FINAL REPORT

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DETROIT RENEWABLE POWER

DETROIT, MICHIGAN

2017 RELATIVE ACCURACY TEST AUDIT – BOILER 11

RWDI #1702046

April 5, 2018

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI AIR Inc. was retained by Detroit Renewable Power to conduct a Relative Accuracy Test Audit (RATA) at the Russell street facility, located in Detroit, Michigan. Testing was completed on January 26, 2018 (for the 2017 operating period). The testing is conducted annually and is a requirement under the facility permit MI-ROP-M4148-2011a and under 40 CFR 60 subparts Cb and Eb.

The monitors audited during this testing program include: sulphur dioxide (SO_2); oxides of nitrogen (NO_X), carbon monoxide (CO), oxygen (O_2), carbon dioxide (CO_2) and carbon dioxide emission rate.

The relative accuracy requirements are set-out in the applicable Performance Specification in 40 CFR 60, **Appendix B**. The table below presents a summary of the results.

Table 1: Summary of Results

Parameter	Relative Accuracy
Sulphur Dioxide	7.5%
Oxides of Nitrogen	10.8%
Carbon Monoxide	2.5%
Oxygen	2.3%
Carbon Dioxide	1.4%
Carbon Dioxide Emission Rate	14.9%

1 INTRODUCTION

RWDI AIR Inc. was retained by Detroit Renewable Power to conduct a Relative Accuracy Test Audit (RATA) at the Russell street facility, located in Detroit, Michigan. Testing was completed on February 7, 2018 (for the 2017 calendar year). The testing is conducted annually and is a requirement under the facility permit MI-ROP-M4148-2011a and under 40 CFR 60 subparts Cb and Eb.

The monitors audited during this testing program include: sulphur dioxide (SO_2); oxides of nitrogen (NO_X), carbon monoxide (CO), oxygen (O_2), carbon dioxide (CO_2) and carbon dioxide emission rate. 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	Supervising Engineer	John Glasworthy
RWDI	Project Manager / Field Technician	Brad Bergeron
RWDI	Field Technician	Ty Deweerd
Detroit Renewable Power	Detroit Renewable Power	Damian Doerfer
Michigan Department of Environmental Quality	Test Observer	Tom Gasloli; Todd Zynda; and Regina Hines

2 PLANT AND SOURCE DESCRIPTION

2.1 Plant Overview

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

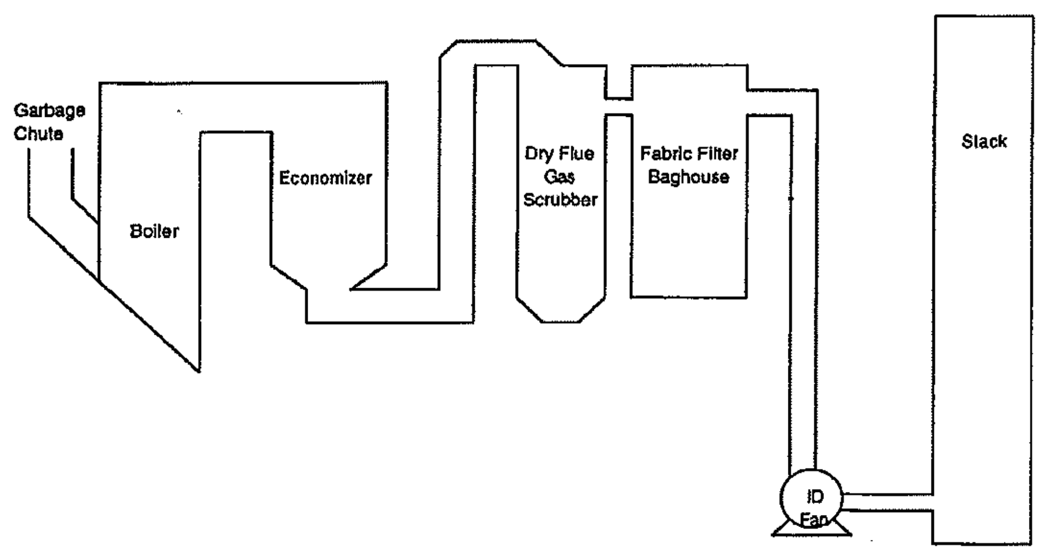
2.2 Process Description

Detroit Renewable Power is located in Detroit, Michigan. The facility consists of three identical Combustion Engineering (VU40) refuse derived fuel (RDF) fired boilers or municipal waste combustors (MWC). Normal operation of the facility consists of two 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 1: Process Flow Diagram



