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**RTO AND SAND SYSTEM FLOW RATE AND HEXANE  
RELATIVE ACCURACY TEST AUDITS**

**BREMBO NORTH AMERICA, INC.  
HOMER, MICHIGAN**

***MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES & ENERGY  
PERMIT NUMBER 199-14D***

***RATAS COMPLETED OCTOBER 4 AND 5, 2023***



*Optimal Report Number RPT 23BR-A*

**2023 RATA REPORT  
BREMBO NORTH AMERICA, INC.  
HOMER, MICHIGAN**

**Testing Conducted October 4 and 5, 2023  
Optimal RPT 23BR-A**

This report was prepared by Optimal Air Testing Services, Inc. (Optimal) and contains the results of testing that was conducted on the Sand System and the RTO continuous emission monitors (CEMs) at the Brembo North America, Inc. facility near Homer, Michigan on October 4 and 5, 2023.

We certify that we have examined the information contained in this report and believe the results presented are true, accurate, and complete. The undersigned do so attest as certificate that the results herein have been reviewed for the authenticity and accuracy of the testing details and results, to the best of our knowledge, uphold standards of quality assurance. Any questions concerning this report should be directed to the undersigned.

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**FACILITY INFORMATION**

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**Facility Address:** 29991 M-60 | East Homer, Michigan, 49256 - Calhoun County

**Facility Contact:** Dr. Harsha Madiraju, Environmental and Energy Engineer, 517.568.4398 x5307, smadiraju@us.brembo.com

**EPA Facility Registry Service Number (FRS):** [110000783082](#)

**Facility ID:** N6226

**Standard Industrial Code (SIC):** 3714

**North American Industry Classification System (NAICS):** 336340

This facility operated in accordance with Michigan Department of Environment, Great Lakes & Energy (EGLE) Permit Number 199-14D.

<u>Source</u>	<u>Source ID</u>
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Sand System	SVSSBH
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RTO	SVRTO1
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RATA Parameters

Standard Flow Rate, kdscfm  
Volatile Organic Compounds (VOC)  
as Hexane (C<sub>6</sub>H<sub>14</sub>), ppm  
Standard Flow Rate, kdscfm  
Volatile Organic Compounds (VOC)  
as Hexane (C<sub>6</sub>H<sub>14</sub>), ppm

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**TESTER INFORMATION**

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## 1. Executive Summary

### 1.1 Introduction

Brembo North America, Inc. (“Brembo”) contracted Optimal Air Testing Services, Inc. (“Optimal” or “OATS”) to conduct audits at the Brembo North America, Inc. facility near Homer, Michigan. The objective of the audit program was to accurately calculate Relative Accuracy (RA) of the Continuous Emission/Rate Monitoring Systems (CEMS/CRMS) by performing Relative Accuracy Test Audits (RATA). The measured constituents were Standard Flow Rate and Volatile Organic Compounds (VOCs) as Total Hydrocarbons (THC) as Hexane (C<sub>6</sub>H<sub>14</sub>).

Coordinating the field portion of the test program were Harsha Madiraju, PhD of Brembo and Daniel Klassen of Optimal. No representative from the Michigan Department of Environment, Great Lakes & Energy (EGLE) was present during the testing.

### 1.2 Summary of Test Program

The test program conducted followed the procedures prescribed in Title 40 of the Code of Federal Regulations Part 60 (40CFR60) Appendix A, 40CFR60 Appendix B, 40CFR51 Appendix M, and 40CFR63 Subpart EEEEE. Optimal conducted the following testing:

Parameters	Test Method
Test Sample Points	40CFR60 Appendix A Method 1
Stack Gas Velocity	40CFR60 Appendix A Method 2
Oxygen and Carbon Dioxide	40CFR60 Appendix A Method 3A
Gas Moisture Content	40CFR60 Appendix A Method 4
Gaseous Organic Concentration (FID)	40CFR60 Appendix A Method 25A
Flow Rate RATA	Performance Specification 6
Volatile Organic Compounds RATA	Performance Specification 8

These parameters were measured from the Sand System (SVSSBH) and Regenerative Thermal Oxidizer, or RTO (SVRTO1) sampling ports on October 4 and 5, 2023. The complete description of the Test Program is provided in Section 2.

Sampling was conducted while the unit was operating above 50% of the maximum permitted operating rates. The methodologies utilized during this testing program are found under Section 2.1. Comments concerning the results of this testing program and any deviations utilized are found under Section 2.2 of this report. A summary of the results are found in Section 1.3; within Section 3 are detailed tables outlining the testing results and parameters. Appendices are listed under Section 4.

Appendix A contains website hyperlinks to Methodologies utilized in this testing program. Appendix B contains examples of calculations utilized within this report. Appendix C contains process data relevant to the testing program. Appendix D contains reference method test data entry and raw data collected during this test program. Appendix E contains calibrations of equipment and equipment certifications relevant to this report. Appendix F contains quality control data maintained during the testing program.

### 1.3 Facility and Source Description

Brembo operates a automobile brake manufacturing facility in Homer, Michigan under EGLE Permit Number 199-14D.

Both the Sand System and RTO are monitored by Total Hydrocarbon FIDs calibrated to hexane and flow rate monitors. Gas samples are continuously extracted from the stacks and delivered to the FIDs which continuously measure hexane concentrations and are calibrated daily using certified mixtures of hexane calibration gases. Flow rate on both sources is monitored with pitot tubes and pressure transducers. Details regarding the CEMS analytical instrumentation can be seen in the table below:

<b>Sand System</b>				
<b>Constituent</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Serial Number</b>	<b>Principle</b>
Hexane	CAI	700	2104041	FID
Flow Rate	MonSol	CEMFLOW	061521-3-1132	Pressure Differential (Pitot)
<b>RTO</b>				
<b>Constituent</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Serial Number</b>	<b>Principle</b>
Hexane	CAI	700	2104032	FID
Flow Rate	MonSol	CEMFLOW	61521-3-1133	Pressure Differential (Pitot)

#### 1.4 Summary of Results

The following summarizes the pertinent results of the testing.

