn through a stainless-steel probe with a heated in-line filter to remove any particulate, a heated Teflon® sample line, through a refrigerated Teflon® sample conditioner to remove the moisture from the sample before it enters the O<sub>2</sub>/CO<sub>2</sub> analyzer. Data is recorded on a PC equipped with data acquisition software. Recorded O<sub>2</sub>/CO<sub>2</sub> concentrations are averaged and reported for the duration of each test (as drift corrected per Method 7E). A drawing of the sampling train used for the testing program is presented as Figure 1.

In accordance with Method 3A, a 3-point (zero, mid, and high) bias check and calibration check is performed on the O<sub>2</sub>/CO<sub>2</sub> analyzer prior to initiating the test program. Following each test run, a 2-point (zero and high) calibration drift check is performed. The O<sub>2</sub>/CO<sub>2</sub> analyzer is operated at the 0-25 ppm range.

## Prism Analytical Technologies Method 18 - TDT Sampling and Analysis Procedures for Formaldehyde

Prism Analytical Technologies utilizes thermal desorption tube (TDT) and GC/FTIR (MAX™) methodology for the determination of low level source emissions. These combined technologies minimize or remove the primary interferences from water and carbon dioxide while collecting a time averaged sample. The time averaging provides an additional benefit of concentrating the analytes of interest prior to analysis. 1 to 50 ppbv dry minimum detection limit (MDL) specifications can be met for many VOCs and HAPs while ensuring analytical accuracy. The expected formaldehyde MDL is 10 ppbv. To demonstrate QAQC compliance of the technology to US-EPA Method 18, calibration checks are performed before and after the TDT analysis. Additionally, TDTs pre-spiked with the components of interest are collected simultaneously with a clean (sample) TDT to demonstrate the sample recovery for the analytes of interest.

## Instruments and Apparatus

### 1. Sampling System

- a. MAX™ TDT Sampler and Manifold
  - i. Two channel device, collects two TDT samples simultaneously (1 spiked and 1 unspiked)

- ii. Manifold holds the TDTs and maintains the gas temperature at 191C until slipstream is pulled from manifold into TDT.
- iii. Manifold can be mounted on nearly any environmental source (inlet or outlet of abatement device)
- iv. Sample flow control (slipstream) is handled by two 0 – 200 mL/min MFCs that maintain the flow at better than 1% of reading.
- v. No moisture impingers required (water collected with analytes on TDT)

b. Thermal desorption tube

- i. Prism's AS014 tubes will be utilized due to their ability to collect and concentrate formaldehyde without breakthrough
- ii. AS014 is multi-bed adsorbent packed in a stainless tube that can be rapidly heated to desorb the captured analytes.
- iii. TDTs will come in pairs with a spiked and un-spiked tube.

2. Analyzer System (TDT – GC/FTIR)

- a. Prism Analytical Technologies MAX™ analyzer technology is a newly designed GC-FTIR technology that provides lower MDLs than traditional GC-FTIR systems and maintains a constant calibration for all analytes.
- b. The GC is used to separate the compounds and interferences, the carrier flow is controlled by a 0 – 5 mL/min MFC and the carrier gas is normally N<sub>2</sub>.
- c. The FTIR is used to qualify and quantify each analyte, each quantified result has additional QAQC data that allows the tester to validate the reported result.
- d. In the MAX analyzer the GC effluent is captured and held in the FTIR gas cell so that a constant signal (absorbance) is generated for a constant mass of material. The subsequent data generates a “MAX” peak that is constant for all instruments for a specific mass of material.
- e. TDTs are desorbed by the MAX Desorber mounted on the rear side of the instrument. The entire sample is passed to a GC (30 m resistively heated steel capillary column). There is no splitting of the sample, so that all the material that is captured on the TDT goes to the GC and eventually into the FTIR gas cell.

3. Calibration and QAQC

- a. Calibration TDTs containing the analytes of interest are analyzed before and after the sample TDTs to demonstrate the permanent calibration curve for each compound.
  - i. A fixed amount (ie 1,000 ng) for each compound is placed on each TDT from a prepared mixture via a calibrated microliter syringe.
  - ii. Standards are run in triplicate at each of three levels to demonstrate the calibration curve for each compound.
- b. Spiked tubes are analyzed from each sample pair to determine the percent recovery for specie.

**Analysis Methodology****AIR QUALITY DIVISION**

1. Thermal desorption tubes will be analyzed independently by our MAX (GC-FTIR)
  - a. The MAX system is calibrated from neat standards.
  - b. Analysis will be performed in pairs with the spiked tube first and the sample tube second.
2. Sample analysis will be performed on the MAX system which utilizes the following GC column (MTX-624, 30m, 0.53mm id, 3um film thickness) to separate the compounds in time. As the compounds elute from the GC they are collected by an FTIR gas analyzer that will spectrally identify and quantify each as they elute. The gas cell will be isolated at this time to integrate the effluents into the cell.
3. MAX Analyzer will be used to determine the maximum ng concentration of the analytes of interest using a least squares algorithm approach.

