FINAL REPORT

COMPLIANCE EMISSION TESTING

TWO CAT G3520C ENGINES (SOURCE IDS: EUICENGINE 1&2)

BLUEWATER RENEWABLES, LLC
SMITHS CREEK, MICHIGAN

PERMIT NO. 163-09D

LEMOS LABS LLC PROJECT 0793

TEST DATE: February 6, 2019

PREPARED BY
ALEX KEFFALAS
GENERAL MANAGER

LEMOS LABS, LLC

329 PILLOW STREET
BUTLER, PENNSYLVANIA 16001

STATEMENT OF COMPLETENESS

The information contained herein has been reviewed and all testing requirements required by the Air Quality Division (AQD) have been incorporated in this Final Report. To the best of our knowledge the information contained herein conforms to all AQD of MDEQ and EPA regulations applicable to the source being tested.

Test Team On-Site Supervisor

Alex Keffalas
General Manager

2-26-19
Date

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APPENDICES

1.0 EXECUTIVE SUMMARY

Bluewater Renewables, LLC contracted Lemos Labs, LLC to conduct nitrogen oxide (NOx), carbon monoxide (CO), and volatile organic compound (VOC) emission testing at two CAT G3520C engines located at the Bluewater Renewables, LLC facility in Smiths Creek, Michigan. Three one hour runs were conducted per engine to determine compliance with the limitations listed in Permit No. 163-09D, dated June 1, 2017. Testing was conducted using the principles of U.S. Environmental Protection Agency (EPA) Methods specified in 40 CFR, Part 60, Appendix A and Part 10 of the MDEQ Rules, Intermittent Testing and Sampling. Testing was conducted on January 31, 2019.

Bluewater Renewables, LLC is located at 6797 Smiths Creek Road, Smiths Creek, Michigan. The facility is associated with the Smiths Creek Landfill. Bluewater Renewables, LLC operates two Caterpillar G3520C engines with associated generator sets. The engines are fueled by landfill gas generated by the landfill and produce electricity which is sent to the electric grid.

The engines are landfill gas-fired units. Fuel consumption varies with field pressure and heat content of the gas. Pertinent engine operating parameters were measured throughout each emissions test and are included in Appendix B.

The engines operate per contract with electricity providers on an as needed basis with load varying according to fuel supply. Operation is dependent on landfill gas field pressure. Two engines (EUICENGINE1 & 2) operate at the facility. Testing was performed on each engine 90-100% speed and torque to meet Subpart JJJJ Requirements.

Operating parameters used to regulate the engines includes speed (RPM) and torque. Additional parameters monitored were include fuel flow, exhaust temperature, inlet temperature & pressure, torque (BHp) and fuel/air ratio.

The results demonstrate compliance with the MDEQ permit limits. Table 1 presents the test results summary of the emissions.

TABLE 1

BLUEWATER RENEWABLES
SMITHS CREEK, MICHIGAN

CATERPILLAR G3520C ENGINES 1&2
MDEQ PERMIT NO. 163-09D

TEST RESULTS SUMMARY

Parameter	Measured Average	Compliance Limit	Compliance Determination
ENGINE 2, February 6, 2019			
Nitrogen Oxides Emissions: ppmvd @ 15% O2	**35.3**	**150.0**	**compliant**
Carbon Monoxide Emissions: ppmvd @ 15% O2	**276.3**	**610.0**	**compliant**
Volatile Organic Compound Emissions: ppmvd @ 15% O2	**3.3**	**80.0**	**compliant**
ENGINE 1, February 6, 2019			
Nitrogen Oxides Emissions: ppmvd @ 15% O2	**42.8**	**150.0**	**compliant**
Carbon Monoxide Emissions: ppmvd @ 15% O2	**287.1**	**610.0**	**compliant**
Volatile Organic Compound Emissions: ppmvd @ 15% O2	**1.2**	**80.0**	**compliant**

2.0 SCOPE AND OBJECTIVES

The scope of this project was to conduct NOx, CO and VOC emission testing at two CAT G3520C engines located at the Bluewater Renewables, LLC facility in Smiths Creek, Michigan using approved reference-sampling methods. The results of the tests are intended to determine compliance with the Subpart JJJJ limits incorporated into the State of Michigan Permit to Install 163-09D. The NOx and CO emissions in terms of parts per million, volumetric dry, (ppmvd), pounds per hour (lb/hr) and/or grams per brake horsepower hours (g/bHp-hr) were calculated using the measured concentration data and measured exhaust gas flow rates for each engine.

