BTEC Inc.

VOC Destruction Efficiency Emissions Test Summary Report

Prepared for:

Ford Motor Company

Dearborn Truck Plant
3001 Miller Road
Dearborn, MI 48120

Project No. 16-4901.00
April 3, 2017

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Ford Motor Company (Ford) to conduct a volatile organic compound (VOC) Destruction Efficiency (DE) emissions test program on two sources at the Ford facility located in Dearborn, Michigan. The emissions test program was conducted on February 8th and 9th, 2017.

Testing of the RTO and Fluidized Bed consisted of triplicate 60-minute test runs on each source. The emissions test program was required by Permit No. MI-ROP-A8648-2015. The results of the emission test program are summarized by Table I.

Table I
Overall Emission Summary

Combined RTO
Test Date: February 8th, 2017

Pollutant	Destruction Efficiency (%)
VOC	95.8

Fluidized Bed
Test Date: February 9th, 2017

Pollutant	Destruction/Removal Efficiency (%)
VOC	78.9

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Ford Motor Company (Ford) to conduct a volatile organic compound (VOC) Destruction Efficiency (DE) emissions test program on two sources at the Ford facility located in Dearborn, Michigan. The emissions test program was conducted on February 8th and 9th, 2017. 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" (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

Sampling and analysis for the emission test program was conducted on February 8th and 9th, 2017 at the Ford facility located in Dearborn, Michigan. The test program included evaluation of VOC DE emissions from an RTO and Fluidized Bed.

1.b Purpose of Testing

The AQD issued Permit No. MI-ROP-A8648-2015 to Ford.

1.c Source Description

The emissions test program evaluated VOC emission rates at sampling locations associated with the fluidized bed concentrator/oxidizer, and Combined RTO exhaust systems.

1.d Test Program Contacts

The contact for the source and test report is:

Ms. Susan Hicks
Senior Environmental Engineer
Ford Motor Company
290 Town Center Drive, Suite 800
Dearborn, Michigan 48126
(313) 594-3185
email: shicks3@ford.com

Names and affiliations for personnel who were present during the testing program are summarized by Table 1.

Table 1
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Matt Young Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Steve Smith Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Mason Sakshaug Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Mike Nummer Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Mark Dziadosz Air Quality Division	MDEQ	(586) 753-3745

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance 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. MI-ROP-A8648-2015.

2.c Results

The RTO VOC DE test result is 95.8%. The Fluidized Bed VOC DE/RE test result is 78.9%, the result is the combination of the removal efficiency & destruction efficiency as it was measured as a combined value.

3. Source Description

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

3.a Process Description

Automotive bodies are processed in the paint shop utilizing equipment such as spray booths, scuff booths, hot water heaters, repair painting, ovens and pollution control equipment.

3.b Process Flow Diagram

Due to the simplicity of the thermal oxidizer, a process flow diagram is not necessary.

3.c Raw and Finished Materials

Pipeline quality natural gas is used in the oxidizers as combustion fuel.

3.d Process Capacity

DTP operates at a maximum line speed of 72 jobs per hour.

3.e Process Instrumentation

Section 3.d provides summary.

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

Measurement of exhaust gas velocity, molecular weight, and moisture content were conducted using the following reference test methods codified at 40 CFR 60, Appendix A:

- Method 1 -"Sample and Velocity Traverses for Stationary Sources"
- Method 2 -"Determination of Stack Gas Velocity and Volumetric Flow rate"
- Method 3 -"Determination of Molecular Weight of Dry Stack Gas" (Fyrite)
- Method 4 - "Determination of Moisture Content in Stack Gases"
- Method 25A -"Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

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 was used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. 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 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 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 3. The O_2 /CO_2 content of the gas stream was measured using an O_2 /CO_2 Fyrite gas analyzer.

Exhaust gas moisture content was evaluated using wet bulb/dry bulb procedure or 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 water, (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content is then determined gravimetrically.

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 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 data acquisition software. BTEC used a VIG Model 20 THC hydrocarbon analyzer to determine the VOC concentrations at the inlet, and a JUM 109A Methane/Non-Methane THC hydrocarbon analyzer to determine the VOC concentrations at the outlet.

