Pontiac Engineering Center
850 Glenwood Avenue
Pontiac, MI 48340-2295

July 15, 2022

Joyce Zhu
Michigan Department of Environment, Great Lakes, And Energy
Air Quality Division
27700 Donald Court
Warren, Michigan 48092-2793

RE: NOx Emission Test Report: Engine Dynamometer NOx Emission Factor Testing for FG-TESTCELLS Special Condition V.2. and FG-RACINGTCS Special Condition V.1.

Pontiac Engineering Center/Permit Number MI-ROP-B4032-2020

Dear Joyce:

General Motors is pleased to provide the attached Emission Test Report that details sampling, analytical analysis and test results as part of the compliance testing the Pontiac Engineering Center located in Pontiac, Michigan. Emission Testing was performed by Montrose Air Quality Services, LLC (MAQS) on May 16, 2022, and May 17, 2022. The average Wing 3 annual fuel flow rate was used to determine the scaled-up Wing 3 NOx emission rate. The Racing Emission Test was performed on the exhaust of a single racing dynamometer and includes the evaluation of oxides of nitrogen (NOx), and oxygen (O_2) from a high-performance engine.

Based on the test results, NOx emission rates are below permit limits for Wing 3 (24.5 lb/hr) and Racing (73.9 lb/hr). The Emission Test Report is included.

If you have any questions, please contact me at either charles.kessler@gm.com or 248.883.2629

Sincerely,

Charles Kessler
Environmental Engineer

Enclosure

CC: Jeremy Howe, EGLE-AQD
Iranna Konanahalli, EGLE-AQD
Jessica Alderton, GM
Rachel Gribas, GM

B4032_test_20220517

EGLE

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
AIR QUALITY DIVISION

RECEIVED
AUG 01 2022
AIR QUALITY DIVISION

RENEWABLE OPERATING PERMIT REPORT CERTIFICATION

Authorized by 1994 P.A. 451, as amended. Failure to provide this information may result in civil and/or criminal penalties.

Reports submitted pursuant to R 336.1213 (Rule 213), subrules (3)(c) and/or (4)(c), of Michigan's Renewable Operating Permit (ROP) program must be certified by a responsible official. Additional information regarding the reports and documentation listed below must be kept on file for at least 5 years, as specified in Rule 213(3)(b)(ii), and be made available to the Department of Environment, Great Lakes, and Energy, Air Quality Division upon request.

Source Name: General Motors LLC - Pontiac Engineering Center County: Oakland

Source Address: 850 Glenwood Avenue City: Pontiac

AQD Source ID (SRN): B4032 ROP No.: MI-PTI-B4032-2020 ROP Section No.:

Please check the appropriate box(es):

☐ **Annual Compliance Certification (Pursuant to Rule 213(4)(c))**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, this source was in compliance with **ALL** terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference. The method(s) used to determine compliance is/are the method(s) specified in the ROP.

☐ 2. During the entire reporting period this source was in compliance with all terms and conditions contained in the ROP, each term and condition of which is identified and included by this reference, **EXCEPT** for the deviations identified on the enclosed deviation report(s). The method used to determine compliance for each term and condition is the method specified in the ROP, unless otherwise indicated and described on the enclosed deviation report(s).

☐ **Semi-Annual (or More Frequent) Report Certification (Pursuant to Rule 213(3)(c))**

Reporting period (provide inclusive dates): From _____ To _____

☐ 1. During the entire reporting period, **ALL** monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred.

☐ 2. During the entire reporting period, all monitoring and associated recordkeeping requirements in the ROP were met and no deviations from these requirements or any other terms or conditions occurred, **EXCEPT** for the deviations identified on the enclosed deviation report(s).

☒ **Other Report Certification**

Reporting period (provide inclusive dates): From 7/15/2022 To 7/15/2022

Additional monitoring reports or other applicable documents required by the ROP are attached as described:

GM LLC Pontiac Engineering Center is submitting the Emission Test Report for NOx emission testing for FG-RACINGTCS V.1. and FG-TESTCELLS V.Testing/Sampling Condition 2. as Required by MI-ROP-B4032-2020. Enclosed is the final Test Report detailing the testing, the post test analytical, as well as the final test results.

I certify that, based on information and belief formed after reasonable inquiry, the statements and information in this report and the supporting enclosures are true, accurate and complete

Stephen Jenkins	Director, Operations	586-675-0090
Name of Responsible Official (print or type)	Title	Phone Number

Signature of Responsible Official — Date: 7/15/2022

* Photocopy this form as needed.

EQP 5736 (Rev 04/30/2019)

SOURCE TEST REPORT
2022 COMPLIANCE TESTING
GENERAL MOTORS, LLC
PONTIAC ENGINEERING CENTER
RACING ENGINE AND WING 3 GAS ENGINE
PONTIAC, MICHIGAN

Prepared For:

General Motors
800 N Glenwood Ave
Pontiac, Michigan 48340

For Submittal To:

Michigan Department of Environment, Great Lakes and Energy
525 West Allegan Street
Lansing, Michigan 48933

Prepared By:

Montrose Air Quality Services, LLC
1371 Brummel Ave
Elk Grove Village, Illinois 60007

Document Number:	**MW023AS-015629-RT-1395**
Test Dates:	**May 17 and 18, 2022**
Submittal Date:	**July 14, 2022**

ACCREDITED
TO ASTM D7036 ONLY
CERT #3928.01

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature: _____ Date: 06 / 21 / 2022

Name: Sean Wheeler, QI Title: Field Project Manager

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature: Henry M. Taylor Date: 06 / 21 / 2022

Name: Henry M. Taylor, QSTO Title: Senior Reporting Specialist

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1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

General Motors, LLC (GM) contracted Montrose Air Quality Services, LLC (Montrose) to perform compliance emissions test program on the Racing and Wing 3 Gas Engines at their Pontiac Engineering Center facility located in Pontiac, Michigan. The tests were conducted to determine compliance with the emission limits listed in permit number MI-ROP-B4032-2020 issued by Michigan Department of Environment, Great Lakes, and Energy (EGLE).

The specific objectives were to:

- Determine the NOx emission rate from the Racing and Wing 3 Gas Engines
- Conduct the test program with a focus on safety

Montrose performed the tests to measure the emission parameters listed in Table 1-1.

TABLE 1-1
SUMMARY OF TEST PROGRAM

Test Dates	Unit ID/ Source Name	Activity/ Parameters	Test Methods	No. of Runs	Duration (Minutes)
5/17/22	Race Engine (EU-RACINGTC2)	O_2, CO_2	EPA 3A	1 / 2	72 / 71
		NO_x	EPA 7E & 19	1 / 2	72 / 71
5/18/22	Wing 3 Gas Engine (D301)	O_2, CO_2	EPA 3A	1 / 1 / 1	68 / 64 / 65
		NO_x	EPA 7E & 19	1 / 1 / 1	68 / 64 / 65

To simplify this report, a list of Units and Abbreviations is included in Appendix C.1. Throughout this report, chemical nomenclature, acronyms, and reporting units are not defined. Please refer to the list for specific details.

This report presents the test results and supporting data, descriptions of the testing procedures, descriptions of the facility and sampling locations, and a summary of the quality assurance procedures used by Montrose. The average emission test results are summarized and compared to their respective permit limits in Tables 1-2 and 1-3. Detailed results for individual test runs can be found in Section 4.0. All supporting data can be found in the appendices.

The tests were conducted according to Test Protocol Nos. MW023AS-015629-PP-439 dated April 14, 2022 and MW023AS-015629-PP-446 dated April 14, 2022.

TABLE 1-2
SUMMARY OF AVERAGE COMPLIANCE RESULTS -
RACE ENGINE
MAY 17, 2022

Source ID Number:	EU-RACINGTC2
Sampling Location:	Combined Exhaust Ducts
Engine Dynamometer Fuel Flow (g/sec):	19.096
Combined Nitrogen Oxide Emissions (lb/hr) (as NO_2):	4.23
Permit Limit – Nitrogen Oxides Emissions (lb/hr) (as NO_2):	73.90
Emission Results Above Permit Limit:	No
EGLE Renewable Permit Operating Permit No.:	MI-ROP-B4032-2020

TABLE 1-3
SUMMARY OF AVERAGE COMPLIANCE RESULTS -
WING 3 GAS ENGINE
MAY 18, 2022

Source ID Number:	D301
Sampling Location:	Exhaust Duct
Engine Dynamometer Fuel Type Utilized:	Gasoline
Engine Dynamometer Fuel Flow (g/sec):	0.649
Nitrogen Oxide Emissions (lb/hr) (as NO_2):	0.15
Scaled-Up Wing 3 Nitrogen Oxides Emissions (lb/hr) (as NO_2)*:	0.18
Permit Limit – Nitrogen Oxides Emissions (lb/hr) (as NO_2):	24.5
Emission Results Above Permit Limit:	No
EGLE Renewable Permit Operating Permit No.:	MI-ROP-B4032-2020

*The scaled-up lb/hr NO_x (as NO_2) emissions for D301 utilizing gasoline is calculated using the facility provided Annual Average Fuel Rate (MMBtu/hr) and the calculated F_d-Based NO_x emissions (as NO_2)

1.2 KEY PERSONNEL

A list of project participants is included below:

Facility Information

Source Location:	General Motors, LLC Pontiac Engineering Center 800 N Glenwood Ave. Pontiac, MI 48340
Project Contact:	Jessica Alderton
Role:	Senior Environmental Project Engineer
Telephone:	586-863-8490
Email:	jessica.alderton@gm.com
Site Contact:	Charles Kessler
Role:	Senior Environmental Engineer
Telephone:	248-883-2629
Email:	Charles.Kessler@gm.com

Agency Information

Regulatory Agency:	Jeremy Howe
Agency Contact:	EGLE
Telephone:	231-878-6687
Email:	Howej1@michigan.gov

Testing Company Information

Testing Firm:	Montrose Air Quality Services, LLC
Contact:	Sean Wheeler
Title:	Field Project Manager
Telephone:	630-860-4740
Email:	stwheeler@montrose-env.com

Test personnel and observers are summarized in Table 1-4.

TABLE 1-4
TEST PERSONNEL AND OBSERVERS

Name	Affiliation	Role/Responsibility
Mike Hess	Montrose	Client Project Manager/QI/Trailer Operator
Paul Repuyan	Montrose	Field Technician/ Field Support
Jack Hutchison	Montrose	Report Preparation
Jessica Alderton	GM	Client Liaison/Test Coordinator

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 PROCESS DESCRIPTION, OPERATION, AND CONTROL EQUIPMENT

General Motors owns and operates an extensive engine testing facility for research and development of internal combustion engines using a wide variety of fuels and test protocols mandated by the United States Environmental Protection Agency (EPA). Depending on the engine type, the engines can be fueled by unleaded gasoline, leaded gasoline, diesel, and other fuels running a variety of tests on engines and engine components. A variety of test cycles are used depending on the purpose of the test program and the type of the engine. The engines are tested with or without control equipment, such as catalytic converters and particulate traps. The Race Engine and Wing 3 Gas Engine were in operation during this test event.

2.2 OPERATING CONDITIONS AND PROCESS DATA

Plant personnel were responsible for establishing the test conditions and collecting all applicable unit-operating data. The process data that was provided is presented in Appendix B.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 TEST METHODS

The test methods for this test program were presented previously in Table 1-1. Additional information regarding specific applications or modifications to standard procedures is presented below.

3.1.1 EPA Methods 3A and 7E, Determination of Oxygen and Nitrogen Oxides Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedures)

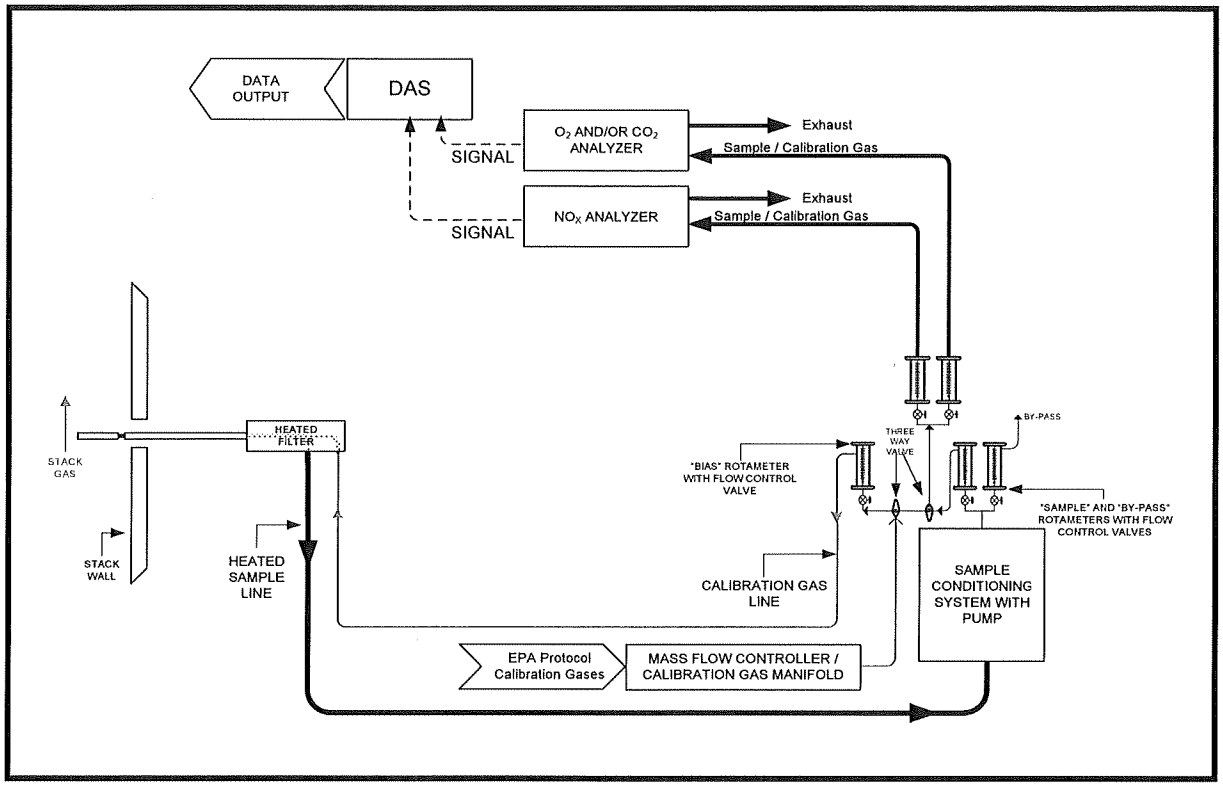
Concentrations of O_2 and NO_x are measured simultaneously using EPA Methods 3A and 7E which are instrumental test methods. Conditioned gas is sent to a series of analyzers to measure the gaseous emission concentrations. The performance requirements of the method must be met to validate the data.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - A paramagnetic analyzer is used to measure O_2
  - A chemiluminescent analyzer is used to measure NO_x
  - The alternative NO_x converter efficiency test described in EPA Method 7E Section 16.2 is used
- Method Exceptions:
  - None
- Target and/or Minimum Required Sample Duration: 64 - 72 minutes

With the exception of CO_2 analyzer, the typical sampling system is detailed in Figure 3-1.

