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Certification and Relative Accuracy Test Audit Test Report

Carbon Green BioEnergy, LLC
Woodbury Facility
Thermal Oxidizer Stack (C10)
Lake Odessa, Michigan
Project No. M233705
September 14, 2023





**Relative Accuracy Test Audit
Test Report**

**Carbon Green BioEnergy, LLC
Woodbury Facility
Thermal Oxidizer Stack (C10)
Lake Odessa, Michigan
RATA Test Date: September 14, 2023
Seven Day Drift Test Dates: September 12 through 19, 2023**

**Report Submittal Date
October 16, 2023**

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Project No. M233705

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1.0 EXECUTIVE SUMMARY

Mostardi Platt conducted a Continuous Emissions Monitoring System (CEMS) Relative Accuracy Test Audit (RATA) and certification test program for Carbon Green BioEnergy, LLC at the Woodbury Facility in Lake Odessa, Michigan, on the Thermal Oxidizer Stack (C10) on September 14, 2023. This report summarizes the results of the test program and test methods.

The test location, test date, and test parameters are summarized below.

TEST INFORMATION		
Test Location	Test Date	Test Parameters
Thermal Oxidizer Stack (C10)	September 14, 2022	Oxygen (O ₂) and Nitrogen Oxides (NO _x)

The purpose of the test program was to demonstrate the relative accuracies of the Thermal Oxidizer Stack (C10) O₂ and NO_x analyzers during the specified operating condition. The test results from this test program indicate that each CEMS meets the United States Environmental Protection Agency (USEPA) annual performance specification for relative accuracy as published in 40 Code of Federal Regulations Part 60 (40CFR60).

TEST RESULTS					
Parameter	Dates	Test	Units	Relative Accuracy Acceptance Criteria	Relative Accuracy (RA)
NO _x	9/14/23	RATA	lb/mmBtu	≤ 20.0% of the mean reference value	1.38%
NO _x			ppmvd	≤ 20.0% of the mean reference value	1.12%
NO _x			lb/hr	≤ 20.0% of the mean reference value	1.39%
NO _x	9/12/23-9/19/23	7-Day Calibration Drift	ppmvd	≤ 2.5% of the span value	2.1%
O ₂	RATA	RATA	% dry	≤ 20.0% of the mean reference value	0.00%
O ₂	9/12/23-9/19/23	7-Day Calibration Drift	%	≤ 0.5% mean difference	0.17%

The gas cylinders used to perform the RATA are summarized below.

GAS CYLINDER INFORMATION				
Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
NO _x	Airgas	CC17212	0.0 ppm	9/27/2030
NO _x	Airgas	CC273419	44.95 ppm	5/17/2026
NO _x	Airgas	XC035287B	91.28 ppm	3/2/2030
O ₂	Airgas	CC273419	0.0%	5/17/2026
O ₂	Airgas	CC17212	5.011%	9/27/2030
O ₂	Airgas	CC752574	11.99%	7/10/2031

The identification of individuals associated with the test program is summarized below.

TEST PERSONNEL INFORMATION		
Location	Address	Contact
Test Facility	Carbon Green BioEnergy, LLC 7795 Saddlebag Lake Road Lake Odessa, Michigan 48849	Edward Thomas (616) 374-3635 (phone) (517) 712-9034 (fax) ethomas@cgbioenergy.com
Testing Company Supervisor	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Jacob Howe Senior Project Manager 630-993-2100 (phone) jhowe@mp-mail.com
Testing Company Personnel		Henry Hoeksema Test Technician

2.0 TEST METHODOLOGY

Emission testing was conducted following the United States Environmental Protection Agency (USEPA) methods specified in 40CFR60, Appendix A in addition the Mostardi Platt Quality Manual. Schematics of the test section diagram and sampling train used are included in Appendix A and B respectively. Calculation nomenclature is included in Appendix C. Copies of analyzer print-outs for each test run are included in Appendix D. CEM data and process data as provided by Carbon Green BioEnergy, LLC are also included in Appendix E.

