BTEC Inc.

PM and VOC Emissions Test Report

Prepared for:

General Motors

Lansing, Michigan

GM Lansing Delta
8175 Millett Hwy.
Lansing, Michigan

Project No. 17-5080.00
October 12, 2017

BT Environmental Consulting, Inc.
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Royal Oak, Michigan 48071
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Executive Summary

BT Environmental Consulting, Inc. (BTEC) was retained by General Motors, LLC (GM) to conduct emissions testing at the GM Lansing Delta Township facility in Lansing, Michigan. The test program consisted of evaluation of particulate matter (PM), condensable particulate matter (CPM), and volatile organic compounds (VOC) concentrations and emission rates from the primer surfacer regenerative thermal oxidizer (RTO).

Testing of the sources consisted of triplicate 120-minute test runs for PM, CPM, and VOC. Sampling was performed utilizing United States Environmental Protection Agency (USEPA) reference test methods. Testing occurred on August 29-30, 2017. The results of the emissions test program are summarized by Table 1.

Table 1
Overall Results Summary
Sampling Dates: August 29-30, 2017

Pollutant	Emission Limitation	Average Test Result (lb/hr) **
Particulate Matter (PM, PM_{10}, $PM_{2.5}$)	1.1 lb/hr	0.2
Particulate Matter (PM, PM_{10}, $PM_{2.5}$)	0.011 lb/1,000 lbs of exhaust gas	0.002
VOC	N/A*	0.3

* Testing for VOC was not necessary for this test program; VOC test results are included for informational purposes
** All PM reported as $PM_{2.5}$

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1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by General Motors, LLC (GM) to conduct emissions testing at the GM Lansing Delta Township facility in Lansing, Michigan. The test program consisted of evaluation of particulate matter (PM), condensable particulate matter (CPM), and volatile organic compounds (VOC) concentrations and emission rates from the primer surfacer regenerative thermal oxidizer (RTO).

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" (December 2013). 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 Lansing Delta Township facility located in Lansing, Michigan. Testing on the source was conducted August 29-30, 2017.

1.b Purpose of Testing

The purpose of the testing is to demonstrate compliance with the emission limitations listed in Special Condition V.2 of Permit to Install 209-00E. The VOC test results are not required and included for informational purposes only.

1.c Source Description

The primer surfacer oven emissions are controlled by an RTO.

1.d Test Program Contact

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

Ms. Jessica Alderton
Senior Environmental Engineer
General Motors - Global Environmental Compliance & Sustainability
30400 Van Dyke, 5th Floor
Warren, MI 48093
586-863-8490

Mr. Brian Borzenski
Sr. Environmental Engineer
General Motors Lansing Delta Township Assembly
8175 Millett Hwy
Lansing, MI 48917
517-388-0631

Mr. Barry P. Boulianne
Senior Project Manager
BTEC
4949 Fernlee Avenue
Royal Oak, MI 48073
313-449-2361

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
Brian Borzenski	GM-Lansing Delta
Jeff Hummel	GM-Lansing Delta
Tom Caltrider	GM-Warren Tech Center
Jessica Alderton	GM-Warren Tech Center
Steve Smith	BTEC
Mike Nummer	BTEC
Jake Zott	BTEC
Tom Gasloli	MDEQ
Bob Byrnes	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 E.

2.b Applicable Permit

PTI 209-00E

2.c Results

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

2.d Emission Regulation Comparison

The Emission regulations 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

The Primer Surfacer process consists of one booth containing a powder primer surfacer application zone, and a manual observation zone. The booth is followed by an oven. Primer Surfacer oven emissions are directed to the RTO.

3.b Process Flow Diagram

Due to the simplicity of the RTO operations, a process flow diagram is not necessary.

3.c Raw and Finished Materials

GM utilizes numerous raw materials in the fabrication, coating and assembly of vehicles. The raw materials relevant to the tested emission source are surface coatings applied to the vehicle bodies in the paint shop following the ELPO oven: powder primer surfacer, sealers, adhesives, and fillers.

3.d Process Capacity

The production rate is limited to 74 jobs per hour.

3.e Process Instrumentation

The process data from this test includes the temperature and air flow at the test locations. The RTO combustion chamber temperature was also monitored. 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 three 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
(3) Measurement of exhaust VOC using USEPA Methods 25A

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 Figure 1.

