REPORT

DETROIT RENEWABLE POWER

DETROIT, MICHIGAN

2018 SOURCE TESTING PROGRAM (BOILER 13)

RWDI #1804672

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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Detroit Renewable Power to conduct emission sampling on the exhaust of Boiler 13 (EUBOILER013) at their facility located at 5700 Russell Street, Detroit, Michigan. The test program was conducted in order to fulfill the requirements of the Michigan Department of Environmental Quality (MDEQ) Title V Renewable Operating Permit (ROP) # MI-ROP-M4148-2011a dated August 19, 2011.

The Sampling Plan for this testing program was submitted August 2, 2018 to the Michigan Department of Environmental Quality (MDEQ). Approval for the testing program was granted by the MDEQ on September 13, 2018. The 2018 sampling program on Boiler 13 (EUBOILER013) was completed from November 14th to November 16th, 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 Renewable Power's Renewable Operating Permit.

Parameter	Stack Testing Results [1]	ROP Limit [1][3]
Limits from ROP: MI-ROP-M4148-2011a	**EUBOILER013**	
Particulate Matter (PM)	0.0013	0.010 gr/dscf
Cadmium	0.19	37 μg/dscm
Hexavalent Chromium	< 0.09	4.2 μg/dscm
Total Chromium	2.30	200 μg/dscm
Lead	0.003	0.440 mg/dscm
Mercury	< 0.74	80 μg/dscm
Dioxins/Furans (CDD/CDF)	10.97	30 ng/dscm
Hydrogen Chloride (HCl)	5.8	25 ppmv
Sulfur Dioxide (SO_2)	10.6	29 ppmv
Total Fluoride	0.20	5 ppmv
Carbon Monoxide (CO)	93.9	200 ppmv
Volatile Organic Compounds (VOC)	5.4	65 ppmv
Nitrogen Oxides (NO_x)[2]	168	247 ppmv

Notes:
[1] Concentration values are expressed at 101.3 kPa, 68 °F, and 7% oxygen
[2] NO_x based on 1-Hr average excluding start up and shutdown
[3] Refer to **Appendix A** for Renewable Operating Permit: MI-ROP-M4148-2011a

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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Detroit Renewable Power to conduct emission sampling on the exhaust of Boiler 13 (EUBOILER013) at their facility located at 5700 Russell Street, Detroit, Michigan. The test program was conducted in order to fulfill the requirements of the Michigan Department of Environmental Quality (MDEQ) Title V Renewable Operating Permit (ROP) # MI-ROP-M4148-2011a dated August 19, 2011.

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This stack testing study consisted of the following parameters:

- Particulate matter (PM);
- Velocity, flow rate and temperature;
- Metals;
- Dioxins and furans (PCDDs and PCDFs);
- Total Fluoride;
- Hexavalent Chromium;
- Hydrogen chloride (HCl);
- Nitrogen oxides (NO_X);
- Sulfur dioxide (SO_2);
- Oxygen (O_2);
- Carbon dioxide (CO_2);
- Carbon monoxide (CO); and
- Total Hydrocarbons (THC).

2 SOURCE DESCRIPTION

2.1 Facility Description

Detroit Renewable Power is a refuse-derived fuel (RDF) plant that began commercial operation in October 1991. The facility is permitted to receive up to 20,000 tons of municipal solid waste (MSW) per week. The MSW is processed into RDF, which is then combusted in the furnaces, producing a maximum 362,800 pounds of steam per hour per unit. The steam is used to generate up to 68 megawatts of electricity and supply export steam at a rate of up to 550,000 pounds per hour. The energy products are sold to DTE Corporation and Detroit Thermal.

