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Relative Accuracy Test Audit
Test Report

Lansing Board of Water and Light
REO Town Facility
Auxiliary Boiler
Lansing, Michigan
February 28, 2023

Report Submittal Date
March 17, 2023

Project No. M230903C

Crown Point, IN | Mendota Heights, MN | Denver, CO | Henderson, NV

Corporate Headquarters
888 Industrial Drive
Elmhurst, Illinois 60126
630-993-2100

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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 Lansing Board of Water and Light at the REO Town Facility in Lansing, Michigan, on the Auxiliary Boiler on February 28, 2023. This report summarizes the results of the test program and test methods used in accordance with the Mostardi Platt Protocol P230903 dated December 1, 2022. Mostardi Platt is a self-certified air emissions testing body (AETB). A copy of Mostardi Platt's self-certification can be found in Appendix A. A copy of Mostardi Platt's qualified individual (QI) for this test program can be found in Appendix B.

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

TEST INFORMATION		
Test Location	**Test Date**	**Test Parameters**
Auxiliary Boiler	February 28, 2023	Oxygen (O_2) and Nitrogen Oxides (NO_X)

The purpose of the test program was to determine the relative accuracies of the Auxiliary Boiler O_2 and NO_X analyzers during the specified operating conditions. The test results from this test program indicate that each CEMS component 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**	**Parameters**	**Units**	**Relative Accuracy Acceptance Criteria**	**Relative Accuracy (RA)**
Auxiliary Boiler	2/28/2023	NO_X	lb/mmBtu	≤ 20.0% of the mean reference value	3.06%
		NO_X	ppmvd @ 3% O_2	≤ 20.0% of the mean reference value	2.08%
		O_2	% dry	≤ 20.0% of the mean reference value	3.62%

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	CC421924	0 ppm	3/11/2030
NO_X	Airgas	CC140164	12.70 ppm	4/22/2025
NO_X	Airgas	CC432322	25.52 ppm	12/14/2025
O_2	Airgas	CC140164	0%	4/22/2025
O_2	Airgas	CC421924	5.049 %	3/11/2030
O_2	Airgas	CC431939	9.034 %	3/21/2030

The identifications of the individuals associated with the test program are summarized below.

TEST PERSONNEL INFORMATION		
Location	**Address**	**Contact**
Test Coordinator	Lansing Board of Water and Light 1232 Haco Drive P.O. Box 13007 Lansing, Michigan 48912	Mr. Nathan Hude Environmental Compliance Specialist (517) 702-6170 nathan.hude@lbwl.com
Test Facility	Lansing Board of Water and Light REO Town Facility 1201 S. Washington Ave. Lansing, Michigan 48917	
Testing Company Supervisor	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Daniel Kossack Project Supervisor 630-993-2100 (phone) dkossack@mp-mail.com QI Group V (certified on 11/11/21)
Testing Company Personnel		Pravaek Pradhan 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 to the Mostardi Platt Quality Manual. Schematics of the test section diagram and sampling train used are included in Appendix C and D respectively. Calculation and nomenclature are included in Appendix E. Copies of analyzer print-outs for each test run are included in Appendix F. CEM data and process data as provided by Lansing Board of Water and Light are included in Appendix G.

The following methodologies were used during the test program:

Method 3A Oxygen (O_2) Determination

Stack gas O_2 concentrations and emission rates were determined in accordance with USEPA Method 3A, 40CFR60, Appendix A. A Servomex analyzer was used to determine the O_2 concentrations in the manner specified in the Method. The instrument has a paramagnetic detector and the O_2 operates in the nominal range of 0% to 25% with the specific range determined by the high-level calibration gas of 9.034%. 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 % O_2 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 I. This testing met the performance specifications as outlined in the Method.

Method 7E Nitrogen Oxides (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-HL High level 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 100 ppm with the specific range determined by the high-level span calibration gas of 25.52 ppm.

The Model 42i-HL High level is based on the principle that nitric oxide (NO) and ozone (O_3) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited nitrogen dioxide (NO_2) molecules decay to lower energy states. Specifically,

$$NO+O_3 \rightarrow NO_2+O_2+h\upsilon$$

NO_2 must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO_2 is converted to NO by a molybdenum NO_2-to-NO converter heated to about 325°C. The flue gas air sample is drawn into the Model 42i-HL High level through the sample bulkhead. The sample flows through a particulate filter, 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_2-to-NO converter and then to the reaction chamber (NO_X mode).

Dry air enters the Model 42i-HL High level through the dry air bulkhead, through a flow sensor, and then through a silent discharge ozonator. The ozonator generates the necessary ozone concentration needed for the chemiluminescent reaction. The ozone reacts with the NO in the ambient air sample to produce electronically excited NO_2 molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the NO_2 luminescence.

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 NO_2 concentration. The Model 42i-HL High Level outputs NO, NO_2, and NO_X concentrations to both the front panel display and the analog outputs.

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 USEPA Protocol 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 H. Copies of the gas cylinder certifications are found in Appendix I. The NO_2 to NO converter test can be found in Appendix J. This testing met the performance specifications as outlined in the Method.

3.0 TEST RESULT SUMMARIES

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Fuel Type: Natural Gas

Location: Auxiliary Boiler Stack
Date: 2/28/23
Test Method: 7E, 3A
Fuel Factor: 8710

O2 based NOx lb/mmBtu RATA

CEM Analyzer Information

				NO_x Monitor/Model:	Thermo Fisher Scientific 41iQ-LS		**NO_x Serial # :**	12114512143	
				O2 Monitor/Model:	Thermo Fisher Scientific 41iQ-LS		**O2 Serial # :**	12114512143	
1=accept 0=reject	**Test Run**	**Heat Input**	**Test Date**	**Start Time**	**End Time**	**RM NO_x lb/MMBtu**	**CEM NO_x lb/MMBtu**	**(RM-CEM) Difference (di)**	**(RM-CEM) Difference^2 (di^2)**
1	1	141.6	02/28/23	06:16	06:36	0.023	0.024	-0.001	0.000001
1	2	144.7	02/28/23	06:52	07:12	0.024	0.024	0.000	0.000000
1	3	146.1	02/28/23	07:26	07:46	0.024	0.024	0.000	0.000000
1	4	143.0	02/28/23	08:00	08:20	0.024	0.024	0.000	0.000000
1	5	141.3	02/28/23	08:35	08:55	0.024	0.024	0.000	0.000000
1	6	141.3	02/28/23	09:10	09:30	0.023	0.024	-0.001	0.000001
1	7	137.1	02/28/23	09:45	10:05	0.023	0.023	0.000	0.000000
1	8	138.6	02/28/23	10:20	10:40	0.023	0.024	-0.001	0.000001
0	9	138.9	02/28/23	10:55	11:15	0.023	0.024	-0.001	0.000001
1	10	136.2	02/28/23	11:30	11:50	0.023	0.023	0.000	0.000000
					n	**9**			
					t(0.975)	**2.306**			
					Mean Reference Method Value	**0.023**		**RM avg**	
					Mean CEM Value	**0.024**		**CEM avg**	
					Sum of Differences	**-0.003**		**di**	
					Mean Difference	**0.000**		**d**	
					Sum of Differences Squared	**0.000**		**di^2**	
					Standard Deviation	**0.001**		**sd**	
					Confidence Coefficient 2.5% Error (1-tail)	**0.000**		**cc**	
					Relative Accuracy	**3.06**		**RA**	

Client: Lansing Board of Water & Light | **Location:** Auxiliary Boiler Stack
Facility: REO Town Facility | **Date:** 2/28/23
Project #: M230903 | **Test Method:** 3A