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 120-minute test runs were conducted on each source.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a stainless-steel nozzle, (2) a glass probe, (3) a heated borosilicate filter holder with a glass fiber filter, (4) a Teflon connecting line to the impingers, (5) a vertical condenser, (6) an empty pot bellied 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 Teflon connecting line, 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 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.

BTEC 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. BTEC personnel carried all samples to BTEC's laboratory (for filter and acetone gravimetric analysis) in Royal Oak, Michigan. DI water and organic samples were hand delivered to Maxxam for analysis.

VOC Concentration (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 IOtech® data acquisition software. BTEC 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 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. All methane concentrations were negative and have replaced with zero for calculations.

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

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

4.c Sampling Ports

Sampling ports are included as Figure 1.

4.d Traverse Points

Traverse points are included as Figure 1.

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: August 29-30, 2017

Pollutant	Emission Limitation	Average Test Result (lb/hr) **
Particulate Matter (PM, PM_{10}, $PM_{2.5}$)	1.1 lb/hr	0.2
Particulate Matter (PM, PM_{10}, $PM_{2.5}$)	0.011 lb/1,000 lbs of exhaust gas	0.002
VOC	N/A*	0.3

*Testing for VOC was not necessary for this test program.
** All PM reported as $PM_{2.5}$

5.c Sampling Procedure Variations

There were no sampling procedure variations.

5.d Process or Control Device Upsets

No control device upsets occurred during the emissions test program. Vehicle counts in the primer surfacer operation can fluctuate due to work breaks and other assembly line interruptions. Each of the three test runs was paused once for no longer than 76 minutes in order to ensure high vehicle counts in the primer surfacer oven during the emissions sampling periods.

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
Primer Surfacer RTO Particulate Matter Emission Rates

Company	**GM Lansing Delta**			
Source Designation	**Prime RTO Outlet**			
Test Date	**8/29/2017**	**8/29/2017**	**8/30/2017**	
Meter/Nozzle Information	Run 1	Run 2	Run 3	Average
Meter Temperature Tm (F)	69.4	75.4	66.3	70.3
Meter Pressure - Pm (in. Hg)	29.3	29.3	29.2	29.3
Measured Sample Volume (Vm)	101.7	102.4	100.1	101.4
Sample Volume (Vm-Std ft3)	97.8	97.4	96.8	97.3
Sample Volume (Vm-Std m3)	2.77	2.76	2.74	2.76
Condensate Volume (Vw-std)	2.178	2.221	2.188	2.196
Gas Density (Ps(std) lbs/ft3) (wet)	0.0739	0.0739	0.0739	0.0739
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	7.39	7.36	7.32	7.36
Total weight of sampled gas (m g lbs) (dry)	7.29	7.26	7.22	7.26
Nozzle Size - An (sq. ft.)	0.000383	0.000383	0.000383	0.000383
Isokinetic Variation - I	100.3	100.5	100.2	100.3
Stack Data				
Average Stack Temperature - Ts (F)	439.6	438.0	431.7	436.4
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.6	28.6	28.6	28.6
Stack Gas Specific Gravity (Gs)	0.988	0.987	0.987	0.987
Percent Moisture (Bws)	2.18	2.23	2.21	2.21
Water Vapor Volume (fraction)	0.0218	0.0223	0.0221	0.0221
Pressure - Ps ("Hg)	29.1	29.1	29.1	29.1
Average Stack Velocity -Vs (ft/sec)	63.4	62.9	62.3	62.9
Area of Stack (ft2)	10.0	10.0	10.0	10.0
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	37,900	37,610	37,243	37,584
Flowrate ft^3 (Standard Wet)	21,620	21,492	21,418	21,510
Flowrate ft^3 (Standard Dry)	21,149	21,013	20,945	21,036
Flowrate m^3 (standard dry)	599	595	593	596
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	0.5	1.5	0.5	0.8
Organic Condensible Particulate	5.1	3.2	3.0	3.8
Inorganic Condensible Particulate	3.7	3.7	3.5	3.6
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	6.8	4.9	4.5	5.4
Total Filterable and Condensible Particulate	7.3	6.4	5.0	6.2
Filterable 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)	0.2	0.5	0.2	0.3
gr/dscf	0.0001	0.0002	0.0001	0.0001
Filterable Particulate Emission Rate				
lb/ hr	0.01	0.04	0.01	0.02
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.002	0.001	0.001	0.002
lb/1000 lb (dry)	0.002	0.001	0.001	0.002
mg/dscm (dry)	2.5	1.8	1.6	2.0
gr/dscf	0.0011	0.0008	0.0007	0.0009
Condensible Particulate Emission Rate				
lb/ hr	0.20	0.14	0.13	0.15
Total Particulate Concentration				
lb/1000 lb (wet)	0.002	0.002	0.002	0.002
lb/1000 lb (dry)	0.002	0.002	0.002	0.002
mg/dscm (dry)	2.6	2.3	1.8	2.3
gr/dscf	0.0012	0.0010	0.0008	0.0010
Total Particulate Emission Rate				
lb/ hr	0.21	0.18	0.14	0.18

