Relative Accuracy Test Audit Test Report
for the
Continuous Emission Monitoring Systems
at the
Central Power Plant

Prepared for:
University of Michigan
Central Power Plant
SRN M0675

ICT Project No.: 2300229
April 22, 2024

IMPACT
COMPLIANCE & TESTING

Executive Summary

UNIVERSITY OF MICHIGAN - CENTRAL POWER PLANT
RELATIVE ACCURACY TEST AUDIT RESULTS

The University of Michigan (University) contracted Impact Compliance & Testing, Inc. (ICT) to conduct a Relative Accuracy Test Audit (RATA) of nitrogen oxides (NOx) and oxygen (O_2) continuous emission monitoring systems (CEMS) associated with the exhausts of three (3) dual fuel (natural gas or No. 2 fuel oil) fired boilers (EUB0260-03, EUB0260-04 and EUB0260-06) and one (1) dual fuel fired turbine with an associated heat recovery steam generator (EUCPP-CHPHRSG) at the Central Power Plant located in Ann Arbor, Washtenaw County, Michigan.

The compliance emission testing was performed pursuant to conditions of Michigan Department of Environment, Great Lakes and Energy – Air Quality Division (EGLE-AQD) Renewable Operating Permit (ROP) No. MI-ROP-M0675-2021b, 40 CFR Part 60 and 40 CFR Part 75. The following tables present the emissions results and operating data from the performance demonstration.

Unit ID	Steam Load klb/hr	Fuel Use kscfh	NO_x ppmvd at 15% O_2 RATA %	O2 %, dry RATA [d']
EUCPP-CHPHRSG	102.1	127.4	2	0.5
Allowable Standard	-	-	*10*	*1.0*

klb=1,000 pounds, hr=hour, kscfh=1,000 cubic feet per hour, [d']=average mean difference

Unit ID	Steam Load klb/hr	Fuel Use kscfh	NO_x lb/MMBtu RATA %	O2 %, dry RATA [d']
EUB0260-03	106.9	128.2	0.9	0.2
EUB0260-04	121.8	148.2	0.9	0.1
EUB0260-06	125.9	164.0	1.8	0.0
Allowable Standard	-	-	*7.5*	*0.7*

klb=1,000 pounds, hr=hour, kscfh=1,000 cubic feet per hour, [d']=average mean difference

The data above indicate that the NO_x and O_2 RATAs demonstrated compliance with the 40 CFR Part 60 or 40 CFR Part 75 allowable standards for each emission unit. The results of the RATAs for the emission units subject to 40 CFR Part 75 demonstrated compliance with the emission standards that allow for repeat testing to be performed on an annual basis.

Report Certification

Relative Accuracy Test Audit Test Report
for the
Continuous Emission Monitoring Systems
at the
Central Power Plant

University of Michigan
Central Power Plant
Ann Arbor, MI

Impact Compliance & Testing, Inc. is an Air Emissions Testing Body (AETB) that conforms with ASTM D7036–12.

Andy Rusnak is a Qualified Individual (QI) as defined by ASTM D7036-12 and oversaw all portions of the emissions testing.

The material and data in this document were prepared under the supervision and direction of the undersigned.

Impact Compliance & Testing, Inc.

Andy Rusnak, QSTI, QI
Technical Manager

Table of Contents

List of Tables

List of Appendices

1.0 Introduction

The University operates a three (3) dual fuel (natural gas or No. 2 fuel oil) fired boilers (EUB0260-03, EUB0260-04 and EUB0260-06) and one (1) dual fuel fired turbine with an associated heat recovery steam generator (EUCPP-CHPHRSG) that are required to have CEMS installed on the respective exhaust gas streams at the Central Power Plant located in Ann Arbor, Washtenaw County, Michigan.

The University has been issued ROP No. MI-ROP-M6075-2021b by the EGLE-AQD for the operation of equipment installed at the source. The three (3) referenced boilers have NOx and oxygen O_2 CEMS installed in their respective exhaust gas streams. Conditions of the ROP require the University to conduct RATAs on the installed CEMS in accordance with 40 CFR Part 75. The referenced turbine and heat recovery steam generator (HRSG) has NOx and O2 CEMS installed on the exhaust gas stream. Conditions of the ROP require the University to conduct a RATA on the installed CEMS in accordance with 40 CFR Part 60.

