FINAL REPORT

DETROIT THERMAL, L.L.C.

DETROIT, MICHIGAN

2022 QUARTER 2 RELATIVE ACCURACY AUDIT:
BOILER 6 & BOILER 7
RWDI #2202500
June 8, 2022

SUBMITTED TO

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by Detroit Thermal, L.C.C. to conduct a Relative Accuracy Audit (RAA) at the Detroit Thermal Beacon Heating Plant location at 541 Madison Street facility, located in Detroit, Michigan. The RAA was completed on April 11, 2022 on EUBOILER6 (Boiler 6) & EUBOILER7 (Boiler 7) for Nitrogen Oxides (NO$_x$) and Oxygen (O$_2$) for the Predictive Emission Monitoring Systems (PEMS). RAA is conducted yearly and is a requirement under the facility permit MI-ROP-B2814-2014 and under United States Environmental Protection Agency (U.S. EPA) Appendix A, 40 CFR, Part 60. NO$_x$ and O$_2$ measurements were collected using U.S. EPA Methods 7E and 3A under 40 CFR, Part 60, Appendix A and Performance Specifications (PS) 2, 3, and 16 stipulated in 40 CFR, Part 60, Appendix B.

The monitors audited during this testing program include: oxides of nitrogen (NO$_x$) and oxygen (O$_2$). The relative accuracy requirements are set-out in the applicable Performance Specification in 40 CFR 60, Appendix B.

Table 2: Test Personnel

Company	Position	Individual
RWDI	Project Supervisor	Brad Bergeron
RWDI	Field Technician	Ben Durham
Detroit Thermal, L.C.C	Environment, Health & Safety Engineering Manager	Dale Lane
Detroit Thermal, L.C.C	Plant Manager	Phil Malara

2 PLANT AND SOURCE DESCRIPTION

2.1 Plant Overview

Detroit Thermal Beacon Heating Plant located at 541 Madison Street in Detroit Michigan, operates two (2) natural gas fired boilers. Each of the boilers (Boiler 6 and Boiler 7) has a maximum heat input rating of 180.2 MMBTU while firing on natural gas. The steam from the boilers is distributed to the Detroit network for use in process and comfort heating systems. Each of the boilers are equipped with low-NO$_x$ burners to control the NO$_x$ emissions from the boilers.

2.2 Predictive Emission Monitors Specifications Boiler 6 & Boiler 7

Boiler 6 & Boiler 7 are equipped with the AMP-Cherokee Prologix P60TM PEMS. The P60TM PEMS is a PLC-based system which calculates pollutant emissions from sensors inputs using high-order polynomial equations. The process sensor inputs are read by the PLC via signals from the facility distributive control system (DCS). Sensor data is validated and predicted gas concentrations for each sensor are calculated using relationships that are defined by calculating a weighted average of the individual predictions. The PEMS hardware is comprised of three (3) basic components: the PLC, a touch panel PC and a data historian and report server.

The AMP-Cherokee Prologix P60TM PEMS records data continuously and generates reports in compliance with 40 CFR Part 60 regulations. These reports can be operated on any workstation on the local area network and provide the operators information on compliance status of the boilers in real-time.

The AMP-Cherokee Prologix P60TM PEMS at Detroit Thermal have the following Serial Numbers:

Unit	Model	Serial Number
Boiler 6	AMP-Cherokee Prologix P60™	608A9509
Boiler 7	AMP-Cherokee Prologix P60™	607D6B13

3 SAMPLING LOCATION

The sampling port for the RAA testing was located outside within the exhaust duct. Boiler 6 and Boiler 7 share a common duct for the discharge of the emissions from each of the boilers. During the RAA, Detroit Thermal personnel were able to isolate each of the boilers so the RAA would be completed on each boiler individually.

Figure 1: RAA Sampling Location

4 REFERENCE METHOD SAMPLING

The following section provides an overview of the sampling methodologies employed by the sampling program. The table below summarizes the reference methods used in this study.

