

EMISSIONS TEST REPORT

for

OXIDES OF NITROGEN (NO_x), CARBON MONOXIDE (CO), AND NON-METHANE ORGANIC COMPOUNDS (NMOC)

UNITS 1 & 2

BLUE WATER RENEWABLES, LLC
Kimball, Michigan

January 27-28, 2015

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Prepared By
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EXECUTIVE SUMMARY

DTE Energy's Environmental Management and Resources (EM&R), Field Services Group, performed emissions testing at Blue Water Renewables, LLC, located in Kimball, Michigan. The fieldwork, performed on January 27 & 28, 2015 was conducted to satisfy requirements of the Michigan Renewable Operating Permit No. MI-ROP-P0262-2012. Emissions tests were performed on Units 1 & 2 for oxides of nitrogen (NO_x), carbon monoxide (CO), and non-methane organic compounds (NMOC).

The results of the emissions testing are highlighted below:

**Emissions Testing Summary – Units 1 & 2
Blue Water Renewables, LLC
Kimball, MI
January 27 & 28, 2015**

	Oxides of Nitrogen (ppm ¹)	Carbon Monoxide (ppm ¹)	Non-Methane Organic Compounds (ppm ¹)
Unit 1	33.0	272.8	7.5
Unit 2	24.4	247.3	20.7
Permit Limit	150	610	80

¹ppm @ 15% O₂ dry



1.0 INTRODUCTION

DTE Energy's Environmental Management and Resources (EM&R), Field Services Group, performed emissions testing at Blue Water Renewables, LLC, located in Kimball, Michigan. The fieldwork, performed on January 27 & 28, 2015, was conducted to satisfy requirements of the Michigan Renewable Operating Permit No. MI-ROP-P0262-2012.

Testing was performed pursuant to Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40 CFR §60 App. A), Methods 3A, 7E, 10, 18, and 25A.

The fieldwork was performed in accordance with EPA Reference Methods and EM&R's Intent to Test¹, which was approved by the Michigan Department of Environmental Quality (MDEQ)². The following EM&R personnel participated in the testing program: Mr. Mark Grigereit, Principal Engineer, Mr. Mark Westerberg, Environmental Specialist, and Mr. Fred Meinecke, Senior Environmental Technician. Mr. Grigereit was the project leader.

Mr. Jeff Neumann, DTE Biomass Energy, provided on-site operation of the units. Mr. Nathan Hude, MDEQ, reviewed the Test Plan. Mr. Hude and Ms. Rebecca Loftus, MDEQ, observed the testing.

2.0 SOURCE DESCRIPTION

The Blue Water Renewables, LLC power generating facility, located at 6797 Smiths Creek Road, Kimball, MI is a power generating facility. The facility consists of two (2) landfill gas-fired internal combustion engines with associated electrical generators.

The systems are Caterpillar G3520C – 1200 RPM 1600 kW Gas Generator Sets. The purpose of the source is to utilize land fill gas from the Smiths Creek Landfill to produce energy that is sent to the electrical grid. Each unit was tested while operating at greater than 90% of full load conditions.

See Figure 1 for a diagram of the unit sampling locations and stack dimensions.

¹ MDEQ, Test Plan, Submitted December 17, 2014. (Attached-Appendix A)

² MDEQ, Acceptance Letter, January 16, 2015. (Attached-Appendix A)



3.0 SAMPLING AND ANALYTICAL PROCEDURES

DTE Energy obtained emissions measurements in accordance with procedures specified in the USEPA *Standards of Performance for New Stationary Sources*. The sampling and analytical methods used in the testing program are indicated in the table below

Sampling Method	Parameter	Analysis
USEPA Method 3A	Oxygen & Carbon Dioxide	Instrumental Analyzer Method
USEPA Method 4	Moisture Content	Field data analysis and reduction
USEPA Method 7E	Oxides of Nitrogen	Chemiluminescent Instrumental Analyzer Method
USEPA Method 10	Carbon Monoxide	NDIR Instrumental Analyzer Method
USEPA Method 18	Gaseous Organic Compounds (Methane)	GC Analytical Method (Tedlar™ Bag Sample)
USEPA Method 25A	Total Hydrocarbons	FID

3.1 OXYGEN AND CARBON DIOXIDE (USEPA METHOD 3A)

3.1.1 *Sampling Method*

Oxygen (O₂) and Carbon Dioxide (CO₂) emissions were evaluated using USEPA Method 3A, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight (Instrumental Analyzer Method)". The analyzers utilize paramagnetic sensors. Testing was performed simultaneously with the gaseous emissions testing.