The compliance testing presented in this report was performed by ICT, a Michigan-based Air Emissions Testing Body (AETB). ICT representatives Andy Rusnak and Renee Fromwiller performed the field sampling and measurements March 19 – 22, 2024. Mr. Jeremy Howe and Ms. Diane Kavanaugh of EGLE-AQD were on-site to observe portions of the emissions testing.

Each RATA consisted of nine, 21-minute sampling periods for nitrogen oxides (NOx), and oxygen (O_2) content to calculate pollutant mass emission rates.

The exhaust gas sampling and analysis was performed using procedures specified in the Stack Test Protocol dated January 10, 2024 and the EGLE response letter dated March 13, 2024. The following items provide information required in EGLE-AQD "Format for Submittal of Source Emission Test Plans and Reports," dated November 2019.

Appendix 1 contains a copy of the test protocol approval letter and the test protocol and a copy of the EGLE format for Test Plans and Report.

Questions regarding this air emission test report should be directed to:

Andy Rusnak, QSTI, QI
Technical Manager
Impact Compliance & Testing, Inc.
4180 Keller Road, Suite B
Holt, MI 48842
(517) 481-3283
andy.rusnak@impactcandt.com

Mr. Stephen O'Rielly
Manager, Environmental Protection & Permitting Program
Environment, Health & Safety
University of Michigan
1239 Kipke Drive
Ann Arbor, MI 48109-1010
(734) 763-4642
sorielly@umich.edu

2.0 Summary of Test Results and Operating Conditions

2.1 Purpose and Objective of the Tests

Conditions of MI-ROP-M6075-2021b and 40 CFR Part 60, Appendix A require the University to perform a RATA on the NOx and O_2 CEMS installed on the exhaust of EUCPP-CHPHRSG. EUCPP-CHPHRSG is also referred to as Boiler No. 5 in this report and by University representatives.

Conditions of MI-ROP-M6075-2021b and 40 CFR Part 75, Appendix A and B require the University to perform a RATA on the NOx and O_2 CEMS installed on the exhausts of EUB0260-03, EUB0260-04 and EUB0260-06. EUB0260-03, EUB0260-04 and EUB0260-06 are also referred to as Boiler Nos. 3, 4 and 6, respectively, in this report and by University representatives.

2.2 Operating Conditions During the RATAs

Fuel flowrate (kscfh) and steam output (klb/hr) were recorded by University representatives on 1-minute increments for each test period. Heat input (MMBtu/hr) was calculated using the fuel flowrate and 40 CFR Part 98 Table C-1 default higher heating value (HHV) for natural gas of 1,028 Btu/scf and the following equation:

$$\text{Heat Input (MMBtu/hr)} = \text{Fuel Use (kscfh)} * \text{Fuel HHV (Btu/scf)} / 10^3$$

The RATA performed on the CEM system for Boiler No. 5 was performed while the boiler was operated at greater than 50% of maximum load. The boiler combusted an average of 127.4 kscfh and produced approximately 102.1 klb/hr of steam. The calculated heat input is 131.0 MMBtu/hr.

The RATA performed on the CEM system for Boiler No. 3 was performed while the boiler was operated at normal Part 75 boiler load. The University has determined that the normal operating load for the boiler is between 97 and 150 klb/hr of steam output. The boiler combusted an average of 128.2 kscfh and produced approximately 106.9 klb/hr of steam. The calculated heat input is 131.8 MMBtu/hr.

The RATA performed on the CEM system for Boiler No. 4 was performed while the boiler was operated at normal Part 75 boiler load. The University has determined that the normal operating load for the boiler is between 97 and 150 klb/hr of steam output. The boiler combusted an average of 148.2 kscfh and produced approximately 121.8 klb/hr of steam. The calculated heat input is 152.3 MMBtu/hr.

The RATA performed on the CEM system for Boiler No. 6 was performed while the boiler was operated at normal Part 75 boiler load. The University has determined that the normal operating load for the boiler is between 115 and 178 klb/hr of steam output. The boiler combusted an average of 164.0 kscfh and produced approximately 125.9 klb/hr of steam. The calculated heat input is 168.6 MMBtu/hr.

Appendix 2 provides operating records provided by University representatives for the test periods.

Table 2.1 presents a summary of the average boiler operating conditions during the test periods.