Table 3: Summary of Sampling Methodologies

Parameter	Reference Method
RAA Methodology and Calculations	U.S EPA Performance Specifications 2,3, and 16
Oxides of Nitrogen	U.S. EPA Method 7E
Oxygen	U.S. EPA Method 3A
Nitrogen Oxide Emission Rates	U.S. EPA Method 19

4.1 Relative Accuracy Audit

The reference test method procedures outlined above are instrumental test methods. They were conducted in accordance with 40 CFR 60, Appendix B, Performance Specifications 2, 3, and 16. The relative accuracies were calculated according to the appropriate emission standards. To satisfy the RAA requirements of 40 CFR 60, Appendix B, the relative accuracy must not exceed 20.0% of the mean of the reference method since the concentration of NO_x was less than 100ppm. As outlined in Performance Specification 16, Section 13.5 the performance specifications for the RAAs are as follows:

- The average of the three portable analyzer or RM determinations must not differ from the simultaneous PEMS average value by more than 2ppm of the criteria. Therefore, for NO_x, the evaluation of RA was compared to 2ppm of the criteria since the NOx values were less than 20ppm.
- For Oxygen, 20 percent for concentrations was used as the RAA criteria.

The RAA was conducted while the unit operated at a minimum of 50% capacity. The exhaust gas sample was withdrawn from the duct using a stainless-steel probe at a single centroid port along the duct. The sample proceeded through a heated filter where particulate matter was removed. The sample was then transferred via a heated Teflon® line maintained at a temperature of 250°F to a sample conditioner. The sample conditioner removed any moisture from the exhaust gas. The sample was then routed through a manifold system and introduced to the individual CEM's for measurement.

Appendix A and **Appendix C** of this report contains detailed information on the Reference Method RAA test runs, including; a summary of results, raw PEMs data, corrected CEM data and pre and post-test calibration information for all parameters, respectively for Boiler 6 and 7. **Appendix B** and **Appendix D** of this report contain 1-minute averages of Detroit Thermal PEMS system, respectively for Boiler 6 and Boiler 7. **Appendix E** contains calibration gas Certificates of Accuracy. Below is a schematic of the RWDI reference method sampling system.
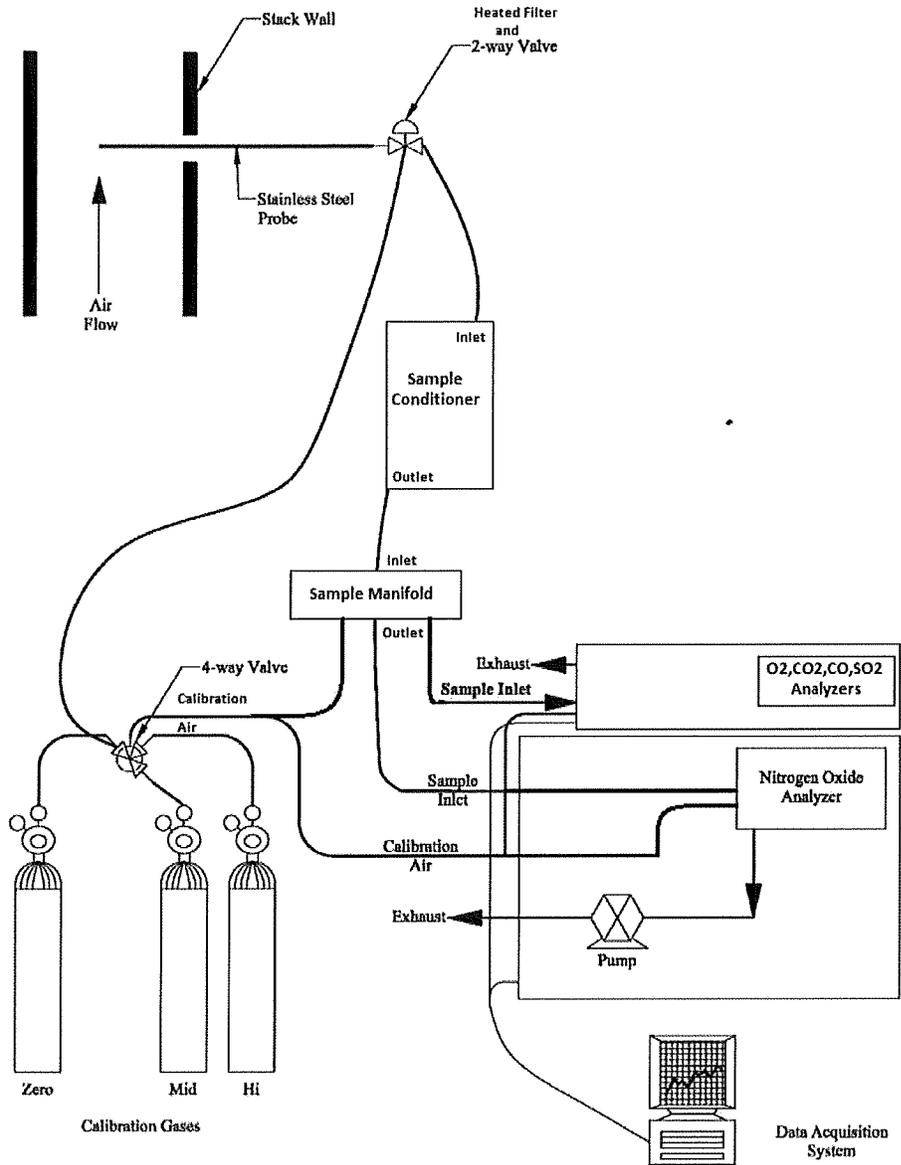
Figure 2: RWDI CEM Sampling System

