BTEC Inc.

Hot Water Generators 1-3
VOC, CO, and NOx
Emissions Test Summary Report

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Prepared for:

Metro Energy, LLC

Detroit Metropolitan Airport
Romulus, Michigan

Project No. 17-5009.00
May 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 Metro Energy, LLC (Metro Energy) to measure oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) emission rates from three hot water generators located at Detroit Metropolitan Wayne County Airport (DTW) in Romulus, Michigan. The emissions test program was conducted on April 6 and 7, 2017.

Testing of the three hot water generators consisted of triplicate test runs for each pollutant at each source. The emissions test program was required by MDEQ Air Quality Division ROP No. MI-ROP-M4174-2010. The results of the emission test program are summarized by Table I.

Table I
Overall Emission Summary
Test Date: April 6 and 7, 2017

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)	Test Result (lbs/MMBtu)
Boiler 1	NOx	0.15	0.100
	CO	0.20	0.001
	VOC	0.20	0.000

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)	Test Result (lbs/MMBtu)
Boiler 2	NOx	0.15	0.095
	CO	0.20	0.001
	VOC	0.20	0.000

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)	Test Result (lbs/MMBtu)
Boiler 3	NOx	0.15	0.131
	CO	0.20	0.001
	VOC	0.20	0.000

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Metro Energy, LLC (Metro Energy) to measure oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) emission rates from three hot water generators located at Detroit Metropolitan Wayne County Airport (DTW) in Romulus, Michigan. The emissions test program was conducted on April 6 and 7, 2017.

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 April 6 and 7, 2017 at the Metro Energy facility in Romulus, Michigan.

1.b Purpose of Testing

AQD issued ROP No. MI-ROP-M4174-2010. The permit limits are summarized by Table 1.

Table 1
Emission Limitations
Metro Energy, LLC
ROP No. MI-ROP-M4174-2010

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)
Boilers 1, 2, and 3	NOx	0.15
	CO	0.20
	VOC	0.20

1.c Source Description

The Metro Energy facility is located at DTW in Romulus, Michigan. The facility includes three high temperature hot water generators capable of firing on natural gas or Jet-A fuel. Hot water generators 1, 2, and 3 were operating on natural gas while testing.

The purpose of the hot water generator is to provide primary hot water to the heat exchangers in the McNamara Terminal and Westin Hotel for heating the buildings and for process heating (i.e. laundry, kitchen, and swimming pool in the hotel), and re-heat coils in the terminal used to temper air during cooling season.

1.d Test Program Contacts

The contacts for the source and test report are:

Mr. Thomas A. Shoemaker
Plant Manager
Metro Energy, LLC
2646 Worldgateway Place, Bldg. 821
Detroit, Michigan 48242
(734) 955-8507

Mr. Randal Tysar
Senior Environmental Engineer
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

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 Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Dave Trahan Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Molenda Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Steve Weis MDEQ	MDEQ Air Quality Division	(313) 456-4688
Mr. Tom Gasloli MDEQ	MDEQ Air Quality Division	(517) 284-6778

2. Summary of Results

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

2.a Operating Data

All boiler operating data can be found in Appendix D.

2.b Applicable Permit

AQD issued ROP No. MI-ROP-M4174-2010.

2.c Results

See Table 1 in Section 1.b.

3. Source Description

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

3.a Process Description

See section 1.c.

3.b Process Flow Diagram

A process flow diagram is available on request.

3.c Raw and Finished Materials

Natural gas is used to heat water.

3.d Process Capacity

Each hot water generator has a maximum rated heat input capacity of 47 MMBtu/hr while firing natural gas.

3.e Process Instrumentation

The process data monitored during the emissions test program included fuel flow (KSCFH), fuel to air ratio, hot water supply (GPM), boiler temperature (°F), and boiler pressure (PSI). Process data 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.