FIGURE 3-1
EPA METHOD 3A AND 7E SAMPLING TRAIN



3.1.2 EPA Method 19, Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates

EPA Method 19 is used to calculate mass emission rates in units of lb/MMBtu. EPA Method 19, Table 19-2 contains a list of assigned fuel factors for different types of fuels, which can be used for these calculations.

Pertinent information regarding the performance of the method is presented below:

- Method Options:
  - F factor is calculated from analysis of fuel samples collected on the test day
- Method Exceptions:
  - None

3.2 PROCESS TEST METHODS

The test plan did not require that process samples be collected during this test program; therefore, no process sample data are presented in this test report.

4.0 TEST DISCUSSION AND RESULTS

4.1 FIELD TEST DEVIATIONS AND EXCEPTIONS

No field deviations or exceptions from the test plan or test methods occurred during this test program.

4.2 PRESENTATION OF RESULTS

The average results are compared to the permit limits in Tables 1-2 and 1-3. The results of individual compliance test runs performed are presented in Tables 4-1 and 4-2. Emissions are reported in units consistent with those in the applicable regulations or requirements. Additional information is included in the appendices as presented in the Table of Contents.

TABLE 4-1
NOx EMISSIONS RESULTS -
RACE ENGINE

Run Number	1	2	3	Average
Date	5/17/2022	5/17/2022	5/17/2022	--
Time	09:43-11:06	11:17-12:39	12:50-14:11	--
Process Data				
heating value, Btu/lb	18,663	18,663	18,663	18,663
gas flow, g/sec	19.223	18.888	19.176	19.096
gas flow, lb/hr	152.573	149.914	152.200	151.562
Sampling & Flue Gas Parameters				
sample duration, minutes	72	71	71	--
O_2, % volume dry	2.8	3.1	2.6	2.8
Nitrogen Oxides (NO_x as NO_2)				
ppmvd	1,211.5	1,153.3	1,188.3	1,184.4
lb/MMBtu	1.53	1.48	1.48	1.49
lb/hr	4.35	4.13	4.20	4.23

TABLE 4-2
NOx EMISSIONS RESULTS -
WING 3 GAS ENGINE

Run Number	1	2	3	Average
Date	5/18/2022	5/18/2022	5/18/2022	--
Time	10:16-11:23	11:37-12:40	13:02-14:06	--
Process Data				
heating value, Btu/lb	19,208	19,208	19,208	19,208
gas flow, g/sec	0.629	0.646	0.671	0.649
gas flow, lb/hr	4.990	5.129	5.327	5.149
annual average fuel rate, MMBtu/hr				0.12
Sampling & Flue Gas Parameters				
sample duration, minutes	68	64	65	--
O_2, % volume dry	0.8	0.8	0.8	0.8
Nitrogen Oxides (NO_x as NO_2)				
ppmvd	1,366.8	1,379.2	1,322.7	1,356.2
lb/MMBtu	1.55	1.56	1.50	1.53
lb/hr	0.15	0.15	0.15	0.15
lb/hr-scaled up*				0.18

*The scaled-up lb/hr NO_x (as NO_2) emissions for D301 utilizing gasoline is calculated using the facility provided Annual Average Fuel Rate (MMBtu/hr) and the calculated F_d-Based NO_x emissions (as NO_2)

5.0 INTERNAL QA/QC ACTIVITIES

5.1 QA/QC AUDITS

EPA Method 3A and 7E calibration audits were all within the measurement system performance specifications for the calibration drift checks, system calibration bias checks, and calibration error checks.

The NO_2 to NO converter efficiency checks of each analyzer were conducted per the procedures in EPA Method 7E, Section 8.2.4. The conversion efficiencies met the criteria.

5.2 QA/QC DISCUSSION

All QA/QC criteria were met during this test program.

5.3 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one QI as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is included in the report appendices. The content of this report is modeled after the EPA Emission Measurement Center Guideline Document (GD-043).

APPENDIX A
FIELD DATA AND CALCULATIONS

Appendix A.1
Instrumental Test Method Data

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	2.92	1182.9

9:43:26	5.64	59.19			
9:44:26	1.81	120.3			
9:45:26	3.10	661.9			
9:46:26	3.05	1330			
9:47:26	3.58	1312			
9:48:26	2.94	1256			
9:49:26	2.62	1261			
9:50:26	2.80	1289			
9:51:26	3.13	1156			
9:52:26	2.69	1140			
9:53:26	2.94	1303			
9:54:26	2.77	1298			
9:55:26	2.82	1269			
9:56:26	2.93	1129			
9:57:26	2.92	1292			
9:58:26	2.68	1186			
9:59:26	2.72	1193			
10:00:26	2.96	1243			
10:01:26	2.71	1292			
10:02:26	2.74	1304			
10:03:26	2.84	1281			
10:04:26	2.89	1356			
10:05:26	2.50	1328			
10:06:26	2.71	1334			
10:07:26	3.02	1230			
10:08:26	3.08	1223			
10:09:26	2.33	1281			
10:10:26	2.65	1312			
10:11:26	3.23	1333			
10:12:26	3.14	1419			
10:13:26	2.19	1184			
10:14:26	2.71	1156			
10:15:26	3.20	1274			
10:16:26	3.33	1375			
10:17:26	2.56	1333			
10:18:26	2.74	1282			
10:19:26	3.94	1226			
10:20:26			4.31	1117	
10:21:26			0.92	635.9	
10:22:26			2.03	127.1	
10:23:26			18.78	106.8	Switched headers
10:24:26			20.62	16.96	
10:25:26			20.91	9.68	
10:26:26			20.97	8.71	
10:27:26			20.90	6.64	
10:28:26			20.82	5.52	
10:29:26			20.85	3.89	
10:30:26			16.91	6.94	
10:31:26			4.75	363.7	
10:32:26	2.71	1014			
10:33:26	2.80	1282			
10:34:26	3.36	1134			
10:35:26	3.16	1279			
10:36:26	2.63	1170			
10:37:26	2.64	1130			
10:38:26	2.93	1241			
10:39:26	2.95	1317			
10:40:26	2.84	1283			
10:41:26	2.81	1211			
10:42:26	2.90	1273			
10:43:26	2.61	1335			
10:44:26	2.84	1250			

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	2.92	1182.9
10:45:26	3.17	1253
10:46:26	2.70	1156
10:47:26	2.43	1164
10:48:26	2.65	1002
10:49:26	3.25	1042
10:50:26	2.59	1205
10:51:26	2.40	1192
10:52:26	2.80	1175
10:53:26	3.09	1087
10:54:26	2.66	1220
10:55:26	2.77	1176
10:56:26	2.81	1158
10:57:26	2.90	1137
10:58:26	2.78	1193
10:59:26	2.92	1137
11:00:26	2.75	1131
11:01:26	2.61	1085
11:02:26	3.01	1292
11:03:26	2.85	1172
11:04:26	2.65	1168
11:05:26	3.36	1093
11:06:26	5.27	995.8

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	3.19	1116.4

11:17:12	19.89	437.4
11:18:12	14.47	25.43
11:19:12	4.37	364.7
11:20:12	2.89	982.4
11:21:12	3.16	994.2
11:22:12	3.04	1069
11:23:12	2.47	1135
11:24:12	2.72	1128
11:25:12	3.13	1062
11:26:12	2.50	1111
11:27:12	2.43	1080
11:28:12	2.72	1103
11:29:12	3.13	1058
11:30:12	2.55	1180
11:31:12	2.74	1146
11:32:12	2.67	1047
11:33:12	2.92	1100
11:34:12	2.75	1183
11:35:12	2.85	1126
11:36:12	2.68	1117
11:37:12	2.62	1081
11:38:12	2.85	1155
11:39:12	2.62	1118
11:40:12	2.66	1114
11:41:12	2.63	993.8
11:42:12	2.96	1056
11:43:12	2.64	1148
11:44:12	2.64	1126
11:45:12	2.81	1112
11:46:12	2.92	1227
11:47:12	2.38	1113
11:48:12	2.66	1024
11:49:12	2.99	1066
11:50:12	2.97	1022
11:51:12	2.38	1103
11:52:12	2.60	1084
11:53:12		
11:54:12		
11:55:12		
11:56:12		
11:57:12		
11:58:12		
11:59:12		
12:00:12		
12:01:12		
12:02:12		
12:03:12		
12:04:11		
12:05:11	2.72	1181
12:06:11	2.86	1185
12:07:11	3.12	1237
12:08:11	2.74	1240
12:09:11	2.58	1121
12:10:11	2.67	1167
12:11:11	2.84	1269
12:12:11	2.59	1229
12:13:11	2.60	1228
12:14:11	2.72	1132
12:15:11	2.97	1192
12:16:11	2.34	1251
12:17:11	2.62	1218
12:18:11	2.94	1231

4.13	979.7	
4.19	990.5	
1.46	656.8	
7.86	102.9	
19.61	80.31	Switched headers
20.63	12.66	
20.91	8.09	
20.96	6.40	
20.86	5.77	
20.59	3.93	
4.08	65.31	
3.34	588.5	

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	3.19	1116.4

12:19:11	2.97	1384
12:20:11	2.10	1202
12:21:11	2.61	1203
12:22:11	3.02	1162
12:23:11	3.03	1131
12:24:11	2.18	1237
12:25:11	2.58	1208
12:26:11	2.98	1211
12:27:11	3.09	1393
12:28:11	2.44	1191
12:29:11	2.48	1225
12:30:11	2.84	1304
12:31:11	2.95	1350
12:32:11	2.63	1095
12:33:11	2.64	1145
12:34:11	2.84	1240
12:35:11	2.83	1260
12:36:11	2.84	1210
12:37:11	3.39	1130
12:38:11	3.83	1101
12:39:11	2.45	1007

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	2.71	1145.6

12:50:42	0.74	689.0
12:51:42	2.22	263.0
12:52:42	3.33	1105
12:53:42	2.66	1228
12:54:42	2.78	1202
12:55:42	3.05	1362
12:56:42	2.57	1132
12:57:42	2.53	1236
12:58:42	2.77	1160
12:59:42	2.93	1409
13:00:42	2.29	1222
13:01:42	2.60	1258
13:02:42	2.94	1244
13:03:42	3.05	1282
13:04:42	2.18	1308
13:05:42	2.57	1132
13:06:42	3.03	1210
13:07:42	3.05	1319
13:08:42	2.15	1212
13:09:42	2.48	1220
13:10:42	2.96	1179
13:11:42	3.11	1377
13:12:42	2.67	1185
13:13:42	2.40	1259
13:14:42	2.77	1217
13:15:42	2.95	1268
13:16:42	2.62	1217
13:17:42	2.66	1190
13:18:42	2.65	1141
13:19:42	2.70	1260
13:20:42	2.69	1264
13:21:42	2.96	1190
13:22:42	2.66	1244
13:23:41	2.86	1325
13:24:42	2.79	1191
13:25:41	3.38	1266
13:26:41		
13:27:41		
13:28:41		
13:29:41		
13:30:41		
13:31:41		
13:32:41		
13:33:41		
13:34:41		
13:35:41		
13:36:41		
13:37:41	2.75	1052
13:38:41	3.21	973.9
13:39:41	2.81	1159
13:40:41	2.59	1174
13:41:41	2.60	1152
13:42:41	2.74	1141
13:43:41	2.61	1130
13:44:41	2.87	1152
13:45:41	2.63	1155
13:46:41	2.50	1097
13:47:41	2.80	1075
13:48:41	2.69	1114
13:49:41	2.59	1086
13:50:41	2.64	1026
13:51:41	2.86	1098

4.39	1098	
2.32	1000	
0.90	273.7	
13.19	121.2	
20.41	50.39	Switched headers
20.86	11.35	
21.00	8.77	
20.96	7.06	
20.48	6.01	
3.60	41.88	
3.43	686.3	