As per each Permit, the results of the tests were intended to demonstrate that each source would not exceed 150 ppmvd NOx at 15% O_2, 610 ppmvd CO at 15% O_2 and 80 ppmvd VOC 15 % O_2. Three runs were conducted and the average of the three runs constituted each test per engine.

The following parameters were determined at a minimum for each of three test runs per engine:

• Gas Analysis	CO_2 and O_2 % by volume
• Gas Moisture	% by volume
• Sample Gas Volume	dscf
• NOx Emissions	ppmvd, ppmvd @15% O_2
• CO Emissions	ppmvd, ppmvd @15% O_2
• VOC Emissions	ppm, ppmvd and ppmvd @15% O_2

CO2	carbon dioxide
O2	oxygen
ppmvd	parts per million volumetric dry
ppmvd @ 15%O_2	parts per million volumetric dry corrected to 15% O_2

The field-sampling program was performed on February 6, 2019. The Lemos Labs test personnel consisted of Messrs. Alex Keffalas (Meterbox Operator) and Roger Mellars (Trailer Operator). Mr. Ron Sanch served as plant liaison for this test program. The process data was collected by Delta Gas.

Contacts:

Lemos Labs, LLC contact: PADEP Lab 65-05224	Alex Keffalas Lemos Labs, LLC 329 Pillow Street Butler, Pennsylvania 16001 Telephone: (724) 519-2936 Facsimile: (724) 519-2317
Bluewater Contact:	Robert B. Sanch Bluewater Renewables, LLC 6797 Smiths Creek Road Smiths Creek, Michigan 48074

3.0 PROCESS DESCRIPTION

Bluewater Renewables, LLC is located at 6797 Smiths Creek Road, Smiths Creek, Michigan. The facility is associated with the Smiths Creek Landfill. Bluewater Renewables, LLC operates two Caterpillar G3520C engines with associated generator sets. The engines are fueled by landfill gas generated by the landfill and produce electricity which is sent to the electric grid.

The engines are landfill gas-fired units. Fuel consumption varies with field pressure and heat content of the gas. Pertinent engine operating parameters were measured throughout each emissions test.

The engines operate per contract with electricity providers on an as needed basis with load varying according to fuel supply. Operation is dependent on landfill gas field pressure.

4.0 PROCEDURES

4.1 FIELD WORK

4.1.1 Field Data Sheets

Copies of all field data sheets including the one-minute average concentration data for each engine are included in Appendix A.

4.1.2 Emission Testing Station

The sampling locations are at the engines' exhausts. There are two test ports located 90 degrees to center at the stack sampling location. The internal diameter of the stack is 16 inches. The nearest downstream disturbance is the stack exit, which is 10 inches or 0.6 diameters from the test ports. The nearest upstream disturbance is 72 inches or 4.5 diameters from the test ports. A drawing of the stack sampling locations is included in Figure 1.

Each stack met the stratification criteria for O_2. The stratification results are included in Appendix D.

4.1.3 Determination of Carbon Dioxide and Oxygen

The oxygen and carbon dioxide contents of the gas stream were measured using the principles of EPA Method 3A - Gas Determination of Oxygen (O_2) and Carbon Dioxide (CO_2) Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure). A gas sample was continuously extracted from each exhaust stack using a heated Teflon sample line and a portion of the sample was conveyed to two analyzers after the removal of moisture. The O_2/CO_2 sampling was conducted simultaneously with the NOx, CO and VOC sampling using the same extraction system.

4.1.4 Determination of Moisture Content

Moisture sampling was conducted using the principles presented in EPA Method 4 - Determination of Moisture Content in Stack Gases. Parameters evaluated to determine the gas stream moisture content were: sample gas volume, sample gas temperature, sample gas pressure, impinger moisture gain, and silica gel moisture gain.

4.1.5 Determination of Nitrogen Oxides Emissions

The principles of EPA Method 7E - Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure) were used for this test program. A gas sample was continuously be extracted from the stack and a portion of the sample was conveyed to an analyzer. The analyzer measured the NOx concentration using the principles of chemiluminescence. The NOx sampling was conducted simultaneously with the CO and VOC sampling using the same extraction system.

