mostardi platt

Relative Accuracy Test Audit
Test Report

Michigan State University
T.B. Simon Power Plant
Unit 4 Outlet Duct
East Lansing, Michigan
February 27 through March 1, 2017

Report Submittal Date
April 26, 2017

Project No. M170605D

888 Industrial Drive
Elmhurst, Illinois 60126
630-993-2100

1.0 EXECUTIVE SUMMARY

MOSTARDI PLATT conducted a Continuous Emissions Monitoring System (CEMS) Relative Accuracy Test Audit (RATA) test program for Michigan State University at the T.B. Simon Power Plant in East Lansing, Michigan, on the Unit 4 Outlet Duct on February 27 through March 1, 2017. This report summarizes the results of the test program and test methods used in accordance with the Mostardi Platt Protocol M170605D Rev. 1 dated February 2, 2017. Mostardi Platt is a self-certified air emissions testing body (AETB). A copy of Mostardi Platt's self-certification can be found in Appendix A.

The test location, test dates, and test parameters are summarized below.

TEST INFORMATION		
Test Location	**Test Dates**	**Test Parameters**
Unit 4 Outlet Duct	February 27 through March 1, 2017	Carbon Monoxide (CO), Carbon Dioxide (CO_2), Nitrogen Oxides (NO_x), and Volumetric Flow

The purpose of the test program was to demonstrate the relative accuracies of the Unit 4 Outlet Duct CO, CO_2, NO_x, and volumetric flow analyzers during the specified operating conditions. The test results from this test program indicate that each CEMS component meets the United States Environmental Protection Agency (USEPA) annual performance specification for relative accuracy as published in 40 Code of Federal Regulations Part 75 (40CFR75) and 40 Code of Federal Regulations (40CFR60).

RATA RESULTS						
Test Location	**Date**	**Parameter**	**Units**	**Relative Accuracy Acceptance Criteria**	**Relative Accuracy (RA)**	**Bias Adjustment Factor (BAF)**
Unit 4 Outlet Duct	2/27/17	NO_x	lb/mmBtu	± 0.015 lb/mmBtu mean difference	0.004 lb/mmBtu mean difference	1.111*
		CO_2	% wet	≤ 7.5 % of the mean reference value	1.38%	N/A
		CO	ppmv	± 5 ppm mean difference + confidence coefficient	0.98 mean difference + confidence coefficient	N/A
		CO	lb/mmBtu	≤ 10.0% of mean reference method value	4.99%	N/A
	2/28/17	Volumetric Flow - Low (Normal) Load	scfh	≤ 7.5 % of the mean reference value	0.40%	1.000
	3/1/17	Volumetric Flow – Mid Load	scfh	≤ 7.5 % of the mean reference value	1.16%	1.007

*Maximum Bias Adjustment Factor

The gas cylinders used to perform the RATA are summarized below.

GAS CYLINDER INFORMATION				
Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
NO_x	Airgas	CC135830	0.0 ppm	9/21/2024
NO_x	Airgas	CC216539	47.06 ppm	11/7/2019
NO_x	Airgas	CC301314	90.12 ppm	8/29/2024
CO_2	Airgas	CC216539	0.0 %	11/7/2019
CO_2	Airgas	CC135830	10.2 %	9/21/2024
CO_2	Airgas	EB0075821	19.7 %	2/1/2024
CO	Airgas	CC216539	0.0 ppm	11/7/2019
CO	Airgas	CC486880	88.98 ppm	7/7/2024
CO	Airgas	CC233856	181.5 ppm	7/5/2024

No deviations, additions, or exclusions from the test protocol, test methods, the Mostardi Platt Quality Manual, or the ASTM D7036-12 occurred. The specific test conditions encountered did not interfere with the collection of the data.

The identifications of the individuals associated with the test program are summarized below.

