

Dearborn Industrial Generation CH₂O Emissions Test Report

AIR QUALITY DIVISION

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Prepared for:

Dearborn Industrial Generation

Dearborn, MI

Dearborn Industrial Generation
2400 Miller Road
Dearborn, MI 48121

Project No. 049AS-521788
January 29, 2019

Montrose Air Quality Services, LLC
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EXECUTIVE SUMMARY

Montrose Air Quality Services, LLC (MAQS) was retained by Dearborn Industrial Generation LLC (DIG) to evaluate formaldehyde (CH₂O) 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 test program was conducted on December 4-6, 2018.

MDEQ issued permit to install (PTI) No. 163-17 to DIG on January 31, 2018 that contains a formaldehyde emission limit of 36 tons 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 "winter" 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 ₂ O (lb/MMBtu)
Boiler 1100	1.30×10^{-4}
Boiler 2100	1.74×10^{-4}
Boiler 3100	8.08×10^{-5}
Turbine 1100	2.07×10^{-4}
Turbine 2100	1.07×10^{-4}
Turbine 3100	1.11×10^{-4}

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1. Introduction

Montrose Air Quality Services, LLC (MAQS) was retained by Dearborn Industrial Generation LLC (DIG) to evaluate formaldehyde (CH₂O) 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 tons 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 "winter" formaldehyde testing as required by SC V.1 of PTI No. 163-17.

The emissions testing was conducted on December 4-6, 2018. MAQS personnel Steven Smith, Mike Nummer, and Shane Rabideau, and Prism personnel Dave Schuberg, and Trevor Tilmann performed the testing. Mr. Paul Snoes of DIG provided onsite coordination for the test program. Mr. Mark Dziados and Mr. John Lamb 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 December 4-6, 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 ¹	CH ₂ O	36 tons/yr

¹DIG'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 Factors¹
Dearborn Industrial Generation LLC**

Equipment Category	Emission Factor
Boilers	1.12E-03
Simple-cycle Turbine	8.67E-04
Combined-cycle Turbine	1.36E-03

¹These 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. Todd Wessel
 Client Project Manager
 Montrose Air Quality Services, LLC
 4949 Fernlee Avenue
 Royal Oak, Michigan 48073
 Phone (616) 885-4013

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**

Name and Title	Affiliation	Telephone
Mr. Paul Snoes Health & Safety Coordinator	Dearborn Industrial Generation LLC 2400 Miller Rd. Dearborn, MI 48120	(313) 336-7189
Mr. Steven Smith Client Project Manager	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(616) 885-4013
Mr. Michael Nummer Field Technician	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Shane Rabideau Field Technician	MAQS 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Dave Schuberg Field Project Manager	Prism Analytical Technologies 2625 Denison Drive Mt. Pleasant, MI 48858	(989) 772-5088
Mr. Trevor Tilmann Field Project Manager	Prism Analytical Technologies 2625 Denison Drive Mt. Pleasant, MI 48858	(989) 772-5088
Mr. Mark Dziados Air Quality Division, MDEQ	Southeast Michigan District Office 27700 Donald Court Warren, MI 48092-2793	(586) 753-3745
Mr. Jon Lamb Air Quality Division, MDEQ	MDEQ	(313) 456-4683

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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_x combustors minimize the emissions of nitrogen oxides from the turbines, while the emissions of CO

and SO₂ 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 O₂ and CO₂ content of the gas stream is measured using a Servomex 4100 O₂/CO₂ 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 O₂/CO₂ analyzer. Data is recorded on a PC equipped with data acquisition software. Recorded O₂/CO₂ 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 O₂/CO₂ analyzer prior to initiating the test program. Following each test run, a 2-point (zero and high) calibration drift check is performed. The O₂/CO₂ analyzer was 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 were 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 N₂.
 - 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

- 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.

The lb/MMBtu emission factors for the boilers were also calculated using the Fd factor from the PEMS, to demonstrate that Method 19 provides comparable results to those calculated using Methods 1, 2, and 4. The emission rates calculated using Method 19 are presented in Tables 6 to 8 for each boiler.

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.

4.e Boiler 1100, 2100, and 3100 CO₂ Determination

During the testing of Boilers 1100, 2100, and 3100, the measured Carbon Dioxide concentration exceeded the analyzer calibration span value of 22.94%. Because a cylinder with a higher CO₂ concentration was not available, samples were taken during each run in Tedlar bags and sent to Enthalpy Analytical's laboratory in Durham, North Carolina for Method 18 analysis. A copy of Enthalpy's results report can be found in Appendix G. Because the data collected was not used in calculating emission rates, analyzer calibration and drift correction data for Boilers 1100, 2100, and 3100 has been omitted from the report but can be found in the compact disk containing all of MAQS's CEMS data files.