**Data Analysis**

1. Prism's MAX Source Tester software will be utilized to analyze all the data collected during the data collection of the TDT samples.
2. The user selects the sample directory to be analyzed. Normally one TDT run is present per directory.
3. The user then selects a predefined qualitative and quantitative library to utilize in the analysis.
4. The user then selects a predefined method that will analyze for a specific set of compounds.
5. Normally the Baseline Correct and Background Removal algorithms are checked and utilized but they can be turned off if a better analysis can be obtained without them.
6. The user then presses the Find All IU button for the data analysis to proceed. The entire data set can normally be analyzed within about 1 minute. The time is dependent on the number of analytes and number of spectral files collected.
7. The tester or data validator or both will then review the results, screenshots and %error to validate the result.
8. Tools are available to quantify different or multiple spectral regions to get improved analyses.
9. Once the analysis is complete, the data can be reported to a .CSV file for reporting purposes.
10. The full method analysis of the data can be saved into a .QTA file for further validation

A schematic drawing of the formaldehyde sampling train is provided as Figure 2.

**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 Figures 4-6.

#### 4.d Traverse Points

Sampling port and traverse point locations for the exhaust stacks are illustrated by Figures 4-6.

### 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 4.

**Table 4**  
**Overall Emission Rates Summary**

Source	CH <sub>2</sub> O (lb/MMBtu)
Boiler 1100	4.21E-05
Boiler 2100	3.30E-05
Boiler 3100	4.35E-05
Turbine 1100	6.72E-05
Turbine 2100	5.82E-05
Turbine 3100	5.41E-05

Detailed data for each test run can be found in Tables 6-11.

#### 5.b Discussion of Results

This formaldehyde testing was performed to verify the emission factor from each unit in FGPLANT for comparison to the emission factors listed in PTI No. 163-17, provided in Table 2. This emission factor comparison, shown in Table 5, demonstrates that the formaldehyde emission factors from the Equipment Categories are below the emission factors from PTI No. 163-17.

**Table 5  
Formaldehyde Emission Factor Comparison**

<b>Equipment Category</b>	<b>Emission Unit(s)</b>	<b>Test Result Average<sup>1</sup> (lb/MMBtu)</b>	<b>Emission Factor<sup>2</sup> (lb/MMBtu)</b>
Boilers	Boiler 1100 Boiler 2100 Boiler 3100	3.96E-05	1.12E-03
Simple-cycle Turbine	Turbine 1100	6.72E-05	8.67E-04
Combined-cycle Turbine	Turbine 2100 Turbine 3100	5.61E-05	1.36E-03

<sup>1</sup> The Equipment Category test result averages are calculated as the arithmetic average of the emission unit results in the Equipment Category (refer to Table 4 for individual unit emission rates).

<sup>2</sup> These emission factors do not constitute emission limits; the results of emissions testing are compared to these factors as required by PTI No. 163-17.

**5.c Sampling Procedure Variations**

Process data in Appendix E as well as BTEC’s electronic CEMS data (and accompanying hand written CEMS sheets) are recorded in Eastern Standard Time (EST). Prism’s report included in Appendix F, as well as electronic and hand written data sheets for flow rates and moisture measurements were recorded using the local time which is Eastern Daylight Time (EDT). At the time of testing there was a 1-hour difference between EST and EDT (ie 13:00 EST is equivalent to 14:00 EDT).

Two fuel samples of BFG were taken for each of the two days testing (8-22-18 and 8-23-18) was performed on the boilers. One of the BFG samples from 8-23-18 was damaged during shipping and was unable to be analyzed. The remaining BFG sample for 8-23-18 was analyzed but the results are inconsistent with historical BFG results and ambient air contamination is suspected. Fuel analysis results from 8-23-18 have been included in Appendix E, however they are not used to calculate emission rates. Boiler emission rates are calculated using the fuel analysis from the sample taken on 8-22-18.

**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 F.



## MEASUREMENT UNCERTAINTY STATEMENT

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose Air Quality Services, LLC, (MAQS) personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, MAQS personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of our Quality Manual and ASTM D 7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

### Limitations

All testing performed was done in conformance to the ASTM D7036-04 standard. The information and opinions rendered in this report are exclusively for use by DIG. BTEC will not distribute or publish this report without DIG's consent except as required by law or court order. BTEC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

This report was prepared by: Brandon Chase  
Brandon Chase  
QA/QC Manager

This report was reviewed by: Todd Wessel  
Todd Wessel  
Client Project Manager

**Tab.**  
**Boiler 1100**  
**Formaldehyde Emission Rates**  
**Dearborn Industrial Generation**  
**Dearborn, MI**  
**BTEC Project No. 049AS-455247**  
**Sampling Dates: 8/23/2018**

Parameter	Run 1	Run 2	Run 3	Average	Average of Boiler 1 Boiler 2 Boiler 3
Test Run Date	8/23/2018	8/23/2018	8/23/2018		
Test Run Time	13:00-14:00	14:15-15:15	15:26-16:26		
Outlet Flowrate (dscfm)	153,970	155,017	152,713	153,900	
Outlet Flowrate (scfm)	171,268	171,668	168,558	170,498	
BFG Flow Rate (kscf/hr)	4,932.976	4,718.733	4,941.479	4,864.40	
NG Flow Rate (kscf/hr)	32.285	32.258	32.219	32.25	
BFG Heat Input (MMBtu/hr)	552.5	528.5	553.4	544.8	
NG Heat Input (MMBtu/hr)	34.1	34.1	34.1	34.1	
Total Heat Input (MMBtu/hr)	586.6	562.6	587.5	578.9	
Oxygen Concentration (%)	4.27	4.39	4.38	4.35	
Oxygen Concentration (% , drift corrected as per USEPA 7E)	4.33	4.46	4.41	4.40	
Carbon Dioxide Concentration (%)	23.33	23.53	23.58	23.48	
Carbon Dioxide Concentration (% , drift corrected as per USEPA 7E)	23.07	23.32	23.57	23.32	
Outlet Formaldehyde Concentration (ppmvd)	0.029	0.034	0.039	0.034	
Formaldehyde Emission Rate (lb/hr)	0.021	0.025	0.028	0.024	
<b>Formaldehyde Emission Rate (lb/MMBtu)</b>	<b>3.55E-05</b>	<b>4.37E-05</b>	<b>4.72E-05</b>	<b>4.21E-05</b>	<b>3.96E-05</b>

