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 compliance quality assurance audits and performance testing at the MPLP Cogeneration facility located in Ludington, Michigan. Testing at MPLP was performed from October 17 through 20, 2017. 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

Performance testing was performed for volatile organic compounds (VOC), condensable Particulate Matter (PM) and opacity on FGTURBINE/HRSG concurrently with Relative Accuracy Test Audit (RATA) testing to satisfy the requirements in MPLP Renewable Operating Permit (ROP) No. MI-ROP-N4975-2014.

The RATA was 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.

NOx and O_2 determinations were conducted with the turbine operating in simple cycle mode (HRSG off), at four load conditions consisting of 65, 75, 85, and 100 percent of peak load. Load conditions stated in subpart GG are: 30, 50, 75, and 100 percent of peak load, or at four points in the normal operating range of the gas turbine, including the minimum point in the range and peak load.

Performance testing was performed for VOC, PM and opacity on EUTURBINE with the HRSG off.

RATAs were performed on the common NO_X 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 analyzers were averaged for each test run.

Performance testing was performed for VOC, PM, CO and opacity on both boiler unit stacks concurrently with the RATA testing.

1.3 Project Contact Information

Location	Contact
Test Facility	Mr. Dan Cox Ms. Becky Sparks 231-843-7573 Daniel.cox@michiganpowerlp.com Becky.sparks@michiganpowerlp.com
Test Company Representative	Ms. Brooke Gillespie 616-828-2745 Environmentalstacktesting@gmail.com
State Representative	Mr. Rob Dickman 231-876-4412 dickmanr@michigan.gov

2.0 SUMMARY OF RESULTS

The detailed results of testing performed pursuant to MI-ROP-N4975-2014 can be found in Tables 1 - 17 located at the end of this report. PM testing on FGTURBINE/HRSG, EUBOILERA and EUBOILERB was performed concurrently with the RATA testing. The summary of test results performed for MI-ROP-N4975-2014 can be found below:

Summary of FGTURBINE/HRSG Emissions

Load Condition (Percent)	Particulate/PM_{10} (lb/hr)	Volatile Organic Compounds (lb/hr)	Opacity (Percentage)
100	3.899	0.3	0
Permit Limit	7.00	11.9	10

Summary of FGTURBINE/HRSG RATA Results

Compound	Relative Accuracy	Relative Accuracy Limit
NO_X lb/mmBtu	0.0021 PPM Difference	0.020 PPM Difference
NO_X @ 15% O_2	9.3%	20%

CO	0.57 PPM Difference	5 PPM Difference
O_2 %	1.1%	7.5%

Summary of EUTURBINE Emissions

Load Condition (Percent)	Particulate/PM10 (lb/hr)	Volatile Organic Compounds (lb/hr)	Opacity (Percentage)
100	1.9	0.0	0
Permit Limit	7.0	2.0	10

Summary of EUBOILERA Emissions

Load Condition (Percent)	Particulate/PM10 (lb/hr)	CO (lb/hr)	Volatile Organic Compounds (lb/hr)	Opacity (Percentage)
100	0.332	1.4	0.97	0
Permit Limit	2.65	19.9	1.1	10

Summary of EUBOILERA RATA Results

Compound	Relative Accuracy	Relative Accuracy Limit
NO_X lb/mmBtu	1.8%	20%

Summary of EUBOILERB Emissions

Load Condition (Percent)	Particulate/PM10 (lb/hr)	CO (lb/hr)	Volatile Organic Compounds (lb/hr)	Opacity (Percentage)
100	0.497	0.5	0.9	0
Permit Limit	2.65	19.9	1.1	10

Summary of EUBOILERB RATA Results

Compound	Relative Accuracy	Relative Accuracy Limit
NO_X lb/mmBtu	5.0%	20%

RATAs were performed concurrently with the performance testing in accordance with specifications stipulated in Appendix A, 40 CFR, Part 75 and Appendix B and F, 40 CFR, Part 60. The results from each set of triplicate RATA test runs were combined to determine compliance with the NO_X, CO and O_2 performance test requirements described in MI-ROP-N4975-2014. Run number 4 for testing on FGTURBINE/HRSG was not included in the results due to the data collection system freezing up and providing inaccurate concentration results.

Summary of EUTURBINE Subpart GG Results

Load Condition	NO_X Corrected to 15% O_2
65%	4.82
75%	5.74
85%	6.56
100%	4.51

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 SAMPLING AND ANALYTICAL PROCEDURES

Emission rate determinations for the boilers were conducted according to the procedures outlined in Appendix A, 40 CFR 60 and Appendix M, 40 CFR 52.21(j) with the quality assurance requirements of Appendix F, 40 CFR 60 and the applicable performance specifications of Appendix B, 40 CFR 60. Testing was also performed to satisfy requirements of 40 CFR, Part 60, Subpart GG, Standards of Performance for Stationary Gas Turbines.

4.1 Traverse Points Location (Emission Sampling)

The number of traverse and sampling points for the exhaust stacks were determined using U.S. EPA Method 1 *Sample and Velocity Traverses for Stationary Sources.*

FGTURBINE/HRSG

The stack associated with FGTURBINE/HRSG and EUTURBINE measured 180 inches in diameter at the sampling site. Four traverse points were selected for each of the four sampling ports. A diagram of the particulate sampling locations is shown in Figure 1.

EUBOILERA & EUBOILERB

The stacks associated with EUBOILERA and EUBOILERB each measured 72 inches in diameter at the sampling site. Six traverse points were selected for each of the two sampling ports. A diagram of the particulate sampling locations is shown in Figure 2.

4.2 Velocity and Temperature

Stack gas velocity and temperature were determined using U.S. EPA Reference Method 2, *Determination of Stack Gas Velocity and Volumetric Flow Rate (Type "S" Pitot Tube).* The velocity head measurements (delta P) were made using Type "S" pitot tubes conforming to the geometric specifications outlines in EPA Method 2. Flue gas temperatures were measured with chromel-alumel (Type "K") thermocouples.

4.3 Molecular Weight

The flue gas composition was determined using U.S. EPA Reference Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure).* The carbon dioxide was used only for flue gas composition and molecular weight determinations, while oxygen was used for diluent corrections of emissions.