O_2 % (dry) RATA

CEM Analyzer Information

O_2 Monitor/Model:	Thermo Fisher Scientific 41iQ-LS	O_2 Serial # :	12114512143

1=accept 0=reject	Test Run	Heat Input	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	141.6	02/28/23	06:16	06:36	4.2	4.3	-0.1	0.01
1	2	144.7	02/28/23	06:52	07:12	4.2	4.2	0.0	0.00
0	3	146.1	02/28/23	07:26	07:46	4.0	4.2	-0.2	0.04
1	4	143.0	02/28/23	08:00	08:20	4.3	4.2	0.1	0.01
1	5	141.3	02/28/23	08:35	08:55	4.3	4.3	0.0	0.00
1	6	141.3	02/28/23	09:10	09:30	4.2	4.3	-0.1	0.01
1	7	137.1	02/28/23	09:45	10:05	4.2	4.4	-0.2	0.04
1	8	138.6	02/28/23	10:20	10:40	4.1	4.3	-0.2	0.04
1	9	138.9	02/28/23	10:55	11:15	4.2	4.3	-0.1	0.01
1	10	136.2	02/28/23	11:30	11:50	4.2	4.3	-0.1	0.01

n	9	
t(0.975)	2.306	
Mean Reference Method Value	4.211	RM avg
Mean CEM Value	4.289	CEM avg
Sum of Differences	-0.700	di
Mean Difference	0.078	d
Sum of Differences Squared	0.130	di^2
Standard Deviation	0.097	sd
Confidence Coefficient 2.5% Error (1-tail)	0.075	cc
Relative Accuracy	3.62	RA

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903

Location: Auxiliary Boiler Stack
Date: 2/28/23
Test Method: 7E, 3A

NOx ppmvd @ 3% O2 RATA

CEM Analyzer Information

NO_x Monitor/Model:	Thermo Fisher Scientific 41iQ-LS	NO_x Serial # :	12114512143
O_2 Monitor/Model:	Thermo Fisher Scientific 41iQ-LS	O_2 Serial # :	12114512143

1=accept 0=reject	Test Run	Heat Input	Test Date	Start Time	End Time	RM NOx ppmvd @ 3 %O2	CEM NOx ppmvd @ 3 %O2	(RM-CEM) Difference (di)	(RM-CEM) Difference^2 (di^2)
1	1	141.6	02/28/23	06:16	06:36	19.2	19.6	-0.4	0.16
1	2	144.7	02/28/23	06:52	07:12	19.6	19.9	-0.3	0.09
1	3	146.1	02/28/23	07:26	07:46	19.5	20.0	-0.5	0.25
1	4	143.0	02/28/23	08:00	08:20	19.5	19.8	-0.3	0.09
1	5	141.3	02/28/23	08:35	08:55	19.4	19.7	-0.3	0.09
1	6	141.3	02/28/23	09:10	09:30	19.3	19.7	-0.4	0.16
1	7	137.1	02/28/23	09:45	10:05	19.0	19.3	-0.3	0.09
0	8	138.6	02/28/23	10:20	10:40	18.9	19.4	-0.5	0.25
1	9	138.9	02/28/23	10:55	11:15	19.1	19.4	-0.3	0.09
1	10	136.2	02/28/23	11:30	11:50	18.9	19.2	-0.3	0.09

n	9	
t(0.975)	2.306	
Mean Reference Method Value	19.278	RM avg
Mean CEM Value	19.622	CEM avg
Sum of Differences	-3.100	di
Mean Difference	-0.344	d
Sum of Differences Squared	1.110	di^2
Standard Deviation	0.073	sd
Confidence Coefficient 2.5% Error (1-tail)	0.056	cc
Relative Accuracy	2.08	RA

4.0 CERTIFICATION

Mostardi Platt is pleased to have been of service to Lansing Board of Water and Light. 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.

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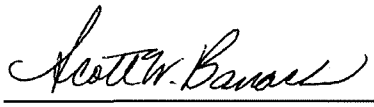
Program Manager

Daniel J. Kossack



Quality Assurance

Scott W. Banach

APPENDICES

Appendix A - Company AETB Certification

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March 23, 2012

Effective immediately, Mostardi Platt self-certifies that all Part 75 test projects conform to the ASTM D 7036-04 Standard Practice. The following contact information is provided as required by the Standard:

Mostardi Platt
888 Industrial Drive
Elmhurst, Illinois 60126

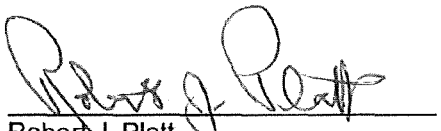
630-993-2100

tplatt@mp-mail.com

Also, attached is a list of each Qualified Individual (QI) with the type of exam (e.g., Group I, II, III IV and/or V), the date the exam was taken and the name and email address of the exam provider.

Should you have any questions or need additional information, please contact Thomas Platt, P.E. at 630-993-2683.

Approved:

By: 

Robert J. Platt
Chief Executive Officer

QSTI AETB Import Data

QI Last Name [REQUIRED]	QI First Name [REQUIRED]	QI Middle Initial	AETB Name [REQUIRED]	AETB Phone Number [REQUIRED]	AETB Email [REQUIRED]	Exam Date mm/dd/yyyy [REQUIRED]	Exam Provider Name [REQUIRED]	Exam Provider Email [REQUIRED]	Comment
Burton	Stuart	L	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/4/2023	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Carlisle	Robert	W	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/8/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Colangelo	Nicholas	C	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/1/2019	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Coleman	Paul	F	Mostard Platt	630-993-2100	tplatt@mp-mail.com	3/15/2018	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Crivlare	Jeffrey	M	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/4/2023	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Eldridge	Christopher	S	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/18/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Gross	Jeffrey	M	Mostard Platt	630-993-2100	tplatt@mp-mail.com	11/20/2018	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Hendricks	Benjamin	W	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/30/2020	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Howe	Jacob	W	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/17/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Jensen	Christopher	E	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/4/2023	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Jones	Kyle	L	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/11/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Kaschinske	Jordan	R	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/8/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Kossack	Daniel	J	Mostard Platt	630-993-2100	tplatt@mp-mail.com	11/11/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Kukla	Joshua	R	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/4/2019	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Lipinski	Michal		Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/31/2020	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
McGough	Scott	W	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/27/2018	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Panek	Damian	P	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/19/2021	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Peterson	Mark	E	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/17/2023	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Petrovich	William	A	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/4/2022	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Russ	Timothy	E	Mostard Platt	630-993-2100	tplatt@mp-mail.com	4/8/2020	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Sands	Stuart	T	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/5/2023	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Sather	Michael	P	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/7/2020	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Simon	Ryan	K	Mostard Platt	630-993-2100	tplatt@mp-mail.com	1/19/2023	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Sorce	Angelo	M	Mostard Platt	630-993-2100	tplatt@mp-mail.com	2/18/2022	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)
Trezak	Christopher	S	Mostard Platt	630-993-2100	tplatt@mp-mail.com	4/14/2020	Source Evaluation Society	qstiprogram@gmail.com	Group V (Part 75)

2/21/2023

Appendix B - QI Certification(s) for Field Personnel

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Qualified Individual

Daniel J. Kossack

Has satisfactorily completed the requirements of

ASTM D 7036 – 04, Section 8.3

Standard Practice for Competence of Air Emission Testing Bodies

Examinations provided by Source Evaluation Society: www.sesnews.org, (919) 544-6338

All Part 75 test methods, under my supervision, shall conform to the company's Quality Manual and to this practice, in all respects.

Passed Group V on 11/11/2021

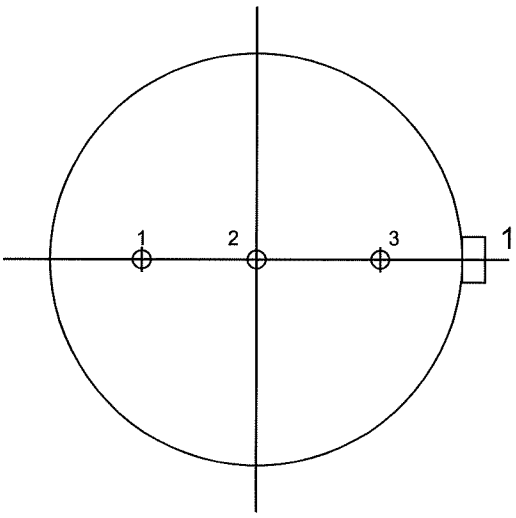
Expiration Date: 11/11/2026

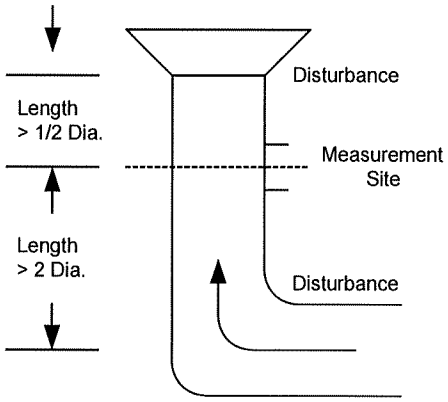
Signature: _____ Date: November 11, 2021