The VIG 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 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 JUM analyzer was calibrated for a range of 0 to 100 ppm on each channel and the VIG analyzer was calibrated for a range of 0 to 1,000 ppm.

In accordance with Method 25A, a 3-point (zero, mid, and high) calibration check was performed on the THC analyzer. Calibration drift checks were performed at the completion of each run.

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. A field quality assurance check of the system was performed pursuant to Method 205 by setting the diluted concentration to a value identical to a Protocol 1 calibration gas and then verifying that the analyzer response is the same with the diluted gas as with the Protocol 1 gas.

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 3-7.

4.d Traverse Points

A diagram of the stack indicating traverse point locations and stack dimensions is included as Figures 3-7.

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

Table 2
Overall Emission Summary

Combined RTO
Test Date: February 8th, 2017

Pollutant	Destruction Efficiency (%)
VOC	95.8

Fluidized Bed
Test Date: February 9th, 2017

Pollutant	Destruction/Removal Efficiency (%)
VOC	78.9

5.b Discussion of Results

The RTO VOC DE test result is 95.8%.

The fluidized bed VOC DE/RE test result is 78.9%, which is lower than anticipated. The team has replaced the carbon beads and a second test is scheduled.

5.c Sampling Procedure Variations

No moisture was performed on the RTO inlet during Run 1. After run 1 was completed, Mark Dziadosz from the MDEQ arrived on site and discussed this with BTEC and requested we perform moisture runs for Run 2 and Run 3. The average moisture value for runs 2 and 3 was used for approximant moisture for run 1.

5.d Process or Control Device Upsets

There were no process upsets during this test.

5.e Control Device Maintenance

No maintenance was performed during the 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 B.

5.i Sample Calculations

Sample calculations are provided in Appendix C.

5.j Field Data Sheets

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

5.k Laboratory Data

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

Table 3
Combined RTO Destruction Efficiency Summary
Ford DTP
Dearborn, MI
2/8/2017

Parameter	Run 1	Run 2	Run 3	Average
Sampling Date	2/8/2017	2/8/2017	2/8/2017	
Sampling Time	8:15-9:15	9:45-10:45	12:00-13:00	
Inlet Flowrate (scfm)	50,232	51,753	50,720	50,902
Outlet Flowrate (scfm)	55,561	54,807	55,939	55,436
Inlet VOC Concentration (ppmv propane)	506.7	512.8	352.2	457.2
Inlet VOC Concentration (ppmv, corrected as per USEPA 7E)	492.8	488.2	327.8	436.3
Inlet VOC Mass Flowrate (lb/hr)	169.9	173.4	114.1	152.5
Outlet VOC Concentration (ppmv propane)	17.2	16.6	13.3	15.7
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	17.4	16.8	14.6	16.3
Outlet CH4 Concentration (ppmv methane)*	0.0	0.0	0.0	0.0
Outlet CH4 Concentration (ppmv, corrected as per USEPA 7E)	0.0	0.0	0.0	0.0
Outlet VOC Concentration (- methane)*	17.4	16.8	14.6	16.3
Outlet VOC Mass Emission Rate (lb/hr)	6.6	6.3	5.6	6.2
VOC Destruction Efficiency (%)	**96.1**	**96.3**	**95.1**	**95.8**

*: The methane concentration was insignificant and has been excluded from calculations

Inlet VOC Correction			
Co	5.91	12.95	13.67
Cma	496	496	496
Cm	509.91	520.76	525.93

Outlet VOC Correction			
Co	0.38	0.58	0.14
Cma	29.8	29.8	29.8
Cm	29.28	28.89	27.11

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

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

Table 4
Fluidized Bed Detailed Emission Test Results Summary
Ford Motor Company
Dearborn, Michigan
2/9/2017