<b>Constituent</b>	<b>Units</b>	<b>Relative Accuracy</b>	
		<u>Basis - Reference Method (limit)</u>	<u>Basis - Applicable Std. or Difference of Mean Values (limit)</u>
<b>Sand System</b>			
Flow Rate	kdscfm	12.08% (limit - 20%)	5.02% (limit - 10%)
Total Hydrocarbons	ppm wet		
<b>RTO</b>			
Flow Rate	kdscfm	7.20% (limit - 20%)	6.91% (limit - 10%)
Total Hydrocarbons	ppm wet		

Detailed results are provided in Section 3. Data and calculations to support these results are shown in the Appendices.

**2. Reference Method Test Program Description**

**2.1 Test Method Description**

**2.1.1 Determination of Stack Sampling Points**

40CFR60 Appendix A, Method 1 was used to determine sample points for traverses measuring velocity head and temperature.

Velocity and temperature sampling points were based on upstream and downstream distances from flow disturbances and the stack diameter according to Figure 1-1 as presented in Section 4.2 of this report.

Description	RTO	Sand System
Number of Ports	2	2
Port Length, inches	4.25	4.25
Stack Diameter, inches	75.6875	95.375
Diameters from ports to stack exit (A)	2.39	3.77
Distance from ports to stack exit (A), inches	181	360
Diameters from ports to upstream disturbance (B)	4.78	6.29
Distance from ports to upstream disturbance (B), inches	362	600
Total number of sampling points	16	12
Number of sampling points per port (see location below)	8	6
Area, ft <sup>2</sup>	31.245	49.613
<b>Sampling Points, Distance from wall</b>		
Traverse Point 1, inches	2 <sup>7</sup> / <sub>16</sub>	4 <sup>3</sup> / <sub>16</sub>
Traverse Point 2, inches	7 <sup>15</sup> / <sub>16</sub>	13 <sup>15</sup> / <sub>16</sub>
Traverse Point 3, inches	14 <sup>11</sup> / <sub>16</sub>	28 <sup>1</sup> / <sub>4</sub>
Traverse Point 4, inches	24 <sup>7</sup> / <sub>16</sub>	67 <sup>1</sup> / <sub>8</sub>
Traverse Point 5, inches	51 <sup>1</sup> / <sub>4</sub>	81 <sup>7</sup> / <sub>16</sub>
Traverse Point 6, inches	61	91 <sup>3</sup> / <sub>16</sub>
Traverse Point 7, inches	67 <sup>3</sup> / <sub>4</sub>	
Traverse Point 8, inches	73 <sup>1</sup> / <sub>4</sub>	

**2.1.2 Determination of Stack Gas Velocity**

40CFR60 Appendix A, Method 2 procedures were followed to calculate stack gas velocity during each run.

The velocity and temperature sampling apparatus consisted of calibrated Stausscheibe (Type S) stainless steel pitot tube and a thermocouple to measure gas temperature. Velocity apparatus were checked for leaks before and after each test run. The thermocouples were verified in field following the testing by following the procedures in Method 2 Section 10.3 or ALT-011.

### 2.1.3 Determination of Diluents and Molecular Weights

40CFR60 Appendix A, Method 3A procedures were followed to calculate molecular weight during each run.

Instrumental Reference Method procedures for determination of oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) concentrations were conducted utilizing a common sample apparatus. Gas samples were extracted from the sources at a constant rate through a probe, filter, and sampling system at stack temperatures or heated to 250 °F until introduction to a gas conditioning system for removal of moisture. The particulate free and dry gas samples were then introduced to the analyzers.

The following gas analyzers were used for sample analysis:

Constituent	Manufacturer	Model	Measurement Principle
Oxygen	Horiba	PG-350	Paramagnetic
Carbon Dioxide	Horiba	PG-350	Infrared

The Calibration Error Test, or 3-point analyzer calibration error test, was performed by introducing the zero and high level gases, and making adjustments, in Direct Calibration Mode, the mid level gas was then introduced, without making adjustments, to verify linearity. The values achieved were validated by the Analyzer Calibration Error, maintaining within two percent of the Calibration Span.

System Bias Checks were performed during the testing program to determine analyzer bias and drift. The check is performed after every run, or after up to three runs during RATA testing. The analyzer biases (pre and post run) were less than the allowable five percent difference from the direct calibration values and the analyzer drift was less than the allowable three percent from the pre-run calibration value for all runs. The pre/post-run bias check values were used to calculate bias corrected numbers from the recorded data average for analyzer bias and drift. EPA Traceability Protocol 1 calibration gases with known concentrations were used for all calibrations.

A data acquisition system (DAS) was used to continuously record all gas concentrations and integrate these values into minute intervals/averages. These results were transferred to a spreadsheet where average values corrected for calibration responses are reported.

### 2.1.4 Determination of Moisture Content

40CFR60 Appendix A, Method 4 procedures were followed to assemble the sampling equipment and to calculate moisture content during each run.

A sample of the stack gas was drawn into impingers immersed in an ice bath to cool the gas below 68°F, which condensed the moisture collected into the impingers. The total weight gain of the impingers (condensate) and the measured volume of the gas drawn through the impingers was used to calculate moisture concentration.