4.a Sampling Train and Field Procedures

Sampling and analysis procedures follow the methodologies of the following emissions test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 3A - *"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources"* was used to evaluate the O_2 content of the exhaust
- Method 4 - *"Determination of Moisture Content in Stack Gases"* was used to evaluate the moisture content of the exhaust
- Method 7E - *"Determination of Nitrogen Oxides Emissions from Stationary Sources"* was used to measure NOx concentrations in the exhaust gas
- Method 10 - *"Determination of Carbon Monoxide Emissions from Stationary Sources"* was used to measure CO concentrations in the exhaust gas
- Method 19 - *"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates"* was used to calculate NOx, CO, and VOC emission rates.
- Method 25A- *"Determination of Total Gaseous Organic Emissions from Stationary Sources"* was used to measure VOC concentrations in the exhaust gas

Oxygen (USEPA Method 3A)

The O_2 content was measured using a Servomex O_2 gas analyzer. A sample of the gas stream was drawn through an insulated stainless-steel probe with an in-line glass fiber filter to remove any particulate, a heated Teflon® sample line, and through an electronic sample conditioner to remove the moisture from the sample before it enters the analyzers. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

Oxides of Nitrogen (USEPA Method 7E)

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

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

All analyzers were calibrated in accordance with the procedures of Methods 3A, 7E, and 10. Consistent with the provisions of Method 7E, testing of each hot water generator included a stratification test during each test run.

Carbon Monoxide (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 T300 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 data acquisition software. Recorded CO concentrations were averaged and reported for the duration of each 60-minute test (as drift corrected per Method 7E).

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.

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 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.

BTEC did not use methane subtraction for this test due to the low VOC results.

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.

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

BTEC did not have any samples to recover.

4.c Sampling Ports

A diagram of the stacks showing sampling ports in relation to upstream and downstream disturbances are included as Figure 4.

4.d Traverse Points

A diagram of the stacks indicating traverse point locations and stack dimensions are included as Figure 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 Tables 4-6.

Table 3
Overall Emission Summary
Test Date: April 6 and 7, 2017

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)	Test Result (lbs/MMBtu)
Boiler 1	NOx	0.15	0.100
	CO	0.20	0.001
	VOC	0.20	0.000

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)	Test Result (lbs/MMBtu)
Boiler 2	NOx	0.15	0.095
	CO	0.20	0.001
	VOC	0.20	0.000

Emission Unit	Pollutant	Permit Limit (lbs/MMBtu)	Test Result (lbs/MMBtu)
Boiler 3	NOx	0.15	0.131
	CO	0.20	0.001
	VOC	0.20	0.000

5.b Discussion of Results

The test results for each boiler were below permit limits.

5.c Sampling Procedure Variations

During testing on Boiler 1, BTEC had to change out the sample conditioner after Run 1 and then recalibrated prior to Run 2. BTEC also had to change out the sample line after Run 2 and recalibrated before Run 3. MDEQ accepted changing the sample conditioner and the sample line.

5.d Process or Control Device Upsets

There were no process upsets during this test.

5.e Control Device Maintenance

The boilers are not equipped with emissions control devices.

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 was no lab data.

Table 4
Boiler 1 Hot Water Generator NOx, VOC, and CO Emission Rates
Detroit Metropolitan Wayne County Airport
Detroit, Michigan
BTEC Project No. 17-5009.00
Sampling Date: 4/6/17

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/6/2017	4/6/2017	4/6/2017	
Test Run Time	9:15-10:15	11:05-12:05	12:45-13:45	
Outlet O_2 Concentration (%, corrected as per USEPA 7E)	5.12	4.57	4.58	4.76
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	75.33	74.05	74.42	74.60
NOx Emission Rate (lbs/MMBtu)	0.104	0.099	0.099	**0.100**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	1.39	1.31	0.91	1.20
CO Emission Rate (lbs/MMBtu)	0.001	0.001	0.001	**0.001**
Outlet VOC Concentration (ppmv as propane)	0.18	-0.87	-1.26	-0.65
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)*	0.55	***0.00***	***0.00***	0.18
Exhaust Gas Mositure Content (% v/v)	14.0	14.0	14.0	14.0
Outlet VOC Concentration (ppmvd as Propane)	0.6	0.0	0.0	0.2
VOC Emission Rate (lbs/MMBtu)	0.001	0.000	0.000	**0.000**

*All negative numbers replaced with zero.