Table 4
RTO VOC Emission Rates
GM Lansing Delta
Lansing, MI
BTEC Project No. 17-5080
Sampling Dates: 8/29/2017-8/30/2017

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	8/29/2017	8/29/2017	8/30/2017	
Test Run Time	7:41-8:59	12:17-13:36	7:43-8:43	
Test Run Time	10:15-11:00	14:20-15:05	9:58-10:58	
Outlet Flowrate (scfm)	21,620	21,492	21,418	**21,510**
Outlet VOC Concentration (ppmv as propane)	1.9	3.0	2.9	**2.6**
Outlet Methane Concentration (ppmv as methane)	*0.0*	*0.0*	*0.0*	**0.0**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	1.7	2.8	2.6	**2.4**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	*0.0*	*0.0*	*0.0*	**0.0**
Outlet VOC Concentration (ppmv propane, -Methane)	1.9	3.0	2.9	**2.6**
Outlet VOC Concentration (ppmv propane, -Methane, corrected as per USEPA 7E)	1.7	2.8	2.6	**2.4**
VOC Emission Rate as Propane (lb/hr) (-Methane)	**0.3**	**0.4**	**0.4**	**0.4**
VOC Emission Rate as Propane(lb/hr) (-Methane) (corrected as per USEPA 7E)	**0.3**	**0.4**	**0.4**	**0.3**

VOC Correction			
Co	0.17	0.30	0.44
Cma	29.8	29.8	29.8
Cm	29.28	28.96	29.16

Methane Correction			
Co	-0.02	-0.04	0.08
Cma	29.8	29.8	29.8
Cm	29.92	30.21	30.06

Negative corrected numbers replaced with zero

scfm = standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour
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

Response factor obtained from introducing propane into methane analyzer:	**2.25**	**2.25**	**2.24**

Equations

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

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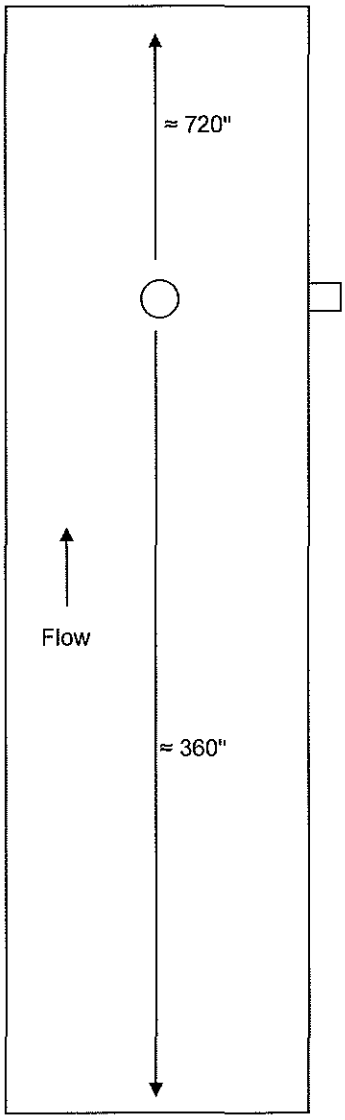
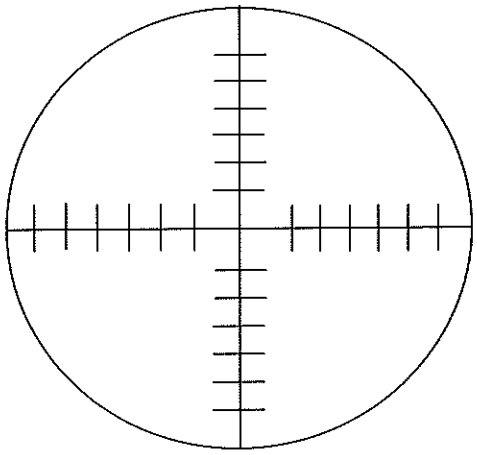
diameter = 42.75 inches