2.3 Summary of Air Pollutant Sampling Results

The gases exhausted from Boiler No. 3 were sampled for nine (9) twenty-one minute test periods during the compliance testing performed March 19, 2024. The gases exhausted from Boiler No. 4 were sampled for nine (9) twenty-one minute test periods during the compliance testing performed March 20, 2024. The gases exhausted from Boiler No. 5 were sampled for nine (9) twenty-one minute test periods during the compliance testing performed March 21, 2024. The gases exhausted from Boiler No. 6 were sampled for nine (9) twenty-one minute test periods during the compliance testing performed March 22, 2024.

Table 2.2 presents a summary of the results of the NO_X and O_2 RATA performed on Boiler No. 5.

Table 2.3 presents a summary of the results of the NO_X and O_2 RATAs performed on Boiler Nos. 3, 4 and 6.

Appendix 2 provides the CEMS output, provided by University representatives, for the test periods.

Test results for each twenty-one minute sampling period are presented in Section 6.0 of this report.

Table 2.1 Average Boiler Operating Conditions During the Test Periods

Boiler Parameter	EUCPP-CHPHRSG (Boiler No. 5)	EUB0260-03 (Boiler No. 3)	EUB0260-04 (Boiler No. 4)	EUB0260-06 (Boiler No. 6)
Natural Gas Flow (kscfh)	127.4	128.2	148.2	164.0
Steam Flow (klb/hr)	102.1	106.9	121.8	125.9
Heat Input (MMBtu/hr)	131.0	131.8	152.3	168.6

Table 2.2 40 CFR Part 60 RATA Results (Nine-Test Average)

Emission Unit	NO_x – ppmvd@15% O2			O2 - %dry		
	CEM	Reference Method	Relative Accuracy	CEM	Reference Method	Relative Accuracy
EUCPP-CHPHRSG	5.6	5.0	2%	13.3	12.9	0.5[A]
Permit Limit	*25*	*25*	*10%*	-	-	*1.0*[A]

Notes for Table 2.2:
A – Mean difference.

Table 2.3 40 CFR Part 75 RATA Results (Nine-Test Average)

Emission Unit	NO_x – lb/MMBtu			O2 - %dry		
	CEM	Reference Method	Relative Accuracy	CEM	Reference Method	Relative Accuracy
EUB0260-03	0.222	0.221	0.9%	4.5	4.3	0.2[A]
EUB0260-04	0.171	0.171	0.9%	3.7	3.6	0.1[A]
EUB0260-06	0.092	0.090	1.8%	4.8	4.8	0.0[A]
Permit Limit	[B]	[B]	*7.5%*	-	-	*0.7*[A]

Notes for Table 2.2:
A – Mean difference.
B – Permit Limit for Boiler Nos. 3 and 4 is 0.55 lb/MMBtu (on a 24-hr average) and Boiler No. 6 is 0.10 lb/MMBtu (on a 24-hr rolling time period).

3.0 Source and Sampling Location Description

3.1 General Process Description

The University operates three (3) dual fuel (natural gas or No. 2 fuel oil) fired boilers (EUB0260-03, EUB0260-04 and EUB0260-06) and one (1) dual fuel fired turbine with an associated heat recovery steam generator (EUCPP-CHPHRSG).

EUB0260-03, EUB0260-04 and EUB0260-06 and EUCPP-CHPHRSG generate steam and electricity for use by various University campus buildings. Steam is routed to the University's underground steam delivery system and to various campus buildings to provide thermal energy to heat the buildings during winter and air conditioning in the summer.

3.2 Rated Capacities and Air Emission Controls

EUB0260-03 and EUB0260-04 both have rated heat inputs of 300 MMBtu/hr. The boilers are not equipped with add-on control equipment. Exhaust gas is exhausted to the atmosphere through a combined exhaust stack (SV-B0260-01 or SV-B0260-02).

EUB0260-06 has a rated heat input of 376 MMBtu/hr. The boiler utilizes low-NO_x burners and flue gas recirculation to reduce NO_x emissions. Exhaust gas is exhausted to the atmosphere through a combined exhaust stack (SV-B0260-02).

