

**SOURCE TEST REPORT
2020 NO_x, CO, AND PM TESTING
FORD MOTOR COMPANY
MICHIGAN ASSEMBLY PLANT
WAYNE, MICHIGAN**

Prepared For:

Ford Motor Company
Fairlane Plaza North, Suite 800
290 Town Center Drive
Dearborn, MI 48126

For Submittal To:

Michigan Department of Environment, Great Lakes, and Energy

Prepared By:

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

Document Number: **M049AS-601431**
Test Dates: **February 6-7, 2020**
Submittal Date: **March 12, 2020**



EXECUTIVE SUMMARY

Montrose Air Quality Services (MAQS) was retained by Ford Motor Company (Ford) to evaluate NOx, CO, and PM from the outlet of the Hot Water Generator at the Michigan Assembly Plant in Wayne, Michigan. The emissions test program was conducted from February 6th-7th, 2020. The purpose of this report is to document the results of the test program.

Testing consisted of triplicate 60-minute test runs for NOx and CO. Triplicate 180-minute test runs were conducted for PM. The results of the emission test program are summarized by Table I.

Table I
Overall Results Summary
Test Dates: February 6-7, 2020

Source	Test Dates	PM (lb/hr)	NOx (lb/hr)	CO (lb/hr)
Hot Water Generator	February 6-7, 2020	1.16E-02	0.55	0.01

TABLE OF CONTENTS

1. INTRODUCTION	1
1.A IDENTIFICATION, LOCATION, AND DATES OF TEST	1
1.B PURPOSE OF TESTING	1
1.C SOURCE DESCRIPTION	1
1.D TESTING PERSONNEL	1
2. SUMMARY OF RESULTS	2
2.A OPERATING DATA.....	2
2.B APPLICABLE PERMIT	2
2.C RESULTS	2
2.D EMISSION REGULATION COMPARISON.....	3
3. SOURCE DESCRIPTION	3
3.A PROCESS FLOW DIAGRAM	3
3.B PROCESS DESCRIPTION.....	3
3.C RAW AND FINISHED MATERIALS.....	3
3.D PROCESS CAPACITY	3
3.E PROCESS INSTRUMENTATION.....	3
4. SAMPLING AND ANALYTICAL PROCEDURES	3
4.A SAMPLING TRAIN AND FIELD PROCEDURES	3
4.B RECOVERY AND ANALYTICAL PROCEDURES	5
4.C SAMPLING PORTS.....	5
4.D TRAVERSE POINTS	5
5. TEST RESULTS AND DISCUSSION	6
5.A RESULTS TABULATION	6
5.B SAMPLING PROCEDURE VARIATIONS	6
5.C PROCESS OR CONTROL DEVICE UPSETS	6
5.D CONTROL DEVICE MAINTENANCE	6
5.E RETEST	6
5.F AUDIT SAMPLE ANALYSES.....	6
5.G CALIBRATION SHEETS.....	6
5.H SAMPLE CALCULATIONS.....	6
5.I FIELD DATA SHEETS.....	6
5.J LABORATORY DATA	6

TABLE OF CONTENTS (continued)

SUMMARY TABLES

Table 1	Test Personnel
Table 2	Test Program Overall Results Summary
Table 3	Hot Water Generator CO and NOx Emissions Summary
Table 4	Hot Water Generator Particulate Matter Summary

FIGURES

Figure 1	Hot Water Generator Sampling Location Traverse Point Diagram
Figure 2	USEPA 5/202 Sampling Train Diagram
Figure 3	USEPA 7E/10 Sampling Train Diagram

APPENDIX

Appendix A	Field and Computer-Generated Raw Data and Raw CEM Data
Appendix B	Equipment Calibration and Span Gas Documents
Appendix C	Example Calculations
Appendix D	Process Operating Data
Appendix E	Laboratory Analytical Results

1. Introduction

Montrose Air Quality Services (MAQS) was retained by Ford Motor Company (Ford) to evaluate NO_x, CO, and PM from the outlet of the Hot Water Generator at the Michigan Assembly Plant in Wayne, Michigan. The emissions test program was conducted from February 6th-7th, 2020. The purpose of this report is to document the results of the test program.