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 ₂ O (lb/MMBtu)
Boiler 1100	1.30*10 ⁻⁴
Boiler 2100	1.74*10 ⁻⁴
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Turbine 2100	1.07*10 ⁻⁴
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Turbine 2100	1.07*10 ⁻⁴
Turbine 3100	1.11*10 ⁻⁴

Detailed data for each test run can be found in Tables 5-10.

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**

Equipment Category	Emission Unit(s)	Test Result Average¹ (lb/MMBtu)	Emission Factor² (lb/MMBtu)
Boilers	Boiler 1100 Boiler 2100 Boiler 3100	1.26E-04	1.12E-03
Simple-cycle Turbine	Turbine 1100	2.07E-04	8.67E-04
Combined-cycle Turbine	Turbine 2100 Turbine 3100	1.09E-04	1.36E-03

¹ 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).

² 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

A fourth run on Boiler 3 was performed due to a failed spike recovery after Run 1.

Two fuel samples of BFG were taken for each of the two days testing (12/3/18 and 12/5/18) was performed on the boilers. Boiler emission rates are calculated using the fuel analysis from the samples taken on 12/5/18 and 12/6/18.

Due to the measured concentration Boilers 1100, 2100, and 3100 exceeding the calibration span for Carbon Dioxide, bag samples were taken for Method 18 analysis by Enthalpy Analytical.

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

A copy of the report form Prismo Analytical Technologies can be found in Appendix F. Laboratory analytical results relevant to the emissions test program are provided in Appendix G.

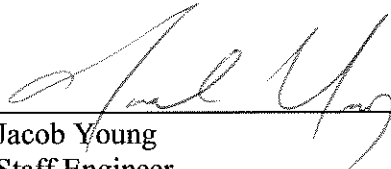
MEASUREMENT UNCERTAINTY STATEMENT

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. MAQS will not distribute or publish this report without DIG's consent except as required by law or court order. MAQS 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:



Jacob Young
Staff Engineer

This report was reviewed by:



Randal Tysar
District Manager

Tables

Table 6
Boiler 1100
Formaldehyde Emission Rates
Dearborn Industrial Generation
Dearborn, MI
MAQS Project No. 049AS-521788
Sampling Dates: 12/6/2018

Parameter	Run 1	Run 2	Run 3	Average	Average of Boiler 1 Boiler 2 Boiler 3
Test Run Date	12/6/2018	12/6/2018	12/6/2018		
Test Run Time	13:10-14:10	14:22-15:22	15:33-16:33		
Outlet Flowrate (dscfm)	163,192	164,606	161,960	163,252	
Outlet Flowrate (scfm)	179,135	177,186	175,281	177,201	
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)	508.1	486.0	509.0	501.0	
NG Heat Input (MMBtu/hr)	34.4	34.3	34.3	34.3	
Total Heat Input (MMBtu/hr)	542.4	520.4	543.3	535.4	
Oxygen Concentration (%)	4.42	4.39	4.43	4.41	
Oxygen Concentration (%; drift corrected as per USEPA 7E)	4.40	4.34	4.34	4.36	
Carbon Dioxide Concentration (%)	20.90	20.90	22.10	21.30	
Outlet Formaldehyde Concentration (ppmvd)	0.084	0.081	0.110	0.092	
Formaldehyde Emission Rate (lb/hr)	0.064	0.062	0.083	0.070	
Formaldehyde Emission Rate (lb/MMBtu)	1.18E-04	1.19E-04	1.53E-04	1.30E-04	1.28E-04

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 (CH₂O = 30.03)
24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)
35.31 = ft³ per m³
453600 = mg per lb
1000 = scf per kscf
10⁶ = Btu per MMBtu
BFG Gross Heating Value (Btu/scf) from Laboratory Analysis 103 Btu/scf
NG Gross Heating Value (Btu/scf) from Laboratory Analysis 1064 Btu/scf

Equations

MMBtu/hr = kscf/hr * Btu/scf * 1000 * (1/10⁶)
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453.600 * dscfm * 60
lb/MMBtu = (lb/hr) / (MMBtu/hr)

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Table 7
Boiler 2100
Formaldehyde Emission Rates
Dearborn Industrial Generation
Dearborn, MI
MAQS Project No. 049AS-521788
Sampling Dates: 12/6/2018