O <sub>2</sub> Correction			
Co	0.18	0.17	0.22
Cma	10.06	10.06	10.06
Cm	9.69	9.70	9.73

CO <sub>2</sub> Correction			
Co	0.20	0.26	0.26
Cma	10.07	10.07	10.07
Cm	10.30	10.31	10.23

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 = 30.03)  
 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  
 1000 = scf per kscf  
 10<sup>5</sup> = Btu per MMBtu  
 BFG Gross Heating Value (Btu/scf) from Laboratory Analysis      112      Btu/scf  
 NG Gross Heating Value (Btu/scf) from Laboratory Analysis      1057      Btu/scf

**Equations**

MMBtu/hr = kscf/hr \* Btu/scf \* 1000 \* (1/10<sup>6</sup>)  
 lb/hr = ppmv \* MW/24.14 \* 1/35.31 \* 1/453,600 \* dcfm \* 60  
 lb/MMBtu = (lb/hr) / (MMBtu/hr)



**Tab.**  
**Boiler 2100**  
**Formaldehyde Emission Rates**  
**Dearborn Industrial Generation**  
**Dearborn, MI**  
**BTEC Project No. 049AS-455247**  
**Sampling Dates: 8/23/2018**

Parameter	Run 1	Run 2	Run 3	Average	Average of Boiler 1 Boiler 2 Boiler 3
Test Run Date	8/23/2018	8/23/2018	8/23/2018		
Test Run Time	8:10-9:10	9:23-10:23	10:35-11:35		
Outlet Flowrate (dscfm)	164,194	165,265	164,416	<b>164,625</b>	
Outlet Flowrate (scfm)	184,074	186,109	186,836	<b>185,673</b>	
BFG Flow Rate (kscf/hr)	4,926.163	4,957.292	4,929.063	<b>4,937.51</b>	
NG Flow Rate (kscf/hr)	33.186	33.163	33.147	<b>33.17</b>	
BFG Heat Input (MMBtu/hr)	551.7	555.2	552.1	<b>553.0</b>	
NG Heat Input (MMBtu/hr)	35.1	35.1	35.0	<b>35.1</b>	
Total Heat Input (MMBtu/hr)	586.8	590.3	587.1	<b>588.1</b>	
Oxygen Concentration (%)	5.81	5.68	5.67	<b>5.72</b>	
Oxygen Concentration (% , drift corrected as per USEPA 7E)	5.67	5.67	5.75	<b>5.70</b>	
Carbon Dioxide Concentration (%)	21.64	21.87	21.90	<b>21.80</b>	
Carbon Dioxide Concentration (% , drift corrected as per USEPA 7E)	21.70	21.77	21.68	<b>21.71</b>	
Outlet Formaldehyde Concentration (ppmvd)	0.027	0.025	0.024	<b>0.025</b>	
Formaldehyde Emission Rate (lb/hr)	0.021	0.019	0.018	<b>0.019</b>	
<b>Formaldehyde Emission Rate (lb/MMBtu)</b>	<b>3.52E-05</b>	<b>3.26E-05</b>	<b>3.13E-05</b>	<b>3.30E-05</b>	<b>3.96E-05</b>

O <sub>2</sub> Correction			
Co	0.31	0.25	0.20
Cma	10.06	10.06	10.06
Cm	10.07	9.89	9.78

CO <sub>2</sub> Correction			
Co	0.13	0.21	0.23
Cma	10.07	10.07	10.07
Cm	10.11	10.23	10.30

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 = 30.03)  
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  
1000 = scf per kscf  
10<sup>6</sup> = Btu per MMBtu  
BFG Gross Heating Value (Btu/scf) from Laboratory Analysis      112      Btu/scf  
NG Gross Heating Value (Btu/scf) from Laboratory Analysis      1057      Btu/scf

**Equations**

MMBtu/hr = kscf/hr \* Btu/scf \* 1000 \* (1/10<sup>6</sup>)  
lb/hr = ppmv \* MW/24.14 \* 1/35.31 \* 1/453,600 \* dcfm \* 60  
lb/MMBtu = (lb/hr) / (MMBtu/hr)

**Tab.**  
**Boiler 3100**  
**Formaldehyde Emission Rates**  
**Dearborn Industrial Generation**  
**Dearborn, MI**  
**BTEC Project No. 049AS-455247**  
**Sampling Dates: 8/22/2018**