VOC Correction			
Co	-0.38	-0.81	-1.10
Cma	29.9	29.9	29.9
Cm	30.23	30.29	30.20

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, 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

Table 5
Boiler 1 Hot Water Generator NOx, VOC, and CO Emission Rates
Detroit Metropolitan Wayne County Airport
Detroit, Michigan
BTEC Project No. 17-5009.00
Sampling Date: 4/6/17

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/6/2017	4/6/2017	4/6/2017	
Test Run Time	14:10-15:10	15:40-16:40	16:55-17:55	
Outlet O_2 Concentration (%, corrected as per USEPA 7E)	4.61	4.44	4.56	4.54
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	71.05	71.67	71.50	71.41
NOx Emission Rate (lbs/MMBtu)	0.095	0.095	0.095	**0.095**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	0.90	1.93	2.36	1.73
CO Emission Rate (lbs/MMBtu)	0.001	0.002	0.002	**0.001**
Outlet VOC Concentration (ppmv as propane)	-1.18	-1.14	-1.12	-1.15
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)*	0.03	***0.00***	***0.00***	0.01
Exhaust Gas Mositure Content (% v/v)	16.5	16.5	16.5	16.5
Outlet VOC Concentration (ppmvd as Propane)	0.0	0.0	0.0	0.0
VOC Emission Rate (lbs/MMBtu)	0.000	0.000	0.000	**0.000**

*All negative numbers replaced with zero.

VOC Correction			
Co	-1.21	-1.13	-0.90
Cma	29.9	29.9	29.9
Cm	29.50	29.46	29.36

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, 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

Table 6
Boiler 1 Hot Water Generator NOx, VOC, and CO Emission Rates
Detroit Metropolitan Wayne County Airport
Detroit, Michigan
BTEC Project No. 17-5009.00
Sampling Date: 4/7/17

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	4/7/2017	4/7/2017	4/7/2017	
Test Run Time	7:00-8:00	8:20-9:20	9:40-10:40	
Outlet O_2 Concentration (%, corrected as per USEPA 7E)	3.90	4.02	4.09	4.00
Outlet NOx Concentration (ppmv, corrected as per USEPA 7E)	101.55	102.64	101.98	102.06
NOx Emission Rate (lbs/MMBtu)	0.130	0.132	0.132	**0.131**
Outlet CO Concentration (ppmv, corrected as per USEPA 7E)	1.08	1.05	1.00	1.04
CO Emission Rate (lbs/MMBtu)	0.001	0.001	0.001	**0.001**
Outlet VOC Concentration (ppmv as propane)	0.40	0.29	0.18	0.29
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)*	0.11	***0.00***	***0.00***	0.04
Exhaust Gas Mositure Content (% v/v)	15.8	15.8	15.8	15.8
Outlet VOC Concentration (ppmvd as Propane)	0.1	0.0	0.0	0.0
VOC Emission Rate (lbs/MMBtu)	0.000	0.000	0.000	**0.000**

*All negative numbers replaced with zero.

VOC Correction			
Co	0.29	0.46	0.40
Cma	29.9	29.9	29.9
Cm	30.00	30.16	30.38

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, 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

