



Marathon Petroleum Company LP
1300 South Fort Street
Detroit, MI 48217

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REPORT ON RATA TESTING

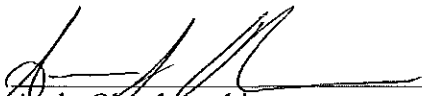
Performed for:
MARATHON PETROLEUM COMPANY LP
DETROIT REFINERY

FCCU REGENERATOR STACK (EU11-FCCU-S1)


Client Reference No: 4100356132
CleanAir Project No: 12687-2
Revision 0: May 1, 2015

To the best of our knowledge, the data presented in this report are accurate, complete, error free, legible and representative of the actual emissions during the test program. Clean Air Engineering operates in conformance with the requirements of ASTM D7036-04 Standard Practice for Competence of Air Emission Testing Bodies.

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PROJECT OVERVIEW

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INTRODUCTION

Marathon Petroleum Company LP (MPC) contracted Clean Air Engineering (CleanAir) to perform a relative accuracy test audit (RATA) on a continuous emissions monitoring system (CEMS) installed at the Detroit Refinery and to demonstrate compliance with permit limits.

All testing was conducted in accordance with the regulations set-forth by the United States Environmental Protection Agency (USEPA) and the Michigan Department of Environmental Quality (MDEQ). The permit limits are referenced in Michigan Department of Environmental Quality, Air Quality Division Permit to Install No. 63-08D, issued May 12, 2014.

Key Project Participants

Individuals responsible for coordinating and conducting the test program were:

Crystal Davis – MPC
Joe Reidy – MPC
John Elzaibak – CleanAir

Test Program Parameters

The testing was performed at the FCCU Regenerator Stack (Emission Unit ID No. EU11-FCCU-S1; Stack ID No. SVFCCU) on March 24, 2015, and included the following emissions measurements:

- oxygen (O₂)
- carbon dioxide (CO₂)
- sulfur dioxide (SO₂)
- nitrogen oxides (NO_x)
- carbon monoxide (CO)

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PROJECT OVERVIEW**TEST PROGRAM SYNOPSIS****Test Schedule**

The on-site schedule followed during the test program is outlined in Table 1-1.

**Table 1-1:
Schedule of Activities**

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	08:59	09:20
2	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	09:50	10:11
3	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	10:32	10:53
4	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	11:12	11:33
5	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	11:50	12:11
6	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	12:35	12:56
7	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	13:18	13:39
8	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	14:04	14:25
9	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	14:58	15:19
10	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	15:39	16:00
11	FCCU Regenerator Stack	USEPA Method 3A / 6C / 7E / 10	O ₂ / CO ₂ / SO ₂ / NO _x / CO	03/25/15	16:29	16:50

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PROJECT OVERVIEW

Results Summary

Table 1-2 and Table 1-3 summarize the results of the test program. A more detailed presentation of the test conditions and results of analysis are shown on pages 2-1 through 2-6.

**Table 1-2:
Summary of RATA Results**

Source Constituent (Units)	Reference Method (USEPA)	Relative Accuracy (%) ¹	Units	Applicable Specification	Specification Limit ²
<u>FCCU Regenerator Stack</u>					
O ₂ (% dv)	M-3A	0.1	%dv	PS3	±1.0% dv
CO ₂ (% dv)	M-3A	0.1	%dv	PS3	±1.0% dv
SO ₂ (ppm @ 0%O ₂)	M-6C	0.3	% of Std.	PS2	10% of Std. ³
NO _x (ppm @ 0%O ₂)	M-7E	5.9	% of Std.	PS2	10% of Std. ⁴
CO (ppm @ 0%O ₂)	M-10	0.8	% of Std.	PS4A ⁵	5% of Std. ⁶

¹ Relative Accuracy is expressed in terms of comparison to the reference method (% RM) or applicable emission standard (% Std.). The specific expression used depends on the specification limit

² Specification limits obtained from 40 CFR 60, Appendix B, Performance Specifications.