The EUCPP-CHPHRSG turbine has a rated heat input of 190.1 MMBtu/hr when firing natural gas and 173.4 MMBtu/hr when firing No. 2 fuel oil. The associated electricity generator has a rated output of 15.8 MW. The EUCPP-CHPHRSG duct burner (Boiler No. 5) has a rated heat input of 112 MMBtu/hr. The turbine and boiler are equipped with dry low-NO_x combustion technology and a selective catalytic reduction (SCR) system to reduce NO_x emissions. Also, recently, a catalyst was installed on EUCPP-CHPHRSG. Exhaust gas is exhausted to the atmosphere through a combined exhaust stack (SV-B0260-01 or SV-B0260-02).

3.3 Sampling Locations

The exhaust gas from each boiler is released to the atmosphere through combined exhaust stacks, SV-B0260-01 or SV-B0260-02. The exhaust stacks have vertical release points. The RATAs were performed in the dedicated exhaust duct for each boiler, prior to tying into a common header duct. The reference analyzer sample probe was installed in a sample port that was accessible and immediately adjacent to the CEM system sample probe. The sample locations are greater than 2 diameters downstream from the point of pollutant generation and greater than 0.5 diameters upstream from the effluent exhaust.

The exhaust ducts for Boiler Nos. 3 and 4 are identical and have approximate dimensions of 64.5" x 135". The calculated equivalent diameter is 87.3".

The exhaust duct for Boiler Nos. 5 has an approximate diameter of 76".

The exhaust duct for Boiler No. 6 has approximate dimensions of 64" x 128". The calculated equivalent diameter is 85.3".

Appendix 3 provides photographs of the reference analyzer and CEM sampling locations.

4.0 Sampling and Analytical Procedures

A test protocol for the air emission testing was reviewed and approved by the EGLE-AQD. This section provides a summary of the sampling and analytical procedures that were used during the testing periods.

The exhaust gas from the emission units was sampled and analyzed to determine the concentration of NO_x in parts per million by volume dry basis (ppmvd) and O_2 in percent (%) by volume, dry basis.

For the 40 CFR Part 75 RATA the NO_x emission rate was calculated in units of pounds per million British thermal units (lb/MMBtu) using procedures specified in USEPA Reference Test Method 19, the measured natural gas use rate, exhaust gas oxygen concentration and default F-factor value and heat content for natural gas.

For the 40 CFR Part 60 RATA the measured NOx concentration (ppmvd) was corrected to ppmvd at 15% oxygen (ppmvd @ 15% O_2).

The following table presents test methods that were used to measure the specified pollutant emissions and exhaust parameters.

Parameter / Analyte	Sampling Methodology	Analytical Methodology
O_2	USEPA Method 3A	Paramagnetic detector
NO_x	USEPA Method 7E	Chemiluminescence instrumental analyzer
NO_x RATA	Performance Specification 2	Specifications for NO_x CEMS RATAs
O_2 RATA	Performance Specification 3	Specifications for O_2 CEMS RATAs
NO_x Emission Rate	USEPA Method 19	Specifications for determining NO_x emission rates

In addition to the sampling and analytical methods presented in the table above, USEPA Method 205, "Verification of Dilution Systems for Field Instrument Calibrations", was used to verify dilution system linearity for the gas divider that was used during the 40 CFR Part 60 RATA (gas divider was not used during the 40 CFR Part 75 RATAs).

4.1 Measurement of O_2 Content (USEPA Method 3A)

Exhaust O_2 content measurements was performed concurrently during each air pollutant sampling period using an instrumental analyzer in accordance with Method 3A. A Servomex Model 4900 gas analyzer that uses a paramagnetic sensor was used to measure the exhaust gas O_2 content.

A continuous sample of the exhaust gas was delivered to the instrumental analyzers using an extractive gas sampling system that prevents condensation or contamination of the sample. The exhaust gas samples were conditioned (i.e., dried) prior to being introduced to the instrumental analyzer.

The instrumental analyzer was calibrated using EPA Protocol 1 certified concentrations of O_2 in nitrogen. For the 40 CFR Part 60 RATA the calibration gas was diluted (using a certified gas divider) with nitrogen to obtain intermediate O_2 concentrations and to demonstrate linearity of the instrumental analyzer.

Appendix 4 provides O_2 calculation sheets. Raw instrument response data are provided in Appendix 5.

4.2 Measurement of NOx Concentration (USEPA Method 7E)

Exhaust NOx concentrations were determined during each test run sample period using a NO-NO_2-NO_x analyzer that utilizes chemiluminescence technology (Thermo Environmental Instruments, Inc. (TEI) Model 42i) in accordance with USEPA Method 7E.