4.1.6 Determination of Carbon Monoxide Emissions

The principles of EPA Method 10 - Determination of Carbon Monoxide Emissions from Stationary Sources were used for this test program. A gas sample was continuously extracted from the stack and a portion of the sample was conveyed to an analyzer. The analyzer measured the CO concentration using the principles of infrared radiation. The CO sampling was conducted simultaneously with the NOx and VOC sampling using the same extraction system. A drawing of Methods 3A, 7E and 10 sampling trains are included in Figure 2.

4.1.7 Determination of Volatile Organic Compound Emissions

VOC was determined onsite using a flame ionization analyzer (FIA) that is equipped with an internal methane / non-methane hydrocarbon separation column; SRI 410C Methane/Non-Methane Hydrocarbon Analyzer (SRI Model 410C).

The SRI Model 410C Direct Methane, Non-Methane Hydrocarbon Analyzer is a back-flush gas chromatography (GC) system designed for automated measurement of methane and non-methane hydrocarbons. Unlike instruments that measure only methane and total hydrocarbons, the backflush GC method provides a direct measurement of non-methane concentrations. This allows accurate and precise measurement of low levels of non-methane hydrocarbons (NMHC), even in the presence of methane at much higher concentrations.

USEPA Method 25A with ALT-096 and calibration procedures from ALT-097a	VOC concentration in the engine exhaust was determined on-site using an instrument that is equipped with an internal methane / non-methane hydrocarbon separation column (SRI 410C). The sampled gas stream was delivered directly to the instrument, the column separates methane from non-methane hydrocarbons, and each was analyzed separately by the FIA. Additional information for the operation of the SRI 410C instrument is below. The FIA was calibrated using the procedures in USEPA Method 25A. A gas dilution system was not used with the calibration gases. The procedures of USEPA Alternate Test Method 097 were used to verify the methane / NMHC separation efficacy of the SRI 410C instrument. A USEPA Protocol 1 certified blend gas containing ethane, methane and propane was used for this demonstration. The blended gas was introduced to the analyzer prior to and following each test period to check analyzer error and drift.

A heated sample line was used to extract the exhaust gas from the stack and convey it to the SRI 410C analyzer. The heated sample line was heated to approximately 250°F and all components leading up to the analyzer were heated to greater than 220°F. The engine exhaust gas sample delivered to the SRI 410C was not conditioned (i.e., moisture was not removed).

The SRI 410C is an automated batch analyzer that repeatedly collects and analyzes samples of the exhaust gas stream that are drawn into the instrument by the internal sampling pump. The sampled gas is separated by an internal gas chromatography (GC) column into methane and non-methane fractions and each fraction is analyzed separately using a flame ionization detector (FID), in accordance with USEPA Method 25A.

The instrument is equipped with an internal rotary valve to control the introduction of the gas sample into the GC column. During injection mode, the rotary valve automatically allows a sample of the stack gas to enter the GC column. The sampled gas is carried through the GC column using an inert carrier gas (nitrogen). Due to its low molecular weight and high volatility, methane is separated from the non-methane components and emerges from the GC column first. The methane is directed to the FID and the methane concentration is recorded (as C1, methane) based on the calibrated detector signal. Once the methane peak has been detected (methane has a retention time of approximately 17 seconds within the GC column), the rotary valve automatically switches position so that the GC column is back-flushed with the carrier gas. All of the NMHC components remaining in the column (after being separated from methane) are directed to the FID and the NMHC concentration is recorded (as C3, propane) based on the calibrated detector signal. Once the NMHC peak is completed (i.e., the FID signal returns to zero for a period of time), the instrument automatically begins another injection sequence.

The SRI 410C is a batch-type instrument and was set to a cycle time such that approximately 30 samples are analyzed per 60-minute test period. VOC (as NMHC) mass emissions were measured as propane.

Before and after each test run, the analyzer was calibrated using low-range calibration (propane) and zero gas to determine analyzer calibration error and system bias.

A diagram of the EPA Method 25A sampling train is included in Figure 3.

