FINAL REPORT

WESTERN MICHIGAN UNIVERSITY

KALAMAZOO, MICHIGAN

COMPLIANCE TESTING REPORT: EUPBTURBIN-7

RWDI #2408411

December 12, 2024

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) has been retained by NTH Consultants, Ltd (NTH) to complete the emission sampling program at the Western Michigan University (WMU) Robert M. Beam Power Plant located at 1903 West Michigan Avenue, Kalamazoo, Michigan 49008. The facility operates under Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit No. MI-ROP-K2131-2021a and Permit to Install (PTI) No. 68-24. The objective of this test was to demonstrate compliance with total oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs), minus methane (NMOC) from EU-138-EMERGEN-01. Also, CO and NOx from EUPBTURBIN-7. As described via email between NTH and EGLE on November 5, 2024, EU-138-EMERGEN-01 was not tested during this event and the revised testing date for the unit is expected to be scheduled for 2025.

Compliance testing took place on November 5th, 2024.

Executive Table i: Results Summary – EUPBTURBIN-7

Source	Analyte	Units	Average	Limit
EUPBTURBIN-7	NO_x	$ppmv_d$ @ 15% O_2	17.5	25
		lb/hr	3.98	12
	CO	$ppmv_d$ @ 15% O_2	2.3	50
		lb/hr	0.32	8.8

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1 INTRODUCTION

RWDI USA LLC (RWDI) has been retained by NTH Consultants, Ltd (NTH)to complete the emission sampling program at the Western Michigan University (WMU) Robert M. Beam Power Plant located at 1903 West Michigan Avenue, Kalamazoo, Michigan 49008. The facility operates under Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit No. MI-ROP-K2131-2021a and Permit to Install (PTI) No. 68-24. The objective of this test was to demonstrate compliance with total oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs), minus methane (NMOC) from EU-138-EMERGEN-01. Also, CO and NOx from EUPBTURBIN-7. As described via email between NTH and EGLE on November 5, 2024, EU-138-EMERGEN-01 was not tested during this event and the revised testing date for the unit is expected to be scheduled for 2025.

Compliance testing took place on November 5th, 2024.

1.1 Location and Date of Testing

The testing program was completed on November 5th, 2024 at the WMU Robert M. Beam Power Plant located at 1903 West Michigan Avenue, Kalamazoo, Michigan 49008.

1.2 Purpose of the Testing

The purpose of testing was to show compliance with EGLE MI-ROP-K2131-2021a and Permit to Install (PTI) No. 68-24. NO_x and CO testing was completed on EUPBTURBIN-7.

1.3 Description of the Source

The Robert M. Beam Power Plant operates EUPBTURBIN-7, a natural gas fired turbine rated at 60 MMBtu/hr heat input.

1.4 Personnel Involved in Testing

Table 1.4.1: List of Testing Personnel

Personnel	Company	Contact Number
George Jarvis Plant Manager George.Jarvis@wmich.edu	**Western Michigan University** **Robert M. Beam Power Plant** 1903 West Michigan Avenue Kalamazoo, Michigan 49008	(269) 387-8548
Abby Brandstatter Staff Engineer ABrandstatter@nthconsultants.com	**NTH Consultants, Ltd** 3300 Eagle Run Drive NE Suite 202 Grand Rapids, Michigan 49525	(616) 915-2565
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Mason Sakshaug Supervisor, Source Mason.Sakshaug@rwdi.com		(989) 323-0355
Shane Rabideau Field Technician Shane.Rabideau@rwdi.com		(248) 841-8442

2 SUMMARY OF RESULTS

2.1 Operating Data

Operational data collected during the testing included the following (found in **Appendix A**):

EUPBTURBIN-7

- Natural gas used, scfm
- Steam load, lb/hr
- Turbine load, kW
- Turbine outlet exhaust temperature, °F
- Duct burner exhaust temperature, °F
- Natural gas heating value provided by fuel supplier, Btu/scf

2.2 Applicable Permit Number

The purpose of testing was to show compliance with Michigan Department of Environment, Great Lakes, and Energy MI-ROP-K2131-2021a and PTI No. 68-24

3 SOURCE DESCRIPTION

3.1 Description of Process and Emission Control Equipment

Refer to Section 1.3 for a description of the process and control equipment.