1.a Identification, Location, and Dates of Test

System/Stack ID	Exhaust Gas Parameters to be Evaluated	Date
Hot Water Generator	NO _x , CO, & PM Emission Rates	February 6-7, 2020

1.b Purpose of Testing

The purpose of the emissions test program was to verify NO_x, CO, and PM to demonstrate overall control efficiency to comply with the requirements of Michigan Department of Environmental Quality Air Quality Division Permit No. MI-ROP-A8650-2016 for the Michigan Assembly Plant.

1.c Source Description

The source generates hot water for the e-coat and pre-treatment operations.

1.d Testing Personnel

Names and affiliations for personnel involved in the emissions test program are summarized by Table 1.

Table 1
Testing Personnel

Name and Title	Affiliation	Telephone
Mr. Steve Smith Client Project Manager	MAQS 4949 Fernlee Ave. Royal Oak, MI	(248) 548-8072
Mr. Todd Wessel Client Project Manager	MAQS 4949 Fernlee Ave. Royal Oak, MI	(248) 548-8070
Mr. Dave Trahan Environmental Technician	MAQS 4949 Fernlee Ave. Royal Oak, MI	(248) 548-8070

Ms. Elizabeth Mathews Environmental Engineer	Ford Motor Company Fairlane Plaza North 290 Town Center Drive, Suite 800 Dearborn, Michigan 48126	(313)495-6054
Ms. Susan Hicks Principal Environmental Engineer	Ford Motor Company Fairlane Plaza North 290 Town Center Drive, Suite 800 Dearborn, Michigan 48126	(313)594-3185
Mr. Mark Dziadosz EGLE Air Quality Division	EGLE – Environmental, Great Lakes, & Energy SE Michigan District 27700 Donald Ct Warren, MI 48092	(586)753-3745
Mr. Steve Weiss EGLE Air Quality Division	EGLE – Environmental, Great Lakes, and Energy Michigan AQD, Cadillac Place 3058 W. Grand Blvd, Suite 2-300 Detroit, MI 48202-6058	(313)456-4688

2. Summary of Results

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

2.a Operating Data

Process operating data for this emissions test program is provided in Appendix D.

2.b Applicable Permit

The applicable permit for this emissions test program is Permit No. PTI-192-17.

2.c Results

The results of the emissions test program are summarized by Table 2. Detailed data for each test run can be found in Tables 3-4.

Table 2
Overall Results Summary
Test Dates: February 6-7, 2020

Source	Test Dates	PM (lb/hr)	NOx (lb/hr)	CO (lb/hr)
Hot Water Generator	February 6-7, 2020	1.16E-02	0.55	0.01

2.d Emission Regulation Comparison

NA

3. Source Description

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

3.a Process Flow Diagram

Due to the simplicity of the process, a process flow diagram is not applicable.

3.b Process Description

The source generates hot water for the e-coat and pre treatment operations baths.

3.c Raw and Finished Materials

NA

3.d Process Capacity

NA

3.e Process Instrumentation

Process data was collected by Ford personnel and can be found in Appendix D.

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 and removal efficiency.

4.a Sampling Train and Field Procedures

USEPA Methods 1-4

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. An S-type pitot tube with a thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was used to measure exhaust gas velocity pressures (using a manometer) and temperatures at each traverse location. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

A cyclonic flow check was 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. Both

sampling locations were evaluated for cyclonic flow and deemed acceptable for flowrate measurement.

Exhaust gas molecular weight was determined according to Method 3. The equipment used for the Method 3 evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. CO₂ and O₂ content was analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4 with triplicate test runs conducted at the outlet. Exhaust gas was extracted and passed through (i) two impingers, each with 100 ml deionized (DI) water, (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content was then determined volumetrically (liquid impingers) and gravimetrically (silica gel impinger). A schematic drawing of the Method 4 sampling train is provided as Figure 19.

USEPA Method 7E

The NO_x content of the gas stream was measured using a Teledyne NO_x 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 NO_x analyzer. Data was recorded on a PC equipped with data acquisition software. Recorded NO_x concentrations were averaged and reported for the duration of each 60-minute test (as drift corrected per Method 7E). A drawing of the sampling train used for the testing program is presented as Figure 23.