Quality Manager: _____ Technical Director: _____

Appendix C - Test Section Diagram

GASEOUS TRAVERSE FOR ROUND DUCTS





Job: Lansing Board of Water and Light
REO Town Facility
Lansing, Michigan

Date: February 28, 2023

Test Location: Auxiliary Boiler Stack

Stack Diameter: 4.75 Feet

Stack Area: 17.72 Square Feet

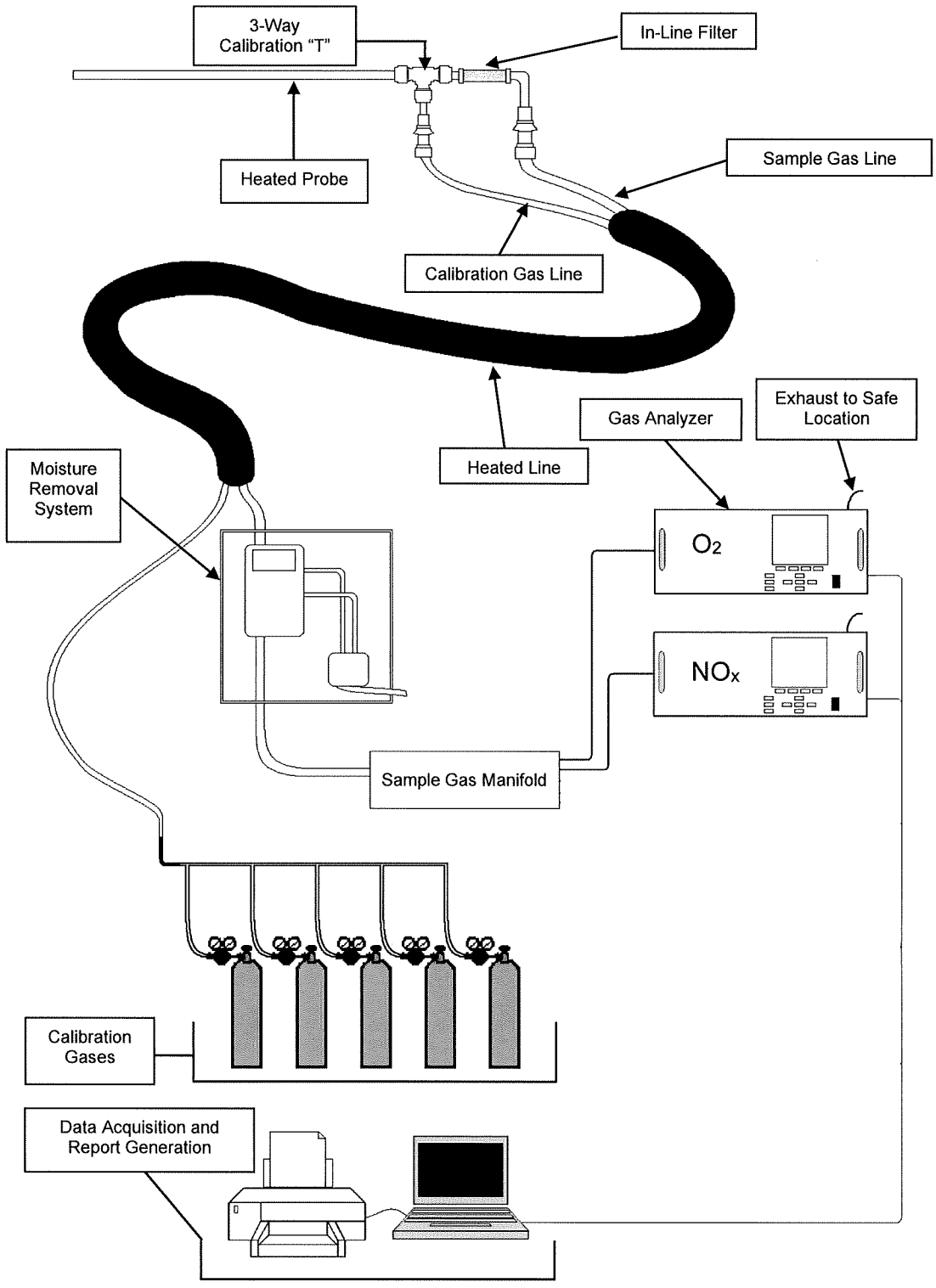
No. Sample Points: 3

Distance from Inside Wall
To Traverse Point:

1. 83.3 % of diameter
2. 50.0 % of diameter
3. 16.7 % of diameter

Appendix D - Sample Train Diagram

USEPA Methods 3A and 7E Extractive Gaseous Sampling Diagram



Appendix E - Calculation Nomenclature and Formulas

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

Sample Calculations

NOx ppmvd

$$(17.9\ \text{ppm} - 0.2\ \text{ppm}) \times \frac{12.7\ \text{ppm}}{12.8\ \text{ppm} - 0.2\ \text{ppm}} = 17.9\ \text{ppm}$$

O2 % (dry)

$$(4.28\ \% - 0.10\ \%) \times \frac{5.05\ \%}{5.10\ \% - 0.10\ \%} = 4.22\ \%$$

O2 based NOx lb/mmBtu

17.9 ppm x (1.194 x 10^-7) = 0.00000213 lbs/dscf

$$0.00000213\ \text{lbs/dscf} \times 8{,}710\ \text{dscf/mmBtu} \times \frac{20.9\%}{(20.9\% - 4.22\ \%)}$$

= 0.023 NOx lbs/mmBtu

NOx ppmvd @ 3% O2

17.9 x ((20.9 - 3.0)/(20.9 - 4.2)) = 19.2 NOx ppmvd @ 3% O2

$$C_{gas} = (C - C_o) \times \frac{C_{ma}}{C_m - C_o}$$

where:
C_{gas} = Effluent gas concentration, dry basis, ppm or %
C = Average gas concentration indicated by gas analyzer, dry basis, ppm or %
C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm or %
C_m = Average of initital and final system calibration bias check responses for the upscale calibration gas, ppm or %
C_{ma} = Actual concentration of the upscale calibration gas, ppm or %

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Derivation of Factors Used in Nitrogen Oxides Calculations

Factors for calculating concentration as pounds per dry standard cubic feet:

$$\text{Factor for } C_{NO_2} \text{ as } NO_2 = \frac{28316.846\,\text{ml/scf}}{4.53592\times10^{8}\ \mu\text{g/lb}} = 6.242801\times10^{-5}\ \frac{\text{lb/scf}}{\mu\text{g/ml}}\ \underline{\text{Use } 6.2428\times10^{-5}}$$

Factors for calculating from parts per million to lb/dscf:

Using 22.414 liters of gas per gram-mole at 0°C and 1 atmosphere pressure,

One pound-mole of gas is contained in 359.04765 ft^3 at 32°F and 29.92 in. Hg, or 385.31943 ft^3 at 68°F and 29.92 in. Hg

$$\text{ppm x } \frac{\text{Mwlb/lb–mole}}{385.31943\ \text{dscf/lb–mole}\times10^{6}} = \text{lb/dscf}$$

Where Mw = pollutant molecular weight; NO_2 = 46.0055 lb/lb-mole

$$\text{Factor for ppm } NO_x = \frac{1}{46.0055\times2.5952494\times10^{-9}} = 8.3755\times10^{6}\ \text{dscf/lb}$$

$$\underline{\text{Use } 8.3755\times10^{6}}$$

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ppm Conversion Calculations and Factors

ppm to lbs/scf

(ppm X) x (conversion factor X) = X lbs/scf

lbs/scf to lbs/hr

Dry ppm's with dry flow, and wet ppm's with wet flow.

(X lbs/scf) x (airflow scf/min) x (60 min/hr) = X lbs/hr

lbs/scf to lbs/mmBtu

Dry ppm's with dry diluent, and wet ppm's with wet diluent.

