MICHIGAN POWER
2023
RATA REPORT

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1.0 INTRODUCTION

1.1 Identification, Location and Dates of Tests

Environmental Stack Testing (EST) was retained by Michigan Power Limited Partnership (MPLP) to provide relative accuracy test audits at the MPLP Cogeneration facility located in Ludington, Michigan. Testing at MPLP was performed from October 16 through October 18, 2023. Part 75 testing was overseen by Ms. Brooke Gillespie, a Qualified Stack Testing Individual (QSTI) with accreditation number 2011-585.

1.2 Purpose of Testing

The purpose of the Relative Accuracy Test Audit (RATA) testing is to satisfy requirements in MPLP Renewable Operating Permit (ROP) No. MI-ROP-N4975-2021.

RATAs were performed on the nitrogen oxides (NO_X), carbon monoxide (CO), and oxygen (O_2) Continuous Emissions Monitoring Systems (CEMS) installed by MPLP to monitor emissions from the FGTURBINE/HRSG. The RATA was conducted to meet the requirements of 40 CFR, Part 60 for CO and O_2. The NO_X RATA was conducted to meet the requirements of 40 CFR, Part 75.

RATAs were performed on the common NO_X and O_2 CEMS installed to monitor emissions from the auxiliary gas fired boiler stacks. The RATAs were conducted to meet the requirements of Appendix B, 40 CFR, Part 60. Data collected from the NO_X and O_2 analyzers were averaged for each test run.

1.3 Project Contact Information

Location	Contact
Test Facility	Mr. Dan Cox 231-843-7573 Daniel.cox@michiganpowerlp.com
Test Company Representative	Ms. Brooke Gillespie 616-828-2745 Environmentalstacktesting@gmail.com
State Representative	Mr. Daniel J Droste 989-225-6052 DrosteD3@michigan.gov

2.0 SUMMARY OF RESULTS

The results of RATA testing performed pursuant to MI-ROP-N4975-2021 can be found in Tables 1 through 5 located at the end of this report and are summarized below:

Summary of EUTURBINE/HRSG RATA Results

Compound	Relative Accuracy	Relative Accuracy Limit
NO_X lb/mmBtu	0.002 lb/mmBtu Difference	0.015 lb/mmBtu Difference
NO_X @ 15% O_2	7.4%	20%
CO @ 15% O_2	0.8 PPM Difference	5 PPM Difference

Summary of EUBOILERA RATA Results

Compound	Relative Accuracy	Relative Accuracy Limit
NO_X lb/mmBtu	7.1%	20%

Summary of EUBOILERB RATA Results

Compound	Relative Accuracy	Relative Accuracy Limit
NO_X lb/mmBtu	3.6%	20%

3.0 DESCRIPTION OF SOURCES

The MPLP Cogeneration facility produces electricity from one General Electric (GE) Corporation Frame 7 (MS7001EA) natural gas turbine designated as EUTURBINE (Turbine) with a power output of approximately 83.5 megawatts (MW). The turbine generator consists of a compressor, combustion turbine, and generator. Energy is generated at the combustion turbine by drawing in ambient air by means of burning fuel and expanding the hot combustion gases in a three-stage turbine. The hot exhaust gases from the combustion turbine are directed to a multi-pressure Heat Recovery Steam Generator (HRSG), designated as EUHRSG to produce steam. The HRSG has an array of low emission duct burners to provide supplemental heat input to the HRSG. The natural gas fired turbine and HRSG are defined as the flexible group FGTURBINE/HRSG. The process steam is used in a GE 58 MW steam turbine-generator set and also supplies the Michigan Power steam host.

Two natural gas fired auxiliary boilers designated as EUBOILERA and EUBOILERB are used during a combined cycle outage, when the HRSG associated with the turbine is offline or during high steam loads to steam host. Each boiler unit is a Nebraska N2S-8 model rated for approximately 220,000 pounds of steam per hour.

