



Boiler No. 5 Nitrogen Oxides Summary Report Central Michigan University

Prepared for:

Central Michigan University

Mount Pleasant, Michigan

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AIR QUALITY DIV.

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

Project No. 13-4467.00
February 19, 2014

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EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Central Michigan University (CMU) to evaluate nitrogen oxides (NOx) emission rates from Boiler No. 5 while operating with and with out the turbine gases passing through it. The boiler and turbine are located on the CMU campus in Mt. Pleasant, Michigan. The emissions test program was conducted on January 16, 2014.

Testing of the boiler consisted of triplicate 60-minute test runs while each unit was operating at 85% or greater. The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-K2460-2009a. The results of the emission test program are summarized by Table I.

Table I

Boiler No. 5 Overall Emission Summary

Test Date: January 16, 2014

Boiler No. 5 (EUBLR5) Fresh Air Fire			
Load	Pollutant	Average Emission Rate	Emission Limit
87%	NOx	0.14 lbs/mmbtu	0.20 lbs/mmbtu
Boiler No. 5 and the Turbine (EUGASTURBINE)			
Load	Pollutant	Average Emission Rate	Emission Limit
87%	NOx	0.19 lbs/mmbtu	0.20 lbs/mmbtu

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1. Introduction

AIR QUALITY DIV.

BT Environmental Consulting, Inc. (BTEC) was retained by Central Michigan University (CMU) to evaluate nitrogen oxides (NO_x) emission rates from Boiler No. 5 while operating with and without the turbine gases passing through it. The boiler and turbine are located on the CMU campus in Mt. Pleasant, Michigan. The emissions test program was conducted on January 16, 2014. 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 while each unit was operating at 85% or greater. The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-K2460-2009a.

AQD has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (February 2008). 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 16, 2014 at the Central Michigan University power house located in Mt. Pleasant, Michigan. The test program included evaluation of NO_x and O₂ emissions from the Boiler in Fresh Air Fire and in combination with the turbine.

1.b Purpose of Testing

AQD issued Renewable Operating Permit No. MI-ROP-K2460-2009a to CMU June 2, 2009. This permit limits emissions from each turbine as summarized by Table 1.

Table 1
NO_x Emission Limitations
CMU Boiler No. 5

Facility	Permit No.	NO _x Emission Limit
CMU	MI-ROP-K2460-2009a	0.20 lbs/mmBtu

1.c Source Description

Boiler No. 5 (EU-BLR5) is a 117 MMBTU/HR boiler that acts as a waste heat boiler using the hot exhaust gases from the turbine. It can also function without the turbine operating using natural gas.

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

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. 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	BTEC 4949 Fernlee Royal Oak, MI 48073	(616) 885-4013
Mr. Andrew Lusk Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Ben Witkopp	MDEQ Air Quality Division	(989) 686-8025

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 natural gas usage for the boiler and turbine, gas valve position and steam flow.

2.b Applicable Permit

The applicable permit for this emissions test program is Renewable Operating Permit (ROP) No. MI-ROP-K2460-2009a, with a SRN # of K2460. The turbine emission unit ID is EU-GASTURBINE and the boiler emission unit is EU-BLR5

2.c Results

The overall results of the emission test program are summarized by Table 3 (see Section 5.a). NO_x emissions from the boiler in fresh air fire mode were 0.14 lbs/mmbtu which is below the corresponding limit of 0.20 lbs/mmbtu. NO_x emissions from the boiler with the turbine gases going through it were 0.19 lbs/mmbtu which is also below the limit of 0.20 lbs/mmbtu.

3. Source Description

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

3.a Process Description

Boiler No. 5 (EU-BLR5) is a 117 MMBTU/HR boiler that acts as a waste heat boiler using the hot exhaust gases from the turbine. It can also function with out the turbine operating using natural gas.

3.b Process Flow Diagram

A process flow diagram is included as Figure 3.

3.c Raw and Finished Materials

The raw material used by the process is natural gas. Turbine and boiler natural gas firing rates were recorded during the emissions test program are summarized by the process field data sheets included in Appendix B.