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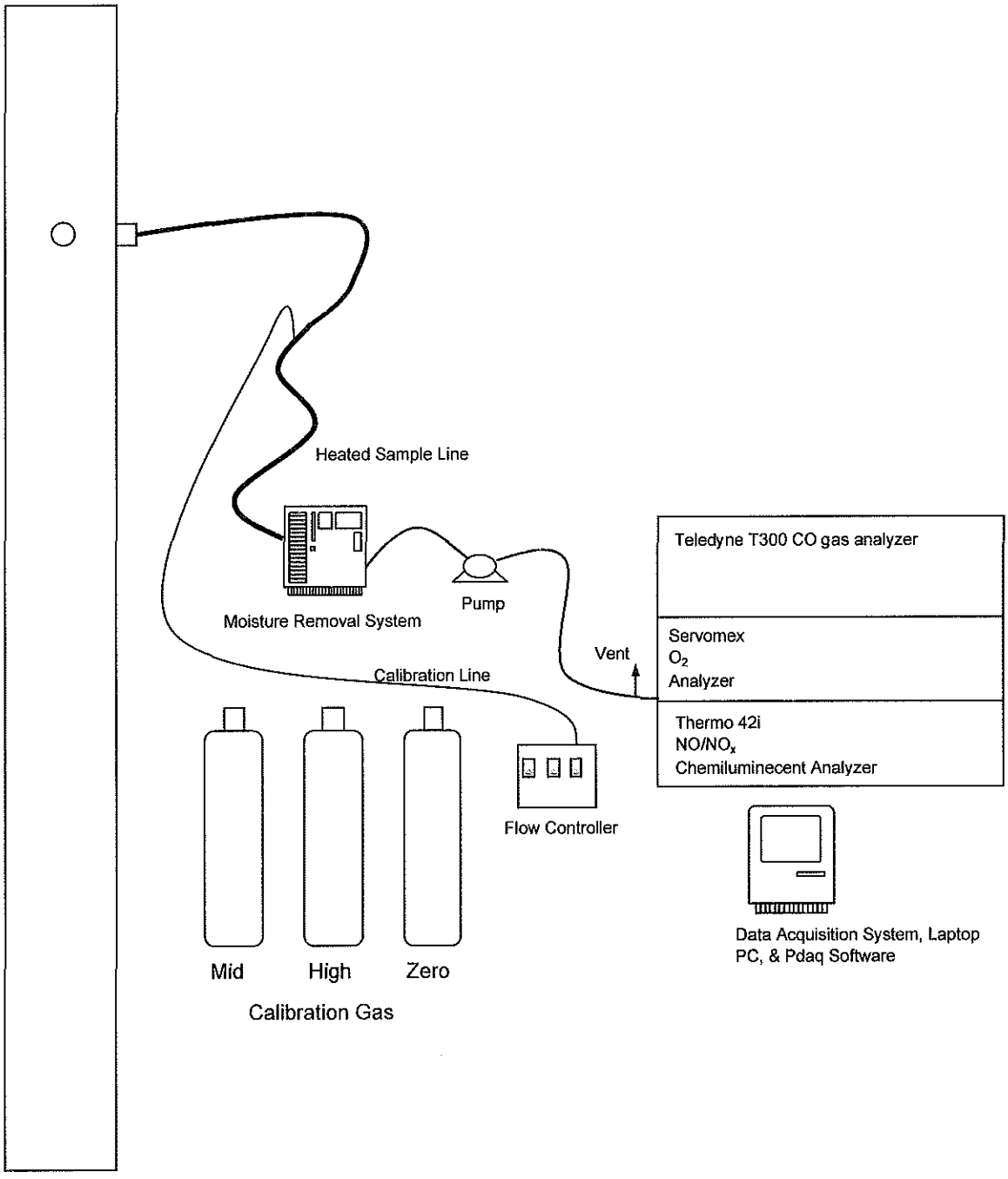

Figure No. 1

Site: **USEPA Method 3A, 7E, and 10** **Metro Energy** **Romulus, Michigan**	**Sampling