4.4 Moisture

The stack gas moisture content was determined using U.S. EPA Reference Method 4, *Determination of Moisture in Stack Gases* in conjunction with the particulate emission testing. Exhaust gas was passed through a series of four impingers; the first two being empty, the third containing 100 milliliters of water, and the fourth containing silica gel. The impingers were immersed in an ice bath to assure condensation of the flue gas stream moisture. The amount of water vapor collected was measured and used to calculate the percent moisture in the stack gas.

4.5 Particulate

All testing followed the guidelines of U.S. EPA Method 201a, *Determination of PM_{10} and $PM_{2.5}$ Emissions from Stationary Sources* and Method 202, *Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources.* A PM-10 head is connected via a "swage-lok" fitting to a probe liner. The probe liner is connected to a Teflon jumper which is attached to the impinger train which consists of a set of pre-weighed impingers connected in series and immersed in an ice bath. The impinger contents are immediately purged after the test run (if necessary) with nitrogen to remove dissolved sulfur dioxide gases from the impinger contents. The samples were drawn from the stack isokinetically and collected in the front half heated probe, the heated glass fiber filter, in the two dry impingers, and the Teflon filter. The front half fraction consisted of the filter itself, as well as, acetone rinses and brushing of the turn around cap, the stem, and the filter housing area before the filter. The filter is recovered to a labeled petri dish made of glass or plastic. Acetone rinses are recoved to a clean labeled polyethylene bottle. The liquid level in the polyethylene bottle is marked upon completion of recovery. The contents of the impingers were measured volumetrically and transferred to appropriately marked sample containers. The two dry impingers were rinsed twice with type II water (inorganic fraction) and put into a sample container then rinsed with acetone and two hexane rinses (organic fraction) and added to a 500ml amber sample jar.

All samples were delivered to the in-house elemental air lab for analysis. The final results are reported to the nearest 0.1 mg. A diagram of the particulate apparatus is presented in Figure 4.

4.6 Opacity

Triplicate six-minute test runs were conducted with a minimum of one set of 72 observations on all four sources. All testing followed the guidelines of U.S. EPA Method 9, *Visual Determination of the Opacity of Emissions from Stationary Sources.* Opacity emissions were determined by a qualified observer. The opacity observations were recorded to the nearest 5 percent (%) at 15-second intervals.

4.7 Volatile Organic Compounds

U.S. EPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*, was used in conjunction with Performance Specification (PS) 8, *Performance Specifications for Volatile Organic Compound Continuous Emission Monitoring Systems in Stationary Sources* for the VOC concentrations at the source. The analyzer was calibrated with propane and operated to meet all method drift and bias requirements.

4.8 NESHAP

Emission rate testing was performed for NO_X and O_2 on the turbine in simple cycle (HRSG off) mode at four load conditions (65%, 75%, 85%, base load (100%)). Three test runs were performed at each load for 21-minutes each. The four simple cycle load conditions were performed to meet 40 CFR, Part 60, Subpart GG requirements.

5.0 RELATIVE ACCURACY TEST AUDIT PROCEDURES

5.1 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 heated probe with a particulate filter, heated sample lines, a moisture removal trap, a secondary particulate filter and a sample pump. The VOC collection system employed the same sample materials as the above-mentioned monitors with the exception of the moisture removal trap. 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 3.

5.1.1 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.

5.1.2 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.

5.1.3 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.

5.1.4 Volatile Organic Compounds (VOC)

VOC emissions were determined following the guidelines of U.S. EPA reference Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer.* A VOC analyzer using a flame ionization detector (FID) was used to measure and provide real time analysis of total VOC. The analyzer was calibrated with propane using hydrocarbon free air for a zero verification, a low-level gas (25 to 35% of calibration span), mid-level gas (45-55% of calibration span) and high-level gas (concentration equal to the calibration span) for the testing.

5.1.5 Data Acquisition System

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

6.0 EXAMPLE CALCULATIONS

The raw concentrations drawn from the stack were corrected for the zero and upscale sampling system bias checks. The following formula was then used to determine the corrected concentrations.

$$C_{gas} = (C_{avg} - C_0) \times \frac{C_{ma}}{C_m - C_0} \quad Eq.\ 7E\text{-}5$$

Where:

C_{gas} = Average effluent gas concentration, adjusted for bias (ppmv).

C_{avg} = Average unadjusted gas concentration indicated by data recorder for the test run (ppmv).

C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas (ppmv).

C_{ma} = Actual concentration of the upscale calibration gas (ppmv).

After correcting the concentration values, Equation 19-1 found in U.S. EPA Method 19 was used to determine the emission rates in terms of pounds per million Btu heat input:

$$E = C_d \times (1.194 \times 10^{-7}) \times F_d \times \frac{20.9}{20.9 - \%O_{2d}} \quad Eq.\ 19\text{-}1$$

Where:

E = Pollutant emission rate, (lb/mmBtu).

C_d = Pollutant concentration, dry basis (ppmv).

F_d = Volumes of combustion components per unit of heat content, dscf/mmBtu

20.9 = Fraction of air that is oxygen, (percent).

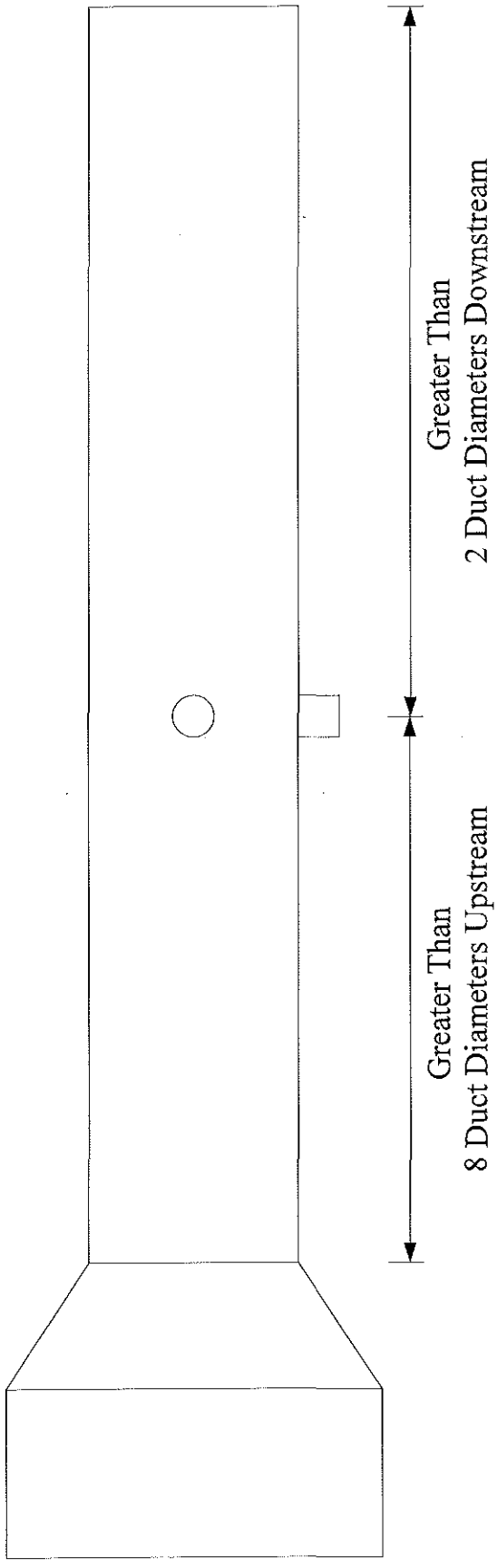
$\%O_{2d}$ = Concentration of oxygen on a dry basis, (percent).