CO_2 – (X lbs/scf) x (F_c) x (100/CO_2) = X lbs/mmBtu

O_2 – (X lbs/scf) x (F_d) x (20.9/(20.9-O_2)) = X lbs/mmBtu

Conversion Factors

NO_x – 1.19396×10^{-7}

SO_2 – 1.6625×10^{-7}

CO – 7.2664×10^{-8}

CH_4 – 4.1637×10^{-8}

C_3H_8 – 1.1419×10^{-7}

Emission Rate Calculations

A pollutant emission rate (E), expressed as pounds of pollutant per million Btu heat input from the fuel combusted can be calculated by several methods as follows:

A. $C = C_s/7000$ where, C = pollutant concentration, lb/dscf
c_s = pollutant concentration, grains/dscf

B. If fuel flow is monitored and the fuel combusted during the test is sampled and analyzed for gross calorific value, then:

$$E = \frac{Q_{sd} C}{fuel\ flow\ rate\ (lb/hr)\ GCV} \times 10^6$$

Where E = lbs per million Btu
GCV = gross calorific value, Btu/lb
Q_{sd} = dry volumetric gas flow at standard conditions, dscf/hr

C. If an integrated gas sample is taken during the test and analyzed for $\%CO_2$ or $\%O_2$, dry basis by volume, with an approved USEPA Method 3 or 3A gas analyzer, then

$$E = CF_C \frac{100}{\%CO_2}\ or\ E = CF_d \frac{20.9}{(20.9 - \%O_2)}$$

Where $\%CO_2$ and $\%O_2$ are expressed as percent values:

F_c = a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the specified fuel type combusted in Figure 1.

Fd = a factor representing a ratio of the volume of dry flue gases generated to the calorific value of the specified fuel type combusted in Figure 1.

Fuel Type	F_d	F_c	Fuel Type	F_d	F_c
Coal, Anthracite	10100	1970	Fuel Oil	9190	1420
Coal, Bituminous	9780	1800	Municipal	9570	1820
Coal, Lignite	9860	1910	Natural Gas	8710	1040
Coal, Sub-Bituminous	9820	1840	Wood	9240	1830

Figure 1. Fuel Type

D. If fuel sample increments are taken and composited during the test and an ultimate analysis is performed and the GCV is determined, then

$$F_C = \frac{321 \times 10^3 (\%C)}{GCV}\ where\ \%C = Carbon\ content\ by\ weight\ expressed\ as\ percent$$

$$F_d = \frac{[3.64(\%H) + 1.53(\%C) + 0.57(\%S) + 0.14(\%N) - 0.46(\%O_2)]}{GCV} \times 10^6$$

H = Hydrogen, percent; C = Carbon, percent; S = Sulfur, percent; N = Nitrogen, percent; O = Oxygen, percent

MOSTARDI PLATT

Relative Accuracy Test Audit (RATA) Calculations and Bias Adjustment Factor Calculation

Mean Difference

$$\bar{d} = \frac{1}{n}\sum_{i=1}^{n} di$$

Standard Deviation

$$Sd = \left[\frac{\sum_{i=1}^{n} d_i^2 - \frac{[\sum_{i=1}^{n} d_i]^2}{n}}{n-1}\right]^{1/2}$$

Confidence Coefficient

$$CC = t_{0.025}\frac{Sd}{\sqrt{n}}$$

Relative Accuracy

$$RA = \frac{|\bar{d}| + |CC|}{RM\ avg} \times 100$$

Bias Adjustment Factor

$$BAF = 1 + \frac{|\bar{d}|}{CEM\ avg}$$

MOSTARDI PLATT

Pollutant Concentration Correction 15% for Percent Oxygen

$$C_{adj} = C_d \frac{20.9 - 15\%}{20.9 - \%O_2}$$

where:

C_{adj} = Pollutant concentration corrected to percent O_2

20.9-15% = Percent O_2, the defined O_2 correction value, percent

20.9 = Percent O_2 in air

$\%O_2$ = Measured O_2 concentration dry basis, percent

C_d = Pollutant concentration measured, dry basis, ppm.

Appendix F - Reference Method Test Data (Computerized Sheets)

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

Run 1			Run 2		
Time	NOx ppmvd	O2 % (dry)	Time	NOx ppmvd	O2 % (dry)
6:16	18.10	4.20	6:52	18.40	4.20
6:17	18.10	4.20	6:53	18.40	4.20
6:18	18.00	4.20	6:54	18.40	4.20
6:19	18.00	4.20	6:55	18.30	4.20
6:20	17.90	4.30	6:56	18.30	4.30
6:21	17.90	4.30	6:57	18.30	4.30
6:22	17.90	4.30	6:58	18.30	4.30
6:23	17.80	4.30	6:59	18.30	4.30
6:24	17.90	4.30	7:00	18.30	4.30
6:25	17.80	4.30	7:01	18.20	4.30
6:26	17.80	4.30	7:02	18.30	4.30
6:27	17.80	4.30	7:03	18.30	4.20
6:28	17.80	4.40	7:04	18.40	4.30
6:29	17.80	4.30	7:05	18.40	4.30
6:30	17.80	4.30	7:06	18.40	4.30
6:31	17.80	4.30	7:07	18.50	4.30
6:32	17.80	4.20	7:08	18.50	4.30
6:33	17.80	4.30	7:09	18.50	4.30
6:34	17.90	4.30	7:10	18.50	4.30
6:35	17.90	4.20	7:11	18.60	4.30
6:36	17.90	4.30	7:12	18.60	4.30
Average	**17.88**	**4.28**	**Average**	**18.39**	**4.28**

Run 3			Run 4		
Time	NOx ppmvd	O2 % (dry)	Time	NOx ppmvd	O2 % (dry)
7:26	18.20	4.10	8:00	18.00	4.30
7:27	18.30	4.10	8:01	18.00	4.30
7:28	18.40	4.00	8:02	18.10	4.40
7:29	18.40	4.00	8:03	18.20	4.30
7:30	18.40	4.10	8:04	18.30	4.30
7:31	18.50	4.10	8:05	18.40	4.30
7:32	18.50	4.10	8:06	18.20	4.20
7:33	18.50	4.10	8:07	18.10	4.30
7:34	18.50	4.10	8:08	18.20	4.30
7:35	18.40	4.10	8:09	18.10	4.30
7:36	18.40	4.10	8:10	18.00	4.30
7:37	18.30	4.10	8:11	18.00	4.30
7:38	18.20	4.10	8:12	18.00	4.30
7:39	18.30	4.10	8:13	18.00	4.30
7:40	18.40	4.20	8:14	18.10	4.30
7:41	18.30	4.10	8:15	18.10	4.40
7:42	18.50	4.10	8:16	18.20	4.30
7:43	18.50	4.10	8:17	18.10	4.40
7:44	18.60	4.10	8:18	17.90	4.40
7:45	18.50	4.20	8:19	18.00	4.40
7:46	18.50	4.20	8:20	18.00	4.30
Average	**18.41**	**4.10**	**Average**	**18.10**	**4.32**

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

Run 5			Run 6		
Time	NOx ppmvd	O2 % (dry)	Time	NOx ppmvd	O2 % (dry)
8:35	17.60	4.40	9:10	17.80	4.30
8:36	17.60	4.40	9:11	17.80	4.30
8:37	17.70	4.40	9:12	17.80	4.20
8:38	17.80	4.40	9:13	17.90	4.30
8:39	17.70	4.40	9:14	17.80	4.30
8:40	17.80	4.40	9:15	17.90	4.30
8:41	17.80	4.40	9:16	18.00	4.30
8:42	17.90	4.40	9:17	17.90	4.30
8:43	17.90	4.40	9:18	17.90	4.30
8:44	18.00	4.40	9:19	17.90	4.30
8:45	18.10	4.40	9:20	17.90	4.30
8:46	18.10	4.40	9:21	17.90	4.30
8:47	18.00	4.50	9:22	17.80	4.30
8:48	17.90	4.50	9:23	17.90	4.20
8:49	18.00	4.50	9:24	17.90	4.20
8:50	18.00	4.40	9:25	18.00	4.20
8:51	18.10	4.40	9:26	18.00	4.20
8:52	18.10	4.40	9:27	18.10	4.20
8:53	18.00	4.40	9:28	18.20	4.20
8:54	18.00	4.40	9:29	18.20	4.20
8:55	18.10	4.40	9:30	18.10	4.20
Average	**17.91**	**4.41**	**Average**	**17.94**	**4.26**

