

**BREMBO, NORTH AMERICA
HOMER, MICHIGAN**

Automobile Brake System Components Foundry

**Hydrocarbon and Carbon Monoxide
Emissions Field Test Report**

**Michigan Department of Environmental Quality, Air Quality Division
Permit To Install No. PTI 199-14A**

Submitted August 7, 2018 to:

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AIR QUALITY DIVISION



AIR TESTING SERVICES, INC

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We certify that we have examined the information submitted in this report
and believe the results presented are true, accurate, and complete.

Daniel Klassen
President

Joseph Ward
Project Manager

1.0 INTRODUCTION

Optimal Air Testing Services, Inc. (Optimal) was contracted by Brembo North America (Brembo) to complete air emissions performance testing at their foundry in Homer, Michigan. The foundry is covered by Part 40 of the Code of Federal Regulations, Part 63 (40 CFR 63), Subpart EEEEE National Emission Standards for Hazardous Air Pollutants from Iron and Steel Foundries (Iron and Steel Foundry MACT). The measured emissions from the high-performance automobile brake system components foundry are compared below to allowable limits set forth by the Michigan Department of Environmental Quality (MDEQ) Permit To Install No. PTI 199-14A Renewable Operating Permit MI-ROP-N6226-2015.

Coordinating the field portion of the test program were:

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Brembo North America	RPS- Environmental Risk	Optimal Air Testing Services, Inc.
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Brembo North America, Inc. is a grey iron foundry that casts components and manufactures high performance automobile brake systems at it's Homer facility located in Calhoun County, Michigan.

The facility is currently classified as a new foundry that is part of a major source of hazardous emissions and is subject to the provisions of the National Emissions Standards for Hazardous Air Pollutants from Iron and Steel Foundries (40 CFR Part 63 Subpart EEEEE, Iron and Steel Foundry MACT).

Samples were collected while Brembo operated the processes associated with each source at the capacity levels expected to occur during normal operations. Operating parameters and production rates were monitored by Brembo personnel and submitted to Optimal for inclusion into the emissions report.

Optimal measured air emissions from:

- Cooling House Regenerative Thermal Oxidizer (RTO) Inlet Duct (horizontal)
- Cooling House RTO Baghouse Stack
- Shakeout System Duct (horizontal)
- Sand and Shakeout System Baghouse Stack

Testing on the Sand and Shakout System and RTO baghouse exhaust stacks and on the RTO inlet was completed concurrently on April 24, 2018. The program followed procedures prescribed in Title 40 of the Code of Federal Regulations, Part 60 (40CFR60), Appendix A, Methods 1, 2, 3 and 4, 10B and 25 to measure Carbon Monoxide (CO), Methane (CH₄) and Total Gaseous Non-Methane Organics (TGNMO) as hexane concentrations and emission rates. TGNMO destruction efficiency of the RTO was also determined by comparing inlet and stack emission rates. Results summarized below in Table 1 are the averages from three 60-minute tests (runs). Measured parameters and results for each run on each source are shown in Tables 3, 4 and 5.

Table 1: CO and TGNMO Concentrations and Emissions, April 24, 2018

Methods 1-4 Parameters	<i>Test locations:</i> Sand and Shaker System	RTO Inlet	RTO Exhaust
Temperature of Source Gas (°F)	121	104	195
Moisture (%)	6.95	2.04	1.97
Dry Standard Flow Rate (dscfm)	145,045	68,938	74,303
Method 10B Results			
Carbon Dioxide Conc. (%)	0.80	0.58	1.04
CO Concentration (ppm)	5.0	407.7	38.7
CO Emission Rate (lb/hr)	3.16	122.6	12.53
Method 25 Results			
Methane Concentration (ppm)	2.7	75.7	7.3
Methane Emission Rate (lb/hr)	0.97	13.03	1.36
TGNMO Conc. as Hexane (ppm dry vol.)	7.64	15.8	2.9
TGNMO as Hexane Emissions (lb/hr)	14.85	14.52	2.84
TGNMO Removal Efficiency (%)	<i>Not applicable</i>	77.67	

Methods 1, 2, 3, 4, 25 and 25A procedures were followed to measure CO, CH₄, TGNMO as hexane concentrations and emission rate in the Shakeout Duct. Results shown in Table 2 are the average of three 60-minute runs. Measured parameters and results for each run are detailed in Table 6.