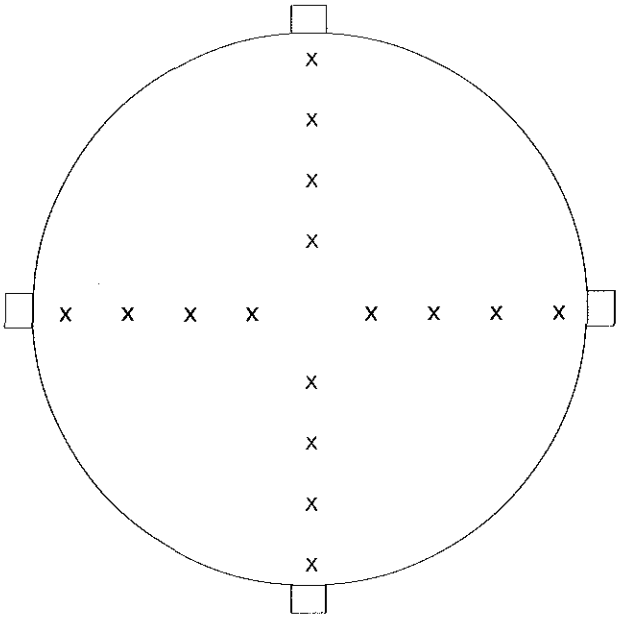
1.194×10^{-7} = Conversion factor (lb/scf to ppm NO_x).

7.0 TEST RESULTS

The results of all testing is presented in Tables 1 through 17.