### 2.1.5 Determination of Volumetric Flow Rate

Data collected from Methods 1-4 was used to determine the Volumetric Flow Rate.

### 2.1.6 Determination of Volatile Organic Compounds Concentrations

Gaseous concentrations of volatile organic compounds were measured following procedures listed in 40CFR60 Method 25A using Instrument Analyzer Methodology.

The gas samples were extracted from the sources at a constant rate, through a stainless-steel heated probe and a heated glass fiber filter. Upon leaving the filter, the gas sample passed through a Teflon sample line heated to above 250°F. A particulate free, wet gas sample was introduced directly into the analyzer. The continuous gas analyzer used for sample analysis consisted of the following:

Constituent	Manufacturer	Model	Measurement Principle
Total Hydrocarbons (as Hexane)	CAI	MH700	FID

A Calibration Error Check to show analyzer linearity was performed prior to the series of tests. The zero and high-range calibration gases were introduced to the analyzer at the calibration valve. The analyzer was adjusted to the appropriate values. The mid-range and low-range gases were then introduced into the analyzer at the calibration valve with no adjustments made. The measured values for each calibration gas were less than five percent of calibration gas values.

Drift Determination was performed during the testing program to determine analyzer bias and drift. After each testing period, the analyzer was checked for drift and bias. The three percent drift error, five percent bias error, and bias correction procedures from Method 7E were utilized. A certified calibration gas was used for all calibrations.

A data acquisition system (DAS) was used to record all gas concentrations and integrate these values into minute intervals/averages. These results were transferred to a computer program where average values corrected for calibration responses are reported.

### 2.1.7 Verification of Gas Dilution System

40CFR51 Appendix M, Method 205 procedures were followed to verify the gas dilution system during the testing project. Protocol gases were blended with a certified and calibrated mass flow gas divider to arrive at the desired calibration concentrations for analyzer calibrations and quality assurance checks.

Manufacturer	Model	Serial	Principle
EnviroNics	4040	8864	Mass Flow Controllers

An EnviroNics Model 4040 gas divider with three mass flow controllers was used to blend nitrogen (N<sub>2</sub>) and protocol gas mixtures for the desired calibration gas concentrations. The mass flow controllers in the gas divider were calibrated prior to testing, and the gas divider operation on-site was verified with the oxygen (O<sub>2</sub>) analyzer and an independent protocol O<sub>2</sub> calibration gas.

The on-site verification was performed by entering two target concentrations into the gas divider software. A high range protocol O<sub>2</sub> gas and the zero N<sub>2</sub> gas were blended with the mass flow controllers to meet the target concentrations introduced to the O<sub>2</sub> analyzer one at a time. Analyzer response was verified by introducing a mid-level calibration gas directly into the analyzer. This process was repeated in triplicate. All analyzer responses for the target concentrations and the verification gas did not deviate more than two percent from the predicted concentrations or more than two percent from the average instrument response for each concentration.

## 2.2 Deviations from Published Test Methods and Testing Comments

No deviations from standard EPA air sampling methodologies were utilized during this testing program. The procedures outlined in the testing protocol were adhered to during this testing program.

### ***Sand System Comments***

A total of twelve Method 25A Runs and twelve Method 2 Traverses were completed on the Sand System. A total of four Method 4 moisture Runs were completed, with each run encompassing three Method 25A Runs and three Method 2 traverses. Quality Assurance requirements were met during the testing program.

### ***RTO Comments***

A total of twelve Method 25A Runs and twelve Method 2 Traverses were completed on the RTO. A total of 4 Method 4 Runs were completed, with each run encompassing three Method 25A Runs and three Method 2 Traverses. *Rain during the test program caused electrical issues inside the moisture meter, forcing the meter to be switched after the second moisture (6<sup>th</sup> RATA) run.* Quality Assurance requirements were met during the testing program.

## 2.3 Calculation of Relative Accuracy (RA)

40CFR60 Performance Specifications 6 and 8 procedures were followed to determine relative accuracy (RA) of the CERMS and CEMS systems. All RA's were calculated using the mean value of the reference method data from nine sets of data (runs).

The RM DAS was set to record on eastern standard time. The CEMS recording time deviated by 60 minutes from eastern daylight time. This difference was calculated before testing was started and was accounted for when retrieving all data for comparison.