³ Standard = 50 ppm_{dv} SO₂ @ 0% O₂

⁴ Standard = 80 ppm_{dv} NO_x @ 0% O₂

⁵ For any sources emitting less than 200 ppm_v of CO, PS4A applies. The PS4A RA limit is either < 10% of RM, < 5% of Standard, or ± 5 ppm_v (abs. average difference plus 2.5 x confidence coefficient).

⁶ Standard = 500 ppm_{dv} CO @ 0% O₂

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**Table 1-3:
Summary of Emission Compliance Test Results**

Source Constituent (Units)	Sampling Method	Average Emission	Permit Limit ¹
<u>FCCU Regenerator Stack</u>			
SO ₂ (ppm _{dv} @ 0% O ₂)	USEPA M-6C	<0.51	50
NO _x (ppm _{dv} @ 0% O ₂)	USEPA M-7E	25.2	80
CO (ppm _{dv} @ 0% O ₂)	USEPA M-10	107	500

¹ Permit limits obtained from MDEQ Permit To Install No. 63-08D.

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PROJECT OVERVIEW

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Discussion of Test Program***O₂, CO₂, SO₂, NO_x, and CO RATA Testing - USEPA Methods 3A, 6C, 7E, and 10; Performance Specifications 2, 3, and 4/4A***

Minute-average data points for O₂, CO₂, SO₂, NO_x, and CO (dry basis) were collected over a period of 21 minutes for each RATA Reference Method (RM) run. The average result for each RM run was calculated and compared to the average result from the facility CEMs over an identical time interval in order to calculate relative accuracy (RA).

- For O₂, RA is expressed as the average absolute difference between the RM and facility CEMs runs. The final result was below the limit of $\pm 1.0\%dv$ set by PS3.
- For CO₂, RA is expressed as the average absolute difference between the RM and facility CEMs runs. The final result was below the limit of $\pm 1.0\%dv$ set by PS3.
- For SO₂, RA is expressed as the percent difference between RM and facility CEMs runs. The final result was below the limit of 10% of the applicable standard (permit limit listed in Table 1-3) set by PS2.
- For NO_x, RA is expressed as the percent difference between RM and facility CEMs runs. The final result was below the limit of 10% of the applicable standard (permit limit listed in Table 1-3) set by PS2.
- For CO, RA is expressed as the percent difference between RM and facility CEMs runs. The final result was below the limit of 5% of the applicable standard (permit limit listed in Table 1-3) set by PS2.

A total of eleven (11) RM runs were performed. For each constituent, RA was calculated by selecting the nine (9) most comparable runs which yielded the lowest calculated result.

Following Run 1, the RM bias did not meet the calibration criterion for CO₂ zero gas. Therefore, Run 1 was not included in the (9) most comparable runs for CO₂ as outlined above. The bias adjusted CO₂ values for Run 2 utilized the initial bias (00) and the post run bias (02). All consecutive bias tests met the necessary criteria.

Calculation of Emission Compliance Results

SO₂, NO_x, and CO emission results in units of dry volume-based concentration (ppmdv) were converted to ppmv at 0% O₂ using data collected by CleanAir concurrent with the applicable constituent measurements.

End of Section 1 – Project Overview

RESULTS

2-1

**Table 2-1:
O₂ Relative Accuracy (USEPA M-3A / PS3)**

Run No.	Start Time	Date (2015)	RM Data (%dv)	CEMS Data (%dv)	Difference (%dv)	Difference Percent
1 *	08:59	Mar 25	2.22	2.45	-0.24	-10.7%
2	09:50	Mar 25	2.95	3.14	-0.19	-6.6%
3	10:32	Mar 25	2.76	2.87	-0.11	-3.8%
4	11:12	Mar 25	3.17	3.33	-0.16	-5.1%
5 *	11:50	Mar 25	2.55	2.74	-0.18	-7.2%
6	12:35	Mar 25	2.41	2.49	-0.09	-3.7%
7	13:18	Mar 25	2.35	2.50	-0.15	-6.5%
8	14:04	Mar 25	2.42	2.57	-0.15	-6.1%
9	14:58	Mar 25	2.36	2.48	-0.12	-5.1%
10	15:39	Mar 25	2.37	2.52	-0.15	-6.3%
11	16:29	Mar 25	2.45	2.61	-0.16	-6.4%
Average			2.58	2.72	-0.14	-5.5%