FIGURES





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

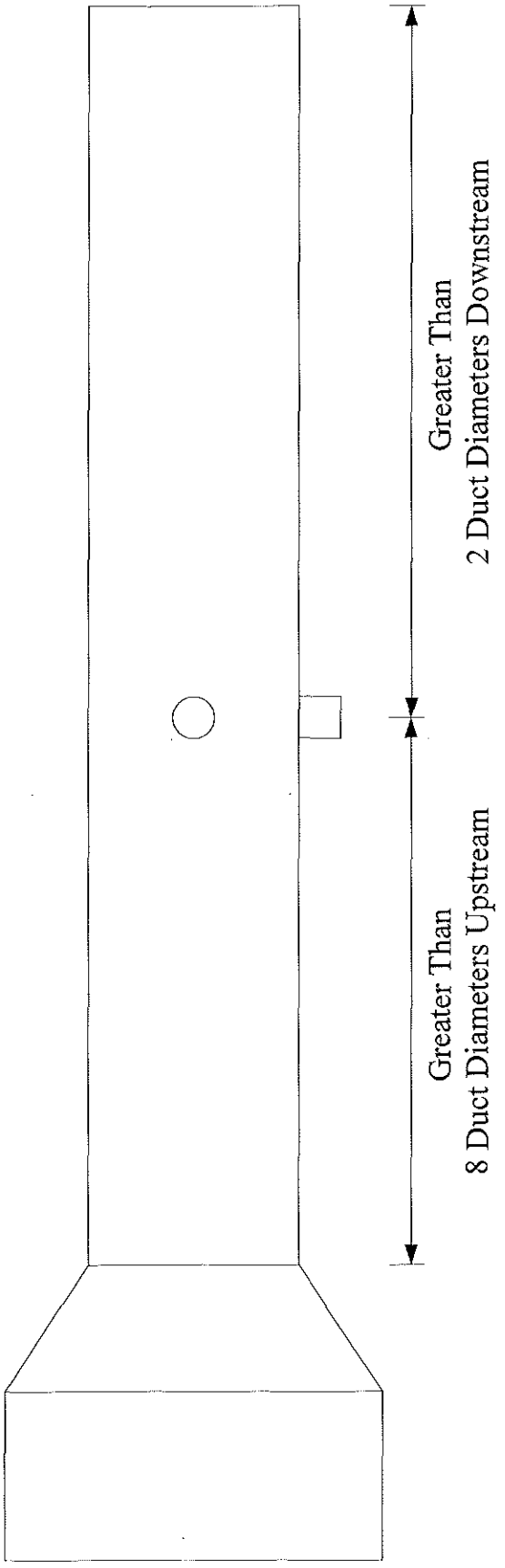
Figure # 1

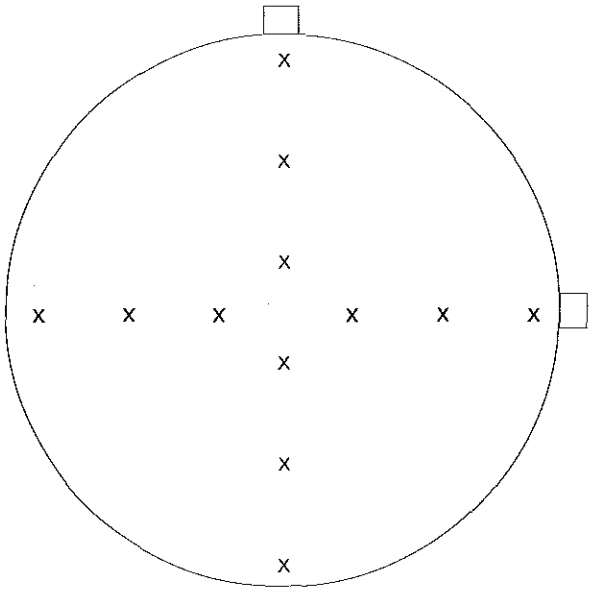
Sampling And Traverse Point Location

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

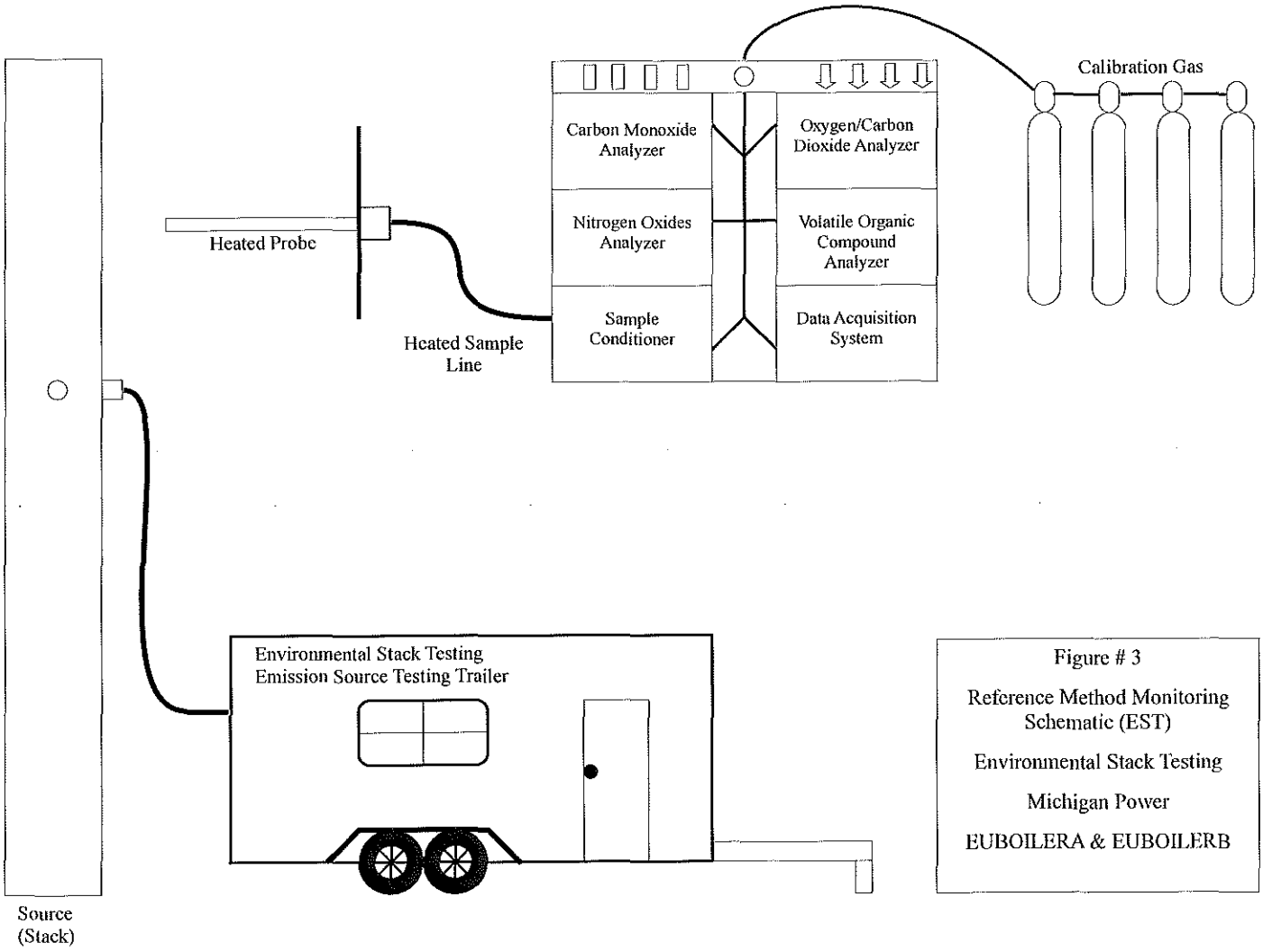


Figure # 3

Reference Method Monitoring Schematic (EST)