The EPA Method 3A sampling system (Figure 2) consisted of the following:

- (1) Single-point sampling probe (located in the centroid of the exhaust stack)
- (2) Heated Teflon™ sampling line
- (3) MAK® gas conditioner with particulate filter
- (4) Flexible unheated Teflon™ sampling line



- c. The fourth impinger containing approximately 300 grams of silica gel desiccant
- (4) Environmental Supply[®] control case equipped with a pump, dry gas meter, and calibrated orifice

Upon completion of each test, the impinger volumes were measured to determine moisture content of the gas stream using the calculations found in USEPA Method 4. After measuring and recording the liquid volumes, the solution was discarded.

Field data sheets for the Method 4 are located in Appendix B.

3.2.2 Quality Control and Assurance

All sampling and analytical equipment was calibrated according to the guidelines referenced in EPA Method 5. Calibration data are located in Appendix D.

3.3 OXIDES OF NITROGEN AND CARBON MONOXIDE (USEPA METHODS 7E AND 10)

3.3.1 Sampling Method

Oxides of nitrogen (NO_x) emissions were evaluated using USEPA Method 7E, "Determination of Oxides of Nitrogen Emissions from Stationary Sources". The NO_x analyzer utilizes a Chemiluminescent detector. Carbon monoxide (CO) emissions were evaluated using USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources". The CO analyzer utilizes an NDIR detector. Triplicate 60-minute tests were performed on each engine exhaust.

The EPA Methods 7E and 10 sampling system (Figure 2) consisted of the following:

- (1) Stainless-steel sample probe (located in centroid of the exhaust stack)
- (2) Heated Teflon™ sampling line
- (3) MAK[®] gas conditioner with particulate filter
- (4) Flexible unheated Teflon™ sampling line
- (5) TECO 42i Chemiluminescent NO/NO_x gas analyzer, and TECO 48i NDIR CO gas analyzer
- (6) Appropriate USEPA Protocol 1 calibration gases
- (7) Data Acquisition System.

3.3.2 Sampling Train Calibration

The NO_x / CO sampling trains were calibrated according to procedures outlined in USEPA Method 7E and 10. Zero, span, and mid range calibration gases were



introduced directly into each analyzer to verify the instruments linearity. A zero and mid range span gas for each pollutant was then introduced through the entire sampling system to determine sampling system bias for each analyzer at the completion of each test.

3.3.3 Quality Control and Assurance

All sampling and analytical equipment was calibrated according to the guidelines referenced in Methods 7E and 10. Calibration gases were EPA Protocol 1 gases and the concentrations were within the acceptable ranges (40-60% mid range and span) specified in Method 7E. Calibration gas certification sheets are located in Appendix D.

DTE performed a daily NO_x converter efficiency test by directly challenging the NO_x analyzer with a nitrogen dioxide (NO₂) calibration gas of 50.9 ppm. Results from the converter efficiency test demonstrated that the analyzer met the requirements of Method 7E (Eq-1). Equation-1 shows the converter efficiency test performed for Units 1 & 2.

$$\text{Eq. 1} \quad \text{Eff}_{NO_2} = \frac{C_{Dir}}{C_v} = \frac{46.1}{50.9} = 90.6\%$$

3.3.4 Data Reduction

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. The NO_x and CO emissions were recorded in parts per million (ppm). The 1-minute readings collected are located in Appendix C.