Date:** **April 6-7, 2017**	**BT Environmental Consulting Inc.** **4949 Fernlee Avenue** **Royal Oak, MI 48073**

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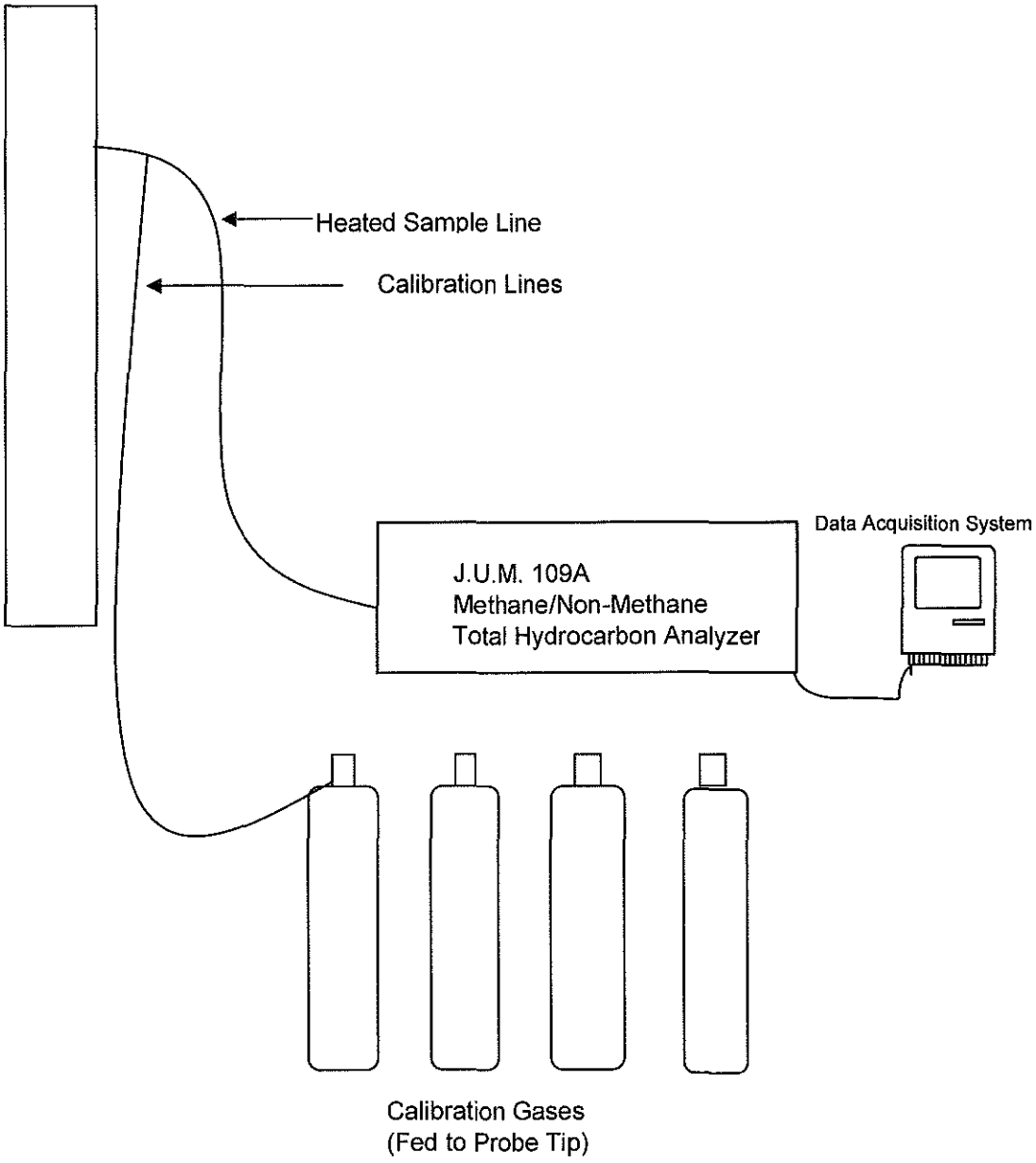


