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# ECoat
# VOC Capture Efficiency
# Emissions Test Summary Report



*Prepared for:*

**Ford Motor Company**

Flat Rock Assembly Plant
1 International Drive
Flat Rock, Michigan 48134

Project No. 049AS-374664
January 2, 2019

Montrose Air Quality Services
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

STAC

ACCREDITED
TO ASTM D3154 ONLY

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## EXECUTIVE SUMMARY

Montrose Air Quality Services (MAQS) was retained by Ford Motor Company (Ford) to evaluate volatile organic compounds (VOC) capture efficiency (CE) emission rates from the ECoat system at the Ford Flat Rock Assembly Plant located in Flat Rock, Michigan. The emissions test program was conducted on December 11, 2018.

Testing of the ECoat system consisted of triplicate 60-minute test runs. The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-N7624-2018. The results of the emission test program are summarized by Table 1.

N0929

**Table 1**
**Overall Emission Summary**
**Test Date: December 11, 2018**

| Pollutant | Average Capture Efficiency |
|---|---|
| ECoat Oven Capture Efficiency | 98.8% |

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### APPENDIX

## 1. Introduction

Montrose Air Quality Services (MAQS) was retained by Ford Motor Company (Ford) to evaluate volatile organic compounds (VOC) capture efficiency (CE) emission rates from the ECoat system at the Ford Flat Rock Assembly Plant located in Flat Rock, Michigan. The emissions test program was conducted on December 11, 2018. The purpose of this report is to document the results of the test program.

AQD 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 suggested by the aforementioned document. All testing was performed in accordance with MAQS test plan 049AS-374664.

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

Sampling and analysis for the emission test program was conducted on December 11, 2018 at the Ford facility located in Flat Rock, Michigan. The test program included evaluation of VOC CE emissions from ECoat system.

### 1.b Purpose of Testing

AQD issued Renewable Operating Permit No. MI-ROP-N7624-2018 to Ford. The oven capture efficiency is used in monthly emission calculations.

### 1.c Source Description

Vehicle bodies are assembled in the plant's body shop from sheet metal components manufactured at other facilities. The bodies are cleaned, treated, and prepared for painting in the phosphate system. Drawing compounds, grease, and dirt are removed from the vehicle bodies utilizing both high-pressure spray and immersion cleaning/rinsing techniques. Vehicle bodies then receive a corrosion treatment in the electrocoat (e-coat) system. The process involves immersing the metal bodies, which are grounded, in a bath of electrically charged water based e-coat. The e-coat is deposited on the bodies as they are conveyed through the dip tank. The e-coat is heat-cured to the vehicle body in a high-temperature bake oven.

### 1.d Test Program Contacts

The contact for the source and test report is:

Ms. Susan Hicks
Senior Environmental Engineer
Ford Motor Company-Environmental Quality Office

Fairlane Plaza North, Suite 800
290 Town Center Drive
Dearborn, MI 48126
Phone: (313) 594-3185

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. Steve Smith<br>Field Project Manager | Montrose Air Quality<br>Detroit Office<br>4949 Fernlee Ave<br>Royal Oak, Michigan 48073 | (248)-548-8070 |
| Mr. Barry Boulianne<br>District Manager | Montrose Air Quality<br>Detroit Office<br>4949 Fernlee Ave<br>Royal Oak, Michigan 48073 | (248)-548-8070 |
| Mr. Jacob Young<br>Field Technician | Montrose Air Quality<br>Detroit Office<br>4949 Fernlee Ave<br>Royal Oak, Michigan 48073 | (248)-548-8070 |

## 2. Summary of Results

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

### 2.a Operating Data

Process data can be found in Appendix E.

### 2.b Applicable Permit

The applicable permit for this emissions test program is Renewable Operating Permit (ROP) No. MI-ROP-N7624-2018.

### 2.c Results

The overall results of the emission test program are summarized by Table 3 (see Section 5.a).

## 3. Source Description

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

### 3.a Process Description

Vehicle bodies are assembled in the plant's body shop from sheet metal components manufactured at other facilities. The bodies are cleaned, treated, and prepared for painting in the phosphate system. Drawing compounds, grease, and dirt are removed from the vehicle bodies utilizing both high-pressure spray and immersion cleaning/rinsing techniques. Vehicle bodies then receive a corrosion treatment in the electrocoat (e-coat) system. The process involves immersing the metal bodies, which are grounded, in a bath of electrically charged water based e-coat. The e-coat is deposited on the bodies as they are conveyed through the dip tank. The e-coat is heat-cured to the vehicle body in a high-temperature bake oven.