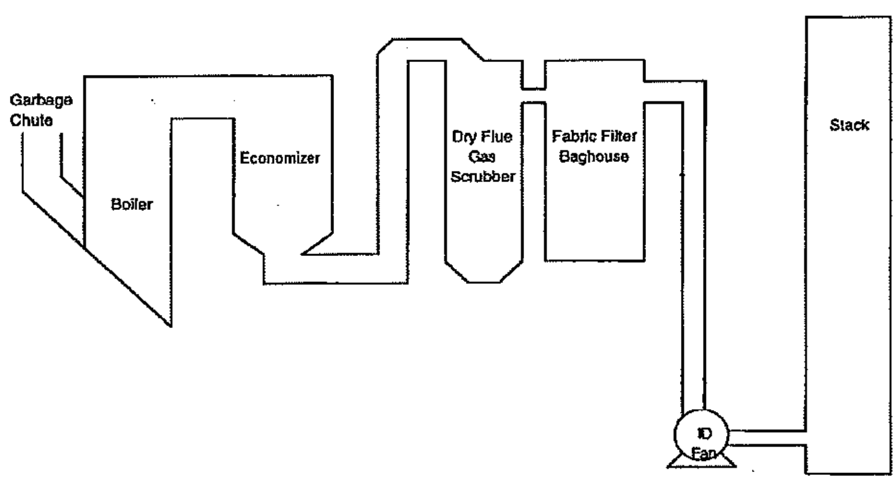
2.2 Process Description

Detroit Renewable Power is located in Detroit, Michigan. The facility consists of three (3) identical Combustion Engineering (VU40) refuse derived fuel (RDF) fired boilers or municipal waste combustors (MWC). Normal operation of the facility consists of two (2) boilers on-line with one boiler in stand-by mode.

Refuse is prepared and purged of non-processible and non-combustible materials through a series of conveyors and shredders. Waste is then combusted in furnaces at temperatures exceeding 1,800 degrees Fahrenheit and reduced to an inert ash residue.

Flue gases pass through each MWC unit pollution control system before exhausting through a separate flue stack in a common stack. The air pollution equipment for each independent train includes lime injection dry flue gas scrubbers for controlling acid gases and fabric filter baghouses for particulate removal. Each unit is also equipped with a continuous emission monitoring system to demonstrate compliance and to provide feedback on the effectiveness of the air pollution control (APC) equipment.

Figure 2.1: Process Flow Diagram



3 SAMPLING LOCATION

3.1 Compliance Source Sample Location Description

The outlet sampling locations for each stack are identical for EUBOILERS011, 012 and 013. Each stack had an inside diameter of 92 inches. Each flue had two sampling ports, 90 degrees apart and 4 inches in diameter. The sampling ports were located 9 duct diameters upstream from the ID fan and 19.8 duct diameters downstream before the stack outlet.

Table 3.1: Summary of Sampling Program – EUBOILERS013

	Boiler 13-(EUBOILER013)
Emission Unit Description [Including Process Equipment & Control Device(s)]	EUBOILERS011, 012 & 013 consisted of three (3) identical Refused Derived Fuel (RDF) fired spreader-stoker boilers rated at 520 MMBTU/hr heat input, 390,000 lb/hr steam at 900 psig and 825°F. The units operated an electric generator with a nameplate capacity of 68 MWe to convert unsold steam into power for internal consumption and for sale to the grid. Air emissions were controlled using a lime slurry injection from the top of each unit followed by a baghouse fabric filter system.
Parameter Tested	Particulate matter, hydrogen chloride, mercury, lead, cadmium, total chromium, hexavalent chromium, dioxins/furans, sulfur dioxide, carbon monoxide, carbon dioxide, oxygen, total fluorides, nitrogen oxides, THC, opacity, in addition to stack gas velocity, stack gas composition, and moisture.
Operating Conditions / Stack Dimensions	320°F / 92 inches
Testing Monitoring Methods	Refer to Section 4.0
Testing Schedule	Refer to **Table 2** of the Tables Section

Figure 3.1a: Diagram of Flow Disturbance Distance and Stack Diameters for EUBOILERS011, 012, and 013