Table 2: Shakeout CO, TGNMO and Hexane Concentrations and Emissions

Methods 1-4 Parameters	April 25, 2018	April 26, 2018
Temperature of Source Gas (°F)	150	134
Carbon Dioxide Conc. (%)	<i>See Method 10B</i>	0.29
Oxygen Conc. (%)	21.2	21.24
Moisture (%)	8.91	9.22
Dry Standard Flow Rate (dscfm)	58,772	59,011
Method 10B Results		
Carbon Dioxide Conc. (%)	0.82	na
CO Concentration (ppm)	7.7	na
CO Emission Rate (lb/hr)	1.97	na
Method 25 Results		
Methane Concentration (ppm)	3.3	na
Methane Emission Rate (lb/hr)	0.49	na
TGNMO Conc. as Hexane (ppm dry vol.)	10.51	na
TGNMO as Hexane Emissions (lb/hr)	8.29	na
Method 25A Results		
Hexane Concentration (ppm wet basis)	na	8.38
Hexane Concentration (ppm dry basis)	na	9.24
Hexane Emission Rate (lb/hr)	na	7.29

2.0 SUMMARY OF RESULTS

Table 3: Sand and Shakeout System Test Parameters and Emissions, April 24, 2018

	Start Time	12:55	15:52	18:38	
	Stop Time*	13:55*	16:52	19:38	
Test Parameters	Units	Run 1	Run 2	Run 3	Avg.
P _{bar} (Barometric Pressure, absolute)	Inches Hg	28.95	28.98	28.95	
Y (Dry Gas Meter Calibration Factor)	unitless	1.0096	1.0096	1.0096	
C _p (Pitot tube Coefficient)	unitless	0.84	0.84	0.84	
θ (Total Sampling Time of Test)	Minutes	60	60	60	
ΔH (Orifice Pressure Drop)	In. H ₂ O	1.0	1.0	1.0	
V _m (Dry Gas Sampled - as measured)	ft ³ (dry)	44.830	44.880	45.500	
T _m (Gas Meter Temperature, avg.)	Degree F	69	70	68	
V _{lc} (Condensate and silica gel)	ml or g	64.9	67.4	76.2	
Location/Process Parameters					
A _s (Cross-sectional Area of Stack)	ft ²	49.61	49.61	49.61	49.61
P _g (Static Pressure of Stack Gas)	Inches H ₂ O	-0.50	-0.60	-0.50	-0.53
T _s (Temperature of Stack Gas)	Degree F	121	122	121	121
√Δp (Sq. root of velocity head of gas)	√In. H ₂ O	0.9918	0.9820	0.9782	0.9840
CO ₂ (Carbon Dioxide, Method 25 analysis)	%	1.00	0.69	0.72	0.80
O ₂ (Oxygen, Method 3 analysis)	%	20.4	20.5	20.9	20.6
Calculations					
V _{mstd} (Gas Sampled, standard (std) cond.)	ft ³	43.83	43.83	43.83	43.83
V _{wstd} (Water Vapor in Gas Sampled, std)	ft ³	3.06	3.18	3.59	3.28
B _{ws} (Water Vapor in Gas, by Vol.)	%	6.53	6.76	7.58	6.95
M _d (Molecular Weight of Dry Stack Gas)	lb/lb-mole	28.98	28.93	28.95	28.95
M _s (Molecular Weight of Wet Stack Gas)	lb/lb-mole	28.26	28.19	28.12	28.19
P _s (Pressure of Stack Gas, Absolute)	In. Hg	28.91	28.94	28.91	28.92
Flow Results					
V _s (Average Stack Gas Velocity)	ft/m (fpm)	3,603	3,573	3,564	3,580
Q _a (Actual Volumetric Flow Rate)	ft ³ /m (cfm)	178,765	177,244	176,813	177,607
Q _{std} (Dry Volumetric Flow Rate, std.)	ft ³ /m (dscfm)	146,703	145,046	143,385	145,045
CO (Method 10)					
Concentration, Drift Corrected - dry	ppma	5.0	4.0	6.0	5.0
CO Emissions	lb/hr	3.199	2.531	3.753	3.16
Methane (Method 25)					
Methane concentration	ppma	3	3	2	2.7
Methane Emissions	lb/hr	1.099	1.087	0.716	0.97
Method 25 VOC - Total Gaseous Non-methane Organics (TGNMO)					
TGNMO Concentration as carbon	mg C / dscm	20.5	23.2	25.1	22.93
TGNMO Concentration as Hexane	mg H / dscm	24.51	27.74	30.01	27.42
TGNMO Concentration as Hexane	ppm dry volume	6.83	7.73	8.36	7.64
TGNMO Hexane Emissions	lb/hr	13.440	15.039	16.084	14.85