### 3.b Process Flow Diagram

Due to the simplicity of the ECoat system, a process flow diagram is not necessary.

### 3.c Raw and Finished Materials

The process uses resin and pigment.

### 3.d Process Capacity

The test was performed at the current production rate. The production data is included.

### 3.e Process Instrumentation

Production and oven temperature was monitored during the test.

## 4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

### 4.a Sampling Train and Field Procedures

**USEPA Methods 1-4**

Measurement of exhaust gas velocity, molecular weight, and moisture 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 1 - *"Location of the Sampling Site and Sampling Points"*

- 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"*

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, Section 4.1.1, 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 were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

Cyclonic flow checks were performed at the 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. If the average of the absolute values of the flow angles is greater than 20 degrees, cyclonic flow exists. The null angle was determined to be less than 10 degrees at each sampling point.

Molecular weight determinations were evaluated according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the moisture sampling (see Section 3.2) 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.

**USEPA Method 25A**

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. MAQS used a VIG Model 20 THC hydrocarbon analyzer to determine the VOC concentration.

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 0-100 ppm at the Tank and 0-1,000 ppm at the Oven.

In accordance with Method 25A, a 4-point (zero, low, 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

This test program did not include laboratory samples, consequently, sample recovery and analysis is not applicable to this test program.

### 4.c Sampling Ports

A diagram of the stack showing sampling ports in relation to upstream and downstream disturbances is included as Figures 3 and 4.

### 4.d Traverse Points

A diagram of the stack indicating traverse point locations and stack dimensions is included as Figure 3 and 4.

## 5. Test Results and Discussion

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

### 5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 3. Detailed results for the emissions test program are summarized by Table 4.

**Table 3**
**Overall Emission Summary**
**Test Date: December 11, 2018**

| Pollutant | Average Capture Efficiency |
|---|---|
| ECoat Oven Capture Efficiency | 98.8% |

### 5.b Discussion of Results

Test results demonstrated an average oven capture efficiency of 98.8%, which is slightly higher than the previous average oven capture efficiency of 96.7% tested in May 2011.

### 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

There was no control equipment maintenance performed during the emissions test program.

### 5.f Re-Test

The emissions test program was not a re-test.

### 5.g Audit Sample Analyses

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

### 5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix C.

### 5.i Sample Calculations

Sample calculations are provided in Appendix D.

### 5.j Field Data Sheets

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

### 5.k Laboratory Data

There are no laboratory results for this test program. Raw CEM data is provided electronically in Appendix E.

## 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 Ford Motor Company. MAQS will not distribute or publish this report without Ford Motor Company'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: _____

Steve Smith
Field Project Manager

This report was reviewed by: _____

Matt Young
Client Project Manager

# Tables

**Table 4**
**Ecoat Capture Efficiency Summary**
**Ford FRAP**
**Flat Rock, MI**

| Parameter | Run 1 | Run 2 | Run 3 | Average |
|---|---|---|---|---|
| Sampling Date | 12/11/2018 | 12/11/2018 | 12/11/2018 | |
| Sampling Time | 8:00-9:00 | 9:55-10:55 | 11:40-12:40 | |
| Oven Flowrate (scfm) | 12,530 | 13,459 | 13,706 | 13,232 |
| Tank Flowrate (scfm) | 1,158 | 1,016 | 960 | 1,045 |
| Oven VOC Concentration (ppmv propane) | 72.3 | 89.2 | 93.1 | 84.9 |
| Oven VOC Concentration (ppmv, corrected as per USEPA 7E) | 62.2 | 79.6 | 82.8 | 74.8 |
| Oven VOC Mass Flowrate (lb/hr) | 5.3 | 7.3 | 7.8 | 6.8 |
| Tank VOC Concentration (ppmv propane) | 10.4 | 12.1 | 11.3 | 11.3 |
| Tank VOC Concentration (ppmv, corrected as per USEPA 7E) | 10.4 | 11.6 | 10.4 | 10.8 |
| Tank VOC Mass Emission Rate (lb/hr) | 0.1 | 0.1 | 0.1 | 0.1 |
| VOC Capture Efficiency (%) | **98.5** | **98.9** | **99.1** | **98.8** |

| Inlet VOC Correction | | | |
|---|---|---|---|
| **Co** | 11.99 | 11.82 | 10.92 |
| **Cma** | 300 | 300 | 300 |
| **Cm** | 302.96 | 303.67 | 308.55 |

| Outlet VOC Correction | | | |
|---|---|---|---|
| **Co** | 0.20 | 0.56 | 0.86 |
| **Cma** | 29.99 | 29.99 | 29.99 |
| **Cm** | 29.72 | 30.42 | 30.92 |

scfm: standard cubic feet per minute
ppmv: parts per million on a volume to volume basis
lb/hr: pounds per hour
VOC: volatile organic compound
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**