4.1.8 Process Data

The process information was recorded at a minimum every 15 minutes during each testing period and is included in Appendix B. The process data collected includes:

1.) Engine speed (RPM),
2.) Load (kW & %),
3.) Gas fuel flow (scfm),
4.) Fuel/air ratio,
5.) Engine Coolant Temperature (deg. F),
6.) Inlet Air Temperature (deg. F), and
7.) Inlet Manifold Air Pressure (psi).

4.1.9 Test Parameters and Methods

The compliance emissions tests will be performed for the parameters listed in Table 4 below. All test methods conducted for this compliance test conform to Title 40, Code of Federal Regulations, Part 60. The test methods will follow the current reference methods.

TABLE 4

TEST PARAMETERS AND METHODS

Parameter	EPA Method #	Sampling and Analytical Procedure	Variations
Sample and Velocity Traverses	1	Sample and Velocity Traverses for Stationary Sources	None
O_2, CO_2	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources	None
Moisture	4	Determination of Moisture Content in Stack Gases	None
NO_x	7E	Determination of Nitrogen Oxide Emissions from Stationary Sources	None
CO	10	Determination of Carbon Monoxide Emissions from Stationary Sources	None
VOC	25A	Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer	None

4.2 CALCULATIONS

Emission calculations were completed using a computer spreadsheet format. The results of each pertinent parameter for each engine were detailed on the spreadsheet for each sampling run and are included in Appendix C. An actual calculation of a run per engine is included in Appendix C.

4.3 FIELD EQUIPMENT CALIBRATIONS

The following field equipment calibration data is included in Appendix D:

- Dry Gas Meter and Orifice;
- Thermocouple;
- Pitot Tube;
- Analyzers; and
- Calibration Gas Certificates.

5.0 SUMMARY OF RESULTS

Table 2 presents a summary of emissions and testing parameters for Engine 2. The NOx emission concentration ranged from 64.3 to 67.6 ppmvd and the average was 66.3 ppmvd. The NOx emission rate ranged from 34.2 to 36.3 ppmvd @ 15% O_2 and the average emission rate was 35.3 ppmvd @ 15% O_2. The CO emission concentration ranged from 506.9 to 524.1 ppmvd and the average was 518.2 ppmvd. The CO emission rate ranged from 271.9 to 278.9 ppmvd @ 15% O_2 and the average was 276.3 ppmvd @ 15% O_2. The VOC emission concentration ranged from 1.7 to 8.7 ppmvd and the average was 5.4 ppmvd. The VOC emission ranged from 1.0 to 5.4 ppmvd @ 15% O_2 and the average was 3.3 ppmvd @ 15% O_2.

Table 3 presents a summary of emissions and testing parameters for Engine 1. The NOx emission concentration ranged from 72.4 to 74.0 ppmvd and the average was 73.5 ppmvd. The NOx emission rate ranged from 42.0 to 43.6 ppmvd @ 15% O2 and the average emission rate was 42.8 ppmvd @ 15% O2. The CO emission concentration ranged from 479.9 to 499.6 ppmvd and the average was 492.9 ppmvd. The CO emission rate ranged from 282.8 to 289.5 ppmvd @ 15% O2 and the average was 287.1 ppmvd @ 15% O2. The VOC emission concentration ranged from 0.8 to 3.2 ppmvd and the average was 2.0 ppmvd. The VOC emission ranged from 0.5 to 1.9 ppmvd @ 15% O2 and the average was 1.2 ppmvd @ 15% O2.

TABLE 1

BLUEWATER RENEWABLES
SMITHS CREEK, MICHIGAN

CATERPILLAR G3520C ENGINES 1&2
MDEQ PERMIT NO. 163-09D

TEST RESULTS SUMMARY

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Volatile Organic Compound Emissions: ppmvd @ 15% O2	**3.3**	**80.0**	**compliant**
ENGINE 1, February 6, 2019			
Nitrogen Oxides Emissions: ppmvd @ 15% O2	**42.8**	**150.0**	**compliant**
Carbon Monoxide Emissions: ppmvd @ 15% O2	**287.1**	**610.0**	**compliant**
Volatile Organic Compound Emissions: ppmvd @ 15% O2	**1.2**	**80.0**	**compliant**