Parameter	Run 1	Run 2	Run 3	Average	Average of Boiler 1 Boiler 2 Boiler 3
Test Run Date	8/22/2018	8/22/2018	8/22/2018		
Test Run Time	13:55-14:55	15:10-16:10	16:25-17:25		
Outlet Flowrate (dscfm)	173,072	173,928	179,466	175,489	
Outlet Flowrate (scfm)	192,945	195,644	198,525	195,705	
BFG Flow Rate (kscf/hr)	5,224.219	5,420.700	4,422.199	5,022.37	
NG Flow Rate (kscf/hr)	33.427	33.380	33.372	33.39	
BFG Heat Input (MMBtu/hr)	585.1	607.1	495.3	562.5	
NG Heat Input (MMBtu/hr)	35.4	35.3	35.3	35.3	
Total Heat Input (MMBtu/hr)	620.5	642.4	530.6	597.8	
Oxygen Concentration (%)	4.90	4.83	5.41	5.05	
Oxygen Concentration (%; drift corrected as per USEPA 7E)	4.90	4.83	5.41	5.05	
Carbon Dioxide Concentration (%)	22.45	22.83	21.25	22.18	
Carbon Dioxide Concentration (%; drift corrected as per USEPA 7E)	22.73	22.92	21.34	22.33	
Outlet Formaldehyde Concentration (ppmvd)	0.034	0.026	0.034	0.031	
Formaldehyde Emission Rate (lb/hr)	0.027	0.021	0.028	0.026	
<b>Formaldehyde Emission Rate (lb/MMBtu)</b>	<b>4.42E-05</b>	<b>3.28E-05</b>	<b>5.36E-05</b>	<b>4.35E-05</b>	<b>3.96E-05</b>

O <sub>2</sub> Correction			
Co	0.10	0.11	0.11
Cma	10.06	10.06	10.06
Cm	9.96	9.95	9.97

CO <sub>2</sub> Correction			
Co	0.15	0.18	0.16
Cma	10.07	10.07	10.07
Cm	10.03	10.13	10.11

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 = 30.03)  
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  
1000 = scf per kscf  
10<sup>6</sup> = Btu per MMBtu  
BFG Gross Heating Value (Btu/scf) from Laboratory Analysis      112      Btu/scf  
NG Gross Heating Value (Btu/scf) from Laboratory Analysis      1058      Btu/scf

**Equations**

MMBtu/hr = kscf/hr \* Btu/scf \* 1000 \* (1/10<sup>6</sup>)  
lb/hr = ppmv \* MW/24.14 \* 1/35.31 \* 1/453,600 \* dcfm \* 60  
lb/MMBtu = (lb/hr) / (MMBtu/hr)

**Table 9**  
**Turbine 1100**  
**Formaldehyde Emission Rates**  
**Dearborn Industrial Generation**  
**Dearborn, MI**  
**BTEC Project No. 049AS-455247**  
**Sampling Dates: 8/21/2018**

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	8/21/2018	8/21/2018	8/21/2018	
Test Run Time	8:25-9:25	9:36-10:36	10:45-11:45	
Oxygen Concentration (%)	12.97	12.93	12.89	<b>12.93</b>
Oxygen Concentration (% , drift corrected as per USEPA 7E)	13.15	13.19	13.20	<b>13.18</b>
Carbon Dioxide Concentration (%)	4.48	4.49	4.51	<b>4.49</b>
Carbon Dioxide Concentration (% , drift corrected as per USEPA 7E)	4.42	4.43	4.43	<b>4.42</b>
Outlet Formaldehyde Concentration (ppmvd)	0.031	0.041	0.038	<b>0.037</b>
Formaldehyde Emission Rate (lb/MMBtu)	<b>5.65E-05</b>	<b>7.52E-05</b>	<b>6.98E-05</b>	<b>6.72E-05</b>

O <sub>2</sub> Correction			
Co	0.12	0.05	0.04
Cma	10.06	10.06	10.06
Cm	9.95	9.88	9.84

CO <sub>2</sub> Correction			
Co	0.14	0.12	0.13
Cma	10.07	10.07	10.07
Cm	10.05	10.06	10.09

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (CH<sub>2</sub>O = 30.03)

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

Fd = 8,710 dscf/MMBtu for natural gas

**Equations**

$$(Cd) \text{ lb/dscf} = \text{ppmv} * \text{MW}/24.14 * 1/35.31 * 1/453,600$$

$$\text{Eq 19-1, lb/MMBtu} = Cd * Fd * 20.9/(20.9-O_2\%)$$

**Table 10**  
**Turbine 2100**  
**Formaldehyde Emission Rates**  
**Dearborn Industrial Generation**  
**Dearborn, MI**  
**BTEC Project No. 049AS-455247**  
**Sampling Dates: 8/21/2018**

Parameter	Run 1	Run 2	Run 3	Average	Average of Turbine 2100 Turbine 3100
Test Run Date	8/21/2018	8/21/2018	8/21/2018		
Test Run Time	13:10-14:10	14:25-15:25	15:39-16:39		
Oxygen Concentration (%)	13.06	13.06	12.96	13.03	
Oxygen Concentration (%), drift corrected as per USEPA 7E)	13.18	13.23	13.20	13.20	
Carbon Dioxide Concentration (%)	4.49	4.50	4.51	4.50	
Carbon Dioxide Concentration (%), drift corrected as per USEPA 7E)	4.43	4.41	4.39	4.41	
Outlet Formaldehyde Concentration (ppmvd)	0.030	0.031	0.034	0.032	
<b>Formaldehyde Emission Rate (lb/MMBtu)</b>	<b>5.50E-05</b>	<b>5.71E-05</b>	<b>6.24E-05</b>	<b>5.82E-05</b>	<b>5.61E-05</b>

O <sub>2</sub> Correction			
Co	0.19	0.14	0.08
Cma	10.06	10.06	10.06
Cm	10.01	9.97	9.90