CE % = (Oven/(Oven+Tank))*100
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * scfm* 60

# Figures

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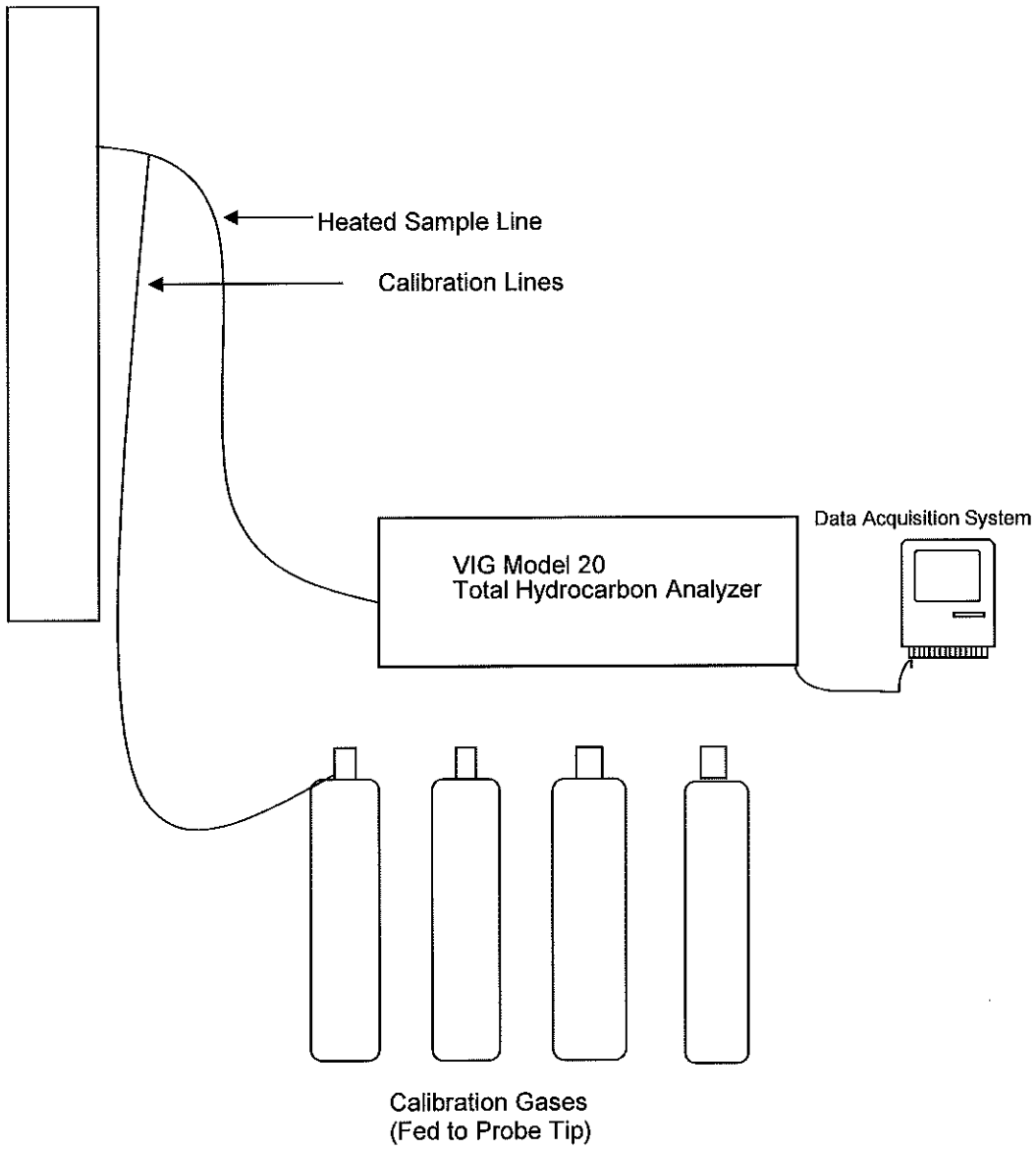