TEST PERSONNEL INFORMATION		
Location	**Address**	**Contact**
Test Facility	Michigan State University 354 Service Rd East Lansing, MI 48824	Mr. Rick Johnson Electrical Engineer (517) 884-7108 (phone) rjohnson@ipf.msu.edu
Testing Company Supervisor	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Mr. Stuart L. Burton Senior Project Manager 630-993-2100 (phone) sburton@mp-mail.com QI Group V (certified on 2/1/13)
Testing Company Personnel		Mr. Benjamin Garcia Test Engineer QI Group V (certified on 3/4/16)
		Mr. David Dixon Test Technician
		Mr. Eric Karberg Test Technician

Copies of the QI certifications for test personnel are included in Appendix B.

2.0 TEST METHODOLOGY

Emission testing was conducted following the United States Environmental Protection Agency (USEPA) methods specified in 40CFR75, and 40CFR60 Appendix A in addition to the Mostardi

Platt Quality Manual and the Mostardi Platt test protocol. Schematics of the test section diagrams and sampling trains used are included in Appendix C and D respectively. Calculation and nomenclature are included in Appendix E. Copies of analyzer print-outs for each test run are included in Appendix F. CEM data and process data as provided by Michigan State University are included in Appendix G.

The following methodologies were used during the test program:

Method 1 Sample and Velocity Traverse Determination

Test measurement points were selected in accordance with USEPA Method 1, 40CFR60, Appendix A. The characteristics of the measurement location are summarized below.

TEST POINT INFORMATION AT Unit 4 Outlet Duct								
Stack Dimensions (Feet)	Equivalent Diameter (Feet)	Stack Area (Square Feet)	No. of Ports	Port Length (Inches)	Upstream Diameters	Downstream Diameters	Test Parameter	Number of Sampling Points
5.17 by 10.33	6.891	53.41	6	21.0	1.210	1.550	Volumetric Flow	24

Method 2 Volumetric Flow Rate Determination

Gas velocity was measured following USEPA Method 2, 40CFR60, Appendix A, for purposes of calculating stack gas volumetric flow rate. A 9.0 foot long S-type pitot tube, 0-10 inch differential pressure gauge, and K-type thermocouple and temperature readout were used to determine gas velocity at each sample point. All of the equipment used was calibrated in accordance with the specifications of the Method. Copies of field data sheets are included in Appendix H. Calibration data are presented in Appendix I. This testing met the performance specifications as outlined in the Method.

Method 3A Oxygen (O_2)/Carbon Dioxide (CO_2) Determination

Stack gas molecular weight was determined in accordance with USEPA Method 3, 40CFR60, Appendix A, during each volumetric flow rate determination. An ECOM analyzer was used to determine stack gas O_2 and CO_2 content and, by difference, nitrogen content. Calibration data are presented in Appendix I. Gas cylinder certifications are included in Appendix J. This testing met the performance specifications as outlined in the Method.

Method 3A Carbon Dioxide (CO_2) Determination

Stack gas CO_2 concentrations were determined in accordance with USEPA Method 3A, 40CFR60, Appendix A. A Thermo Scientific Model 410i Optical Filter Carbon Dioxide Analyzer was used to determine carbon dioxide concentrations in the manner specified in the Method. The instrument has a nondispersive infrared-based detector and operated in the nominal range of 0% to 20% with the specific range determined by the high-level span calibration gas of 19.70%.

The Model 410i operates on the principle that CO_2 absorbs infrared radiation at a wavelength of 4.26 microns. The sample is drawn into the Model 410i through the sample bulkhead. The sample flows through the optical bench. Radiation from an infrared source is chopped and then passed through a rotating optical wheel alternating between sample and reference filters. The radiation then enters the optical bench where absorption by the sample gas occurs. The infrared radiation then exits the optical bench and falls on an infrared detector. The chopped detector signal is modulated by the alternation between the filters with an amplitude related to the concentration of CO_2 in the sample cell. Because infrared absorption is a non-linear measurement, it is necessary to transform the basic analyzer signal into a linear output. The Model 410i uses an internally stored calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000 ppm. The Model 410i outputs the CO_2 concentration to the front panel display, the analog outputs, and also makes the data available over the serial or ethernet connection.