Emissions calculations, based on calculations located in USEPA Methods 7E, 10, and 19, are located in Appendix F. The NO_x and CO emissions data collected during the testing was calculated as pounds per hour (lbs/hr) and grams per brake-horsepower-hour (g/bhp-hr).

3.4 METHANE (USEPA METHOD 18)

3.4.1 Sampling Method

Methane (CH₄) emissions were evaluated using USEPA Method 18, "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography (Tedlar™ Bag Sampling)". This method involves the collection of exhaust gas in a Tedlar™ bag, which is then analyzed at an off-site laboratory by gas chromatography (GC). Triplicate samples were collected simultaneously with the Total Hydrocarbon



(Method 25A) sampling. The vacuum pump flowrate was set to allow for a constant rate, integrated sample, collected for the duration of each test run.

The EPA Method 18 sampling system followed the procedures specified in Section 8.2.1, Integrated Bag Sampling & Analysis.

The EPA Method 18 sampling system (Figure 3) consisted of the following:

- (1) Stainless Steel Probe
- (2) Teflon™ sampling line
- (2) Sampling lung with 10-liter Tedlar™ bag
- (3) Vacuum pump with regulator.

3.4.2 Sample Analysis

The Tedlar bag samples were labeled with the test number, test location and test date. The samples were shipped overnight via Federal Express to the laboratory on the second day of testing (at the completion of Unit 2 testing). Methane analysis was performed on the following day. Analysis, performed by Enthalpy Analytical Laboratory, Durham, NC followed the guidelines of EPA Method 18, including triplicate analysis and a spike recovery study. Analytical results of the Method 18 samples are located in Appendix E.

3.4.3 Data Reduction

Results from the methane sampling were used to determine the non-methane organic compound concentration from the source. Methane emissions were subtracted from total organic compound emissions (as determined by Method 25A).

The CH_4 (as methane) was converted to CH_4 (as propane) in order to subtract the CH_4 from the THC measured in the field (Eq-2). An analyzer response factor (RF) of 3 was applied to the CH_4 concentration in the exhaust gas, as determined by Method 18 sampling.

$$\text{Eq. 2} \quad NMOC = THC_{PPM(asC3H8)} - \left(\frac{CH_4_{ppm(asCH4)}}{RF} \right)$$

3.5 TOTAL HYDROCARBON COMPOUNDS (USEPA METHOD 25A)

3.5.1 Sampling Method

Total hydrocarbon compound (THC) emissions were evaluated using USEPA Method 25A, "Determination of Total Hydrocarbon Emissions from Stationary Sources (Instrumental Analyzer Method)". The THC analyzer utilizes a flame ionization



detector (FID). The FID measures total hydrocarbon compounds (including Methane). Triplicate 60-minute tests were performed on each engine exhaust, simultaneously with the other gaseous emission testing.

The Method 25A sampling system (Figure 4) consisted of the following:

- (1) Single-point sampling probe (placed in the center of the stack)
- (2) Heated Teflon™ sampling line
- (3) JUM 109A® Total Hydrocarbon gas analyzer
- (4) Appropriate USEPA Protocol 1 calibration gasses
- (5) Data Acquisition System

3.5.2 Sampling Train Calibration

In accordance with USEPA Method 25A, a 4-point (zero, low, mid, and high) calibration check was performed on the THC analyzer. The analyzer was calibrated with propane in the 0-1,000 ppm range. Calibration drift checks were performed at the completion of each run.

3.5.3 Quality Control and Assurance

The THC sampling equipment was calibrated with propane (C₃H₈) according to the guidelines referenced in Methods 25A. Calibration gases were EPA Protocol 1 gases and the concentrations were within the acceptable ranges (25-35% low range, 45-55% mid range and 80-100% of span). Calibration gas certification sheets are located in Appendix D.

3.5.4 Data Reduction

Data collected during the emissions testing was recorded at 10-second intervals and averaged in 1-minute increments. The THC emissions were recorded in parts per million (ppm) as propane (C₃H₈). The 1-minute readings collected are located in Appendix C.