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	2.71	1145.6
13:52:41	2.47	1163
13:53:41	2.60	1116
13:54:41	2.74	1108
13:55:41	2.86	1198
13:56:41	2.20	1090
13:57:41	2.60	1139
13:58:41	2.90	1002
13:59:41	2.88	1097
14:00:41	2.02	1056
14:01:41	2.53	1036
14:02:41	2.98	1033
14:03:41	2.98	1121
14:04:41	2.09	1149
14:05:41	2.48	1096
14:06:41	2.92	1019
14:07:41	3.06	1086
14:08:41	2.66	1144
14:09:41	2.70	1161
14:10:41	3.51	1010
14:11:41	3.41	961.1

Date
5/18/2022

Time	O_2 (%)	NO_X (ppm)
Average	0.63	1350.6
10:16:17	1.02	1170
10:17:17	0.94	1221
10:18:17	0.88	1262
10:19:17	0.82	1354
10:20:17	0.75	1496
10:21:17	0.66	1585
10:22:17	0.62	1592
10:23:17	0.61	1599
10:24:17	0.60	1605
10:25:17	0.60	1592
10:26:17	0.60	1567
10:27:17	0.63	1506
10:28:17	0.62	1466
10:29:17	0.60	1428
10:30:17	0.62	1338
10:31:17	0.65	1297
10:32:17	0.64	1213
10:33:17	0.63	1210
10:34:17	0.59	1286
10:35:17	0.58	1268
10:36:17	0.57	1287
10:37:17	0.59	1292
10:38:17	0.58	1289
10:39:17	0.60	1288
10:40:17	0.61	1295
10:41:17	0.59	1300
10:42:17	0.57	1306
10:43:17	0.59	1311
10:44:17	0.59	1311
10:45:17	0.60	1313
10:46:17	0.62	1327
10:47:17	0.62	1332
10:48:17	0.59	1331
10:49:17	0.60	1333
10:50:17	0.60	1334
10:51:17	0.60	1337
10:52:17	0.59	1333
10:53:17	0.59	1324
10:54:17	0.59	1321
10:55:17	0.60	1330
10:56:17	0.58	1331
10:57:17	0.59	1334
10:58:17	0.59	1335
10:59:17	0.61	1336
11:00:17	0.61	1338
11:01:17	0.59	1344
11:02:17	0.62	1340
11:03:17	0.63	1337
11:04:17	0.63	1346
11:05:17	0.63	1351
11:06:17	0.60	1349
11:07:17	0.59	1348
11:08:17	0.60	1340
11:09:17	0.62	1331
11:10:17	0.62	1343
11:11:17	0.61	1342
11:12:17	0.62	1334
11:13:17	0.62	1337
11:14:17	0.63	1343
11:15:17	0.62	1340
11:16:17	0.63	1340
11:17:17	0.63	1336
11:18:17	0.63	1340
11:19:17	0.62	1344
11:20:17	0.61	1348
11:21:17	0.60	1340
11:22:17	0.59	1326
11:23:17	0.60	1319

Date
5/18/2022

Time	O_2 (%)	NO_X (ppm)
Average	0.60	1344.5
11:37:34	0.57	1364
11:38:34	0.58	1340
11:39:34	0.57	1350
11:40:34	0.58	1361
11:41:34	0.58	1365
11:42:34	0.57	1367
11:43:34	0.56	1361
11:44:34	0.58	1355
11:45:34	0.56	1358
11:46:34	0.58	1365
11:47:34	0.59	1357
11:48:34	0.60	1361
11:49:34	0.60	1370
11:50:34	0.61	1367
11:51:34	0.60	1360
11:52:34	0.60	1359
11:53:34	0.61	1363
11:54:34	0.60	1374
11:55:34	0.60	1395
11:56:34	0.62	1392
11:57:34	0.60	1378
11:58:34	0.60	1372
11:59:34	0.62	1370
12:00:34	0.61	1366
12:01:34	0.62	1359
12:02:34	0.61	1356
12:03:34	0.60	1356
12:04:34	0.59	1358
12:05:34	0.61	1359
12:06:34	0.60	1364
12:07:34	0.60	1365
12:08:34	0.60	1367
12:09:34	0.59	1354
12:10:34	0.62	1343
12:11:34	0.61	1343
12:12:34	0.61	1346
12:13:34	0.62	1340
12:14:34	0.61	1339
12:15:34	0.62	1335
12:16:34	0.62	1319
12:17:34	0.62	1314
12:18:34	0.64	1318
12:19:34	0.64	1318
12:20:34	0.65	1321
12:21:34	0.64	1321
12:22:34	0.63	1318
12:23:34	0.64	1319
12:24:34	0.61	1326
12:25:34	0.58	1325
12:26:34	0.60	1319
12:27:34	0.60	1321
12:28:34	0.61	1325
12:29:34	0.59	1323
12:30:34	0.59	1323
12:31:34	0.60	1316
12:32:34	0.60	1309
12:33:34	0.60	1309
12:34:34	0.61	1314
12:35:34	0.60	1319
12:36:34	0.60	1327
12:37:34	0.60	1331
12:38:34	0.61	1323
12:39:34	0.60	1319
12:40:34	0.60	1319

Date		
5/18/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Average	0.60	1281.8
13:02:25	0.63	1264
13:03:25	0.62	1265
13:04:25	0.63	1282
13:05:25	0.65	1284
13:06:25	0.63	1272
13:07:25	0.62	1266
13:08:25	0.64	1263
13:09:25	0.63	1265
13:10:25	0.63	1275
13:11:25	0.66	1278
13:12:25	0.64	1277
13:13:25	0.65	1277
13:14:25	0.64	1273
13:15:25	0.63	1274
13:16:25	0.63	1278
13:17:25	0.62	1284
13:18:25	0.65	1282
13:19:25	0.62	1279
13:20:25	0.62	1281
13:21:25	0.63	1287
13:22:25	0.62	1294
13:23:25	0.62	1300
13:24:25	0.64	1298
13:25:25	0.62	1293
13:26:25	0.56	1290
13:27:25	0.57	1287
13:28:25	0.57	1287
13:29:25	0.57	1285
13:30:25	0.58	1281
13:31:25	0.58	1283
13:32:25	0.57	1285
13:33:25	0.58	1281
13:34:25	0.57	1272
13:35:25	0.57	1269
13:36:25	0.58	1276
13:37:25	0.58	1281
13:38:25	0.57	1282
13:39:25	0.60	1290
13:40:25	0.56	1294
13:41:25	0.57	1294
13:42:25	0.60	1287
13:43:25	0.58	1282
13:44:25	0.60	1285
13:45:25	0.61	1288
13:46:25	0.60	1287
13:47:25	0.60	1288
13:48:25	0.61	1290
13:49:25	0.60	1286
13:50:25	0.60	1280
13:51:25	0.60	1273
13:52:25	0.57	1275
13:53:25	0.60	1280
13:54:25	0.60	1275
13:55:25	0.59	1273
13:56:25	0.60	1274
13:57:25	0.60	1282
13:58:25	0.59	1286
13:59:25	0.60	1285
14:00:25	0.61	1283
14:01:25	0.59	1284
14:02:25	0.59	1289
14:03:25	0.60	1292
14:04:25	0.59	1292
14:05:25	0.60	1288
14:06:25	0.63	1283

Appendix A.2
Calculations/Results

OXYGEN

Analyzer Values	Actual	Cal Error	Bias	Run 1	Run 2	Run 3
Date		5/17/22	5/17/22	5/17/22	5/17/22	5/17/22
Start Time		7:58	8:16	9:43	11:17	12:50
Stop Time		8:16	8:24	11:06	12:39	14:11
Concentration, C (%)				2.92	3.19	2.71
Zero Cal Gas, C_0 (%)	0.0	0.01	0.11	0.13	0.13	0.16
Mid Cal Gas (%)	10.02	10.12				
High Cal Gas (%)	20.12	20.21				
Span Value (%)	20.12					
Bias/Drift Check Gas, C_s (%)	10.02		10.04	10.03	10.03	10.04
RESULTS						
Zero Error (%)	2 % of Span	0.02				
Mid Error (%)		0.47				
High Error (%)		0.43				
Upscale Error (%)						
Zero Bias (%)	5 % of Span		0.51	0.61	0.61	0.77
Upscale Bias (%)			-0.40	-0.43	-0.42	-0.39
Zero Drift (%)	3 % of Span			0.10	0.00	0.16
Upscale Drift (%)				-0.04	0.01	0.04
Concentration Corrected for Drift, C_d (%)				**2.83**	**3.10**	**2.60**

NITROGEN OXIDES

Correction to Fc Factor (lb/MMBtu)
Correction to Fd Factor (lb/MMBtu) 9.126

Analyzer Values	Actual	Cal Error	Bias	Run 1	Run 2	Run 3
Date		5/17/22	5/17/22	5/17/22	5/17/22	5/17/22
Start Time		7:58	8:16	9:43	11:17	12:50
Stop Time		8:16	8:24	11:06	12:39	14:11
Concentration, C (ppm)				1182.9	1116.4	1145.6
Zero Cal Gas, C_0 (ppm)	0.0	1.59	5.3	7.2	6.6	7.6
Mid Cal Gas (ppm)	908.4	906.6				
High Cal Gas (ppm)	1987	1999				
Span Value (ppm)	1987					
Bias/Drift Check Gas, C_s (ppm)	908.4 906.6		895.4	881.6	880.0	874.9

RESULTS						
Zero Error (%)	2 % of Span	0.1				
Mid Error (%)		-0.1				
High Error (%)		0.6				
Upscale Error (%)						
Zero Bias (%)	5 % of Span		0.18	0.28	0.25	0.30
Upscale Bias (%)			-0.56	-1.26	-1.34	-1.60
Zero Drift (%)	3 % of Span			0.10	-0.03	0.05
Upscale Drift (%)				-0.69	-0.08	-0.26
Concentration Corrected for Drift, C_d (ppm)				**1211.5**	**1153.3**	**1188.3**
Emission Rate, Fd Factor, E_{Fd} (lb/MMBtu)				**1.53**	**1.48**	**1.48**

Parameters	**Run 1**	**Run 2**	**Run 3**
Date	5/17/22	5/17/22	5/17/22
Start Time	9:43	11:17	12:50
Stop Time	11:06	12:39	14:11
Dimensions of Sample Location, D_s (in)	4.0	4.0	4.0
Oxygen (% dry)	2.83	3.10	2.60
Run Time, θ (minutes)	72	71	71
RESULTS			
Area of Sample Location, A_s (ft^2)	0.09	0.09	0.09
Nitrogen Oxides Concentration, C (ppmdv)	1211.5	1153.3	1188.3
Nitrogen Oxides Emission rate, E (lb/MMBtu)	1.53	1.48	1.48

Test Parameters	Run 1	Run 2	Run 3	Average
Date	5/17/2022	5/17/2022	5/17/2022	
Start Time	9:43	11:17	12:50	
Stop Time	11:06	12:39	14:11	
Process Data				
Heating Value (Btu/lb)	18,663	18,663	18,663	18,663
Gas flow (g/sec)	19.223	18.888	19.176	19.096
Gas flow (lb/hr)	152.573	149.914	152.200	151.562
Gas Conditions				
Oxygen (% dry)	2.8	3.1	2.6	**2.8**
Pollutant Results				
Nitrogen Oxides Concentration (ppmdv)	1211.5	1153.3	1188.3	**1184.4**
Nitrogen Oxides Emission rate, E (lb/MMBtu)	1.53	1.48	1.48	**1.49**
Nitrogen Oxides Emission rate, E (lb/hr)	4.35	4.13	4.20	**4.23**

OXYGEN

Analyzer Values	Actual	Cal Error	Bias	Run 1	Run 2	Run 3
Date		5/18/22	5/18/22	5/18/22	5/18/22	5/18/22
Start Time		8:31	9:08	10:16	11:37	13:02
Stop Time		8:57	9:13	11:23	12:40	14:06
Concentration, C (%)				0.63	0.60	0.60
Zero Cal Gas, C_0 (%)	0.0	0.04	-0.19	-0.16	-0.16	-0.16
Mid Cal Gas (%)	10.02	9.94				
High Cal Gas (%)	20.12	20.15				
Span Value (%)	20.12					
Bias/Drift Check Gas, C_s (%)	10.02		9.94	9.92	9.91	9.90
RESULTS						
Zero Error (%)	2 % of Span	0.17				
Mid Error (%)		-0.40				
High Error (%)		0.16				
Upscale Error (%)						
Zero Bias (%)	5 % of Span		-1.11	-0.97	-0.96	-0.98
Upscale Bias (%)			-0.01	-0.10	-0.16	-0.20
Zero Drift (%)	3 % of Span			0.14	0.01	-0.02
Upscale Drift (%)				-0.09	-0.06	-0.04
Concentration Corrected for Drift, C_d (%)				**0.79**	**0.76**	**0.76**

NITROGEN OXIDES

Correction to Carbon Dioxide (%)
Correction to Oxygen (%)
Correction to Fc Factor (lb/MMBtu)
Correction to Fd Factor (lb/MMBtu) 9.123