The following methodologies were used during the test program:

Method 3A Oxygen (O₂) Determination

Stack gas O₂ concentrations and emission rates were determined in accordance with USEPA Method 3A. A Servomex analyzer was used to determine the O₂ concentrations in the manner specified in the Method. The instrument has a paramagnetic detector and the O₂ operates in the nominal range of 0% to 25% with the specific range determined by the high-level calibration gas of 11.99%. High-range calibrations were performed using USEPA Protocol gas. Zero nitrogen (a low ppm pollutant in balance nitrogen calibration gases) was introduced during other instrument calibrations to check instrument zero. High- and a mid-range % O₂ levels in balance nitrogen were also introduced. Zero and mid-range calibrations were performed using USEPA Protocol gas after

each test run. Copies of the gas cylinder certifications are found in Appendix G. This testing met the performance specifications as outlined in the Method.

Method 7E Nitrogen Oxide (NO_x) Determination

Stack gas NO_x concentrations and emission rates were determined in accordance with USEPA Method 7E, 40CFR60, Appendix A. A Thermo Scientific Model 42i Chemiluminescence Nitrogen Oxides Analyzer was used to determine nitrogen oxides concentrations, in the manner specified in the Method. The instrument operated in the nominal range of 0 ppm to 200 ppm with the specific range determined by the high-level span calibration gas of 91.28 ppm.

The Model 42i operates on the principle that nitric oxide (NO) and ozone (O₃) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO₂ molecules decay to lower energy states. Specifically,



Nitrogen dioxide (NO₂) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO₂ is converted to NO by a stainless steel NO₂-to-NO converter heated to about 636°C. The flue gas sample is drawn into the Model 42i through the sample bulkhead. The sample flows through a capillary, and then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode) or through the NO₂-to-NO converter and then to the reaction chamber (NO_x mode). A flow sensor prior to the reaction chamber measures the sample flow. Dry air enters the Model 42i through the dry air bulkhead, passes through a flow switch, and then through a silent discharge ozonator. The ozonator generates the ozone needed for the chemiluminescent reaction. At the reaction chamber, the ozone reacts with the NO in the sample to produce excited NO₂ molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the luminescence generated during this reaction. From the reaction chamber, the exhaust travels through the ozone (O₃) converter to the pump, and is released through the vent.

The NO and NO_x concentrations calculated in the NO and NO_x modes are stored in memory. The difference between the concentrations is used to calculate the NO₂ concentration. The Model 42i outputs NO, NO₂, and NO_x concentrations to the front panel display, the analog outputs, and also makes the data available over the serial or ethernet connection.

Stack gas was delivered to the analyzer via a Teflon[®] sampling line, heated to a minimum temperature of 250°F. Excess moisture in the stack gas was removed using a refrigerated condenser. The entire system was calibrated in accordance with the Method, using certified calibration gases introduced at the probe, before and after each test run. This testing met the performance specifications as outlined in the Method.

A list of calibration gases used and the results of all calibration and other required quality assurance checks are found in Appendix F. Copies of the gas cylinder certifications are found in Appendix G. The NO₂ to NO converter test can be found in Appendix H. This testing met the performance specifications as outlined in the Method.

3.0 TEST RESULT SUMMARIES

Client: Carbon Green BioEnergy, LLC				Location: Thermal Oxidizer Stack (C10)				
Facility: Woodbury Facility				Date: 9/14/23				
Project #: M233705				Test Method: 7E, 3A				
Fuel Type: Natural Gas				Fuel Factor: 8710				
O2 based NOx lb/mmBtu RATA								
CEM Analyzer Information								
NO_x Monitor/Model:		CAI NOXYGEN 650		NO_x Serial # :		TT1012		
O2 Monitor/Model:		CAI NOXYGEN 650		O2 Serial # :		TT1012		
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM NO_x lb/MMBtu	CEM NO_x lb/MMBtu	(RM-CEM) Difference (di)	(RM-CEM) Difference² (di²)
1	1	09/14/23	07:10	07:30	0.072	0.072	0.000	0.000000
1	2	09/14/23	07:42	08:02	0.069	0.068	0.001	0.000001
0	3	09/14/23	08:14	08:34	0.071	0.072	-0.001	0.000001
1	4	09/14/23	08:46	09:06	0.071	0.072	-0.001	0.000001
1	5	09/14/23	09:18	09:38	0.071	0.072	-0.001	0.000001
1	6	09/14/23	09:50	10:10	0.073	0.074	-0.001	0.000001
1	7	09/14/23	10:22	10:42	0.073	0.074	-0.001	0.000001
1	8	09/14/23	10:54	11:14	0.073	0.074	-0.001	0.000001
1	9	09/14/23	11:26	11:46	0.075	0.074	0.001	0.000001
1	10	09/14/23	11:58	12:18	0.076	0.076	0.000	0.000000
n					9			
t(0.975)					2.306			
Mean Reference Method Value					0.073		RM avg	
Mean CEM Value					0.073		CEM avg	
Sum of Differences					-0.003		di	
Mean Difference					0.000		d	
Sum of Differences Squared					0.000		di²	
Standard Deviation					0.001		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.001		cc	
Relative Accuracy					1.38		RA	