Environmental Stack Testing

Michigan Power

EUBOILERA & EUBOILERB

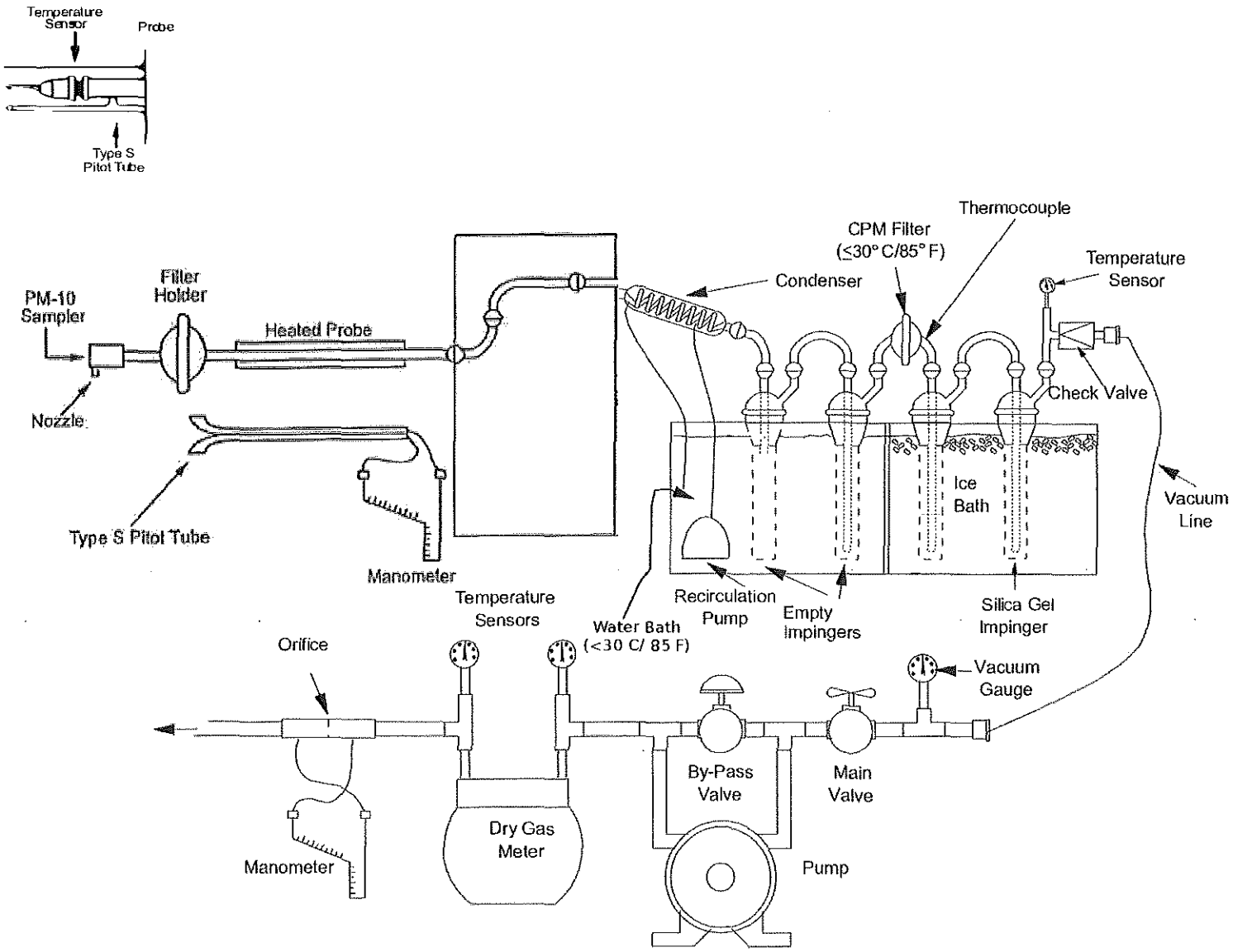


Figure # 4

Method 201A/202 Sampling Apparatus

Environmental Stack Testing

Michigan Power

TABLES

TABLE 1

Summary of FGTURBINE/HRSG Particulate Matter Emissions

Michigan Power

U.S. EPA Method 201A and 202

October 17, 2017

Run No.	1	2	3	Average
Run Time	1139-1319	1405-1543	1642-1822	
	Process Conditions			
	Volumetric Flow Rate			
Stack Gas Flow Rate, DSCFM:	530,435	522,787	527,770	526,997
	Fixed Gases			
Oxygen, percent, dry:	13.80	13.80	13.80	13.80
Carbon Dioxide, percent, dry:	5.00	5.00	5.00	5.00
Moisture, percent by volume:	8.10	8.00	8.10	8.00
Run No.	1	2	3	Average
	Emission Rate (grains per dry standard cubic foot)			
Filterable Particulate, gr/dscf:	0.0001	0.0004	0.0000	0.0002
Aqueous, gr/dscf:	0.0002	0.0000	0.0000	0.001
Organic Condensible Particulate, gr/dscf:	0.0009	0.0004	0.0009	0.0003
Total Particulate, gr/dscf:	0.0012	0.0004	0.0009	0.0008
	Emission Rate (pound per hour)			
Filterable Particulate, lb/hr:	0.00	0.00	0.00	0.00
Aqueous, lb/hr:	0.099	0.000	0.000	0.033
Organic Condensible Particulate, lb/hr:	0.376	0.176	0.345	0.299
Total Particulate, lb/hr:	0.475	0.176	0.345	0.332
MI-ROP-N4975-2014 Permit Limit				10.40

Table 2
Summary of FGTURBINE/HRSG VOC Emissions
Michigan Power
U.S. EPA Method 25A
October 17, 2017

Run No.	1		2		3		Average
Run Times	RATA Run 1	1507-1528	RATA Run 5	1842-1903	RATA Run 8	2027-2048	
	RATA Run 2	1540-1601	RATA Run 6	1916-1937	RATA Run 9	2100-2121	
	RATA Run 3	1615-1636	RATA Run 7	1951-2012	RATA Run 10	2133-2154	
Process Conditions,							
Volumetric Flow Rates							
Actual Cubic Feet Minute	752,843		762,484		765,325		760,217
Standard Cubic Feet Minute	568,239		574,301		577,086		573,209
Dry Standard Cubic Feet Minute	522,888		527,839		530,504		527,077
Fixed Gases,							
Oxygen, % by volume, dry	13.00		13.00		13.00		13.00
Carbon dioxide, % by volume, dry	5.00		5.00		5.00		5.00
Moisture, % by volume	7.98		8.09		8.07		8.05

Run No.	1	2	3	Average
Emission Rate, (lb/hr):				
VOC	0.1	0.2	0.5	0.3
MI-ROP-N4975-2014 Permit Limit				11.9

lb/hr = pounds per hour

TABLE 3

SUMMARY OF NO_X lb/MMBTU RATA RESULTS

October 17, 2017

Michigan Power

FGTURBINE/HRSG

NO_X Relative Accuracy					
	Mean Difference:		**0.0021**		
Run #	**Time**	**RM lb/MMBtu**	**CEM lb/MMBtu**	**Diff**	**%Diff**
1	1507-1528	0.0262	0.0280	-0.0018	-6.67%
2	1540-1601	0.0260	0.0280	-0.0020	-7.51%
3	1615-1636	0.0263	0.0280	-0.0017	-6.41%
4	**1649-1710**	**0.0000**	**0.0280**	**-0.0280**	**NA**
5	1842-1903	0.0262	0.0280	-0.0018	-6.94%
6	1916-1937	0.0258	0.0280	-0.0022	-8.59%
7	1951-2012	0.0257	0.0280	-0.0023	-8.87%
8	2027-2048	0.0258	0.0280	-0.0022	-8.38%
9	2100-2121	0.0256	0.0280	-0.0024	-9.20%
10	2133-2154	0.0256	0.0280	-0.0024	-9.41%
		0.0259	0.0280	-0.0021	-7.99%
		Sdev	0.0003		
		CC	0.0002		
	Mean Difference		**0.0021**		
	Bias Test Pass/Fail		**Pass**		
	Bias Adjustment Factor		**1.000**		

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

RA calculated as specified in Performance Specification 2, Appendix B, 40 CFR 60 - Equation 2-4

As specified in P.S. 2, subsection 8.4.4, three sets of test runs may be rejected, these rejected test runs are bolded in the table

