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# EU-SPMCASTLINE4
# Emissions Test Report



*Prepared for:*

**General Motors**

Saginaw, Michigan

GM SMCO
1629 N. Washington Ave.
Saginaw, Michigan

Project No. 049AS-451360
November 29, 2018

Montrose Air Quality Services
4949 Fernlee Avenue
Royal Oak, Michigan 48071
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STAC

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TO ASTM D7036 ONLY

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## Executive Summary

Montrose Air Quality Services (MAQS) was retained by General Motors, LLC (GM) to conduct emissions testing at the GM SMCO facility in Saginaw, Michigan. The test program consisted of evaluation of particulate matter (PM) and condensable particulate matter (CPM), along with nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) concentrations and emission rates from the SPM Castline 4 which is covered by Renewable Operating Permit (ROP) No. MI-ROP-B1991-2015b.

Testing of the sources consisted of triplicate 60-minute test runs for PM, CPM, NOx, CO, and VOC. Sampling was performed utilizing United States Environmental Protection Agency (USEPA) reference test methods. Testing occurred on October 18, 2018. The results of the emissions test program are summarized by Table 1.

**Table 1**
**Overall Results Summary**
**Sampling Dates: October 18, 2018**

| Pollutant | Emission Limitation (lb/hr) | Average Test Result (lb/hr) * |
|---|---|---|
| PM | 6.02 | 0.95 |
| $PM_{10}$ | 3.63 | 0.95 |
| $PM_{2.5}$ | 3.63 | 0.95 |
| NOx | 2.59 | 0.09 |
| CO | 10.77 | 0.89 |
| VOC[1] | 9.19 | 0.41 |
| VOC[2] | 1.3 | 0.41 |

* All PM reported as $PM_{2.5}$
1. Sections 1 and 2
2. Section 3 (Exhaust indoors)

## 1. Introduction

Montrose Air Quality Services (MAQS) was retained by General Motors, LLC (GM) to conduct emissions testing at the GM SMCO facility in Saginaw, Michigan. The test program consisted of evaluation of particulate matter (PM) and condensable particulate matter (CPM), along with nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) concentrations and emission rates from the SPM Castline 4 which is covered by ROP No. MI-ROP-B1991-2015b.

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 suggested by the aforementioned document.

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

The source tested is located at the GM Saginaw Metal Casting Operations located in Saginaw, Michigan. Testing on the source was conducted on October 18, 2018.

### 1.b Purpose of Testing

The purpose of the testing is to demonstrate compliance with emission limitations for EU-SPMCASTLINE4 under MI-ROP-B1991-2015b.

### 1.c Source Description

Sources identified under this project specifically include, EU-SPMCASTLINE4, Castline 4.

### 1.d Test Program Contact

The contacts for information regarding the test program as well as the test report are:

Jeff Hummel
GM Sustainable Workplaces
30400 Van Dyke Ave
VEC East, Floor 5
Warren, MI 48093
Phone: 517-719-9053
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Saginaw, Michigan 48605
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Matt Young
Client Project Manager
Montrose Air Quality Services.
4949 Fernlee Avenue
Royal Oak, MI 48073
Phone: 313-449-2361
myoung@montrose-env.com

### 1.e Test Personnel

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

**Table 2**
**Test Personnel**

| Name | Affiliation |
|---|---|
| Renee Mietz | GM-SMCO |
| Karen Carlson | GM-WTC |
| Brent Wilson | GM-WTC |
| Jeff Hummel | GM-WTC |
| Matthew Young | MAQS |
| Steve Smith | MAQS |
| David Trahan | MAQS |
| Gina McCann | MDEQ |
| Mark Dziadosz | MDEQ |

## 2. Summary of Results

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

### 2.a Operating Data

Process and control equipment operating data relevant to the emissions test program is provided in Appendix D.

### 2.b Applicable Permit

The emission unit tested for EU-SPMCASTLINE4 is included in ROP No. MI-ROP-B1991-2015b.

### 2.c Results

The results of the emissions test program are summarized by Table 1. Detailed results for are summarized in Tables 3-4.

### 2.d Emission Regulation Comparison

The emission limits and test results are summarized by Table 1.

## 3. Source Description

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

### 3.a Process Description

**Cast Line processes**
Cast Line 4 has a nominal maximum production rate of 50 castings per hour (1,160 castings per day)

The cast lines consist of the following: *Section #1:* making a final mold; mold filling; initial cooling; extraction; and cut sprue. Making a final mold includes mold and core assembly and mold heating with natural gas-fired 16 MMBtu/hr (total heat input rate) burners/torches. Mold filling is conducted by gravity pour. Initial cooling and solidification of the molten metal occurs inside the mold. Extraction of the casting (including sand cores) from the steel mold is completed by the casting extraction unload robot. Core and down sprue removal. Additional cooling and complete solidification occur in the casting solidification buffer area. Sprue, risers, runners, and other internal scrap are collected and remelted. *Section #2:* extended casting cooling in a cooling area. *Section #3:* Deflash; Decore; Degate. Finishing operations include the removal of excess metal and sand from the casting. Excess metal is collected and remelted.