A continuous sample of the exhaust gas was delivered to the instrumental analyzer using an extractive gas sampling system that prevents condensation or contamination of the sample. The exhaust gas samples were conditioned (i.e., dried) prior to being introduced to the instrumental analyzer. Therefore, NOx measurements correspond to standard conditions with moisture correction (dry basis).

The instrumental analyzer was calibrated using certified concentrations of NOx in nitrogen. For the 40 CFR Part 60 RATA the calibration gas was diluted (using a certified gas divider) with nitrogen to obtain intermediate NOx concentrations and to demonstrate linearity of the instrumental analyzer.

Appendix 4 provides NO_X calculation sheets. Raw instrument response data are provided in Appendix 5.

4.3 Relative Accuracy Performance Specifications (PS2 and PS3)

The RA was calculated for each CEMS using the equations in Performance Specifications 2 and 3.

For the 40 CFR Part 75 RATA the performance of the CEMS satisfy the performance specification for repeat annual testing when the:

- Calculated O_2 RA is less than or equal to 7.5% of the Reference Method (RM) or within 0.7% O_2.
- Calculated NOx RA is less than or equal to 7.5% of the RM or within 0.015 lb/MMBtu.

For the 40 CFR Part 60 RATA the performance of the CEMS satisfy the performance specification when the:

- Calculated O_2 RA is no greater than 1% O_2.
- Calculated NO_x RA is no greater than 20% of the RM or 10% if using the actual emission standard (AS) in the denominator of the RA calculation.

4.4 Mass Emission Rate Calculations (USEPA Method 19)

The Boiler Nos. 3, 4 and 6 NOx mass emission rate (lb/MMBtu) was calculated using the measured concentrations and appropriate fuel F factors (ratio of combustion gas volume to heat input) as described in USEPA Method 19.

The fuel used in the boilers was pipeline natural gas, which has a published default F-factor in USEPA Method 19, Table 19-2. Exhaust gas oxygen content and NO_x concentrations were measured on a dry gas basis. Therefore, the NOx emission factor, E (lb/MMBtu) was calculated using Equation 19-1:

$E = (C_d) \times (F_d) \times (20.9) / (20.9 - \%O_2)$

E	=	Calculated emission factor, lb/MMBtu
C_d	=	Measured concentration, dry basis, lb/scf
F_d	=	8,710 dscf/MMBtu for natural gas
$\%O_2$	=	Measured oxygen content, dry basis, %vol.

The heat input (MMBtu/hr) of the boiler was calculated using the measured natural gas use rate (kscfh) and the HHV of the fuel. The fuel used in the boilers is pipeline-quality natural gas which has a published heating value (40 CFR Part 98 Table C-1). The default heating value for natural gas is 1.028E-03 MMBtu/scf.

Boiler Heat Input (MMBtu/hr) = fuel use (kscfh) * (1.028E-3 MMBtu/scf) * (1,000 scf/kscf)

5.0 QA/QC Activities

5.1 NOx Converter Efficiency Test

The NO_2 – NO conversion efficiency of the Model 42i analyzer was verified prior to the RATAs. A USEPA Protocol 1 certified concentration of NO_2 in air was injected directly into the analyzer, following the initial three-point calibration, to verify the analyzer's conversion efficiency. The analyzer's NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. The conversion efficiency of the analyzer is deemed acceptable if the measured NOx concentration is within 90% of the expected value.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (measured NOx concentration was 91.1% of the expected value).

5.2 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used during the 40 CFR Part 60 RATA to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivers calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider.

5.3 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NOx and O_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 2.5% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.4 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the NOx and O_2 analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing an appropriate upscale calibration gas and zero gas into the sampling system (at the base of the stainless-steel sampling probes prior to the particulate filter and Teflon® heated sample line) and verifying the instrument response against the initial instrument calibration readings.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of O_2 and NOx in nitrogen and zeroed using nitrogen. A STEC Model SGD-710C 10-step gas divider was used for the 40 CFR Part 60 RATA to obtain intermediate calibration gas concentrations as needed.

5.5 Determination of Exhaust Gas Stratification

Sampling points were determined using the procedures specified in PS2 Section 8.1.3.2. Stratification across the ducts was not expected. Three (3) stainless-steel sample probes attached to a 3-way valve were positioned at three sample points located at 16.7%, 50.0%, and 83.3% of the duct diameter. Sampling occured for an equal time at each point during the sample periods.

