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REPORT ON RATA & COMPLIANCE TESTING

Performed for:
MARATHON PETROLEUM COMPANY LP
DETROIT REFINERY

CRUDE/VACUUM HEATER STACK (SV04-H1-05-H1)

Client Reference No: 4100048779
CleanAir Project No: 12497-1
Revision 0: August 11, 2014

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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REVISION HISTORY

REPORT ON RATA & COMPLIANCE TESTING

DRAFT REPORT REVISION HISTORY

Revision:	Date	Pages	Comments
D0a	07/25/14	All	Draft version of original document.

FINAL REPORT REVISION HISTORY

Revision:	Date	Pages	Comments
0	08/11/14	All	Final version of original document.

PROJECT OVERVIEW

INTRODUCTION

Marathon Petroleum Company LP (MPC) contracted Clean Air Engineering (CleanAir) to perform emission measurements at the Detroit refinery for relative accuracy test audit (RATA) and compliance purposes.

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 (DEQ). 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
Thomas Gasloli – DEQ
Ken Sullivan – CleanAir

Test Program Parameters

The testing was performed at the Crude/Vacuum Heater Stack (Emission Unit ID No. EG05-CRUDEHTR and EG04-VACHTR; Common Stack ID No. SV04-H1-05-H1) on June 24 and 25, 2014, and included the following emissions measurements:

- particulate matter (PM), assumed equivalent to filterable particulate matter (FPM) only
- volatile organic compounds (VOCs), assumed equivalent to total hydrocarbons (THCs) minus the following constituents:
  - methane (CH_4)
  - ethane (C_2H_6)
- nitrogen oxides (NO_X)
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas flow rate

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	Crude/Vacuum Heater Stack	USEPA Method 5	FPM	06/24/14	11:50	16:27
2	Crude/Vacuum Heater Stack	USEPA Method 5	FPM	06/24/14	17:05	19:47
3	Crude/Vacuum Heater Stack	USEPA Method 5	FPM	06/25/14	11:20	13:45
1	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	11:19	11:40
2	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	12:10	12:31
3	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	12:43	13:04
4	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	13:14	13:35
5	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	13:48	14:09
6	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	15:37	15:58
7	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	16:13	16:34
8	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	17:01	17:22
9	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	17:43	18:04
10	Crude/Vacuum Heater Stack	USEPA Method 3A/7E	$O_2/CO_2/NO_X$	06/24/14	18:19	18:40
1	Crude/Vacuum Heater Stack	USEPA Method 3A/18/25A	$O_2/CO_2/CH_4/C_2H_6/THC$	06/24/14	12:10	13:35
2	Crude/Vacuum Heater Stack	USEPA Method 3A/18/25A	$O_2/CO_2/CH_4/C_2H_6/THC$	06/24/14	13:48	16:34
3	Crude/Vacuum Heater Stack	USEPA Method 3A/18/25A	$O_2/CO_2/CH_4/C_2H_6/THC$	06/24/14	17:01	18:40

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PROJECT OVERVIEW

Results Summary

Tables 1-2 and 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 Emission Compliance Test Results

Source Constituent (Units)	Sampling Method	Average Emission	Permit Limit[1]
Crude/Vacuum Heater Stack			
PM (lb/MMBtu)	USEPA 5	0.0007	0.0019
VOC (lb/MMBtu)	USEPA 25A / 18	<0.0007	0.0055
NO_X (lb/MMBtu)	USEPA 7E	0.03	0.05

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

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Table 1-3:
Summary of RATA Results

Source Constituent (Units)	Reference Method (USEPA)	Applicable Specification	Relative Accuracy (%)	Specification Limit[1]
Crude/Vacuum Heater Stack				
O_2 (% dv)	3A	PS3	0.1	±1.0% dv
NOx (ppmdv)	7E	PS2	6.4	20% of RM

[1] Specification limits obtained from 40 CFR 60, Appendix B, Performance Specifications.

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Discussion of Test Program

FPM Testing - USEPA Method 5

For this test program, PM emission rate is assumed equivalent to FPM emission rate. Three (3) 120-minute Method 5 test runs were performed on June 24 and 25. The final result was expressed as the average of three valid runs and was below the permit limit for PM.