TABLE 2

BLUEWATER RENEWABLES
SMITHS CREEK, MICHIGAN
CATERPILLAR G3520C ENGINE 2

LEMOS LABS, LLC PROJECT 0793

February 6, 2019

SUMMARY OF EMISSIONS AND TESTING PARAMETERS

Parameter	Run 1	Run 2	Run 3	Average
Gas moisture, % by volume	13.0	13.9	13.4	**13.4**
Oxygen content, % by volume	9.9	9.8	9.8	**9.8**
Carbon dioxide content, % by volume	9.7	9.8	9.9	**9.8**
Sample volume, dscf	43.823	43.606	42.842	**43.424**
Nitrogen Oxides Emissions:				
ppmvd	67.6	64.3	66.8	**66.3**
ppmvd @ 15% O2	36.3	34.2	35.6	**35.3**
Carbon Monoxide Emissions:				
ppmvd	506.9	523.4	524.1	**518.2**
ppmvd @ 15% O2	271.9	278.2	278.9	**276.3**
Volatile Organic Compound Emissions:				
ppmvd	1.7	8.7	5.8	**5.4**
ppmvd @ 15% O2	1.0	5.4	3.6	**3.3**

TABLE 3

BLUEWATER RENEWABLES
SMITHS CREEK, MICHIGAN
CATERPILLAR G3520C ENGINE 1

LEMOS LABS, LLC PROJECT 0793

February 6, 2019

SUMMARY OF EMISSIONS AND TESTING PARAMETERS

Parameter	Run 1	Run 2	Run 3	Average
Gas moisture, % by volume	12.6	12.4	13.2	**12.7**
Oxygen content, % by volume	10.9	10.7	10.7	**10.8**
Carbon dioxide content, % by volume	8.8	9.0	9.0	**8.9**
Sample volume, dscf	42.417	42.288	42.393	**42.366**
Nitrogen Oxides Emissions:				
ppmvd	74.0	72.4	74.0	**73.5**
ppmvd @ 15% O2	43.6	42.0	42.8	**42.8**
Carbon Monoxide Emissions:				
ppmvd	479.9	499.6	499.1	**492.9**
ppmvd @ 15% O2	282.8	289.5	289.0	**287.1**
Volatile Organic Compound Emissions:				
ppmvd	3.2	1.9	0.8	**2.0**
ppmvd @ 15% O2	1.9	1.1	0.5	**1.2**

TABLE 4

TEST PARAMETERS AND METHODS

Parameter	EPA Method #	Sampling and Analytical Procedure	Variations
Sample and Velocity Traverses	1	Sample and Velocity Traverses for Stationary Sources	None
O_2, CO_2	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources	None
Moisture	4	Determination of Moisture Content in Stack Gases	None
NO_x	7E	Determination of Nitrogen Oxide Emissions from Stationary Sources	None
CO	10	Determination of Carbon Monoxide Emissions from Stationary Sources	None
VOC	25A	Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer	None