Parameter	Run 1	Run 2	Run 3	Average
Sampling Date	2/9/2017	2/9/2017	2/9/2017	
Sampling Time	8:25-9:25	9:40-10:05 10:20-10:55	12:00-13:00	
Inlet Flowrate (scfm)	60,041	59,868	59,713	59,874
Clean Air Outlet Flowrate (scfm)	64,510	69,545	67,825	67,293
Oxidizer Outlet Flowrate (scfm)	655	593	644	630
Inlet VOC Concentration	149.1	140.7	140.9	
Inlet VOC Concentration (corrected for 7E)	149.5	140.5	141.0	143.7
Inlet VOC Mass Flowrate (lb/hr)	61.4	57.6	57.6	58.9
Clean Air Outlet VOC Concentration	31.4	27.4	32.0	30.3
Clean Air Outlet VOC Concentration (corrected for 7E)	30.9	26.4	30.1	29.1
Clean Air Outlet CH4 Concentration	5.2	4.4	5.1	4.9
Clean Air Outlet CH4 Concentation (corrected for 7E)	5.0	4.3	5.0	4.7
Clean Air Outlet VOC Concentration (- methane)	28.7	24.5	27.9	27.0
Clean Air Outlet VOC Mass Emission Rate (lb/hr)	12.7	11.7	13.0	12.4
Oxidizer Outlet VOC Concentration	-0.01	0.05	-0.11	0.0
Oxidizer Outlet VOC Concentration (corrected for 7E)	0.1	0.2	0.0	0.1
Oxidizer Outlet VOC Mass Emission Rate (lb/hr)	0.0	0.0	0.0	0.0
Combined Outlet Concentraton	28.7	24.7	27.9	27.1
Combined Outlet Mass Emission Rate (lb/hr)	12.7	11.7	13.0	12.4
VOC Removal Efficiency (%)	**79.4**	**79.7**	**77.5**	**78.9**

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

RF= 2.29

Inlet VOC Correction			
Co	-0.59	-1.21	-0.80
Cma	199	199	199
Cm	198.69	199.76	199.16

Clean Air VOC Correction			
Co	0.40	0.86	1.06
Cma	29.8	29.8	29.8
Cm	30.36	30.79	31.71

Clean Air CH4 Correction			
Co	0.13	0.14	0.19
Cma	29.8	29.8	29.8
Cm	30.04	29.77	30.01

Oxidizer VOC Correction			
Co	-0.07	-0.13	-0.11
Cma	29.8	29.8	29.8
Cm	29.39	28.92	29.00

BTEC Inc.