3.d Process Capacity

Boiler No. 5 (EU-BLR5) is a 117 mmbtu/hr

3.e Process Instrumentation

Process data monitored during the emissions test program included natural gas meter readings for the boiler and the turbine, gas valve position and steam flow.

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

BTEC's extractive monitors require that the effluent gas sample be conditioned to eliminate any possible interference (i.e., water vapor and/or particulate matter) before being transported and injected into each analyzer. All components of the sampling system that contact the sample were constructed of Type 316 stainless steel, Pyrex glass or Teflon[®]. The output signal from each monitor was recorded at 10-second intervals on a PC equipped with Labview[®] II data acquisition software (DAS). The samples were extracted from the stack using a stainless steel probe assembly, heated sample line, stack gas conditioner with a Teflon diaphragm pump and routed through a distribution manifold for delivery to the analyzers. The configuration of the sampling system allowed for the injection of calibration gases directly to the analyzers or through the sampling system. All monitors in use were calibrated with U.S. EPA Protocol No. 1 calibration gases and operated to insure that zero drift, calibration gas drift, and calibration error met the specified method requirements. Copies of the Protocol gas certificates can be found in Appendix B.

The sample gas was extracted at three points through a stainless steel probe positioned at approximately 16.7%, 50% and 83.3% of the sample stream diameter as described by 40 CFR Part 60, Appendix B Performance Specification 2 Section 8.1.3.2 and illustrated in Figure 2.

The boiler NO_x concentrations were measured in parts per million (ppm), converted to an emission rate and reported as Lb/MMBtu, using equation 19-1 of U.S. EPA Method 19 of Appendix A, 40 CFR 60. Oxygen concentrations are reported in percent (%).

Sampling and analysis procedures 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 3A, "*Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources*", was used to measure the O₂ concentration of the exhaust gas.
- Method 7E, "*Determination of Nitrogen Oxide Emissions from Stationary Sources*", was used to measure the NO_x concentration of 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 the exhaust gas emission rates.

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 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 3. Detailed results for the emissions test program are summarized by Tables 4 and 5.

**Table 3
Turbine 1 Overall Emission Summary
Test Date: January 16, 2014**

Boiler No. 5 (EUBLR5) Fresh Air Fire			
Load	Pollutant	Average Emission Rate	Emission Limit
87%	NOx	0.14 lbs/mmbtu	0.20 lbs/mmbtu
Boiler No. 5 and the Turbine (EUGASTURBINE)			
Load	Pollutant	Average Emission Rate	Emission Limit
87%	NOx	0.19 lbs/mmbtu	0.20 lbs/mmbtu

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AIR QUALITY DIV.**5.b Discussion of Results**

The overall results of the emission test program are summarized by Table 3 (see Section 5.a). NO_x emissions from the boiler in fresh air fire mode were 0.14 lbs/mmbtu which is below the corresponding limit of 0.20 lbs/mmbtu. NO_x emissions from the boiler with the turbine gases going through it were 0.19 lbs/mmbtu which is also below the limit of 0.20 lbs/mmbtu.

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 B

5.k Laboratory Data

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

Table 4
 Boiler No. 5 (EUBLR5) Fresh Air Fire Detailed Emission Test Results Summary
 Central Michigan University
 BTEC Project No. 13-4467.00
 Sampling Date: January 16, 2014

Parameter		Run 4	Run 5	Run 6	Average
87% Load	Test Run Date	1/16/2014	1/16/2014	1/16/2014	
	Test Run Time	13:35-14:34	14:46-15:45	15:58-16:57	
	Oxides of Nitrogen Concentration (ppmv)	94.11	94.44	93.34	93.96
	NOx Concentration (ppmv, corrected as per USEPA 7E)	93.68	93.84	92.83	93.45
	Oxygen concentration (%)	6.89	6.82	6.89	6.87
	Oxygen concentration (%) (corrected as per USEPA 7E)	6.87	6.80	6.86	6.84
	NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.1E-05	1.1E-05	1.1E-05	1.1E-05
	NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.14	0.14	0.14	0.14