4.0 RELATIVE ACCURACY TEST AUDIT PROCEDURES

4.1 Reference Monitoring System (EST)

For all CEMS sampling, the 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 stainless steel and Teflon. The monitor outputs were connected to a computerized data acquisition system (DAS). The O_2, NO_X, and CO sample collection system consisted of a probe, heated sample lines, a moisture removal trap and a sample pump. The sample was collected from the stack and routed through a distribution manifold board 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. A reference method/performance test monitoring system (EST) schematic is shown in Figure 1.

4.1.1 Oxygen

O_2 concentrations were monitored using a paramagnetic analyzer following the guidelines of U.S. EPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from a Stationary Source* (Instrumental Analyzer Procedure). The analyzer was calibrated at a minimum of three points: a zero gas, mid-level gas (40-60% of calibration span) and high-level gas (concentration equal to the calibration span) for the testing.

4.1.2 Nitrogen Oxides

NO_X concentrations were monitored using a chemiluminescence analyzer following the guidelines of U.S. EPA Method 7E, *Determination of Nitrogen Oxides from Stationary Sources* (Instrumental Analyzer Procedure). The analyzer was calibrated at a minimum of three points: a zero gas, mid-level gas (40-60% of calibration span) and high-level gas (concentration equal to the calibration span) for the testing.

4.1.3 Carbon Monoxide

The CO emissions were measured using a non-dispersive infrared analyzer (NDIR) following the guidelines of U.S. EPA Reference Method 10, *Determination of Carbon Monoxide Emissions from Stationary Sources* (Instrumental Analyzer Procedure). The analyzer was calibrated at a minimum of three points: a zero gas, mid-level gas (40-60% of calibration span) and high-level gas (concentration equal to the calibration span) for the testing.

4.1.4 Data Acquisition System

Information and data from each analog instrument signal output was collected with a data acquisition system (DAS). All gathered data was linked to spreadsheets that support dynamic data exchange (i.e. Microsoft Excel) for quick data reduction and report generation. Calibration error, drift and bias corrections were calculated in a separate excel sheet.