Parameter	Run 1	Run 2	Run 3	Average	Average of Boiler 1 Boiler 2 Boiler 3
Test Run Date	12/6/2018	12/6/2018	12/6/2018		
Test Run Time	8:40-9:40	9:51-10:51	11:01-12:01		
Outlet Flowrate (dscfm)	154,121	153,112	156,997	154,743	
Outlet Flowrate (scfm)	167,522	166,245	171,394	168,387	
BFG Flow Rate (kscf/hr)	4,798.059	4,853.511	4,901.540	4,851.04	
NG Flow Rate (kscf/hr)	33.512	33.528	33.507	33.52	
BFG Heat Input (MMBtu/hr)	494.2	499.9	504.9	499.7	
NG Heat Input (MMBtu/hr)	35.7	35.7	35.7	35.7	
Total Heat Input (MMBtu/hr)	529.9	535.6	540.5	535.3	
Oxygen Concentration (%)	3.97	3.98	3.94	3.96	
Oxygen Concentration (%), drift corrected as per USEPA 7E)	3.89	3.92	3.90	3.90	
Carbon Dioxide Concentration (%)	21.30	19.80	22.70	21.27	
Outlet Formaldehyde Concentration (ppmvd)	0.107	0.136	0.145	0.129	
Formaldehyde Emission Rate (lb/hr)	0.077	0.097	0.106	0.093	
Formaldehyde Emission Rate (lb/MMBtu)	1.45E-04	1.81E-04	1.96E-04	1.74E-04	1.28E-04

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 (CH₂O = 30.03)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft³ per m³

453600 = mg per lb

1000 = scf per kscf

10⁶ = Btu per MMBtu

BFG Gross Heating Value (Btu/scf) from Laboratory Analysis

103 Btu/scf

NG Gross Heating Value (Btu/scf) from Laboratory Analysis

1064 Btu/scf

Equations

$$\text{MMBtu/hr} = \text{kscf/hr} * \text{Btu/scf} * 1000 * (1/10^6)$$

$$\text{lb/hr} = \text{ppmv} * \text{MW}/24.14 * 1/35.31 * 1/453,600 * \text{dscfm} * 60$$

$$\text{lb/MMBtu} = (\text{lb/hr}) / (\text{MMBtu/hr})$$

Table 8
Boiler 3100
Formaldehyde Emission Rates
Dearborn Industrial Generation
Dearborn, MI
MAQS Project No. 049AS-521788
Sampling Dates: 12/5/2018

Parameter	Run 1	Run 2	Run 3	Run 4	Average	Average of Boiler 1 Boiler 2 Boiler 3
Test Run Date	12/5/2018	12/5/2018	12/5/2018	12/5/2018		
Test Run Time	12:40-13:40	13:56-14:56	15:12-16:12	16:24-17:24		
Outlet Flowrate (dscfm)	175,919	173,643	173,741	176,351	174,434	
Outlet Flowrate (scfm)	190,183	186,513	187,220	188,409	187,972	
BFG Flow Rate (kscf/hr)	5,205.242	5,226.815	5,308.626	5,259.504	5,250.05	
NG Flow Rate (kscf/hr)	33.465	33.457	33.474	33.480	33.47	
BFG Heat Input (MMBtu/hr)	536.1	538.4	546.8	541.7	540.4	
NG Heat Input (MMBtu/hr)	35.5	35.5	35.5	35.6	35.5	
Total Heat Input (MMBtu/hr)	571.7	573.9	582.3	577.3	576.0	
Oxygen Concentration (%)	4.74	4.77	4.64	4.65	4.70	
Oxygen Concentration (% , drift corrected as per USEPA 7E)	4.68	4.79	4.68	4.70	4.71	
Carbon Dioxide Concentration (%)	22.30	22.40	21.80	22.20	22.18	
Outlet Formaldehyde Concentration (ppmvd)		0.054	0.055	0.063	0.057	
Formaldehyde Emission Rate (lb/hr)		0.044	0.045	0.052	0.047	
Formaldehyde Emission Rate (lb/MMBtu)		7.61E-05	7.65E-05	8.97E-05	8.08E-05	1.28E-04

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 (CH₂O = 30.03)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft³ per m³

453600 = mg per lb

1000 = scf per kscf

10⁶ = Btu per MMBtu

BFG Gross Heating Value (Btu/scf) from Laboratory Analysis

103 Btu/scf

NG Gross Heating Value (Btu/scf) from Laboratory Analysis

1062 Btu/scf

Equations

$$\text{MMBtu/hr} = \text{kscf/hr} * \text{Btu/scf} * 1000 * (1/10^6)$$

$$\text{lb/hr} = \text{ppmv} * \text{MW}/24.14 * 1/35.31 * 1/453,600 * \text{dscfm} * 60$$

$$\text{lb/MMBtu} = (\text{lb/hr}) / (\text{MMBtu/hr})$$

Table 9
Turbine 1100
Formaldehyde Emission Rates
Dearborn Industrial Generation
Dearborn, MI
MAQS Project No. 049AS-521788
Sampling Dates: 12/4/2018

