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# **Boiler No. 4 Particulate Matter Summary Report Central Michigan University**

*Prepared for:*

**Central Michigan University**

Mount Pleasant, Michigan

Central Energy Facility  
1720 South East Campus Drive  
Mount Pleasant, Michigan

Project No. 15-4790.00  
February 1, 2015

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Royal Oak, Michigan 48073  
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## EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Central Michigan University (CMU) to evaluate particulate matter (PM) concentrations and emission rates from Boiler No. 4 (EU-BLR4). The boiler is located on the CMU campus in Mt. Pleasant, Michigan. The emissions test program was conducted on January 22, 2016.

Testing of the boiler consisted of triplicate 60-minute test runs. The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-K2460-2015. The results of the emission test program are summarized by Table I.

**Table I**  
**Boiler No. 4 Overall Emission Summary**  
**Test Date: January 22, 2016**

Source	Permit Limit	Average Test Result
Boiler 4	0.15 lb / 1,000 lb exhaust gas, corrected to 50% excess air	0.11 lb / 1,000 lb exhaust gas, corrected to 50% excess air

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## **1. Introduction**

BT Environmental Consulting, Inc. (BTEC) was retained by Central Michigan University (CMU) to evaluate particulate matter (PM) concentrations and emission rates from Boiler No. 4 (EU-BLR4). The boiler is located on the CMU campus in Mt. Pleasant, Michigan. The emissions test program was conducted on January 22, 2016. The purpose of this report is to document the results of the test program.

Testing of the boiler consisted of triplicate 60-minute test runs. The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-K2460-2015.

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 January 22, 2016 at the Central Michigan University power house located in Mt. Pleasant, Michigan. The test program included evaluation of PM emissions from Boiler 4.

### **1.b Purpose of Testing**

AQD issued Renewable Operating Permit No. MI-ROP-K2460-2015 to CMU January 7, 2015 and limits PM emissions from EU-BLR4 to not more than 0.15 pounds per 1,000 pounds of exhaust gas, corrected to 50% excess air.

### **1.c Source Description**

Wood Boiler #4, a 68.5 MMBtu/hr. steam boiler, wood-fired for campus heat and electricity, equipped with ash handling system. The electricity is generated by steam coming from EU-BLR4 at 450 psi. After a small turbine (approx. 1 MW or 3.413 MMBtu), the steam pressure is down to 60 psi suitable for campus piping. The boiler emissions are controlled by a multi-cyclone collector and a wet scrubber. Emissions from chip unloading, wood feed, and ash handling are controlled by three individual baghouses.

### **1.d Test Program Contacts**

The contact for the source and test report is:



Mr. John Fernandez  
SPV/Utility Operations  
Central Michigan University  
1730 E. Campus Drive  
Mt. Pleasant, Michigan 48859  
(989) 774-4437

Mr. Todd Wessel  
Senior Project Manager  
BT Environmental Consulting  
4949 Fernlee Avenue  
Royal Oak, MI 48073  
(616) 885-4013

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

**Table 1**  
**Test Personnel**

<b>Name and Title</b>	<b>Affiliation</b>	<b>Telephone</b>
Mr. John Fernandez SPV/Utility Operations	Central Michigan University 1730 E. Campus Drive Mt. Pleasant, Michigan 48859	(989)-774-4437
Mr. Steve Smith Project Manager	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Diven Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Mason Sakshaug Environmental Technician	BTEC 4949 Fernlee Avenue Royal Oak, MI 48073	(248) 548-8070
Mr. Dave Patterson	MDEQ Air Quality Division	(517) 284-6782

## 2. Summary of Results

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

## **2.a Operating Data**

Process data monitored during the emissions test program included boiler load, pressure drops, water flow rate, and wood fuel usage.

## **2.b Applicable Permit**

The applicable permit for this emissions test program is Renewable Operating Permit (ROP) No. MI-ROP-K2460-2015, with a SRN # of K2460. The boiler emission unit ID is EU-BLR4.

## **2.c Results**

The overall results of the emission test program are summarized by Table 2 (see Section 5.a).

## **3. Source Description**

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

### **3.a Process Description**

Wood Boiler #4, a 68.5 MMBtu/hr. steam boiler, wood-fired for campus heat and electricity, equipped with ash handling system. The electricity is generated by steam coming from EU-BLR4 at 450 psi. After a small turbine (approx. 1 MW or 3.413 MMBtu), the steam pressure is down to 60 psi suitable for campus piping. The boiler emissions are controlled by a multi-cyclone collector and a wet scrubber. Emissions from chip unloading, wood feed, and ash handling are controlled by three individual baghouses.