Relative Accuracy Test Audit Results

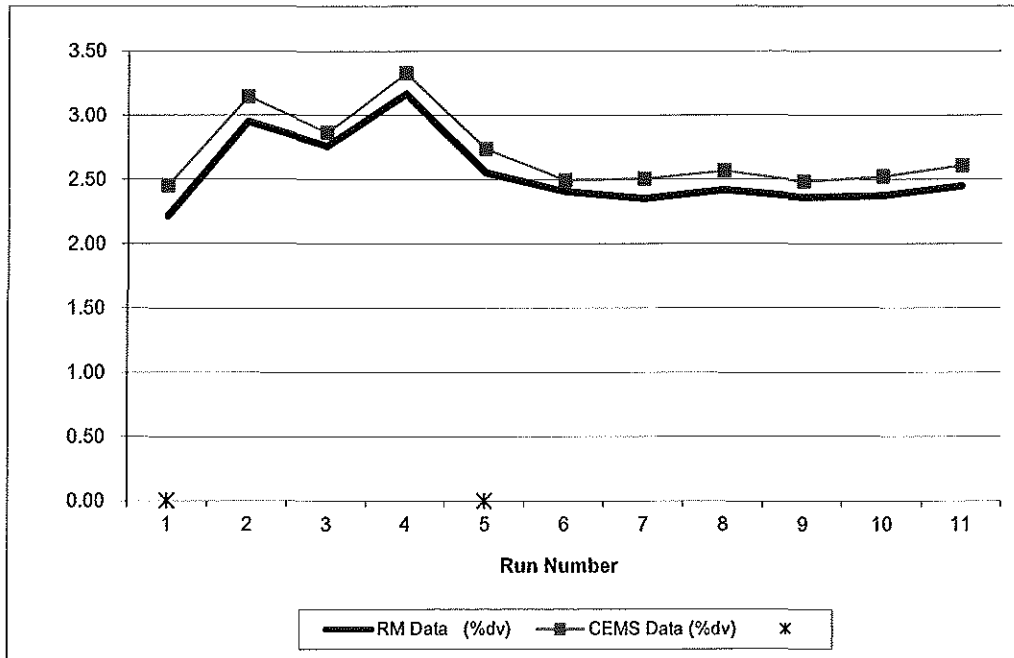
Standard Deviation of Differences	0.032	
Confidence Coefficient (CC)	0.025	
t-Value for 9 Data Sets	2.306	
Avg. Abs. Diff. (%dv)	0.142	1.0

RM = Reference Method (CleanAir Data)

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CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)

RATA calculations are based on 9 of 11 runs. * indicates the excluded runs.



RESULTS

**Table 2-2:
CO₂ Relative Accuracy (USEPA M-3A / PS3)**

Run No.	Start Time	Date (2015)	RM Data (%dv)	CEMS Data (%dv)	Difference (%dv)	Difference Percent
1 *	08:59	Mar 25	16.56	16.16	0.40	2.4%
2	09:50	Mar 25	15.58	15.62	-0.03	-0.2%
3	10:32	Mar 25	15.91	15.82	0.09	0.6%
4	11:12	Mar 25	15.53	15.45	0.08	0.5%
5	11:50	Mar 25	16.11	15.90	0.20	1.3%
6	12:35	Mar 25	16.33	16.14	0.19	1.2%
7	13:18	Mar 25	16.29	16.12	0.17	1.0%
8	14:04	Mar 25	16.22	16.07	0.16	1.0%
9 *	14:58	Mar 25	16.36	16.15	0.21	1.3%
10	15:39	Mar 25	16.27	16.10	0.17	1.0%
11	16:29	Mar 25	16.18	16.03	0.15	0.9%
Average			16.05	15.92	0.13	0.8%