CO <sub>2</sub> Correction			
Co	0.16	0.17	0.18
Cma	10.07	10.07	10.07
Cm	10.02	10.07	10.12

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (CH<sub>2</sub>O = 30.03)

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

Fd = 8,710 dscf/MMBtu for natural gas

**Equations**

(Cd) lb/dscf = ppmv \* MW/24.14 \* 1/35.31 \* 1/453,600

Eq 19-1, lb/MMBtu = Cd \* Fd \* 20.9/(20.9-O<sub>2</sub>%)

**Table 11**  
**Turbine 3100**  
**Formaldehyde Emission Rates**  
**Dearborn Industrial Generation**  
**Dearborn, MI**  
**BTEC Project No. 049AS-455247**  
**Sampling Dates: 8/22/2018**

Parameter	Run 1	Run 2	Run 3	Average	Average of Turbine 2100 Turbine 3100
Test Run Date	8/22/2018	8/22/2018	8/22/2018		
Test Run Time	8:10-9:10	9:25-10:25	10:50-11:50		
Oxygen Concentration (%)	13.08	13.05	12.99	13.04	
Oxygen Concentration (%; drift corrected as per USEPA 7E)	13.14	13.15	13.15	13.15	
Carbon Dioxide Concentration (%)	4.53	4.56	4.59	4.56	
Carbon Dioxide Concentration (%; drift corrected as per USEPA 7E)	4.45	4.44	4.45	4.45	
Outlet Formaldehyde Concentration (ppmvd)	0.029	0.027	0.033	0.030	
Formaldehyde Emission Rate (lb/MMBtu)	5.28E-05	4.93E-05	6.02E-05	5.41E-05	5.61E-05

O <sub>2</sub> Correction			
Co	0.30	0.32	0.31
Cma	10.06	10.06	10.06
Cm	10.09	10.06	10.01

CO <sub>2</sub> Correction			
Co	0.14	0.17	0.19
Cma	10.07	10.07	10.07
Cm	10.08	10.14	10.16

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (CH<sub>2</sub>O = 30.03)