Stack gas was delivered to the analyzer through an EPM in-situ dilution sampling system. Stack gas concentrations were diluted at a nominal 100:1 ratio utilizing purified dilution air. The entire system was calibrated in accordance with the Method, using USEPA Protocol gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks are found in Appendix I. Copies of the gas cylinder certifications are found in Appendix J. This testing met the performance specifications as outlined in the Method.

Method 4 Moisture Determination

USEPA Method 4, 40CFR60, Appendix A, was utilized to determine water (H_2O) content of the exhaust gas. 100 milliliters (ml) of water were added to each of the first two impingers, the third impinger was left empty, and the fourth impinger was charged with approximately 200 grams of silica gel. The impingers were placed in an ice bath to maintain the sampled gas passed through the silica gel impinger outlet below 68°F in order to increase the accuracy of the sampled dry gas volume measurement. The water volumes of the impinger train were measured and the silica gel was weighed before and after each test run to determine the mass of moisture condensed.

Each sample was extracted through a heated stainless-steel probe and filter assembly at a constant sample rate of approximately 0.75 cubic feet per minute, which was maintained throughout the course of the test run. Approximately, 21 dry standard cubic feet (dscf) were sampled for each, moisture run. After each run, a leak check of the sampling train was performed at a vacuum greater than the sampling vacuum to determine if any leakage had occurred during sampling. Following the leak check, the impingers were removed from the ice bath, water levels were measured, and the silica gel weight was recorded.

All of the equipment used was calibrated in accordance with the specifications of the Method. Copies of field data sheets are included in Appendix H. Calibration data is presented in Appendix I. This testing met the performance specifications as outlined in the Method.

Method 7E Nitrogen Oxides (NO_x) Determination

Stack gas NO_x concentrations and emission rates were determined in accordance with USEPA Method 7E, 40CFR60, Appendix A. A Thermo Scientific Model 42i Chemiluminescence Nitrogen Oxides Analyzer was used to determine nitrogen oxides concentrations, in the manner specified in the Method. The instrument operated in the nominal range of 0 ppm to 200 ppm with the specific range determined by the high-level span calibration gas of 90.12 ppm.

The Model 42i operates on the principle that nitric oxide (NO) and ozone (O_3) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO_2 molecules decay to lower energy states. Specifically,

$$NO+O_3 \rightarrow NO_2+O_2+hv$$

Nitrogen dioxide (NO_2) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO_2 is converted to NO by a molybdenum NO_2-to-NO converter heated to about 340 °C. The flue gas sample is drawn into the Model 42*i* through the sample bulkhead. The sample flows through a capillary, and then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode) or through the NO_2-to-NO converter and then to the reaction chamber (NO_x mode). A flow sensor prior to the reaction chamber measures the sample flow. Dry air enters the Model 42*i* through the dry air bulkhead, passes through a flow switch, and then through a silent discharge ozonator. The ozonator generates the ozone needed for the chemiluminescent reaction. At the reaction chamber, the ozone reacts with the NO in the sample to produce excited NO_2 molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the luminescence generated during this reaction. From the reaction chamber, the exhaust travels through the ozone (O_3) converter to the pump, and is released through the vent.

The NO and NO_x concentrations calculated in the NO and NO_x modes are stored in memory. The difference between the concentrations is used to calculate the NO_2 concentration. The Model 42i outputs NO, NO_2, and NO_x concentrations to the front panel display, the analog outputs, and also makes the data available over the serial or ethernet connection.

Stack gas was delivered to the analyzer through an EPM in-situ dilution sampling system. Stack gas concentrations were diluted at a nominal 100:1 ratio utilizing purified dilution air. The entire system was calibrated in accordance with the Method, using USEPA Protocol gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks are found in Appendix I. Copies of the gas cylinder certifications are found in Appendix J. The NO_2 to NO converter test can be found in Appendix K. This testing met the performance specifications as outlined in the Method.