3.2 Process Flow Sheet or Diagram

A process schematic can be provided upon request.

3.3 Type and Quantity of Raw and Finished Materials

EUPBTURBIN-7 burns natural gas to produce energy.

3.4 Normal Rated Capacity of Process

EUPBTURBIN-7 has a rating of 60 MMBtu/hr heat input.

3.5 Process Instrumentation Monitored During the Testing

There are no CEMS or PEMS installed on the processes.

4 POLLUTANTS TO BE MEASURED

Testing consisted of emissions for nitrogen oxides (NO_x) and carbon monoxide (CO) on EUPBTURBIN-7.

5 SAMPLING AND ANALYSIS PROCEDURES

The following section provides brief descriptions of the proposed sampling methods and discusses any proposed modifications to the reference test methods.

5.1 NO_x and CO USEPA Method 320

Emissions testing was performed at the outlet of EUPBTURBIN-7. Pollutant concentrations were determined utilizing RWDI's continuous emissions monitoring system (CEM) which consists of the FTIR and oxygen analyzer (measuring on wet basis).

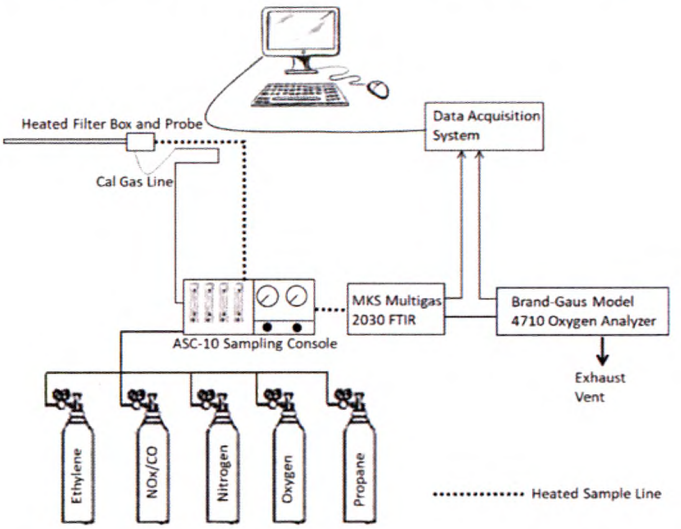
Stack gas concentrations for NO_x, CO, and O_2 were measured using EPA Reference Methods 320 and 3A.

Oxygen measurements were taken continuously following USEPA Method 3A on the outlet (using a wet oxygen analyzer or equivalent).

Regular performance checks on the CEMS were carried out by zero and span calibration checks on the oxygen analyzer and necessary QA procedures on the FTIR using USEPA Protocol calibration gases. These checks verified the ongoing precision of the FTIR with time by introducing pollutant-free (zero) air followed by a known CTS gas into the FTIR. Spikes for each pollutant were done before and after each test. The response of the monitor to pollutant-free air and the corresponding sensitivity to the calibration gases were reviewed frequently as an ongoing indication of analyzer performance.

Monitoring was conducted by drawing a sample stream of flue gases through a stainless-steel probe attached to a heated filter and a heated sample line that is attached to the MAX Analytical ASC-10ST sampling console. Lengths of unheated sample line was kept to a minimum and insulated. The ASC-10ST sampling console delivers a continuous sample to the MKS MultiGas 2030 FTIR and oxygen analyzer for analysis. The heated filter and line were maintained at approximately 191°C (375°F) and the MKS MultiGas 2030 FTIR and ASC-10ST gas components were kept at 191°C (375°F). The end of the probe was connected to a heated Teflon sample line, which deliver the sample gases from the stack to the FTIR system. The heated sample line was designed to maintain the gas temperature at approximately 375°F to prevent condensation of stack gas moisture within the line and condition air to the same temperature as the FTIR. A schematic of the sampling system setup is depicted in **Figure 5.2a.**

Figure 5.2a: MKS 2030 Multigas FTIR/ASC-10ST/Model 4710 Oxygen Analyzer Sampling System Schematic



The ASC-10ST was used to deliver calibration gases (Calibration Transfer Standard (CTS), QA Spike and Nitrogen) to the FTIR in direct (to analyzer) and system (to probe) modes.