In accordance with Method 7E, a 3-point (zero, mid, and high) bias check and calibration check was performed on the NO_x analyzer prior to initiating the test program. Following each test run, a 2-point (zero and high) calibration drift check was performed. The NO_x analyzer was operated at the 0-100 ppm range.

USEPA Method 10

The CO content of the exhaust gas was evaluated according to procedures outlined in 40 CFR 60, Appendix A, Method 10. The CO content of the gas stream was measured using a Teledyne 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 sample conditioner with a peristaltic pump to remove the moisture from the sample before it entered the analyzer. Data was recorded on a PC equipped with Labview® II data acquisition software. Recorded CO concentrations were averaged and reported for the duration of each 60-minute test (as drift corrected per Method 7E). The analyzer was calibrated for a range of 0 to 100 ppm.

In accordance with Method 10, a 3-point (zero, mid, and high) calibration check was performed on the CO analyzer. Calibration drift checks were performed at the completion of each run.

Method 5/202

40 CFR 60, Appendix A, Method 5, “*Determination of Particulate Emissions from Stationary Sources*” 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 21 for a schematic of the sampling train). Triplicate 180-minute test runs were conducted for each source.

MAQS’ Nutech[®] Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) a steel probe, (3) a heated filter holder, (4) a vertical condenser, (5) an empty pot bellied impinger, (6) an empty modified Greenburg-Smith (GS) impinger, (7) unheated filter holder with a teflon filter, (8) a second modified GS impinger with 100 ml of deionized (DI) water, and a third modified GS impinger containing approximately 300 g of silica gel desiccant, (9) a length of sample line, and (10) a Nutech[®] control case equipped with a pump, dry gas meter, and calibrated orifice.

A sampling train leak test was conducted before and after each test run. After completion of the final leak test for each test run, the filter was recovered, and the nozzle and the front half of the filter holder assembly were brushed and triple rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The impinger train was then purged with nitrogen for one hour at a flow rate of 14 liters per minute. The CPM filter was recovered and placed in a petri dish. The back half of the filter housing, the condenser, the pot bellied impinger, the moisture drop out impinger, and the front half of the CPM filter housing and all connecting glassware were triple rinsed with deionized (DI) 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’ laboratory (for filter and acetone gravimetric analysis) in Royal Oak, Michigan. DI water and organic samples were hand delivered to Bureau Veritas for analysis.

4.b Recovery and Analytical Procedures

All recoveries were performed according to the correct USEPA Method.

4.c Sampling Ports

The outlet sampling locations satisfy the minimum criteria for Method 1.

4.d Traverse Points

Stack traverse point diagrams are appended as Figure 1.

5. Test Results and Discussion

The detailed results can be found in Tables 3 and 4. The hot water generator would shut down intermittently as the process did not require hot water continuously which resulted in brief gaps in the testing. These occurrences were discussed with Mr. Weiss and Mr. Dziadosz.

5.a Results Tabulation

The results of the emission test program are detailed in Tables 3-4.

5.b Sampling Procedure Variations

Due to the different length of runs for PM and gases, MAQS did a separate flow for run 1 of the gases. Then run 2 and 3 from the PM runs were used for 2 and 3 of the gas runs.

5.c Process or Control Device Upsets

No upset conditions occurred during testing.

5.d Control Device Maintenance

There has been no major maintenance performed during the past three months.

5.e Retest

This test program was not a re-test.

5.f Audit Sample Analyses

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

5.g Calibration Sheets

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 are presented as well as raw analyzer test data (provided electronically on CD) are provided in Appendix A.

