FINAL REPORT

DETROIT THERMAL BEACON HEATING PLANT

DETROIT, MICHIGAN

2018 SOURCE TESTING PROGRAM (BOILER 6 & 7)

RWDI #1802544

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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Detroit Thermal Beacon Heating Plant (DTBHP) to complete a compliance emission sampling program at their facility located at 541 Madison Avenue, Detroit, Michigan. The sampling program was conducted in order to fulfill the requirements of the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) # MI-ROP-B2814-2014 dated April 23, 2014 to demonstrate compliance with 40 CFR 60, Appendices A, B & F. The pollutants that were tested include particulate matter (PM10) and carbon monoxide (CO) from Boiler 6 and 7 (FGBOILER_6, 7). A copy of the ROP is provided in **Appendix A.**

The Sampling Plan for this testing program was submitted February 7, 2018 to the Michigan Department of Environmental Quality (MDEQ). Approval for the testing program was granted by the MDEQ on February 26, 2018. The 2018 sampling program on Boiler 6 and 7 (FGBOILER_6, 7) was completed on March 6, 2018. A copy of the MDEQ approval letter can be found in **Appendix B**.

The following table represents a summary of the stack testing results and compares the testing results to the limits set out in Detroit Thermal Beacon Heating Plant Renewable Operating Permit.

Parameter	Units	Stack Testing Results	Stack Testing Results	ROP Limit [1]
Limits from ROP: MI-ROP-B2814-2014		**Boiler 6**	**Boiler 7**	
Particulate Matter (PM)	lb/MMBtu	0.003	0.005	0.007
Carbon Monoxide (CO)	lb/MMBtu	0.0012	0.0011	0.073

Notes: *[1] Refer to Appendix A for Renewable Operating Permit: MI-ROP-B2814-2014*

The results of the testing indicate that all parameters are in compliance with respect to the ROP limits. A summary of all testing results can be found in the **Tables** section of the report with detailed sampling results in the Appendices.

1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Detroit Thermal Beacon Heating Plant (DTBHP) to complete a compliance emission sampling program at their facility located at 541 Madison Avenue, Detroit, Michigan. The sampling program was conducted in order to fulfill the requirements of the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) # MI-ROP-B2814-2014 dated April 23, 2014 to demonstrate compliance with 40 CFR 60, Appendices A, B & F. The pollutants that were tested include particulate matter (PM10) and carbon monoxide (CO) from Boiler 6 and 7 (FGBOILER_6, 7). A copy of the ROP is provided in **Appendix A.**

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- Velocity, flow rate and temperature
- Total particulate matter (TPM);
- Condensable particulate matter (CPM);
- Oxygen (O_2);
- Carbon dioxide (CO_2); and
- Carbon monoxide (CO);

2 SOURCE DESCRIPTION

2.1 Facility Description

Detroit Thermal Beacon Heating Plant located at 541 Madison Street in Detroit Michigan, operates four (4) natural gas fired boilers. This sampling program focused on Boiler 6 and Boiler 7 (FGBOILER_6,7) that each have 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 is equipped with low-NO_x burners to control the NO_x emissions from the boilers.

2.2 Process Description

Boiler 6 is a 180.2 million Btu/hr natural gas fired boiler that is equipped with a No. 2 fuel oil back-up. Currently Boiler 6 is fired using natural gas only. Boiler 7 is also a 180.2 million Btu/hr natural gas fired boiler that is equipped with a No. 2 fuel oil back-up. Currently Boiler 7 is also fired using natural gas only. Each of the boilers are equipped with low-NO_x burners to control the NO_x emissions.

3 SAMPLING LOCATION

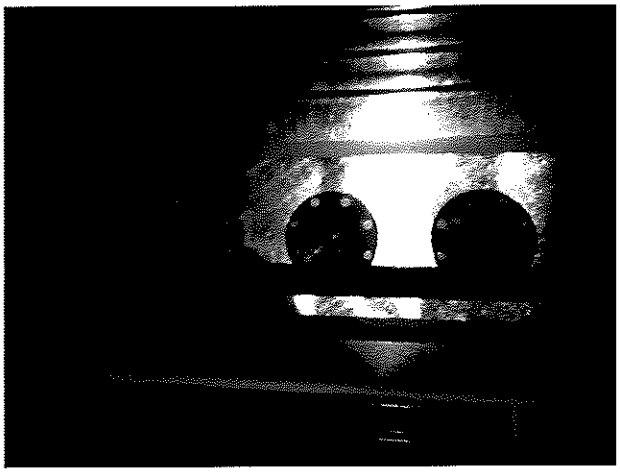
3.1 Compliance Source Sample Location Description

The sampling locations for Boilers No. 6 & 7 are through a common duct (S12). The common duct has six (6) sampling ports, along the longest side of the duct, and each are 4 inches in diameter. The sampling ports are located ~5 duct diameters upstream from any flow disturbances and >8 duct diameters downstream before the stack outlet.