A laptop computer was utilized for operating the MKS MultiGas 2030 FTIR and MAX Analytical ASC-10ST sampling console and logging the multi-gas FTIR data. Data was logged as one-minute averages for the actual test period (FTIR PRN files and Spectra). All concentration data was determined using the MKS 2030 MultiGas FTIR software. A typical MKS 2030 FTIR and ASC-10 ST configuration is depicted in **Figure 5.2b.**

For oxygen measurement only, prior to testing, a 3-point analyzer calibration error check was conducted using USEPA protocol gases. The calibration error check was performed by introducing zero, mid and high-level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response is within ±2% of the certified calibration gas introduced. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run. The analyzer measured the respective gas concentrations on a wet volumetric basis which was converted to a dry volumetric number.

The probe tip was equipped with a heated filter for particulate removal. The end of the probe was connected to a heated Teflon sample line, which delivered the sample gases from the stack to the FTIR/4710 Oxygen analyzer system. The heated sample line was designed to maintain the gas temperature at approximately 375°F to prevent condensation of stack gas moisture within the line.

Figure 5.2b: Typical MKS 2030 Multigas FTIR and ASC-10ST Configuration

6 NUMBER AND LENGTH OF SAMPLING RUNS

Testing consisted of triplicate 1-hour test at the outlet of EUPBTURBIN-7.

7 STACK INFORMATION

A detailed stack schematic is available in the **Figures** section.

Table 7.1: Summary of the Stack Characteristics

Source	Diameter	Number of Ports	Points per Traverse	Total Points per Test
EUPBTURBIN-7	55	2	3 (1 traverse)	3

8 TEST RESULTS AND DISCUSSION

8.1 Detailed Results

Detailed results for all analytes are provided in **Appendix B**.

8.2 Discussion of Results

The following tables give a summary of the results.

Table 8.2.1: Results Summary – EUPBTURBIN-7

Source	Analyte	Units	Average	Limit
EUPBTURBIN-7	NO_x	$ppmv_d$ @ 15% O_2	17.5	25
		lb/hr	3.98	12
	CO	$ppmv_d$ @ 15% O_2	2.3	50
		lb/hr	0.32	8.8

8.3 Variations in Testing Procedures

There was no variation in the testing procedures.

8.4 Modifications to Testing Program

The test plan indicated that EU-138-EMERGEN-01 was to be tested during this program. Due to a parts malfunction, the unit was not operable and was not tested. This unit will be tested on a future date.

8.5 Process Upset Conditions During Testing

There were no upsets in the process during testing.

8.6 Maintenance Performed in Last Three Months

All maintenance performed in the previous three months has been routine.

8.7 Re-Test

This was not a re-test.

8.8 Audit Samples

This test did not require any audit samples.

8.9 Process Data

Process data can be found in **Appendix A**.

8.10 Field Notes

Field notes can be found in **Appendix C**.

8.11 Calibration Data

Calibration data can be found in **Appendix D**.

8.12 Example Calculations

Example calculations can be found in **Appendix E**.

8.13 Source Testing Plan and EGLE Correspondence

Copy of the correspondence received from the Source Testing Plan from EGLE and the Source Testing Plan submitted can be found in **Appendix F.**

8.14 Laboratory Data

There was no laboratory data affiliated with this testing.

TABLES

Table 1: WMU EUPBTURBIN-7 NO_x Emissions Summary

RWDI Project #2408411

	EUPBTURBIN-7			O_2	NO_x	NO_x	NO_x Emission Rate	Gas Used	MMBTU/hr	NO_x Emission Rate (US EPA Method 19 Equation 19-1)
Test ID	**Date**	**Start**	**End**	**%**	**ppm**	**ppm @ 15% O_2**	**lb/hr**	**ft^3/hr**	**MMBTU/hr**	**lb/MMBTU**
1	2024-11-05	8:30	9:29	15.3	16.8	17.7	4.04	58,498	62.13	0.065
2	2024-11-05	10:10	11:09	15.3	16.7	17.4	3.95	57,864	61.45	0.064
3	2024-11-05	11:35	12:34	15.3	16.7	17.5	3.95	57,720	61.30	0.064
		Average		15.3	16.7	17.5	3.98	58,027	61.63	0.065
					Limit	*25*	*12.0*	--	--	--