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	12/4/2018	12/4/2018	12/4/2018	
Test Run Time	7:00-8:00	8:20-9:20	9:30-10:30	
Oxygen Concentration (%)	12.97	12.83	12.88	12.89
Oxygen Concentration (%), drift corrected as per USEPA 7E)	13.22	13.16	13.36	13.25
Carbon Dioxide Concentration (%)	4.46	4.51	4.53	4.50
Carbon Dioxide Concentration (%), drift corrected as per USEPA 7E)	4.38	4.40	4.39	4.39
Outlet Formaldehyde Concentration (ppmv)	0.113	0.117	0.106	0.112
Formaldehyde Emission Rate (lb/MMBtu)	2.08E-04	2.14E-04	1.99E-04	2.07E-04

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

lb/hr = pounds per hour

MW = molecular weight (CH₂O = 30.03)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft³ per m³

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-O₂%)

Table 10
Turbine 2100
Formaldehyde Emission Rates
Dearborn Industrial Generation
Dearborn, MI
MAQS Project No. 049AS-521788
Sampling Dates: 12/4/2018

Parameter	Run 1	Run 2	Run 3	Average	Average of Turbine 2100 and 3100
Test Run Date	12/4/2018	12/4/2018	12/4/2018		
Test Run Time	12:22-13:22	13:37-14:37	15:05-16:05		
Oxygen Concentration (%)	12.76	12.47	12.83	12.69	
Oxygen Concentration (%), drift corrected as per USEPA 7E)	13.03	12.94	12.94	12.97	
Carbon Dioxide Concentration (%)	4.49	4.60	4.54	4.54	
Carbon Dioxide Concentration (%), drift corrected as per USEPA 7E)	4.42	4.47	4.44	4.44	
Outlet Formaldehyde Concentration (ppmvd)	0.056	0.065	0.059	0.060	
Formaldehyde Emission Rate (lb/MMBtu)	1.01E-04	1.15E-04	1.05E-04	1.07E-04	1.09E-04

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

lb/hr = pounds per hour

MW = molecular weight (CH₂O = 30.03)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft³ per m³

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-O₂%)

Table 11
Turbine 3100
Formaldehyde Emission Rates
Dearborn Industrial Generation
Dearborn, MI
MAQS Project No. 049AS-521788
Sampling Dates: 12/5/2018

Parameter	Run 1	Run 2	Run 3	Average	Average of Turbine 2100 and 3100
Test Run Date	12/5/2018	12/5/2018	12/5/2018		
Test Run Time	7:05-8:05	8:15-9:15	9:27-10:27		
Oxygen Concentration (%)	12.94	13.02	12.89	12.95	
Oxygen Concentration (% , drift corrected as per USEPA 7E)	13.02	13.06	12.93	13.00	
Carbon Dioxide Concentration (%)	4.57	4.57	4.57	4.57	
Carbon Dioxide Concentration (% , drift corrected as per USEPA 7E)	4.50	4.49	4.46	4.48	
Outlet Formaldehyde Concentration (ppmvd)	0.059	0.068	0.059	0.062	
Formaldehyde Emission Rate (lb/MMBtu)	1.06E-04	1.23E-04	1.05E-04	1.11E-04	1.09E-04

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

lb/hr = pounds per hour

MW = molecular weight (CH₂O = 30.03)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft³ per m³

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-O₂%)