TABLE 4

SUMMARY OF NO_X PPM @ 15% O_2 RATA RESULTS

October 17, 2017

Michigan Power

FGTURBINE/HRSG

NO_X Relative Accuracy

Relative Accuracy: **9.3**

Run #	Time	RM PPM@15% O2	CEM PPM@15% O2	Diff	%Diff
1	1507-1528	7.1	7.5	-0.37	-5.26%
2	1540-1601	7.1	7.6	-0.53	-7.50%
3	1615-1636	7.1	7.7	-0.56	-7.80%
4	**1649-1710**	**0.0**	**7.7**	**-7.70**	**NA**
5	1842-1903	7.1	7.7	-0.59	-8.34%
6	1916-1937	7.0	7.7	-0.70	-10.01%
7	1951-2012	7.0	7.6	-0.62	-8.86%
8	2027-2048	7.0	7.6	-0.59	-8.38%
9	2100-2121	7.0	7.6	-0.64	-9.19%
10	2133-2154	6.9	7.6	-0.65	-9.40%
		7.0	7.6	-0.58	-8.31%
		Sdev	0.0936		
		CC	0.0720		
		RA (based on Ref. Meth.)	**9.3%**		

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

RA calculated as specified in Performance Specification 2, Appendix B, 40 CFR 60 - Equation 2-4

As specified in P.S. 2, subsection 8.4.4, three sets of test runs may be rejected, these rejected test runs are bolded in the table

TABLE 5

SUMMARY OF CO RATA TEST RESULTS

October 17, 2017

Michigan Power

FGTURBINE/HRSG

CO Relative Accuracy

	Mean Difference:		**0.57**		
Run #	**Time**	**RM PPM**	**CEM PPM**	**Diff**	**%Diff**
1	1507-1528	0.83	1.5	-0.67	-81.16%
2	1540-1601	0.84	1.5	-0.66	-78.57%
3	1615-1636	0.85	1.5	-0.65	-76.26%
4	**1649-1710**	**0.00**	**1.4**	**-1.40**	**NA**
5	1842-1903	0.89	1.4	-0.51	-57.84%
6	1916-1937	0.90	1.5	-0.60	-66.11%
7	1951-2012	0.96	1.4	-0.44	-45.83%
8	2027-2048	0.92	1.5	-0.58	-63.04%
9	2100-2121	0.98	1.5	-0.52	-52.44%
10	2133-2154	1.00	1.5	-0.50	-50.60%
		0.91	1.48	-0.57	-63.54%
		Sdev	0.0814		
		CC	0.0626		
	RA (based on Ref. Meth.)		**69.7%**		
	Alternative RA (PPM Difference)		**-0.57**		
	Acceptable Alternative RA (PPM Difference)		**5.00**		

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

RA calculated as specified in Performance Specification 2, Appendix B, 40 CFR 60 - Equation 2-4

As specified in P.S. 2, subsection 8.4.4, three sets of test runs may be rejected, these rejected test runs are bolded in the table

TABLE 6

SUMMARY OF O_2 RATA TEST RESULTS

October 17, 2017

Michigan Power

FGTURBINE/HRSG

O_2 Relative Accuracy

Relative Accuracy: **1.1**

Run #	Time	RM %	CEM %	Diff	%Diff
1	1507-1528	13.58	13.60	-0.02	-0.15%
2	1540-1601	13.62	13.60	0.02	0.15%
3	1615-1636	13.53	13.60	-0.07	-0.55%
4	**1649-1710**	**0.00**	**13.60**	**-13.60**	**NA**
5	1842-1903	13.44	13.60	-0.16	-1.20%
6	1916-1937	13.56	13.60	-0.04	-0.32%
7	1951-2012	13.49	13.60	-0.11	-0.82%
8	2027-2048	13.47	13.60	-0.13	-0.96%
9	2100-2121	13.41	13.60	-0.19	-1.42%
10	2133-2154	13.43	13.60	-0.17	-1.24%
		13.50	13.60	-0.10	-0.72%
		Sdev	0.0724		Mean
		CC	0.0556		Difference
	RA (based on Ref. Meth.)		**1.1%**		**-0.097**

Confidence Coefficient =

n=9

t = 2.306

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

P.S. 2 Equation 2-5

Standard Deviation =

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

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

RA calculated as specified in Performance Specification 2, Appendix B, 40 CFR 60 - Equation 2-4

As specified in P.S. 2, subsection 8.4.4, three sets of test runs may be rejected, these rejected test runs are bolded in the table

TABLE 7

Summary of EUTURBINE Particulate Matter Emissions

Michigan Power

U.S. EPA Method 201A and 202

October 18, 2017

Run No.	1	2	3	Average
Run Time	953-1134	1203-1338	1412-1548	
	Process Conditions			
	Volumetric Flow Rate			
Stack Gas Flow Rate, DSCFM:	537,467	529,217	525,592	530,759
	Fixed Gases			
Oxygen, percent, dry:	14.80	14.80	14.80	14.80
Carbon Dioxide, percent, dry:	4.00	4.00	4.00	4.00
Moisture, percent by volume:	6.71	6.65	6.42	6.59
Run No.	1	2	3	Average
	Emission Rate (grains per dry standard cubic foot)			
Filterable Particulate, gr/dscf:	0.0000	0.0000	0.0000	0.0000
Aqueous, gr/dscf:	0.0000	0.0000	0.0000	0.000
Organic Condensible Particulate, gr/dscf:	0.0005	0.0005	0.0008	0.0006
Total Particulate, gr/dscf:	0.0005	0.0005	0.0008	0.0006
	Emission Rate (pound per hour)			
Filterable Particulate, lb/hr:	0.191	0.00	0.00	0.064
Aqueous, lb/hr:	0.000	0.196	0.000	0.065
Organic Condensible Particulate, lb/hr:	2.290	2.159	3.696	2.715
Total Particulate, lb/hr:	2.481	2.356	3.696	2.844
MI-ROP-N4975-2014 Permit Limit				7.00

Table 8
Summary of EUTURBINE VOC Emissions
Michigan Power
U.S. EPA Method 25A
October 18, 2017