Client: Carbon Green BioEnergy, LLC					Location: Thermal Oxidizer Stack (C10)			
Facility: Woodbury Facility					Date: 9/14/23			
Project #: M233705					Test Method: 7E			
NO_x ppmvd RATA								
CEM Analyzer Information								
NO _x Monitor/Model:			CAI NOXYGEN 650		NO _x Serial # :		TT1012	
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM NO _x ppmvd	CEM NO _x ppmvd	(RM-CEM) Difference (di)	(RM-CEM) Difference ² (di ²)
1	1	09/14/23	07:10	07:30	61.4	61.5	-0.1	0.01
1	2	09/14/23	07:42	08:02	58.9	58.2	0.7	0.49
1	3	09/14/23	08:14	08:34	60.5	61.5	-1.0	1.00
1	4	09/14/23	08:46	09:06	60.5	61.2	-0.7	0.49
1	5	09/14/23	09:18	09:38	59.8	60.4	-0.6	0.36
0	6	09/14/23	09:50	10:10	61.1	61.9	-0.8	0.64
1	7	09/14/23	10:22	10:42	61.2	62.0	-0.8	0.64
1	8	09/14/23	10:54	11:14	61.5	61.7	-0.2	0.04
1	9	09/14/23	11:26	11:46	63.6	63.4	0.2	0.04
1	10	09/14/23	11:58	12:18	64.0	63.7	0.3	0.09
n					9			
t(0.975)					2.306			
Mean Reference Method Value					61.267		RM avg	
Mean CEM Value					61.511		CEM avg	
Sum of Differences					-2.200		di	
Mean Difference					-0.244		d	
Sum of Differences Squared					3.160		di ²	
Standard Deviation					0.573		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.440		cc	
Relative Accuracy					1.12		RA	

Client: Carbon Green BioEnergy, LLC **Location:** Thermal Oxidizer Stack (C10)
Facility: Woodbury Facility **Date:** 9/14/23
Project #: M233705 **Test Method:** 7E, 2

NO_x lb/hr RATA

CEM Analyzer Information

NO _x Monitor/Model:		CAI NOXYGEN 650			NO _x Serial # :		TT1012	
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM NO _x lb/hr	CEM NO _x lb/hr	(RM-CEM) Difference (di)	(RM-CEM) Difference ² (di ²)
1	1	09/14/23	07:10	07:30	6.3	6.3	0.0	0.00
1	2	09/14/23	07:42	08:02	6.0	5.9	0.1	0.01
0	3	09/14/23	08:14	08:34	6.1	6.2	-0.1	0.01
1	4	09/14/23	08:46	09:06	6.2	6.3	-0.1	0.01
1	5	09/14/23	09:18	09:38	6.1	6.2	-0.1	0.01
1	6	09/14/23	09:50	10:10	6.4	6.5	-0.1	0.01
1	7	09/14/23	10:22	10:42	6.4	6.4	0.0	0.00
1	8	09/14/23	10:54	11:14	6.3	6.4	-0.1	0.01
1	9	09/14/23	11:26	11:46	6.5	6.5	0.0	0.00
1	10	09/14/23	11:58	12:18	6.6	6.6	0.0	0.00
n					9			
t(0.975)					2.306			
Mean Reference Method Value					6.311		RM avg	
Mean CEM Value					6.344		CEM avg	
Sum of Differences					-0.300		di	
Mean Difference					-0.033		d	
Sum of Differences Squared					0.050		di²	
Standard Deviation					0.071		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.054		cc	
Relative Accuracy					1.39		RA	

Client: Carbon Green BioEnergy, LLC **Location:** Thermal Oxidizer Stack (C10)
Facility: Woodbury Facility **Date:** 9/14/23
Project #: M233705 **Test Method:** 3A