Method 10 Carbon Monoxide (CO) Determination

Stack gas CO concentrations and emission rates were determined in accordance with USEPA Method 10, 40CFR60, Appendix A. A Thermo Scientific Model 48i Gas Filter Correlation Carbon Monoxide was used to determine carbon monoxide concentrations, in the manner specified in the Method. The instrument operated in the nominal range of 0 ppm to 200 ppm with the specific range determined by the high-level span calibration gas of 181.50 ppm.

The Model 48i operates on the principle that CO absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a non-linear measurement technique, it is necessary to transform the basic analyzer signal into a linear output. The Model 48i uses an internally stored calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000 ppm. The sample is drawn into the Model 48i through the sample bulkhead. The sample flows through the optical bench. Radiation from an infrared source is chopped and then passed through a gas filter alternating between CO and N_2. The radiation then passes through a narrow bandpass interference filter and enters the optical bench where absorption by the sample gas occurs. The infrared radiation then exits the optical bench and falls on an infrared detector. The CO gas filter acts to produce a reference beam which cannot be further attenuated by CO in the sample cell. The N_2 side of the filter wheel is transparent to the infrared radiation and therefore produces a measurement beam which can be absorbed by CO in the cell. The chopped detector signal is modulated by the alternation between the two gas filters with an amplitude related to the concentration of CO in the sample cell. Other gases do not cause modulation of the detector signal since they absorb the reference and measure beams equally. Thus, the GFC system responds specifically to CO. The Model 48i outputs the CO concentration to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.

Stack gas was delivered to the analyzer through an EPM in-situ dilution sampling system. Stack gas concentrations were diluted at a nominal 100:1 ratio utilizing purified dilution air. The entire system was calibrated in accordance with the Method, using USEPA Protocol gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks are found in Appendix I. Copies of the gas cylinder certifications are found in Appendix J. This testing met the performance specifications as outlined in the Method.

3.0 TEST RESULT SUMMARIES

Client: Michigan State University	**Location:** Unit 4 Outlet Duct Low Load
Facility: T.B. Simon Power Plant	**Date:** 2/27/17 and 2/28/17
Project #: M170605	**Test Method:** 7E, 3A
Fuel Type: Natural Gas	**Fuel Factor:** 1040

NO_x lb/mmBtu RATA

CEM Monitor Information

NO_x Monitor/Model:	TEI 42C	**NO_x Serial # :**	42C-6421383
CO_2 Monitor/Model:	TEI 41CHL	**CO_2 Serial # :**	41CHL-75680-380

1=accept 0=reject	Test Run	KPPH	Test Date	Start Time	End Time	RM NO_x lb/mmBtu	CEM NO_x lb/mmBtu	(RM-CEM) Difference (di)	(RM-CEM) Difference^2 (di^2)
1	1	163.3	02/27/17	17:15	17:35	0.012	0.009	0.003	0.000
1	2	164.0	02/27/17	18:00	18:20	0.013	0.009	0.004	0.000
1	3	163.9	02/27/17	18:40	19:00	0.013	0.009	0.004	0.000
1	4	164.6	02/27/17	19:16	19:36	0.013	0.009	0.004	0.000
0	5	166.0	02/27/17	19:51	20:11	0.014	0.009	0.005	0.000
1	6	163.4	02/27/17	20:28	20:48	0.013	0.009	0.004	0.000
1	7	163.2	02/27/17	21:06	21:26	0.013	0.009	0.004	0.000
1	8	163.3	02/27/17	21:43	22:03	0.013	0.009	0.004	0.000
1	9	163.1	02/27/17	22:20	22:40	0.013	0.009	0.004	0.000
1	10	164.0	02/27/17	22:58	23:18	0.013	0.009	0.004	0.000
0	11	163.9	02/27/17	23:34	23:54	0.013	0.009	0.004	0.000
0	12	163.4	02/28/17	00:10	00:30	0.013	0.008	0.005	0.000

n	9	
t(0.025)	2.306	
Mean Reference Method Value	0.013	RM avg
Mean CEM Value	0.009	CEM avg
Sum of Differences	0.035	di
Mean Difference	0.004	d
Sum of Differences Squared	0.000	di^2
Standard Deviation	0.000	sd
Confidence Coefficient 2.5% Error (1-tail)	0.000	cc
Relative Accuracy - APS	0.004	lb/mmBtu difference [A]
Bias Adjustment Factor	1.111	BAF[B]

[A] Relative accuracy for low emission sources with NO_x emissions of ≤ 0.200 lbs/mmBtu based on a mean difference of +/- 0.015 lbs/mmBtu for annual RATA testing, or +/- 0.020 lbs/mmBtu for semi-annual RATA testing.