### **3.b Process Flow Diagram**

Due to the simplicity of the boiler a process flow diagram is not necessary.

### **3.c Raw and Finished Materials**

The raw material used by the process is wood.

### **3.d Process Capacity**

Boiler No. 4 (EU-BLR4) is a 68.5 mmbtu/hr.

### **3.e Process Instrumentation**

Process data monitored during the emissions test program included boiler load, pressure drops, water flow rate, and wood fuel usage.

#### 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

The emissions test program utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - “Sample and Velocity Traverses for Stationary Sources”
- Method 2 - “Determination of Stack Gas Velocity and Volumetric Flowrate”
- Method 3A - “Determination of Molecular Weight of Dry Stack Gas”(Analyzer)
- Method 4 - “Determination of Moisture Content in Stack Gases”
- Method 5 - “Determination of Particulate Matter Emissions from stationary sources”

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 are within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) is assigned. A diagram of the sample points is provided in Figure 2.

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.

Boiler exhaust O<sub>2</sub>/CO<sub>2</sub> content was measured using a Severomex 4100 O<sub>2</sub>/CO<sub>2</sub> 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<sup>®</sup> sample line, and through an electronic sample conditioner to remove the moisture from the sample before it enters the analyzer. Data was recorded at 4-second intervals on a PC equipped with data acquisition software.

Exhaust gas was extracted as part of the Method 5 sampling train. Exhaust gas moisture content was determined gravimetrically.

40 CFR 60, Appendix A, Method 5, "*Determination of Particulate Emissions from Stationary Sources*" was used to measure PM concentrations and calculate PM emission rates (see Figure 1 for a schematic of the sampling train).

BTEC's Nutech<sup>®</sup> Model 2010 modular isokinetic stack sampling system consists of (1) a steel nozzle, (2) a glass probe, (3) a Teflon connecting line to the impingers, (4) a set of four Greenburg-Smith (GS) impingers with the first two with 100 ml of deionized water (ii) an empty impinger, (iii) and an impinger filled with approximately 300 grams of silica gel. (5) a length of sample line, and (6) a Nutech<sup>®</sup> control case equipped with a pump, dry gas meter, and calibrated orifice.

Upon completion of the final leak test for each test run, the filter was recovered, and the nozzle, probe, and the front half of the filter holder assembly were brushed and triple rinsed with acetone which was collected in a pre-cleaned sample container.

BTEC labeled each container with the test number, test location, and test date, then marked the level of liquid on the outside of the container. Blank samples of the filter and acetone were collected. BTEC personnel transported all samples to BTEC's laboratory in Royal Oak, Michigan, for analysis.

#### **4.b Recovery and Analytical Procedures**

See section 4.a.

#### **4.c Sampling Ports**

A diagram of the stack showing sampling ports in relation to upstream and downstream disturbances is included as Figure 2.

#### **4.d Traverse Points**

A diagram of the stack indicating traverse point locations and stack dimensions is included as Figure 2.

### **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 Table 3.

**Table 2**  
**Boiler No. 4 Overall Emission Summary**  
**Test Date: January 22, 2016**

<b>Source</b>	<b>Permit Limit</b>	<b>Average Test Result</b>
Boiler 4	0.15 lb / 1,000 lb exhaust gas, corrected to 50% excess air	0.11 lb / 1,000 lb exhaust gas, corrected to 50% excess air

#### **5.b Discussion of Results**

The overall results of the emission test program are summarized by Table 2 (see Section 5.a). PM emissions from the boiler were 0.11 lb / 1,000 lb exhaust gas, corrected to 50% excess air which is below the corresponding limit of 0.15 lb / 1,000 lb exhaust gas, corrected to 50% excess air.

#### **5.c Sampling Procedure Variations**

There were no sampling variations used during the emission compliance test program.

#### **5.d Process or Control Device Upsets**

No upset conditions occurred during testing.

#### **5.e Control Device Maintenance**

There was no control equipment maintenance performed during the emissions 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**

Laboratory analytical results are available in Appendix D.