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>

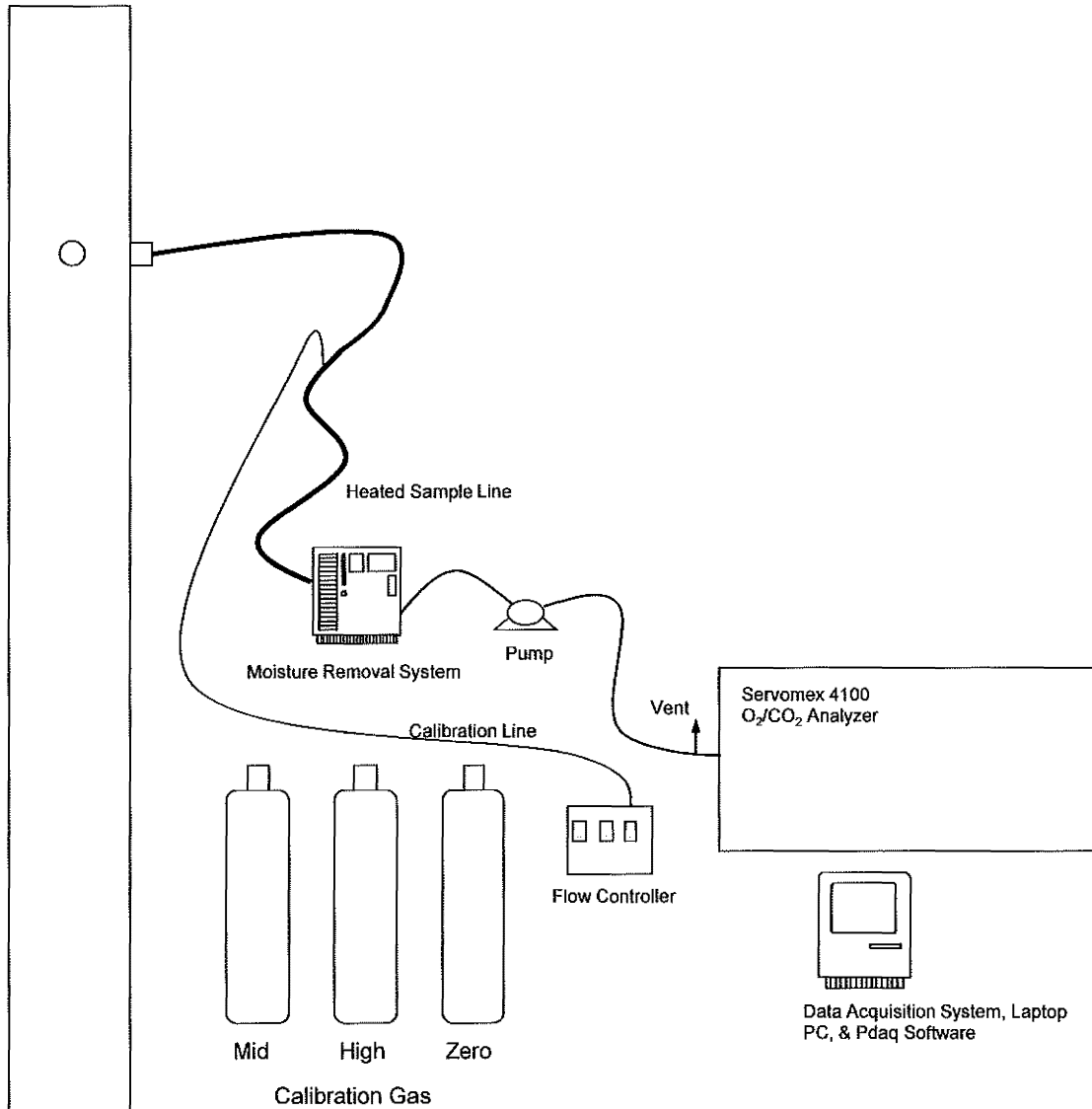
453600 = mg per lb

Fd = 8,710 dscf/MMBtu for natural gas

**Equations**

(Cd) lb/dscf = ppmv \* MW/24.14 \* 1/35.31 \* 1/453,600

Eq 19-1, lb/MMBtu = Cd \* Fd \* 20.9/(20.9-O<sub>2</sub>%)