The NMOC emissions data collected during the testing was calculated and reported as g/bhp-h. Emissions calculations, based on equations located in USEPA Methods 25A and 19, are located in Appendix F.

4.0 OPERATING PARAMETERS

The test program included the collection of generator load (kW), engine speed (RPM), inlet manifold air pressure (psi), fuel upper heating value (BTU), fuel flow (scfm) and generator operating hours (kW-hour).



Operational data is located in Appendix G.

5.0 DISCUSSION OF RESULTS

Table Nos. 1 and 2 present the emission testing results from Units 1 & 2 while operating at greater than 90% of full load conditions. The NO_x, CO, and NMOC emissions are presented in parts per million corrected to 15% Oxygen on a dry basis (ppm@ 15%O₂ dry). Additional test data presented for each test includes the engine load in percentage (%), kilowatts generated (kW), and the air/fuel ratio. Units 1 & 2 are in compliance with NO_x, CO, and NMOC emission limits as stated in Michigan Renewable Operating Permit No. MI-ROP-P0262-2012.

6.0 CERTIFICATION STATEMENT

"I certify that I believe the information provided in this document is true, accurate, and complete. Results of testing are based on the good faith application of sound professional judgment, using techniques, factors, or standards approved by the Local, State, or Federal Governing body, or generally accepted in the trade."

Mark R. Grigereit for:
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his report prepared by: Mark R. Grigereit for:
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TABLE NO. 1
NO_x, CO, AND NMOC EMISSION TESTING RESULTS - UNIT 1
Blue Water Renewables, LLC
Smiths Creek, MI
January 27, 2015

Test	Test Date	Test Time	Generator Power (kW)	Oxygen ⁽¹⁾ (%)	CO Emissions	NO _x Emissions	NMOC Emissions
					(ppm @ 15% O _{2,dry} ¹)	(ppm @ 15% O _{2,dry} ¹)	(ppm @ 15% O _{2,dry} ¹)
Test 1	27-Jan-15	8:40-9:40	1,528	8.1	275.1	33.3	12.2
Test 2	27-Jan-15	9:57-10:57	1,532	8.2	275.4	33.7	5.5
Test 3	27-Jan-15	11:09-12:09	<u>1,538</u>	<u>8.2</u>	<u>267.9</u>	<u>32.0</u>	<u>4.8</u>
		<i>Average:</i>	<i>1,533</i>	<i>8.2</i>	<i>272.8</i>	<i>33.0</i>	<i>7.5</i>

NOTES:

(1): Corrected for analyzer drift per USEPA method 7E.

PERMIT LIMITS:

CO 610 ppm @15% O_{2,dry}
 NO_x 150 ppm @15% O_{2,dry}
 NMOC 80 ppm @15% O_{2,dry}

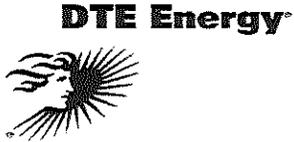


TABLE NO. 2
NO_x, CO, AND NMOC EMISSION TESTING RESULTS - UNIT 2
Blue Water Renewables, LLC
Smiths Creek, MI
January 28, 2015

Test	Test Date	Test Time	Generator Power (kW)	Oxygen ⁽¹⁾ (%)	CO Emissions	NO _x Emissions	NMOC Emissions
					(ppm @ 15% O _{2,dry} ¹)	(ppm @ 15% O _{2,dry} ¹)	(ppm @ 15% O _{2,dry} ¹)
Test 1	28-Jan-15	8:14-9:14	1,537	8.1	249.4	24.5	ND
Test 2	28-Jan-15	9:34-10:34	1,543	8.1	247.4	24.5	62.2
Test 3	28-Jan-15	10:46-11:46	<u>1,524</u>	<u>8.1</u>	<u>245.1</u>	<u>24.3</u>	<u>ND</u>
		<i>Average:</i>	<i>1,535</i>	<i>8.1</i>	<i>247.3</i>	<i>24.4</i>	<i>20.7</i>

NOTES:

(1): Corrected for analyzer drift per USEPA method 7E.