2.3 Unit 11 Continuous Emission Monitors Specifications

The permanently installed CEMs servicing Unit 11 are dedicated dry extractive systems that consist of oxygen, carbon dioxide, sulphur dioxide, oxides of nitrogen and carbon monoxide analyzers, a dry extractive system, and a microcomputer based data acquisition system. The figure below describes the DRP analyzers

Table 3: Boiler 11 Permanent CEM Analyzers

Source CEM Analyzers					
Parameter	**Unit**	**Location**	**Range**	**Analyzer**	**Serial Number**
O_2	11	Stack	0 - 25%	California Analytical ZRE	UA2E4831T O_2
CO_2	11	Stack	0 - 20%	California Analytical ZRE	A066348T
SO_2	11	Stack	0 - 200 ppm	California Analytical ZRE	UA2E44831T SO_2
NOx	11	Stack	0 - 500 ppm	California Analytical ZRE	UA2E4839T NO_x
CO	11	Stack	0 - 2000 ppm	California Analytical ZRE	UA2E4839T CO
Air Flow	11	Stack	0 - 400 kwscfm	Trace Environmental CEMS Flow 500	TS-101124-11

3 SAMPLING LOCATION

The sampling port for the RATA testing was located outside, at the Induced Draft fans discharge, east of the baghouse. Note that the flow measurements during the RATA testing were taken from sampling ports at the platform level located inside the stack annulus.

Figure 2: RATA 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 4: Summary of Sampling Methodologies

Parameter	Reference Method
RATA Methodology and Calculations	U.S EPA Performance Specifications 2,3, and 4
Sulfur Dioxide	U.S. EPA Method 6C
Oxides of Nitrogen	U.S. EPA Method 7E
Carbon Monoxide	U.S. EPA Method 10
Oxygen and Carbon Dioxide	U.S. EPA Method 3A
Flow Rate	U.S. EPA Method 1-4