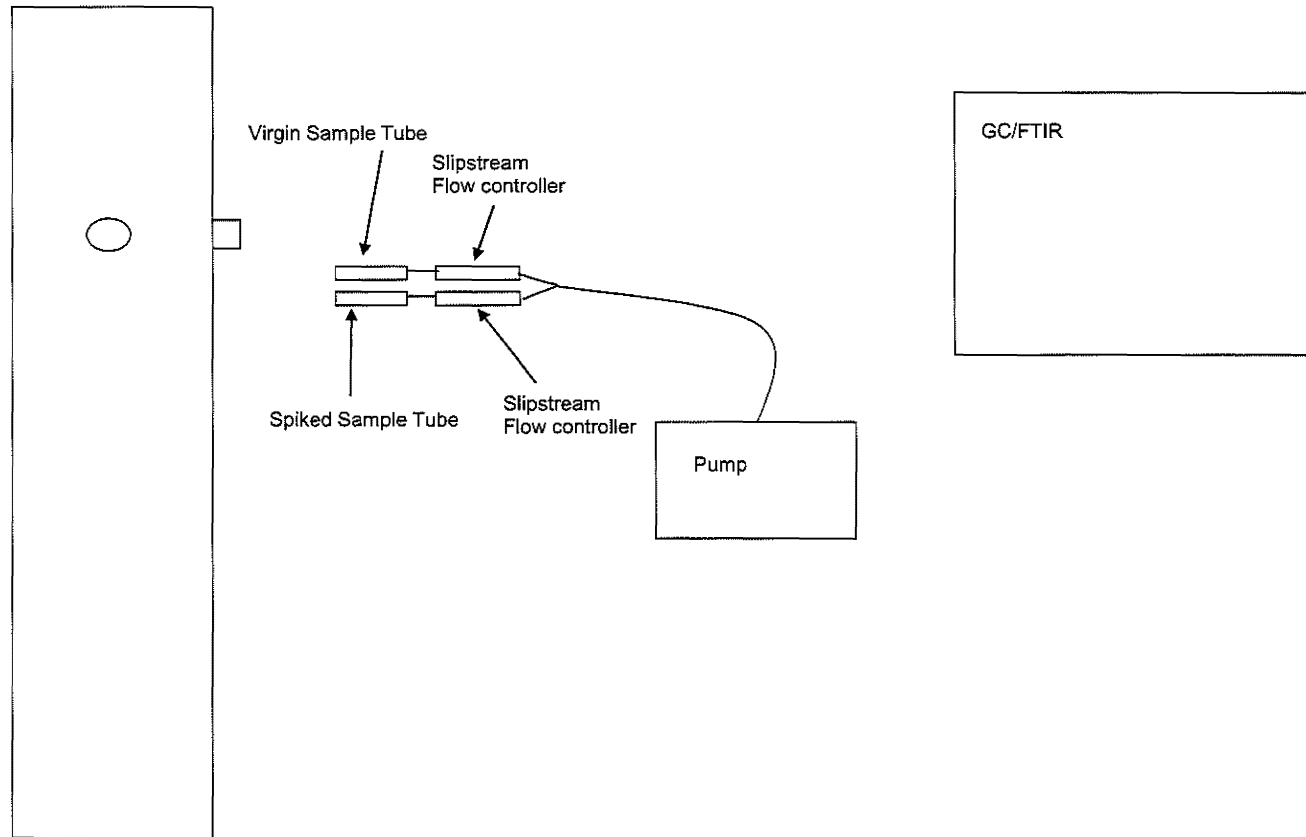


**Figure No. 1**

**Site:**  
**USEPA Method 3A**  
**Dearborn Industrial Generation**  
**Dearborn, Michigan**

**Sampling Date:**  
**August 21-23, 2018**

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



**Figure No. 2**

Site:  
USEPA Method 18  
Dearborn Industrial Generation  
Dearborn, Michigan

Sampling Date:  
August 21-23, 2018

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

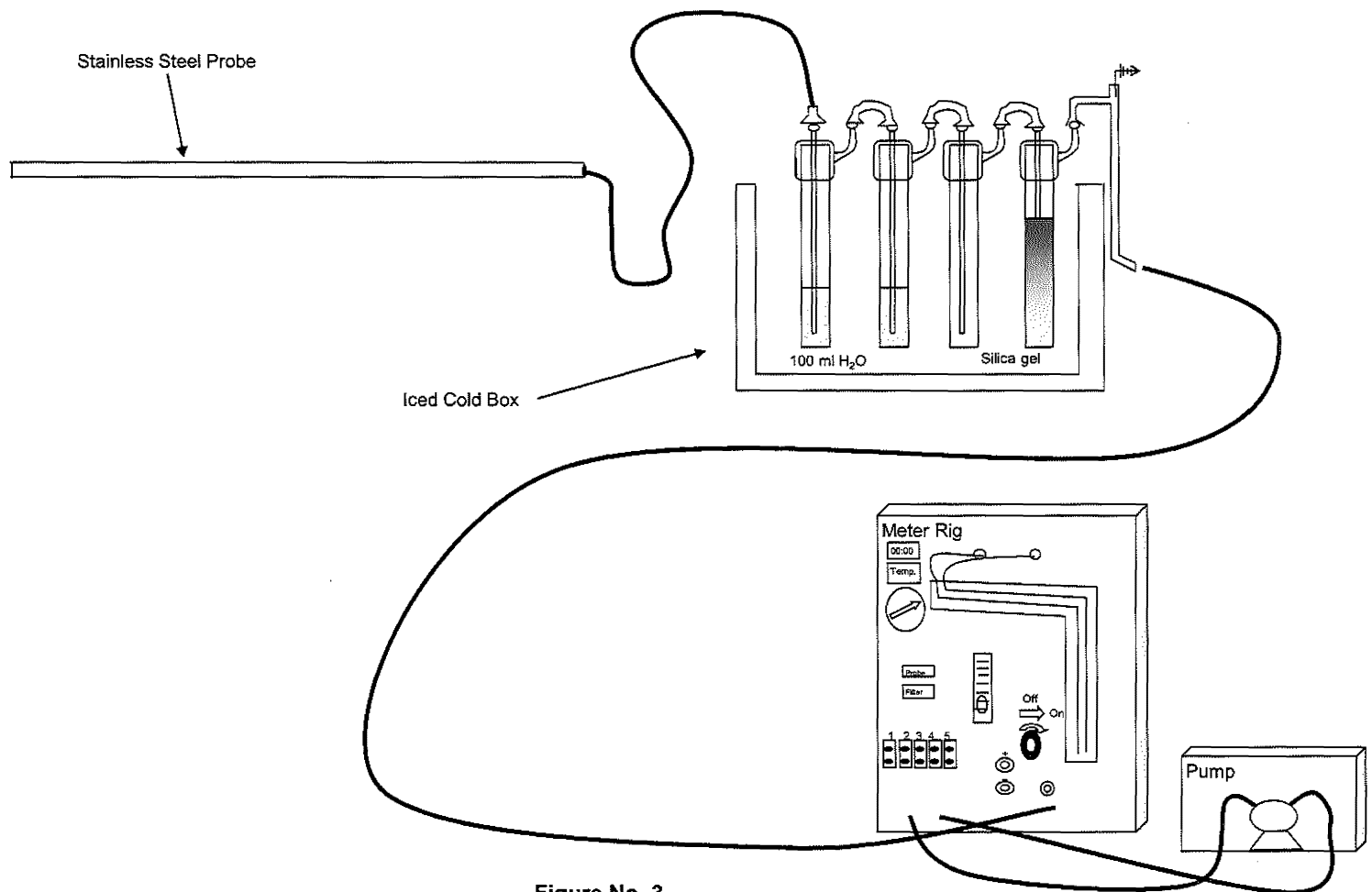


Figure No. 3

Site:  
USEPA Method 4  
Dearborn Industrial Generation  
Dearborn, Michigan

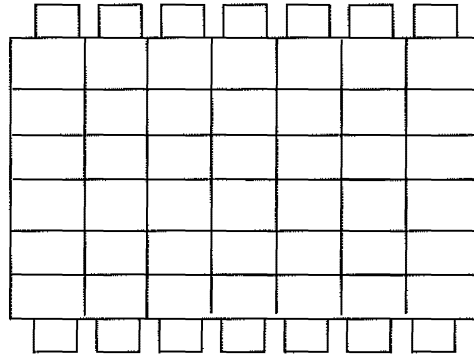
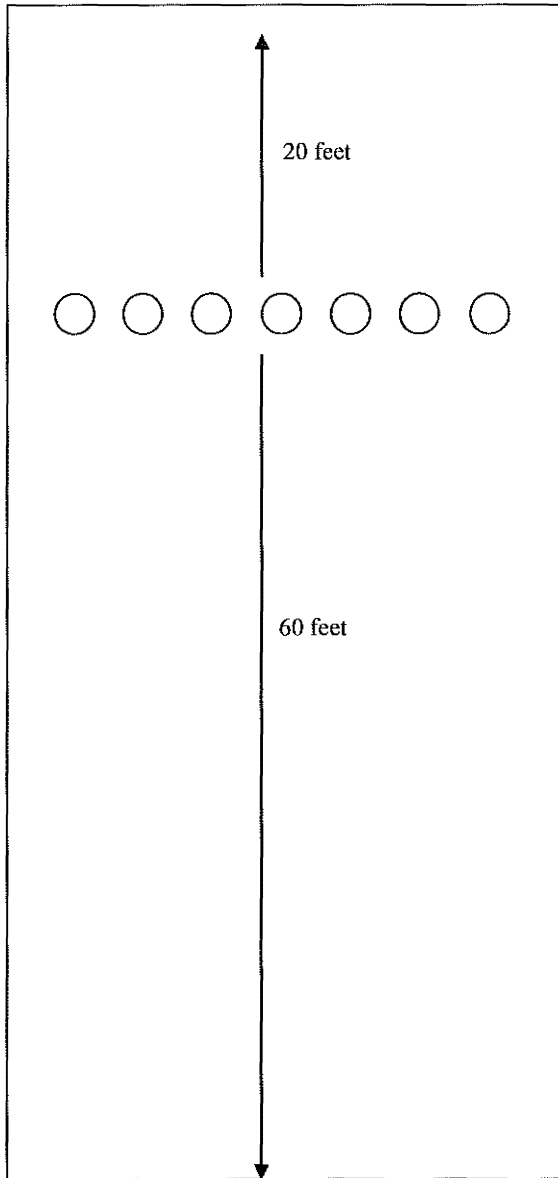
Sampling Date:  
August 22-23, 2018