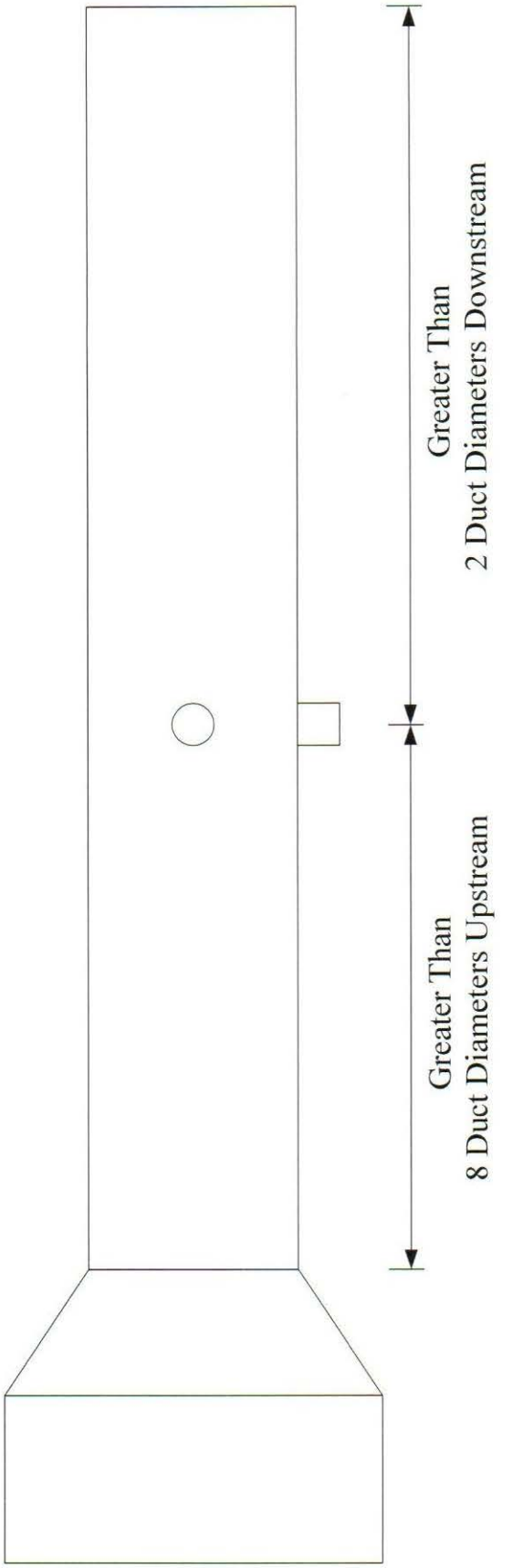
5.0 EXAMPLE CALCULATIONS

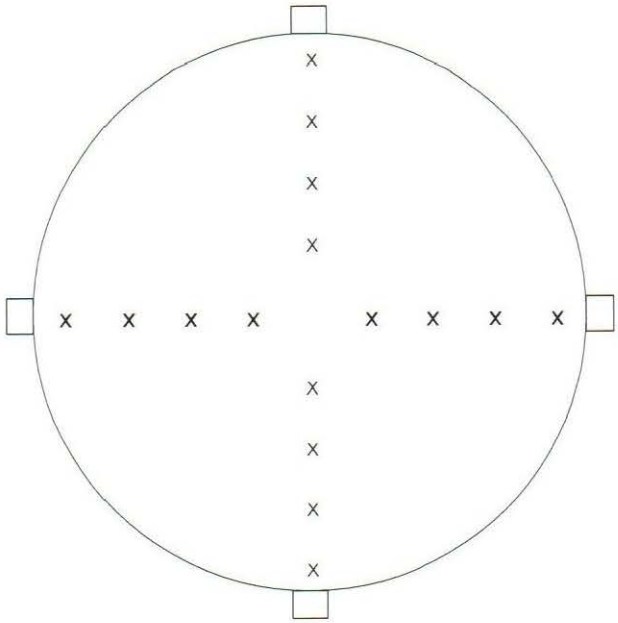
The raw concentrations drawn from the stack were corrected for the zero and upscale sampling system bias checks. See Appendix G for the example formulas used in the calculations used to determine relative accuracy.

6.0 TEST RESULTS

All CEMS associated with the sources tested at MPLP passed the Relative Accuracy Test Audit. The best nine test runs at each source were used to calculate the relative accuracy. The results of all testing are presented in Tables 1 through 5.

FIGURES





Traverse Point	Point Location Inches
1	17.8
2	30.9
3	46.9
4	70.1
Port Length	12.0