5.j Laboratory Data

The laboratory data can be found in Appendix E

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: _____ Date: _____

Name: Steve Smith Title: Client Project Manager

I have reviewed, technically and editorially, details calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: _____ Date: _____

Name: Randal Tysar Title: District Manager

Tables

Table 3
Hot Water Generator NOx and CO Emission Rates
Ford
Wayne, Michigan
MAQS Project 049AS-601431
Sampling Dates: February 6, 2020

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	2/6/2020	2/6/2020	2/6/2020	
Test Run Time	7:23-8:25	8:38-9:38	10:38-11:38	
Outlet Flowrate (dscfm)	2,358	2,365	2,388	2,370
Outlet Oxides of Nitrogen Concentration (ppmv)	31.04	30.23	31.77	31.01
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	32.29	31.39	33.17	32.28
NOx Emission Rate (lb/hr)	0.52	0.51	0.54	0.52
NOx Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.54	0.53	0.57	0.55
Outlet Carbon Monoxide Concentration (ppmv)	-0.48	1.00	-0.39	0.04
Outlet CO Concentration (ppmv, corrected as per USEPA 7E) *	0.00	1.49	0.11	0.53
CO Emission Rate (lb/hr)	0.00	0.01	0.00	0.00
CO Emission Rate (lb/hr) (corrected as per USEPA 7E)	0.00	0.02	0.00	0.01

NOx Correction			
Co	0.30	0.54	0.40
Cma	50.36	50.36	50.36
Cm	48.25	48.17	48.03

CO Correction			
Co	-0.28	-0.48	-0.50
Cma	49.84	49.84	49.84
Cm	49.05	48.89	48.92

*Run 1 corrected per 7E resulted in a negative number. This was replaced with zero.

sefm = 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)

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

35.31 = ft³ per m³

453600 = mg per lb

Response factor obtained from introducing propane into methane analyzer:

2.3

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=K C_{meas}

where C_c = Concentration as Carbon (ppmv), K= Carbon equivalent correction factor (3 for Propane)

and C_{meas} = concentration as measured (as propane)

¹emission rate calculated on dry basis

²emission rate calculated on wet basis

Equations

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

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * *dscfm* * 60

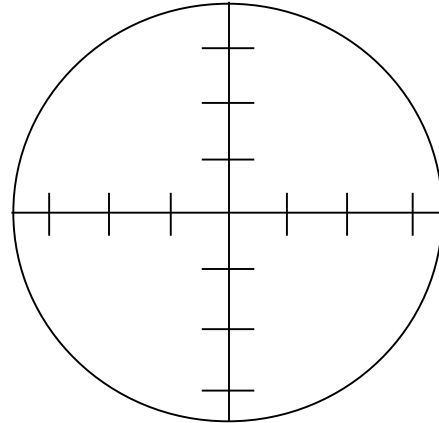
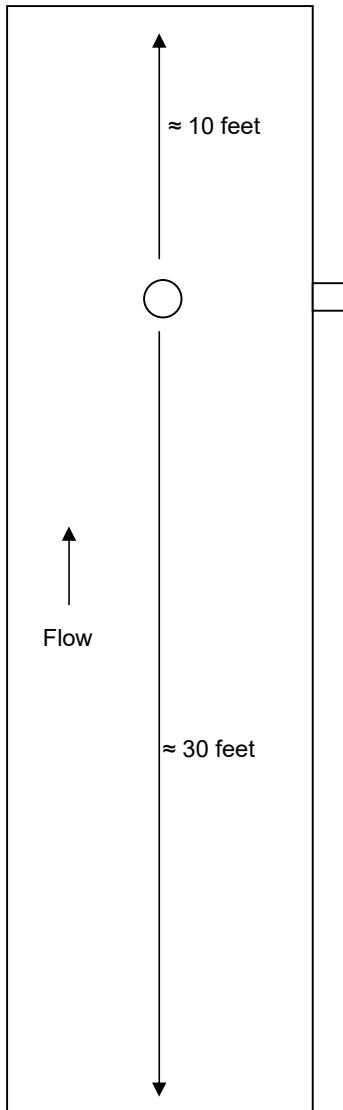
Conc_{@15%O₂} = Conc * (20.9 - 15)/(20.9 - %O₂)