PROJECT OVERVIEW

O_2 and NO_X Emissions / RATA Testing - USEPA Methods 3A and 7E; Performance Specifications 2 and 3

Minute-average data points for O_2, CO_2 and NO_X (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 O_2, RA is expressed as the average absolute difference between the RM and facility CEMS runs. The final result was below the limit of ±1.0%dv set by PS3.
- For NOx, RA is expressed as the percent difference between RM and facility CEMS runs. The final result was below the limit of 20% of the RM set by PS2.
- CO_2 data was collected only as supplemental information.

NO_X results from the RATA were converted from units of dry volume-based concentration (ppmdv) to mass-based emission rate units (lb/MMBtu) to demonstrate compliance with permit limits. The final result was expressed as the average of all 10 RATA runs. The final result was below the permit limit.

VOC Testing - USEPA Methods 25A and 18

VOC testing was performed concurrently with the RATA testing. Nine (9) 21-minute Method 25 test runs for THCs were performed concurrently with three (3) Method 18 bag collections for CH_4 and C_2H_6, with each Method 18 sample collected over a period of about 63 minutes. The Method 18 samples were collected as follows:

- Method 18 Run 1: Collected during Method 25A Runs 2, 3 and 4,
- Method 18 Run 2: Collected during Method 25A Runs 5, 6 and 7,
- Method 18 Run 3: Collected during Method 25A Runs 8, 9 and 10.

Following the first 21-minute test run, the THC analyzer failed the bias test. The analyzer was re-calibrated before Run 2 started. The THC data from the first 21-minute test run was not used to calculate the final results. The raw data from this run can be found in Appendix G of the report.

VOC emission rate is normally equivalent to THC emission rate, minus CH_4 and C_2H_6 emission rate (lb/MMBtu for all constituents).

- For THC, the drift-corrected concentration was below the assumed detection limit of 1% of the instrument calibration span for Runs 1 through 3. The worst-case concentration results used to calculate mass-based emissions for these runs is defined as some number "less than" 1% of the calibration span.
- For CH_4 and C_2H_6, a non-detectable result was obtained for all runs, so no correction made to the THC results.

Therefore, VOC emissions are equivalent to THC emissions. The final results were expressed as the average of three (3) valid runs and were below the permit limit.

Calculation of Final Results

Emission results in units of dry volume-based concentration (lb/dscf, ppmdv) were converted to units of pounds per million Btu (lb/MMBtu) by calculating an oxygen-based fuel factor (F_d) for refinery gas per USEPA Method 19 specifications. The heat content and F_d factor were calculated from percent volume composition analytical data provided by MPC and tabulated heating values for each of the measured constituents.

Two fuel gas analyses were performed by MPC on each test day (3:30 and 15:30, respectively). The analysis used to calculate the emissions results for each test run was selected by choosing the analysis performed nearest to each emissions test run interval.

General Considerations

The total time it took to complete Method 5 Run 1 and Method 25A/18 Run 2 was significantly greater than the other test runs. This was a result of an approximately 90-minute extreme weather delay. During this time period, the test crew paused the testing in order to seek shelter. The pause in testing occurred just following the completion of Method 3A/7E/25A Run 5, which coincided with approximately the 85th minute of Method 5 Run 1. When the facility issued the all-clear notice, testing resumed.

End of Section 1 – Project Overview

RESULTS

Table 2-1:
Crude/Vacuum Heater Stack – FPM Emissions (USEPA M-5)