[B] Maximum Bias Adjustment Factor

Client: Michigan State University
Facility: T.B. Simon Power Plant
Project #: M170605

Location: Unit 4 Outlet Duct Low Load
Date: 2/27/17 and 2/28/17
Test Method: 3A

CO_2 % (wet) RATA

1=accept 0=reject	Test Run	KPPH	Test Date	Start Time	End Time	RM CO_2 % (wet)	PEM CO_2 % (wet)	(RM-PEM) Difference (di)	(RM-PEM) Difference^2 (di^2)
0	1	163.3	02/27/17	17:15	17:35	6.4		6.4	40.96
0	2	164	02/27/17	18:00	18:20	6.2	5.9	0.3	0.09
0	3	163.9	02/27/17	18:40	19:00	6.3	5.9	0.4	0.16
1	4	164.6	02/27/17	19:16	19:36	6.3	6.0	0.3	0.09
1	5	166.0	02/27/17	19:51	20:11	6.2	6.0	0.2	0.04
1	6	163.4	02/27/17	20:28	20:48	6.2	6.0	0.2	0.04
1	7	163.2	02/27/17	21:06	21:26	6.2	6.0	0.2	0.04
1	8	163.3	02/27/17	21:43	22:03	6.1	6.0	0.1	0.01
1	9	163.1	02/27/17	22:20	22:40	6.1	6.0	0.1	0.01
1	10	164.0	02/27/17	22:58	23:18	6.1	6.0	0.1	0.01
1	11	163.9	02/27/17	23:34	23:54	6.1	6.1	0.0	0.00
1	12	163.4	02/28/17	00:10	00:30	6.1	6.1	0.0	0.00

n	9	
t(0.975)	2.306	
Mean Reference Method Value	6.156	RM avg
Mean CEM Value	6.022	CEM avg
Sum of Differences	1.200	di
Mean Difference	0.133	d
Sum of Differences Squared	0.240	di^2
Standard Deviation	0.100	sd
Confidence Coefficient 2.5% Error (1-tail)	0.077	cc
Relative Accuracy	3.41	RA

Client: Michigan State University						**Location:** Unit 4 Outlet Duct Low Load			
Facility: T.B. Simon Power Plant						**Date:** 2/27/17 and 2/28/17			
Project #: M170605						**Test Method:** 10			
CO ppmv RATA									
CEM Monitor Information									
CO Monitor/Model:				TEI 48C			**CO Serial # :**	48C-75478-380	
1=accept 0=reject	**Test Run**	**KPPH**	**Test Date**	**Start Time**	**End Time**	**RM CO ppmv**	**CEM CO ppmv**	**(RM-CEM) Difference (di)**	**(RM-CEM) Difference^2 (di^2)**
1	1	163.3	02/27/17	17:15	17:35	9.3	10.2	-0.9	0.81
1	2	164.0	02/27/17	18:00	18:20	9.4	10.4	-1.0	1.00
1	3	163.9	02/27/17	18:40	19:00	10.5	11.3	-0.8	0.64
0	4	164.6	02/27/17	19:16	19:36	8.6	11.4	-2.8	7.84
1	5	166.0	02/27/17	19:51	20:11	12.2	11.5	0.7	0.49
1	6	163.4	02/27/17	20:28	20:48	11.1	11.8	-0.7	0.49
1	7	163.2	02/27/17	21:06	21:26	11.9	11.9	0.0	0.00
1	8	163.3	02/27/17	21:43	22:03	11.0	11.9	-0.9	0.81
0	9	163.1	02/27/17	22:20	22:40	10.3	12.1	-1.8	3.24
0	10	164.0	02/27/17	22:58	23:18	10.4	12.7	-2.3	5.29
1	11	163.9	02/27/17	23:34	23:54	11.8	12.4	-0.6	0.36
1	12	163.4	02/28/17	00:10	00:30	12.1	12.9	-0.8	0.64
					n	9			
					t(0.975)	2.306			
					Mean Reference Method Value	11.033		**RM avg**	
					Mean CEM Value	11.589		**CEM avg**	
					Sum of Differences	-5.000		**di**	
					Mean Difference	-0.556		**d**	
					Sum of Differences Squared	5.240		**di^2**	
					Standard Deviation	0.555		**sd**	
					Confidence Coefficient 2.5% Error (1-tail)	0.426		**cc**	
					Relative Accuracy - APS	0.98		**ppm + cc difference[A]**	