*Runs 1 – 3 Moisture tests were respectively completed at 14:18, 17:16 and 20:01

Table 4: RTO Inlet Test Parameters and Emissions, April 24, 2018

		Start Time	12:55	15:52	18:38	
		Stop Time	13:55	16:52	19:38	
Test Parameters	Units	Run 1	Run 2	Run 3	Avg.	
P _{bar} (Barometric Pressure, absolute)	Inches Hg	28.85	28.85	28.75		
Y (Dry Gas Meter Calibration Factor)	unitless	1.0186	1.0186	1.0186		
C _p (Pitot tube Coefficient)	unitless	0.84	0.84	0.84		
θ (Total Sampling Time of Test)	Minutes	60	60	60		
ΔH (Orifice Pressure Drop)	In. H ₂ O	0.95	0.95	0.95		
V _m (Dry Gas Sampled - as measured)	ft ³ (dry)	33.327	34.491	34.664		
T _m (Gas Meter Temperature, avg.)	Degree F	74	76	75		
V _{lc} (Condensate and silica gel)	ml or g	19.1	14.7	10.1		
Location/Process Parameters						
A _s (Cross-sectional Area of Stack)	ft ²	27.79	27.79	27.79		
P _g (Static Pressure of Stack Gas)	Inches H ₂ O	-2.50	-2.40	-2.20		-2.37
T _s (Temperature of Stack Gas)	Degree F	104	105	104		104
√Δp (Sq. root of velocity head of gas)	√ In. H ₂ O	0.7808	0.8009	0.7961		0.7926
CO ₂ (Carbon Dioxide, Method 25 analysis)	%	0.7	0.3	0.8		0.58
O ₂ (Oxygen, Method 3 analysis)	%	21.0	21.0	21.0		21.0
Calculations						
V _{mstd} (Gas Sampled, standard (std) cond.)	ft ³	32.44	33.44	33.53		33.15
V _{wstd} (Water Vapor in Gas Sampled, std)	ft ³	0.90	0.69	0.48		0.69
B _{ws} (Water Vapor in Gas, by Vol.)	%	2.70	2.03	1.40		2.04
M _d (Molecular Weight of Dry Stack Gas)	lb/lb-mole	28.95	28.88	28.97		28.93
M _s (Molecular Weight of Wet Stack Gas)	lb/lb-mole	28.65	28.66	28.81		28.71
P _s (Pressure of Stack Gas, Absolute)	In. Hg	28.67	28.67	28.59		28.64
Flow Results						
V _s (Average Stack Gas Velocity)	ft/m (fpm)	2,789	2,861	2,838		2,829
Q _a (Actual Volumetric Flow Rate)	ft ³ /m (cfm)	77,483	79,500	78,861		78,614
Q _{std} (Dry Volumetric Flow Rate, std.)	ft ³ /m (dscfm)	67,548	69,725	69,534		68,936
CO (Method 10)						
Concentration, Drift Corrected - dry	ppm _d	411	410	402		407.7
CO Emissions	lb/hr	121.095	124.693	121.926		122.57
Methane (Method 25)						
Methane concentration	ppm _d	74	76	77		75.7
Methane Emissions	lb/hr	12.487	13.238	13.376		13.03
Method 25 VOC - Total Gaseous Non-methane Organics (TGNMO)						
TGNMO Concentration as carbon	mg C / dscm	76.60	32.90	32.80		47.4
TGNMO Concentration as Hexane	mg H / dscm	91.60	39.34	39.22		56.7
TGNMO Concentration as Hexane	ppm dry volume	25.51	10.96	10.92		15.8
TGNMO Hexane Emissions	lb/hr	23.124	10.251	10.192		14.52