### 3.b Process Flow Diagram

A process flow diagram is provided in Appendix F.

### 3.c Raw and Finished Materials

The raw materials used in the processes include molten aluminum and sand cores. Natural gas is used in the burners to preheat the molds. See section 3.a.

### 3.d Process Capacity

**Process Production Capacities**

| Process | Maximum Production Rate | Current Targeted Production Rate | Current Average Production Rate | Average Production Rate Emission Testing |
|---|---|---|---|---|
| EU-SPMCASTLINE4 | 50 molds/hr | 38 molds/hr | 22 molds/hr | 38 molds/hr |

### 3.e Process Instrumentation

The fabric filter pressure drop (in. H2O) and the production throughput were recorded during every run of the compliance test. This data is included in Appendix E.

## 4. Sampling and Analytical Procedures

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

### 4.a Sampling Train and Field Procedures

Sampling and analytical methodologies for the emissions test program can be separated into two categories as follows:

(1) Measurement of exhaust gas velocity, molecular weight, and moisture content;
(2) Measurement of exhaust gas filterable and condensable PM concentration using USEPA Methods 5/202

Sampling and analytical methodologies by category are summarized below.

***Exhaust Gas Velocity, Molecular Weight, and Moisture Content***

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. A diagram of the sample points is provided in Figures 1-2.

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. 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 20 degrees at each sampling point.

The Molecular Weight of the gas stream was evaluated according to procedures outlined in Title 40, Part 60, Appendix A, Method 3A. The $O_2$ /$CO_2$ content of the gas stream was measured using a Fyrite combustion analyzer.

Exhaust gas was extracted as part of the sampling train. Exhaust gas moisture content was then determined gravimetrically.

***Filterable and Condensable PM (USEPA Method 5 /202)***

40 CFR 60, Appendix A, Method 5, *"Determination of Particulate Emissions from Stationary"* and 40 CFR 60, Appendix A, Method 202, *"Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"* was used to measure PM concentrations and calculate PM emission rates (see Figure 3 for a schematic of the sampling train). Triplicate 60-minute test runs were conducted on each source.

MAQS's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) a glass probe, (3) a stainless-steel filter housing, (4) a Teflon connecting line to the impingers (5) a vertical condenser, (6) an empty potbellied impinger, (7) an empty modified Greenburg-Smith (GS) impinger, (8) unheated borosilicate filter holder with a teflon filter and Teflon filter support, (9) a second modified GS impinger with 100 ml of deionized water, and a third modified GS impinger containing approximately 300 g of silica gel desiccant, (10) a length of sample line, and (11) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

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

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

***NOx and CO (USEPA Methods 7E and 10)***

The NOx and CO content of the gas stream were measured using a Thermo Model 42i NOx gas analyzer and a Teledyne T300M CO gas analyzer. The gas stream was 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 entered the analyzers. Data was recorded on a PC equipped with data acquisition software. Recorded NOx and CO concentrations were averaged and reported for the duration of each 60-minute test (as drift corrected per Method 7E).

***Volatile Organic Compounds (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 be 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 entered the analyzer. Data was recorded at 4-second intervals on a PC equipped with IOtech® data acquisition software. MAQS used a JUM Model 109A Methane/Non-Methane THC hydrocarbon analyzer to determine the VOC concentration.

The JUM Model 109A analyzer utilizes two flame ionization detectors (FIDs) in order to report the average ppmv for total hydrocarbons (THC), as propane, as well as the average ppmv for methane (as methane). Upon entry, the analyzer splits the gas stream. One FID ionizes all of the hydrocarbons in the gas stream sample into carbon, which is then detected as a concentration of total hydrocarbons. Using an analog signal, specifically voltage, the concentration of THC is then sent to the data acquisition system (DAS), where recordings are taken at 4-second intervals to produce an average based on the overall duration of the test. This average is then used to determine the average ppmv for THC reported as the calibration gas, propane, in equivalent units.

The second FID reports methane only. The sample enters a chamber containing a catalyst that destroys all of the hydrocarbons present in the gas stream other than methane. As with the THC sample, the methane gas concentration is sent to the DAS and recorded. The methane concentration, reported as methane, can then be converted to methane, reported as propane, by dividing the measured methane concentration by the analyzer's response factor.

The analyzer's response factor is obtained by introducing a methane calibration gas to the calibrated J.U.M. 109A. The response of the analyzer's THC FID to the methane calibration gas, in ppmv as propane, is divided by the Methane analyzer's response to the methane calibration gas, in ppmv as methane.

For analyzer calibrations, calibration gases were mixed to desired concentrations using an Environics Series 4040 Computerized Gas Dilution System. The Series 4040 consists of a single chassis with four mass flow controllers. The mass flow controllers are factory-calibrated using a primary flow standard traceable to the United States' National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11 point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity.