Figures

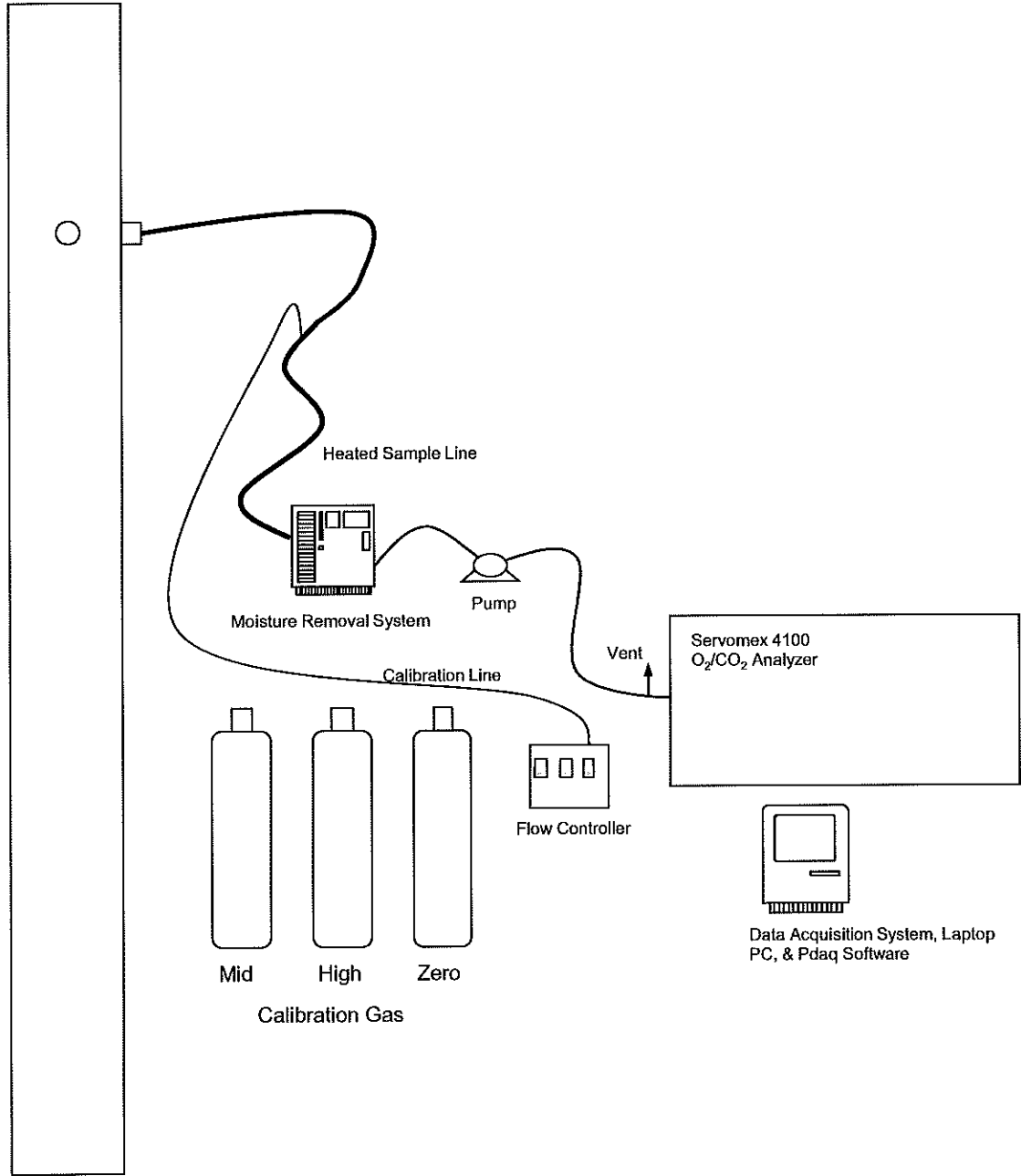


Figure No. 1

<p>Site: USEPA Method 3A Dearborn Industrial Generation Dearborn, Michigan</p>	<p>Sampling Date: December 4-6, 2018</p>	