**Table 4
Particulate Matter Emission Rates**

Company Source Designation Test Date	Ford MAP Boiler South			Average
	2/6/2020	2/6/2020	2/7/2020	
Meter/Nozzle Information				
	Run 1	Run 2	Run 3	Average
Meter Temperature Tm (F)	72.4	74.6	75.4	74.1
Meter Pressure - Pm (in. Hg)	29.1	29.1	28.9	29.0
Measured Sample Volume (Vm)	145.0	147.7	143.6	145.4
Sample Volume (Vm-Std ft3)	142.3	144.4	139.2	142.0
Sample Volume (Vm-Std m3)	4.03	4.09	3.94	4.02
Condensate Volume (Vw-std)	18.577	19.407	19.313	19.099
Gas Density (Ps(std) lbs/ft3) (wet)	0.0728	0.0728	0.0727	0.0727
Gas Density (Ps(std) lbs/ft3) (dry)	0.0762	0.0764	0.0763	0.0763
Total weight of sampled gas (m g lbs) (wet)	11.71	11.93	11.52	11.72
Total weight of sampled gas (m g lbs) (dry)	10.84	11.03	10.62	10.83
Nozzle Size - An (sq. ft.)	0.001027	0.001027	0.001027	0.001027
Isokinetic Variation - I	102.3	102.8	101.1	102.1
Stack Data				
Average Stack Temperature - Ts (F)	194.6	205.0	209.8	203.1
Molecular Weight Stack Gas- dry (Md)	29.5	29.5	29.5	29.5
Molecular Weight Stack Gas-wet (Ms)	28.2	28.2	28.1	28.1
Stack Gas Specific Gravity (Gs)	0.972	0.973	0.971	0.972
Percent Moisture (Bws)	11.54	11.85	12.18	11.86
Water Vapor Volume (fraction)	0.1154	0.1185	0.1218	0.1186
Pressure - Ps ("Hg)	28.9	28.9	28.7	28.9
Average Stack Velocity -Vs (ft/sec)	18.2	18.7	18.7	18.5
Area of Stack (ft2)	3.1	3.1	3.1	3.1
Exhaust Gas Flowrate				
Flowrate ft ³ (Actual)	3,426	3,524	3,516	3,489
Flowrate ft ³ (Standard Wet)	2,672	2,706	2,662	2,680
Flowrate ft ³ (Standard Dry)	2,364	2,385	2,338	2,362
Flowrate m ³ (standard dry)	67	68	66	67
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	4.5	3.4	3.6	3.8
Organic Condensable Particulate	1.0	1.0	1.0	1.0
Inorganic Condensable Particulate	2.6	2.5	2.1	2.4
Condensable Blank Correction	2.0	2.0	2.0	2.0
Total Condensable Particulate	1.6	1.5	1.1	1.4
Total Filterable and Condensable Particulate	6.1	4.9	4.7	5.2
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.001	0.001
mg/dscm (dry)	1.1	0.8	0.9	1.0
gr/dscf	0.0005	0.0004	0.0004	0.0004
Filterable Particulate Emission Rate				
lb/ hr	9.92E-03	7.46E-03	8.03E-03	8.47E-03
Condensable Particulate Concentration				
lb/1000 lb (wet)	0.000	0.000	0.000	0.000
lb/1000 lb (dry)	0.000	0.000	0.000	0.000
mg/dscm (dry)	0.4	0.4	0.3	0.3
gr/dscf	0.0002	0.0002	0.0001	0.0002
Condensable Particulate Emission Rate				
lb/ hr	3.53E-03	3.29E-03	2.45E-03	3.09E-03
Total Particulate Concentration				
lb/1000 lb (wet)	0.001	0.001	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.001	0.001
mg/dscm (dry)	1.5	1.2	1.2	1.3
gr/dscf	0.0007	0.0005	0.0005	0.0006
Total Particulate Emission Rate				
lb/ hr	1.34E-02	1.07E-02	1.05E-02	1.16E-02