Caloric value for natural gas used 1062 btu/ft^3

Conversion for ppm to lbs/scf (U.S. EPA Method 19) 1.194E-07

Fd - 8710 dscf/10^6 BTU

$E = (1.194 \times 10^{-7}) \times C_d \times F_d \times ((20.9/(20.9-\%O_{2d}))$

Where:

E = Pollutant Emission Rate (lb/10^6 BTU)

C_d = Pollutant Concentration, Dry Basis (ppm)

F_d = Fuel Factor, Dry Basis (dscf/10^6 BTU)

$\%O_{2d}$ = Oxygen Concentration, Dry Basis (%)

Table 2: WMU EUPBTURBIN-7 CO Emissions Summary

RWDI Project #2408411

EUPBTURBIN-7				O_2	CO	CO	CO Emission Rate	Gas Used	MMBTU/hr	CO Emission Rate (US EPA Method 19 Equation 19-1)
Test ID	Date	Start	End	%	ppm	ppm @ 15% O_2	lb/hr	ft^3/hr	MMBTU/hr	lb/MMBTU
1	2024-11-05	8:30	9:29	15.3	2.2	2.3	0.32	58,498	62.13	0.0052
2	2024-11-05	10:10	11:09	15.3	2.2	2.3	0.32	57,864	61.45	0.0052
3	2024-11-05	11:35	12:34	15.3	2.2	2.3	0.32	57,720	61.30	0.0052
		Average		15.3	2.2	2.3	0.32	58,027	61.63	0.0052
					Limit	*50*	*8.8*	--	--	--

Caloric value for natural gas used 1062 btu/ft^3

Conversion for ppm to lbs/scf (U.S. EPA Method 19) 7.264E-08

Fd - 8710 dscf/10^6 BTU

$E = (7.26 \times 10^{-8}) \times C_d \times F_d \times ((20.9/(20.9-\%O_{2d}))$

Where:

E = Pollutant Emission Rate (lb/10^6 BTU)

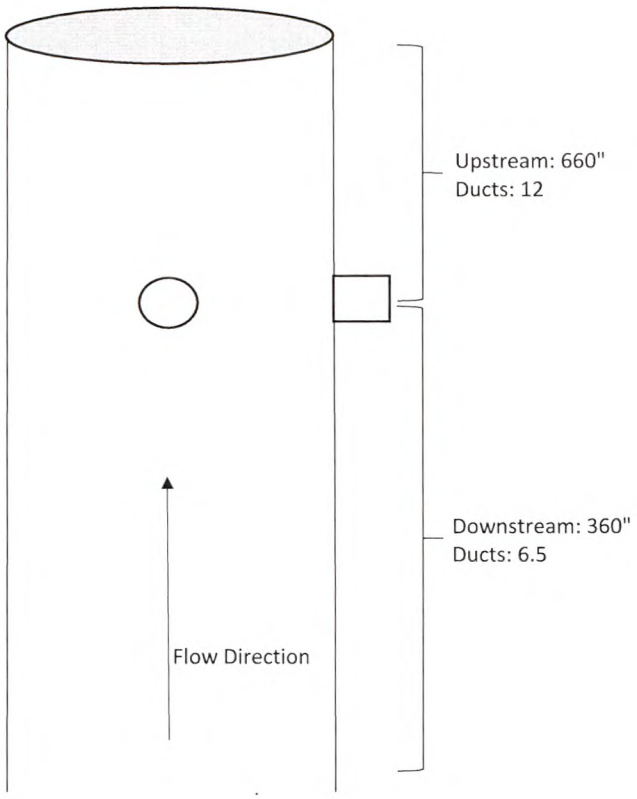
C_d = Pollutant Concentration, Dry Basis (ppm)

F_d = Fuel Factor, Dry Basis (dscf/10^6 BTU)

$\%O_{2d}$ = Oxygen Concentration, Dry Basis (%)