Table 5: RTO Exhaust Test Parameters and Emissions, April 24, 2018

		Start Time	12:55	15:52	18:38	
		Stop Time	13:55	16:52	19:38	
Test Parameters	Units	Run 1	Run 2	Run 3	Avg.	
P _{bar} (Barometric Pressure, absolute)	Inches Hg	29.05	28.98	28.95		
Y (Dry Gas Meter Calibration Factor)	unitless	1.0005	1.0005	1.0005		
C _p (Pitot tube Coefficient)	unitless	0.84	0.84	0.84		
θ (Total Sampling Time of Test)	Minutes	60	60	60		
ΔH (Orifice Pressure Drop)	In. H ₂ O	0.90	0.90	0.90		
V _m (Dry Gas Sampled - as measured)	ft ³ (dry)	33.090	33.020	32.740		
T _m (Gas Meter Temperature, avg.)	Degree F	71	70	69		
V _{ic} (Condensate and silica gel)	ml or g	18.7	13.4	8.9		
Location/Process Parameters						
A _s (Cross-sectional Area of Stack)	ft ²	30.94	30.94	30.94		
P _g (Static Pressure of Stack Gas)	Inches H ₂ O	-0.43	-0.61	-0.48		-0.51
T _s (Temperature of Stack Gas)	Degree F	203	193	190		195
√Δp (Sq. root of velocity head of gas)	√ In. H ₂ O	0.8368	0.8150	0.8162		0.8227
CO ₂ (Carbon Dioxide, Method 25 analysis)	%	1.2	1.3	0.7		1.04
O ₂ (Oxygen, Method 3 analysis)	%	20.8	20.6	20.7		20.7
Calculations						
V _{mstd} (Gas Sampled, standard (std) cond.)	ft ³	32.05	31.94	31.72		31.90
V _{wstd} (Water Vapor in Gas Sampled, std)	ft ³	0.88	0.63	0.42		0.64
B _{ws} (Water Vapor in Gas, by Vol.)	%	2.68	1.94	1.31		1.97
M _d (Molecular Weight of Dry Stack Gas)	lb/lb-mole	29.02	29.02	28.94		28.99
M _s (Molecular Weight of Wet Stack Gas)	lb/lb-mole	28.73	28.81	28.79		28.78
P _s (Pressure of Stack Gas, Absolute)	In. Hg	29.02	28.94	28.91		28.96
Flow Results						
V _s (Average Stack Gas Velocity)	ft/m (fpm)	3,215	3,108	3,108		3,143
Q _a (Actual Volumetric Flow Rate)	ft ³ /m (cfm)	99,443	96,147	96,145		97,245
Q _{std} (Dry Volumetric Flow Rate, std.)	ft ³ /m (dscfm)	74,771	73,704	74,435		74,303
CO (Method 10)						
Concentration, Drift Corrected - dry	ppm _d	40	40	36		38.7
CO Emissions	lb/hr	11.317	11.838	10.674		12.53
Methane (Method 25)						
Methane concentration	ppm _a	8	7	7		7.3
Methane Emissions	lb/hr	1.296	1.187	1.189		1.36
Method 25 VOC - Total Gaseous Non-methane Organics (TGNMO)						
TGNMO Concentration as carbon	mg C / dscm	8.97	9.79	6.92		8.56
TGNMO Concentration as Hexane	mg H / dscm	10.73	11.71	8.27		10.24
TGNMO Concentration as Hexane	ppm dry volume	2.99	3.26	2.30		2.85
TGNMO Hexane Emissions	lb/hr	3.00	3.22	2.30		2.84