[A] Relative accuracy based upon alternate performance standard of +/- 5 ppm CO plus the confidence coefficient.

Client: Michigan State University
Facility: T.B. Simon Power Plant
Project #: M170605
Fuel Type: Natural Gas

Location: Unit 4 Outlet Duct Low Load
Date: 2/27/17 and 2/28/17
Test Method: 10, 3A
Fuel Factor: 1040

CO lb/mmBtu RATA

CEM Monitor Information

CO Monitor/Model:	TEI 48C	**CO Serial # :**	48C-75478-380
CO2 Monitor/Model:	TEI 41CHL	**CO2 Serial # :**	41CHL-75680-380

1=accept 0=reject	Test Run	KPPH	Test Date	Start Time	End Time	RM CO lb/mmBtu	CEM CO lb/mmBtu	(RM-CEM) Difference (di)	(RM-CEM) Difference^2 (di^2)
1	1	163.3	02/27/17	17:15	17:35	0.011	0.010	0.001	0.000
1	2	164.0	02/27/17	18:00	18:20	0.011	0.010	0.001	0.000
0	3	163.9	02/27/17	18:40	19:00	0.013	0.010	0.003	0.000
1	4	164.6	02/27/17	19:16	19:36	0.010	0.010	0.000	0.000
1	5	166.0	02/27/17	19:51	20:11	0.015	0.014	0.001	0.000
1	6	163.4	02/27/17	20:28	20:48	0.014	0.015	-0.001	0.000
1	7	163.2	02/27/17	21:06	21:26	0.015	0.015	0.000	0.000
1	8	163.3	02/27/17	21:43	22:03	0.014	0.015	-0.001	0.000
0	9	163.1	02/27/17	22:20	22:40	0.013	0.015	-0.002	0.000
0	10	164.0	02/27/17	22:58	23:18	0.013	0.016	-0.003	0.000
1	11	163.9	02/27/17	23:34	23:54	0.015	0.015	0.000	0.000
1	12	163.4	02/28/17	00:10	00:30	0.015	0.016	-0.001	0.000

n	**9**	
t(0.975)	**2.306**	
Mean Reference Method Value	**0.013**	**RM avg**
Mean CEM Value	**0.013**	**CEM avg**
Sum of Differences	**0.000**	**di**
Mean Difference	**0.000**	**d**
Sum of Differences Squared	**0.000**	**di^2**
Standard Deviation	**0.001**	**sd**
Confidence Coefficient 2.5% Error (1-tail)	**0.001**	**cc**
Relative Accuracy	**4.99**	**RA**

Client: Michigan State University
Facility: T.B. Simon Power Plant
Project #: M170605