The recorded concentration data for the boilers exhaust stacks indicated that the measured NOx and O_2 concentrations did not vary by more than 5% of the mean or +/-0.5 ppmv (for NOx) and +/- 0.3% (for O_2) from the mean (whichever is less restrictive) across the duct diameter. Therefore, each boiler exhaust gas stream was considered to be unstratified.

5.6 System Response Time

The response time of the sampling system was determined prior to the RATAs by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

Sampling periods did not commence until the sampling probe had been in place for at least twice the greatest system response time.

Appendix 6 presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results and stratification checks).

6.0 Results

6.1 Test Results and Allowable Standards

Emission measurement results for each RATA test period are presented in Table 6.2 through 6.9.

Table 6.1 presents the acceptable criteria for the RATAs performed on each individual boiler.

Table 6.1 Acceptable RATA Criteria

Pollutants and Limits	
Facility ID	**Annual RATA Requirements**
Boiler Nos. 3, 4 and 6	O_2 ($\%_{dry}$) - ≤7.5% RM or ± 0.7% NO_x (ppmvd) - ≤7.5 % RM or ± 12 ppmvd NO_x (lb/MMBtu) - ≤7.5% RM or ± 0.015 lb/MMBtu
Turbine and Boiler No. 5	O_2 ($\%_{dry}$) - ± 1.0% NO_x (ppmvd) - ≤20% RM or ≤10% AS

RM – Reference Method, AS – Actual Emission Standard

Each RATA demonstrated compliance with the respective allowable standards listed in Table 6.1. For the 40 CFR Part 60 RATA the actual emission standard (25 ppmvd @ 15% O_2) was used to calculate the relative accuracy. For the 40 CFR Part 75 RATAs the results met the criteria that specifies subsequent RATAs will be performed on an annual basis.

Based on the results of the RATA, bias adjustment factors were calculated for Boiler No. 3, 4 and 6 using Equation A-12 from 40 CFR Part 75, Appendix A:

$$\text{Bias Adjustment Factor} = 1 + [d'] / CEM_{avg}$$

Where:
[d'] = mean difference during the RATA
CEM_{avg} = mean of values recorded by CEMS during RATA

The bias adjustment factor for Boiler No. 3 is 1.005. The bias adjustment factor for Boiler No. 4 is 1.002. The bias adjustment factor for Boiler No. 6 is 1.014.

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with 40 CFR Part 60, 40 CFR Part 75 and the USEPA reference test methods and the approved Stack Test Protocol. The boilers were operated at the required loads and no variations from normal operating conditions occurred during the RATA test periods.

Table 6.2 - NO_x Emission Rate RATA for Boiler No. 3 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (lb NO_x/MMBtu)	CEMS Data	Difference [d]
1	3/19/24	7:55	8:15	0.220	0.219	0.0011
2	3/19/24	8:27	8:47	0.219	0.221	-0.0020
3	3/19/24	8:57	9:17	0.223	0.221	0.0017
4	3/19/24	9:29	9:49	0.224	0.222	0.0021
5	3/19/24	10:00	10:20	0.223	0.222	0.0014
6	3/19/24	10:31	10:51	0.223	0.221	0.0017
7	3/19/24	11:04	11:24	0.222	0.221	0.0014
8	3/19/24	11:35	11:55	0.221	0.220	0.0015
9	3/19/24	12:07	12:27	0.221	0.220	0.0012

Number of tests periods:	[n]	9
Arithmetic Mean Difference:	[$\bar{d}$]	0.0011
Allowable Limit*:		0.0150
Standard Deviation:	[S_d]	0.0012
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[CC]	0.0009
Arithmetic Mean RM Values*:	[$\bar{RM}$]	0.2219
Relative Accuracy:	[RA]	0.9%
Allowable Limit*:		7.5%

* Acceptable annual RA is less than 7.5% if the mean RM value is used or 0.015 lb/MMBtu if mean difference is used.