Figure No. 2

Site: **USEPA Method 25A** **Metro Energy** **Romulus, Michigan**	**Sampling Date:** **April 6-7, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

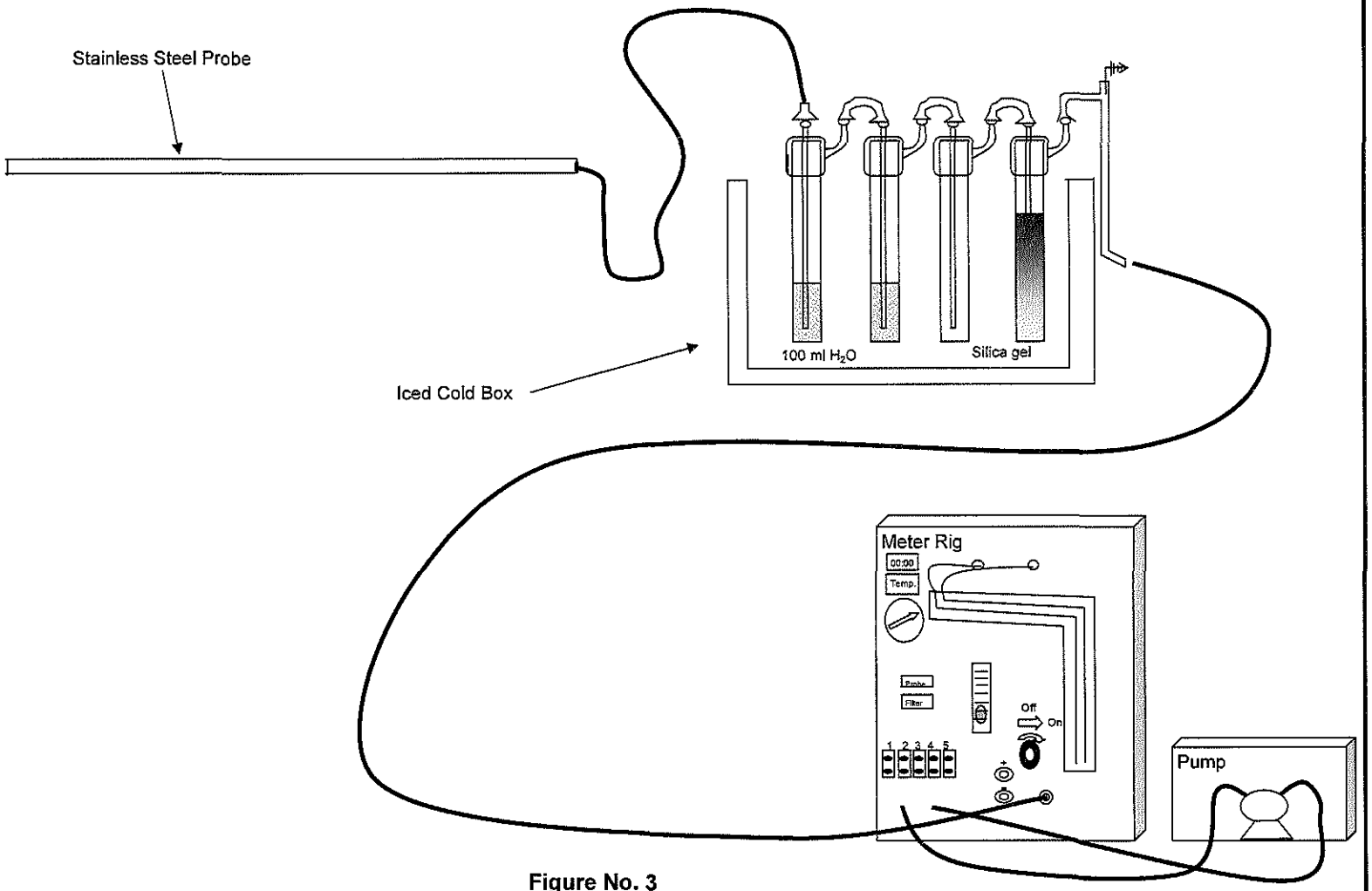
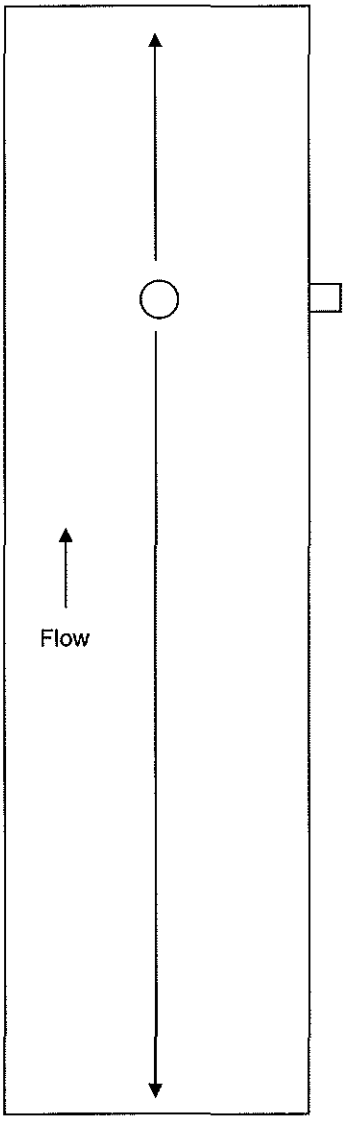


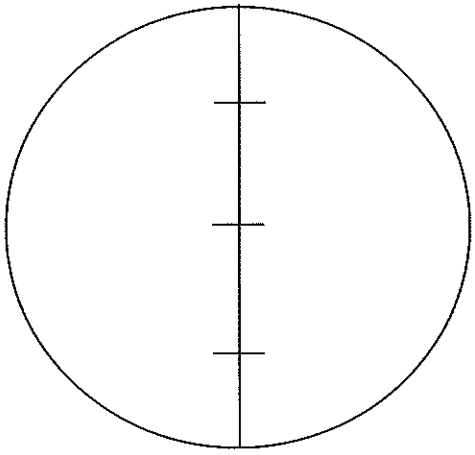
Figure No. 3

Site: **USEPA Method 4** **Metro Energy** **Romulus, Michigan**	**Sampling Date:** **April 6-7, 2017**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan**

BTEC Inc.

diameter = 48 inches





Not to Scale

CEM

Points	Distance "
1	8.0
2	24.0
3	40.0

Note: NOx/O2/CO sampling was extracted at three points through a stainless steel probe positioned at approximately 16.7%, 50% and 83.3% of the sample stream diameter (20 minutes at each point).

Figure No. 4

Site: **Boiler 1-3** **Metro Energy** **Romulus, Michigan**	**Sampling Date:** **April 6-7, 2017**

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073