Run 7			Run 8		
Time	NOx ppmvd	O2 % (dry)	Time	NOx ppmvd	O2 % (dry)
9:45	17.40	4.40	10:20	17.10	4.20
9:46	17.40	4.40	10:21	17.20	4.20
9:47	17.40	4.40	10:22	17.20	4.20
9:48	17.50	4.30	10:23	17.10	4.20
9:49	17.40	4.40	10:24	17.10	4.20
9:50	17.50	4.30	10:25	17.10	4.20
9:51	17.50	4.30	10:26	17.20	4.30
9:52	17.40	4.30	10:27	17.30	4.20
9:53	17.40	4.30	10:28	17.30	4.20
9:54	17.40	4.40	10:29	17.30	4.20
9:55	17.40	4.40	10:30	17.60	4.20
9:56	17.40	4.40	10:31	17.70	4.20
9:57	17.50	4.40	10:32	17.90	4.20
9:58	17.60	4.40	10:33	17.90	4.10
9:59	17.70	4.40	10:34	17.90	4.10
10:00	17.80	4.30	10:35	18.00	4.10
10:01	17.90	4.30	10:36	18.00	4.10
10:02	17.70	4.30	10:37	18.00	4.20
10:03	17.80	4.20	10:38	18.00	4.20
10:04	17.70	4.20	10:39	18.00	4.20
10:05	17.80	4.30	10:40	18.00	4.20
Average	**17.55**	**4.34**	**Average**	**17.57**	**4.19**

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

	Run 9			Run 10	
Time	NOx ppmvd	O2 % (dry)	Time	NOx ppmvd	O2 % (dry)
10:55	17.60	4.20	11:30	17.20	4.20
10:56	17.60	4.20	11:31	17.30	4.20
10:57	17.50	4.20	11:32	17.30	4.20
10:58	17.60	4.20	11:33	17.30	4.20
10:59	17.60	4.20	11:34	17.20	4.20
11:00	17.50	4.20	11:35	17.20	4.20
11:01	17.50	4.20	11:36	17.20	4.30
11:02	17.50	4.20	11:37	17.20	4.20
11:03	17.40	4.30	11:38	17.30	4.20
11:04	17.50	4.20	11:39	17.40	4.20
11:05	17.60	4.20	11:40	17.40	4.20
11:06	17.50	4.20	11:41	17.60	4.20
11:07	17.60	4.20	11:42	17.60	4.20
11:08	17.70	4.20	11:43	17.60	4.20
11:09	17.70	4.20	11:44	17.60	4.30
11:10	17.70	4.20	11:45	17.60	4.30
11:11	18.10	4.20	11:46	17.60	4.30
11:12	17.90	4.20	11:47	17.70	4.30
11:13	17.90	4.20	11:48	17.70	4.20
11:14	17.90	4.20	11:49	17.70	4.20
11:15	18.00	4.20	11:50	17.70	4.30
Average	**17.66**	**4.20**	**Average**	**17.45**	**4.23**

Appendix G - Continuous Emissions Monitoring System Data and Fuel Analysis

RUN1	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 06:16	142.7
02/28/2023 06:17	142.2
02/28/2023 06:18	141.9
02/28/2023 06:19	141.5
02/28/2023 06:20	141.2
02/28/2023 06:21	140.7
02/28/2023 06:22	140.5
02/28/2023 06:23	140.5
02/28/2023 06:24	140.3
02/28/2023 06:25	140.3
02/28/2023 06:26	140.4
02/28/2023 06:27	140.5
02/28/2023 06:28	140.7
02/28/2023 06:29	140.7
02/28/2023 06:30	140.9
02/28/2023 06:31	141.3
02/28/2023 06:32	141.8
02/28/2023 06:33	142.5
02/28/2023 06:34	143.2
02/28/2023 06:35	144
02/28/2023 06:36	144.3

RUN2	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 06:52	145.9
02/28/2023 06:53	145.3
02/28/2023 06:54	144.8
02/28/2023 06:55	144.4
02/28/2023 06:56	144.2
02/28/2023 06:57	144.1
02/28/2023 06:58	144.1
02/28/2023 06:59	144.1
02/28/2023 07:00	144.2
02/28/2023 07:01	144.1
02/28/2023 07:02	143.9
02/28/2023 07:03	143.6
02/28/2023 07:04	143.6
02/28/2023 07:05	143.7
02/28/2023 07:06	144
02/28/2023 07:07	144.5
02/28/2023 07:08	145.3
02/28/2023 07:09	145.9
02/28/2023 07:10	145.9
02/28/2023 07:11	146.4
02/28/2023 07:12	146.7

RUN3	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 07:26	148.2
02/28/2023 07:27	148
02/28/2023 07:28	147.5
02/28/2023 07:29	147.2
02/28/2023 07:30	146.9
02/28/2023 07:31	146.7
02/28/2023 07:32	146.7
02/28/2023 07:33	146.4
02/28/2023 07:34	146
02/28/2023 07:35	145.4
02/28/2023 07:36	145.4
02/28/2023 07:37	145.2
02/28/2023 07:38	145.2
02/28/2023 07:39	145.4
02/28/2023 07:40	145.4
02/28/2023 07:41	145.3
02/28/2023 07:42	145.2
02/28/2023 07:43	144.9
02/28/2023 07:44	145.3
02/28/2023 07:45	145.7
02/28/2023 07:46	146.1

RUN4	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 08:00	143.8
02/28/2023 08:01	144
02/28/2023 08:02	144.3
02/28/2023 08:03	144.6
02/28/2023 08:04	144.3
02/28/2023 08:05	143.8
02/28/2023 08:06	143.2
02/28/2023 08:07	143
02/28/2023 08:08	142.8
02/28/2023 08:09	142.8
02/28/2023 08:10	142.6
02/28/2023 08:11	142.6
02/28/2023 08:12	142.6
02/28/2023 08:13	142.4
02/28/2023 08:14	141.9
02/28/2023 08:15	141.7
02/28/2023 08:16	141.8
02/28/2023 08:17	142.1
02/28/2023 08:18	142.5
02/28/2023 08:19	143
02/28/2023 08:20	143.8

RUN5	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 08:35	141.4
02/28/2023 08:36	141.5
02/28/2023 08:37	141
02/28/2023 08:38	140.7
02/28/2023 08:39	140.7
02/28/2023 08:40	140.4
02/28/2023 08:41	140.8
02/28/2023 08:42	141.1
02/28/2023 08:43	141.2
02/28/2023 08:44	141.1
02/28/2023 08:45	141
02/28/2023 08:46	141
02/28/2023 08:47	141.2
02/28/2023 08:48	141.9
02/28/2023 08:49	142.1
02/28/2023 08:50	142.1
02/28/2023 08:51	141.8
02/28/2023 08:52	141.5
02/28/2023 08:53	141.1
02/28/2023 08:54	141.7
02/28/2023 08:55	141.8

RUN6	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 09:10	140.8
02/28/2023 09:11	140.7
02/28/2023 09:12	140.4
02/28/2023 09:13	140.1
02/28/2023 09:14	140
02/28/2023 09:15	140
02/28/2023 09:16	139.6
02/28/2023 09:17	139.6
02/28/2023 09:18	139.5
02/28/2023 09:19	139.6
02/28/2023 09:20	139.8
02/28/2023 09:21	140.4
02/28/2023 09:22	141.1
02/28/2023 09:23	141.8
02/28/2023 09:24	142.3
02/28/2023 09:25	142.4
02/28/2023 09:26	142.9
02/28/2023 09:27	143.1
02/28/2023 09:28	143.7
02/28/2023 09:29	144.1
02/28/2023 09:30	144.4

RUN7	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 09:45	136.7
02/28/2023 09:46	136.6
02/28/2023 09:47	136.1
02/28/2023 09:48	135.8
02/28/2023 09:49	135.8
02/28/2023 09:50	135.2
02/28/2023 09:51	134.7
02/28/2023 09:52	134.4
02/28/2023 09:53	134.4
02/28/2023 09:54	134.8
02/28/2023 09:55	135.6
02/28/2023 09:56	136.4
02/28/2023 09:57	137.2
02/28/2023 09:58	138.2
02/28/2023 09:59	138.9
02/28/2023 10:00	139.4
02/28/2023 10:01	139.6
02/28/2023 10:02	139.9
02/28/2023 10:03	139.8
02/28/2023 10:04	139.6
02/28/2023 10:05	139.3