Not to Scale

Points	Distance "
1	0.9
2	2.9
3	5.0
4	7.6
5	10.7
6	15.2
7	27.5
8	32.1
9	35.2
10	37.7
11	39.9
12	41.9

Figure No. 1

Site: **RTO Outlet** **GM Lansing Delta** **Lansing, Michigan**	**Sampling Date:** **August 29-30, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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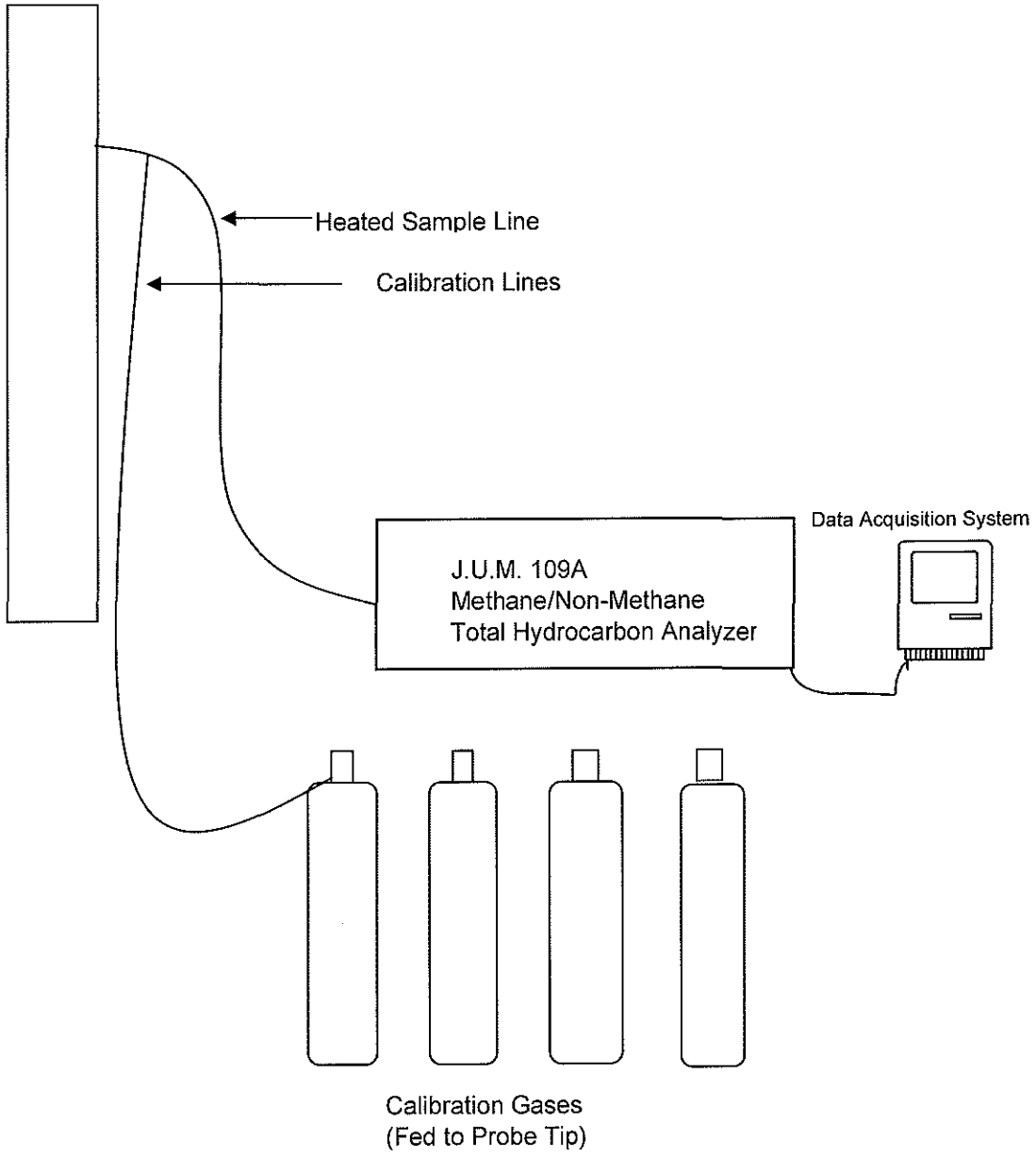