Table 6: Shakeout Methods 1, 2, 3, 4, 10B & 25 Parameters and Emissions, April 25, 2018

		Start Time	11:27	13:59	15:55	
		Stop Time	12:27	14:59	16:55	
Test Parameters	Units	Run 1	Run 2	Run 3	Avg.	
P _{bar} (Barometric Pressure, absolute)	Inches Hg	28.95	28.90	28.89		
Y (Dry Gas Meter Calibration Factor)	unitless	1.0186	1.0186	1.0186		
C _p (Pitot tube Coefficient)	unitless	0.84	0.84	0.84		
θ (Total Sampling Time of Test)	Minutes	60	60	60		
ΔH (Orifice Pressure Drop)	In. H ₂ O	0.9	0.9	0.9		
V _m (Dry Gas Sampled - as measured)	ft ³ (dry)	32.880	32.980	33.100		
T _m (Gas Meter Temperature, avg.)	Degree F	78	79	81		
V _{lc} (Condensate and silica gel)	ml or g	71.7	55.4	71.4		
Location/Process Parameters						
A _s (Cross-sectional Area of Stack)	ft ²	19.47	19.47	19.47		19.47
P _g (Static Pressure of Stack Gas)	Inches H ₂ O	-6.70	-7.00	-6.30		-6.67
T _s (Temperature of Stack Gas)	Degree F	153	149	148		150
√Δp (Sq. root of velocity head of gas)	√ In. H ₂ O	1.0890	1.0768	1.0402		1.0687
CO ₂ (Carbon Dioxide, Method 25 analysis)	%	1.09	0.64	0.72		0.82
O ₂ (Oxygen, Method 3 analysis)	%	21.2	21.2	21.2		21.2
Calculations						
V _{mstd} (Gas Sampled, standard (std) cond.)	ft ³	31.86	31.86	31.86		31.86
V _{wstd} (Water Vapor in Gas Sampled, std)	ft ³	3.38	2.61	3.37		3.12
B _{ws} (Water Vapor in Gas, by Vol.)	%	9.59	7.58	9.56		8.91
M _d (Molecular Weight of Dry Stack Gas)	lb/lb-mole	29.02	28.95	28.96		28.98
M _s (Molecular Weight of Wet Stack Gas)	lb/lb-mole	27.96	28.12	27.92		28.00
P _s (Pressure of Stack Gas, Absolute)	In. Hg	28.46	28.39	28.43		28.42
Flow Results						
V _s (Average Stack Gas Velocity)	ft/m (fpm)	4,117	4,052	3,924		4,031
Q _a (Actual Volumetric Flow Rate)	ft ³ /m (cfm)	80,170	78,895	76,415		78,493
Q _{std} (Dry Volumetric Flow Rate, std.)	ft ³ /m (dscfm)	59,377	59,972	56,967		58,772
CO (Method 10)						
Concentration, Drift Corrected - dry	ppma	9	7	7		7.67
CO Emissions	lb/hr	2.331	1.831	1.739		1.97
Methane (Method 25)						
Methane concentration	ppma	3	4	3		3.33
Methane Emissions	lb/hr	0.445	0.599	0.427		0.49
Method 25 VOC - Total Gaseous Non-methane Organics (TGNMO)						
TGNMO Concentration as carbon	mg C / dscm	33.90	30.20	30.60		31.57
TGNMO Concentration as Hexane	mg H / dscm	40.54	36.11	36.59		37.75
TGNMO Concentration as Hexane	ppm _{dry volume}	11.29	10.06	10.19		10.51
TGNMO Hexane Emissions	lb/hr	9.00	8.09	7.79		8.29