RUN8	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 10:20	136.3
02/28/2023 10:21	135.7
02/28/2023 10:22	135.2
02/28/2023 10:23	134.8
02/28/2023 10:24	134.8
02/28/2023 10:25	135.4
02/28/2023 10:26	136.3
02/28/2023 10:27	136.8
02/28/2023 10:28	137.7
02/28/2023 10:29	138.8
02/28/2023 10:30	139.6
02/28/2023 10:31	140.4
02/28/2023 10:32	140.7
02/28/2023 10:33	141.1
02/28/2023 10:34	141
02/28/2023 10:35	141
02/28/2023 10:36	141
02/28/2023 10:37	140.9
02/28/2023 10:38	141
02/28/2023 10:39	140.9
02/28/2023 10:40	140.7

RUN9	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 10:55	139.5
02/28/2023 10:56	138.9
02/28/2023 10:57	138.3
02/28/2023 10:58	137.9
02/28/2023 10:59	137.4
02/28/2023 11:00	136.8
02/28/2023 11:01	136.4
02/28/2023 11:02	136.6
02/28/2023 11:03	137.3
02/28/2023 11:04	137.9
02/28/2023 11:05	138.7
02/28/2023 11:06	139.3
02/28/2023 11:07	139.5
02/28/2023 11:08	139.6
02/28/2023 11:09	139.9
02/28/2023 11:10	140.3
02/28/2023 11:11	140.5
02/28/2023 11:12	140.4
02/28/2023 11:13	140.5
02/28/2023 11:14	140.4
02/28/2023 11:15	140

RUN10	
Date/Time	AUXBOILR HEATIN Value
02/28/2023 11:30	136.6
02/28/2023 11:31	136.1
02/28/2023 11:32	135.5
02/28/2023 11:33	135
02/28/2023 11:34	134.8
02/28/2023 11:35	134.9
02/28/2023 11:36	135.4
02/28/2023 11:37	135.6
02/28/2023 11:38	136
02/28/2023 11:39	136.1
02/28/2023 11:40	136.2
02/28/2023 11:41	136.1
02/28/2023 11:42	136
02/28/2023 11:43	136
02/28/2023 11:44	136.3
02/28/2023 11:45	136.8
02/28/2023 11:46	137.1
02/28/2023 11:47	137.6
02/28/2023 11:48	137.6
02/28/2023 11:49	137.5
02/28/2023 11:50	137.5

RATA Test - Permit

Plant: LREO Source: AUXBOILR

Parameter: NOX#MM60
Effective Date/Time: 02/28/2023 12:50
Test Result: Passed
Overall RA: 3.06
RA Calc Method: Standard Equation
CEMS Time Offset :
Test Comment:

Operating Level: Mid
APS Indicator: False
Mean CEMS: 0.02400
Relative Accuracy: 3.06
tValue: 2.306
Mean Reference: 0.02300
Standard Deviation: 0.00100
Avg Load:
Mean Difference: 0.00000
Confidence Coefficient: 0.00000

Run	Started	Ended	Reference Value	CEMS Value	Difference	Load	Use
1	02/28/2023 06:16	02/28/2023 06:36	0.023	0.024	-0.001		Y
2	02/28/2023 06:52	02/28/2023 07:12	0.024	0.024	0.000		Y
3	02/28/2023 07:26	02/28/2023 07:46	0.024	0.024	0.000		Y
4	02/28/2023 08:00	02/28/2023 08:20	0.024	0.024	0.000		Y
5	02/28/2023 08:35	02/28/2023 08:55	0.024	0.024	0.000		Y
6	02/28/2023 09:10	02/28/2023 09:30	0.023	0.024	-0.001		Y
7	02/28/2023 09:45	02/28/2023 10:05	0.023	0.023	0.000		Y
8	02/28/2023 10:20	02/28/2023 10:40	0.023	0.024	-0.001		Y
9	02/28/2023 10:55	02/28/2023 11:15	0.023	0.024	-0.001		
10	02/28/2023 11:30	02/28/2023 11:50	0.023	0.023	0.000		Y

Air Emissions Testing Data

QI Name:	Kossack, Daniel J	**AETB Name:**	Mostardi Platt
Exam Date:	11/11/2021	**AETB Phone Number:**	630-993-2100
Provider Name:	SES	**AETB Email:**	tplatt@mp-mail.com
Provider Email:	qstiprogram@gmail.com		

RATA Test - Permit

Plant: LREO Source: AUXBOILR

Parameter: O2
Effective Date/Time: 02/28/2023 12:50
Test Result: Passed
Overall RA: 3.62
CEMS Time Offset :
Test Comment:

RA Calc Method: Standard Equation

Operating Level: Mid
Mean CEMS: 4.28900
Mean Reference: 4.21100
Mean Difference: -0.07800

Relative Accuracy: 3.62
Standard Deviation: 0.09700
Confidence Coefficient: 0.07500

APS Indicator: False
tValue: 2.306
Avg Load:

Run	Started	Ended	Reference Value	CEMS Value	Difference	Load	Use
1	02/28/2023 06:16	02/28/2023 06:36	4.2	4.3	-0.1		Y
2	02/28/2023 06:52	02/28/2023 07:12	4.2	4.2	0.0		Y
3	02/28/2023 07:26	02/28/2023 07:46	4.0	4.2	-0.2		
4	02/28/2023 08:00	02/28/2023 08:20	4.3	4.2	0.1		Y
5	02/28/2023 08:35	02/28/2023 08:55	4.3	4.3	0.0		Y
6	02/28/2023 09:10	02/28/2023 09:30	4.2	4.3	-0.1		Y
7	02/28/2023 09:45	02/28/2023 10:05	4.2	4.4	-0.2		Y
8	02/28/2023 10:20	02/28/2023 10:40	4.1	4.3	-0.2		Y
9	02/28/2023 10:55	02/28/2023 11:15	4.2	4.3	-0.1		Y
10	02/28/2023 11:30	02/28/2023 11:50	4.2	4.3	-0.1		Y

Air Emissions Testing Data

QI Name:	Kossack, Daniel J	**AETB Name:**	Mostardi Platt
Exam Date:	11/11/2021	**AETB Phone Number:**	630-993-2100
Provider Name:	SES	**AETB Email:**	tplatt@mp-mail.com
Provider Email:	qstiprogram@gmail.com		

RATA Test - Permit

Plant: LREO Source: AUXBOILR

Parameter: NOXPPMC
Effective Date/Time: 02/28/2023 12:50
Test Result: Passed
Overall RA: 2.08
RA Calc Method: Standard Equation
CEMS Time Offset :
Test Comment:

Operating Level: Mid
APS Indicator: False
Mean CEMS: 19.62200
Relative Accuracy: 2.08
tValue: 2.306
Mean Reference: 19.27800
Standard Deviation: 0.07300
Avg Load:
Mean Difference: -0.34400
Confidence Coefficient: 0.05600

Run	Started	Ended	Reference Value	CEMS Value	Difference	Load	Use
1	02/28/2023 06:16	02/28/2023 06:36	19.2	19.6	-0.4		Y
2	02/28/2023 06:52	02/28/2023 07:12	19.6	19.9	-0.3		Y
3	02/28/2023 07:26	02/28/2023 07:46	19.5	20.0	-0.5		Y
4	02/28/2023 08:00	02/28/2023 08:20	19.5	19.8	-0.3		Y
5	02/28/2023 08:35	02/28/2023 08:55	19.4	19.7	-0.3		Y
6	02/28/2023 09:10	02/28/2023 09:30	19.3	19.7	-0.4		Y
7	02/28/2023 09:45	02/28/2023 10:05	19.0	19.3	-0.3		Y
8	02/28/2023 10:20	02/28/2023 10:40	18.9	19.4	-0.5		
9	02/28/2023 10:55	02/28/2023 11:15	19.1	19.4	-0.3		Y
10	02/28/2023 11:30	02/28/2023 11:50	18.9	19.2	-0.3		Y