### 4.b Recovery and Analytical Procedures

Descriptions of the recovery procedures are provided in section 4.a for each sampling method.

### 4.c Sampling Ports

Diagrams of the stacks showing sampling ports are included as Figures 1 and 2.

### 4.d Traverse Points

Diagrams of the stacks showing traverse points are included as Figures 1 and 2.

## 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 1. Detailed results for the emissions test program are summarized by Tables 3-4.

### 5.b Discussion of Results

**Table 1**
**Overall Results Summary**
**Sampling Dates: October 18, 2018**

| Pollutant | Emission Limitation (lb/hr) | Average Test Result (lb/hr) * |
|---|---|---|
| PM | 6.02 | 0.95 |
| $PM_{10}$ | 3.63 | 0.95 |
| $PM_{2.5}$ | 3.63 | 0.95 |
| NOx | 2.59 | 0.09 |
| CO | 10.77 | 0.89 |
| VOC[1] | 9.19 | 0.41 |
| VOC[2] | 1.3 | 0.41 |

* All PM reported as $PM_{2.5}$
1. Sections 1 and 2
2. Section 3 (Exhaust indoors)

Detailed results for the emissions test program are summarized by Tables 3-4.

### 5.c Sampling Procedure Variations

Run 1 was voided due to weather conditions for PM. Run 2-4 were used for compliance results. Handwritten sheets for the voided run can be found in appendix A.

### 5.d Process or Control Device Upsets

No control device upsets occurred during the emissions test program. During emission testing, the SPM Castline 4 process paused for mold cleaning and various equipment maintenance.

### 5.e Control Device Maintenance

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

### 5.f Audit Sample Analyses

Audit samples were not analyzed as part of this emissions test program.

### 5.g Calibration Sheets

Calibration documents are provided as Appendix B.

### 5.h Sample Calculations

Sample calculations are provided as Appendix C.

### 5.i Field Data Sheets

Field data sheets are provided in Appendix A.

### 5.j Laboratory Data

Laboratory analysis is provided in Appendix D.