O₂ % (dry) RATA
CEM Analyzer Information

O ₂ Monitor/Model:		CAI NOXYGEN 650			O ₂ Serial # :		TT1012	
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM O ₂ % (dry)	CEM O ₂ % (dry)	(RM-CEM) Difference (di)	(RM-CEM) Difference ² (di ²)
1	1	09/14/23	07:10	07:30	2.3	2.3	0.0	0.00
1	2	09/14/23	07:42	08:02	2.3	2.3	0.0	0.00
1	3	09/14/23	08:14	08:34	2.4	2.4	0.0	0.00
1	4	09/14/23	08:46	09:06	2.4	2.4	0.0	0.00
1	5	09/14/23	09:18	09:38	2.6	2.6	0.0	0.00
1	6	09/14/23	09:50	10:10	2.8	2.8	0.0	0.00
1	7	09/14/23	10:22	10:42	2.7	2.7	0.0	0.00
1	8	09/14/23	10:54	11:14	2.6	2.6	0.0	0.00
1	9	09/14/23	11:26	11:46	2.4	2.4	0.0	0.00
0	10	09/14/23	11:58	12:18	2.6	2.6	0.0	0.00
n					9			
t(0.025)					2.306			
Mean Reference Method Value					2.500		RM avg	
Mean CEM Value					2.500		CEM avg	
Sum of Differences					0.000		di	
Mean Difference					0.000		d	
Sum of Differences Squared					0.000		di²	
Standard Deviation					0.000		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.000		cc	
Relative Accuracy					0.00		RA	

4.0 CERTIFICATION

Mostardi Platt is pleased to have been of service to Carbon Green BioEnergy, LLC. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

As the program manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results. The test program was performed in accordance with the test methods and the Mostardi Platt Quality Manual, as applicable.

MOSTARDI PLATT



Jacob Howe

Program Manager



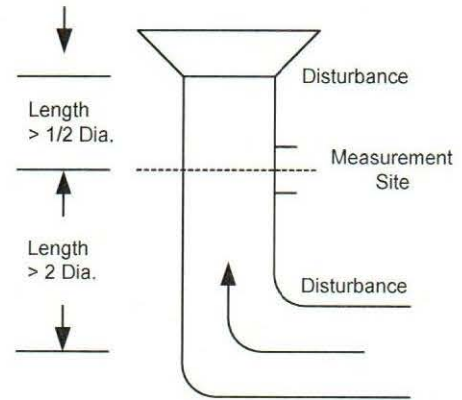
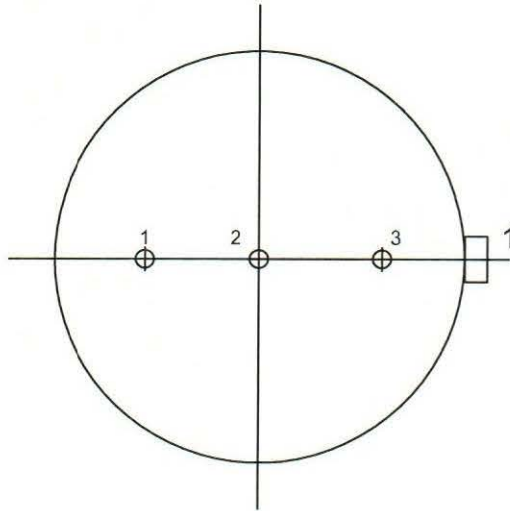
Jeffery M. Crivlare

Quality Assurance

APPENDICES

Appendix A - Test Section Diagram

GASEOUS TRAVERSE FOR ROUND DUCTS



Job: Carbon Green BioEnergy, LLC
Woodbury, Illinois

Date: September 14, 2023

Test Location: Thermal Oxidizer Stack (C10)

Stack Diameter (Feet): 6.0

Stack Area (Square Feet): 28.27

No. Sample Points: 3

No of Ports: 1

Port Length (Inches): 8.0

Distance from inside wall
at port to traverse point:

1. 5.0 Feet (83.3 % of diameter)
2. 3.0 Feet (50.0 % of diameter)
3. 1.0 Feet (16.7 % of diameter)

Appendix B - Sample Train Diagram

USEPA Methods 3A and 7E Extractive Gaseous Sampling Diagram