**3. Test Results**

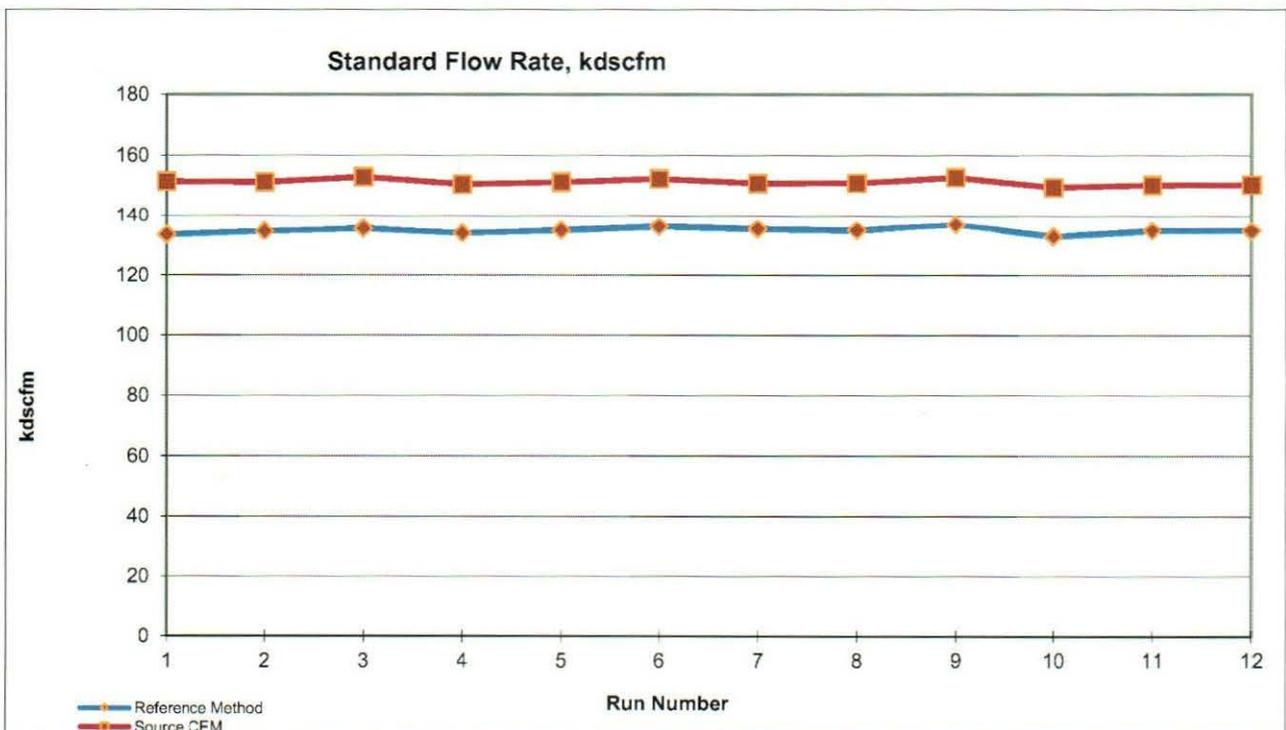
**3.1 Sand System Results**

**3.1.1 Standard Flow Rate**

*Kilo Dry Standard Cubic Feet Per Minute (kdscfm)*

Standard Flow Rate, kdscfm			
Relative Accuracy:	12.08	Mean of Difference:	15.91
Confidence Coeff. (CC):	0.38	Mean of Reference Method:	134.89
Standard Deviation:	0.51	Mean of CEMS Values:	150.80
T-Factor:	2.306		

Run	Flag	Initial Minute	Stop Time	Reference Method	Source CEM	Diff.	Standard Deviation	Confid. Coeff.	Relative Accuracy
1		07:25:14	7:46	133.59	151.40	NA			
2	✓	07:46:14	8:07	134.70	151.20	-16.50	NC	NC	NC
3		08:15:14	8:36	135.60	152.90	NA	NA	NA	NA
4	✓	09:43:14	10:04	134.08	150.50	-16.42	0.06	0.09	12.32
5	✓	10:04:14	10:25	135.05	151.20	-16.15	0.19	0.24	12.33
6		10:25:14	10:46	136.34	152.30	NA	NA	NA	NA
7	✓	11:03:14	11:24	135.55	150.80	-15.25	0.57	0.64	12.40
8	✓	12:07:14	12:28	134.98	150.90	-15.92	0.50	0.50	12.27
9	✓	12:28:14	12:49	137.02	152.70	-15.68	0.47	0.43	12.14
10	✓	13:19:14	13:40	132.89	149.40	-16.51	0.48	0.40	12.21
11	✓	13:40:14	14:01	134.87	150.20	-15.33	0.51	0.40	12.14
12	✓	14:01:14	14:22	134.86	150.30	-15.44	0.51	0.38	12.08