Run No.	1		2		3		Average
Run Times	RATA Run 1 RATA Run 2 RATA Run 3	0844-0905 0918-0939 0950-1011	RATA Run 4 RATA Run 5 RATA Run 6	1024-1045 1101-1122 1135-1156	RATA Run 7 RATA Run 8 RATA Run 9	1206-1227 1239-1300 1311-1332	
Process Conditions,							
Volumetric Flow Rates							
Actual Cubic Feet Minute	796,516		788,010		779,385		787,970
Standard Cubic Feet Minute	576,115		566,935		561,657		568,236
Dry Standard Cubic Feet Minute	537,467		529,217		525,592		530,759
Fixed Gases							
Oxygen, % by volume, dry	15.00		15.00		15.00		15.00
Carbon dioxide, % by volume, dry	3.50		3.50		3.50		3.50
Moisture, % by volume	6.71		6.65		6.42		6.59
Run No.	**1**		**2**		**3**		**Average**
VOC (PPM)	0		0		0		0
Emission Rate, (lb/hr):							
VOC	0.0		0.0		0.0		0.0
MI-ROP-N4975-2014 Permit Limit							2.0

lb/hr = pounds per hour

TABLE 9

Summary of EUBOILERA Particulate Matter Emissions

Michigan Power

U.S. EPA Method 201A and 202

October 19, 2017

Run No.	1	2	3	Average
Run Time	1028-1157	1232-1402	1430-1601	
	Process Conditions			
	Volumetric Flow Rate			
Stack Gas Flow Rate, DSCFM:	46,807	46,075	46,230	46,371
	Fixed Gases			
Oxygen, percent, dry:	3.80	3.80	3.80	3.80
Carbon Dioxide, percent, dry:	9.70	9.70	9.70	9.70
Moisture, percent by volume:	15.98	16.01	16.14	16.05
Run No.	1	2	3	Average
	Emission Rate (grains per dry standard cubic foot)			
Filterable Particulate, gr/dscf:	0.0000	0.0000	0.0000	0.0000
Aqueous, gr/dscf:	0.0002	0.0000	0.0000	0.001
Organic Condensible Particulate, gr/dscf:	0.0009	0.0004	0.0009	0.0003
Total Particulate, gr/dscf:	0.0012	0.0004	0.0009	0.0008
	Emission Rate (pound per hour)			
Filterable Particulate, lb/hr:	0.00	0.00	0.00	0.00
Aqueous, lb/hr:	0.099	0.000	0.000	0.033
Organic Condensible Particulate, lb/hr:	0.376	0.176	0.345	0.299
Total Particulate, lb/hr:	0.475	0.176	0.345	0.332
MI-ROP-N4975-2014 Permit Limit				2.65

Table 10
Summary of EUBOILERA VOC Emissions
Michigan Power
U.S. EPA Method 25A
October 19, 2017

Run No	1		2		3		Average
Run Times	RATA Run 2	0955-1016	RATA Run 5	1136-1157	RATA Run 8	1318-1339	
	RATA Run 3	1030-1051	RATA Run 6	1209-1230	RATA Run 9	1351-1412	
	RATA Run 4	1103-1124	RATA Run 7	1245-1306	RATA Run 10	1426-1447	
Process Conditions,							
Volumetric Flow Rates							
Actual Cubic Feet Minute	81,925		80,868		81,111		81,301
Standard Cubic Feet Minute	55,711		54,861		55,130		55,234
Dry Standard Cubic Feet Minute	46,807		46,075		46,230		46,371
Fixed Gases,							
Oxygen, % by volume, dry	4.00		4.00		4.00		4.00
Carbon dioxide, % by volume, dry	10.00		10.00		10.00		10.00
Moisture, % by volume	15.98		16.01		16.14		16.04
Run No	**1**		**2**		**3**		**Average**
Emission Rate, (lb/hr):							
VOC	0.86		1.05		0.99		0.97
MI-ROP-N4975-2014 Permit Limit							1.1

lb/hr = pounds per hour

Table 11
Summary of EUBOILERA CO Emissions
Michigan Power
U.S. EPA Method 10
October 19, 2017

Run No.	1		2		3		Average
Run Times	RATA Run 2 RATA Run 3 RATA Run 4	0955-1016 1030-1051 1103-1124	RATA Run 5 RATA Run 6 RATA Run 7	1136-1157 1209-1230 1245-1306	RATA Run 8 RATA Run 9 RATA Run 10	1318-1339 1351-1412 1426-1447	
Process Conditions,							
Volumetric Flow Rates							
Actual Cubic Feet Minute	81,925		80,868		81,111		81,301
Standard Cubic Feet Minute	55,711		54,861		55,130		55,234
Dry Standard Cubic Feet Minute	46,807		46,075		46,230		46,371
Fixed Gases,							
Oxygen, % by volume, dry	4.00		4.00		4.00		4.00
Carbon dioxide, % by volume, dry	10.00		10.00		10.00		10.00
Moisture, % by volume	15.98		16.01		16.14		16.04
Run No.	**1**		**2**		**3**		**Average**
Emission Rate, (lb/hr):							
CO	1.48		1.43		1.40		1.4
MI-ROP-N4975-2014 Permit Limit							19.9

lb/hr = pounds per hour

Table 12

SUMMARY OF NO_X LB/MMBTU RATA RESULTS

October 19, 2017

Michigan Power

EUBOILERA

NO_X Relative Accuracy

Relative Accuracy: **1.8**

Run #	Time	RM LB/MMBTU	CEM LB/MMBTU	Diff	%Diff
1	0920-0941	0.035	0.036	-0.001	-2.18%
2	0955-1016	0.035	0.036	-0.001	-1.48%
3	1030-1051	0.036	0.036	0.000	-0.53%
4	1103-1124	0.036	0.036	0.000	-0.59%
5	1136-1157	0.036	0.036	0.000	-1.36%
6	1209-1230	0.035	0.036	-0.001	-2.33%
7	**1245-1306**	**0.035**	**0.035**	**0.000**	**0.30%**
8	1318-1339	0.035	0.036	-0.001	-1.79%
9	1351-1412	0.036	0.036	0.000	-0.88%
10	1426-1447	0.036	0.036	0.000	-0.78%
		0.036	0.036	0.000	-1.32%

Sdev	0.0002
CC	0.0002
RA (based on Ref. Meth.)	**1.8%**
Bias Test Pass/Fail	**Pass**
Bias Adjustment Factor	**1.000**

Confidence Coefficient =

n=9

t = 2.306

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

P.S. 2 Equation 2-5

Standard Deviation =

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

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

RA calculated as specified in Performance Specification 2, Appendix B, 40 CFR 60 - Equation 2-4

As specified in P.S. 2, subsection 8.4.4, three sets of test runs may be rejected, these rejected test runs are bolded in the table

Run 1 was rejected due to Michigan Powers DAS not recording enough valid data points.