Table 6.3 - O_2 Concentration RATA for Boiler No. 3 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (%, dry O_2)	CEMS Data	Difference [d]
1	3/19/24	7:55	8:15	4.45	4.30	0.15
2	3/19/24	8:27	8:47	4.46	4.34	0.12
3	3/19/24	8:57	9:17	4.51	4.34	0.17
4	3/19/24	9:29	9:49	4.54	4.33	0.21
5	3/19/24	10:00	10:20	4.52	4.31	0.21
6	3/19/24	10:31	10:51	4.49	4.32	0.17
7	3/19/24	11:04	11:24	4.51	4.32	0.19
8	3/19/24	11:35	11:55	4.51	4.33	0.18
9	3/19/24	12:07	12:27	4.50	4.34	0.16

Number of tests periods:	[n]	9
Arithmetic Mean Difference:	[d']	0.2
Allowable Limit*:		0.7
Standard Deviation:	[S_d]	0.027
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[CC]	0.021
Arithmetic Mean RM Values*:	[RM']	4.50
Relative Accuracy:	[RA]	4.3%
Allowable Limit*:		7.5%

* Acceptable annual RA is less than 7.5% if the mean RM value is used or 0.7% if mean difference is used.

Table 6.4 - NO_x Emission Rate RATA for Boiler No. 4 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (lb NO_x/MMBtu)	CEMS Data (lb NO_x/MMBtu)	Difference [d]
1	3/20/24	7:47	8:07	0.169	0.166	0.0032
2	3/20/24	8:18	8:38	0.168	0.166	0.0020
3	3/20/24	8:49	9:09	0.168	0.167	0.0006
4	3/20/24	9:20	9:40	0.171	0.171	0.0002
5	3/20/24	9:51	10:11	0.171	0.171	0.0000
6	3/20/24	10:21	10:41	0.171	0.172	-0.0007
7	3/20/24	10:52	11:12	0.172	0.173	-0.0009
8	3/20/24	11:23	11:43	0.175	0.176	-0.0007
9	3/20/24	11:54	12:14	0.176	0.176	0.0001

Number of tests periods:	[*n*]	9
Arithmetic Mean Difference:	[*d*']	0.0004
Allowable Limit*:		0.0150
Standard Deviation:	[S_d]	0.0014
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[*CC*]	0.0011
Arithmetic Mean RM Values*:	[*RM*']	0.1713
Relative Accuracy:	[*RA*]	0.9%
Allowable Limit*:		7.5%

* Acceptable annual RA is less than 7.5% if the mean RM value is used or 0.015 lb/MMBtu if mean difference is used.

Table 6.5 - O_2 Concentration RATA for Boiler No. 4 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (%, dry O_2)	CEMS Data	Difference [d]
1	3/20/24	7:47	8:07	3.70	3.63	0.07
2	3/20/24	8:18	8:38	3.72	3.62	0.10
3	3/20/24	8:49	9:09	3.69	3.61	0.08
4	3/20/24	9:20	9:40	3.69	3.61	0.08
5	3/20/24	9:51	10:11	3.68	3.62	0.06
6	3/20/24	10:21	10:41	3.66	3.61	0.05
7	3/20/24	10:52	11:12	3.66	3.60	0.06
8	3/20/24	11:23	11:43	3.66	3.60	0.06
9	3/20/24	11:54	12:14	3.64	3.59	0.05

Number of tests periods:	[n]	9
Arithmetic Mean Difference:	[$\bar{d}$]	0.1
Allowable Limit*:		0.7
Standard Deviation:	[S_d]	0.017
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[CC]	0.013
Arithmetic Mean RM Values*:	[$\overline{RM}$]	3.677
Relative Accuracy:	[RA]	2.2%
Allowable Limit*:		7.5%

* Acceptable annual RA is less than 7.5% if the mean RM value is used or 0.7% if mean difference is used.

Table 6.6 - NO_x Corrected Concentration RATA for Boiler No. 5 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (ppmvd NO_x @ 15% O_2)	CEMS Data	Difference [d]
1	3/21/24	7:50	8:10	5.50	5.03	0.5
2	3/21/24	8:28	8:48	5.67	5.02	0.7
3	3/21/24	9:01	9:21	5.62	5.06	0.6
4	3/21/24	9:34	9:54	5.58	4.96	0.6
5	3/21/24	10:07	10:27	5.42	5.04	0.4
6	3/21/24	10:41	11:01	5.51	4.91	0.6
7	3/21/24	11:13	11:33	5.73	5.07	0.7
8	3/21/24	11:45	12:05	5.55	5.07	0.5
9	3/21/24	12:20	12:40	5.55	5.08	0.5