Test Location: Unit 4 Outlet Duct
Test Date: 2/28/2017
Test Method: 2

CEM Monitor Information

Volumetric Flow RATA – Low (Normal) Load

Flow Monitor/Model:	OFS 2000	Flow Serial # :	02070060

1=accept 0=reject	Test Run	Test Date	Start Time	End Time	Reference Method Flow SCFH	CEM Flow SCFH	(RM-CEM) Difference (di)	(RM-CEM) Difference ^{2} (di^2)
0	1	02/28/17	15:03	15:13	4,275,000	4,371,000	-96,000	9,216,000,000
1	2	02/28/17	15:14	15:21	4,353,000	4,354,000	-1,000	1,000,000
1	3	02/28/17	15:22	15:30	4,358,000	4,348,000	10,000	100,000,000
1	4	02/28/17	15:56	16:03	4,361,000	4,352,000	9,000	81,000,000
1	5	02/28/17	16:04	16:12	4,364,000	4,355,000	9,000	81,000,000
1	6	02/28/17	16:14	16:22	4,333,000	4,317,000	16,000	256,000,000
1	7	02/28/17	16:40	16:50	4,352,000	4,352,000	0	0
1	8	02/28/17	16:55	17:02	4,314,000	4,343,000	-29,000	841,000,000
1	9	02/28/17	17:03	17:10	4,312,000	4,341,000	-29,000	841,000,000
1	10	02/28/17	17:12	17:20	4,319,000	4,339,000	-20,000	400,000,000

n	9	
t(0.025)	2.306	
Mean Reference Method Value	4340666.667	RM avg
Mean CEM Value	4344555.556	CEM avg
Sum of Differences	-35000.000	di
Mean Difference	-3888.889	d
Sum of Differences Squared	2601000000.000	di^2
Standard Deviation	17553.094	sd
Confidence Coefficient 2.5% Error (1-tail)	13492.478	cc
Relative Accuracy	0.40	RA
Bias Adjustment Factor	1.000	BAF

Client: Michigan State University
Facility: T.B. Simon Power Plant
Project #: M170605
Test Location: Unit 4 Outlet Duct
Test Date: 3/1/2017
Test Method: 2

CEM Monitor Information

Volumetric Flow RATA – Mid Load

Flow Monitor/Model:	OFS 2000	**Flow Serial # :**	02070060

1=accept 0=reject	Test Run	Test Date	Start Time	End Time	Reference Method Flow SCFH	CEM Flow SCFH	(RM-CEM) Difference (di)	(RM-CEM) Difference ^{2} (di^2)
1	1	03/01/17	04:45	04:58	5,192,000	5,144,000	48,000	2,304,000,000
1	2	03/01/17	04:59	05:06	5,212,000	5,128,000	84,000	7,056,000,000
0	3	03/01/17	05:07	05:14	5,169,000	5,065,000	104,000	10,816,000,000
1	4	03/01/17	05:34	05:41	5,153,000	5,161,000	-8,000	64,000,000
1	5	03/01/17	05:42	05:49	5,148,000	5,144,000	4,000	16,000,000
1	6	03/01/17	05:55	06:05	5,185,000	5,147,000	38,000	1,444,000,000
1	7	03/01/17	06:14	06:21	5,153,000	5,153,000	0	0
1	8	03/01/17	06:23	06:30	5,172,000	5,139,000	33,000	1,089,000,000
1	9	03/01/17	06:31	06:41	5,186,000	5,114,000	72,000	5,184,000,000
1	10	03/01/17	06:42	06:50	5,173,000	5,126,000	47,000	2,209,000,000

n	**9**	
t(0.025)	**2.306**	
Mean Reference Method Value	**5174888.889**	**RM avg**
Mean CEM Value	**5139555.556**	**CEM avg**
Sum of Differences	**318000.000**	**di**
Mean Difference	**35333.333**	**d**
Sum of Differences Squared	**19366000000.000**	**di^2**
Standard Deviation	**31878.676**	**sd**
Confidence Coefficient 2.5% Error (1-tail)	**24504.076**	**cc**
Relative Accuracy	**1.16**	**RA**
Bias Adjustment Factor	**1.007**	**BAF**

4.0 CERTIFICATION

MOSTARDI PLATT is pleased to have been of service to Michigan State University. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

CERTIFICATION

As the program manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results. The test program was performed in accordance with the test protocol, test methods, the Mostardi Platt Quality Manual, and the ASTM D7036-12, as applicable.

MOSTARDI PLATT

Program Manager

Stuart L. Burton

Quality Assurance

Jeffrey M. Crivlare