**Table 3**
**Particulate Matter Emission Rates**

| | | | | |
|---|---|---|---|---|
| **Company** | **GM SMCO** | | | |
| **Source Designation** | **SPM** | | | |
| **Test Date** | **10/18/2018** | **10/18/2018** | **10/18/2018** | |
| **Meter/Nozzle Information** | Run 2 | Run 3 | Run 4 | Average |
| Meter Temperature Tm (F) | 63.8 | 81.4 | 80.1 | 75.1 |
| Meter Pressure - Pm (in. Hg) | 29.9 | 29.9 | 29.9 | 29.9 |
| Measured Sample Volume (Vm) | 45.7 | 47.0 | 47.1 | 46.6 |
| Sample Volume (Vm-Std ft3) | 47.2 | 46.9 | 47.1 | 47.1 |
| Sample Volume (Vm-Std m3) | 1.34 | 1.33 | 1.33 | 1.33 |
| Condensate Volume (Vw-std) | 0.306 | 0.358 | 0.335 | 0.333 |
| Gas Density (Ps(std) lbs/ft3) (wet) | 0.0744 | 0.0743 | 0.0743 | 0.0743 |
| Gas Density (Ps(std) lbs/ft3) (dry) | 0.0745 | 0.0745 | 0.0745 | 0.0745 |
| Total weight of sampled gas (m g lbs) (wet) | 3.53 | 3.52 | 3.53 | 3.52 |
| Total weight of sampled gas (m g lbs) (dry) | 3.51 | 3.50 | 3.51 | 3.51 |
| Nozzle Size - An (sq. ft.) | 0.000355 | 0.000355 | 0.000355 | 0.000355 |
| Isokinetic Variation - I | 99.2 | 99.4 | 99.5 | 99.4 |
| **Stack Data** | | | | |
| Average Stack Temperature - Ts (F) | 87.8 | 90.7 | 91.2 | 89.9 |
| Molecular Weight Stack Gas- dry (Md) | 28.8 | 28.8 | 28.8 | 28.8 |
| Molecular Weight Stack Gas-wet (Ms) | 28.8 | 28.8 | 28.8 | 28.8 |
| Stack Gas Specific Gravity (Gs) | 0.993 | 0.993 | 0.993 | 0.993 |
| Percent Moisture (Bws) | 0.65 | 0.76 | 0.71 | 0.70 |
| Water Vapor Volume (fraction) | 0.0065 | 0.0076 | 0.0071 | 0.0070 |
| Pressure - Ps ("Hg) | 29.8 | 29.8 | 29.8 | 29.8 |
| Average Stack Velocity -Vs (ft/sec) | 39.1 | 39.1 | 39.2 | 39.1 |
| Area of Stack (ft2) | 23.0 | 23.0 | 23.0 | 23.0 |
| **Exhaust Gas Flowrate** | | | | |
| Flowrate $ft^3$(Actual) | 54,005 | 54,007 | 54,187 | 54,066 |
| Flowrate $ft^3$ (Standard Wet) | 51,786 | 51,521 | 51,646 | 51,651 |
| Flowrate $ft^3$ (Standard Dry) | 51,451 | 51,130 | 51,281 | 51,288 |
| Flowrate $m^3$ (standard dry) | 1,457 | 1,448 | 1,452 | 1,452 |
| **Total Particulate Weights (mg)** | | | | |
| Total Nozzle/Probe/Filter | 0.7 | 1.3 | 2.3 | 1.4 |
| Organic Condensible Particulate | 2.0 | 0.8 | 1.3 | 1.4 |
| Inorganic Condensible Particulate | 2.0 | 1.2 | 1.6 | 1.6 |
| Condensible Blank Correction | 1.0 | 1.0 | 1.0 | 1.0 |
| Total Condensible Particulate | 3.1 | 1.0 | 1.9 | 2.0 |
| Total Filterable and Condensible Particulate | 3.8 | 2.3 | 4.2 | 3.4 |
| **Filterable Particulate Concentration** | | | | |
| lb/1000 lb (wet) | 0.000 | 0.001 | 0.001 | 0.001 |
| lb/1000 lb (dry) | 0.000 | 0.001 | 0.001 | 0.001 |
| mg/dscm (dry) | 0.5 | 1.0 | 1.7 | 1.1 |
| gr/dscf | 0.0002 | 0.0004 | 0.0008 | 0.0005 |
| **Filterable Particulate Emission Rate** | | | | |
| lb/ hr | 0.10 | 0.19 | 0.33 | 0.21 |
| **Condensible Particulate Concentration** | | | | |
| lb/1000 lb (wet) | 0.002 | 0.001 | 0.001 | 0.001 |
| lb/1000 lb (dry) | 0.002 | 0.001 | 0.001 | 0.001 |
| mg/dscm (dry) | 2.3 | 0.7 | 1.4 | 1.5 |
| gr/dscf | 0.0010 | 0.0003 | 0.0006 | 0.0006 |
| **Condensible Particulate Emission Rate** | | | | |
| lb/ hr | 0.45 | 0.14 | 0.27 | 0.29 |
| **Total Particulate Concentration** | | | | |
| lb/1000 lb (wet) | 0.002 | 0.001 | 0.003 | 0.002 |
| lb/1000 lb (dry) | 0.002 | 0.001 | 0.003 | 0.002 |
| mg/dscm (dry) | 2.8 | 1.7 | 3.1 | 2.6 |
| gr/dscf | 0.0012 | 0.0007 | 0.0014 | 0.0011 |
| **Total Particulate Emission Rate** | | | | |
| lb/ hr | 0.55 | 0.33 | 0.61 | 0.49 |

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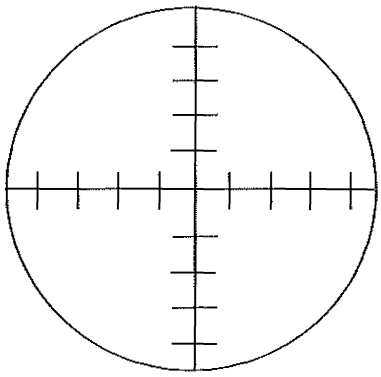
diameter = 10 inches inches

| Points | Distance " |
|---|---|
| 1 | 1.8 |
| 2 | 5.8 |
| 3 | 10.7 |
| 4 | 17.8 |
| 5 | 37.2 |
| 6 | 44.3 |
| 7 | 49.2 |
| 8 | 53.2 |



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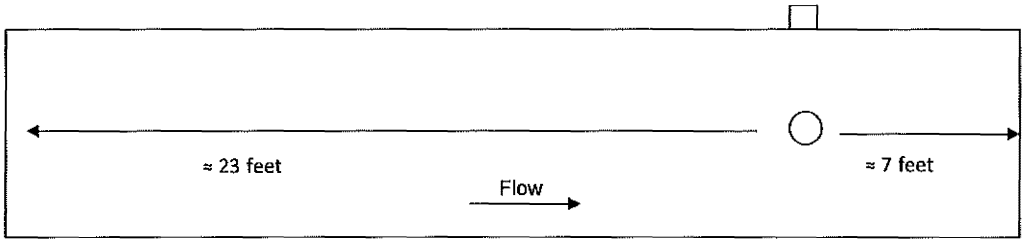


**Figure No. 1**

| Site: | Sampling Date: | |
|---|---|---|
| SPMCASTLINE 4 INLET<br>General Motors, LLC<br>Saginaw, Michigan | October 18, 2018 | Montrose Air Quality Services<br>4949 Fernlee Avenue<br>Royal Oak, Michigan 48073 |