<p>Montrose Air Quality Services, LLC. 4949 Fernlee Avenue Royal Oak, MI 48073</p>
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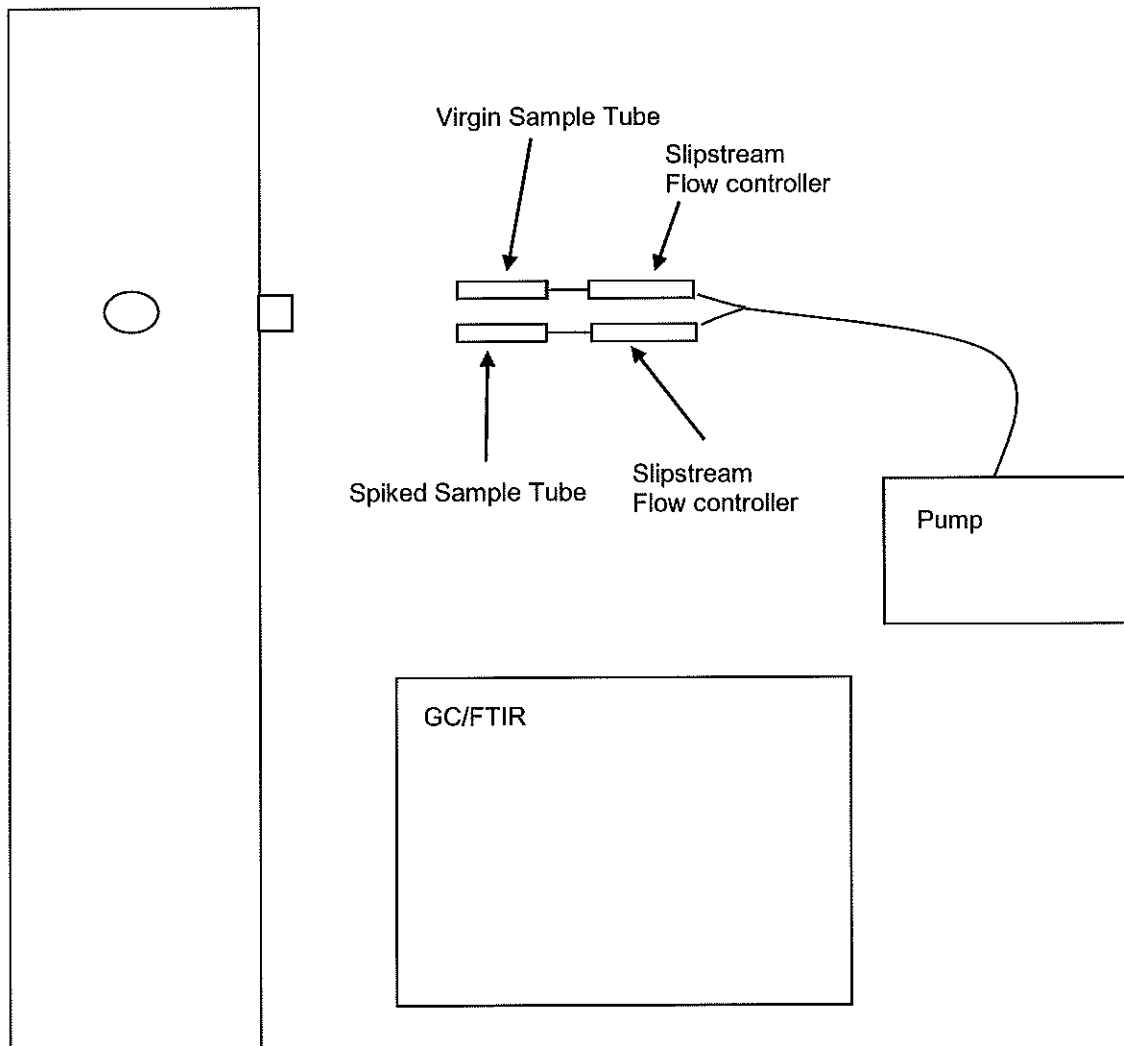