Air Emissions Testing Data

QI Name:	Kossack, Daniel J	**AETB Name:**	Mostardi Platt
Exam Date:	11/11/2021	**AETB Phone Number:**	630-993-2100
Provider Name:	SES	**AETB Email:**	tplatt@mp-mail.com
Provider Email:	qstiprogram@gmail.com		

Appendix H - Calibration and Response Time Data

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/2023
Operator: DJK

Box Truck:	BT21				
Probe Length:	10.0	ft	**Point Markings (including port length):**		
Probe Type:	Extractive		**Point #**	**Inches**	
Sample Plane:	Horizontal		1	16.02	
Port Length:	6.5	in.	2	35.00	
Port Size (diameter):	6	in.	3	53.98	
Port Type:	Flange				
Duct Shape:	Circular				
Diameter:	4.75	ft			
Duct Area:	17.72	Sq. Ft.			
Upstream Diameters:	> 0.5		Minimum Upstream Distance		2.4 Feet
Downstream Diameters:	> 2.0		Minimum Downstream Distance		9.5 Feet
Number of Ports Sampled:	1		Ideal Upstream Distance		9.5 Feet
Number of Points per Port:	3		Ideal Downstream Distance		38.0 Feet
Total Number of Traverse Points:	3				

Calibration Gases

Type	Setting	Cylinder ID	Cylinder Value	Analyzer Response	Difference, % of Span	Expiration Date	Mid cylinder % of high cylinder
NOx ppmvd	Zero	CC421924	0	0.10	-0.39%	3/11/2030	
	Mid	CC140164	12.70	12.60	0.39%	4/22/2025	49.76%
	High	CC432322	25.52	25.50	0.08%	12/14/2025	
O2 % (dry)	Zero	CC140164	0	0.00	0.00%	4/22/2025	
	Mid	CC421924	5.049	5.10	-0.56%	3/11/2030	55.89%
	High	CC431939	9.034	9.10	-0.73%	3/21/2030	

Analyzer and Span Data

Type	CEM Analyzer Model	CEM Analyzer s/n	CEM Gas Span		
NOx ppmvd	Thermo Fisher Scientific 41iQ-LS	12114512143	30		
O2 % (dry)	Thermo Fisher Scientific 41iQ-LS	12114512143	25		

Response Time Data

Type	RM Analyzer Make/Model	RM Analyzer s/n	Analyzer Span	RM Gas Span
NOx ppmvd	Thermo 42i	1324958972	100	25.52
O2 % (dry)	Servomex 1440	01440D1/3950	25	9.034
	Start		95% Response	Time (min)
Upscale				1
Downscale				1

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Fuel Type: Natural Gas
Fuel Factor: 8710
Diluent: O2 %

Test Location: Auxiliary Boiler Stack
Date: 2/28/23
Operator: DJK
Project #: M230903
O2 % Correction: 3

NOx ppmvd Correction Data

Run #	Cma	Precal	Postcal	Pre zero	Post zero	Co	Cm	C	Cgas	Span Bias	Span Drift	Zero Bias	Zero Drift
1	12.70	12.70	12.80	0.10	0.20	0.15	12.75	17.88	17.9	-0.78	0.39	-0.39	0.39
2	12.70	12.80	12.80	0.20	0.20	0.20	12.80	18.39	18.3	-0.78	0.00	-0.39	0.00
3	12.70	12.80	12.80	0.20	0.20	0.20	12.80	18.41	18.4	-0.78	0.00	-0.39	0.00
4	12.70	12.80	12.70	0.20	0.20	0.20	12.75	18.10	18.1	-0.39	-0.39	-0.39	0.00
5	12.70	12.70	12.70	0.20	0.20	0.20	12.70	17.91	18.0	-0.39	0.00	-0.39	0.00
6	12.70	12.70	12.70	0.20	0.20	0.20	12.70	17.94	18.0	-0.39	0.00	-0.39	0.00
7	12.70	12.70	12.60	0.20	0.20	0.20	12.65	17.55	17.7	0.00	-0.39	-0.39	0.00
8	12.70	12.60	12.60	0.20	0.10	0.15	12.60	17.57	17.8	0.00	0.00	0.00	-0.39
9	12.70	12.60	12.60	0.10	0.10	0.10	12.60	17.66	17.8	0.00	0.00	0.00	0.00
10	12.70	12.60	12.60	0.10	0.10	0.10	12.60	17.45	17.6	0.00	0.00	0.00	0.00

O2 % (dry) Correction Data

Run #	Cma	Precal	Postcal	Pre zero	Post zero	Co	Cm	C	Cgas	Span Bias	Span Drift	Zero Bias	Zero Drift
1	5.049	5.10	5.10	0.10	0.10	0.10	5.10	4.28	4.2	0.00	0.00	-1.11	0.00
2	5.049	5.10	5.20	0.10	0.00	0.05	5.15	4.28	4.2	-1.11	1.11	0.00	-1.11
3	5.049	5.20	5.10	0.00	0.10	0.05	5.15	4.10	4.0	0.00	-1.11	-1.11	1.11
4	5.049	5.10	5.10	0.10	0.10	0.10	5.10	4.32	4.3	0.00	0.00	-1.11	0.00
5	5.049	5.10	5.20	0.10	0.10	0.10	5.15	4.41	4.3	-1.11	1.11	-1.11	0.00
6	5.049	5.20	5.10	0.10	0.00	0.05	5.15	4.26	4.2	0.00	-1.11	0.00	-1.11
7	5.049	5.10	5.30	0.00	0.00	0.00	5.20	4.34	4.2	-2.21	2.21	0.00	0.00
8	5.049	5.30	5.10	0.00	-0.10	-0.05	5.20	4.19	4.1	0.00	-2.21	1.11	-1.11
9	5.049	5.10	5.10	-0.10	0.00	-0.05	5.10	4.20	4.2	0.00	0.00	0.00	1.11
10	5.049	5.10	5.10	0.00	0.00	0.00	5.10	4.23	4.2	0.00	0.00	0.00	0.00

Cma = Concentration of Cal Gas
Cm=Average Pre and Post Span
C = Average value of test
Cgas = Corrected gas value of test
Co=Average Pre and Post Zero

Calibration Corrected Data

Run #	Run Date	Start Time	End Time	NOx ppmvd	NOx ppmvd @ 3% O2	O2 % (dry)	O2 based NOx lb/mmBtu
1	2/28/23	6:16	6:36	17.9	19.2	4.2	0.023
2	2/28/23	6:52	7:12	18.3	19.6	4.2	0.024
3	2/28/23	7:26	7:46	18.4	19.5	4.0	0.024
4	2/28/23	8:00	8:20	18.1	19.5	4.3	0.024
5	2/28/23	8:35	8:55	18.0	19.4	4.3	0.024
6	2/28/23	9:10	9:30	18.0	19.3	4.2	0.023
7	2/28/23	9:45	10:05	17.7	19.0	4.2	0.023
8	2/28/23	10:20	10:40	17.8	18.9	4.1	0.023
9	2/28/23	10:55	11:15	17.8	19.1	4.2	0.023
10	2/28/23	11:30	11:50	17.6	18.9	4.2	0.023

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Test Location: Auxiliary Boiler Stack
Date: 2/28/23
Project #: M230903

Linearity Cal/Pre 1 Cal

Time	NOx ppmvd		O2 % (dry)	
5:42	25.50	ih	0.00	iz
5:43	24.90		2.80	
5:44	1.90		8.90	
5:45	0.10	iz	9.10	ih
5:46	0.20		7.20	
5:47	6.90		-0.20	
5:48	13.20		-0.30	
5:49	12.90		-0.10	
5:50	12.60	im	0.10	
5:51	4.90		4.60	
5:52	0.10		5.30	
5:53	0.00		5.10	im
6:07	12.60		0.10	
6:08	12.70	m	0.10	z
6:09	12.50		0.90	
6:10	1.10		5.00	
6:11	0.10	z	5.10	m