**Table 3**  
**Boiler 4 Particulate Matter Emission Rates**

Company Source Designation Test Date	CMU Boiler 4			Average
	1/22/2016	1/22/2016	1/22/2016	
<b>Meter/Nozzle Information</b>	P-1	P-2	P-3	
Meter Temperature Tm (F)	67.0	82.3	81.6	77.0
Meter Pressure - Pm (in. Hg)	29.6	29.6	29.6	29.6
Measured Sample Volume (Vm)	44.3	44.7	44.6	44.5
Sample Volume (Vm-Std ft3)	44.1	43.2	43.26	43.5
Sample Volume (Vm-Std m3)	1.25	1.22	1.22	1.23
Condensate Volume (Vw-std)	14.475	15.277	16.125	15.292
Gas Density (Ps(std) lbs/ft3) (wet)	0.0711	0.0708	0.0704	0.0708
Gas Density (Ps(std) lbs/ft3) (dry)	0.0792	0.0794	0.0793	0.0793
Total weight of sampled gas (m g lbs) (wet)	4.17	4.14	4.18	4.16
Total weight of sampled gas (m g lbs) (dry)	3.50	3.43	3.43	3.45
Nozzle Size - An (sq. ft.)	0.000830	0.000830	0.000830	0.000830
Isokinetic Variation - I	102.8	102.7	105.5	103.7
<b>Stack Data</b>				
Average Stack Temperature - Ts (F)	174.8	168.9	172.2	172.0
Molecular Weight Stack Gas- dry (Md)	30.6	30.7	30.7	30.7
Molecular Weight Stack Gas-wet (Ms)	27.5	27.4	27.2	27.4
Stack Gas Specific Gravity (Gs)	0.950	0.946	0.941	0.946
Percent Moisture (Bws)	24.69	26.10	27.16	25.98
Water Vapor Volume (fraction)	0.2469	0.2610	0.2716	0.2598
Pressure - Ps ("Hg)	29.4	29.4	29.4	29.4
Average Stack Velocity -Vs (ft/sec)	23.4	23.1	23.0	23.2
Area of Stack (ft2)	19.8	19.8	19.8	19.8
Oxygen (%)	5.4	4.9	5.0	5.1
Carbon Dioxide (%)	15.1	15.8	15.5	15.5
Carbon Monoxide (%)	0.0	0.0	0.0	0.0
Nitrogen (%)	79.5	79.4	79.5	79.5
% Excess Air	34.5	30.2	31.4	32.0
<b>Exhaust Gas Flowrate</b>				
Flowrate ft <sup>3</sup> (Actual)	27,760	27,473	27,285	27,506
Flowrate ft <sup>3</sup> (Standard Wet)	22,673	22,649	22,377	22,567
Flowrate ft <sup>3</sup> (Standard Dry)	17,074	16,737	16,301	16,704
Flowrate m <sup>3</sup> (standard dry)	483	474	462	473
<b>Total Particulate Weights (mg)</b>				
Nozzle/Probe/Filter	171.3	257.2	284.9	237.8
<b>Total Particulate Concentration</b>				
lb/1000 lb (wet)	0.091	0.137	0.150	0.13
lb/1000 lb (wet) corrected to 50% Excess Air	0.083	0.122	0.135	0.11
lb/1000 lb (dry)	0.108	0.165	0.183	0.15
mg/dscm (dry)	137.0	210.0	232.6	193.2
gr/dscf	0.0599	0.0918	0.1017	0.0844
<b>Total Particulate Emission Rate</b>				
lb/ hr	8.80	13.22	14.25	12.09