Figure No. 2

Site:
USEPA Method 18
Dearborn Industrial Generation
Dearborn, Michigan

Sampling Date:
December 4-6, 2018

**Montrose Air Quality Services,
LLC.**
4949 Fernlee Avenue
Royal Oak, MI 48073

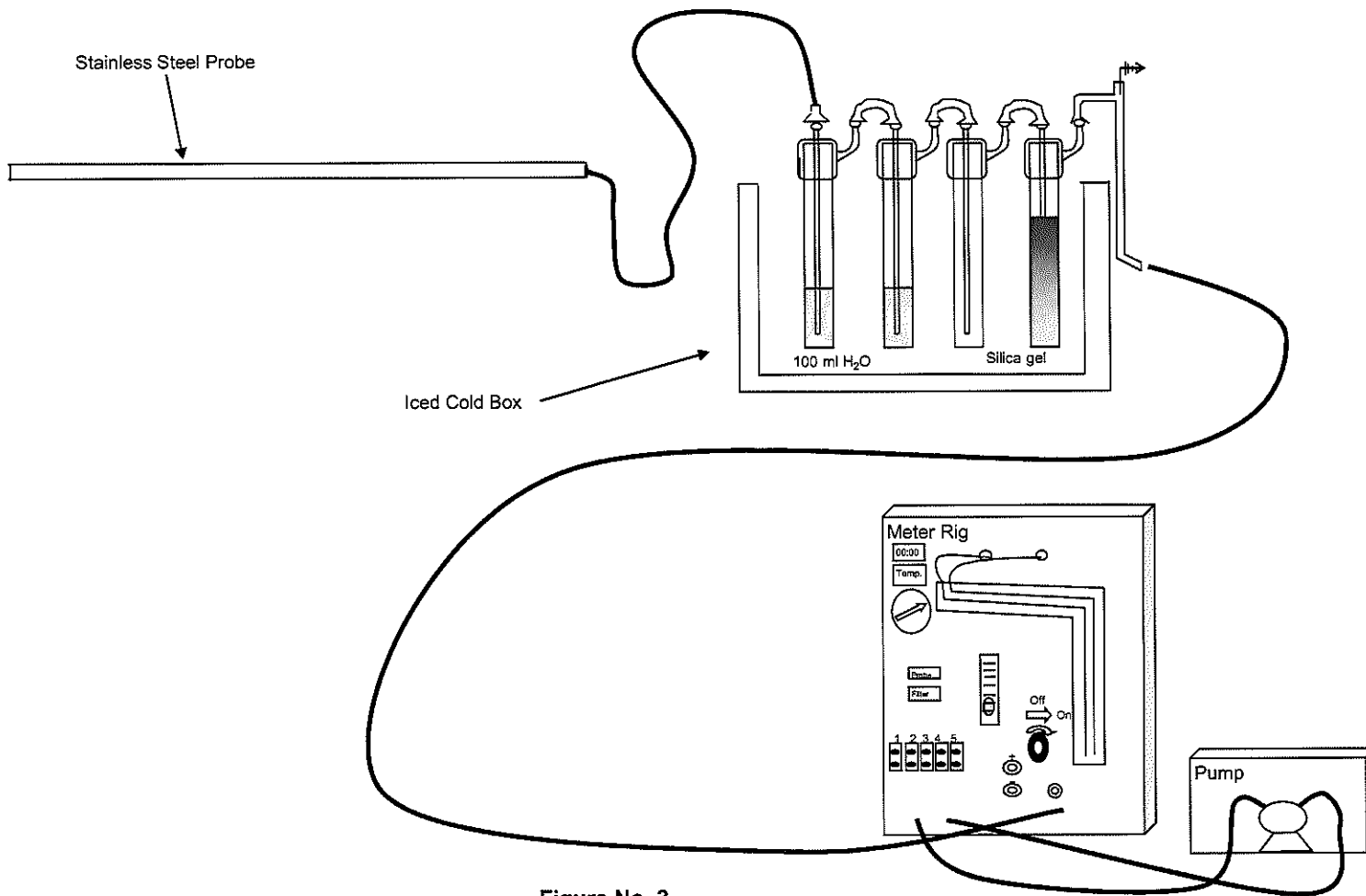


Figure No. 3

Site:
USEPA Method 4
Dearborn Industrial Generation
Dearborn, Michigan

Sampling Date:
December 4-6, 2018

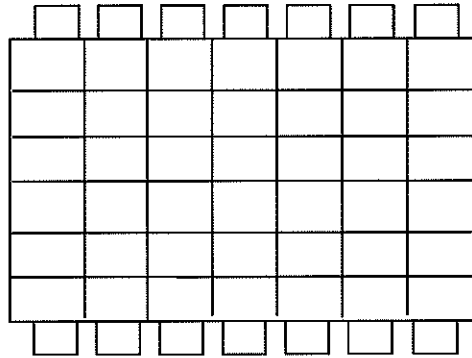
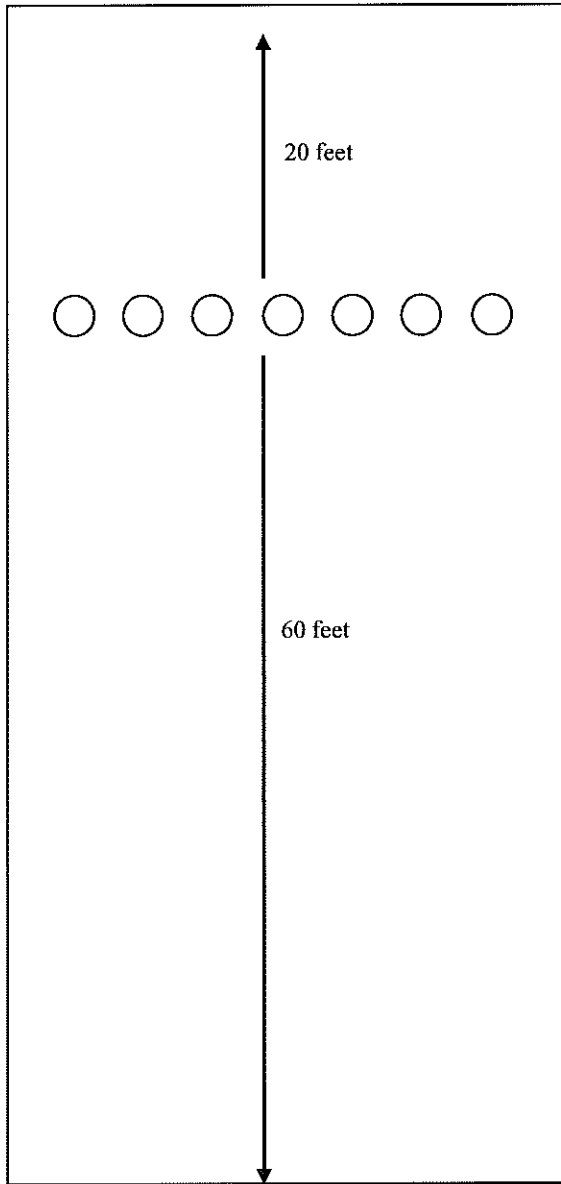
Montrose Air Quality Services, LLC
4949 Fernlee Avenue
Royal Oak, Michigan 48073