FIGURES

FIGURE 1

Bluewater Renewables, LLC
2 Caterpillar G3520C IC Engines
Smiths Creek, Michigan

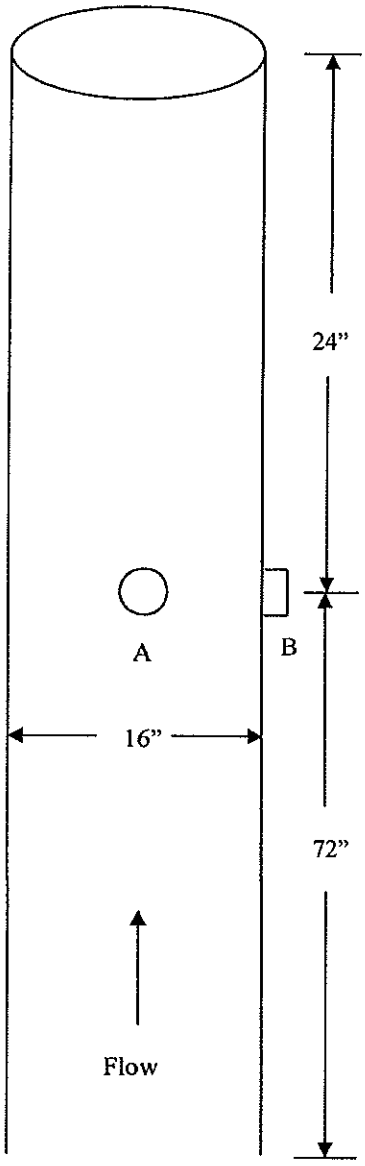

FIGURE 2

EPA METHODS 3A, 7E AND 10
SAMPLING TRAIN

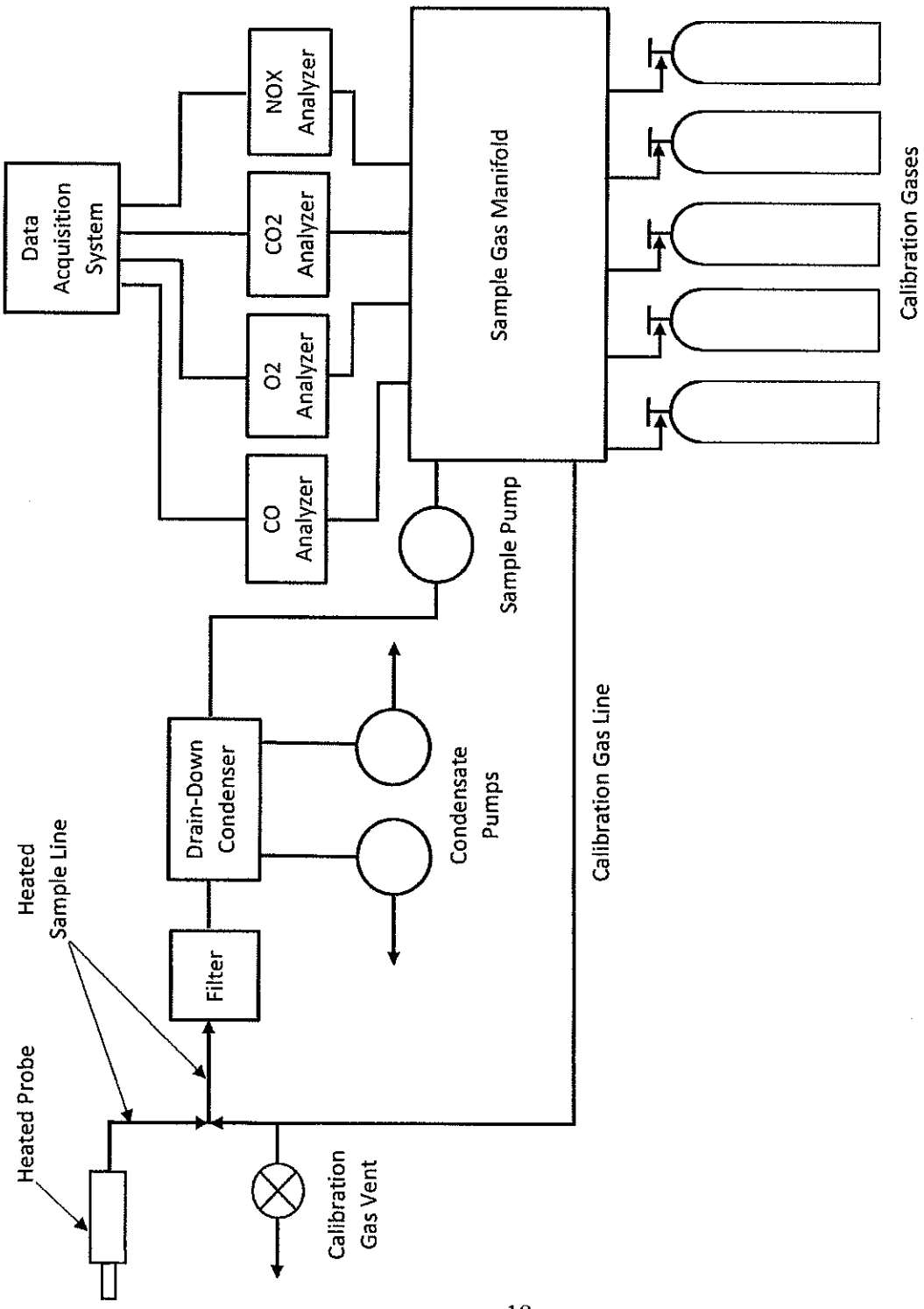

FIGURE 3

EPA Method 25A
Sampling Train