Figures

diameter = 24 inches



Not to Scale

Points	Distance in Inches
1	1.1
2	3.5
3	7.1
4	16.9
5	20.5
6	22.9

Figure No. 1

Site:
Hot Water Generator
Ford MAP
Wayne, Michigan

Sampling Date:
February 6-7, 2020

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

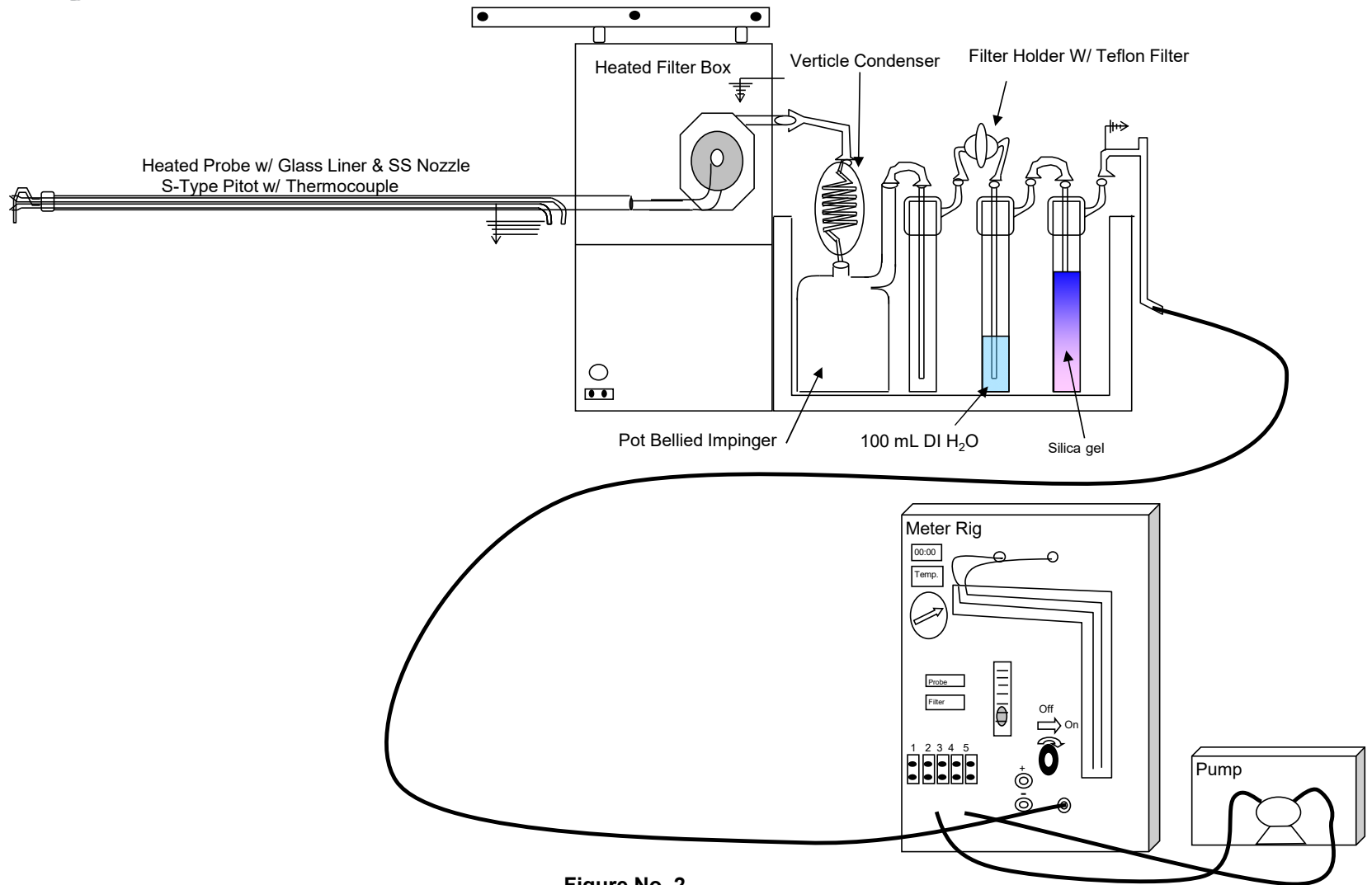


Figure No. 2

Site:
USEPA Method 5/202