Table 3.1.1: Summary of Sampling Program – FGBOILER_6 and FGBOILER_7

	FGBOILER_6	FGBOILER_7
Emission Unit Description [Including Process Equipment & Control Device(s)]	Boiler No. 6 – 180.2 million Btu/hr, natural gas fired with No. 2 fuel oil back-up. Currently Boiler 6 is fired solely using natural gas. Boiler No. 7 – 180.2 million Btu/hr, natural gas fired with No. 2 fuel oil back-up. Currently Boiler 7 is fired solely using natural gas. Boiler No. 6 and No. 7 are equipped with low-NOx burners and flue gas recirculation.	
Parameter Tested	Particulate (PM_{10}) and Carbon Monoxide (CO)	
Operating Conditions / Stack Dimensions	320°F / 70 inches X 46 inches	320°F / 70 inches x 46 inches
Testing Monitoring Methods	Refer to Section 3.0	
Testing Schedule	Refer to Section 1.2	

During the PM_{10}/CO testing, DTBHP personnel were able to isolate each of the boilers so the PM_{10}/CO testing can be completed on each boiler individually. Sampling was completed equally over each of the sample ports. A total of 18 point (3 per traverse) was sampled for 4 minutes each for a total sampling time of 72 minutes.



4 SAMPLING METHODOLOGY

The following section provides an overview of the sampling methodologies used in this program. **Table 1**, located in the **Tables** section, summarizes the testing parameters and corresponding methodologies.

4.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

The exhaust velocities and flow rates were determined following the US EPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)". Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer. Volumetric flow rates were determined following the equal area method as outlined in US EPA Method 2. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a digital temperature indicator.

The dry molecular weight of the stack gas was determined following calculations outlined in US EPA Method 3, "Determination of Molecular Weight of Dry Stack Gas". Stack moisture content was determined through direct condensation and according to US EPA Method 4, "Determination of Moisture Content of Stack Gas".

4.2 Sampling for Total Particulate Matter (TPM)

Sampling for TPM in the exhaust stacks was performed in accordance with US EPA Method 5, "Sampling of Total Particulate Matter from Stationary Sources". Sampling was conducted using an Environmental Supply C-5000 Source Sampling System. Triplicate sampling runs were conducted for each boiler. Particulate matter concentrations and emission rates were determined utilizing EPA Method 5.

The combined sample train consisted of a glass nozzle, a heated glass probe, a heated flex line, and a heated tared quartz filter. The remainder of the sampling train was performed in accordance with US EPA Method 202, "Dry Impinger Method for Determining Condensable Particulate Matter from a Stationary Source". This method is described in detail in section 4.3. The temperature of the filter was monitored and controlled to 248 + 250F.

At the end of each test run, the nozzle, probe, flex line and filter front half were first rinsed and brushed with acetone into a sample jar. The filter was then recovered into the original labeled petri dish.

Samples were then packaged for transport to ALS Global Laboratories in Burlington, Ontario for analysis.

4.3 Sampling for Condensable Particulate Matter (CPM)

Sampling for CPM in the exhaust stacks was performed in accordance with US EPA Method 202, "Dry Impinger Method for Determining Condensable Particulate Matter from a Stationary Source". Sampling was conducted using an Environmental Supply C-5000 Source Sampling System. Triplicate sampling runs were conducted for each boiler. The Method 202 sampling train was attached to the back half of the Method 5 TPM sampling train.

The CPM sampling train consisted of a condenser, an empty water dropout impinger, an empty Greenburg-Smith backup impinger, a polymer CPM filter in a quartz glass filter holder, a Greenburg-Smith impinger with 100 mL of H_2O, and a silica impinger. The temperature of the CPM filter was monitored at all times and kept between 65°F and 85°F. As mentioned in the ITTP a nitrogen purge was not conducted because the Sulphur Dioxide levels in natural gas fuel are below 5 parts per million.