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





Stack Dimensions: 19' Deep X 22' Wide



Not to Scale

All samples were extracted from a single point in the center of the stack

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**Figure No. 4**

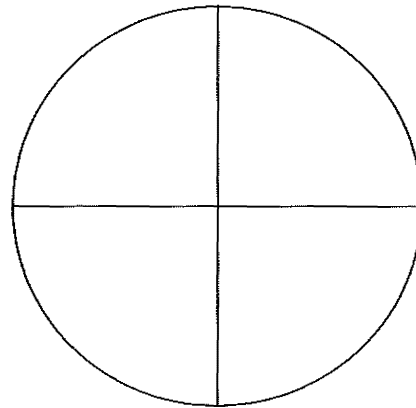
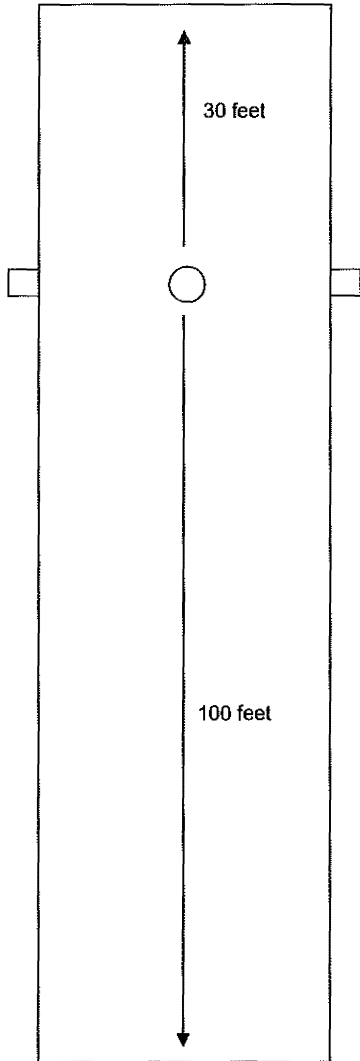
**Site:**  
Turbine 1100 (EUCTG1)  
Dearborn Industrial Generation  
Dearborn, Michigan

**Sampling Date:**  
August 21, 2018

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



diameter = 210 inches



Not to Scale

All samples were extracted from a single point in the center of the stack

Figure No. 5

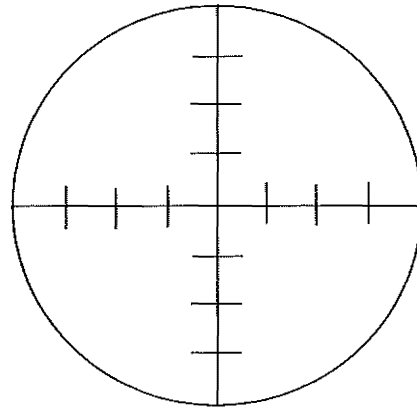
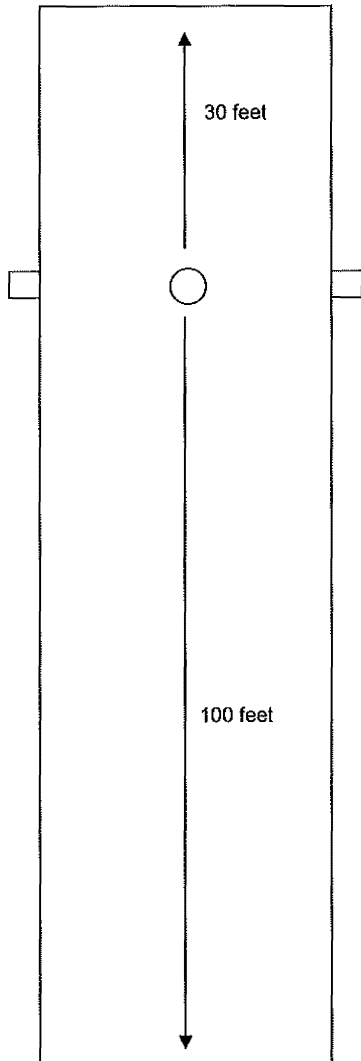
Site:  
Turbine 2100 and 3100  
Dearborn Industrial Generation  
Dearborn, Michigan

Sampling Date:  
August 21-22, 2018

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



diameter = 126 inches



Not to Scale

Points	Distance "
1	5.5
2	18.4
3	37.3
4	88.7
5	107.60
6	120.46

All samples were extracted from a single point in the center of the stack

Figure No. 6

Site: Boilers 1100, 2100, and 3100  
Dearborn Industrial Generation  
Dearborn, Michigan

Sampling Date: August 22-23, 2018

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