Relative Accuracy Test Audit Results

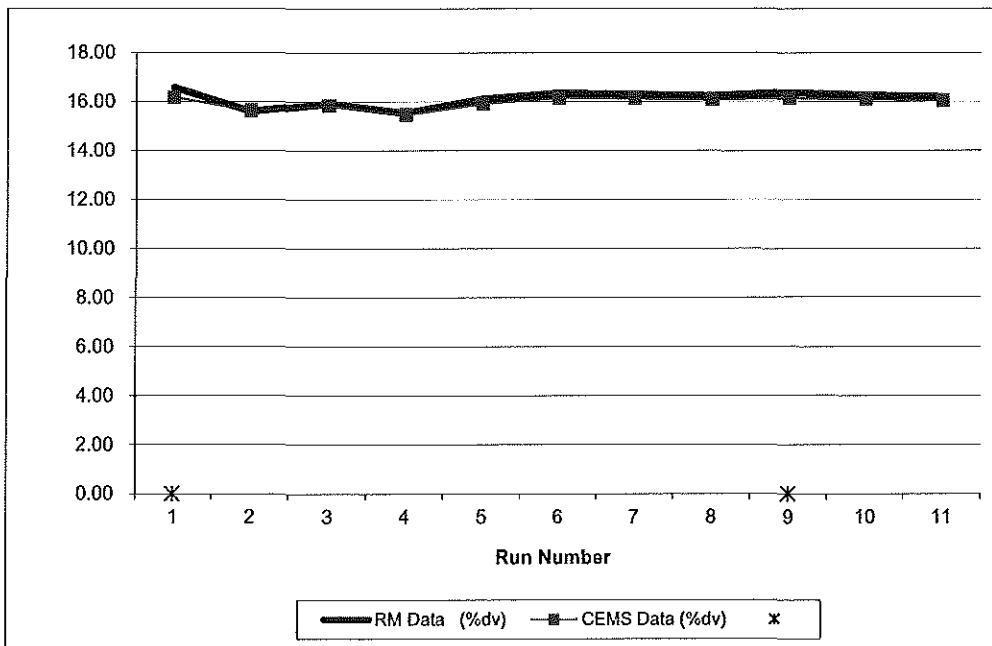
Standard Deviation of Differences	0.074	
Confidence Coefficient (CC)	0.057	
t-Value for 9 Data Sets	2.306	
Avg. Abs. Diff. (%dv)	0.138	Limit 1.0

RM = Reference Method (CleanAir Data)

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CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)

RATA calculations are based on 9 of 11 runs. * indicates the excluded runs.



RESULTS

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**Table 2-3:
SO₂ Relative Accuracy (USEPA M-6C / PS2)**

Run No.	Start Time	Date (2015)	RM Data (ppm@0%O2)	CEMS Data (ppm@0%O2)	Difference (ppm@0%O2)
1	08:59	Mar 25	0.00	0.09	-0.09
2	09:50	Mar 25	0.00	0.17	-0.17
3	10:32	Mar 25	0.00	0.12	-0.12
4	11:12	Mar 25	0.00	0.12	-0.12
5 *	11:50	Mar 25	0.00	0.25	-0.25
6	12:35	Mar 25	0.00	0.12	-0.12
7	13:18	Mar 25	0.00	0.14	-0.14
8	14:04	Mar 25	0.00	0.15	-0.15
9	14:58	Mar 25	0.00	0.14	-0.14
10 *	15:39	Mar 25	0.00	0.33	-0.33
11	16:29	Mar 25	0.00	0.14	-0.14
Average			0.00	0.13	-0.13

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.025	
Confidence Coefficient (CC)	0.019	
t-Value for 9 Data Sets	2.306	
Relative Accuracy (as % of Appl. Std.)	0.3%	Limit
Appl. Std. = 50 ppm@0%O2		10.0%

RM = Reference Method (CleanAir Data)

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CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)

RATA calculations are based on 9 of 11 runs. * indicates the excluded runs.