Analyzer Values	Actual	Cal Error	Bias	Run 1	Run 2	Run 3
Date		5/18/22	5/18/22	5/18/22	5/18/22	5/18/22
Start Time		8:31	9:08	10:16	11:37	13:02
Stop Time		8:57	9:13	11:23	12:40	14:06
Concentration, C (ppm)				1350.6	1344.5	1281.8
Zero Cal Gas, C_0 (ppm)	0.0	0.41	6.0	6.7	7.2	6.8
Mid Cal Gas (ppm)	908.4	908.3				
High Cal Gas (ppm)	1987	1987				
Span Value (ppm)	1987					
Bias/Drift Check Gas, C_s (ppm)	908.4		908.6	890.9	884.9	880.1
RESULTS						
Zero Error (%)	2 % of Span	0.0				
Mid Error (%)		0.0				
High Error (%)		0.0				
Upscale Error (%)						
Zero Bias (%)	5 % of Span		0.28	0.32	0.34	0.32
Upscale Bias (%)			0.02	-0.87	-1.18	-1.42
Zero Drift (%)	3 % of Span			0.04	0.03	-0.02
Upscale Drift (%)				-0.89	-0.30	-0.24
Concentration Corrected for Drift, C_d (ppm)				**1366.8**	**1379.2**	**1322.7**
Emission Rate, Fd Factor, E_{Fd} (lb/MMBtu)				**1.55**	**1.56**	**1.50**

Parameters	**Run 1**	**Run 2**	**Run 3**
Date	5/18/22	5/18/22	5/18/22
Start Time	10:16	11:37	13:02
Stop Time	11:23	12:40	14:06
Dimensions of Sample Location, D_s (in)	2.0	2.0	2.0
Oxygen (% dry)	0.79	0.76	0.76
Run Time, θ (minutes)	68	64	65
RESULTS			
Area of Sample Location, A_s (ft^2)	0.09	0.09	0.09
Nitrogen Oxides Concentration, C (ppmdv)	1366.8	1379.2	1322.7
Nitrogen Oxides Emission rate, E (lb/MMBtu)	1.55	1.56	1.50

Test Parameters	Run 1	Run 2	Run 3	Average
Date	5/18/2022	5/18/2022	5/18/2022	
Start Time	10:16	11:37	13:02	
Stop Time	11:23	12:40	14:06	
Process Data				
Heating value (Btu/lb)	19,208	19,208	19,208	**19,208**
Gas flow (g/sec)	0.629	0.646	0.671	**0.649**
Gas flow (lb/hr)	4.990	5.129	5.327	**5.149**
Annual average fuel rate (MMBtu/hr)				**0.12**
Gas Conditions				
Oxygen (% dry)	0.8	0.8	0.8	**0.8**
Pollutant Results				
Nitrogen Oxides Concentration (ppmdv)	1366.8	1379.2	1322.7	**1356.2**
Nitrogen Oxides Emission rate (lb/MMBtu)	1.55	1.56	1.50	**1.53**
Nitrogen Oxides Emission rate, E (lb/hr)	0.15	0.15	0.15	**0.15**
Nitrogen Oxides Emission rate, E (lb/hr-scaled up)				**0.18**

Appendix A.3
Example Calculations

Sample Calculations Race Engine Run 1

Area of Sample Location

$$A_s = (\pi)\left(\frac{d_s}{2 \times 12}\right)^2$$

A_s = 0.09
d_s = 4

Where:

A_s = area of sample location (ft^2)
d_s = diameter of sample location (in)
12 = conversion factor (in/ft)
2 = conversion factor (diameter to radius)

Nitrogen Oxides Concentration, Corrected for Analyzer Drift[1]

$$C_d = \left(C - \left(\frac{c_{0i} + c_{0f}}{2}\right)\right)\left(\frac{c_a}{\left(\frac{c_{si} + c_{sf}}{2}\right) - \left(\frac{c_{0i} + c_{0f}}{2}\right)}\right)$$

C_d = 1211.5 C_a = 908.4
C = 1182.9 C_{si} = 7.2
C_{0i} = 5.3 C_{sf} = 881.6
C_{0f} = 895.4

Where:

C_d = nitrogen oxides concentration, corrected for analyzer drift (ppmdv)
C = nitrogen oxides concentration (ppmdv)
C_{0i} = initial zero calibration value (ppm)
C_{0f} = final zero calibration value (ppm)
C_a = actual span gas value (ppm)
C_{si} = initial span calibration value (ppm)
C_{sf} = final span calibration value (ppm)

[1]Calculations for O2 are performed in a similar manner

Nitrogen Oxide Emission Rate, lb/MMBtu

$$E_{NOx(lb/MMBtu)} = \frac{(C_d)(MW)(Fd)(20.9)}{(385.3\times10^6)(20.9-O_2)}$$

E_{NOx}	= 1.53	F_d	= 9,126
C_d	= 1211.5	O_2	= 2.83
MW	= 46.01		

Where:

$E_{NOx(lb/MMBtu)}$	= nitrogen oxides emission rate (lb/MMBtu)
C_d	= nitrogen oxides concentration, corrected for drift (ppmdv)
MW	= molecular weight of nitrogen oxide (lb/lb-mole)
F_d	= oxygen based fuel factor (scf/MMBtu)
O_2	= oxygen content of the gas stream (%)
20.9	= oxygen content of ambient air (%)
385.3	= volume occupied by one pound of gas at standard conditions (dscf/lbmole)
10^6	= conversion factor (ppm)

Nitrogen Oxide Emission Rate, lb/hr

$$E_{NOx} = \frac{(F_{gas})(H)(E_{NOx(lb/MMBtu)})}{(1.0\times10^6)}$$

E_{NOx}	= 4.35	H	= 18,663
F_{gas}	= 152.573	$E_{NOx(lb/MMBtu)}$	= 1.53

Where:

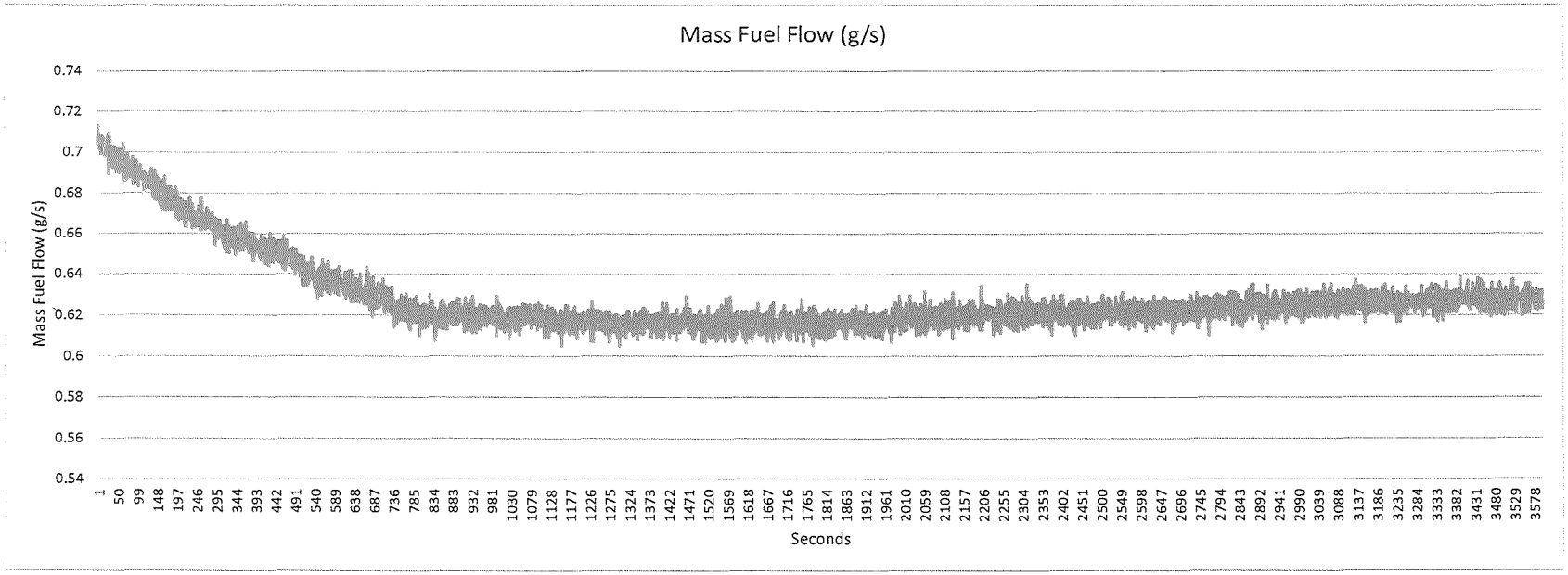
E_{NOx}	= nitrogen oxides emission rate (lb/hr)
F_{gas}	= gas flow rate, (lb/hr)
H	= gas heating value (Btu/lb)
$E_{NOx(lb/MMBtu)}$	= volumetric flow rate of the dry gas stream at standard conditions (dscfm)
1,000,000	= conversion factor (Btu/MMBtu)

APPENDIX B
FACILITY PROCESS DATA

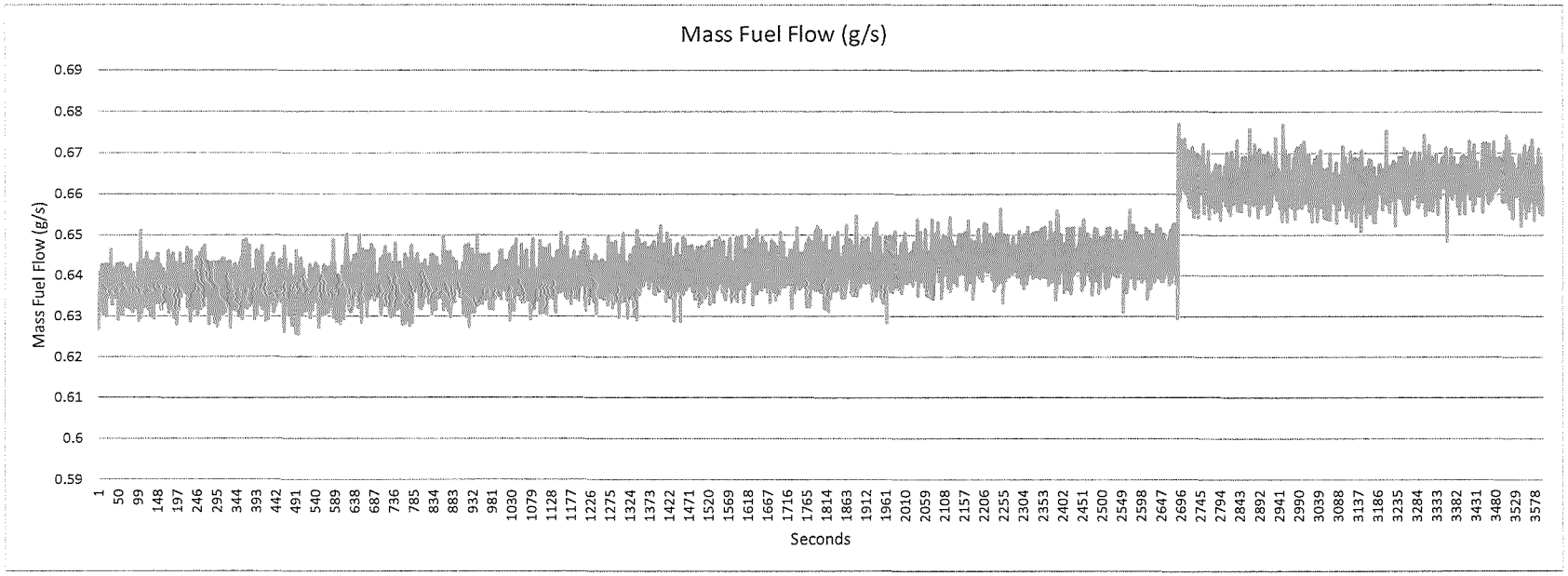
Location:	General Motors Racing - Test Cell C
Date:	5/17/2022
Engine:	LT6R_R011_R07

Run	$iStartTime	SPEED E_ACT_N_avg rpm	BARO CEL_BARO_P_avg kPa	AFR Left E_AFRL_avg -	AFR Right E_AFRR_avg -	Exhaust Temp Left EXGSPRT_L_avg °C	Exhaust Temp Right EXGSPRT_R_avg °C	Fuel Flow S_FC_MF_avg g/s	Engine Inlet Air Temp BSKL_AIR_T_avg °C	Engine Inlet Pressure BSKL_CBA_AP_avg kPa
R005_Lemans_Laps_EPA [avg]	5/17/2022 9:40	5690.1	97.730	0.9789	0.9649	767.8	723.5	19.377	23.048	99.8
R006_Lemans_Laps_EPA_B1 [avg]	5/17/2022 10:28	5689.8	97.729	0.9777	0.9687	757.8	720.5	19.069	30.241	99.6
R007_Lemans_Laps_EPA_B1 [avg]	5/17/2022 11:08	5690.6	97.742	0.9767	0.9678	765.4	729.7	18.731	36.271	99.6
R008_Lemans_Laps_EPA_B2 [avg]	5/17/2022 12:01	5690.6	97.776	0.9831	0.9672	770.2	724.4	19.045	36.898	99.8
R009_Lemans_Laps_EPA_B2 [avg]	5/17/2022 12:37	5690.1	97.813	0.9792	0.9662	765.7	729.1	19.176	29.479	99.7
R010_Lemans_Laps_EPA_B1 [avg]	5/17/2022 13:34	5689.8	97.806	0.9818	0.9656	773.4	728.9	19.175	29.097	99.8
Run 1	5/17/2022 10:04	5690.0	97.729	0.9783	0.9668	762.8	722.0	19.223	26.644	99.7
Run 2	5/17/2022 11:34	5690.6	97.759	0.9799	0.9675	767.8	727.0	18.888	36.584	99.7
Run 3	5/17/2022 13:06	5690.0	97.810	0.9805	0.9659	769.5	729.0	19.176	29.288	99.8