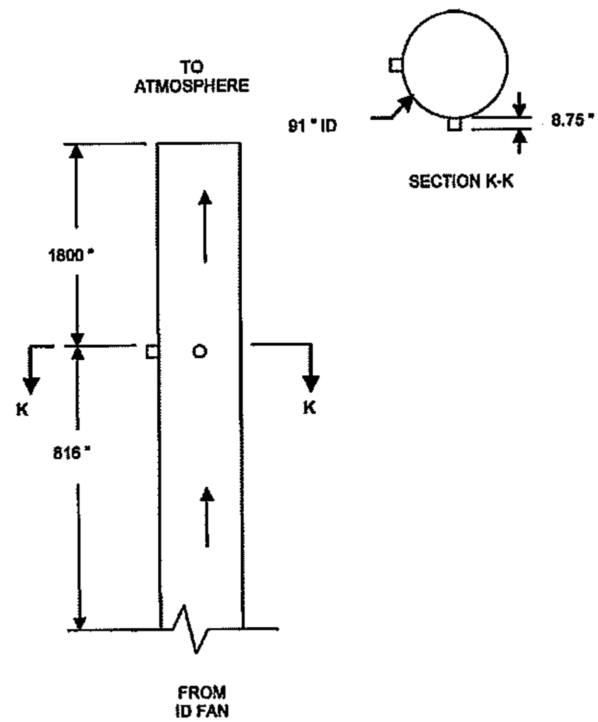


Figure 3.1b: Photo of Stack Exit Point for EUBOILERS011, 012 and 013

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 average DRP oxygen and carbon dioxide values recorded during each test were used for isokinetic calculation and volumetric flow rates.

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 Particulate Matter (PM) and Metals

Sampling for PM in the exhaust stacks was performed in accordance with US EPA Method 5, "Sampling of Particulate Matter from Stationary Sources". Sampling was conducted using an Environmental Supply C-5000 Source Sampling System. Triplicate sampling runs were conducted for each stack. Particulate matter concentrations and emission rates were determined utilizing EPA Method 5. Mercury, lead, chromium, and cadmium concentrations and emission rates were determined utilizing Method 29. Particulate and metals were sampled using combined trains as follows:

The combined sample train consisted of a glass nozzle, a heated glass probe, a heated tared quartz filter, two chilled impingers each with 100 mL of 5% HNO_3/10% H_2O_2, an empty impinger, two chilled impingers each with 100 mL of 4% $KMnO_4$/10% H_2SO_4, an impinger with 200 grams of silica gel, and a dry gas metering console. The temperature of the filter was monitored and controlled to 248 ± 25^{0}F.

At the end of each test run, the nozzle, probe, and filter front half were first rinsed and brushed with acetone into a sample jar. The nozzle, probe, and filter front half were then rinsed with 100 mL of 0.1 N nitric acid into a second sample jar. The filter was then recovered into the original labeled petri dish.

The contents of the 5% HNO_3/10% H_2O_2 impinger were poured back into the original reagent jar. Any condensate in the empty impinger was poured into a sample jar. The 4% $KMnO_4$/10% H_2SO_4 impingers were then recovered into another sample jar.

The moisture catch was then determined gravimetrically. The filter back half and 5% HNO_3/10% H_2O_2 impingers were rinsed with 100 mL of 0.1 N nitric acid into a sample jar.

The empty impinger was rinsed with 100 mL of 0.1 nitric acid into a sample jar. The 4% $KMnO_4$/10% H_2SO_4 impingers were then rinsed with 100 mL 4% $KMnO_4$/10% H_2SO_4 and 100 mL of DI water into the jar containing the 4% $KMnO_4$/10% H_2SO_4 reagent. The 4% $KMnO_4$/10% H_2SO_4 impingers and connecting glassware were rinsed with 25 mL of 8 N HCl if any brown residue remained. This HCl rinse was added to a jar containing 200 mL of DI water.

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

4.3 Sampling for Total Fluorides and Hexavalent Chromium

Total fluorides as hydrogen fluoride and hexavalent chromium concentrations and emission rates were determined utilizing a combined EPA Method 13B and CARB Method 425 sampling train. The sampling train consisted of a glass nozzle, a heated glass probe, a heated filter (with stainless steel frit), and two chilled impingers each with 100mL of 0.5N NaOH, an empty impinger, an impinger with 200 grams of silica gel, and a dry gas metering console. The equipment was operated in accordance with EPA Method 13B and CARB Method 425.

At the end of each test run, the contents of the first three impingers were collected into a sample jar. The moisture catch was then determined gravimetrically. The nozzle, probe, filter holder, impingers, and connecting glassware were rinsed with DI into the sample jar. The filter was placed into the sample jar.

The samples were analyzed in accordance with EPA Method 13B for total fluorides as hydrogen fluoride. The samples were analyzed in accordance with CARB Method 425 for hexavalent chromium.

Samples were packaged for transport to Element One, Inc. in Wilmington, North Carolina for analysis.