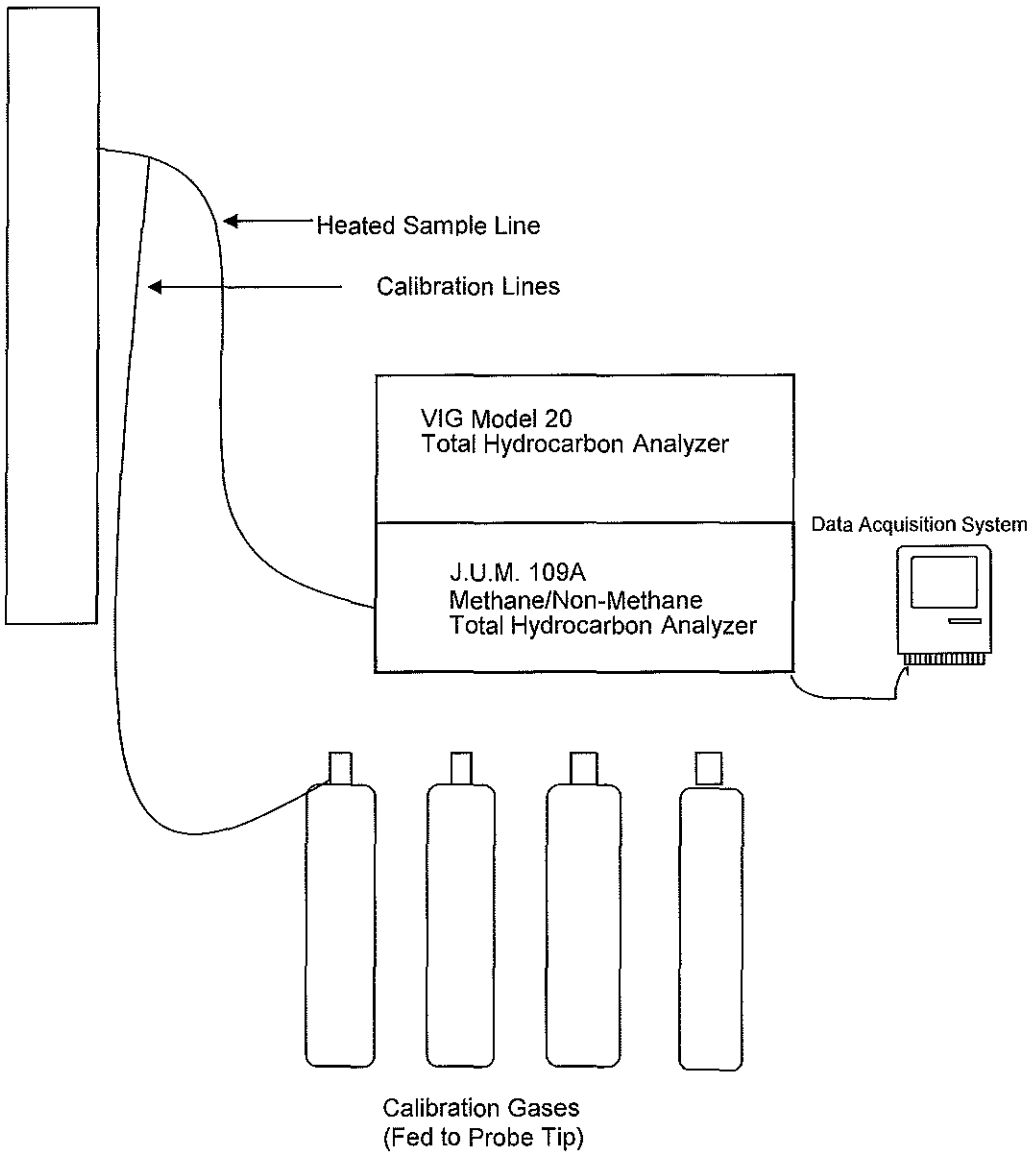


Figure No. 1

Site: **USEPA Method 25A** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 8-9, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