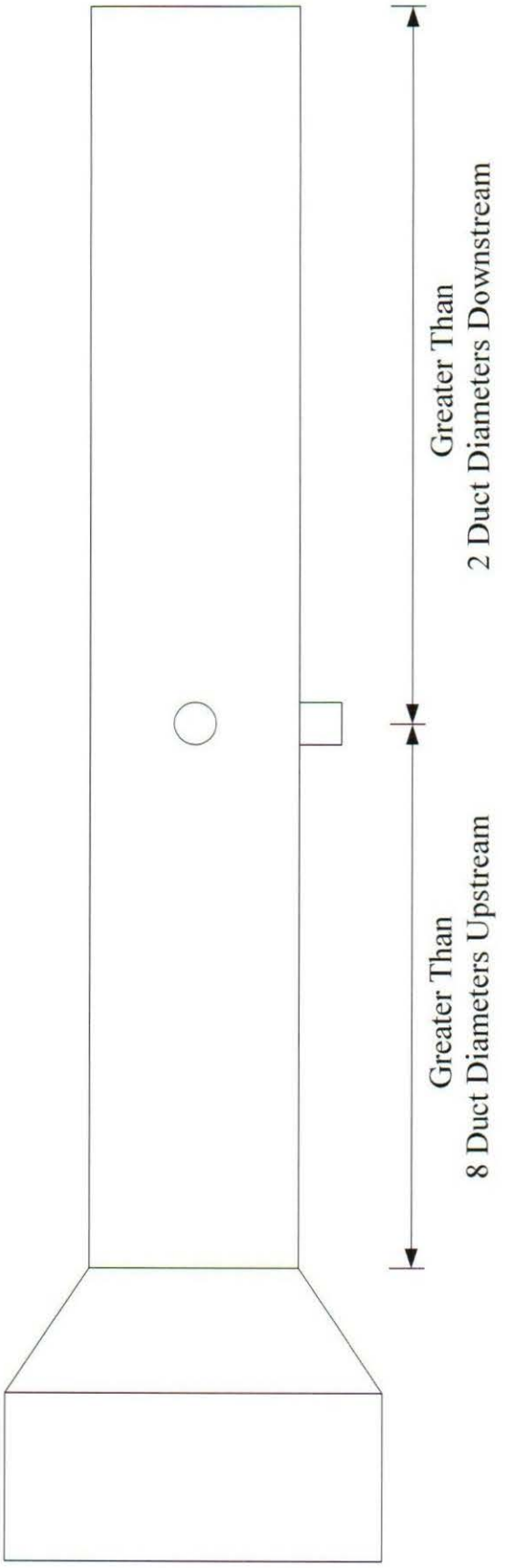
Figure # 1

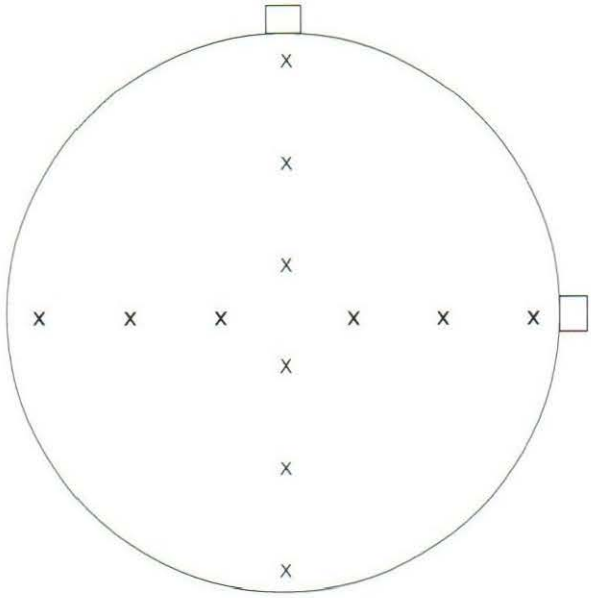
Sampling And Traverse Point Location

Environmental Stack Testing

Michigan Power

FGTURBINE/HRSG and EUTURBINE





Traverse Point	Point Location Inches
1	3.0
2	10.5
3	21.3
4	50.7
5	61.5
6	68.8
Port Length	3.0