Table 4: RWDI CEM Analyzers (RM)

RWDI CEM Analyzers					
Parameter	Unit	Location	Range	Analyzer	Serial Number
O_2	6/7	Stack	0 - 25%	Teledyne T200H NOx, O2	851
NOx	6/7	Stack	0 – 100 ppm	Teledyne T200H NOx, O2	851

4.2 Oxygen (US EPA method 3A)

US EPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure)", was used to measure the oxygen concentration of the flue gas. A Teledyne T200H NOx, O_2 paramagnetic analyzer was used for oxygen measurements.

Prior to testing, a 3-point analyzer calibration error check was conducted using US EPA protocol gases. The calibration error check was performed by introducing zero, mid and high level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response was within ±2% of the certified calibration gas introduced. Prior to each test run, a system-bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if the analyzers response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre-and post-test system bias checks. The system bias checks confirmed that the analyzer did not drift greater than ±3% throughout a test run.

Data acquisition was provided using a data logger system programmed to collect and record data at one second intervals. Average one minute concentrations were calculated from the one second measurements.

4.3 Oxides of Nitrogen (US EPA method 7E)

NOx emissions were measured following USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources." The NOx concentration was measured using a Teledyne T200H NOx, O2 Chemiluminescence gas analyzer.

A NO/NO_2 conversion check was performed prior to each new source by introducing NO_2 gas into the NOx analyzer. The analyzers NOx concentration readout was greater than 90% of the introduced calibration gas; therefore, the conversion met the converter efficiency requirement of section 13.5 of USEPA Method 7E. NO/NO_2 conversion data is outlined in the table below

Table 5: NO/NO_2 Converter Efficiency

Date	Certified Calibration Gas Value (ppmv)	Analyzer Response Peak Value (ppmv)	NO_2 to NO Converter Efficiency (%)	Efficiency: Pass/Fail
4-11-2022 – Boiler 6	97.9	91.17	93%	PASS
4-11-2022 – Boiler 7	97.9	99.89	102%	PASS

Note: Converter Efficiency must be >90%

4.4 Nitrogen Oxides Emission Rate Calculation (US EPA Methods 19)

USEPA Method 19, "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxide Emission Rates," was used to calculate a NO_x emission factor based on Oxygen concentrations and appropriate F-factors. Equation 19-1 from the method was used. Table 19-1 was used to determine the conversion factor for concentration (1.194×10^{-7}) was used for NO_x. Table 19-2 was used for the F-Factor (natural gas 8,710 dscf/10^6 BTU).

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

Where:

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

C_d = Pollutant Concentration, Dry Basis (ppm)

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

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

4.5 Gas Dilution (Method 205)

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included in **Appendix E.** A multi-point EPA Method 205 check was executed in the field prior to testing to ensure accurate gas-mixtures. The gas dilution system consisting of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with US EPA Method 205 *"Verification of Gas Dilution Systems for Field Instrument Calibrations"*. Before testing, the gas divider dilutions were measured to evaluate that the responses are within ±2% of predicted values. In addition, a certified mid-level calibration gas within ±10% of one of the tested dilution gases were introduced into an analyzer to ensure the response of the gas calibration is within ±2% of gas divider dilution concentration.