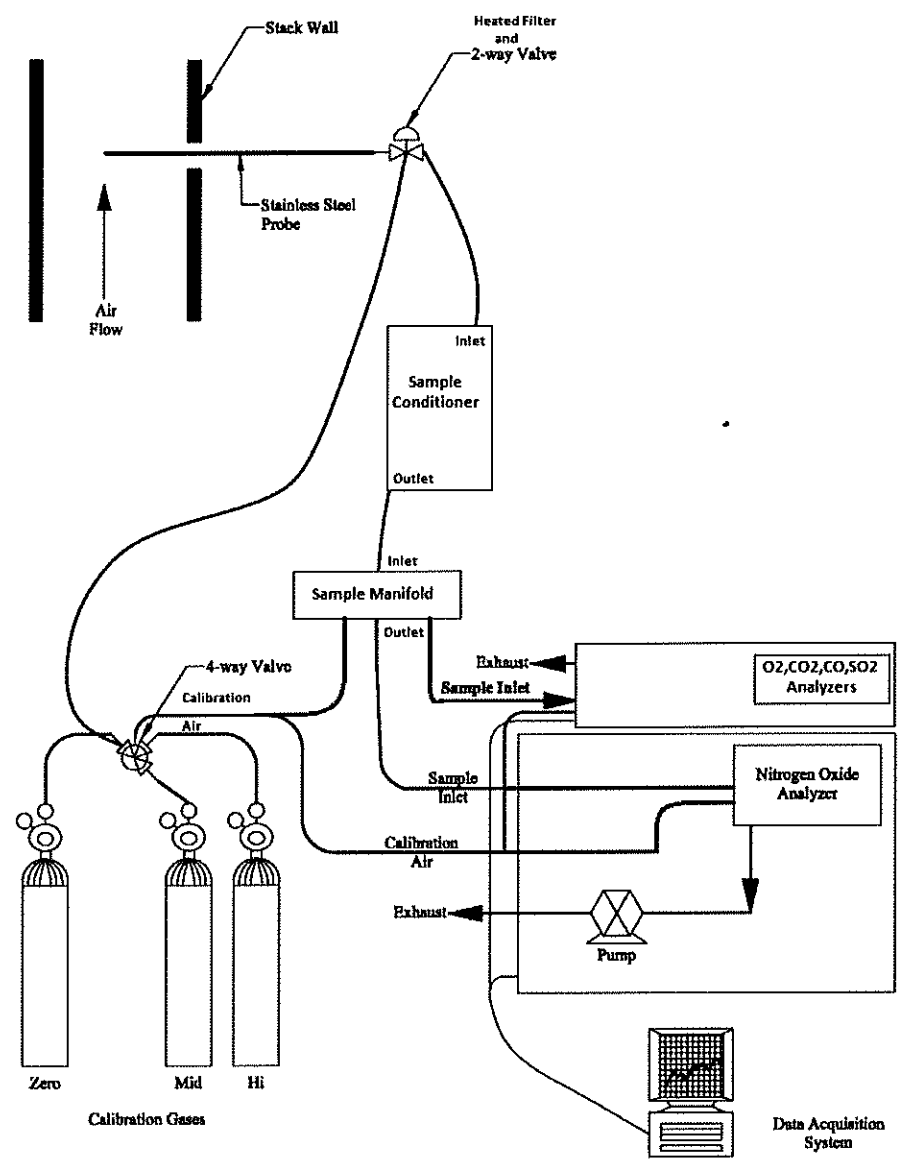
4.1 Relative Accuracy Test Audit

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, 4A and 6. The relative accuracies were calculated according to the appropriate emission standards. To satisfy the RATA requirements of 40 CFR 60, Appendix B, the relative accuracy must not exceed 20.0% of the mean of the reference method (RM) or 10.0% of the applicable standard for sulphur dioxide if the source qualifies as a low emitter. Since the average RM concentration was greater than 50% of the applicable standard, 20% of the RM was used as the criteria for the RATA for SO_2. To satisfy the RATA requirements of 40 CFR 60, Appendix B the relative accuracy must not exceed 20.0% of the mean of the reference method or 10.0% of the applicable standard for oxides of nitrogen and must not exceed 10.0 percent of the mean of the reference method, 5% of the applicable standard, or a mean difference of ±5 ppm plus the confidence coefficient for carbon monoxide.

The RATA was conducted while the unit operated at greater than 50% capacity. A three -point probe was used to traverse sampling points were located along a "measurement line" that passed through the centroidal area of the duct. Three points located at 13.4, 40 and 66.6 inches from the duct wall were used as the RATA sampling points as outlined in 40 CFR 60, Appendix B Performance Specification 2. The exhaust gas sample was withdrawn from the duct using a three-point heated probe with stainless steel in-stack sintered filters. 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 320°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 of this report contains detailed information on the Reference Method RATA test runs, including; a summary of results, raw CEM data, corrected CEM data and pre and post-test calibration information for all parameters. **Appendix B** of this report contains 1-minute averages of Detroit Renewable Power's permanently installed CEM system. **Appendix C** contains calibration gas Certificates of Accuracy and **Appendix D** contains field notes taken during the RATA testing. Below is a schematic of the RWDI reference method sampling system.

Figure 3: RWDI CEM Sampling System



4.2 Oxygen and Carbon Dioxide (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 and carbon dioxide concentration of the flue gas. A Rosemount Model NGA2000 Non-Dispersive Infrared Analyzer (NDIR) was used for oxygen and carbon dioxide 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)

NO_x emissions were measured following USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources." The NO_x concentration was measured using a Thermo 42i HL Chemiluminescence gas analyzer

A NO/NO_2 conversion check was performed prior to each new source by introducing NO_2 gas into the NO_x analyzer. The analyzers NO_x 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

Certified Calibration Gas Value (ppmv)	Analyzer Response Peak Value (ppmv)	NO_2 to NO Converter Efficiency (%)	Efficiency: Pass/Fail
99.3	89.6	90.2%	PASS

Note: Converter Efficiency must be >90%

Calibration error and system-bias checks were performed as described in section 4.2.

4.4 Sulfur Dioxide (US EPA method 6C)

SO_2 emissions were measured following USEPA Method 6C, "Determination of Sulfur Dioxide Emissions from Stationary Sources." The SO_2 concentration was measured using an Ametek model 721 photometric analyzer.

Calibration error and system-bias checks were performed as described in section 4.2.

4.5 Carbon Monoxide (US EPA Method 10)

CO emissions were measured following USEPA Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources." The CO concentration was measured using A Rosemount Model NGA2000 Non-Dispersive Infrared Analyzer (NDIR).

Calibration error and system-bias checks were performed as described in section 4.2.