Table 7: Shakeout Test Parameters and Hexane Emissions, April 25, 2018

		9:28	11:05	13:27	
		10:28	12:05	14:27	
<u>Test Parameters</u>	<u>Units</u>	<u>Run 1</u>	<u>Run 2</u>	<u>Run 3</u>	<u>Avg.</u>
P _{bar} (Barometric Pressure, absolute)	Inches Hg	28.92	28.92	28.75	
Y (Dry Gas Meter Calibration Factor)	unitless	1.0186	1.0186	1.0186	
C _p (Pitot tube Coefficient)	unitless	0.84	0.84	0.84	
θ (Total Sampling Time of Test)	Minutes	60	60	60	
ΔH (Orifice Pressure Drop)	In. H ₂ O	0.9	0.9	1.0	
V _m (Dry Gas Sampled - as measured)	ft ³ (dry)	32.960	32.690	34.543	
T _m (Gas Meter Temperature, avg.)	Degree F	68	54	76	
V _{ic} (Condensate and silica gel)	ml or g	64.2	63.3	82.7	
<u>Location/Process Parameters</u>					
A _s (Cross-sectional Area of Stack)	ft ²	19.47	19.47	19.47	19.47
P _g (Static Pressure of Stack Gas)	Inches H ₂ O	-7.00	-7.50	-7.00	-7.17
T _s (Temperature of Stack Gas)	Degree F	139	129	133	134
√Δp (Sq. root of velocity head of gas)	√ In. H ₂ O	1.0659	1.0742	1.0447	1.0616
CO ₂ (Carbon Dioxide, Method 25 analysis)	%	0.18	0.23	0.45	0.29
O ₂ (Oxygen, Method 3 analysis)	%	21.0	21.9	20.9	21.24
<u>Calculations</u>					
V _{mstd} (Gas Sampled, standard (std) cond.)	ft ³	32.49	32.49	32.49	32.49
V _{wstd} (Water Vapor in Gas Sampled, std)	ft ³	3.03	2.98	3.90	3.30
B _{ws} (Water Vapor in Gas, by Vol.)	%	8.52	8.41	10.72	9.22
M _d (Molecular Weight of Dry Stack Gas)	lb/lb-mole	28.87	28.91	28.91	28.90
M _s (Molecular Weight of Wet Stack Gas)	lb/lb-mole	27.94	27.99	27.74	27.89
P _s (Pressure of Stack Gas, Absolute)	In. Hg	28.41	28.37	28.24	28.34
<u>Flow Results</u>					
V _s (Average Stack Gas Velocity)	ft/m (fpm)	3,990	3,986	3,917	3,964
Q _a (Actual Volumetric Flow Rate)	ft ³ /m (cfm)	77,690	77,621	76,265	77,192
Q _{std} (Dry Volumetric Flow Rate, std.)	ft ³ /m (dscfm)	59,449	60,391	57,192	59,011
<u>Hexane Emissions</u> (Method 25A, Total hydrocarbons as hexane)					
Hexane concentration, wet basis	ppm _w	9.95	5.8	9.39	8.38
Hexane concentration, dry basis	ppm _d	10.88	6.33	10.52	9.24
Hexane Emissions	lb/hr	8.678	5.132	8.072	7.29

3.0 SUMMARY OF SAMPLING METHODS

Optimal performed the following U.S. Environmental Protection Agency (EPA) test methods to meet the requirements of the specified work. These methods may be referenced in Title 40 of the Code of Federal Regulations, Parts 51 and 60. The methods are titled as follows:

- Method 1 “Sample and Velocity Traverses for Stationary Sources;”
- Method 2 “Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube);”
- Method 3 “Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources;”
- Method 4 “Determination of Moisture Content in Stack Gases;”
- Method 10B “Determination of Carbon Monoxide Emissions from Stationary Sources;”
- Method 25 “Determination of Gaseous Nonmethane Organic Emissions from Stationary Sources
- Method 25A “Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer;”

4.0 METHODOLOGY AND PROCEDURES

Optimal collected source data and samples of exhaust gas from the three stacks to measure particulate emissions. Particulate emissions were based on the average of three runs following test methods listed in Title 40 of the Code of Federal Regulations, Part 51 (40CFR51) and Part 60 (40CFR60). Brief descriptions of the sampling methods are shown below.

4.1 Stack Gas Velocity and Volumetric Flow Rate.

The velocity and temperature sampling apparatus consisted of S-type stainless steel pitot tubes and a thermocouple to measure gas temperature. Pitots were calibrated at the Optimal laboratory prior to job mobilization. The velocity apparatus was leak checked before and after each run.

40 CFR 60 Method 1 was used to determine sample points for traverses measuring velocity head and temperature. Method 2 procedures were followed to calculate stack gas velocity during each run. Velocity and temperature sampling points were based on upstream and downstream distances from flow disturbances and the stack diameter.

Table 8 Duct/Stack Dimensions and Traverse Points

Emissions Source	RTO Inlet	RTO Baghouse Stack	Shakeout	Shakeout & Sand System
Stack Configuration	Horizontal, Circular	Circular, Vertical	Horizontal, Circular	Circular, Vertical
Test Location	Stack	Stack	Stack	Stack
Measured Inside Dimensions	71 ³ / ₈ inches	75 ⁵ / ₁₆ inches	Horiz – 60.0 in. Vert. – 59.5 in.	95 ³ / ₈ inches
Port Length	2 ³ / ₈ inch	4 ⁵ / ₁₆ inch	2 ¹ / ₂ inch	4 ¹ / ₄ inch
Distance (diameters) from ports upstream to disturbance (B)	~6.7**	4.8	greater than 2*	~ 6.3*
Distance (diameters) from ports downstream to disturbance (A)	> 2.5	2.4	greater than 0.5*	~ 3.8
No. of Ports	2	2	2	2
Velocity/Temp. traverse points	16 (8 per	16 (8 per port)	16 (8 per port)	12 (6 per port)
Point #1	2 ⁵ / ₁₆ "	2 ⁷ / ₁₆ "	1 ¹⁵ / ₁₆ "	3 ¹ / ₁₆ "
Point #2	7 ¹ / ₂ "	7 ¹⁵ / ₁₆ "	6 ¹ / ₄ "	10.0"
Point #3	13 ⁷ / ₈ "	14 ⁵ / ₈ "	11 ⁹ / ₁₆ "	18 ¹ / ₂ "
Point #4	23 ¹ / ₁₆ "	24 ⁵ / ₁₆ "	19 ⁵ / ₁₆ "	30 ¹³ / ₁₆ "
Point #5	48 ⁵ / ₁₆ "	51.0"	40 ⁷ / ₁₆ "	64 ⁹ / ₁₆ "
Point #6	57 ¹ / ₂ "	60 ¹¹ / ₁₆ "	48 ³ / ₁₆ "	76 ⁷ / ₈ "
Point #7	63 ⁷ / ₈ "	67 ³ / ₈ "	53 ¹ / ₂ "	85 ³ / ₈ "
Point #8	69 ¹ / ₁₆ "	72 ⁷ / ₈ "	57 ¹³ / ₁₆ "	92 ⁵ / ₁₆ "

*Estimated Measurement

**Additional diameters of straight duct upstream of minor disturbance

Stack gas molecular weights were calculated from oxygen (O₂) and carbon dioxide (CO₂) concentrations. A Orsat analyzer was used to measure O₂ concentrations in accordance with 40 CFR 60 Method 3. CO₂ was taken from the Method 10B results. O₂ and CO₂ concentrations were measured with analyzers per Method 3A during the hexane testing.