4.4 Sampling for Dioxins (PCDD) and Furans (PCDF)

The concentrations and emissions rates of polychlorinated dibenzo-p-dioxins/polychlorinated dibenzofurans (PCDD/PCDF) or dioxins/furans) were determined utilizing EPA Method 23. The EPA Method 23 sampling train consisted of a glass nozzle, a heated glass probe, a heated glass filter, a condenser, and XAD resin trap, an empty impinger, two chilled impingers each with 100mL of DI water, an empty impinger, an impinger with 200 grams of silica gel, and a dry gas metering console.

Methylene chloride was not used for recovery, as per approval from MDEQ. At the end of each test run, the nozzle, probe and filter front half were rinsed with acetone into a sample jar. The filter was recovered dry into a glass petri dish. The filter backhalf, and condenser were rinsed with acetone into a sample jar. All of the components listed above up to the XAD resin trap were then rinsed again with toluene into a sample jar. The XAD resin trap was sealed and placed into a chilled ice chest. The contents of the first three impingers were poured back into the original reagent jar. The silica gel was poured back into its original container.

The moisture catch was then determined gravimetrically. The samples were analyzed in accordance with EPA Method 23 for dioxins/furans.

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

4.5 Sampling for Hydrogen Chloride

Hydrogen chloride concentrations and emission rates were determined utilizing EPA Method 26 modified to use large impingers. The EPA Method 26 sampling train consisted of a heated glass probe, a heated quartz filter, and two chilled impingers each with 100mL of 0.1N H_2SO_4, one empty impinger, an impinger with 200 grams of silica gel, and a dry gas metering console.

At the end of each test run, the contents of the impingers were poured into a sample jar. The silica gel was returned to its original container. The moisture catch in the train components was then determined gravimetrically. The filter backhalf and H_2SO_4 impingers were rinsed with DI water into the H_2SO_4 reagent jar.

The H_2SO_4 portion of the sample was analyzed in accordance with EPA Method 26 for hydrogen chloride.

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

4.6 Sampling for Total Hydrocarbons (as Methane)

Testing for THC (as methane) was accomplished using continuous emission monitors (CEM). The exhaust gas sample was drawn from a single point at the center of the stack using a stainless-steel probe. The sample then proceeded to a heated filter, where particulate matter was removed, and then transferred via a heated Teflon line that was heated to 320°F to prevent any condensation. The stack gas was routed through a manifold system and introduced to the CEM's for measurement.

Prior to testing, sample system bias checks and instrument linearity checks (calibration error) were conducted. In addition, the analyzers were calibrated (zeroed and span checked) at the completion of each run. Data acquisition was provided using a data logger system that generates one-minute averages concentrations.

4.7 Sampling for Gases (Continuous Emissions Monitoring)

RWDI operated continuous emission monitors for oxygen and carbon dioxide in accordance with the applicable US EPA reference method. 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.

RWDI recorded data is presented in the **tables** section and appendices. DRP's CEM data was recorded of NO_x, SO_2, O_2, CO_2 and CO. For comparison with the facilities permit the DRP CEMs data was used.

4.8 Sampling for Opacity

Opacity (visible emissions) data were collected by the facility Continuous Opacity Monitors (COMs) in lieu of Method 9 observations.

4.9 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, filter ID's, and XAD trap ID's.

Stationary Source Audit Samples (SSAS) were provided from ERA and sent to ALS Global Laboratories for analysis. All results were deemed acceptable. The final report of the SSAS program is provided in **Appendix K.**

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 stack 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	Table	Appendix
Stack Gas Characteristics	3	C/D/E
Particulate Matter and Selected Metals	4	C
Dioxins and Furans	5	D
Total Fluoride and Hexavalent Chromium	6	E
Hydrogen chloride	7	F
Opacity	8	G
Continuous Emission Monitoring	9/10	H
ROP Limit Comparison	11	-

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

5.1 Discussion of Results

Results for Boiler 13 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 11 shows a comparison of the sampling results to the boiler performance limits defined in the ROP.

6 OPERATING CONDITIONS

Operating conditions during the sampling were monitored by Detroit Renewable 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 L** contains the process information supplied by Detroit Renewable Power.

7 CONCLUSIONS

Testing was successfully completed between November 14th and November 16th, 2018 on Boiler 13. All sources were tested in accordance with referenced methodologies following the MDEQ approved Sampling Plan submitted August 2, 2018.