# Figures

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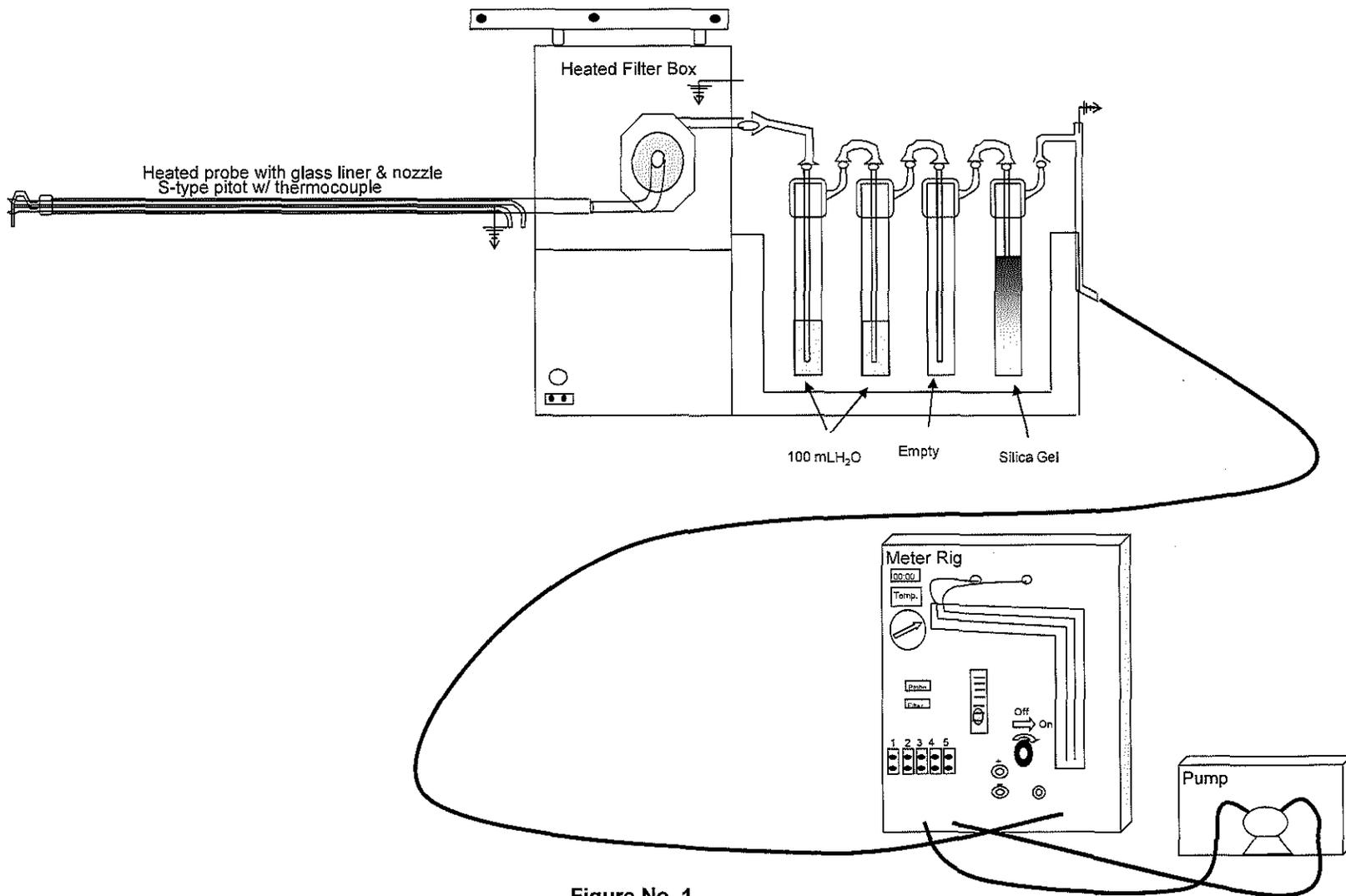


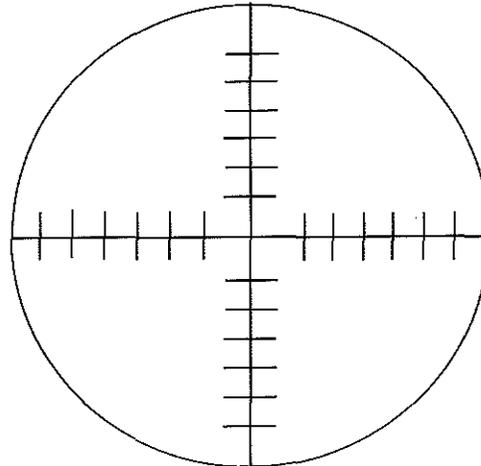
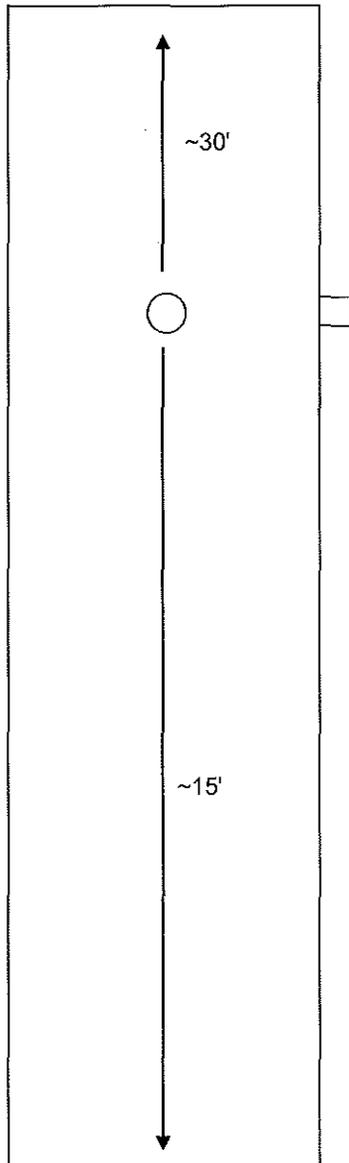
Figure No. 1

Site:  
USEPA Method 5  
Central Michigan University  
Mount Pleasant, Michigan

Sampling Date:  
January 22, 2016

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

diameter = 60.25"