Figure # 2

Sampling And Traverse Point Location

Environmental Stack Testing

Michigan Power

EUBOILERA & EUBOILERB

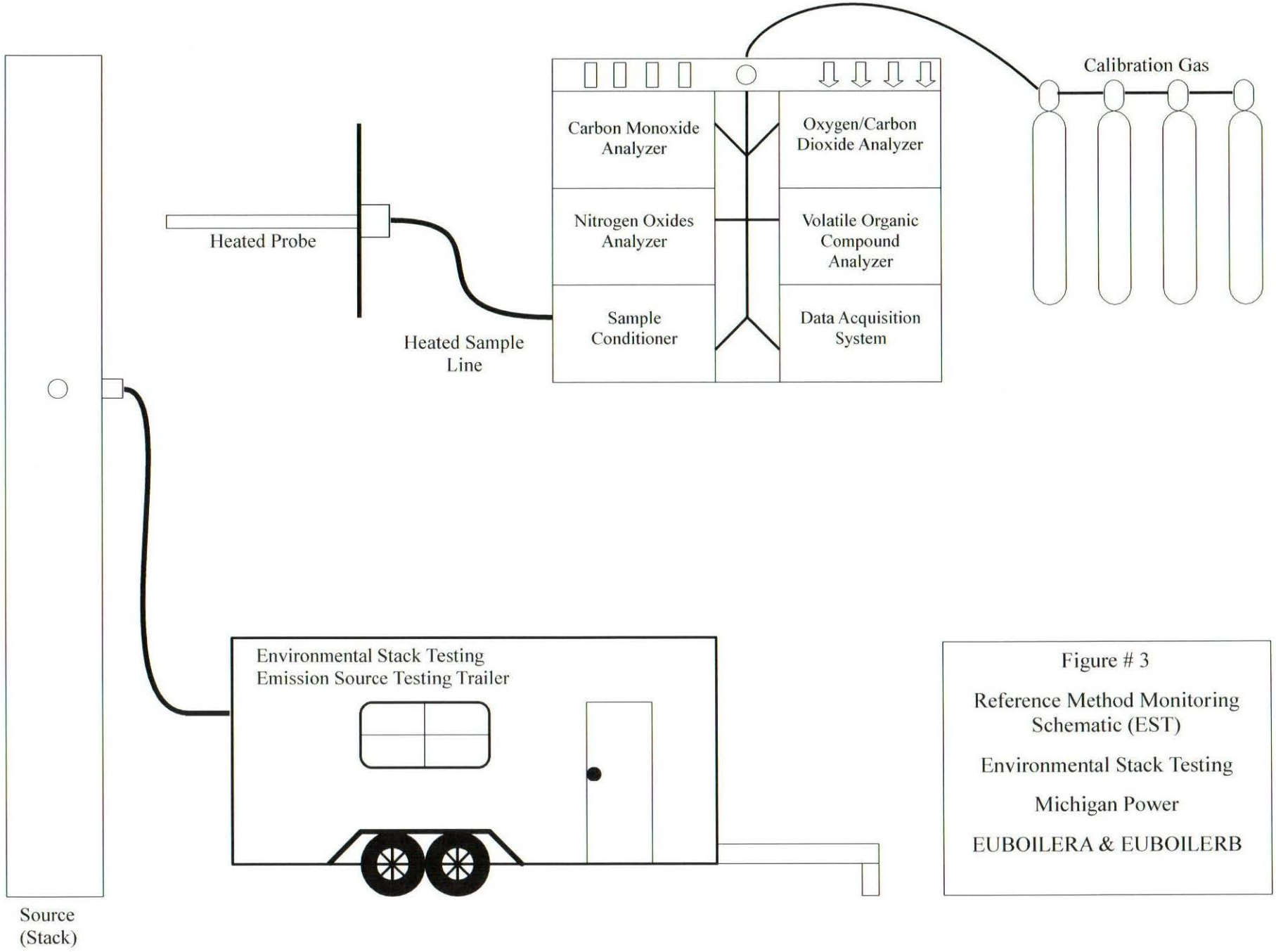


Figure # 3

Reference Method Monitoring Schematic (EST)

Environmental Stack Testing

Michigan Power

EUBOILERA & EUBOILERB

TABLES

TABLE 1

SUMMARY OF NO_x RATA RESULTS

October 16, 2023

Michigan Power

EUTURBINE/HRSG

NO_x Relative Accuracy (lb/mmBtu)					
Relative Accuracy:			**8.2%**		
Run #	**Time**	**RM lb/mmBtu**	**CEM lb/mmBtu**	**Diff**	**%Diff**
1	0711-0732	0.024	0.023	0.001	4.17%
2	**0746-0807**	**0.025**	**0.023**	**0.002**	**8.00%**
3	0820-0841	0.025	0.023	0.002	8.00%
4	0856-0917	0.025	0.023	0.002	8.00%
5	0932-0953	0.025	0.023	0.002	8.00%
6	1005-1026	0.025	0.023	0.002	8.00%
7	1040-1101	0.025	0.023	0.002	8.00%
8	1114-1135	0.025	0.024	0.001	4.00%
9	1149-1210	0.026	0.024	0.002	7.69%
10	1224-1245	0.025	0.024	0.001	4.00%
	9-Run Mean:	0.025	0.023	0.002	6.65%
		Sdev	0.0005		
		CC	0.0004		
		Allowable RA (%)	**7.5%**		
		RA (based on Ref. Meth.)	**8.2%**		
		Allowable RM-CEMS Mean Difference (lb/mmBtu)	**±0.015**	≤0.20 lb/mmBtu	
		RM-CEMS Mean Difference (lb/mmBtu)	**0.002**		
		Bias Adjustment Factor	**1.087**		