At the end of each test run, the contents of the first two impingers were weighed and collected into sample container #1. The back half of the TPM filter, condenser, first two impingers, and front half of the CPM filter holder were then rinsed three times with DI H_2O and added to sample container #1. The back half of the TPM filter, condenser, first two impingers, and front half of the CPM filter holder were then rinsed three times with Acetone and added to sample container #2 "Organic Rinses". The CPM filter was collected and added to a Petri dish and labeled Container #3. Then the final H_2O impinger and silica impinger were weighed for moisture analysis only and disposed.

Samples were then packaged for transport to ALS Global Laboratories in Burlington, Ontario for analysis.

4.4 Sampling for Gases (O_2, CO_2, and CO)

Oxygen (O_2), Carbon Dioxide (CO_2), Carbon Monoxide (CO) concentrations were determined utilizing RWDI's continuous emissions monitoring (CEM) system.

Prior to testing, a 3-point analyzer calibration error check was conducted using USEPA 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 is within ±2% of the certified calibration gas introduced. Prior to each test run, a system-bias 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 were used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Prior to conducting the testing, a stratification check was conducted. The result of the stratification check confirmed that the stack was not stratified and sampling could be conducted at a single point that was most representative of the average CO stack concentration.

The sample was drawn through a probe tip that was equipped with a sintered stainless steel filter for particulate removal. The sample then proceeded from the probe to a heated Teflon sample line, which delivered the sample gases from the stack to the sample conditioner. The heated sample line was designed to maintain the gas temperature above 250°F in order to prevent condensation of stack gas moisture within the line. Once the sample entered the conditioner the sample was rapidly cooled to 35°F to remove the moisture from the stack gas. The sample then exited the conditioner and sent cool dry gas to the sample manifold which relayed the correct sample pressure to the individual CEM analyzers. The analyzers then sent data through an analog output signal to our data acquisition system to be recorded and analyzed.

RWDI recorded data is presented in the **Tables** section and appendices.

4.5 Quality Assurance/ Quality Control Activities

Applicable quality assurance measures were implemented during the sampling program to ensure the integrity of the results. These measures included detailed documentation of field data, equipment calibrations for all measured parameters, completion of Chain of Custody forms when submitting laboratory samples, and submission of field blank samples to the laboratories. **Table 2** presents a sample log and summarizes the sampling times, sample ID's, and filter ID's.

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 analyzer were also carried out during the testing program by performing hourly zero checks and span calibration checks using primary gas standards. Sample system bias checks were also done. These checks were used to verify the ongoing accuracy of the monitor and sampling system over time. Pollutant-free (zero) air was introduced to perform the zero checks, followed by a known calibration (span) gas into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gas were recorded regularly during the tests.

Leak checks were performed on the Method 5 sampling train by plugging the sample inlet and pulling a representative vacuum. This check was done before and after each test. Similar leak check procedures for Pitot tube and pressure lines were also conducted. Daily temperature sensor audits were completed by noting the ambient temperature, as measured by a reference thermometer, and comparing these values to those obtained from the stack sensor. Leak checks for each test were documented on the field data sheets presented in the applicable appendices for each sample parameter.

5 RESULTS

The average emission results for this study are presented in the **Tables** section of this report. **Table 2** presents a summary of test dates and times. A minimum of three (3) tests on the duct for each boiler was performed for all of the parameters tested in the study. Detailed information regarding each test run can be found in the corresponding Appendix. Below is a summary of the applicable Table and Appendix ID with corresponding test parameter.

Parameter	Boiler 6		Boiler 7	
	Table	Appendix	Table	Appendix
Stack Gas Characteristics	3A	C	3B	C
Total Particulate Matter (PM10)	4	C	4	C
Continuous Emission Monitoring	5	D	5	D
ROP Limit Comparison	6	-	6	-

All calibration information for the equipment used for this study is included in **Appendix F**. All laboratory results are included in **Appendix G**.

5.1 Discussion of Results

Results for both boilers indicated that all parameters are in compliance with respect to the ROP limits.

When the laboratory reported values less than their method detection limit for a specific component, the respective concentration and emission rates were calculated using this method detection limit. This method is a conservative approach when calculating the emissions.

Table 6 in the "tables section" of this report shows a comparison of the sampling results to the incinerator performance limits defined in the ROP.