**Table 4**
**Castline 4 Inlet**
**Nox, VOC, and CO Emission Rates**
**GM SMCO**
**Saginaw, Michigan**
**Montrose Project No. 049AS-541360**
**Sampling Dates: 10/18/2018**

| Parameter | Run 2 | Run 3 | Run 4 | Average |
|---|---|---|---|---|
| Test Run Date | 10/18/2018 | 10/18/2018 | 10/18/2018 | |
| Test Run Time | 9:36-11:21 | 14:01-15:16 | 16:50-18:10 | |
| Outlet Flowrate (dscfm) | 45,850 | 47,804 | 47,039 | **46,898** |
| Outlet Flowrate (scfm) | 46,459 | 48,483 | 47,682 | **47,541** |
| Outlet Oxides of Nitrogen Concentration (ppmv) | 0.4 | 0.3 | 0.3 | **0.3** |
| Outlet NOx Concentration (ppmv, corrected as per USEPA 7E) | 0.4 | 0.2 | 0.2 | **0.3** |
| **NOx Emission Rate (lb/hr)** | **0.1** | **0.1** | **0.1** | **0.1** |
| **NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)** | **0.1** | **0.1** | **0.1** | **0.1** |
| Outlet Carbon Monoxide Concentration (ppmv) | 5.2 | 4.0 | 4.0 | **4.4** |
| Outlet CO Concentration (ppmv, corrected as per USEPA 7E) | 5.2 | 4.0 | 3.9 | **4.4** |
| **CO Emission Rate (lb/hr)** | **1.0** | **0.8** | **0.8** | **0.9** |
| **CO Emission Rate (lb/hr) (corrected as per USEPA 7E)** | **1.0** | **0.8** | **0.8** | **0.9** |
| Outlet VOC Concentration (ppmv as propane) | 3.0 | 5.9 | 4.7 | **4.5** |
| Outlet Methane Concentration (ppmv as methane) | 5.5 | 11.7 | 9.1 | **8.8** |
| Outlet VOC Concentration (ppmv, corrected as per USEPA 7E) | 3.1 | 6.4 | 5.1 | **4.9** |
| Outlet Methane Concentration (ppmv, corrected as per USEPA 7E) | 5.3 | 11.5 | 8.9 | **8.6** |
| Outlet VOC Concentration (ppmv propane, -Methane) | 0.6 | 0.9 | 0.8 | **0.8** |
| Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E) | 0.9 | 1.5 | 1.3 | **1.2** |
| **VOC Emission Rate as Propane (lb/hr) (-Methane)** | **0.2** | **0.3** | **0.3** | **0.3** |
| **VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)** | **0.3** | **0.5** | **0.4** | **0.4** |

| NOx Correction | | | |
|---|---|---|---|
| Co | 0.04 | 0.05 | 0.05 |
| Cma | 25.05 | 25.05 | 25.05 |
| Cm | 24.95 | 24.39 | 24.07 |

| CO Correction | | | |
|---|---|---|---|
| Co | -0.23 | -0.08 | 0.17 |
| Cma | 25.375 | 25.375 | 25.375 |
| Cm | 25.91 | 25.58 | 25.18 |

| VOC Correction | | | |
|---|---|---|---|
| Co | -0.19 | -0.47 | -0.46 |
| Cma | 29.9 | 29.9 | 29.9 |
| Cm | 29.88 | 29.34 | 29.37 |

| Methane Correction | | | |
|---|---|---|---|
| Co | 0.17 | 0.04 | 0.04 |
| Cma | 29.9 | 29.9 | 29.9 |
| Cm | 30.63 | 30.32 | 30.28 |

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
MW = molecular weight (CO = 28.01, NOx = 46.01, $SO_2$ = 64.05, $C_3H_8$ = 44.10, carbon = 12.01)
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
Response factor obtained from introducing propane into methane analyzer: **2.36**

Co= Average of initial and final zero gases
Cma=Actual concentration of the calibration gas
Cm= Average of initial and final calibration gases
$C_c=KC_{meas}$
where Cc = Concentration as Carbon (ppmv), K= Carbon equivalent correction factor (3 for Propane)
and $C_{meas}$ = concentration as measured (as propane)
[1]emission rate calculated on dry basis
[2]emission rate calculated on wet basis

**Equations**
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***scfm*** * 60 *for* VOC
lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***dcfm*** * 60
$Conc_{@15\%O2}$ = Conc * (20.9 -15)/(20.9 - $\%O_2$)