Confidence Coefficient =

n=9

t = 2.306

$$cc = t_{0.975}\frac{S_d}{\sqrt{n}}$$

40 CFR 75, Appendix A
Equation A-9

Standard Deviation =

$$S_d = \left[\frac{\sum_{i-1}^{n} d_i^2 - \frac{\left(\sum_{i-1}^{n} d_i\right)^2}{n}}{n-1}\right]^{1/2}$$

40 CFR 75, Appendix A
Equation A-8

Relative Accuracy =

RM=Reference Monitor

$$RA = \frac{|\bar{d}| + |cc|}{\overline{RM}} x100$$

40 CFR 75, Appendix A

Equation A-10

PS2 allows RA within 0.015 lb/mmBtu when the RA is calculated as the absolute average difference between the RM and CEMS plus the confidence coeffient.

TABLE 2

SUMMARY OF NO_x RATA RESULTS

October 16, 2023

Michigan Power

EUTURBINE/HRSG

NO_x Relative Accuracy (PPM@15%O2)

Relative Accuracy: 7.4%

Run #	Time	RM PPM@15% O2	CEM PPM@15% O2	Diff	%Diff
1	0711-0732	6.60	6.20	0.40	6.06%
2	0746-0807	6.70	6.30	0.40	5.97%
3	0820-0841	6.80	6.30	0.50	7.35%
4	**0856-0917**	**6.80**	**6.20**	**0.60**	**8.82%**
5	0932-0953	6.80	6.30	0.50	7.35%
6	1005-1026	6.70	6.20	0.50	7.46%
7	1040-1101	6.80	6.30	0.50	7.35%
8	1114-1135	6.90	6.40	0.50	7.25%
9	1149-1210	6.93	6.50	0.43	6.25%
10	1224-1245	6.88	6.40	0.48	6.94%
	9-Run Mean:	6.79	6.32	0.47	6.89%
			Sdev	0.0443	
			CC	0.0340	
			Allowable RA (%)	**20.0%**	
			RA (based on Ref. Meth.)	**7.4%**	

Confidence Coefficient =

n=9

t = 2.306

$$cc = t_{0.975}\frac{S_d}{\sqrt{n}}$$

P.S. 2 Equation 2-5

Standard Deviation =

$$S_d = \left[\frac{\sum_{i-1}^{n} d_i^2 - \frac{(\sum_{i-1}^{n} d_i)^2}{n}}{n-1}\right]^{1/2}$$

P.S. 2 Equation 2-4

Relative Accuracy =

RM=Reference Monitor

$$RA = \frac{|\bar{d}| + |cc|}{\overline{RM}} x100$$

P.S. 2 Equation 2-6

Table 3

SUMMARY OF CO RATA RESULTS

October 16, 2023

Michigan Power

EUTURBINE/HRSG

CO Relative Accuracy (PPM@15% O2)					
RM-CEMS Mean Difference:		0.8			
Run #	**Time**	**RM PPM**	**CEM PPM**	**Diff**	**%Diff**
1	0711-0732	1.3	2.1	-0.8	-67.80%
2	0746-0807	1.3	2.1	-0.8	-59.92%
3	0820-0841	1.3	2.0	-0.7	-51.46%
4	0856-0917	1.3	2.1	-0.8	-63.68%
5	0932-0953	1.3	2.0	-0.7	-59.63%
6	1005-1026	1.3	2.0	-0.7	-58.03%
7	1040-1101	1.2	2.0	-0.8	-60.38%
8	1114-1135	1.2	2.0	-0.8	-63.07%
9	1149-1210	1.2	2.0	-0.8	-62.81%
10	**1224-1245**	**1.2**	**2.0**	**-0.8**	**-65.32%**
	9-Run Mean:	1.3	2.0	-0.8	-61.03%
		Sdev	0.0464		
		CC	0.0332		
	Allowable RM-CEMS Mean Difference (PPM)		**5**	≤200 ppm	
	RM-CEMS Mean Difference (PPM)		**0.8**		

Confidence Coefficient =

n=9

t = 2.306

$$cc = t_{0.975}\frac{S_d}{\sqrt{n}}$$

P.S. 2 Equation 2-5

Standard Deviation =

$$S_d = \left[\frac{\sum_{i-1}^{n} d_i^2 - \frac{(\sum_{i-1}^{n} d_i)^2}{n}}{n-1}\right]^{1/2}$$