Figure No. 2

Site: **USEPA Method 25A** **General Motors** **Lansing, Michigan**	**Sampling Date:** **August 29-30, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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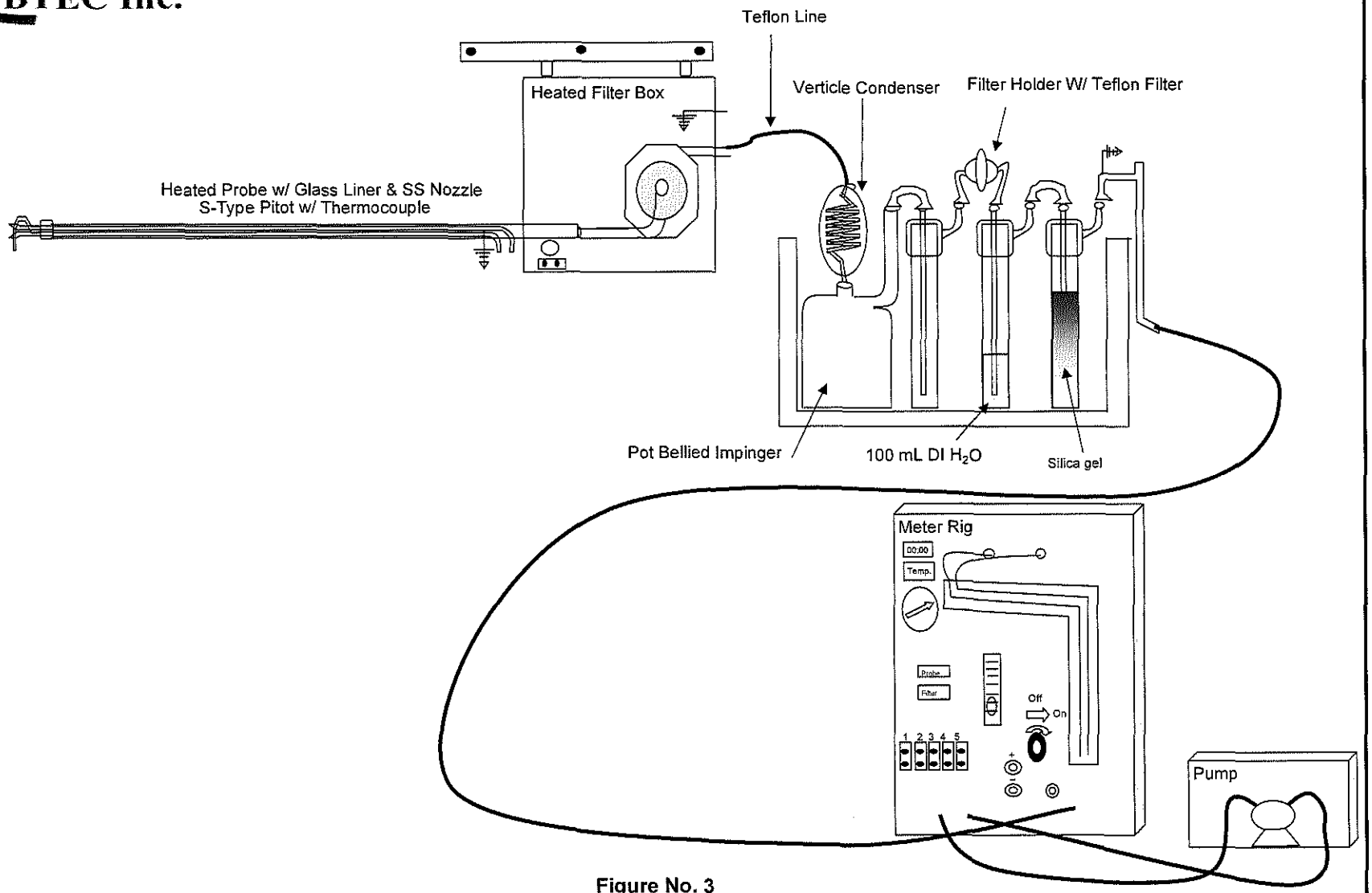

Figure No. 3

Site: **USEPA Method 5/202** **General Motors** **Lansing, Michigan**	**Sampling Date:** **August 29-30, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**