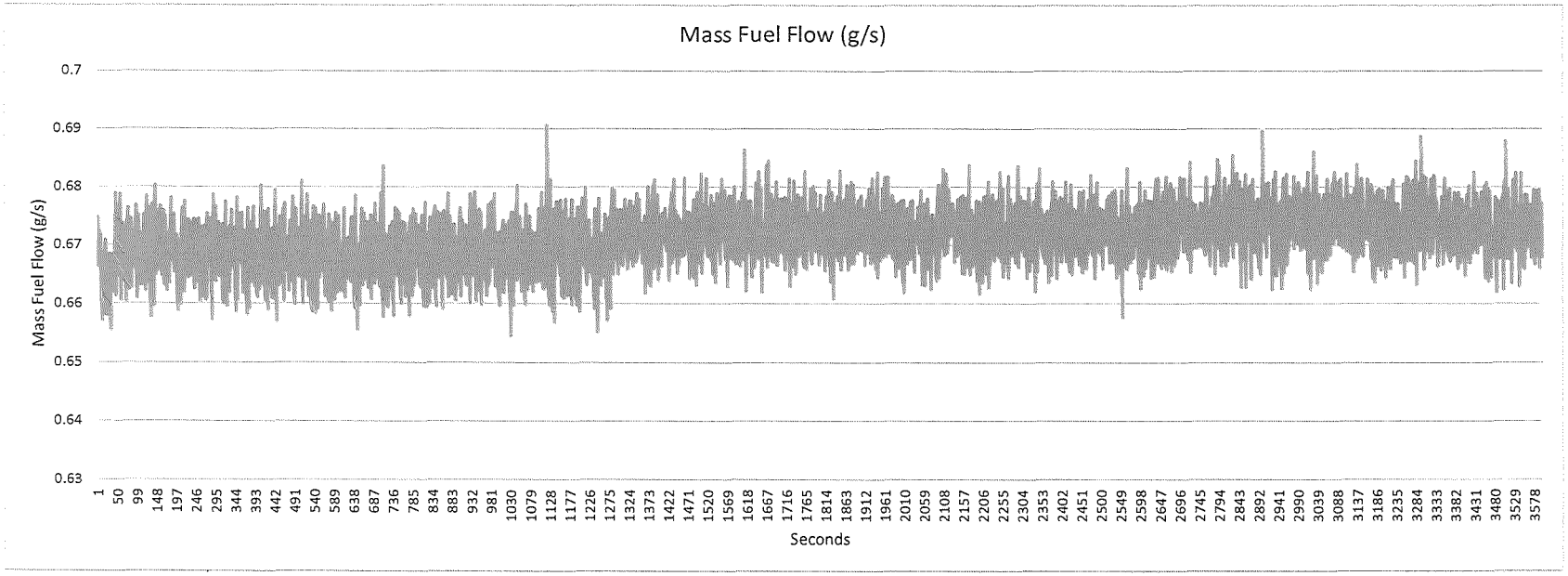
Database File Name	RI036_LFV_12674521_Degreen>2022_05_18_EPA_Cert_1st_1120>D301_S_FC_VF[1]
Total Fuel Flow (g)	2263.17887
Average Fuel Flow (g/s)	0.628660797
Start Time	5/18/2022 10:16
Stop Time	5/18/2022 11:16



Database File Name	RI036_LFV_12674521_Degreen>2022_05_18_EPA_Cert_2nd_1121>D301_S_FC_VF
Total Fuel Flow (g)	2326.486828
Average Fuel Flow (g/s)	0.646246341
Start Time	5/18/2022 11:37
Stop Time	5/18/2022 12:37



Database File Name	RI036_LFV_12674521_Degreen>2022_05_18_EPA_Cert_3rd_1122>D301_S_FC_VF
Total Fuel Flow (g)	2416.382998
Average Fuel Flow (g/s)	0.671217499
Start Time	5/18/2022 13:02
Stop Time	5/18/2022 14:02



		Actual Jan	Actual Feb	Actual Mar	Actual Apr	Actual May	Actual Jun	Actual July	Actual Aug	Actual Sept	Actual Oct	Actual Nov	Dec	Actual Total (YTD)	Estimated Year End	Comments
D301	Tier III	4.48	2.673173	6.72	4.47	9.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.82	27.82	
D302	ULSD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Tank 301 - EPA Cert
D303	RD-587T	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D304	ULSD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Tank 301 - EPA Cert
D305	RD-587T	2.17	4.75	17.10	4.73	15.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.06	44.06	
D306	Tier III	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D307	Tier III	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D308	Tier II	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D309		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D310		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D370	Tier III	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
D370	Tier II	29.38	1559.271	29.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1618.35	1618.35	
														1690.23		

Consolidating amounts by fuel type															GPS provided Actual $/gal	$ Extended	Change vs 2020 (- = reduction)
RD-587T	2.17	4.75	17.1	4.73	15.31	0	0	0	0	0	0	0	44.06		$ -	#DIV/0!
Sunoco GT	0	0	0	0	0	0	0	0	0	0	0	0	0	$ 6.79	$ -	-73%
Tier II	29.38	1559.271	29.7	0	0	0	0	0	0	0	0	0	1618.35	$ 9.00	$ 14,565.16	#DIV/0!
Tier III	4.48	2.673173	6.72	4.47	9.48	0	0	0	0	0	0	0	27.82	$ 9.96	$ 277.12	3257%
EEE w/sulph	0.00	0	0	0	0	0	0	0	0	0	0	0	0.00			-99%
ULSD	0.00	0	0	0	0	0	0	0	0	0	0	0	0.00	$ 9.75	$ -	#DIV/0!
													1690.23		$ 14,842.28	

			Fuel Usage (Gallons)															
			2021							2022					MMBtu/gal	Total (gal)	Total (MMBtu)
Testcell	Fuel Type		Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May			
D301	Gas	Tier III	8.27	1.00	0.71	4.17	2.90	1.70	6.94	4.48	2.673173	6.72	4.47	9.48	0.1391	53.51	7.443682
D303	Gas	RD-587T													0.1276	0.00	0
D305	Gas	RD-587T	6.81	4.20	6.01	10.68	6.30	7.30	0.00	2.17	4.75	17.10	4.73	15.31	0.1276	85.49	10.90822
D306	Gas	Tier III	77.71												0.1391	77.85	10.82881
D307	Gas	Tier III													0.1391	0.00	0
D308	Gas	Tier II													0.1213	0.12	0.014714
D309	Gas	Tier II													0.1213	0.00	0
D310	Gas	Tier III													0.1391	0.00	0
D370	Gas	Tier III													0.1391	0.00	0
D370	Gas	Tier II	31.61	1.30	49.80	261.86	177.80	466.40	115.83	29.38	1559.271	29.70	0.00	0.00	0.1213	2722.95	330.294
																3044.60	

	Test Cell Operating Hours												
	2021							2022					Total
Test Cell	June	July	August	September	October	November	December	January	February	March	April	May	
Gas Total	124.40	6.50	56.52	276.71	187.00	475.40	122.77	36.03	1566.69	53.52	9.20	24.79	2939.53

Wing 3 Average Hourly Fuel Rate			
Fuel Type	Annual Usage (MMBtu)	Annual Operating Hours	Fuel Rate (MMBtu/hr)
Gasoline	359.5	2939.53	0.12

F_d Parameters	Run 1
Hydrogen (%)	13.45
Carbon (%)	80.99
Sulfur (%)	0.00036
Nitrogen (%)	0.00
Oxygen (%)	5.56
Heating Value (Btu/lb)	18,663

Result	
F_d (dscf/MBtu)	9,126

F_d Parameters	Run 1
Hydrogen (%)	13.71
Carbon (%)	82.93
Sulfur (%)	0.00087
Nitrogen (%)	0.00
Oxygen (%)	3.36
Heating Value (Btu/lb)	19,208

Result	
F_d (dscf/MBtu)	9,123

PARAGON LABORATORIES

12649 Richfield Ct.
Livonia, MI 48150
P:734.462.3900
paragonlaboratories.com

Wednesday, May 25, 2022

Sean Wheeler
Montrose Air Qualtiy Services
1371 Brummel Avenue
Elk Grove Village, IL 60007

Workorder: 377704
Project Name: GM Pontiac MI 015629 Race & Single Engine
Purchase Order: PO-27754

Sean Wheeler,
Paragon Laboratories, Inc. received the samples associated with the workorder listed above for the analyses presented in the following report. The analyses pertain only to the aliquot of sample received.

This material is confidential and is intended solely for the person to whom it is addressed. If this is received in error, please contact the number below.

Please note that any unused portion of the sample(s) will be discarded 40 days after sample receipt, unless requested otherwise.

We appreciate the opportunity to assist you. If you have any questions concerning this report, please contact me at 734-469-5614.

Sincerely,

Sharon L. Johnson

Sharon Johnson

GLOSSARY

Abbreviation	Meaning	Explanation
ID	Identification	Preceeded by "Lab", it describes the unique 10-digit sample number assigned by the laboratory. Preceeded by "Sample", it describes the client-specified sample identifier.
Qual	Qualifier	Column that populates with an asterisk (*) when a related narrative comment appears in the Workorder Summary.
RL	Reporting Limit	The value at or above which a result is routinely reported.
MDL	Method Detection Limit	The minimum measured concentration that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results.
DF	Dilution Factor	The dilution applied to the sample during analysis to arrive at the final reported analyte result.
Min	Minimum	The minimum value that a result can be to meet the applicable specification, regulatory, permit, or client-specified limit.
Max	Maximum	The maximum value that a result can be to meet the applicable specification, regulatory, permit, or client-specified limit.
(S)	Surrogate	A compound that is added to the sample to mimic one or more compounds of interest. Its recovery is used to evaluate the efficiency of recovering the compound(s) of interest.
<	Less Than	Symbol that indicates that a result is less than the value following it.
>	Greater Than	Symbol that indicates that a result is greater than the value following it.

SAMPLE SUMMARY

Lab ID	Sample ID	Sample Description	Matrix	Date Collected	Date Received	Collector
3777040001	Way 3	Engine Fuel	G	05/18/2022 00:00	05/19/2022 07:01	
3777040002	WEC	Engine Fuel	G	05/17/2022 00:00	05/19/2022 07:01	

WORKORDER SUMMARY

Accreditations

Paragon Laboratories, Inc. is certified by the Michigan Department of Environment, Great Lakes, and Energy to analyze Drinking Water. (EGLE Lab No. 9901 Expires 2/25/2023)

[A] Paragon Laboratories, Inc. is accredited to ISO/IEC 17025:2017 by A2LA for analytical methods referring to this note. (A2LA Cert. No. 2705.01 Expires 5/31/2023)

ANALYTICAL RESULTS

Lab ID:	3777040001	Date Collected:	05/18/2022 00:00	Matrix:	Gasoline (G)
Sample ID:	Way 3	Date Received:	05/19/2022 07:01	Collector:	
Description:	Engine Fuel				

Parameter	Result	Qual	Unit	RL	MDL	DF	Min	Max	Analyzed	By
Elemental Analysis by ASTM D5291 D [A]										
Carbon (Wt%)	82.93		% m/m	0.05		1			05/19/2022 14:00	AJB
Hydrogen (Wt%)	13.71		% m/m	0.05		1			05/19/2022 14:00	AJB
Elemental Analysis by ASTM D5453 [A]										
Sulfur	8.7		ppm m/m	0.1		1			05/20/2022 08:55	AKL
Sulfur	0.00087		% m/m	0.00001		1			05/20/2022 08:55	AKL
Elemental Analysis by ASTM D5622 A [A]										
Oxygen (Wt%)	3.36		% m/m	0.05		1			05/24/2022 09:00	AJB
Individual Parameters by ASTM D240 [A]										
Gross Heating Value (BTU/lb)	19208		BTU/lb	315		1			05/25/2022 09:40	TXM
Gross Heating Value (MJ/kg)	44.678		MJ/kg			1			05/25/2022 09:40	TXM
Net Heating Value (BTU/lb)	17957		BTU/lb	315		1			05/25/2022 09:40	TXM
Net Heating Value(MJ/kg)	41.769		MJ/kg			1			05/25/2022 09:40	TXM
Individual Parameters by ASTM D4052 [A]										
API Gravity at 15.56°C	57.2		°API	0.1		1			05/20/2022 08:50	LWH
Density at 15.56°C	0.7493		g/mL	0.0001		1			05/20/2022 08:50	LWH
Spec. Grav. at 15.56°C/15.56°C	0.7501			0.0001		1			05/20/2022 08:50	LWH

ANALYTICAL RESULTS

Lab ID:	3777040002	Date Collected:	05/17/2022 00:00	Matrix:	Gasoline (G)
Sample ID:	WEC	Date Received:	05/19/2022 07:01	Collector:	
Description:	Engine Fuel				

Parameter	Result	Qual	Unit	RL	MDL	DF	Min	Max	Analyzed	By
Elemental Analysis by ASTM D5291 D [A]										
Carbon (Wt%)	80.99		% m/m	0.05		1			05/19/2022 14:00	AJB
Hydrogen (Wt%)	13.45		% m/m	0.05		1			05/19/2022 14:00	AJB
Elemental Analysis by ASTM D5453 [A]										
Sulfur	3.6		ppm m/m	0.1		1			05/20/2022 09:32	AKL
Sulfur	0.00036		% m/m	0.00001		1			05/20/2022 09:32	AKL
Elemental Analysis by ASTM D5622 A [A]										
Oxygen (Wt%)	5.56		% m/m	0.05		1			05/24/2022 09:00	AJB
Individual Parameters by ASTM D240 [A]										
Gross Heating Value (BTU/lb)	18663		BTU/lb	315		1			05/25/2022 10:20	TXM
Gross Heating Value (MJ/kg)	43.411		MJ/kg			1			05/25/2022 10:20	TXM
Net Heating Value (BTU/lb)	17436		BTU/lb	315		1			05/25/2022 10:20	TXM
Net Heating Value(MJ/kg)	40.557		MJ/kg			1			05/25/2022 10:20	TXM
Individual Parameters by ASTM D4052 [A]										
API Gravity at 15.56°C	55.7		°API	0.1		1			05/20/2022 08:54	LWH
Density at 15.56°C	0.7552		g/mL	0.0001		1			05/20/2022 08:54	LWH
Spec. Grav. at 15.56°C/15.56°C	0.7559			0.0001		1			05/20/2022 08:54	LWH