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (NOx = 46.01)

24.14 = molar volume of air at standard conditions (70 °F, 29.92" Hg)

35.31 = ft³ per m³

453600 = mg per lb

F_d = 8710 dscf/MMBtu

Equations

$$\text{lb/dscf} = \text{ppmv} * \text{MW} / 24.14 * 1/35.31 * 1/453,600 = C_d$$

$$\text{eq 19-1: } E = C_d F_d * 20.9 / (20.9 - \%O_{2d})$$

Table 5
Boiler No. 5 and the Turbine (EUGASTURBINE) Detailed Emission Test Results Summary
Central Michigan University
BTEC Project No. 13-4467.00
Sampling Date: January 16, 2014

Parameter		Run 1	Run 2	Run 3	Average
	Test Run Date	1/16/2014	1/16/2014	1/16/2014	
	Test Run Time	8:20-9:19	9:32-10:31	10:42-11:41	
87% Load	Oxides of Nitrogen Concentration (ppmv)	110.96	110.96	108.69	110.20
	NOx Concentration (ppmv, corrected as per USEPA 7E)	110.35	109.59	107.93	109.29
	Oxygen concentration (%)	8.38	8.29	8.28	8.32
	Oxygen concentration (%) (corrected as per USEPA 7E)	8.34	8.27	8.26	8.29
	NOx Concentration (lb/dscf, corrected as per USEPA 7E)	1.3E-05	1.3E-05	1.3E-05	1.3E-05
	NOx Emission Factor (lb/MMBtu, corrected as per USEPA 7E)	0.19	0.19	0.18	0.19

Calculated using USEPA Method 19 equation 19-1

dscf = dry standard cubic feet

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (NOx = 46.01)

24.14 = molar volume of air at standard conditions (70 °F, 29.92" Hg)