4.6 Flow Rate (US EPA Methods 1-4)

Volumetric flow rate and moisture were determined utilizing EPA Methods 2 and 4. An S-type pitot tube and thermocouple were used to determine local delta-p and flue gas temperature at each point as pre-determined by EPA Method 1. The flow rates and moisture contents were measured at the platform level located inside the annulus of the stack. The Flow data was collected during each of the RATA test events. Moisture data was collected during the Method 29 and Method 23 tests.

4.7 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 analysers 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. 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. 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**
EPA M3A, 6C,7E and 10	Initial Calibration Error Test	< ±2%	< ±2%	Acceptable
	System Bias Test	< ±5%	< ±5%	Acceptable
	Drift Test	< ±3%	< ±3%	Acceptable
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	10.0%	CC244731
	High	18.9%	EB0048716
Carbon Dioxide	Mid	10.3%	CC244731
	High	19.0%	EB0048716
Carbon Monoxide	Mid	123 ppm	CC244731
	High	260 ppm	EB0048716
Sulfur Dioxide	Mid	49.7 ppm	CC364562
	High	96.7 ppm	EB0025577
Nitrogen Oxides	Mid	254 ppm	CC364562
	High	521 ppm	EB0025577
Nitrogen Dioxide	Converter Gas	99.3 ppm	CC134947

5 RESULTS

The overall results from the testing are discussed in this section. Detailed results of each individual Reference Method test and individual CEM tests may be found in **Appendices A** and **B** respectively.

5.1 Summary Relative Accuracy Test Audit Results

A total of twelve, 21-minute tests were completed on the installed NO_x, SO_2 CO, O_2, CO_2 analyzers on January 26, 2018. A summary of all RATA tests and the results of the relative accuracy calculations are presented in **Appendix A**. For more detailed tables presenting individual test runs refer to **Appendix A** of this report. In comparing the CO_2 mass emission data (lb/min) from the process data to the RM data we discovered that the flow monitor was not working properly and therefore providing erroneous CO_2 mass emission data (lb/min). In order to correct the data, a comparison of the flow rate (dry, reference) to the steam load data from the 2016 RATA was used to determine a ratio of the flow (dry, reference) to steam output. This ratio was applied to the steam output data and used to correct the flow rate and CO_2 mass emission data (lb/min). All other parameters remain as presented by DRP.

flow & CO_2 only for GHG reporting

The relative accuracy test audit was conducted to determine if the Detroit Renewable Power CEM system will give data that can be compared with data obtained using reference test methods. Below is a summary of the results.

Table 1: Summary of Results

Parameter	Relative Accuracy
Sulphur Dioxide	7.5%
Oxides of Nitrogen	10.8%
Carbon Monoxide	2.5%
Oxygen	2.3%
Carbon Dioxide	1.4%
Carbon Dioxide Emission Rate	14.9%

6 BOILER OPERATING CONDITIONS

Operating conditions during the sampling were monitored by Detroit Renewable Power personnel. Testing was performed while the power boiler operated at greater than 50% load. 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 RATA's on the permanent CEMs that were installed to monitor the power boiler exhaust gases. The monitors currently installed include; NO_X, SO_2 CO, O_2, CO_2 and CO_2 emission rate.

In comparing the CO_2 mass emission data (lb/min) from the process data to the RM data we discovered that the flow monitor was not working properly and therefore providing erroneous CO_2 mass emission data (lb/min). In order to correct the data, a comparison of the flow rate (dry, reference) to the steam load data from the 2016 RATA was used to determine a ratio of the flow (dry, reference) to steam output. This ratio was applied to the steam output data and used to correct the flow rate and CO_2 mass emission data (lb/min). All other parameters remain as presented by DRP.