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

Post 1/Pre 2					Post 2/Pre 3				
Time	NOx ppmvd		O2 % (dry)		Time	NOx ppmvd		O2 % (dry)	
6:40	13.30		-0.20		7:17	13.10		0.20	
6:41	13.10		-0.10		7:18	12.80	m	0.00	z
6:42	12.80	m	0.10	z	7:19	12.70		0.50	
6:43	9.10		3.70		7:20	2.40		5.20	
6:44	0.20		5.20		7:21	0.20	z	5.20	m
6:45	0.20	z	5.10	m					

Post 3/Pre 4					Post 4/Pre 5				
Time	NOx ppmvd		O2 % (dry)		Time	NOx ppmvd		O2 % (dry)	
7:51	13.00		0.10		8:25	12.90		0.10	
7:52	12.80	m	0.10	z	8:26	12.70	m	0.10	z
7:53	12.60		0.90		8:27	5.10		5.10	
7:54	1.70		5.10		8:28	0.20	z	5.10	m
7:55	0.20	z	5.10	m					

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

Post 5/Pre 6					Post 6/Pre 7				
Time	NOx ppmvd		O2 % (dry)		Time	NOx ppmvd		O2 % (dry)	
9:00	12.80		0.10		9:35	12.70	m	0.00	z
9:01	12.70	m	0.10	z	9:36	12.60		0.10	
9:02	5.00		5.20		9:37	5.00		5.10	
9:03	0.20	z	5.20	m	9:38	0.20	z	5.10	m

Post 7/Pre 8					Post 8/Pre 9				
Time	NOx ppmvd		O2 % (dry)		Time	NOx ppmvd		O2 % (dry)	
10:09	12.70		0.00		10:45	12.70		-0.10	
10:10	12.60	m	0.00	z	10:46	12.60	m	-0.10	z
10:11	9.10		2.80		10:47	5.00		4.90	
10:12	0.20		5.30		10:48	0.20		5.10	
10:13	0.20	z	5.30	m	10:49	0.10		5.10	
					10:50	0.10	z	5.10	m

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Project #: M230903
Test Location: Auxiliary Boiler Stack
Date: 2/28/23

	Post 9/Pre 10					Post 10			
Time	NOx ppmvd		O2 % (dry)		Time	NOx ppmvd		O2 % (dry)	
11:20	12.80		-0.10		11:54	12.70		0.00	
11:21	12.60	m	0.00	z	11:55	12.60	m	0.00	z
11:22	12.50		0.20		11:56	9.10		3.20	
11:23	4.20		5.10		11:57	0.20		5.10	
11:24	0.20		5.10		11:58	0.10	z	5.10	m
11:25	0.10	z	5.10	m					

Appendix I - Calibration Gas Cylinder Data

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI99E15A1206	Reference Number:	54-402414829-1
Cylinder Number:	CC140164	Cylinder Volume:	144.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12022	Valve Outlet:	660
Gas Code:	NO,NOX,BALN	Certification Date:	Apr 22, 2022

Expiration Date: Apr 22, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	12.55 PPM	12.70 PPM	G1	+/- 1.3% NIST Traceable	04/15/2022, 04/22/2022
NITRIC OXIDE	12.55 PPM	12.65 PPM	G1	+/- 1.4% NIST Traceable	04/15/2022, 04/22/2022
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	200604-12	ND47905	20.72 PPM NITRIC OXIDE/NITROGEN	+/- 1.0%	Apr 27, 2023
NTRM	200604-12	ND47905 NOX	20.72 PPM NOx/NITROGEN	+/- 1.0%	Apr 27, 2023

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
EC-1 Eco Physics nCLD 844S 844n0131 NO	Chemilluminescence	Mar 24, 2022
EC-1 Eco Physics nCLD 844S 844n0131 NOX	Chemilluminescence	Mar 24, 2022

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI99E15A0129	Reference Number:	54-402605117-1
Cylinder Number:	CC432322	Cylinder Volume:	144.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12022	Valve Outlet:	660
Gas Code:	NO,NOX,BALN	Certification Date:	Dec 14, 2022

Expiration Date: Dec 14, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	25.00 PPM	25.52 PPM	G1	+/- 1.4% NIST Traceable	12/02/2022, 12/14/2022
NITRIC OXIDE	25.00 PPM	25.36 PPM	G1	+/- 1.4% NIST Traceable	12/02/2022, 12/14/2022
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	21060726	CC733071	48.41 PPM NITRIC OXIDE/NITROGEN	+/- 1.2 %	Sep 21, 2025
PRM	12386	D685025	9.91 PPM NITROGEN DIOXIDE/AIR	+/- 2.0%	Feb 20, 2020
GMIS	401423838104	CC505590	4.373 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Feb 18, 2023

The SRM, NTRM, PRM, or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet iS50 AUP2010242	FTIR	Dec 05, 2022
Nicolet iS50 AUP2010242	FTIR	Dec 05, 2022

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI95E15A3186	Reference Number:	54-402383055-1
Cylinder Number:	CC421924	Cylinder Volume:	145.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12022	Valve Outlet:	580
Gas Code:	O2,BALN	Certification Date:	Mar 11, 2022

Expiration Date: Mar 11, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	5.000 %	5.049 %	G1	+/- 0.5% NIST Traceable	03/11/2022
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	14060622	CC436908	4.794 % OXYGEN/NITROGEN	+/- 0.4%	Oct 29, 2025

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Feb 23, 2022

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI91E15A3101	Reference Number:	54-402386375-1
Cylinder Number:	CC431939	Cylinder Volume:	145.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12022	Valve Outlet:	590
Gas Code:	O2,BALN	Certification Date:	Mar 21, 2022

Expiration Date: Mar 21, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	9.000 %	9.034 %	G1	+/- 0.4% NIST Traceable	03/21/2022
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09060203	CC261244	9.961 % OXYGEN/NITROGEN	+/- 0.3%	Nov 05, 2024

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Feb 23, 2022

Triad Data Available Upon Request

Appendix J - NO_2 to NO Converter Efficiency Test

NO2 to NO Converter Test

Client: Lansing Board of Water & Light
Facility: REO Town Facility
Test Location: HRSG #1 Stack
Date: 2/27/2023
Project #: M230903

Conv. Temp: 325 °C
Test Type Bag Procedure
Max: 13.7 ppm
Min: 13.6 ppm
Conversion: 99.27 %
Requirement: 98.00 %

Pre-Calibration

Time	NO_x	Cal Flag
13:33	25.50	
13:34	25.50	
13:35	25.50	h
13:36	10.60	
13:37	0.10	
13:38	0.10	z
13:39	2.60	
13:40	11.40	
13:41	12.80	m
13:42	12.5	
13:43	1.0	
13:44	0.0	

Test

Time	NO_x	
13:55	13.7	Max
13:56	13.7	Max
13:57	13.7	Max
13:58	13.7	Max
13:59	13.7	Max
14:00	13.7	Max
14:01	13.7	Max
14:02	13.6	Min
14:03	13.6	Min
14:04	13.6	Min
14:05	13.6	Min
14:06	13.6	Min
14:07	13.6	Min
14:08	13.6	Min
14:09	13.6	Min
14:10	13.6	Min
14:11	13.6	Min
14:12	13.6	Min
14:13	13.6	Min
14:14	13.6	Min
14:15	13.6	Min
14:16	13.6	Min
14:17	13.6	Min
14:18	13.6	Min
14:19	13.6	Min
14:20	13.6	Min
14:21	13.6	Min
14:22	13.6	Min
14:23	13.6	Min
14:24	13.6	Min
14:25	13.6	Min

Post-Calibration

Time	NO_x	Cal Flag
14:29	12.5	m
14:30	9.2	
14:31	0.0	z

PRE-CAL RESULT

zero	0.39%
mid	0.39%
high	-0.08%

POST-CAL RESULT

zero	0.00%
mid	-0.78%

Type		RM Analyzer Make/Model	RM Analyzer s/n	Analyzer Span	RM Gas Span	
NOx ppmvd		Thermo 42i	1324958972	100	25.52	
Type	**Setting**	**Cylinder ID**	**Cylinder Value**	**Analyzer Response**	**Difference, % of Span**	**Expiration Date**
NOx ppmvd	Zero	NA	0	0.10	-0.39%	NA
	Mid	CC140164	12.7	12.80	-0.39%	4/22/2025
	High	CC432322	25.52	25.50	0.08%	12/14/2025

END OF THE REPORT