6 OPERATING CONDITIONS

Operating conditions during the sampling were monitored by Detroit Thermal Power personnel. All equipment was operated under normal maximum operating conditions.

Radio contact was kept between the process operators and the sampling team. A member of the RWDI sampling team contacted the operator before each test, to ensure that the process was at normal operating conditions. **Appendix H** contains the process information supplied by Detroit Thermal Power.

7 CONCLUSIONS

Testing was successfully completed on March 6, 2018. All sources were tested in accordance with referenced methodologies following the MDEQ approved Sampling Plan submitted February 7, 2018. Results for Boiler 6 and Boiler 7 indicated that all parameters are in compliance with respect to the ROP limits.

Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
Boiler 6	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1-4
	3	Total Particulate Matter	U.S. EPA [1] Method 5
	3	Condensible Particulate Matter	U.S. EPA [1] Method 202
	3	Oxygen	U.S. EPA [1] Method 3A (CEM)
	3	Carbon Dioxide	U.S. EPA [1] Method 3A (CEM)
	3	Carbon Monoxide	U.S. EPA [1] Method 10 (CEM)
Boiler 7	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1-4
	3	Total Particulate Matter	U.S. EPA [1] Method 5
	3	Condensible Particulate Matter	U.S. EPA [1] Method 202
	3	Oxygen	U.S. EPA [1] Method 3A (CEM)
	3	Carbon Dioxide	U.S. EPA [1] Method 3A (CEM)
	3	Carbon Monoxide	U.S. EPA [1] Method 10 (CEM)

Notes:

[1] U.S. EPA - United States Environmental Protection Agency

Table 2: Sampling Summary and Sample Log

Boiler 6	Sampling Date	Start Time	End Time	Filter ID / Trap ID	Lab Sample ID
Velocity / TPM[1] / CPM[2]					
Blank	6-Mar-18	-	-	QZ4848	L2065119-(19-21)
Test #1	6-Mar-18	2:24 PM	3:51 PM	QZ4845	L2065119-(1-3)
Test #2	6-Mar-18	4:15 PM	5:38 PM	QZ4846	L2065119-(4-6)
Test #3	6-Mar-18	5:58 PM	7:24 PM	QZ4847	L2065119-(7-9)
Carbon Monoxide					
Test #1	6-Mar-18	2:20 PM	3:20 PM	NA	NA
Test #2	6-Mar-18	3:30 PM	4:30 PM	NA	NA
Test #3	6-Mar-18	5:50 PM	6:50 PM	NA	NA
Boiler 7	**Sampling Date**	**Start Time**	**End Time**	**Filter ID / Trap ID**	**Lab Sample ID**
Velocity / TPM[1] / CPM[2]					
Blank	6-Mar-18	-	-	QZ4848	L2065119-(19-21)
Test #1	6-Mar-18	7:17 AM	9:00 AM	QZ4842	L2065119-(10-12)
Test #2	6-Mar-18	9:38 AM	11:09 AM	QZ4843	L2065119-(13-15)
Test #3	6-Mar-18	11:44 AM	1:10 PM	QZ4844	L2065119-(16-18)
Carbon Monoxide					
Test #1	6-Mar-18	7:17 AM	8:17 AM	NA	NA
Test #2	6-Mar-18	8:31 AM	9:31 AM	NA	NA
Test #3	6-Mar-18	9:46 AM	10:46 AM	NA	NA

Notes:

[1] TPM = Sampling for total particulate matter and metals

[2] CPM = Sampling for Condensible particulate matter and metals

Table 3A: Boiler #6 Sampling Summary - Flow Characteristics

Stack Gas Parameter		Test No. 1 TPM[1]/CPM[2]	Test No. 2 TPM[1]/CPM[2]	Test No. 3 TPM[1]/CPM[2]	TOTAL AVERAGE
Testing Date		6-Mar-18	6-Mar-18	6-Mar-18	-
Stack Temperature	°F	316	317	317	317
	°C	158	158	158	158
Moisture	%	14.9%	14.6%	14.8%	14.7%
Velocity	ft/s	21.58	20.12	21.77	21.16
	m/s	6.58	6.13	6.64	6.45
Actual Flow Rate	CFM	29,589	27,576	29,841	29,002
Referenced Flow Rate[3]	CFM	16,986	15,863	17,134	16,661
	m^3/s	8.01	7.48	8.08	7.86
Sampling Isokinetic Rate	%	107	107	107	107