MONTROSE

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Stack Dimensions: 19' Deep X 22' Wide



Not to Scale

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

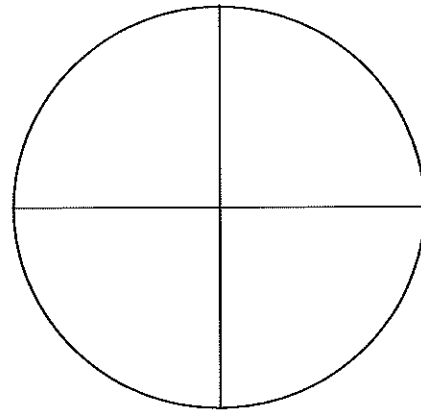
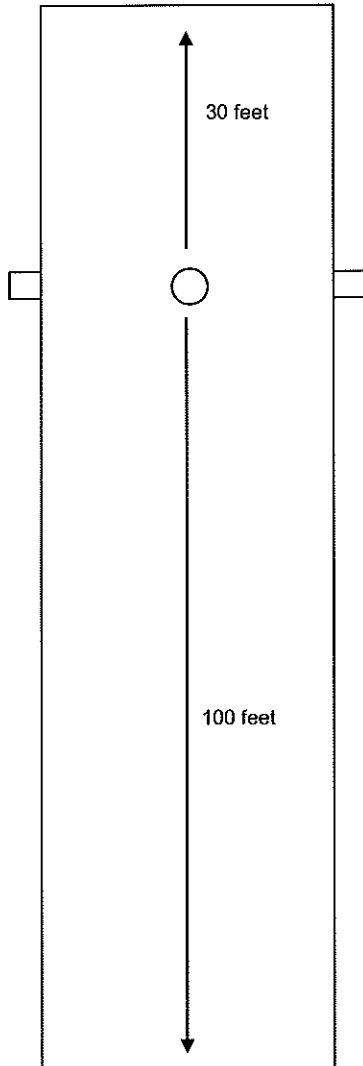
Figure No. 4

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

Sampling Date:
December 4-6, 2018

Montrose Air Quality Services,
LLC
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

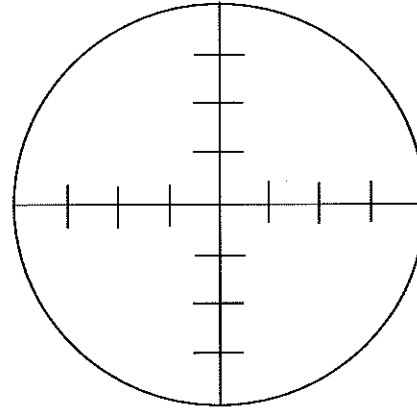
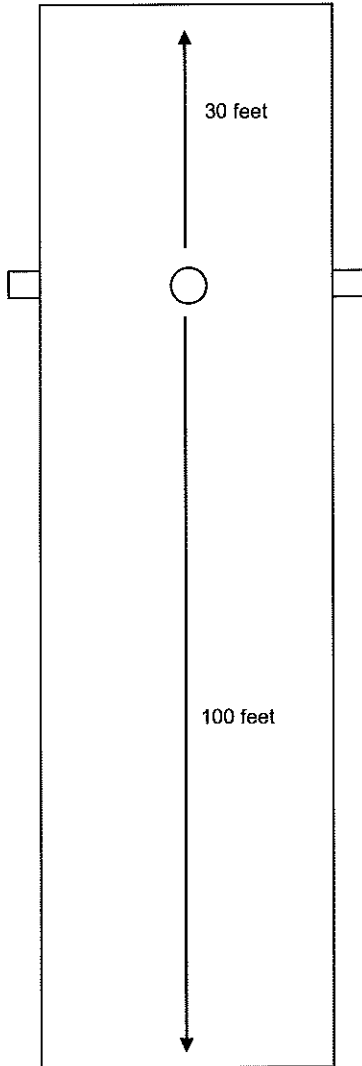
Figure No. 5

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

Sampling Date:
December 4-6, 2018

**Montrose Air Quality Services,
LLC**
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: December 4-6, 2018

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