Moisture was measured in accordance with 40 CFR 60 Method 4 during each run. A sample of the stack gas was drawn into impingers immersed in an ice bath. The gas was cooled below 68°F to condense the moisture from the gas into the impingers. The moisture train consisted of four impingers configured as per Method 4. The first and second impingers each contained 100 ml of water, the third impinger remained empty and the fourth impinger contained a tare-weighted quantity of silica gel. The total weight gain of the impingers and the volume of gas drawn through the impingers were measured to calculate moisture concentration in the gas.

Dry gas meters and pitots were calibrated at the Optimal laboratory prior to job mobilization. A post-test calibration on each meter was performed at the conclusion of the test project to verify that calibration was maintained throughout sampling.

The stack gas temperature, moisture, molecular weight and velocity head were measured at each traverse point and used to calculate the gas velocity (Vs). Volumetric flow rate, expressed in terms of acfm and dscfm, was calculated by multiplying the duct or stack area by the velocity.

4.2 Carbon Monoxide, Methane and Non-Methane Volatile Organic Hazardous Air Pollutant Concentrations. Methods 10B and 25.

Method 10B is applicable for the determination of CO and Method 25 is applicable for the determination of methane (CH₄) and volatile organic compounds (VOC) (measured as total gaseous nonmethane organics (TGNMO) and reported as carbon) in stationary source emissions.

An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to carbon dioxide (CO₂) and quantitatively collecting in the effluent in an evacuated vessel; then a portion of the CO₂ is reduced to CH₄ and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO₂, and CH₄; the NMO are oxidized to CO₂, reduced to CH₄, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

The analyzer used for sample analysis is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. This semi-continuous GC/FID analyzer is capable of: (1) Separating CO, CO₂, and CH₄ from NMO, (2) reducing the CO₂ to CH₄ and quantifying as CH₄, and (3) oxidizing the NMO to CO₂, reducing the CO₂ to CH₄ and quantifying as CH₄, according to section 10.1.2. of Method 25.

4.3 Determination of Hexane Concentrations

A gas divider was used to provide the desired gas concentrations for calibrating the hexane analyzer. Operation and on-site verification of the gas divider followed procedures listed in 40 CFR Part 51, Test Method 205, Appendix M entitled, "Verification of Gas Dilution Systems for Field Instrument Calibrations".

Protocol O₂ gases and a certified hexane (C₆H₁₄) gas were blended with nitrogen using a EnviroNics Model 4040 Gas Divider with three mass flow controllers to arrive at the desired calibration concentrations for O₂, CO₂ and C₆H₁₄ continuous emission monitors. The mass flow controllers were calibrated prior to testing, and the gas divider operation on-site was verified with the oxygen analyzer and an independent protocol calibration gas. Per Method 205, verification of the gas divider operation was demonstrated once during the test project.

The Gas Divider on-site verification was performed by entering two target concentrations into the EnviroNics software. A high range protocol oxygen gas and the zero N₂ gas were blended with the mass flow controllers to meet the target concentrations that were introduced to the oxygen 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.

Method 25A procedures for determination of volatile organic compounds utilizing Instrument Analyzer Methodology were followed. The gas sample was extracted from the source 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 275°F. A particulate free, wet gas sample was then suitable for instrument introduction. A VIG Model 20 FID total hydrocarbon continuous gas analyzer was calibrated by the manufacturer to measure hexane.

A calibration error check to show analyzer linearity was performed prior to collecting gas samples. The zero and high-range calibration gases were introduced to the analyzer at the calibration valve. The analyzer was then 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 two percent of calibration gas value or the calibration was repeated.

Calibration of the analyzer was performed before and after each test run to determine the analyzer drift. The analyzer drift was less than three percent of the span value for all runs. The analyzer drift was used for correcting the recorded data.

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

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