Ford Michigan Assembly Plant
Wayne, Michigan

Sampling Date:
February 6-7, 2020

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

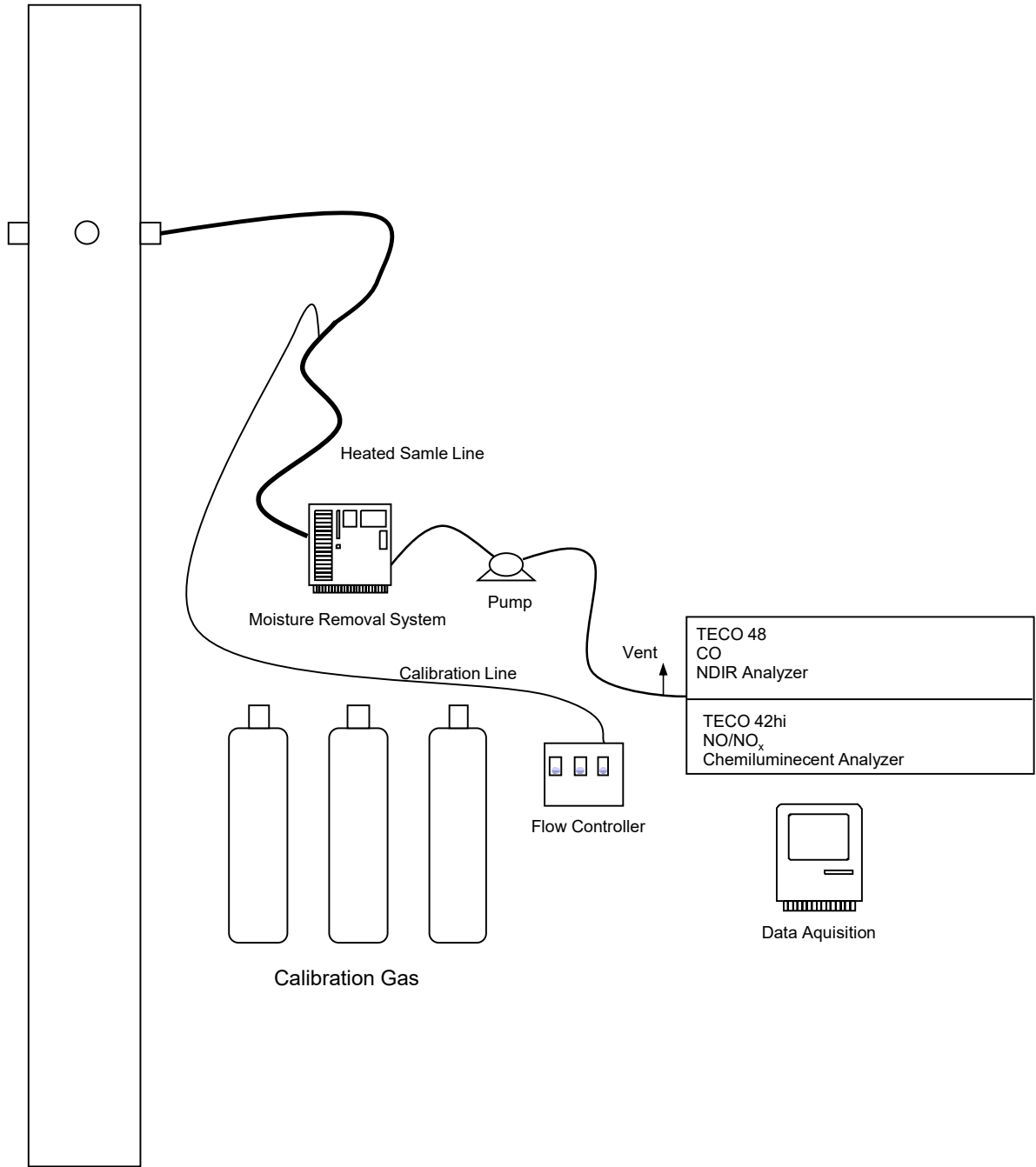


Figure No. 3

Site:
USEPA Method 7E/10
Ford Michigan Assembly Plant
Wayne, Michigan

Sampling Dates:
February 6-7, 2020

Montrose Air Quality Services
4949 Fernlee Ave
Royal Oak, Michigan 48073