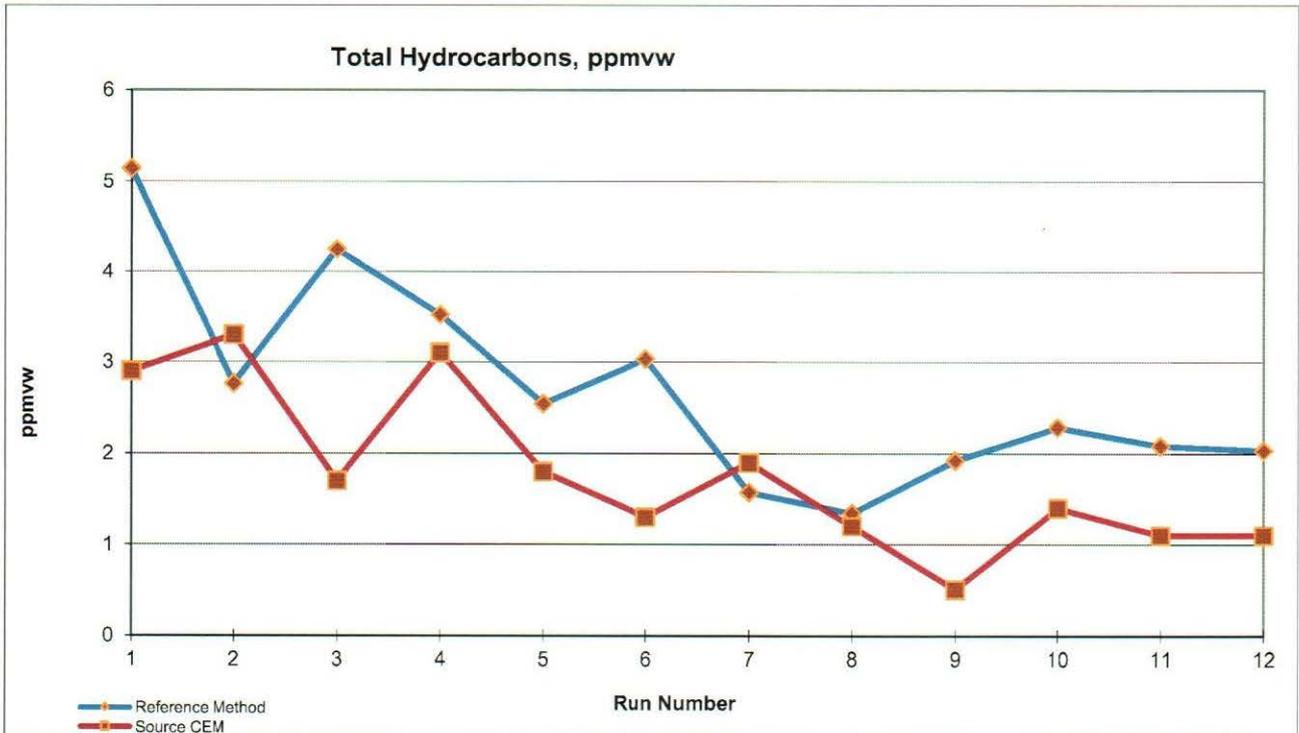


### 3.1.2 Volatile Organic Compounds

#### Hexane as Parts Per Million, volume wet (C<sub>6</sub>H<sub>14</sub> as ppm<sub>vw</sub>)

Total Hydrocarbons, ppmvw			
Relative Accuracy:	45.00	Mean of Difference:	0.52
RA - Appl. Standard:	5.02	Applicable Standard:	20.00
Confidence Coeff. (CC):	0.48	Mean of Reference Method:	2.23
Standard Deviation:	0.65	Mean of CEMS Values:	1.71
T-Factor:	2.306		

Run	Flag	Initial Minute	Stop Time	Reference Method	Source CEM	Diff.	Standard Deviation	Confid. Coeff.	Relative Accuracy
1		07:25:14	7:46	5.14	2.90	NA			
2	✓	07:46:14	8:07	2.76	3.30	-0.54	NC	NC	NC
3		08:15:14	8:36	4.25	1.70	NA	NA	NA	NA
4	✓	09:43:14	10:04	3.52	3.10	0.42	0.68	1.07	36.02
5	✓	10:04:14	10:25	2.54	1.80	0.74	0.67	0.86	36.34
6		10:25:14	10:46	3.03	1.30	NA	NA	NA	NA
7	✓	11:03:14	11:24	1.58	1.90	-0.33	0.60	0.68	28.96
8	✓	12:07:14	12:28	1.35	1.20	0.15	0.52	0.53	26.18
9	✓	12:28:14	12:49	1.92	0.50	1.42	0.72	0.66	42.55
10	✓	13:19:14	13:40	2.29	1.40	0.89	0.69	0.59	42.95
11	✓	13:40:14	14:01	2.08	1.10	0.98	0.67	0.53	44.37
12	✓	14:01:14	14:22	2.03	1.10	0.93	0.65	0.48	45.00



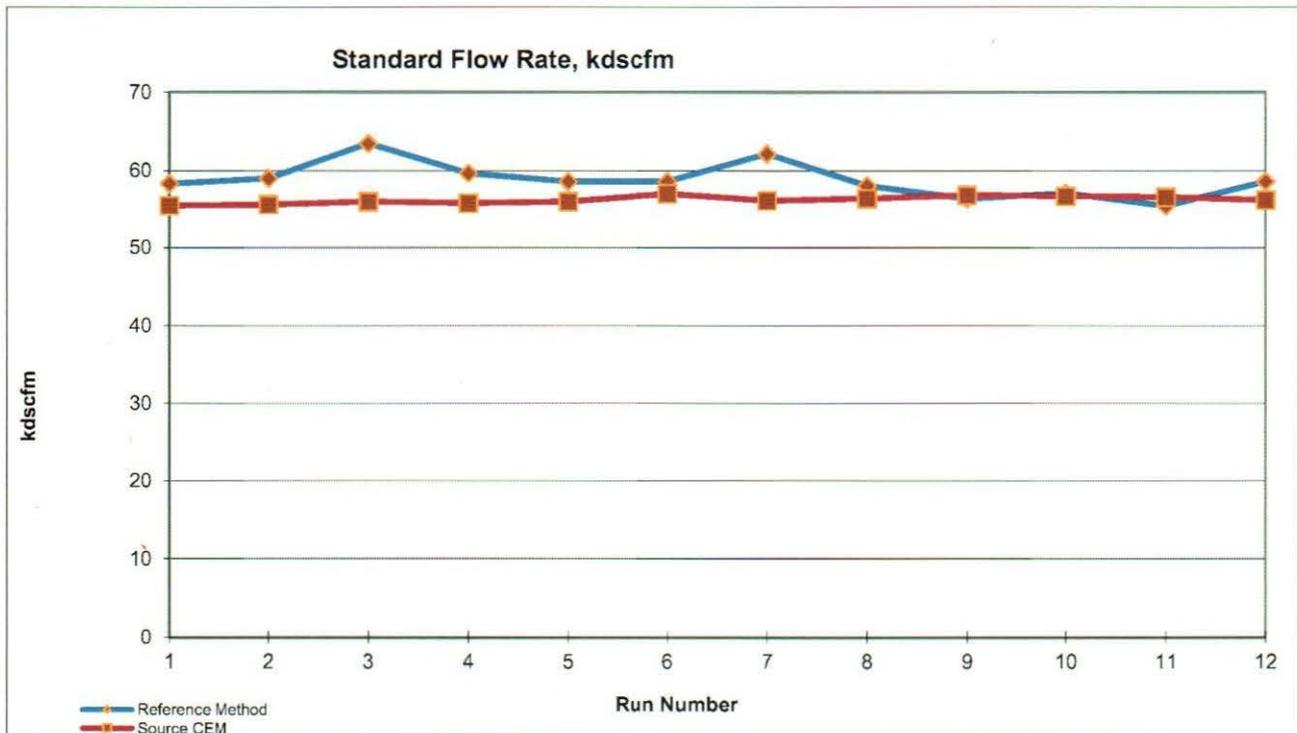
**3.2 RTO Results**

**3.2.1 Standard Flow Rate**

*Kilo Dry Standard Cubic Feet Per Minute (kdscfm)*

Standard Flow Rate, kdscfm			
Relative Accuracy:	7.20	Mean of Difference:	2.53
Confidence Coeff. (CC):	1.71	Mean of Reference Method:	58.81
Standard Deviation:	2.29	Mean of CEMS Values:	56.28
T-Factor:	2.306		