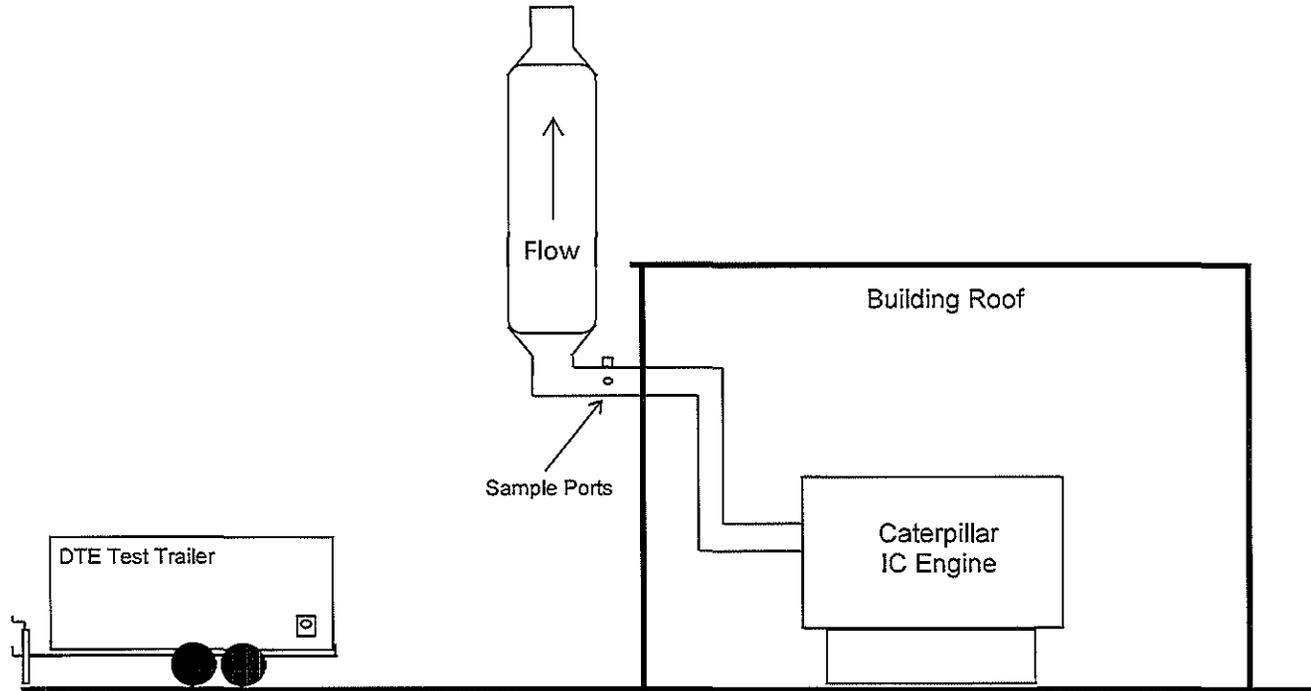
PERMIT LIMITS:

CO 610 ppm @15% O_{2,dry}
 NO_x 150 ppm @15% O_{2,dry}
 NMOC 80 ppm @15% O_{2,dry}

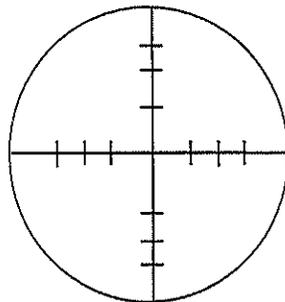
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Figure 1 – Stack Drawing and Exhaust Sampling Point Location
 Blue Water Renewables – Units 1 & 2
 January 27 & 28, 2015



Stack Diameter 15.5"



Velocity Measurement Points

<u>Points</u>	<u>Distance From Inner Wall</u>
1	0.68
2	2.26
3	4.59
4	10.91
5	13.24
6	14.82



Figure 2 – USEPA Method 3A/7E/10 Sampling Train
Blue Water Renewables
January 27 & 28, 2015