Notes:

[1] TPM = Sampling for total particulate matter

[2] CPM = Sampling for Condensible particulate matter

[3] Referenced flow rate expressed as dry at 101.3 kPa, 68 °F, and Actual Oxygen

Detailed sampling results including individual test results can be found in Appendix C,D and E

Table 3B: Boiler #7 Sampling Summary - Flow Characteristics

Stack Gas Parameter		Test No. 1 TPM[1]/CPM[2]	Test No. 2 TPM[1]/CPM[2]	Test No. 3 TPM[1]/CPM[2]	TOTAL AVERAGE
Testing Date		6-Mar-18	6-Mar-18	6-Mar-18	-
Stack Temperature	°F	311	312	312	312
	°C	155	156	156	155
Moisture	%	14.1%	14.6%	13.7%	14.1%
Velocity	ft/s	28.15	27.76	27.64	27.85
	m/s	8.58	8.46	8.42	8.49
Actual Flow Rate	CFM	38,591	38,053	37,889	38,178
Referenced Flow Rate[3]	CFM	22,605	22,089	22,191	22,295
	m^3/s	10.67	10.42	10.47	10.52
Sampling Isokinetic Rate	%	104	106	106	105

Notes:

[1] TPM = Sampling for total particulate matter

[2] CPM = Sampling for Condensible particulate matter

[3] Referenced flow rate expressed as dry at 101.3 kPa, 68 °F, and Actual Oxygen

Detailed sampling results including individual test results can be found in Appendix C,D and E

Table 4: Total Particulate Matter (PM10) – Averaged Results

Boiler 6	Concentration @ Actual O_2	Emission Rate	Emission Rate
Particulate	**(gr/dscf)**	**(lb/hr)**	**(lb/MMBtu)**
Total Particulate Matter	< 0.003	< 0.4	< 0.003
Boiler 7	**Concentration @ Actual O_2**	**Emission Rate**	**Emission Rate**
Particulate	**(gr/dscf)**	**(lb/hr)**	**(lb/MMBtu)**
Total Particulate Matter	< 0.003	< 0.6	< 0.005

Notes:

[1] Sampling followed U.S. EPA Method 5 (TPM) and U.S. EPA Method 202 (CPM)

[2] All referenced concentration values are expressed as dry at 101.3 kPa, 68 °F, and actual Oxygen

[3] "<" When laboratory analysis was below the reportable detection limit for one of the parameters, This detection limit was used to calculate the concentration and emission rate of the parameter

Detailed sampling results including individual test results can be found in Appendix C

Table 5- RWDI CEM - Averaged Results

Boiler 6	Average Test Concentration	Emission Rate[4]	Emission Rate
Units -->	(ppm)	(lb/hr)	(lb/MMBtu)
Carbon Monoxide (CO)	2.1	0.15	0.0012
	%		
Oxygen (O2)	4.9	-	-
Carbon Dioxide (CO2)	8.9	-	-
Boiler 7	**Average Test Concentration**	**Emission Rate[4]**	**Emission Rate**
Units -->	(ppm)	(lb/hr)	(lb/MMBtu)
Carbon Monoxide (CO)	1.4	0.13	0.0011
	%		
Oxygen (O2)	6.2	-	-
Carbon Dioxide (CO2)	8.4	-	-

Notes:

[1] Sampling followed U.S. EPA Method 3 (O_2 and CO_2), and Method 10 (CO)

[2] All referenced concentration values are expressed at 101.3kPa, 68°F

[3] Average of three tests

[4] Emissions rate is calculated based on average volumetric flow rate of all isokinetic tests

[5] Emission rate is calculated based on caloric value of natural gas, average natural gas usage during test times, and lb/hr emission rate.

Detailed sampling results including individual test results can be found in Appendix D

Table 6: ROP Limit Comparisons

Parameter	Units	Stack Testing Results	Stack Testing Results	ROP Limit [1]
Limits from ROP: MI-ROP-B2814-2014		**Boiler 6**	**Boiler 7**	
Particulate Matter (PM)	lb/MMBtu	<0.003	<0.005	0.007
Carbon Monoxide (CO)	lb/MMBtu	0.0012	0.0011	0.073

Notes:

[1] Refer to Appendix A for Renewable Operating Permit: MI-ROP-B2814-2014