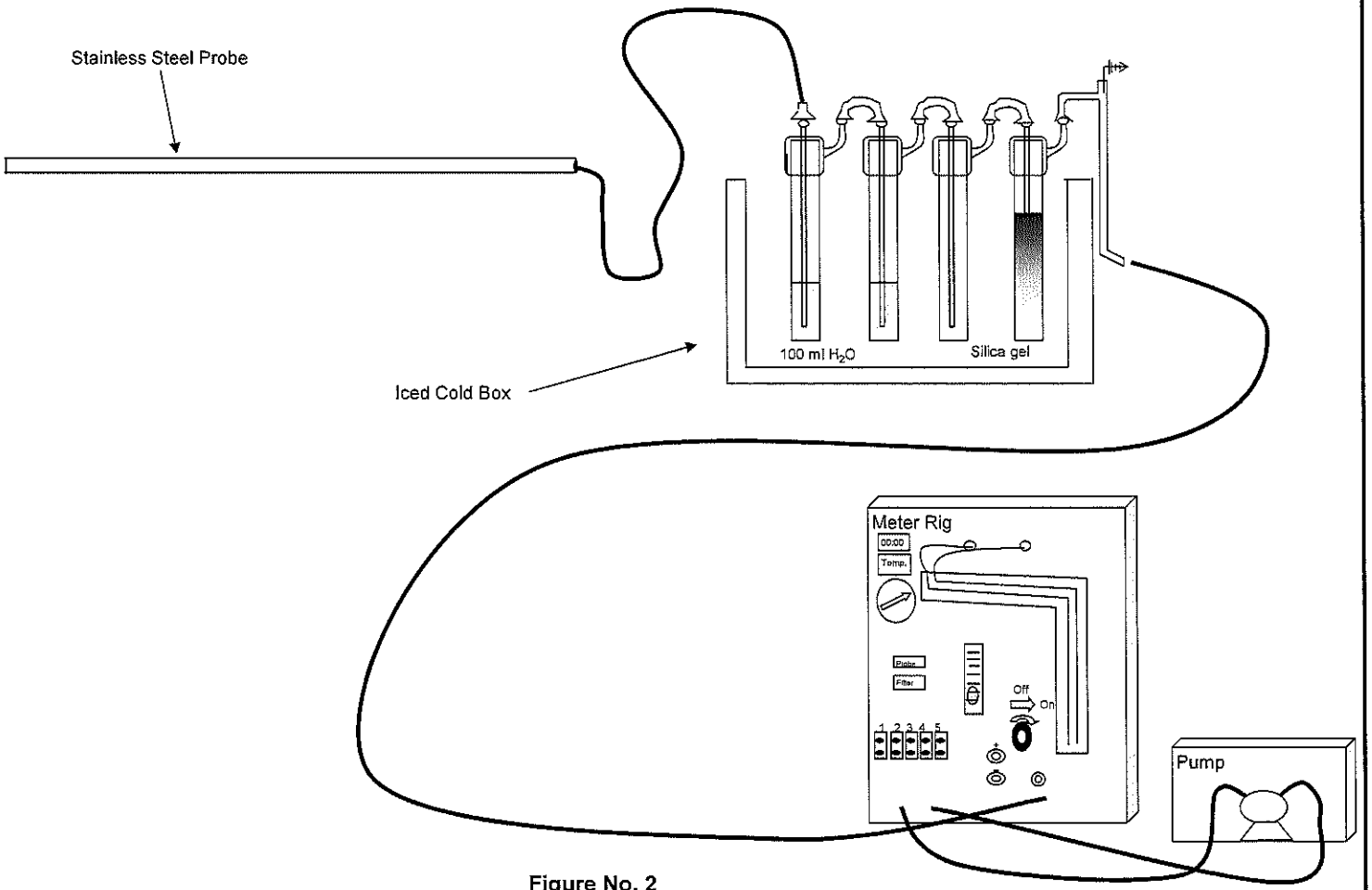
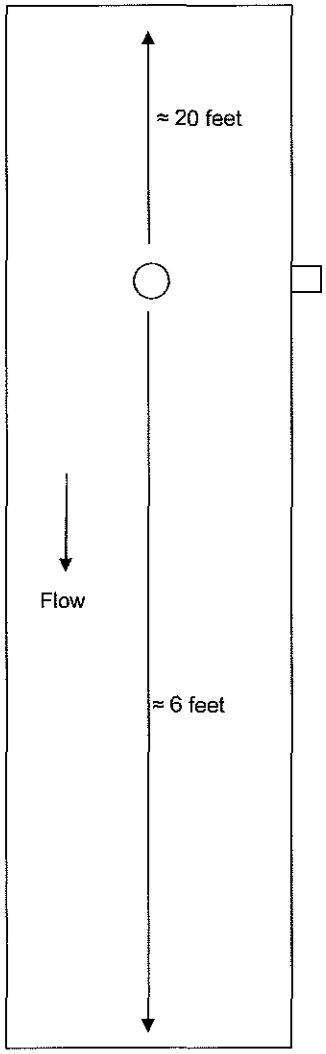


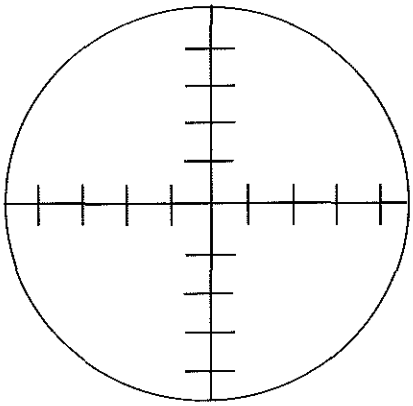
Figure No. 2

Site: **USEPA Method 4** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 8-9, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 63.5 inches