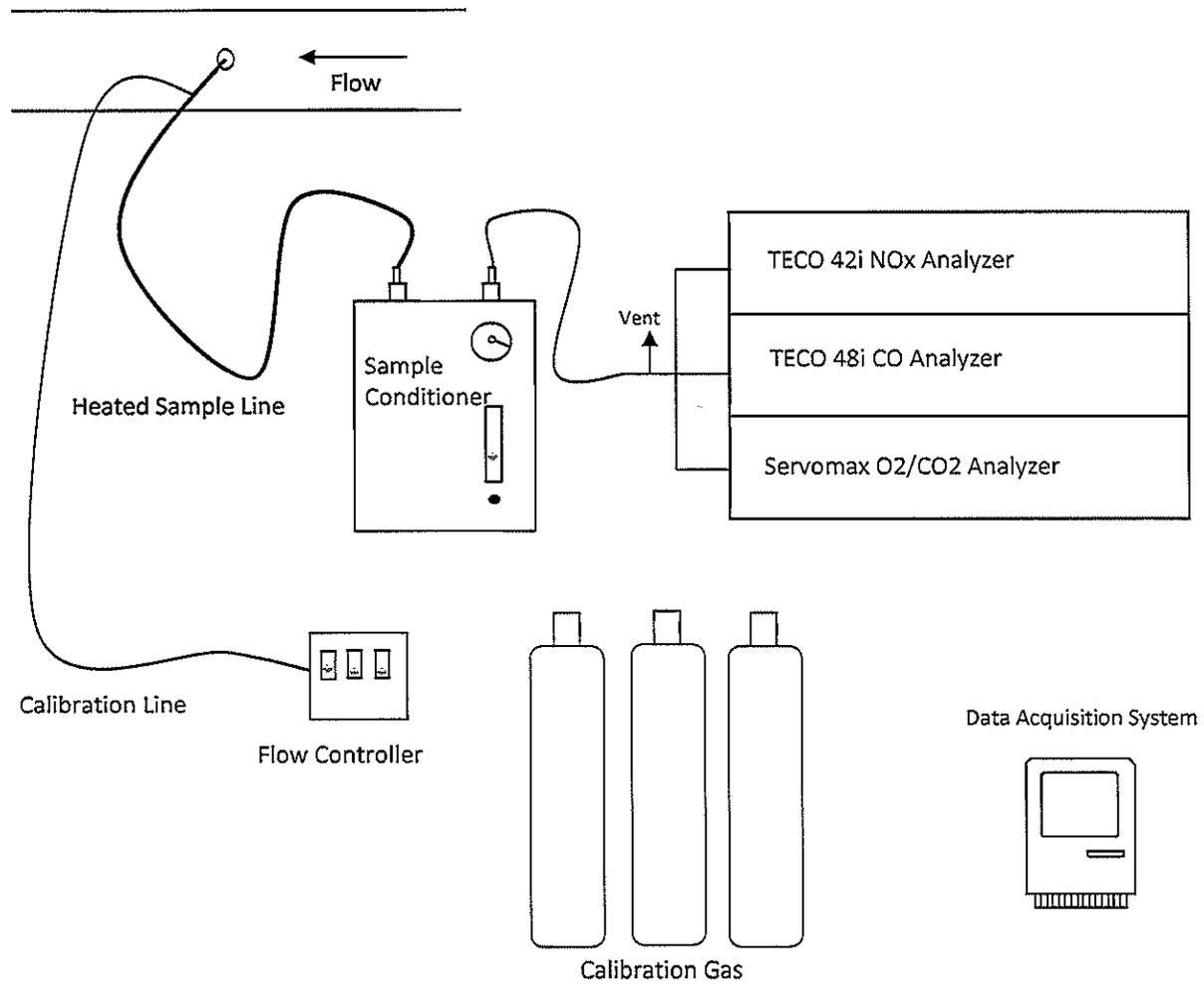
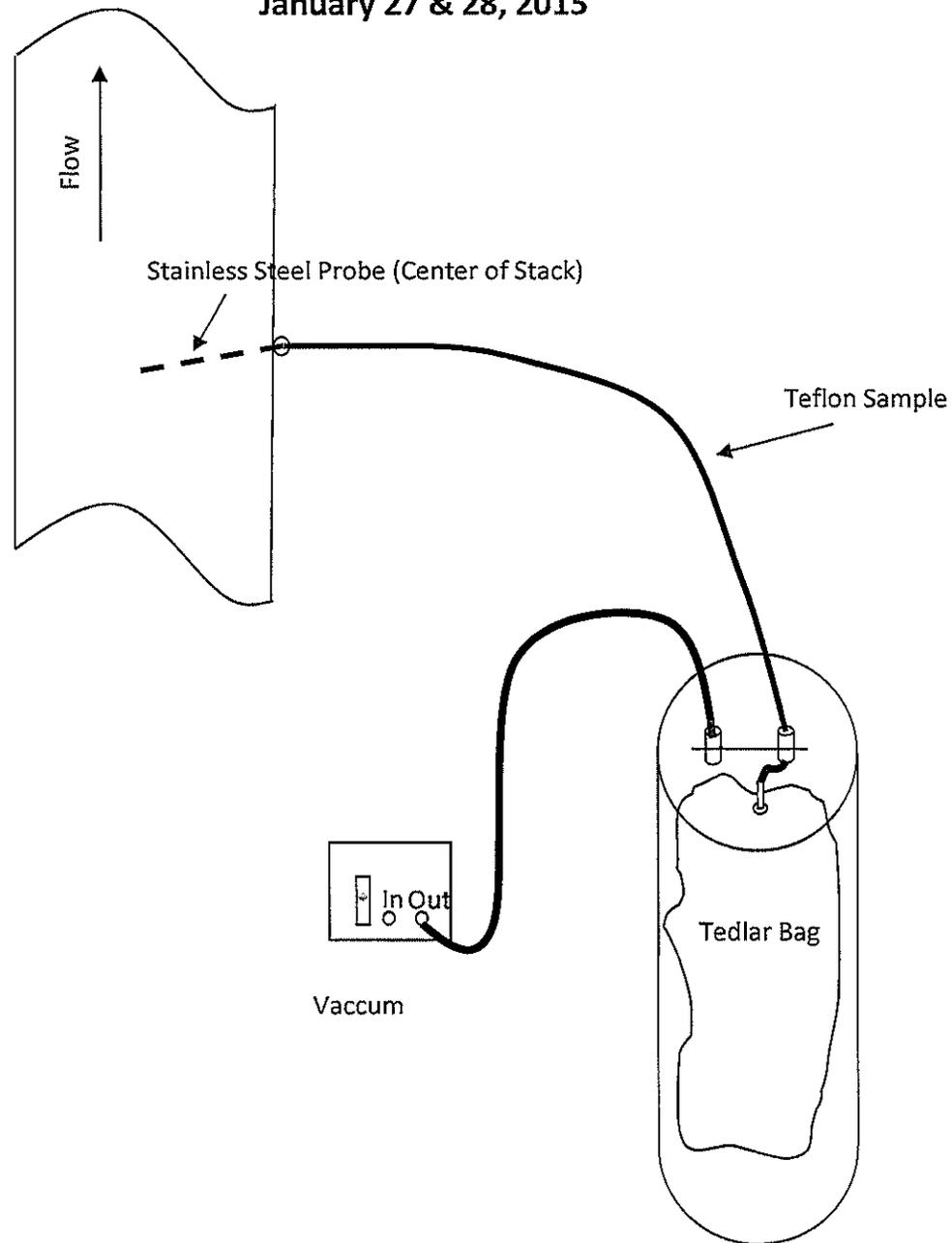




Figure 3 – USEPA Method 18 Sampling Train
Blue Water Renewables
January 27 & 28, 2015



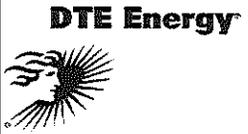


Figure 4 – USEPA Method 25A Sampling Train
Blue Water Renewables
January 27 & 28, 2015

