



**Relative Accuracy Test Audit  
Test Report**

**Carbon Green BioEnergy, LLC  
Woodbury Facility  
Thermal Oxidizer Stack (C10)  
Lake Odessa, Michigan  
September 15, 2022**

**Report Submittal Date  
October 3, 2022**

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**Project No. M223603**

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## 1.0 EXECUTIVE SUMMARY

Mostardi Platt conducted a Continuous Emissions Monitoring System (CEMS) Relative Accuracy Test Audit (RATA) test program for Carbon Green BioEnergy, LLC at the Woodbury Facility in Lake Odessa, Michigan, on the Thermal Oxidizer Stack (C10) on September 15, 2022. 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 15, 2022	Oxygen (O <sub>2</sub> ) and Nitrogen Oxides (NO <sub>x</sub> )

The purpose of the test program was to demonstrate the relative accuracies of the Thermal Oxidizer Stack (C10) O<sub>2</sub> and NO<sub>x</sub> 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).

RATA RESULTS					
Test Location	Date	Parameter	Units	Relative Accuracy Acceptance Criteria	Relative Accuracy (RA)
Thermal Oxidizer Stack (C10)	9/15/2022	NO <sub>x</sub>	lb/mmBtu	≤ 20.0% of the mean reference value	1.02%
		NO <sub>x</sub>	ppmvd	≤ 20.0% of the mean reference value	0.68%
		NO <sub>x</sub>	lb/hr	≤ 20.0% of the mean reference value	0.84%
		O <sub>2</sub>	% dry	≤ 20.0% of the mean reference value	0.00%

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 <sub>x</sub>	Airgas	SG9169555BAL	0.0 ppm	11/15/2029
NO <sub>x</sub>	Airgas	EB0075700	45.78 ppm	3/3/2025
NO <sub>x</sub>	Airgas	CC495474	91.01 ppm	7/19/2030
O <sub>2</sub>	Airgas	EB0075700	0.0%	3/3/2025
O <sub>2</sub>	Airgas	SG9169555BAL	5.100%	11/15/2029
O <sub>2</sub>	Airgas	ALM-025276	12.02%	5/17/2030

The Model 42i operates on the principle that nitric oxide (NO) and ozone (O<sub>3</sub>) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO<sub>2</sub> molecules decay to lower energy states. Specifically,



Nitrogen dioxide (NO<sub>2</sub>) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO<sub>2</sub> is converted to NO by a stainless steel NO<sub>2</sub>-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 NO<sub>2</sub>-to-NO converter and then to the reaction chamber (NO<sub>x</sub> 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 NO<sub>2</sub> 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 (O<sub>3</sub>) converter to the pump, and is released through the vent.

The NO and NO<sub>x</sub> concentrations calculated in the NO and NO<sub>x</sub> modes are stored in memory. The difference between the concentrations is used to calculate the NO<sub>2</sub> concentration. The Model 42i outputs NO, NO<sub>2</sub>, and NO<sub>x</sub> 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<sup>®</sup> 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 NO<sub>2</sub> to NO converter test can be found in Appendix H. This testing met the performance specifications as outlined in the Method.