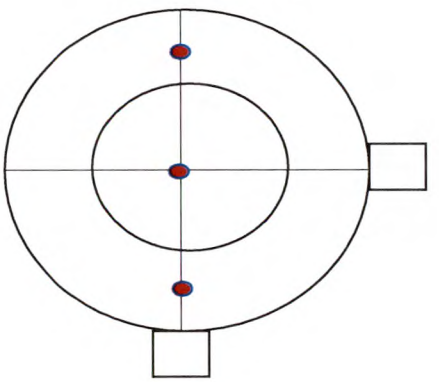
FIGURES

Figure No. 1: EUPBTURBIN-7 Emissions Stack Schematic



Diameter ("): 55

Sampling Points (in.)	
1	9.19
2	27.50
3	45.82



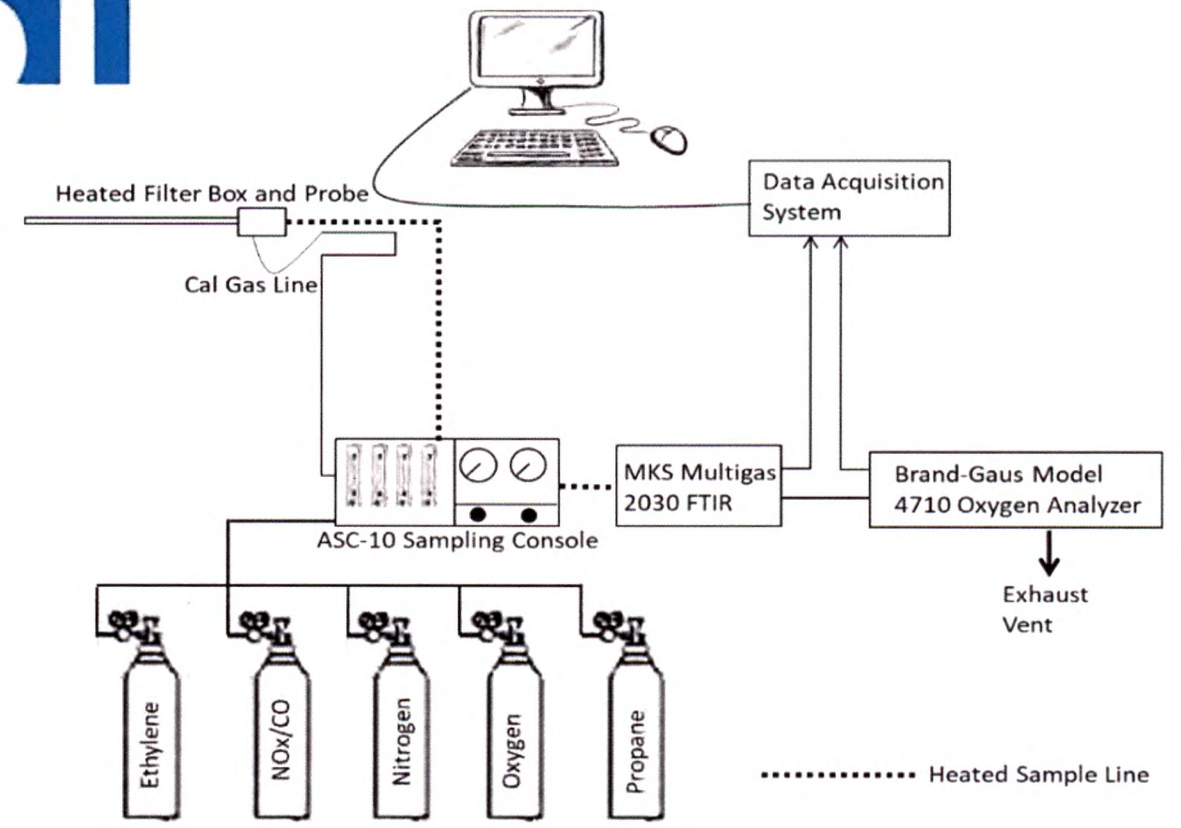
Not to scale

EUPBTURBIN-7
WMU
Robert M. Beam Power Plant
Kalamazoo, Michigan

Date:
5-Nov-24

RWDI USA LLC
24445 Forterra Drive
Warren, Michigan 48089

Figure No. 2: USEPA Method 320/3A Schematic



USEPA Method 320

WMU

Robert M. Beam Power Plant

EUPBTURBIN-7

Kalamazoo, Michigan

Project #2408411

Date: November 5, 2024