MONTROSE AIR QUALITY SERVICES, LLC
Chain of Custody

Project Number	~~015627~~ (PW) 015629	Location	Face + Style Engine	Analysis Requested	Page 1 of
Client	GM	Date	5/18/2022		
Plant	Pontiac MI	Completed By			

ID No.	Run No.	Date	Sample Description	Carbon & Hydrogen	Density / Specific Gravity	Oxygen by Pyro Lyzer - Requires Density	Dot Inertia Value	Requires Eff 10	Sulfur - Requires Density / Specific Gravity	Notes
WW3 (1)	1	5/18/2022	Engine Fuel	✓	✓	✓		✓	✓	
WW3 (2)	1	5/18/2022	Engine Fuel	✓	✓	✓		✓	✓	
WEC (1)	1	5/18/2022	Engine Fuel	✓	✓	✓		✓	✓	
WEC (2)	1	5/18/2022	Engine Fuel	✓	✓	✓		✓	✓	

Relinquished By (signature)	Rachel Gribas	Relinquished By (signature)		Carrier	
(printed)	Rachel Gribas	(printed)		Laboratory	
Date/Time	5/18/2022 3:35 PM	Date/Time	5/18/2022 4:20 pm	Contact	
Accepted By (signature)		Accepted By (signature)		Address	
(printed)		(printed)	Jeff Petrasch	Phone	
Date/Time	5/18/2022 15:36	Date/Time	5-19-22 4:20 pm	Fax	
				Date/Time	

Relinquished by Jeff Petrasch Montrose 7:01am 5-19-22 Received by

MONTROSE AIR QUALITY SERVICES

Montrose Air Quality Services, LLC
1371 Brummel Ave
Elk Grove Village, IL 60007
Phone: (630) 860-4740

APPENDIX C
QUALITY ASSURANCE/QUALITY CONTROL

Appendix C.1
Units and Abbreviations

UNITS AND ABBREVIATIONS

@ X% O_2	corrected to X% oxygen (corrected for dilution air)
|CC|	absolute value of the confidence coefficient
|d|	absolute value of the mean differences
°C	degrees Celsius (centrigade)
°F	degrees Fahrenheit
°R	degrees Rankine
" H_2O	inches of water column
13.6	specific gravity of mercury
ΔH	pressure drop across orifice meter, inches H_2O
ΔP	velocity head of stack gas, inches H_2O
θ	total sampling time, minutes
µg	microgram
ρ_a	density of acetone, mg/ml
ρ_w	density of water, 0.9982 g/ml or 0.002201 lb/ml
acfm	actual cubic feet of gas per minute at stack conditions
A_n	cross-sectional area of nozzle, ft^2
A_s	cross-sectional area of stack, square feet (ft^2)
Btu	British thermal unit
B_{ws}	proportion by volume of water vapor in gas stream
C_a	particulate matter concentration in stack gas, gr/acf
C_{Avg}	average unadjusted gas concentration, ppmv
C_{Dir}	measured concentration of calibration gas, ppmv
cf or ft^3	cubic feet
cfm	cubic feet per minute
C_{Gas}	average gas concentration adjusted for bias, ppmv
C_M	average of initial and final system bias check responses from upscale calibration gas, ppmv
cm or m^3	cubic meters
C_{MA}	actual concentration of the upscale calibration gas, ppmv
C_O	average of initial and final system bias check responses from low-level calibration gas, ppmv
C_p	pitot tube coefficient
C_s	particulate matter concentration in stack gas, gr/dscf
CS	calibration span, % or ppmv
C_S	measured concentration of calibration gas, ppmv
C_V	manufactured certified concentration of calibration gas, ppmv
D	drift assessment, % of span
dcf	dry cubic feet
dcm	dry cubic meters
D_n	diameter of nozzle, inches
D_s	diameter of stack, inches
dscf	dry standard cubic feet
dscfm	dry standard cubic feet per minute
dscm	dry standard cubic meters
F_d	F-factor, dscf/MMBtu of heat input
fpm	feet per minute
fps	feet per second
ft	feet
ft^2	square feet
g	gram
gal	gallons
gr	grains (7000 grains per pound)

UNITS AND ABBREVIATIONS

gr/dscf	grains per dry standard cubic feet
hr	hour
I	percent of isokinetic sampling
in	inch
k	kilo or thousand (metric units, multiply by 10^3)
K	kelvin (temperature)
K_3	conversion factor 0.0154 gr/mg
K_4	conversion factor 0.002668 ((in. Hg)(ft^3))/((ml)(°R))
kg	kilogram
K_p	pitot tube constant (85.49 ft/sec)
kwscfh	thousand wet standard cubic feet per hour
l	liters
lb/hr	pounds per hour
lb/MMBtu	pounds per million Btu
lpm	liters per minute
m	meter or milli
M	thousand (English units) or mega (million, metric units)
m^3	cubic meters
m_a	mass of residue of acetone after evaporation, mg
M_d	molecular weight of stack gas; dry basis, lb/lb-mole
meq	milliequivalent
mg	milligram
Mg	megagram (10^6 grams)
min	minute
ml or mL	milliliter
mm	millimeter
MM	million (English units)
MMBtu/hr	million Btu per hour
m_n	total amount of particulate matter collected, mg
mol	mole
mol. wt. or MW	molecular weight
M_s	molecular weight of stack gas; wet basis, lb/lb-mole
MW	molecular weight or megawatt
n	number of data points
ng	nanogram
nm	nanometer
P_{bar}	barometric pressure, inches Hg
pg	picogram
P_g	stack static pressure, inches H_2O
P_m	barometric pressure of dry gas meter, inches Hg
ppb	parts per billion
ppbv	parts per billion, by volume
ppbvd	parts per billion by volume, dry basis
ppm	parts per million
ppmv	parts per million, by volume
ppmvd	parts per million by volume, dry basis
P_s	absolute stack gas pressure, inches Hg
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
P_{std}	standard absolute pressure, 29.92 inches Hg
Q_a	volumetric flow rate, actual conditions, acfm

UNITS AND ABBREVIATIONS

Q_s	volumetric flow rate, standard conditions, scfm
Q_{std}	volumetric flow rate, dry standard conditions, dscfm
R	ideal gas constant 21.85 ((in. Hg) $(ft^{3)})/((°R)$ (lbmole))
SB_{final}	post-run system bias check, % of span
SB_i	pre-run system bias check, % of span
scf	standard cubic feet
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
scm	standard cubic meters
scmh	standard cubic meters per hour
sec	second
sf, sq. ft., or ft^2	square feet
std	standard
t	metric ton (1000 kg)
$T_{0.975}$	t-value
T_a	absolute average ambient temperature, °R (+459.67 for English)
T_m	absolute average dry gas meter temperature, °R (+459.67 for English)
ton or t	ton = 2000 pounds
tph or tons/hr	tons per hour
tpy or tons/yr	tons per year
T_s	absolute average stack gas meter temperature, °R (+459.67 for English)
T_{std}	absolute temperature at standard conditions
V	volt
V_a	volume of acetone blank, ml
V_{aw}	volume of acetone used in wash, ml
V_{lc}	total volume H_2O collected in impingers and silica gel, grams
V_m	volume of gas sampled through dry gas meter, ft^3
$V_{m(std)}$	volume of gas measured by the dry gas meter, corrected to standard conditions, dscf
V_{ma}	stack gas volume sampled, acf
V_n	volume collected at stack conditions through nozzle, acf
V_s	average stack gas velocity, feet per second
$V_{wc(std)}$	volume of water vapor condensed, corrected to standard conditions, scf
$V_{wi(std)}$	volume of water vapor in gas sampled from impingers, scf
$V_{wsg(std)}$	volume of water vapor in gas sampled from silica gel, scf
W	watt
W_a	weight of residue in acetone wash, mg
W_{imp}	total weight of impingers, grams
W_{sg}	total weight of silica gel, grams
Y	dry gas meter calibration factor, dimensionless

ACRONYMS

AAS	atomic absorption spectroscopy
ACDP	air contaminant discharge permit
ACE	analyzer calibration error, percent of span
AD	absolute difference
ADL	above detection limit
AETB	Air Emissions Testing Body
AS	applicable standard (emission limit)
ASTM	American Society For Testing And Materials
BACT	best achievable control technology
BDL	below detection limit
BHP	brake horsepower
BIF	boiler and industrial furnace
BLS	black liquor solids
CC	confidence coefficient
CD	calibration drift
CE	calibration error
CEM	continuous emissions monitor
CEMS	continuous emissions monitoring system
CERMS	continuous emissions rate monitoring system
CET	calibration error test
CFR	Code of Federal Regulations
CGA	cylinder gas audit
CHNOS	elemental analysis for determination of C, H, N, O, and S content in fuels
CNCG	concentrated non-condensable gas
CO	catalytic oxidizer
COC	chain of custody
COMS	continuous opacity monitoring system
CPM	condensible particulate matter
CPMS	continuous parameter monitoring system
CT	combustion turbine
CTM	conditional test method
CTO	catalytic thermal oxidizer
CVAAS	cold vapor atomic absorption spectroscopy
D_e	equivalent diameter
DE	destruction efficiency
Dioxins	polychlorinated dibenzo-p-dioxins (pcdd's)
DLL	detection level limited
DNCG	dilute non-condensable gas
ECD	electron capture detector
EIT	Engineer In Training
ELCD	electoconductivity detector (hall detector)
EMPC	estimated maximum possible concentration
EPA	US Environmental Protection Agency
EPRI	Electric Power Research Institute
ES	emission standard (applicable limit)
ESP	electrostatic precipitator
EU	emission unit
FCCU	fluid catalytic cracking unit
FGD	flue gas desulfurization
FI	flame ionization
FIA	flame ionization analyzer
FID	flame ionization detector
FPD	flame photometric detector
FPM	filterable particulate matter

ACRONYMS

FTIR	Fourier-transform infrared spectroscopy
FTPB	field train proof blank
FTRB	field train recovery blank
Furans	polychlorinated dibenzofurans (pcdf's)
GC	gas chromatography
GC/MS	gas chromatography/mass spectroscopy
GFAAS	graphite furnace atomic absorption spectroscopy
GFC	gas filter correlation
GHG	greenhouse gas
HAP	hazardous air pollutant
HC	hydrocarbons
HHV	higher heating value
HPLC	high performance liquid chromatography
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectroscopy
HRSG	heat recovery steam generator
IC	ion chromatography
ICAP	inductively-coupled argon plasmography
ICPCR	ion chromatography with a post-column reactor
ICP-MS	inductively coupled plasma-mass spectroscopy
IR	infrared radiation
ISO	International Standards Organization
kW	kilowatts
LFG	landfill gas
LHV	lower heating value
LPG	liquified petroleum gas
MACT	maximum achievable control technology
MDI	methylene diphyenyl diisocyanate
MDL	method detection limit
MNOC	maximum normal operating conditions
MRL	method reporting limit
MS	mass spectrometry
NA	not applicable or not available
NCASI	National Council For Air And Steam Improvement
NCG	non-condensable gases
ND	not detected
NDIR	non-dispersive infrared
NESHAP	National Emissions Standards For Hazardous Air Pollutants
NG	natural gas
NIOSH	National Institute For Occupational Safety And Health
NIST	National Institute Of Standards And Technology
NMC	non-methane cutter
NMOC	non-methane organic compounds
NMVOC	non-methane volatile organic compounds
NPD	nitrogen phosphorus detector
NSPS	New Source Performance Standards
OSHA	Occupational Safety And Health Administration
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl compounds
PCWP	plywood and composite wood products
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances (PFAS)
PI	photoionization
PID	photoionization detector
PM	particulate matter

ACRONYMS

PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
POM	polycyclic organic matter
PS	performance specification
PSD	particle size distribution
PSEL	plant site emission limits
PST	performance specification test
PTE	permanent total enclosure
PTM	performance test method
QA/QC	quality assurance and quality control
QI	Qualified Individual
QSTI	Qualified Source Testing Individual
RA	relative accuracy
RAA	relative accuracy audit
RACT	reasonably available control technology
RATA	relative accuracy test audit
RCTO	rotary concentrator thermal oxidizer
RICE	stationary reciprocating internal combustion engine
RM	reference method
RTO	regenerative thermal oxidizer
SAM	sulfuric acid mist
SCD	sulfur chemiluminescent detector
SCR	selective catalytic reduction system
SD	standard deviation
Semi-VOST	semivolatile organic compounds sample train
SRM	standard reference material
TAP	toxic air pollutant
TBD	to be determined
TCA	thermal conductivity analyzer
TCD	thermal conductivity detector
TGNENMOC	total gaseous non-ethane non-methane organic compounds
TGNMOC	total gaseous non-methane organic compounds
TGOC	total gaseous organic compounds
THC	total hydrocarbons
TIC	tentatively identified compound
TO	thermal oxidizer
TO	toxic organic (as in EPA Method TO-15)
TPM	total particulate matter
TSP	total suspended particulate matter
TTE	temporary total enclosure
ULSD	ultra-low sulfur diesel
UV	ultraviolet radiation range
VE	visible emissions
VOC	volatile organic compounds
VOST	volatile organic sample train
WC	water column
WWTP	waste water treatment plant