Run	Flag	Initial Minute	Stop Time	Reference Method	Source CEM	Diff.	Standard Deviation	Confid. Coeff.	Relative Accuracy
1		07:31:44	7:52	58.28	55.50	NA			
2	✓	07:52:44	8:13	58.97	55.60	3.37	NC	NC	NC
3	✓	08:13:44	8:34	63.47	56.00	7.47	2.90	4.60	16.36
4	✓	09:15:44	9:36	59.62	55.80	3.82	2.25	2.91	12.84
5	✓	09:36:44	9:57	58.56	56.00	2.56	2.17	2.44	11.20
6	✓	11:04:44	11:25	58.57	57.00	1.57	2.24	2.25	10.04
7		12:06:44	12:27	62.14	56.10	NA	NA	NA	NA
8	✓	12:27:44	12:48	58.04	56.40	1.64	2.18	2.00	9.08
9	✓	12:48:44	13:09	56.39	56.80	-0.41	2.46	2.09	8.37
10	✓	13:32:44	13:53	57.08	56.70	0.38	2.44	1.94	7.62
11		13:53:44	14:14	55.46	56.60	NA	NA	NA	NA
12	✓	14:14:44	14:35	58.57	56.20	2.37	2.29	1.71	7.20

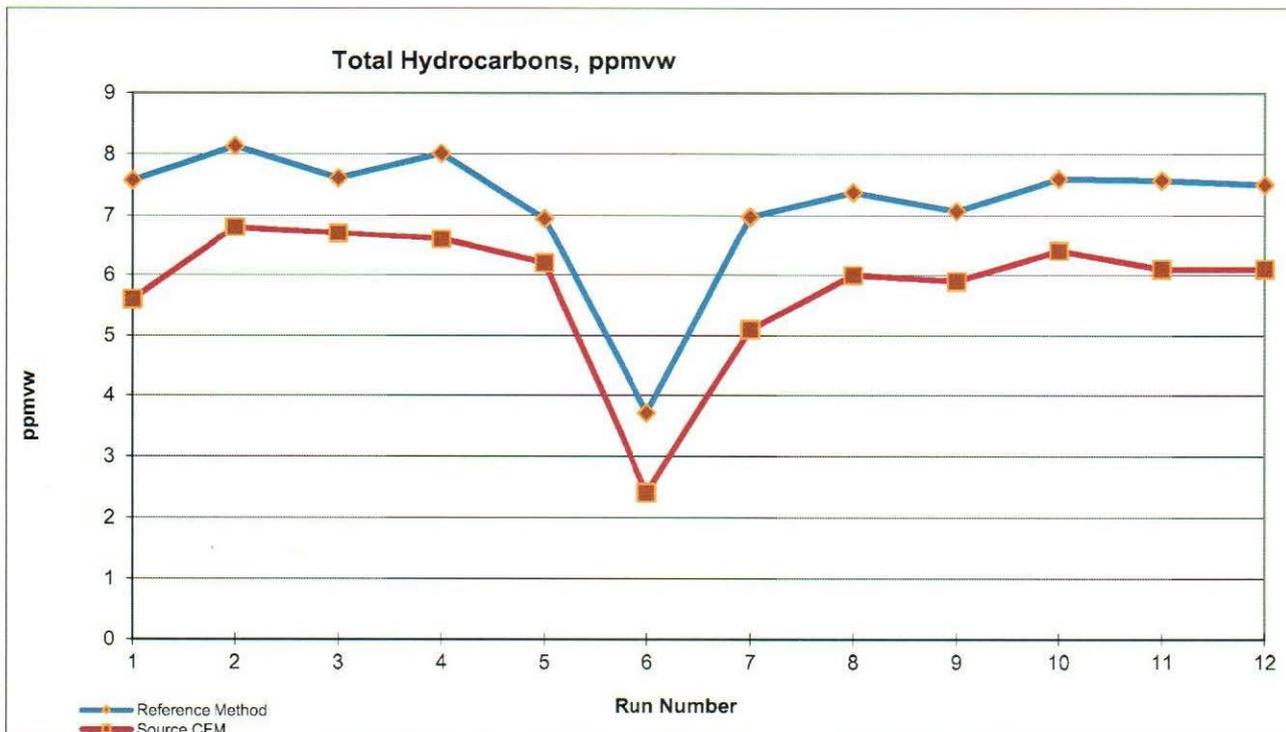


### 3.2.2 Volatile Organic Compounds

#### Hexane as Parts Per Million, Volume Wet (C<sub>6</sub>H<sub>14</sub> as ppm<sub>vw</sub>)

Total Hydrocarbons, ppmvw			
Relative Accuracy:	19.45	Mean of Difference:	1.21
RA - Appl. Standard:	6.91	Applicable Standard:	20.00
Confidence Coeff. (CC):	0.17	Mean of Reference Method:	7.11
Standard Deviation:	0.23	Mean of CEMS Values:	5.90
T-Factor:	2.306		