Not to Scale

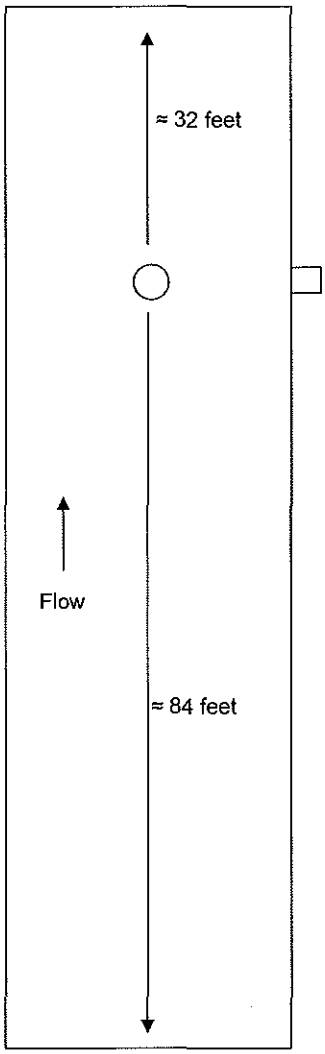
Points	Distance "
1	2.0
2	6.7
3	12.3
4	20.5
5	43.0
6	51.2
7	56.8
8	61.5

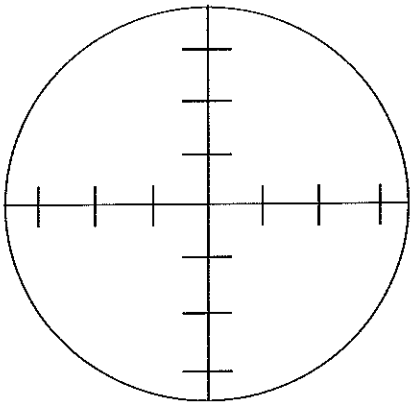
Figure No. 3

Site: **Combined RTO Inlet** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 8, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 80 inches





Not to Scale

Points	Distance "
1	3.5
2	11.7
3	23.7
4	56.3
5	68.3
6	76.5

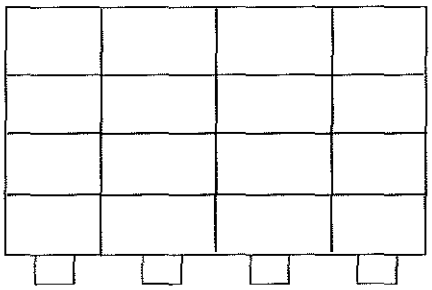
Figure No. 4

Site: **Combined RTO Outlet** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 8, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

Stack Dimensions: 45.5" Deep X 82" Tall

Points	Distance "
1	5.7
2	17.1
3	28.4
4	39.8



Not to Scale

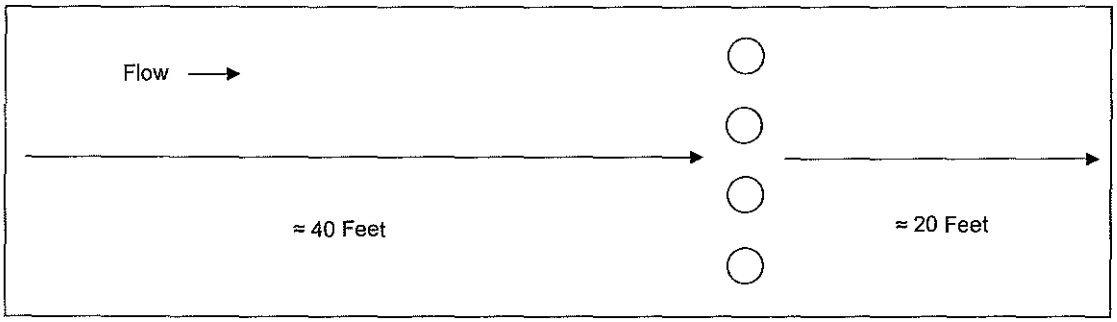
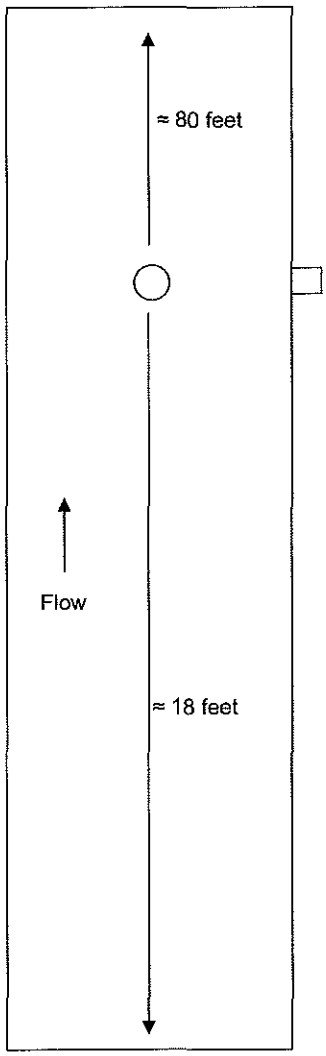