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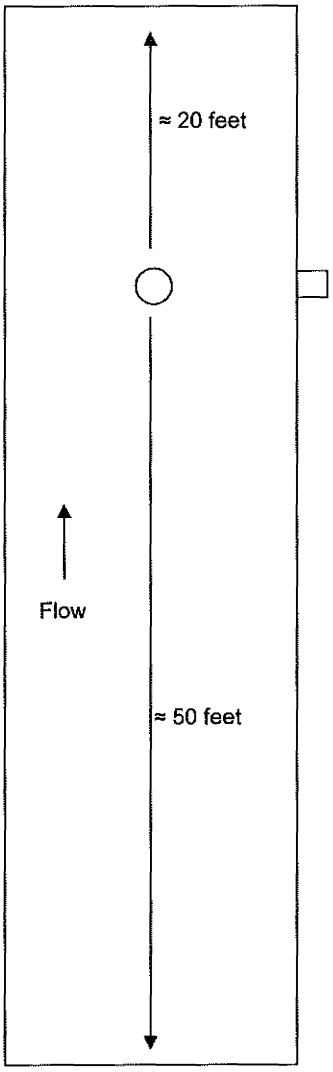
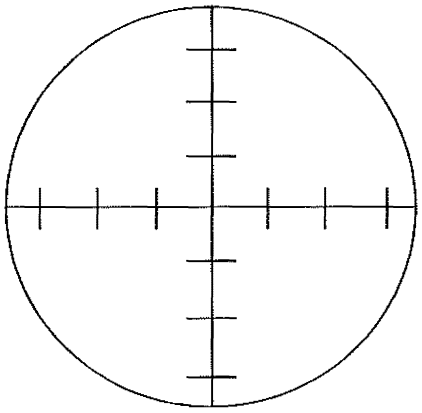
diameter = 65 inches



Not to Scale

| Points | Distance " |
|---|---|
| 1 | 2.9 |
| 2 | 9.5 |
| 3 | 19.2 |
| 4 | 45.8 |
| 5 | 55.5 |
| 6 | 62.1 |

**Figure No. 2**

| | | |
|---|---|---|
| **Site:**<br>**SPMCASTLINE 4 Outlet**<br>**General Motors, LLC**<br>**Saginaw, Michigan** | **Sampling Date:**<br>**October 18, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |

MONTROSE
AIR QUALITY SERVICES

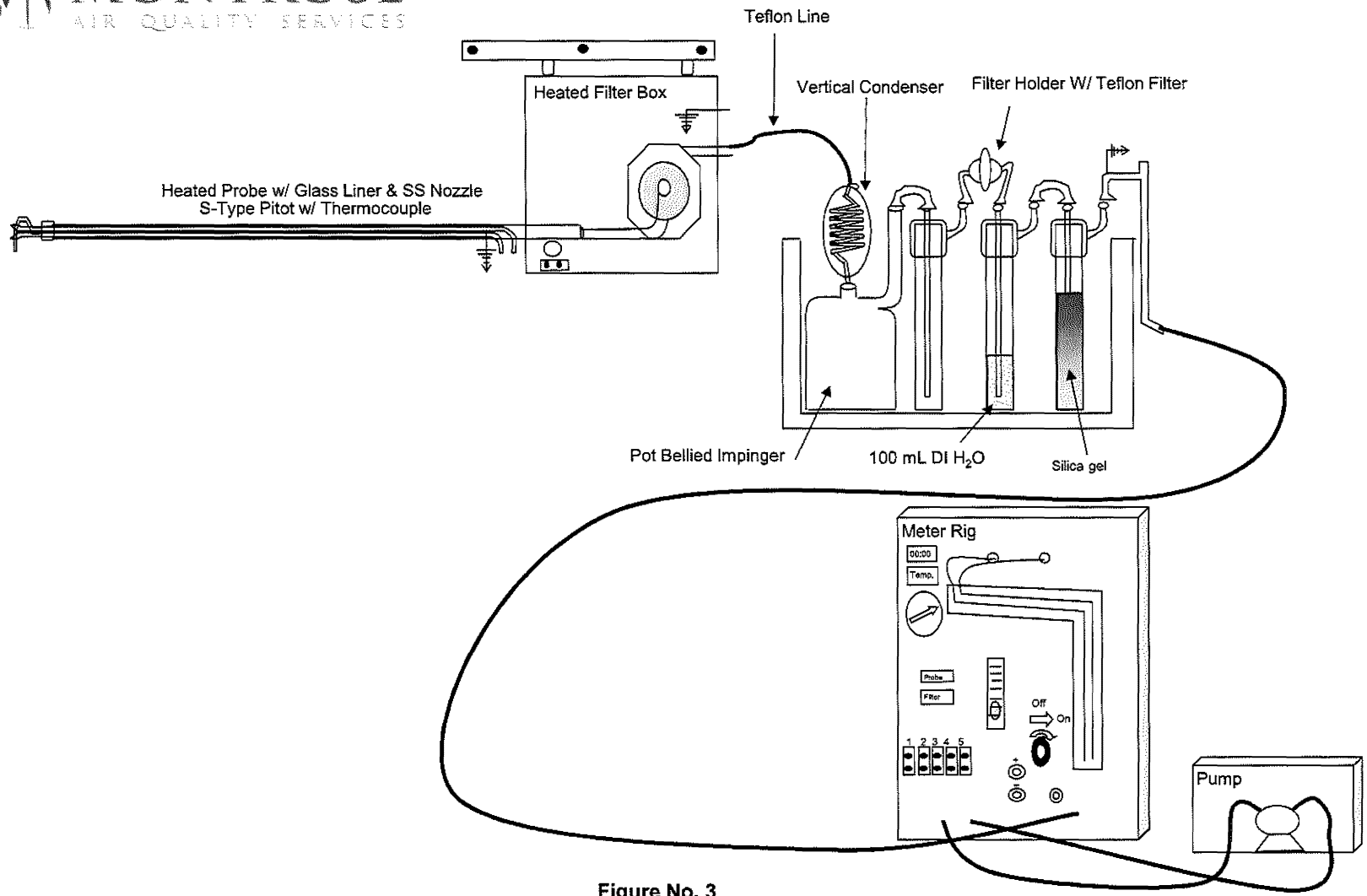



**Figure No. 3**

| | | |
|---|---|---|
| **Site:**<br>**USEPA Method 5/202**<br>**General Motors, LLC**<br>**Saginaw, Michigan** | **Sampling Date:**<br>**October 18, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |

MONTROSE
AIR QUALITY SERVICES

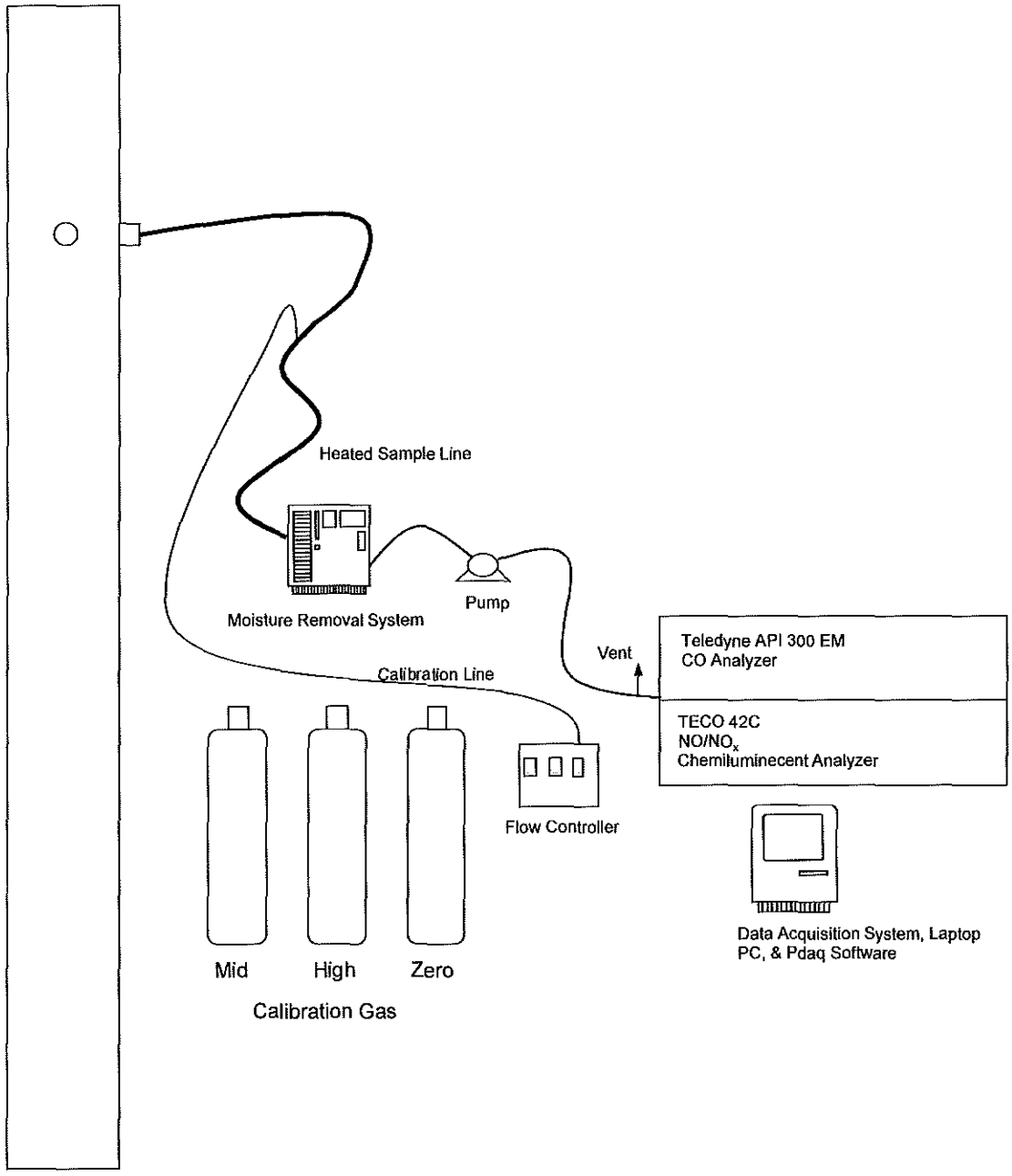



**Figure No. 4**

| | | |
|---|---|---|
| **Site:**<br>**USEPA Method 7E and 10**<br>**General Motors, LLC**<br>**Saginaw, Michigan** | **Sampling Date:**<br>**October 18, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, MI 48073** |