35.31 = ft³ per m³

453600 = mg per lb

F_d = 8710

Equations

$$\text{lb/dscf} = \text{ppmv} * \text{MW}/24.14 * 1/35.31 * 1/453,600 = C_d$$

$$\text{eq 19-1: } E = C_d F_d * 20.9 / (20.9 - \%O_{2d})$$

Figures

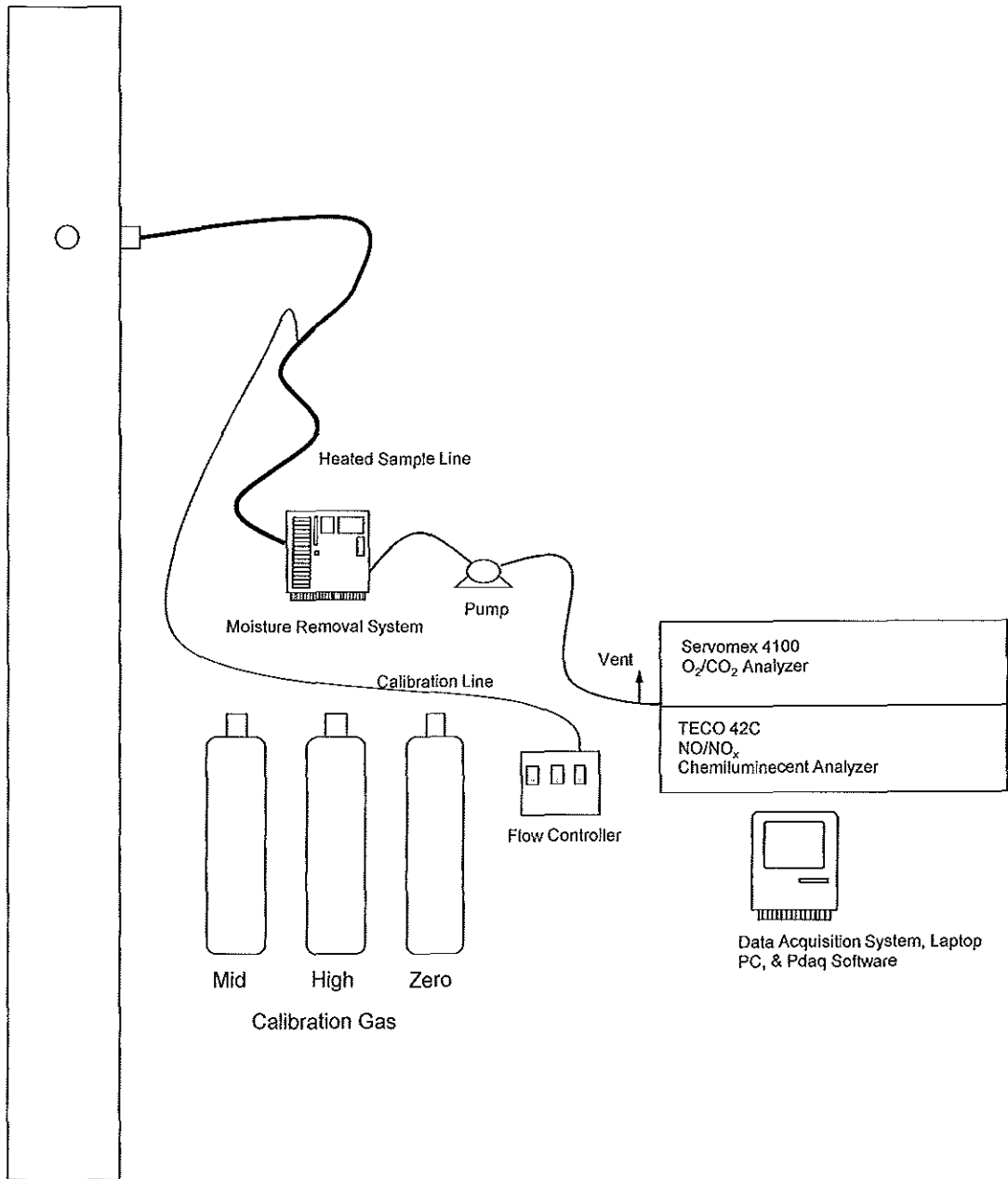


Figure No. 1

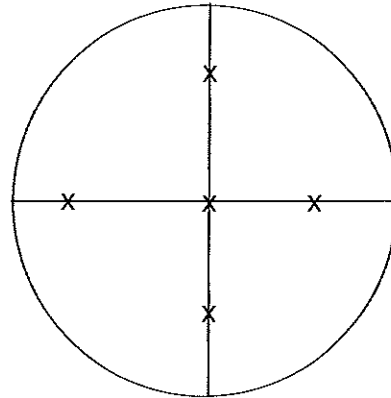
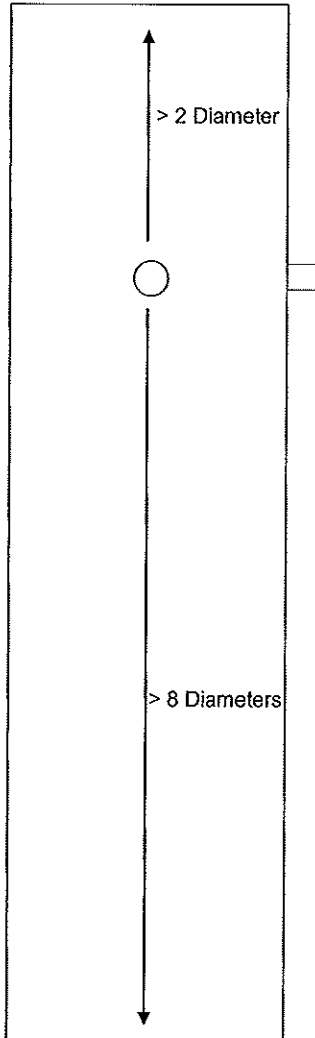
Site:
 USEPA Method 3A and 7E
 Central Michigan University
 Mt. Pleasant, Michigan

Sampling Date:
 January 16, 2014

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



diameter = 58 inches



Not to Scale

Points	Distance "
1	9.7
2	29.0
3	48.3

Figure No. 2

Site:
Boiler No. 5 Exhaust Stack
Central Michigan University
Mt. Pleasant, Michigan

Sampling Date:
January 16, 2014

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

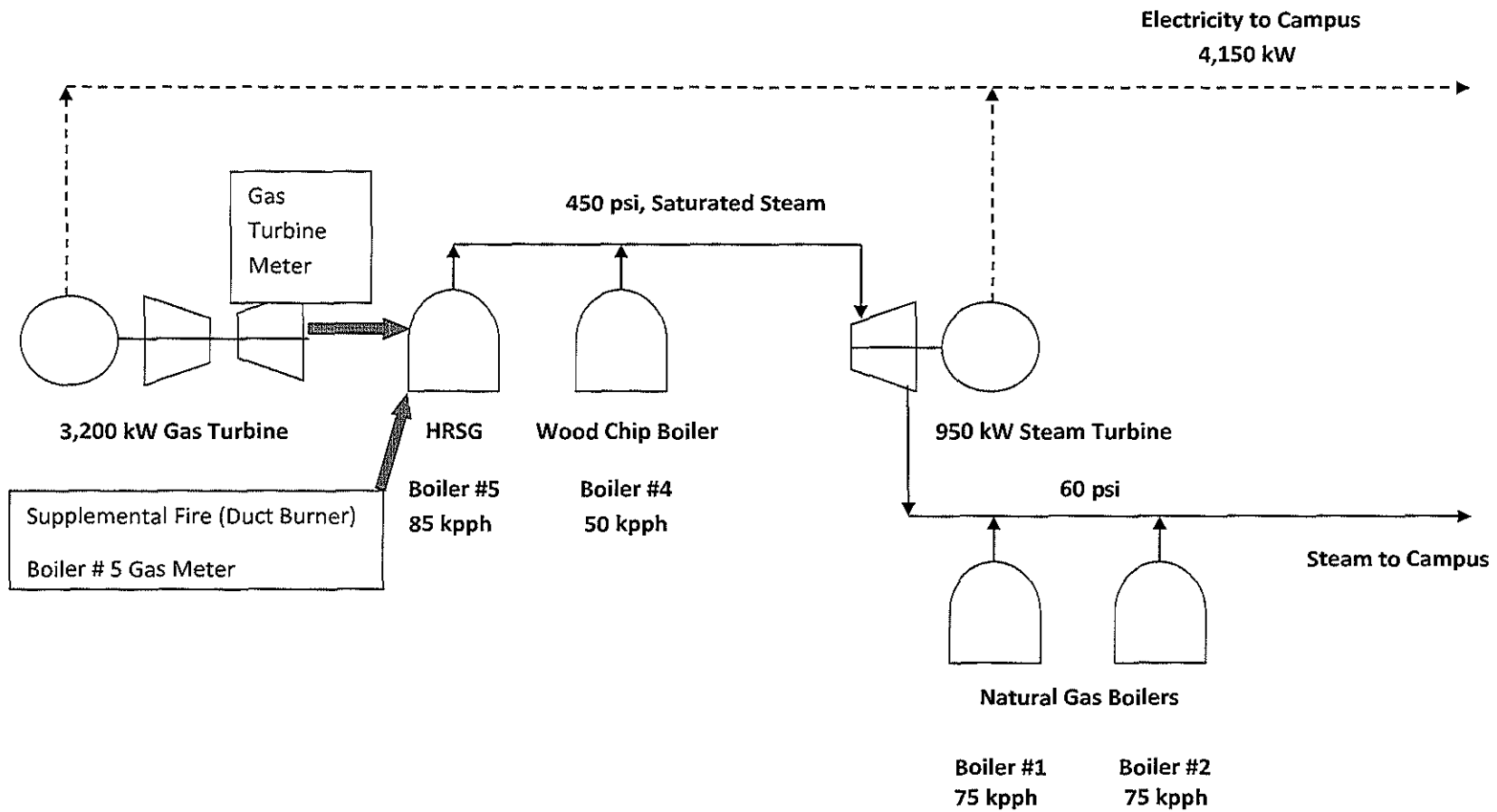


Figure 3
 Central Michigan University
 Boiler #5