Run	Flag	Initial Minute	Stop Time	Reference Method	Source CEM	Diff.	Standard Deviation	Confid. Coeff.	Relative Accuracy
1		07:31:44	7:52	7.57E+00	5.60E+00	NA			
2	✓	07:52:44	8:13	8.13E+00	6.80E+00	1.33	NC	NC	NC
3	✓	08:13:44	8:34	7.61E+00	6.70E+00	0.91	0.30	0.48	20.30
4	✓	09:15:44	9:36	8.01E+00	6.60E+00	1.41	0.27	0.35	19.83
5	✓	09:36:44	9:57	6.95E+00	6.20E+00	0.75	0.32	0.36	19.07
6	✓	11:04:44	11:25	3.71E+00	2.40E+00	1.31	0.30	0.30	20.91
7		12:06:44	12:27	6.98E+00	5.10E+00	NA	NA	NA	NA
8	✓	12:27:44	12:48	7.38E+00	6.00E+00	1.38	0.28	0.26	20.66
9	✓	12:48:44	13:09	7.07E+00	5.90E+00	1.17	0.26	0.22	20.02
10	✓	13:32:44	13:53	7.60E+00	6.40E+00	1.20	0.24	0.19	19.43
11		13:53:44	14:14	7.57E+00	6.10E+00	NA	NA	NA	NA
12	✓	14:14:44	14:35	7.50E+00	6.10E+00	1.40	0.23	0.17	19.45



**4. Appendices**

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**Appendix A. Test Methods**

**Appendix A.1. Test Methodology Links**



[Method 1 \(40 CFR 60 Appendix A\)](https://www.epa.gov/emc/method-1-sample-velocity-traverses)

<https://www.epa.gov/emc/method-1-sample-velocity-traverses>



[Method 2 \(40 CFR 60 Appendix A\)](https://www.epa.gov/emc/method-2-velocity-s-type-pitot)

<https://www.epa.gov/emc/method-2-velocity-s-type-pitot>



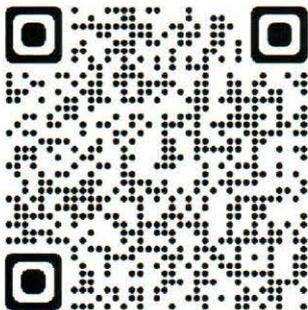
[Method 3A \(40 CFR 60 Appendix A\)](https://www.epa.gov/emc/method-3a-oxygen-and-carbon-dioxide-concentrations-instrumental)

<https://www.epa.gov/emc/method-3a-oxygen-and-carbon-dioxide-concentrations-instrumental>



[Method 4 \(40 CFR 60 Appendix A\)](https://www.epa.gov/emc/method-4-moisture-content)

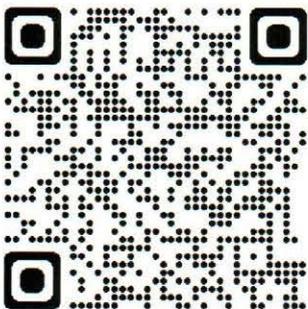
<https://www.epa.gov/emc/method-4-moisture-content>



[Method 25A \(40 CFR 60 Appendix A\)](#)  
<https://www.epa.gov/emc/method-25a-gaseous-organic-concentration-flame-ionization>



[Method 205 \(40 CFR 51 Appendix M\)](#)  
<https://www.epa.gov/emc/method-205-gas-dilution-calibration>



[Performance Specification 6 \(40 CFR 60 Appendix B\)](#)  
<https://www.epa.gov/emc/performance-specification-6-flow-rate>

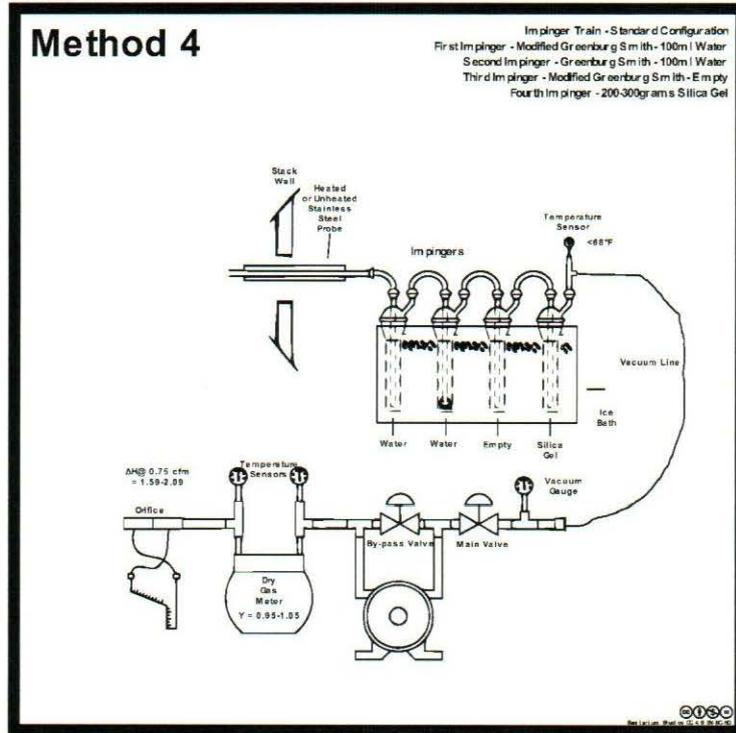


[Performance Specification 8A \(40 CFR 60 Appendix B\)](#)  
<https://www.epa.gov/emc/performance-specification-8a-total-hydrocarbon>