CHEMICAL NOMENCLATURE

Ag	silver
As	arsenic
Ba	barium
Be	beryllium
C	carbon
Cd	cadmium
CdS	cadmium sulfide
CH_2O	formaldehyde
CH_3CHO	acetaldehyde
CH_3OH	methanol
CH_4	methane
C_2H_4O	ethylene oxide
C_2H_6	ethane
C_3H_4O	acrolein
C_3H_6O	propionaldehyde
C_3H_8	propane
C_6H_5OH	phenol
Cl_2	chlorine
ClO_2	chlorine dioxide
CO	carbon monoxide
Co	cobalt
CO_2	carbon dioxide
Cr	chromium
Cu	copper
EtO	ethylene oxide
EtOH	ethyl alcohol (ethanol)
H_2	hydrogen
H_2O	water
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
H_2SO_4	sulfuric acid
HCl	hydrogen chloride
Hg	mercury
IPA	isopropyl alcohol
MDI	methylene diphyenyl diisocyanate
$MeCl_2$	methylene chloride
MEK	methyl ethyl ketone
MeOH	methanol
Mn	manganese
N_2	nitrogen
NH_3	ammonia
Ni	nickel
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_2	oxygen
P	phosphorus
Pb	lead
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
Sb	antimony
Se	selenium
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SO_x	sulfur oxides
TCDD	tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzofuran
TGOC	total gaseous organic concentration
THC	total hydrocarbons
Tl	thallium
TRS	total reduced sulfur compounds
Zn	zinc

Appendix C.2
QA/QC Data

Date
5/17/2022

Time	O_2 (%)	NO_X (ppm)
Zero	0.01	1.59
High	20.21	1,999
Mid	10.12	906.6
7:58:42	0.01	883.5
7:58:57	0.03	887.1
7:59:12	-0.01	887.1
7:59:27	0.01	889.5
7:59:42	0.01	891.3
7:59:57	0.01	894.3
8:00:12	7.47	924.5
8:00:27	19.51	903.3
8:00:42	20.14	864.3
8:00:57	20.16	806.4
8:01:12	20.15	486.0
8:01:27	20.17	370.1
8:01:42	20.2	348.4
8:01:57	20.18	16.60
8:02:12	20.16	4.76
8:02:27	20.18	4.84
8:02:42	20.16	4.11
8:02:57	20.16	3.16
8:03:12	20.18	3.37
8:03:27	20.17	2.89
8:03:42	20.17	2.72
8:03:57	20.20	3.17
8:04:12	20.20	2.46
8:04:27	20.20	1.75
8:04:42	20.21	2.48
8:04:57	20.19	1.52
8:05:12	20.23	3.14
8:05:27	20.22	2.86
8:05:42	20.19	1.50
8:05:57	17.09	1.49
8:06:12	12.07	1.64
8:06:27	15.85	1.73
8:06:42	10.37	1.70
8:06:57	10.14	2.56
8:07:12	10.12	1.40
8:07:27	10.11	1.35
8:07:42	10.09	1.54
8:07:57	8.74	1.66
8:08:12	1.40	270.4
8:08:27	0.11	1010
8:08:42	0.11	1010
8:08:57	0.1	1979
8:09:12	0.12	2057
8:09:27	0.12	2087
8:09:42	0.13	2098
8:09:57	0.13	2101
8:10:12	0.13	2102
8:10:27	0.11	2100
8:10:42	0.11	2072
8:10:57	0.11	1988
8:11:12	0.09	1982
8:11:27	0.08	1980
8:11:42	0.07	1980
8:11:57	0.08	1986
8:12:12	0.07	1990
8:12:27	0.10	1995
8:12:42	1.61	2001
8:12:57	0.66	2000
8:13:12	0.06	1999
8:13:27	0.06	1913
8:13:42	0.08	1798
8:13:57	0.06	1297
8:14:12	0.04	926.4

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Zero	0.01	1.59
High	20.21	1,999
Mid	10.12	906.6
8:14:27	0.04	911.0
8:14:42	0.04	908.0
8:14:57	0.06	908.9
8:15:12	0.04	906.9
8:15:27	0.05	907.3
8:15:42	0.04	906.7
8:15:57	0.38	905.7
8:16:12	0.93	886.9

Date		
5/17/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Zero	0.11	5.3
High	10.04	895.4
Mid	NA	NA
Low	NA	NA
8:16:42	8.20	892.3
8:16:57	12.07	885.1
8:17:12	2.56	806.9
8:17:27	0.18	739.0
8:17:42	0.14	853.4
8:17:57	0.13	870.6
8:18:12	0.12	873.7
8:18:27	0.11	890.2
8:18:42	0.11	892.5
8:18:57	0.09	893.5
8:19:12	0.09	895.2
8:19:27	0.08	895.2
8:19:42	0.11	896.7
8:19:57	0.10	895.1
8:20:12	0.08	894.6
8:20:27	1.17	895.3
8:20:42	8.24	888.9
8:20:57	9.92	867.0
8:21:12	9.95	839.4
8:21:27	9.98	632.3
8:21:42	9.99	449.9
8:21:57	10.01	98.39
8:22:12	10.04	17.60
8:22:27	10.06	9.75
8:22:42	10.03	6.99
8:22:57	10.04	6.42
8:23:12	10.04	5.52
8:23:27	10.03	5.28
8:23:42	10.04	5.45
8:23:57	10.03	5.13
8:24:12	10.05	5.14

Date
5/19/2022

Time	NO_X (ppm)
Average	203.6
Minimum	202.1
Maximum	205.3
% Difference	1.57
15:01	205.12
15:02	205.01
15:03	204.53
15:04	205.13
15:05	204.70
15:06	204.81
15:07	205.26
15:08	204.94
15:09	204.59
15:10	204.53
15:11	203.17
15:12	203.28
15:13	204.10
15:14	203.31
15:15	203.15
15:16	204.07
15:17	204.39
15:18	202.56
15:19	202.48
15:20	202.07
15:21	202.13
15:22	203.16
15:23	202.59
15:24	203.16
15:25	202.24
15:26	202.79
15:27	202.67
15:28	202.26
15:29	202.45
15:30	202.32

Date
5/17/2022

Time	O_2 (%)	NO_X (ppm)
Zero	0.13	7.2
Upscale	10.03	881.6
11:09:34	10.02	10.02
11:09:49	10.03	8.44
11:10:04	10.03	7.60
11:10:19	10.03	7.98
11:10:34	10.03	7.99
11:10:49	10.03	8.02
11:11:04	10.03	7.20
11:11:19	10.24	7.91
11:11:34	14.08	7.22
11:11:49	6.34	6.66
11:12:04	0.39	145.9
11:12:19	0.18	428.6
11:12:34	0.18	573.9
11:12:49	0.16	863.9
11:13:04	0.16	872.2
11:13:19	0.14	880.3
11:13:34	0.12	881.1
11:13:49	0.13	882.4
11:14:04	0.12	882.7
11:14:19	0.11	880.2
11:14:34	0.10	877.5

Date
5/17/2022

Time	O_2 (%)	NO_X (ppm)
Zero	0.13	6.6
Upscale	10.03	880.0
12:42:26	10.01	9.97
12:42:41	10.02	8.06
12:42:56	10.06	9.53
12:43:11	10.03	6.84
12:43:26	10.03	6.72
12:43:41	10.03	6.40
12:43:56	10.03	6.62
12:44:11	10.03	6.33
12:44:26	10.04	6.88
12:44:41	10.11	6.22
12:44:56	10.09	5.00
12:45:11	1.69	228.2
12:45:26	0.23	422.8
12:45:41	0.19	795.8
12:45:56	0.17	853.3
12:46:11	0.15	856.7
12:46:26	0.13	874.7
12:46:41	0.13	878.3
12:46:56	0.13	879.4
12:47:11	0.13	881.4
12:47:26	0.12	881.7
12:47:41	0.10	877.5
12:47:56	0.14	879.3
12:48:11	0.12	878.2

Date
5/17/2022

Time	O_2 (%)	NO_X (ppm)
Zero	0.16	7.6
Upscale	10.04	874.9
14:15:29	10.02	7.52
14:15:44	10.02	7.49
14:15:59	10.05	7.98
14:16:14	10.06	7.77
14:16:29	10.06	7.26
14:16:44	10.06	6.27
14:16:59	10.08	7.43
14:17:14	10.97	6.65
14:17:29	4.83	5.71
14:17:44	0.31	228.9
14:17:59	0.22	424.6
14:18:14	0.20	655.0
14:18:29	0.18	856.9
14:18:44	0.17	868.4
14:18:59	0.16	871.9
14:19:14	0.15	872.9
14:19:29	0.16	874.9
14:19:44	0.13	875.4
14:19:59	0.12	875.6
14:20:14	0.14	873.6
14:20:29	0.13	870.6
14:20:44	0.13	870.3

Date
5/18/2022

Time	O_2 (%)	NO_X (ppm)
Zero	0.04	0.4
High	20.15	1,987.0
Mid	9.94	908.3
8:31:21	20.77	-1.22
8:31:36	20.73	-1.61
8:31:51	20.75	-0.55
8:32:06	20.74	-1.19
8:32:21	20.73	-1.42
8:32:36	20.77	0.53
8:32:51	20.47	0.30
8:33:06	14.65	-1.41
8:33:21	13.30	-0.64
8:33:36	13.53	-1.15
8:33:51	13.75	-0.88
8:34:06	14.11	-0.98
8:34:21	14.51	-1.51
8:34:36	14.87	-0.99
8:34:51	15.13	-1.16
8:35:06	15.23	-1.63
8:35:21	16.11	-1.24
8:35:36	20.49	-0.86
8:35:51	20.74	-0.56
8:36:06	20.73	-1.36
8:36:21	20.68	-0.51
8:36:36	20.52	-0.61
8:36:51	20.36	-1.87
8:37:06	20.24	-0.63
8:37:21	20.18	-0.6
8:37:36	20.20	-1.19
8:37:51	20.39	-1.19
8:38:06	21.23	-0.2
8:38:21	21.22	-1.2
8:38:36	21.22	-1.26
8:38:51	21.23	-0.75
8:39:06	21.22	-0.54
8:39:21	21.16	-0.52
8:39:36	21.07	-1.14
8:39:51	21.01	-1.21
8:40:06	20.94	-1.00
8:40:21	20.94	-0.11
8:40:36	20.93	-0.62
8:40:51	20.95	1.59
8:41:06	21.00	1.63
8:41:21	21.19	0.27
8:41:36	21.00	0.36
8:41:51	20.15	0.64
8:42:06	20.15	0.36
8:42:21	20.16	0.80
8:42:36	20.16	1.22
8:42:51	20.14	0.05
8:43:06	19.54	0.28
8:43:21	11.76	0.17
8:43:36	9.96	-0.08
8:43:51	9.96	0.33
8:44:06	9.95	1.00
8:44:21	9.93	0.25
8:44:36	9.92	0.02
8:44:51	10.09	0.65
8:45:06	11.41	0.62
8:45:21	0.92	0.09
8:45:36	-0.15	758.7
8:45:51	-0.14	1077
8:46:06	-0.16	1913
8:46:21	-0.15	1925
8:46:36	-0.17	1942
8:46:51	-0.19	1954

Date
5/18/2022

Time	O_2 (%)	NO_X (ppm)
Zero	0.04	0.4
High	20.15	1,987.0
Mid	9.94	908.3
8:47:06	-0.19	1960
8:47:21	-0.15	1966
8:47:36	-0.19	1965
8:47:51	-0.18	1964
8:48:06	-0.17	1958
8:48:21	-0.17	1956
8:48:36	-0.17	1956
8:48:51	-0.15	1956
8:49:06	-0.18	1956
8:49:21	-0.17	1957
8:49:36	-0.19	1958
8:49:51	-0.19	1989
8:50:06	-0.19	1989
8:50:21	-0.17	1987
8:50:36	-0.16	1985
8:50:51	-0.14	1986
8:51:06	-0.18	1987
8:51:21	-0.19	1987
8:51:36	-0.19	1988
8:51:51	-0.05	1991
8:52:06	0.09	2000
8:52:21	0.07	1997
8:52:36	0.06	1956
8:52:51	-0.08	1907
8:53:06	-0.23	1397
8:53:21	-0.24	924.1
8:53:36	-0.24	904.0
8:53:51	-0.22	900.5
8:54:06	-0.23	896.8
8:54:21	-0.24	895.1
8:54:36	-0.24	895.2
8:54:51	-0.22	896.1
8:55:06	-0.24	893.1
8:55:21	-0.24	891.3
8:55:36	-0.23	892.0
8:55:51	-0.23	891.9
8:56:06	-0.23	893.0
8:56:21	-0.24	898.0
8:56:36	-0.25	908.6
8:56:51	-0.23	908.5
8:57:06	-0.24	909.0
8:57:21	-0.24	908.0
8:57:36	-0.23	907.6
8:57:51	-0.24	908.1

Date		
5/18/2022		
Time	**O_2 (%)**	**NO_X (ppm)**
Zero	-0.19	6.0
High	9.94	908.6
Mid	NA	NA
Low	NA	NA
9:08:11	-0.19	912.0
9:08:26	-0.20	910.3
9:08:41	-0.18	910.3
9:08:56	-0.19	909.7
9:09:11	-0.18	908.5
9:09:26	-0.18	906.0
9:09:41	-0.20	905.5
9:09:56	-0.20	905.2
9:10:11	-0.09	906.1
9:10:26	8.66	905.1
9:10:41	12.59	902.0
9:10:56	9.73	880.4
9:11:11	9.81	742.7
9:11:26	9.82	743.3
9:11:41	9.84	465.0
9:11:56	9.93	356.2
9:12:11	10.05	96.16
9:12:26	10.06	11.37
9:12:41	9.95	7.71
9:12:56	9.93	7.00
9:13:11	9.93	5.87
9:13:26	9.94	6.37
9:13:41	9.93	5.75
9:13:56	9.93	5.83