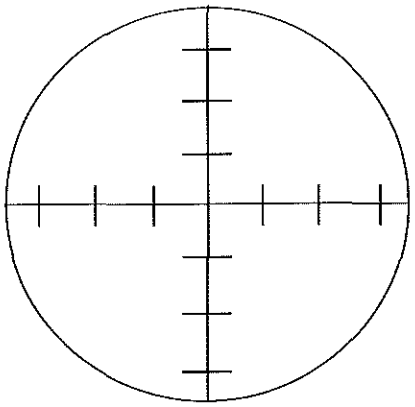
Figure No. 5

Site: **Fluidized Bed Inlet** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 9, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee** **Royal Oak, Michigan**

BTEC Inc.

diameter = 20 inches





Not to Scale

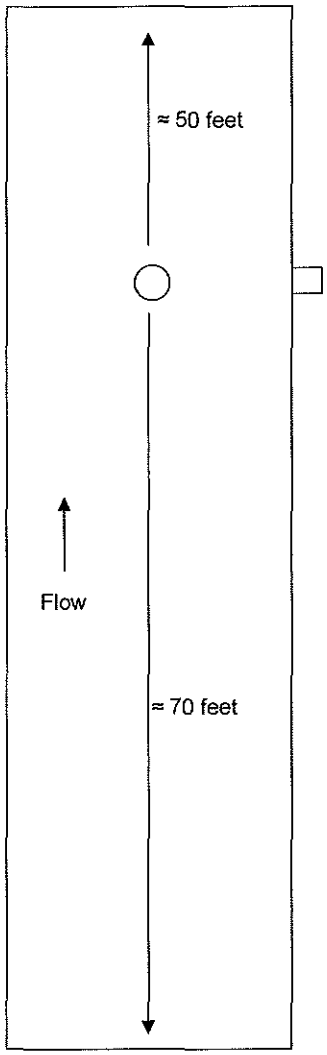
Points	Distance "
1	0.9
2	2.9
3	5.9
4	14.1
5	17.1
6	19.1

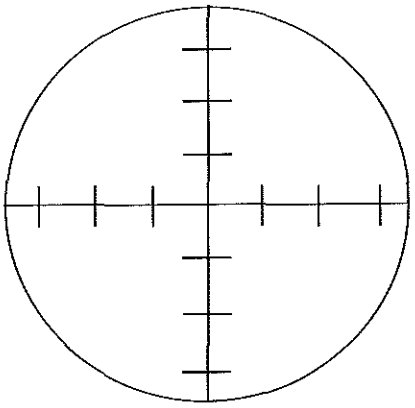
Figure No. 6

Site: **Fluidized Bed Oxidizer** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 9, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 68.25 inches





Not to Scale

Points	Distance "
1	3.0
2	10.0
3	20.2
4	48.0
5	58.3
6	65.2

Figure No. 7

Site: **Fluidized Bed Clean Air** **Ford** **Dearborn, Michigan**	**Sampling Date:** **February 9, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**