**Appendix A.2. Test Method Train Configuration Figures**

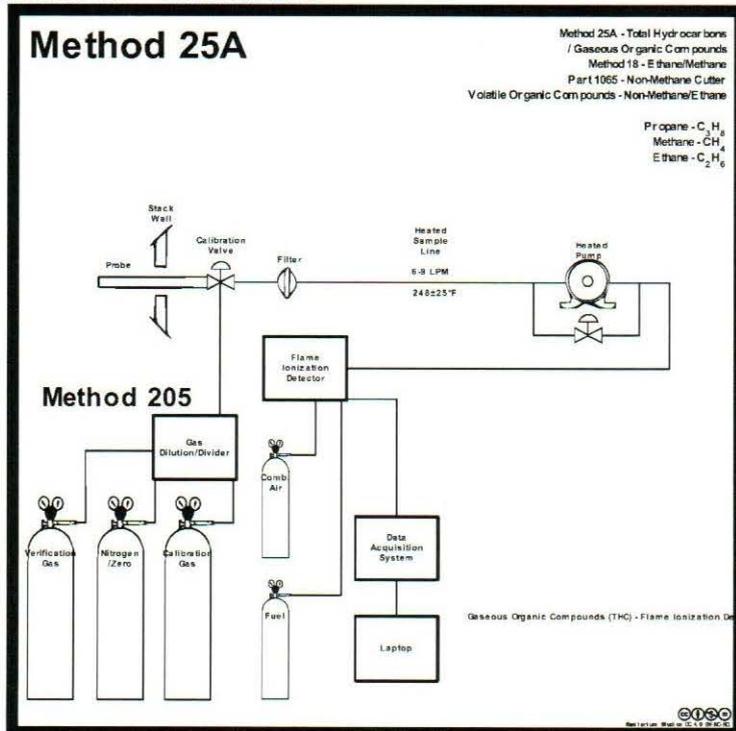
**Appendix A.2.1. Wet Methods**

**Method 4**



**Appendix A.2.2. Instrumental Analyzers**

**Method 25A – Method 205**



**Appendix B. Sample Calculations**

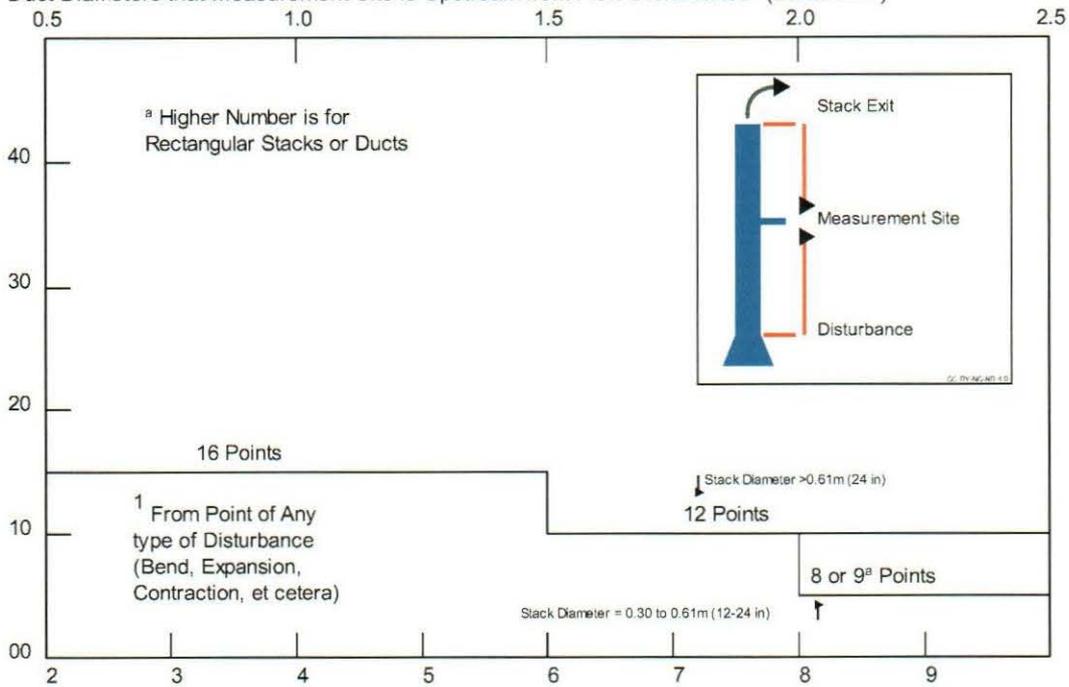
**Appendix B.1. Method 1 Calculations**

**Percent of stack diameter from inside wall to traverse point**

Traverse point number on a diameter	Number of traverse points on a diameter					
	2	4	6	8	10	12
1	14.6	6.7	4.4	3.2	2.6	2.1
2	85.4	25.0	14.6	10.5	8.2	6.7
3		75.0	29.6	19.4	14.6	11.8
4		93.3	70.4	32.3	22.6	17.7
5			85.4	67.7	34.2	25.0
6			95.6	80.6	65.8	35.6
7				89.5	77.4	64.4
8				96.8	85.4	75.0
9					91.8	82.3
10					97.4	88.2
11						93.3
12						97.9

**Calculation of Non-Isokinetic Sampling Points**

Duct Diameters that Measurement Site is Upstream from Flow Disturbance<sup>1</sup> (Distance A)



Duct Diameters that Measurement Site is from Downstream to Flow Disturbance<sup>1</sup> (Distance B)

Method 1 Figure 1-2 Number of traverse points for non-isokinetic sampling