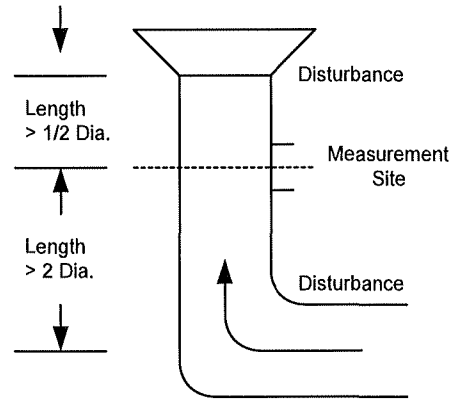
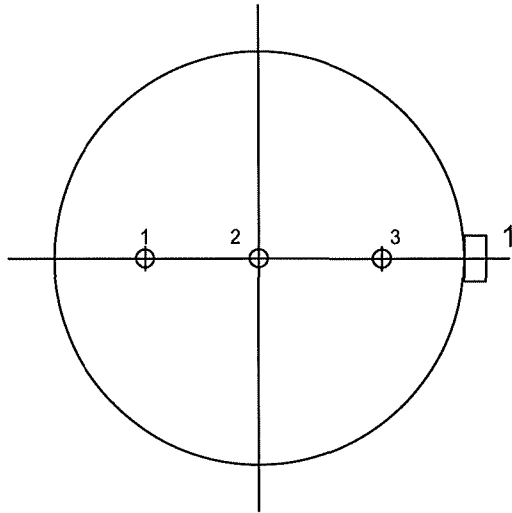
Client: Carbon Green BioEnergy, LLC					Location: Thermal Oxidizer Stack (C10)			
Facility: Woodbury Facility					Date: 9/15/22			
Project #: M223603					Test Method: 7E			
<b>NO<sub>x</sub> ppmvd RATA</b>								
<b>CEM Analyzer Information</b>								
NO <sub>x</sub> Monitor/Model:			CAI NOXYGEN 650		NO <sub>x</sub> Serial # :		TT1012	
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM NO <sub>x</sub> ppmvd	CEM NO <sub>x</sub> ppmvd	(RM-CEM) Difference (di)	(RM-CEM) Difference <sup>2</sup> (di <sup>2</sup> )
1	1	09/15/22	07:25	07:45	57.7	57.9	-0.2	0.04
1	2	09/15/22	07:58	08:18	57.3	57.4	-0.1	0.01
1	3	09/15/22	08:30	08:50	57.6	57.4	0.2	0.04
1	4	09/15/22	09:09	09:29	60.6	60.4	0.2	0.04
1	5	09/15/22	09:41	10:01	59.7	59.5	0.2	0.04
1	6	09/15/22	10:13	10:33	60.5	60.3	0.2	0.04
1	7	09/15/22	10:48	11:08	59.8	59.6	0.2	0.04
1	8	09/15/22	11:20	11:40	59.1	58.7	0.4	0.16
1	9	09/15/22	11:52	12:12	59.5	58.8	0.7	0.49
0	10	09/15/22	12:25	12:45	58.9	57.9	1.0	1.00
n					9			
t(0.975)					2.306			
Mean Reference Method Value					59.089		RM avg	
Mean CEM Value					58.889		CEM avg	
Sum of Differences					1.800		di	
Mean Difference					0.200		d	
Sum of Differences Squared					0.900		di <sup>2</sup>	
Standard Deviation					0.260		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.200		cc	
Relative Accuracy					0.68		RA	

<b>Client:</b> Carbon Green BioEnergy, LLC					<b>Location:</b> Thermal Oxidizer Stack (C10)			
<b>Facility:</b> Woodbury Facility					<b>Date:</b> 9/15/22			
<b>Project #:</b> M223603					<b>Test Method:</b> 3A			
<b>O<sub>2</sub> % (dry) RATA</b>								
<b>CEM Analyzer Information</b>								
<b>O<sub>2</sub> Monitor/Model:</b>			CAI NOXYGEN 650		<b>O<sub>2</sub> Serial # :</b>		TT1012	
<b>1=accept 0=reject</b>	<b>Test Run</b>	<b>Test Date</b>	<b>Start Time</b>	<b>End Time</b>	<b>RM O<sub>2</sub> % (dry)</b>	<b>CEM O<sub>2</sub> % (dry)</b>	<b>(RM-CEM) Difference (di)</b>	<b>(RM-CEM) Difference<sup>2</sup> (di<sup>2</sup>)</b>
1	1	09/15/22	07:25	07:45	2.2	2.2	0.0	0.00
1	2	09/15/22	07:58	08:18	2.3	2.3	0.0	0.00
1	3	09/15/22	08:30	08:50	2.3	2.3	0.0	0.00
1	4	09/15/22	09:09	09:29	2.7	2.7	0.0	0.00
1	5	09/15/22	09:41	10:01	2.7	2.7	0.0	0.00
1	6	09/15/22	10:13	10:33	2.8	2.8	0.0	0.00
1	7	09/15/22	10:48	11:08	3.0	3.0	0.0	0.00
1	8	09/15/22	11:20	11:40	2.7	2.7	0.0	0.00
1	9	09/15/22	11:52	12:12	2.8	2.8	0.0	0.00
0	10	09/15/22	12:25	12:45	2.6	2.6	0.0	0.00
<b>n</b>					<b>9</b>			
<b>t(0.975)</b>					<b>2.306</b>			
<b>Mean Reference Method Value</b>					<b>2.611</b>		<b>RM avg</b>	
<b>Mean CEM Value</b>					<b>2.611</b>		<b>CEM avg</b>	
<b>Sum of Differences</b>					<b>0.000</b>		<b>di</b>	
<b>Mean Difference</b>					<b>0.000</b>		<b>d</b>	
<b>Sum of Differences Squared</b>					<b>0.000</b>		<b>di<sup>2</sup></b>	
<b>Standard Deviation</b>					<b>0.000</b>		<b>sd</b>	
<b>Confidence Coefficient 2.5% Error (1-tail)</b>					<b>0.000</b>		<b>cc</b>	
<b>Relative Accuracy</b>					<b>0.00</b>		<b>RA</b>	

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# APPENDICES

## GASEOUS TRAVERSE FOR ROUND DUCTS



Job: Carbon Green BioEnergy, LLC  
Woodbury, Illinois

Distance from inside wall  
at port to traverse point:

Date: September 15, 2022

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

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



# USEPA Methods 3A and 7E Extractive Gaseous Sampling Diagram