P.S. 2 Equation 2-4

Relative Accuracy =

RM=Reference Monitor

$$RA = \frac{|\bar{d}| + |cc|}{\overline{RM}} x100$$

P.S. 2 Equation 2-6

PS 4A allows RA within 5 ppmv when the RA is calculated as the absolute average difference

TABLE 4

SUMMARY OF NO_x RATA RESULTS

October 18, 2023

Michigan Power

EUBOILERA

NO_x Relative Accuracy (lb/mmBtu)

Relative Accuracy: 7.1%

Run #	Time	RM lb/mmBtu	CEM lb/mmBtu	Diff	%Diff
1	0653-0714	0.042	0.039	0.003	7.14%
2	0725-0746	0.042	0.039	0.003	7.14%
3	0758-0819	0.041	0.039	0.002	4.88%
4	**0829-0850**	**0.041**	**0.038**	**0.003**	**7.32%**
5	0900-0921	0.041	0.038	0.003	7.32%
6	0931-0952	0.042	0.039	0.003	7.14%
7	1002-1023	0.041	0.039	0.002	4.88%
8	1035-1056	0.041	0.039	0.002	4.88%
9	1106-1127	0.042	0.040	0.002	4.76%
10	1141-1202	0.042	0.039	0.003	7.14%
	9-Run Mean:	0.042	0.039	0.003	6.14%
		Sdev	0.0005		
		CC	0.0004		
		Allowable RA (%)	**20.0%**	Part 60	
		RA (based on Ref. Meth.)	**7.1%**		

Confidence Coefficient =

n=9

t = 2.306

$$CC = t_{0.975}\frac{S_d}{\sqrt{n}}$$

40 CFR 75, Appendix A Equation A-9

Standard Deviation =

$$S_d = \left[\frac{\sum_{i=1}^{n} d_i^2 - \frac{(\sum_{i=1}^{n} d_i)^2}{n}}{n-1}\right]^{1/2}$$

40 CFR 75, Appendix A Equation A-8

Relative Accuracy =

RM=Reference Monitor

$$RA = \frac{|\bar{d}| + |cc|}{\overline{RM}} x100$$

40 CFR 75, Appendix A Equation A-10

TABLE 5

SUMMARY OF NO_x RATA RESULTS

October 17, 2023

Michigan Power

EUBOILERB

NO_x Relative Accuracy (lb/mmBtu)					
Relative Accuracy:			**3.6%**		
Run #	**Time**	**RM lb/mmBtu**	**CEM lb/mmBtu**	**Diff**	**%Diff**
1	0723-0744	0.055	0.053	0.002	3.64%
2	0755-0816	0.055	0.054	0.001	1.82%
3	0826-0847	0.055	0.053	0.002	3.64%
4	0856-0917	0.055	0.054	0.001	1.82%
5	0927-0948	0.055	0.053	0.002	3.64%
6	0959-1020	0.055	0.054	0.001	1.82%
7	1030-1051	0.055	0.053	0.002	3.64%
8	1100-1121	0.055	0.053	0.002	3.64%
9	**1131-1152**	**0.055**	**0.053**	**0.002**	**3.64%**
10	1201-1222	0.054	0.053	0.001	1.85%
	9-Run Mean:	0.055	0.053	0.002	2.83%
		Sdev	0.0005		
		CC	0.0004		
		Allowable RA (%)	**20.0%**	Part 60	
		RA (based on Ref. Meth.)	**3.6%**		

Confidence Coefficient =

n=9

t = 2.306

$$cc = t_{0.975}\frac{S_d}{\sqrt{n}}$$

40 CFR 75, Appendix A Equation A-9

Standard Deviation =

$$S_d = \left[\frac{\sum_{i-1}^{n} d_i^2 - \frac{\left(\sum_{i-1}^{n} d_i\right)^2}{n}}{n-1}\right]^{1/2}$$

40 CFR 75, Appendix A Equation A-8

Relative Accuracy =

RM=Reference Monitor

$$RA = \frac{|\bar{d}| + |cc|}{\overline{RM}} x100$$

40 CFR 75, Appendix A Equation A-10