RESULTS

**Table 2-4:
NO_x Relative Accuracy (USEPA M-7E / PS2)**

Run No.	Start Time	Date (2015)	RM Data (ppm@0%O2)	CEMS Data (ppm@0%O2)	Difference (ppm@0%O2)	Difference Percent
1 *	08:59	Mar 25	22.2100	26.4672	-4.2572	-19.2%
2	09:50	Mar 25	28.0322	32.9002	-4.8680	-17.4%
3	10:32	Mar 25	25.9799	30.6771	-4.6972	-18.1%
4	11:12	Mar 25	29.2240	35.0127	-5.7888	-19.8%
5 *	11:50	Mar 25	23.8573	29.8820	-6.0247	-25.3%
6	12:35	Mar 25	23.3360	27.5282	-4.1922	-18.0%
7	13:18	Mar 25	25.0187	27.6917	-2.6730	-10.7%
8	14:04	Mar 25	25.9021	28.3237	-2.4216	-9.3%
9	14:58	Mar 25	23.5102	27.2760	-3.7658	-16.0%
10	15:39	Mar 25	24.8941	28.0098	-3.1157	-12.5%
11	16:29	Mar 25	25.3567	28.7155	-3.3588	-13.2%
Average			25.6949	29.5706	-3.8757	-15.1%

Relative Accuracy Test Audit Results

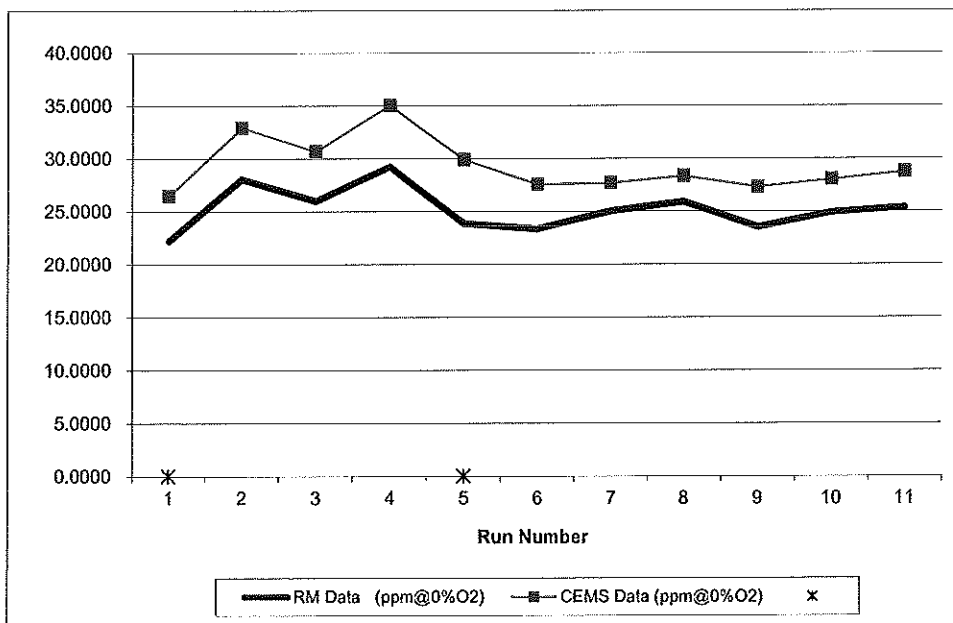
Standard Deviation of Differences	1.108892	
Confidence Coefficient (CC)	0.852369	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	18.4%	20.0%
Relative Accuracy (as % of Appl. Std.)	5.9%	10.0%
Appl. Std. = 80 ppm@0%O2		

RM = Reference Method (CleanAir Data)

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CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)

RATA calculations are based on 9 of 11 runs. * indicates the excluded runs.