TABLE 13

Summary of EUBOILERB Particulate Matter Emissions

Michigan Power

U.S. EPA Method 201 and 202

October 20, 2017

Run No.	1	2	3	Average
Run Time	720-854	922-1054	1125-1256	
	Process Conditions			
	Volumetric Flow Rate			
Stack Gas Flow Rate, DSCFM:	50,139	50,116	49,992	50,082
	Fixed Gases			
Oxygen, percent, dry:	4.60	4.60	4.20	4.47
Carbon Dioxide, percent, dry:	8.80	8.80	9.20	8.93
Moisture, percent by volume:	15.10	15.31	15.68	15.36
Run No.	1	2	3	Average
	Emission Rate (grains per dry standard cubic foot)			
Filterable Particulate, gr/dscf:	0.000	0.000	0.000	0.000
Aqueous, gr/dscf:	0.000	0.000	0.000	0.000
Organic Condensible Particulate, gr/dscf:	0.0008	0.0009	0.0012	0.00095
Total Particulate, gr/dscf:	0.0008	0.0011	0.0016	0.0012
	Emission Rate (pound per hour)			
Filterable Particulate, lb/hr:	0.00	0.00	0.00	0.00
Aqueous, lb/hr:	0.0000	0.104	0.166	0.090
Organic Condensible Particulate, lb/hr:	0.346	0.376	0.499	0.407
Total Particulate, lb/hr:	0.346	0.481	0.666	0.497
MI-ROP-N4975-2014 Permit Limit				2.65

Table 14
Summary of EUBOILERB VOC Emissions
Michigan Power
U.S. EPA Method 25A
October 20, 2017

Run No.	1		2		3		Average
Run Times	RATA Run 1 RATA Run 2 RATA Run 3	0700-0721 0740-0801 0815-0836	RATA Run 4 RATA Run 5 RATA Run 6	0851-0912 0929-0950 1004-1025	RATA Run 7 RATA Run 8 RATA Run 9	1040-1101 1114-1135 1154-1215	
Process Conditions,							
Volumetric Flow Rates							
Actual Cubic Feet Minute	87,716		87,892		87,993		87,867
Standard Cubic Feet Minute	59,059		59,172		59,289		59,173
Dry Standard Cubic Feet Minute	50,139		50,116		49,992		50,082
Fixed Gases,							
Oxygen, % by volume, dry	5.00		5.00		5.00		5.00
Carbon dioxide, % by volume, dry	9.00		9.00		9.00		9.00
Moisture, % by volume	15.10		15.31		15.68		15.36
Run No.	**1**		**2**		**3**		**Average**
Emission Rate, (lb/hr):							
VOC	0.92		0.89		0.94		0.9
MI-ROP-N4975-2014 Permit Limit							1.1

lb/hr = pounds per hour

Table 15
Summary of EUBOILERB CO Emissions
Michigan Power
U.S. EPA Method 10
October 20, 2017

Run No.	1	2	3	Average
Run Times	RATA Run 1 0700-0721 RATA Run 2 0740-0801 RATA Run 3 0815-0836	RATA Run 4 0851-0912 RATA Run 5 0929-0950 RATA Run 6 1004-1025	RATA Run 7 1040-1101 RATA Run 8 1114-1135 RATA Run 9 1154-1215	
Process Conditions,				
Volumetric Flow Rates				
Actual Cubic Feet Minute	87,716	87,892	87,993	87,867
Standard Cubic Feet Minute	59,059	59,172	59,289	59,173
Dry Standard Cubic Feet Minute	50,139	50,116	49,992	50,082
Fixed Gases,				
Oxygen, % by volume, dry	5.00	5.00	5.00	5.00
Carbon dioxide, % by volume, dry	9.00	9.00	9.00	9.00
Moisture, % by volume	15.10	15.31	15.68	15.36
Run No.	**1**	**2**	**3**	**Average**
Emission Rate, (lb/hr):				
CO	0.9	0.3	0.3	0.5
MI-ROP-N4975-2014 Permit Limit				19.9

lb/hr = pounds per hour

Table 16

SUMMARY OF NO_X LB/MMBTU RATA RESULTS

October 20, 2017

Michigan Power

EUBOILERB

NO_X Relative Accuracy

Relative Accuracy: **5.0**

Run #	Time	RM LB/HR	CEM LB/HR	Diff	%Diff
1	**0700-0721**	**0.055**	**0.058**	**-0.003**	**-5.78%**
2	0740-0801	0.054	0.056	-0.002	-3.85%
3	0815-0836	0.054	0.056	-0.002	-4.31%
4	0851-0912	0.053	0.056	-0.003	-5.59%
5	0929-0950	0.052	0.055	-0.003	-4.95%
6	1004-1025	0.052	0.055	-0.003	-5.33%
7	1040-1101	0.052	0.054	-0.002	-4.40%
8	1114-1135	0.052	0.054	-0.002	-4.26%
9	1154-1215	0.052	0.054	-0.002	-4.45%
10	1230-1251	0.052	0.054	-0.002	-3.96%
		0.052	0.055	-0.002	-4.57%
	Sdev		0.0003		
	CC		0.0002		
	RA (based on Ref. Meth.)		**5.0%**		
	Bias Adjustment Factor		**1.000**		

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

$$RA = \frac{|\bar{d}| + |cc|}{RM} x\,100$$

P.S. 2 Equation 2-6

RA calculated as specified in Performance Specification 2, Appendix B, 40 CFR 60 - Equation 2-4

As specified in P.S. 2, subsection 8.4.4, three sets of test runs may be rejected, these rejected test runs are bolded in the table

Table 17
Summary of EUTURBINE Subpart GG Emission Rates
Michigan Power
October 18, 2017

65% Load				
Run No.	**1**	**2**	**3**	**Average**
Run Time	1856-1917	1924-1945	1956-2017	
NO_x Corrected to 15% O_2	4.78	4.84	4.84	4.82
75% Load				
Run No.	**1**	**2**	**3**	**Average**
Run Time	1721-1742	1751-1812	1819-1830	
NO_x Corrected to 15% O_2	5.75	5.72	5.74	5.74
88% Load				
Run No.	**1**	**2**	**3**	**Average**
Run Time	1548-1609	1619-1640	1648-1709	
NO_x Corrected to 15% O_2	6.57	6.57	6.55	6.56
100% Load				
Run No.	**1**	**2**	**3**	**Average**
Run Time	0844-0905	0918-0939	0950-1011	
NO_x Corrected to 15% O_2	4.63	4.47	4.43	4.51