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

Table 1 - *Boiler 11* - RATA Results

Certification Date - February 7, 2018

Test	RWDI Time		SO_2				NOx				O_2				CO				CO2			Emission Rate CO2		
	Start Time	End Time	RM (dppm)	RM cor	CEM (ppm)	di (ppm)	RM (dppm)	RM cor	CEM (ppm)	di (ppm)	RM (d%)	RM (d%)	CEM (%)	di (%)	RM (dppm)	RM cor	CEM (dppm)	di (dppm)	RM (%)	CEM (%)	di (%)	RM (lb/min)	CEM (lb/min)	di (lb/min)
1	8:29	8:49	~~10.57~~	~~17.1~~	~~13.0~~	~~-4.1~~	118.21	190.9	213.0	22.1	12.33	12.3	12.5	0.2	15.40	24.9	29	4.14	7.55	7.54	0.0	~~1948~~	~~2289~~	~~341~~
2	~~9:01~~	~~9:21~~	~~9.26~~	~~15.0~~	~~10.0~~	~~-5.0~~	119.39	193.0	219.0	26.0	12.34	12.3	12.7	0.4	9.62	15.5	19	3.45	7.45	7.35	-0.1	1930	2187	257
3	~~9:38~~	~~9:58~~	~~13.95~~	~~22.6~~	~~17.0~~	~~-5.6~~	117.79	189.5	211.0	21.5	12.30	12.3	12.5	0.2	10.27	16.5	20	3.48	7.60	7.58	0.0	1970	2307	337
4	10:11	10:31	12.77	20.5	20.0	-0.5	112.56	179.9	197.0	17.1	12.24	12.2	12.4	0.2	42.64	68.1	74	5.86	7.56	7.61	0.0	~~1952~~	~~2334~~	~~382~~
5	10:46	11:06	13.74	22.8	22.0	-0.8	113.11	186.5	205.00	18.5	12.51	12.5	12.60	0.1	36.11	59.5	62	2.46	7.51	7.43	-0.1	1941	2226	285
6	11:21	11:41	12.58	20.2	18.0	-2.2	112.78	180.2	198.00	17.8	12.24	12.2	12.40	0.2	49.19	78.6	87	8.40	7.68	7.68	0.0	~~1988~~	~~2394~~	~~406~~
7	11:58	12:18	12.00	19.4	19.0	-0.4	111.41	179.4	200.00	20.6	12.31	12.3	12.90	0.6	74.48	120.0	122	2.05	6.95	7.33	0.4	1830	2132	302
8	12:28	12:48	10.46	17.8	20.0	2.2	115.51	195.4	210.00	14.6	12.72	12.7	12.90	0.2	24.38	41.2	48	6.76	7.35	7.23	-0.1	1931	2128	197
9	13:15	13:35	9.58	16.6	16.0	-0.6	111.54	192.5	207.00	14.5	12.89	12.9	13.00	0.1	37.84	65.3	68	2.72	7.09	7.12	0.0	1860	2055	195
10	13:50	14:10	9.91	17.7	16.0	-1.7	106.40	188.6	202.00	13.4	13.10	13.2	13.20	0.0	30.72	54.5	63	8.55	6.91	6.94	0.0	1812	1958	146
11	14:40	15:00	6.03	10.4	11.0	0.6	114.78	196.8	210.00	13.2	12.84	12.8	12.90	0.1	14.19	24.3	32	7.67	7.29	7.16	-0.1	1923	2070	147
12	15:24	15:44	8.16	13.6	14.0	0.4	112.44	186.4	197.00	10.6	12.56	12.6	12.70	0.1	17.33	28.7	36	7.27	7.50	7.34	-0.2	1965	2196	231
		AVERAGE		17.7	17.3	-0.3		188.3	205.8	17.5		12.5	12.7	0.2		49.8	55.0	5.2	7.4	7.4	0.0	1907	2140	233
		STDS		4	3	1		6	7	4		0.3	0.3	0.2		30.9	30.6	2.4	0.3	0.2	0.1	58.1	103.7	67.6

	SO_2	NOx	O_2	CO	CO2	Emission Rate CO2
n	9	12	12	12	12	9
Full Scale	29	500	10	267	-	-
$t_{0.025}$	2.306	2.201	2.201	2.201	2.201	2.306
I d I	0.3	17.5	0.19	5.23	0.0	232.95
I cc I	0.99	2.84	0.10	1.55	0.09	51.94
ACCURACY (20% limit)	7.5%	10.8%	2.3%	2.5%	1.4%	14.9%

Notes: *RM = Reference Method (RWDI measurements)*
CEM = Continuous Emission Monitors (Detroit Renewable Power measurements)
di = Difference between CEM and RM for each point
n = number of tests
$t_{0.025}$ = value for a one-tailed t-test
I d I = Absolute mean difference between the CEM and RM results
I cc I = Confidence coefficient
~~99~~ indicates test was ommited from calculating criteria
corr = dry ppm values corrected to 7% oxygen
CO_2 Emission Rates calcuated from the Flow Measurements taken during each test.