Date
5/18/2022

Time	O_2 (%)	NO_X (ppm)
Zero	-0.16	6.7
Upscale	9.92	890.9
11:27:31	9.90	9.51
11:27:46	9.91	8.55
11:28:01	9.92	8.37
11:28:16	9.93	8.47
11:28:31	9.92	8.22
11:28:46	9.92	7.02
11:29:01	9.91	6.67
11:29:16	6.67	5.05
11:29:31	3.28	168.8
11:29:46	0.34	313.0
11:30:01	-0.10	399.4
11:30:16	-0.12	751.1
11:30:31	-0.14	777.4
11:30:46	-0.15	886.9
11:31:01	-0.15	889.8
11:31:16	-0.16	892.1
11:31:31	-0.18	890.8
11:31:46	-0.19	891.1

Date
5/18/2022

Time	O_2 (%)	NO_X (ppm)
Zero	-0.16	7.2
Upscale	9.91	884.9
12:44:07	9.89	11.38
12:44:22	9.90	9.99
12:44:37	9.91	8.79
12:44:52	9.93	8.26
12:45:07	9.91	6.74
12:45:22	9.93	7.38
12:45:37	9.91	6.57
12:45:52	9.94	9.11
12:46:07	8.09	6.28
12:46:22	2.99	231.4
12:46:37	-0.01	363.4
12:46:52	-0.11	682.0
12:47:07	-0.13	733.6
12:47:22	-0.13	879.8
12:47:37	-0.15	882.9
12:47:52	-0.15	886.3
12:48:07	-0.17	886.5
12:48:22	-0.15	884.0
12:48:37	-0.16	874.3
12:48:52	-0.15	876.9

Date
5/18/2022

Time	O_2 (%)	NO_x (ppm)
Zero	-0.16	6.8
Upscale	9.90	880.1
14:10:56	9.9	8.67
14:11:11	9.89	7.87
14:11:26	9.91	7.51
14:11:41	9.9	6.71
14:11:56	9.92	6.6
14:12:11	9.92	7.02
14:12:26	9.93	6.95
14:12:41	9.93	7.19
14:12:56	9.52	5.55
14:13:11	3.83	87.6
14:13:26	0.05	420.02
14:13:41	-0.13	648.77
14:13:56	-0.14	850.27
14:14:11	-0.15	862.49
14:14:26	-0.15	878.28
14:14:41	-0.15	879.71
14:14:56	-0.16	880.65
14:15:11	-0.15	881.69
14:15:26	-0.16	872.82
14:15:41	-0.18	867.15

Date: 10-18-2017 Name: David Wagner
Analyzer: Type / Model: Viasala CO2/O2 Cells, Teledyne T100, T200, T300

Method Referenced: EPA Method 7E

O2 Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response ppmv	Interference % of Span (21.46 %)
SO_2	27.46	-0.01	0.046
CO_2	5.02	0.02	0.093
NOx	125.5	0.02	0.093
CO	126.5	0.02	0.093
Ch4	301.3	-0.01	0.046

A Calibration Cylinder containing 21.46 % O2 was used to Span Analyzer

Results:

Test Gas	Sum of Absolute Differences	Sum of Individual Gases Percent Interferences	Max Allowable Percent of Span Interference (%)
O2	0.08	0.371	2.5

CO2 Results:

Test Gas	Concentration, ppmv or %	Analyzer Output Response %	Interference % of Span (18.01%)
SO_2	27.02	-0.001	.006
O_2	21.05	-0.003	.017
CO	124.7	0.290	1.6
NO	47.89	0.000	0.000
NO2	50.08	-0.001	0.006
Ch4	50.66	-0.001	0.006

A Calibration Cylinder containing 18.01% Carbon Dioxide was used to Span Analyzer

Results:

Test Gas	Sum of Absolute Differences %	Sum of Individual Gases % Interferences	Max Allowable Percent of Span Interference (%)
CO2	0.296	1.635	2.5

*data collected from S:\Portland\Company\Calibrations\Analyzers\Interference Response Checks/CO CO2 Interference Check Teledyne T300M

ThermoFisher
SCIENTIFIC

Thermo Scientific Model 42 NO-NO_2-NO_x Analyzer Potential Interference Gas Responses

Potential Interferent		*Model 42iLS*			*Model 42iHL*		
Test Gas	*Concentration*	*NO*	*NO_2*	*NO_x*	*NO*	*NO_2*	*NO_x*
CO_2	5.20%	0.001	0.004	0.004	0.001	0.003	0.004
CO_2	15.60%	0	0.003	0.003	0.001	0.004	0.005
H_2O	1.00%	0	0	0	0.003	0.001	0.004
NO	15 ppm	14.9	0.1	15	15	-0.06	14.99
NO_2	15 ppm	1.1	14	15	0.4	14.6	15
N_2O	10 ppm	0	0	0	0	0	0
CO	50 ppm	0	0	0	0	0	0
SO_2	21 ppm	-0.01	0	-0.01	0.007	0	0.007
CH_4	50 ppm	0	0	0	0	0	0
HCl	10 ppm	0	0.006	0.006	0	0.004	0.004
NH_3[1]	10 ppm	0	0	0	0.17	8.9	9.1
Sum of Responses		**0.011**	**0.01**	**0.02**	**0.011**	**0.009**	**0.02**
Span Value		**160**	**152**	**160**	**160**	**152**	**160**
% of Calibration Span		**0.01%**	**0.01%**	**0.01%**	**0.01%**	**0.01%**	**0.01%**

Acceptance Criteria found in Section 13.4 of Method 7E is the sum of responses must not be greater than 2.5% of the analyzer calibration span value.

[1]NH_3 interferent results shown for the Model 42iHL was not used in calculation of interference response check because it is a known interferent with an approximate 1 ppm to 1 ppm positive bias in analyzers using stainless steel NO_2 to NO converters. Thermo recommends that NO_x analyzers with stainless steel NO_2 to NO converters must use a NH_3 scrubber when testing sources with potential NH_3 in the flue gas.

This document is subject to change without notice.

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

Part Number:	E03NI75E15A1104	Reference Number:	54-401455479-1
Cylinder Number:	CC720472	Cylinder Volume:	148.9 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12019	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Mar 29, 2019

Expiration Date: Mar 29, 2027

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 volume/volume 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
CARBON DIOXIDE	5.000 %	4.982 %	G1	+/- 0.5% NIST Traceable	03/29/2019
OXYGEN	20.00 %	20.12 %	G1	+/- 0.4% NIST Traceable	03/29/2019
NITROGEN	Balance			-	

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	10060136	CC308178	5.027 % CARBON DIOXIDE/NITROGEN	+/- 0.4%	Dec 02, 2021
NTRM	15010420	K027067	22.454 % OXYGEN/NITROGEN	+/- 0.2%	Aug 05, 2021

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
CO2-1 HORIBA VIA-510 V1E3H7P5	NDIR	Mar 26, 2019
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Mar 23, 2019

Triad Data Available Upon Request

Signature on file
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:	E03NI80E15A0138	Reference Number:	54-402217719-1
Cylinder Number:	CC161601	Cylinder Volume:	150.9 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12021	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Sep 13, 2021

Expiration Date: Sep 13, 2029

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
CARBON DIOXIDE	10.00 %	9.922 %	G1	+/- 0.7% NIST Traceable	09/13/2021
OXYGEN	10.00 %	10.02 %	G1	+/- 0.8% NIST Traceable	09/13/2021
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	08010601	K002531	13.94 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	Jan 30, 2024
NTRM	98051012	SG9159596BAL	12.05 % OXYGEN/NITROGEN	+/- 0.7%	Dec 14, 2023

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
CO2-1 HORIBA VIA-510 V1E3H7P5	NDIR	Aug 20, 2021
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Aug 27, 2021

Triad Data Available Upon Request

Signature on file

Approved for Release

Airgas
an Air Liquide company

Airgas USA, LLC
1290 Combermere Dr.
Troy, MI 48083
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Customer:	BT ENVIRONMENTAL CONSULTING		
Part Number:	E02NI99E15A0124	Reference Number:	32-401502188-1
Cylinder Number:	CC284861	Cylinder Volume:	144.4 CF
Laboratory:	112 - Troy-32 (SAP) - MI	Cylinder Pressure:	2015 PSIG
PGVP Number:	B62019	Valve Outlet:	660
Gas Code:	NO,NOX,BALN	Certification Date:	May 29, 2019

Expiration Date: May 29, 2027

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 volume/volume 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	2000 PPM	1987 PPM	G1	+/- 0.7% NIST Traceable	05/21/2019, 05/29/2019
NITRIC OXIDE	2000 PPM	1982 PPM	G1	+/- 0.6% NIST Traceable	05/21/2019, 05/29/2019
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09010125	KAL003328	2954 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	Oct 05, 2021
PRM	C1305910.02	D562881	30.0 PPM NITROGEN DIOXIDE/NITROGEN	+/-2.0%	Sep 04, 2018
GMIS	7292017110	CC511376	29.97 PPM NITROGEN DIOXIDE/NITROGEN	+/-2.0%	Mar 06, 2021

The SRM, 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
E/N 54 Nicolet 6700 NO	FTIR	May 15, 2019
E/N 54 Nicolet 6700 NO2	FTIR	May 21, 2019

Triad Data Available Upon Request

Approved for Release

Airgas

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E02NI99E15A0907	Reference Number:	54-401419735-1
Cylinder Number:	SG9161420BAL	Cylinder Volume:	144.4 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12019	Valve Outlet:	660
Gas Code:	NO,NOX,BALN	Certification Date:	Feb 19, 2019

Expiration Date: Feb 19, 2027

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	900.0 PPM	908.4 PPM	G1	+/- 0.7% NIST Traceable	02/12/2019, 02/19/2019
NITRIC OXIDE	900.0 PPM	907.6 PPM	G1	+/- 0.7% NIST Traceable	02/12/2019, 02/19/2019
NITROGEN	Balance			-	

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	08011705	KAL003776	970.9 PPM NITRIC OXIDE/NITROGEN	+/- 0.6%	Apr 16, 2024
PRM	12367	APEX1099237	10.0 PPM NITROGEN DIOXIDE/AIR	+/- 1.5%	Jun 02, 2017
GMIS	1114201605	CC506716	4.995 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Nov 14, 2019

The SRM, 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 6700 AHR0801332	FTIR	Jan 28, 2019
Nicolet 6700 AHR0801332	FTIR	Jan 28, 2019

Triad Data Available Upon Request

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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

Part Number:	E02NI99E15A0919	Reference Number:	54-401913314-1A
Cylinder Number:	CC416694	Cylinder Volume:	144.4 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12020	Valve Outlet:	660
Gas Code:	NO,NOX,BALN	Certification Date:	Oct 08, 2020

Expiration Date: Oct 08, 2028

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	500.0 PPM	509.9 PPM	G1	+/- 0.7% NIST Traceable	10/01/2020, 10/08/2020
NITRIC OXIDE	500.0 PPM	509.9 PPM	G1	+/- 0.7% NIST Traceable	10/01/2020, 10/08/2020
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	15010122	KAL003982	494.6 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	Sep 01, 2021
PRM	12386	D685025	9.91 PPM NITROGEN DIOXIDE/AIR	+/- 2.0%	Feb 20, 2020
GMIS	401438583103	EB0120479	3.882 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.1%	Feb 18, 2023

The SRM, 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 6700 AHR0801332	FTIR	Sep 10, 2020
Nicolet 6700 AHR0801332	FTIR	Sep 10, 2020

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Appendix C.3
Accreditation Information/Certifications

STAC
STACK TESTING ACCREDITATION COUNCIL

A2LA
American Association for Laboratory Accreditation

Accredited Air Emission Testing Body

A2LA has accredited

MONTROSE AIR QUALITY SERVICES

In recognition of the successful completion of the joint A2LA and Stack Testing Accreditation Council (STAC) evaluation process, this laboratory is accredited to perform testing activities in compliance with ASTM D7036:2004 - Standard Practice for Competence of Air Emission Testing Bodies.

Presented this 4th day of February 2022.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3925.01
Valid to February 29, 2024

This accreditation program is not included under the A2LA ILAC Mutual Recognition Arrangement.

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

MICHAEL D. HESS

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS

ISSUED THIS 11TH DAY OF AUGUST 2017 AND EFFECTIVE UNTIL AUGUST 10TH, 2022

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2012-632

SOURCE EVALUATION SOCIETY

Qualified Source Testing Observer

LET IT BE KNOWN THAT

HENRY M. TAYLOR

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 7TH DAY OF JANUARY 2020 AND EFFECTIVE UNTIL JANUARY 6TH, 2025

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Tina Sanderson, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2015-872

SOURCE EVALUATION SOCIETY

Qualified Source Testing Observer

LET IT BE KNOWN THAT

HENRY M. TAYLOR

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GASEOUS POLLUTANTS SOURCE SAMPLING METHODS

ISSUED THIS 28TH DAY OF JANUARY 2020 AND EFFECTIVE UNTIL JANUARY 27TH, 2025

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Tina Sanderson, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2015-872

THIS IS THE LAST PAGE OF THIS DOCUMENT

If you have any questions, please contact one of the following individuals by email or phone.

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Title: Midwest District Manager
Region: Midwest
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