MONTROSE
AIR QUALITY SERVICES

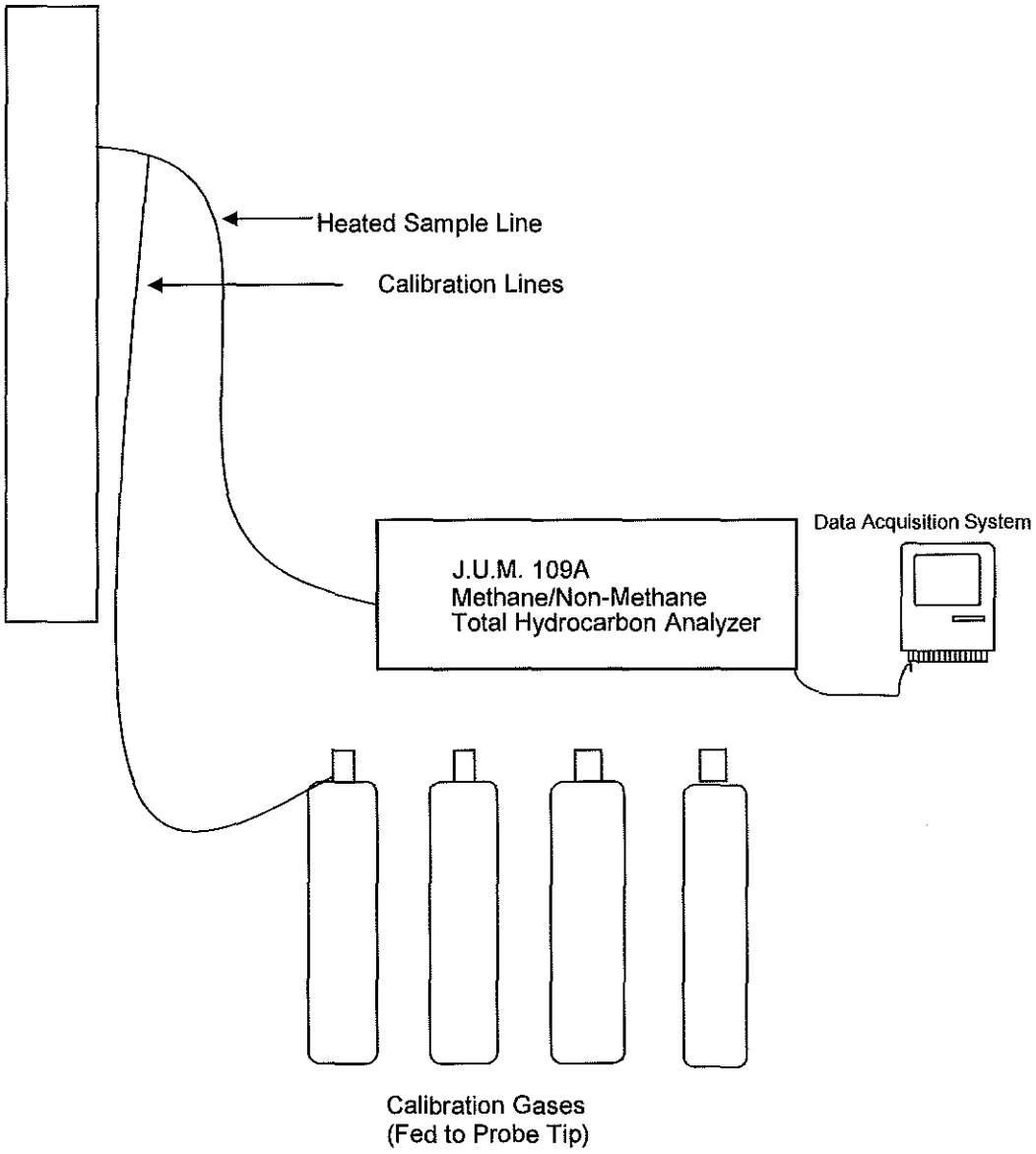



**Figure No. 5**

| | | |
|---|---|---|
| **Site:**<br>**USEPA Method 25A**<br>**General Motors, LLC**<br>**Saginaw, Michigan** | **Sampling Date:**<br>**October 18, 2018** | **Montrose Air Quality Services**<br>**4949 Fernlee Avenue**<br>**Royal Oak, Michigan 48073** |