Number of tests periods:	[*n*]	9
Arithmetic Mean Difference:	[*d*']	0.54
Standard Deviation:	[S_d]	0.097
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[*CC*]	0.07
Arithmetic Mean RM Values*:	[*RM*']	5.57
Relative Accuracy**:	[*RA*]	2%
Allowable Limit**:		10%

* If actual measured emissions are less than 50% of applicable standard, use the emission standard for RM'

** Relative accuracy for the CEMS must be no greater than 20% (10% if the emission standard is used for RM').

Table 6.7 - O_2 Concentration RATA for Boiler No. 5 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (%, dry O_2)	CEMS Data	Difference [d]
1	3/21/24	7:50	8:10	13.2	12.7	0.4
2	3/21/24	8:28	8:48	13.2	12.8	0.4
3	3/21/24	9:01	9:21	13.3	12.9	0.4
4	3/21/24	9:34	9:54	13.3	12.9	0.4
5	3/21/24	10:07	10:27	13.3	12.8	0.5
6	3/21/24	10:41	11:01	13.3	12.9	0.4
7	3/21/24	11:13	11:33	13.4	12.9	0.4
8	3/21/24	11:45	12:05	13.4	12.9	0.5
9	3/21/24	12:20	12:40	13.4	13.0	0.5
	Number of tests periods:			[*n*]	9	
	Arithmetic Mean Difference:			[*d*]	0.5	
	Allowable Limit*:				1.0	

* Mean difference for the CEMS must be no greater than 1%.

Table 6.8 - NO_x Emission Rate RATA for Boiler No. 6 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result ($lb\ NO_x/MMBtu$)	CEMS Data ($lb\ NO_x/MMBtu$)	Difference [d]
1	3/22/24	8:41	9:01	0.091	0.090	0.0006
2	3/22/24	9:11	9:31	0.092	0.091	0.0011
3	3/22/24	9:41	10:01	0.090	0.089	0.0010
4	3/22/24	10:11	10:31	0.092	0.091	0.0014
5	3/22/24	10:40	11:00	0.091	0.090	0.0015
6	3/22/24	11:09	11:29	0.092	0.091	0.0012
7	3/22/24	11:38	11:58	0.093	0.091	0.0017
8	3/22/24	12:08	12:28	0.092	0.090	0.0020
9	3/22/24	12:40	13:00	0.091	0.090	0.0008

Number of tests periods:	[*n*]	9
Arithmetic Mean Difference:	[*d*']	0.0013
Allowable Limit*:		0.0150
Standard Deviation:	[S_d]	0.0004
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[*CC*]	0.0003
Arithmetic Mean RM Values*:	[*RM*']	0.0916
Relative Accuracy:	[*RA*]	1.8%
Allowable Limit*:		7.5%

* Acceptable annual RA is less than 7.5% if the mean RM value is used or 0.015 lb/MMBtu if mean difference is used.

Table 6.9 - O_2 Concentration RATA for Boiler No. 6 Exhaust

Run Number	Test Date	Begin	End	Ref. Method Result (%, dry O_2)	CEMS Data	Difference [d]
1	3/22/24	8:41	9:01	4.71	4.67	0.04
2	3/22/24	9:11	9:31	4.99	4.99	0.00
3	3/22/24	9:41	10:01	4.69	4.68	0.01
4	3/22/24	10:11	10:31	4.90	4.90	0.00
5	3/22/24	10:40	11:00	4.77	4.77	0.00
6	3/22/24	11:09	11:29	4.84	4.83	0.01
7	3/22/24	11:38	11:58	4.80	4.80	0.00
8	3/22/24	12:08	12:28	4.80	4.80	0.00
9	3/22/24	12:40	13:00	4.84	4.85	-0.01

Number of tests periods:	[n]	9
Arithmetic Mean Difference:	[d']	0.0
Allowable Limit*:		0.7
Standard Deviation:	[S_d]	0.0134
97.5% Confidence T-Value:	[$t_{0.975}$]	2.306
Confidence Coefficient:	[CC]	0.0103
Arithmetic Mean RM Values*:	[RM']	4.8175
Relative Accuracy:	[RA]	0.4%
Allowable Limit*:		7.5%

* Acceptable annual RA is less than 7.5% if the mean RM value is used or 0.7% if mean difference is used.