Not to Scale

Points	Distance "
1	4.26
2	7.0
3	10.1
4	13.7
5	18.1
6	24.4
7	41.8
8	48.2
9	52.6
10	56.1
11	59.2
12	62.0

**Figure 2**

Site:  
**CMU**  
 MT. Pleasant, Michigan

Sampling Dates:  
 January 22, 2016

**BT Environmental Consulting,**  
**Inc.**  
 4949 Fernlee  
 Royal Oak, Michigan

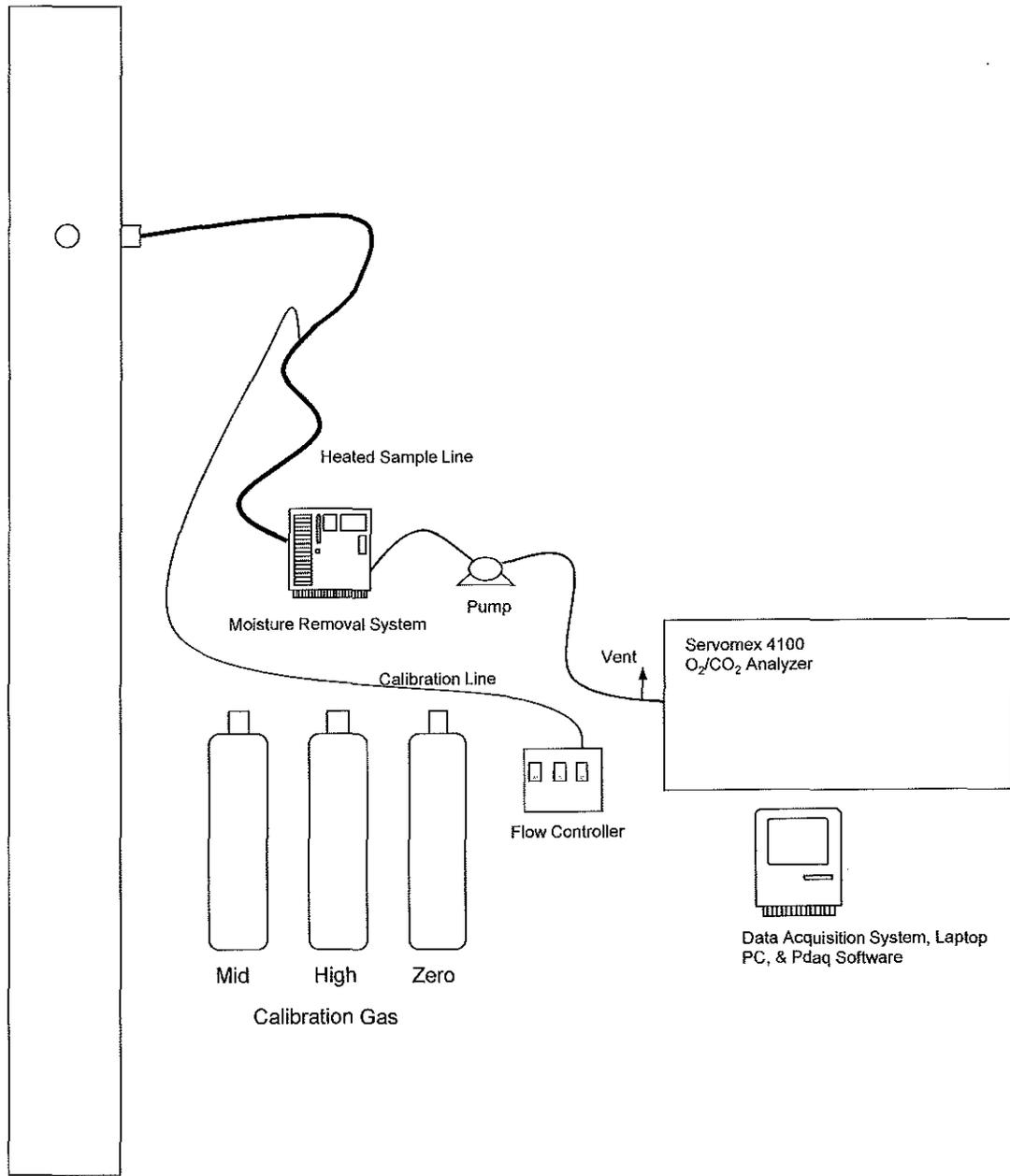


Figure No. 3

Site:  
USEPA Method 3A  
Central Michigan University  
Mount Pleasant, Michigan

Sampling Date:  
January 22, 2016

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