RESULTS

**Table 2-5:
CO Relative Accuracy (USEPA M-10 / PS4A)**

Run No.	Start Time	Date (2015)	RM Data (ppm@0%O2)	CEMS Data (ppm@0%O2)	Difference (ppm@0%O2)	Difference Percent
1	08:59	Mar 25	149.96	154.55	-4.58	-3.1%
2 *	09:50	Mar 25	53.15	58.88	-5.73	-10.8%
3	10:32	Mar 25	66.35	69.31	-2.96	-4.5%
4 *	11:12	Mar 25	27.00	23.94	3.06	11.3%
5	11:50	Mar 25	100.51	97.81	2.70	2.7%
6	12:35	Mar 25	129.78	134.76	-4.98	-3.8%
7	13:18	Mar 25	140.33	139.60	0.73	0.5%
8	14:04	Mar 25	125.30	128.97	-3.67	-2.9%
9	14:58	Mar 25	133.01	132.65	0.36	0.3%
10	15:39	Mar 25	134.39	128.22	6.17	4.6%
11	16:29	Mar 25	115.06	117.95	-2.89	-2.5%
Average			121.63	122.65	-1.01	-0.8%

Relative Accuracy Test Audit Results

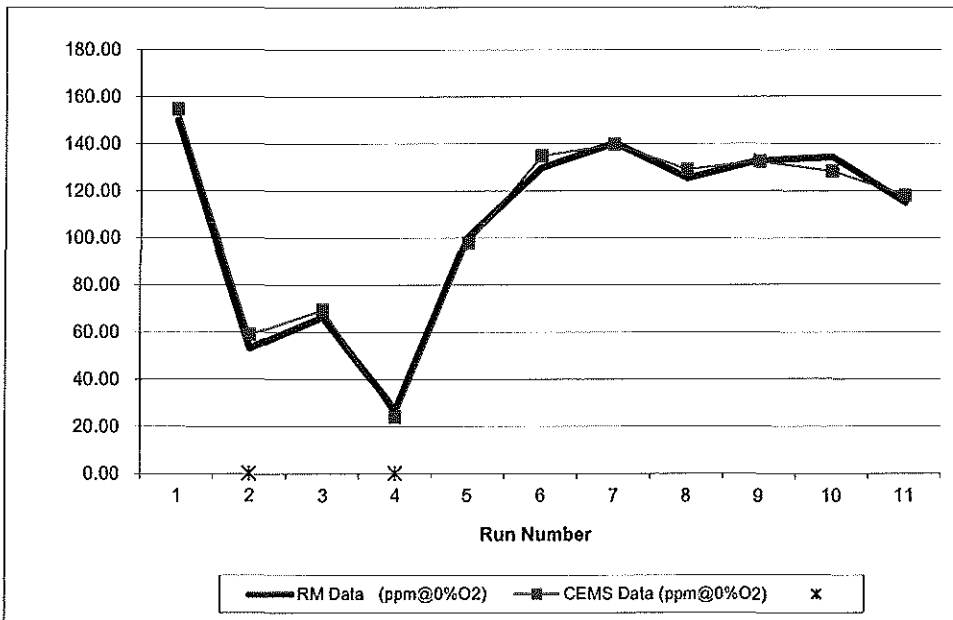
Standard Deviation of Differences	3.761	
Confidence Coefficient (CC)	2.891	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	3.2%	10.0%
Relative Accuracy (as % of Appl. Std.)	0.8%	5.0%
Appl. Std. = 500 ppm@0%O2		

RM = Reference Method (CleanAir Data)

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CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)

RATA calculations are based on 9 of 11 runs. * indicates the excluded runs.