4.6 Quality Assurance and Quality Control Procedures

Quality assurance measures were implemented during the sampling program to ensure the integrity of the results. These measures included detailed documentation of field data, and equipment calibrations for all measured parameters.

Quality control procedures specific to the CEM monitoring included linearity checks, to determine the instrument performance, and reproducibility checks prior to its use in the field. Regular performance checks on the analyzers were also carried out during the testing program by performing 30 minute zero and span calibration checks using EPA Protocol 1 gas standards. Sample system bias checks were also conducted. These checks were used to verify the ongoing precision of the monitor and sampling system over time. Nitrogen was introduced to perform the zero checks, followed by a known calibration (span) gas into the monitor. The response of the monitor to nitrogen and the corresponding sensitivity to the span gas were recorded regularly during the tests. The tables below outline the QA/QC procedures and calibration gas summary.

Table 6: Summary of QA/QC Procedures

Summary of QA/QC Procedures				
Test Method	QA/QC Procedure	QA/QC Objective	QA/QC Results	Status of QA/QC
US EPA 3A & 7E	Initial Calibration Error Test	< ±2%	< ±2%	Acceptable
	System Bias Test	< ±5%	< ±5%	Acceptable
	Drift Test	< ±3%	< ±3%	Acceptable
US EPA 7E	NOx Converter Checks	>90% conversion efficiency	>90%	Acceptable

Table 7: Reference Method Calibration Gas Values

Reference Method Calibration Gas Values			
Parameter	Span Level	Calibration Gas Value	Calibration Gas Serial Number
Oxygen	Mid	10.1%	DT0015960
	High	20.93%	EB0119153
Nitrogen Oxides	High	1514 ppm	CC245021
Nitrogen Dioxide	Converter Gas	97.9 ppm	SA10321

5 RESULTS

The overall results from the testing are discussed in this section. Detailed results of each individual Reference Method test and individual PEMS tests may be found in **Appendices A & B** for Boiler 6 and **Appendices C & D** for Boiler 7.

5.1 Summary Relative Accuracy Audit (RAA) Results

A total of three (3), 30-minute tests were completed on the PEMS for NO_x and O_2. A summary of all RAA tests and the results of the relative accuracy calculations are presented in in **Tables** section. **Appendix E** contains the calibration gas certifications and **Appendix F** contains the field notes.

The relative accuracy audit was conducted to determine if the Detroit Thermal Beacon Heating Plant PEMS will give data that can be compared with data obtained using reference test methods. Below is a summary of the results.

Table 8: Summary of Results

Parameter	Boiler 6		Boiler 7	
	Relative Accuracy (RA) (Mean Difference from RM %)	Relative Accuracy (RA) (Absolute Difference from RM Concentration)	Relative Accuracy (RA) (Mean Difference from RM %)	Relative Accuracy (RA) (Absolute Difference from RM Concentration)
Oxides of Nitrogen (ppm)	9.2% (Pass – 20% Limit)	1.22 ppm (Pass – 2ppm Limit)	3.6% (Pass – 20% Limit)	0.40 ppm (Pass – 2ppm Limit)
Oxides of Nitrogen (lb/MMBTU)	5.9% (Pass – 20% Limit)	Not Applicable	3.5% (Pass)	Not Applicable
Oxygen (%)	9.4% (Pass – 20% Limit)	0.41% (Pass – 1% Limit)	4.2% (Pass – 20% Limit)	0.28% (Pass – 1% Limit)

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6 BOILER OPERATING CONDITIONS

Operating conditions during the sampling were monitored by Detroit Thermal personnel. Testing was performed while Boiler 7 operated at a minimum of 50% load during the RAA. Contact was kept between RWDI and boiler operators to ensure the boiler was running at all times during the testing.

7 CONCLUSIONS

The purpose of the study was to perform 2022 Quarter 2 RAA on the PEMS for EUBOILER6 (Boiler 6) and EUBOILER7 (Boiler 7).

All analyzers meet the relative accuracy requirements set out in Performance Specification in 40 CFR 60, Appendix B.