**Figure No. 1**

| | | |
|---|---|---|
| **Site:**<br>**USEPA Method 25A**<br>**Ford FRAP**<br>**Flat Rock, Michigan** | **Sampling Date:**<br>**December 11, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |

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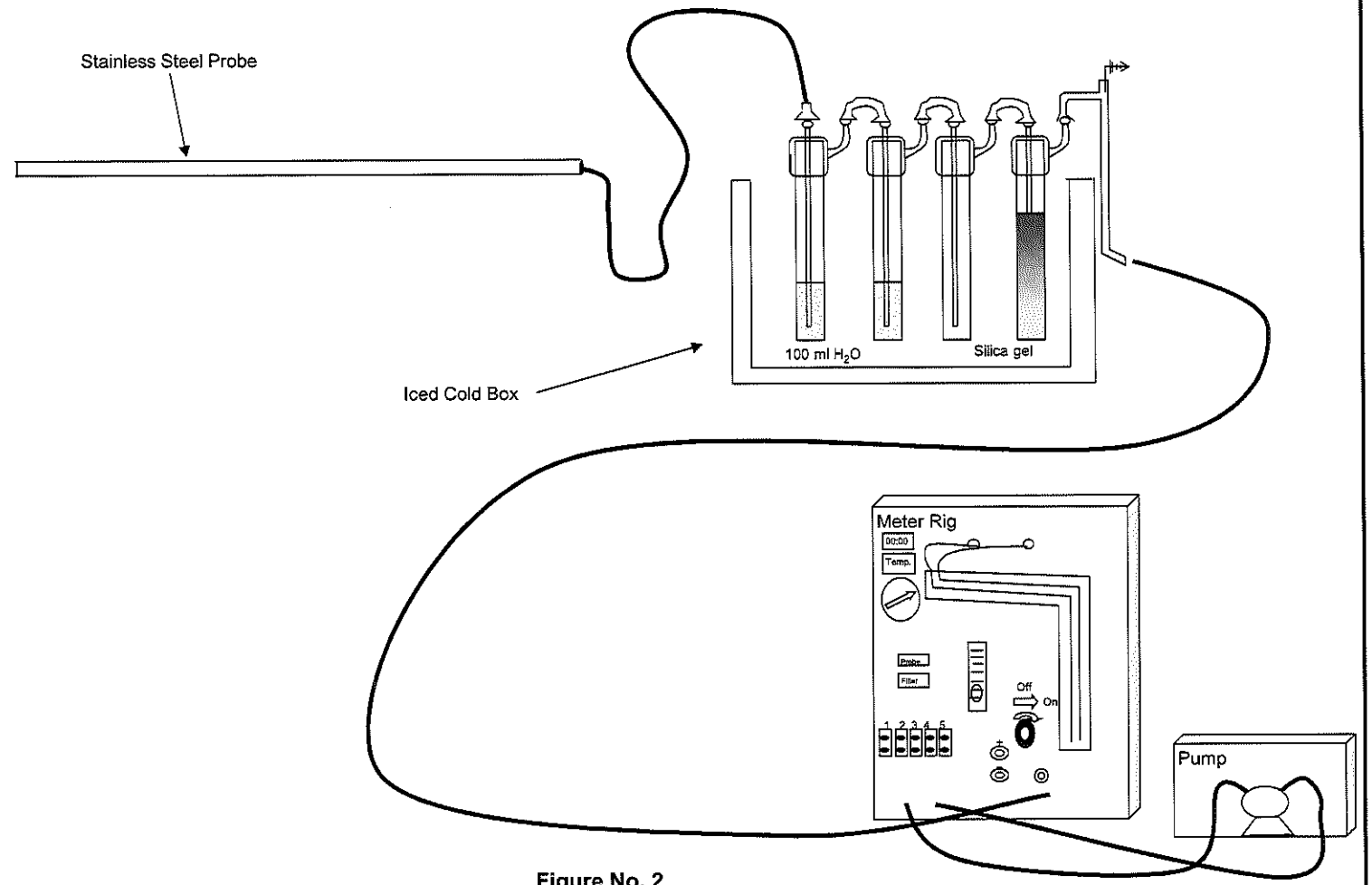


**Figure No. 2**

| | | |
|---|---|---|
| **Site:**<br>**USEPA Method 4**<br>**Ford FRAP**<br>**Flat Rock, Michigan** | **Sampling Date:**<br>**December 11, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |

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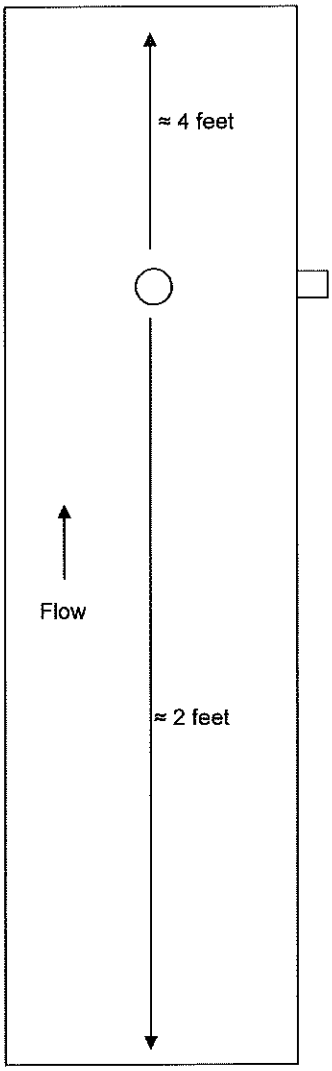
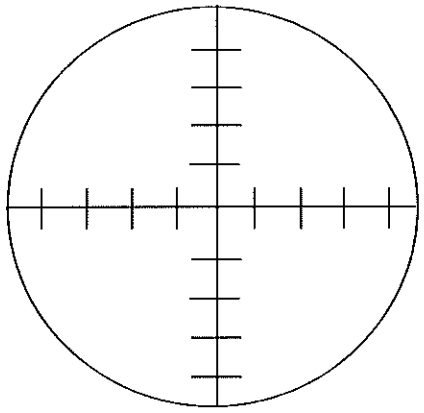
diameter = 45 inches



Not to Scale

| Points | Distance " |
|---|---|
| 1 | 1.4 |
| 2 | 4.7 |
| 3 | 8.7 |
| 4 | 14.5 |
| 5 | 30.5 |
| 6 | 36.3 |
| 7 | 40.3 |
| 8 | 43.6 |

**Figure No. 3**

| | | |
|---|---|---|
| **Site:**<br>**Oven**<br>**Ford FRAP**<br>**Flat Rock, Michigan** | **Sampling Date:**<br>**December 11, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |

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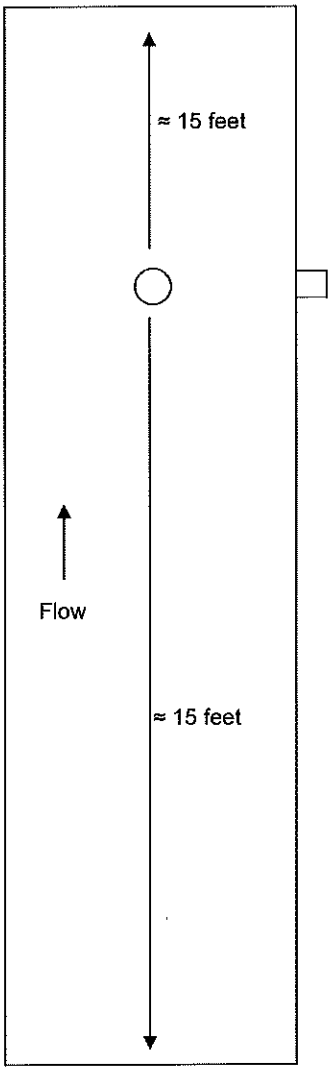
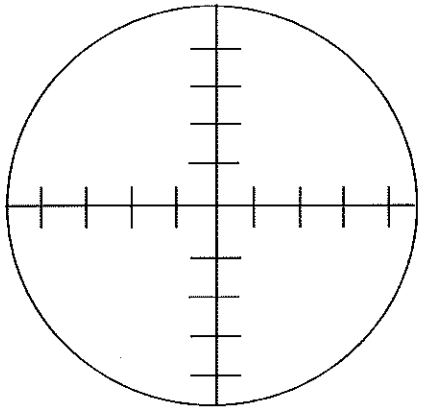
diameter = 24 inches



Not to Scale

| Points | Distance " |
|---|---|
| 1 | 0.8 |
| 2 | 2.5 |
| 3 | 4.7 |
| 4 | 7.8 |
| 5 | 16.2 |
| 6 | 19.3 |
| 7 | 21.5 |
| 8 | 23.2 |

**Figure No. 4**

| | | |
|---|---|---|
| **Site:**<br>**Tank**<br>**Ford FRAP**<br>**Flat Rock, Michigan** | **Sampling Date:**<br>**December 11, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |