Source Test Report for 2022 Compliance Emissions Testing

Turbine 8 (EUPBTURBIN-8)

Western Michigan University
Robert M. Beam Power Plant
Kalamazoo, Michigan

Prepared For:

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K2131_test_20221129

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STAC A2LA ACCREDITED TO ASTM D7036 ONLY

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Review and Certification

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: John Nestor **Date:** 01 / 05 / 2023

Name: John Nestor **Title:** District Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: robert j lisy jr **Date:** 01 / 26 / 2023

Name: Robert J. Lisy, Jr. **Title:** Reporting Hub Manager

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1.0 Introduction

1.1 Summary of Test Program

NTH Consultants, Ltd. (NTH) contracted Montrose Air Quality Services, LLC (Montrose) to perform a compliance test program on natural gas-fired Turbine 8 (EUPBTURBIN-8) at the Western Michigan University (WMU) Robert M. Beam Power Plant (State Registration No.: K2131) located in Kalamazoo, Michigan. Testing was performed on November 29, 2022, for the purpose of satisfying the emission testing requirements pursuant to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operation Permit No. MI-ROP-K2131-2021a.

The specific objectives were to:

- Verify the concentrations of nitrogen oxides (NO_x) and carbon monoxide (CO), corrected to 15% oxygen (O_2), from the Exhaust Stack (SVPBTURBIN8) serving EUPBTURBIN-8
- Verify the emissions of NO_x (as NO_2) and CO from the Exhaust Stack (SVPBTURBIN8) serving EUPBTURBIN-8
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

Table 1-1
Summary of Test Program

Test Date(s)	Unit ID/ Source Name	Activity/ Parameters	Test Methods	No. of Runs	Duration (Minutes)
11/29/2022	EUPBTURBIN-8	O_2	EPA 3A	3	60
11/29/2022	EUPBTURBIN-8	NO_x	EPA 7E	3	60
11/29/2022	EUPBTURBIN-8	CO	EPA 10	3	60

To simplify this report, a list of Units and Abbreviations is included in Appendix C.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Table 1-2. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The testing was conducted by the Montrose personnel listed in Table 1-3. The tests were conducted according to the test plan (protocol) dated September 26, 2022, that was submitted to and approved by the EGLE.

Table 1-2
Summary of Average Compliance Results – EUPBTURBIN-8

November 29, 2022

Parameter/Units	Average Results	Emission Limits
Nitrogen Oxides (NO_x)		
ppmvd @ 15% O_2	21.8	25*
lb/hr	8.5	12
Carbon Monoxide (CO)		
ppmvd @ 15% O_2	3.4	50*
lb/hr	0.81	8.8

* At ISO conditions

1.2 Key Personnel

A list of project participants is included below:

Facility Information

Source Location:	Western Michigan University Robert M. Beam Power Plant 1903 West Michigan Avenue Kalamazoo, MI 49008	
Project Contact:	George Jarvis	Mark Weiss
Role:	Power Plant Director	Director of EHS
Company:	WMU	WMU
Telephone:	269-387-8548	269-387-5588
Email:	George.jarvis@wmich.edu	mark.weiss@wmich.edu

Agency Information

Regulatory Agency:	EGLE	
Agency Contact:	Trevor Drost	Monica Brothers
Telephone:	517-245-5781	269-567-3552
Email:	drostt@michigan.gov	brothersm@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC	
Contact:	John Nestor	Robert J. Lisy, Jr.
Title:	District Manager	Reporting Hub Manager
Telephone:	248-548-8070	440-262-3760
Email:	jonestor@montrose-env.com	rlisy@montrose-env.com

Consultant Information

Company: NTH Consultants, Ltd.
Contact: Eric Marko, P.E.
Telephone: 440-781-2429
Email: Emarko@nthconsultants.com

Test personnel and observers are summarized in Table 1-3.

Table 1-3
Test Personnel and Observers

Name	Affiliation	Role/Responsibility
John Nestor	Montrose	District Manager, QI
Shane Rabideau	Montrose	Field Technician
George Jarvis	WMU	Test Coordinator
Trevor Drost	EGLE	Observer

2.0 Plant and Sampling Location Descriptions

2.1 Process Description, Operation, and Control Equipment

Western Michigan University's Robert M. Beam Power Plant operates two natural gas-fired turbines (EUPBTURBIN-7 and EUPBTURBIN-8). EUPBTURBIN-8 is a natural gas-fired turbine rated at 54 MMBtu/hr (LHC) at ISO site installed conditions. The turbine can either operate alone or in conjunction with its duct burner. EUPBTURBIN-8 and the duct burners associated with EUPBTURBIN-8 were in operation for this test event.

2.2 Flue Gas Sampling Location

Information regarding the sampling location is presented in Table 2-1.

Table 2-1
Sampling Location

Sampling Location	Stack Inside Diameter (in.)	Number of Traverse Points
EUPBTURBIN-8 Exhaust Stack	72.5	Gaseous: 3

See Appendix A.1 for more information.

2.3 Operating Conditions and Process Data

Emission tests were performed while EUPBTURBIN-8 was operating at or near maximum load.

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The process data that was provided is presented in Appendix B. Data collected includes the following parameters:

- Steam Load, lb/hr
- Natural Gas Usage Rate, scfm
- Turbine Load, kW
- Turbine Outlet Exhaust Temperature, °F
- Duct Burner Exhaust Temperature, °F
- Natural Gas Heating Value, Btu/scf

3.0 Sampling and Analytical Procedures

3.1 Test Methods

The test methods for this test program have been presented in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Method 3A, Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

EPA Method 3A is an instrumental test method used to measure the concentration of O_2 and CO_2 in stack gas. The effluent gas is continuously or intermittently sampled and conveyed to analyzers that measure the concentration of O_2 and CO_2. The performance requirements of the method must be met to validate data.

The typical sampling system is detailed in Figure 3-1.

3.1.2 EPA Method 7E, Determination of Nitrogen Oxides Emissions from Stationary Source (Instrumental Analyzer Procedure)

EPA Method 7E is an instrumental test method used to continuously measure emissions of NO_x as NO_2. Conditioned gas is sent to an analyzer to measure the concentration of NO_x. NO and NO_2 can be measured separately or simultaneously together but, for the purposes of this method, NO_x is the sum of NO and NO_2. The performance requirements of the method must be met to validate the data.

The typical sampling system is detailed in Figure 3-1.

3.1.3 EPA Method 10, Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)

EPA Method 10 is an instrumental test method used to continuously measure emissions of CO. Conditioned gas is sent to an analyzer to measure the concentration of CO. The performance requirements of the method must be met to validate the data.

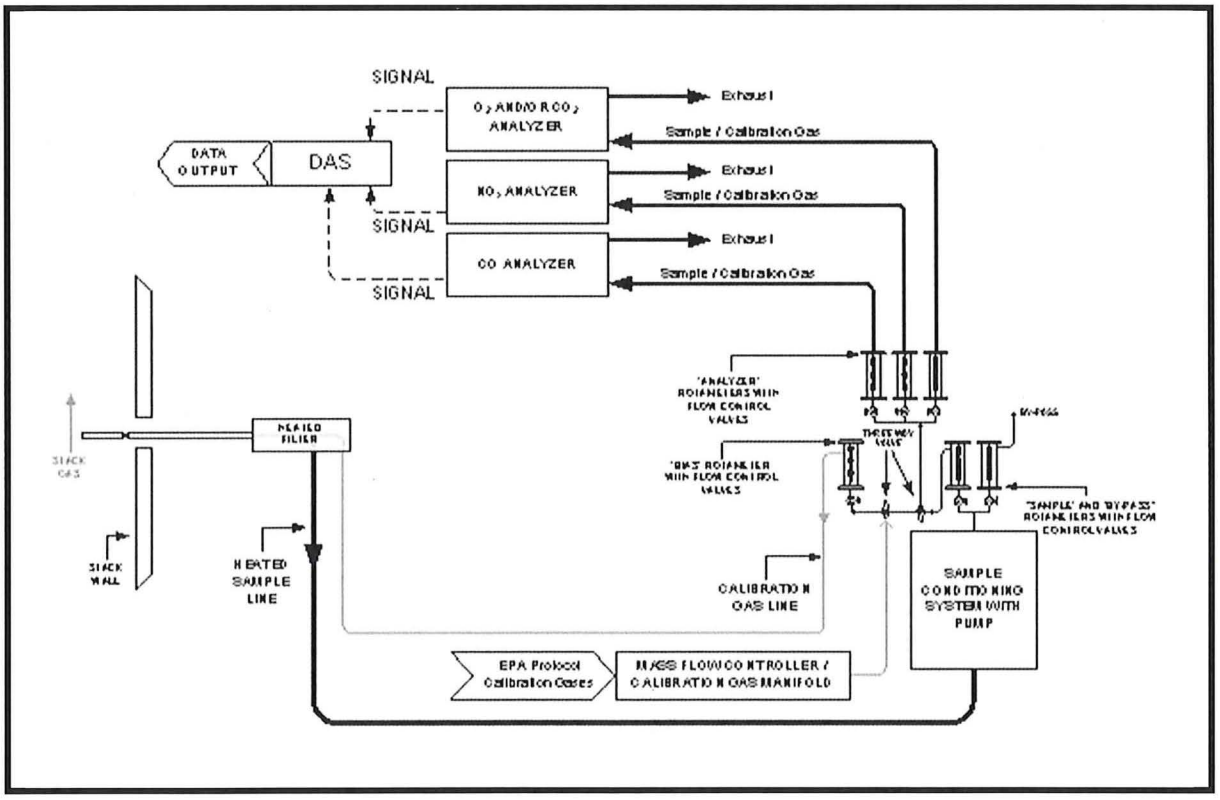
The typical sampling system is detailed in Figure(s) 3-1.

3.1.4 EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

EPA Method 19 is a manual method used to determine (a) PM, SO_2, and NO_x emission rates; (b) sulfur removal efficiencies of fuel pretreatment and SO_2 control devices; and (c) overall reduction of potential SO_2 emissions. This method provides data reduction procedures, but does not include any sample collection or analysis procedures.

EPA Method 19 is used to calculate mass emission rates in units of lb/MMBtu. EPA Method 19, Table 19-2 contains a list of assigned fuel factors for different types of fuels, which can be used for these calculations.

Figure 3-1
EPA Methods 3A, 7E, and 10 Sampling Train



3.2 Process Test Methods

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 Test Discussion and Results

4.1 Field Test Deviations and Exceptions

No field deviations or exceptions from the test plan or test methods occurred during this test program.

4.2 Presentation of Results

The average results are compared to the permit limits in Table 1-2. The results of individual compliance test runs performed are presented in Table 4-1. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

The published EPA Method 19 F-Factor for natural gas (Fd) was utilized in conjunction with the run-specific fuel feed rate and monthly average heating value to calculate lb/hr emissions.

Table 4-1
NO_x and CO Emissions Results -
EUPBTURBIN-8

Parameter/Units	Run 1	Run 2	Run 3	Average
Date	11/29/2022	11/29/2022	11/29/2022	--
Time	8:10-9:10	9:25-10:25	10:40-11:40	--
Process Data *				
F-Factor, dscf/MMBtu	8,710	8,710	8,710	--
Fuel Feed Rate, scfm	1,679	1,673	1,718	1,690
Fuel Feed Rate, scfh	100,752	100,380	103,080	101,404
Fuel Heat Content, Btu/scf	1,047	1,047	1,047	1,047
Heat Input, MMBtu/hr	105.5	105.1	107.9	106.2
Sampling & Flue Gas Parameters				
sample duration, minutes	60	60	60	--
O_2, % volume dry	11.29	11.24	10.90	11.14
Nitrogen Oxides (NOx)				
ppmvd	35.7	36.2	36.4	36.1
ppmvd @ 15% O_2	21.9	22.1	21.5	21.8
lb/MMBtu, as NO_2	0.081	0.081	0.079	0.080
lb/hr, as NO_2	8.5	8.6	8.5	8.5
Carbon Monoxide (CO)				
ppmvd	6.5	6.1	4.2	5.6
ppmvd @ 15% O_2	4.0	3.7	2.5	3.4
lb/MMBtu	0.0089	0.0084	0.0056	0.0076
lb/hr	0.94	0.88	0.61	0.81

* Process data was provided by WMU personnel.

5.0 Internal QA/QC Activities

5.1 QA/QC Audits

EPA Method 3A, 7E, and 10 calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

The NO_2 to NO converter efficiency check of the analyzer was conducted per the procedures in EPA Method 7E, Section 8.2.4. The conversion efficiency met the criteria.

5.2 QA/QC Discussion

Montrose did not have a Qualified Individual (QI) for EPA Method 10 onsite during the test event as per ASTM D7036-04 requirements. However, upon data review, all EPA Method 10 data quality objectives were met.

5.3 Quality Statement

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

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Appendix A
Field Data and Calculations

EUPBTURBIN-8 SAMPLING LOCATION SCHEMATIC