RESULTS

2-6

**Table 2-6:
SO₂, NO_x, and CO Emissions (USEPA M-6C / 7E / 10)**

Run No.		1	2	3	4	5	6
Date (2015)		Mar 25	Mar 25	Mar 25	Mar 25	Mar 25	Mar 25
Start Time (approx.)		08:59	09:50	10:32	11:12	11:50	12:35
Stop Time (approx.)		09:20	10:11	10:53	11:33	12:11	12:56
Process Conditions							
P ₁	FCC charge rate (bpd)	23,314	22,394	22,812	23,155	23,411	23,500
P ₂	NH ₃ Injection (lb/hr)	17.89	17.98	17.83	17.83	17.77	17.80
Gas Conditions							
O ₂	Oxygen (dry volume %)	2.22	2.95	2.76	3.17	2.55	2.41
CO ₂	Carbon dioxide (dry volume %) ¹	16.6	15.6	15.9	15.5	16.1	16.3
Sulfur Dioxide Results²							
C _{sd}	Concentration (ppmdv)	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45
C _{sd-x}	Concentration @ 0% O ₂ (ppmdv)	< 0.51	< 0.53	< 0.52	< 0.53	< 0.51	< 0.51
C _{sd}	Concentration (lb/dscf)	<7.52E-08	<7.52E-08	<7.52E-08	<7.52E-08	<7.52E-08	<7.52E-08
Nitrogen Oxides Results							
C _{sd}	Concentration (ppmdv)	19.9	24.1	22.5	24.8	20.9	20.7
C _{sd-x}	Concentration @ 0% O ₂ (ppmdv)	22.2	28.0	26.0	29.2	23.9	23.3
C _{sd}	Concentration (lb/dscf)	2.37E-06	2.87E-06	2.69E-06	2.96E-06	2.50E-06	2.47E-06
Carbon Monoxide Results							
C _{sd}	Concentration (ppmdv)	134.07	45.65	57.59	22.91	88.23	114.85
C _{sd-x}	Concentration @ 0% O ₂ (ppmdv)	150.0	53.2	66.3	27.0	100.5	129.8
Run No. 7 8 9 10 11 Average							
Date (2015)		Mar 25	Mar 25	Mar 25	Mar 25	Mar 25	
Start Time (approx.)		13:18	14:04	14:58	15:39	16:29	
Stop Time (approx.)		13:39	14:25	15:19	16:00	16:50	
Process Conditions							
P ₁	FCC charge rate (bpd)	23,451	23,438	23,460	23,478	23,387	23,255
P ₂	NH ₃ injection (lb/hr)	17.67	17.80	17.77	17.76	17.77	17.81
Gas Conditions							
O ₂	Oxygen (dry volume %)	2.35	2.42	2.36	2.37	2.45	2.55
CO ₂	Carbon dioxide (dry volume %) ¹	16.3	16.2	16.4	16.3	16.2	16.1
Sulfur Dioxide Results²							
C _{sd}	Concentration (ppmdv)	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45
C _{sd-x}	Concentration @ 0% O ₂ (ppmdv)	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	<0.51
C _{sd}	Concentration (lb/dscf)	<7.52E-08	<7.52E-08	<7.52E-08	<7.52E-08	<7.52E-08	<7.52E-08
Nitrogen Oxides Results							
C _{sd}	Concentration (ppmdv)	22.2	22.9	20.9	22.1	22.4	22.1
C _{sd-x}	Concentration @ 0% O ₂ (ppmdv)	25.0	25.9	23.5	24.9	25.4	25.2
C _{sd}	Concentration (lb/dscf)	2.65E-06	2.73E-06	2.49E-06	2.63E-06	2.67E-06	2.64E-06
Carbon Monoxide Results							
C _{sd}	Concentration (ppmdv)	124.55	110.80	117.98	119.14	101.57	94.30
C _{sd-x}	Concentration @ 0% O ₂ (ppmdv)	140.3	125.3	133.0	134.4	115.1	106.80

Average includes 11 runs.

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¹ Average CO₂ includes 10 run, Run 1 is not included.² For SO₂, '<' indicates a measured response below the detection limit (assumed to be 1% of the instrument calibration span).

End of Section 2 – Results