Run No.		1	2	3	Average
Date (2014)		Jun 24	Jun 24	Jun 25	
Start Time (approx.)		11:50	17:05	11:20	
Stop Time (approx.)		16:27	19:47	13:45	
Process Conditions					
F_d	Oxygen-based F-factor (dscf/MMBtu)	7,889	7,889	7,884	**7,887**
H_I	Actual heat input (MMBtu/hr)	291	285	273	**283**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	5.7	6.1	5.9	**5.9**
CO_2	Carbon dioxide (dry volume %)	8.8	8.4	8.6	**8.6**
T_s	Sample temperature (°F)	288	289	291	**289**
B_w	Actual water vapor in gas (% by volume)	16.2	16.1	15.2	**15.9**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	114,000	116,000	110,000	**113,000**
Q_s	Volumetric flow rate, standard (scfm)	77,600	78,300	75,200	**77,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	65,000	65,700	63,800	**64,800**
Q_a	Volumetric flow rate, actual (acf/hr)	6,850,000	6,930,000	6,570,000	**6,790,000**
Q_s	Volumetric flow rate, standard (scf/hr)	4,650,000	4,700,000	4,510,000	**4,620,000**
Q_{std}	Volumetric flow rate, dry standard (dscf/hr)	3,900,000	3,940,000	3,830,000	**3,890,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	80.01	80.75	83.13	**81.30**
%I	Isokinetic sampling (%)	99.7	99.6	105.5	**101.6**
Laboratory Data					
m_n	Total FPM (g)	0.00228	0.00248	0.00213	
m_{Part}	Total filterable particulate matter (g)	0.00228	0.00248	0.00213	
n_{MDL}	Number of non-detectable fractions	N/A	N/A	N/A	
DLC	Detection level classification	ADL	ADL	ADL	
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	6.28E-08	6.77E-08	5.65E-08	**6.24E-08**
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.245	0.267	0.216	**0.243**
$E_{T/yr}$	Particulate Rate (Ton/yr)	1.07	1.17	0.947	**1.06**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0007	0.0008	0.0006	**0.0007**

Average includes 3 runs.

Detection level classifications are defined as follows:

ADL = Above Detection Level - all fractions are above detection limit

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RESULTS

Table 2-2:
Uncertainty Analysis – FPM (USEPA M-5)

		FPM Results (lb/MMBtu)		FPM Results (lb/hr)		FPM Results (Ton/yr)
Method		**5**		**5**		**5**
Run No.	**1**	0.0007	**1**	0.2450	**1**	1.0732
	2	0.0008	**2**	0.2668	**2**	1.1687
	3	0.0006	**3**	0.2162	**3**	0.9470
SD		0.0001		0.0254		0.1112
AVG		**0.0007**		**0.2427**		**1.0630**
RSD		9.8%		10.5%		10.5%
N		3		3		3
SE		0.0000		0.0147		0.0642
RSE		5.6%		6.0%		6.0%
P		95.0%		95.0%		95.0%
TINV		4.303		4.303		4.303
CI +		0.0009		0.3058		1.3393
AVG		**0.0007**		**0.2427**		**1.0630**
CI -		0.0005		0.1796		0.7866
TB +		0.0012		0.4371		1.9146

AVG (average) is the mean value of the runs; N is the number of individual runs.

SD (standard deviation) and RSD (relative standard deviation) are measures of the variability of individual runs.

SE (standard error) and RSE (relative standard error) are measures of the variability of the average of the runs.

P (probability) is the confidence level associated with the two-tailed Student's t-distribution.

TINV (t-value) is the value of the Student's t-distrubution as a function of P (probability) and N-1 (degrees of freedom).

CI (confidence interval) indicates that if the test is conducted again under the same conditions, the average would be expected to fall within the interval (CI- to CI+) about 95% of the time.

TB+ (upper tolerance bound) is the value below which 95% of future runs are expected to fall (assuming testing at the same conditions).

RESULTS

Table 2-3:
Crude/Vacuum Heater Stack – THC, CH_4, C_2H_6 & VOC Emissions (USEPA M-25A/18)

Run No.		1	2	3	Average
Date (2014)		Jun 24	Jun 24	Jun 24	
Start Time (approx.)		12:10	13:48	17:01	
Stop Time (approx.)		13:35	16:34	18:40	
Process Conditions					
F_d	Oxygen-based F-factor (dscf/MMBtu)	7,889	7,889	7,889	7,889
H_I	Heat input (MMBtu/hr)	289	291	285	289
Gas Conditions					
O_2	Oxygen (dry volume %)	7.66	7.58	7.78	7.67
CO_2	Carbon dioxide (dry volume %)	6.7	6.8	6.7	6.8
B_w	Actual water vapor in gas (% by volume)[1]	16.2	16.2	16.1	16.2
THC Results					
C_{sd}	Concentration (ppmdv as C_3H_8)	<0.498	<0.498	<0.497	<0.498
C_{sd}	Concentration (lb/dscf)	<5.70E-08	<5.70E-08	<5.69E-08	<5.69E-08
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Methane Results					
C_{sd}	Concentration (ppmdv)	<0.108	<0.108	<0.108	<0.108
C_{sd}	Concentration (lb/dscf)	<4.50E-09	<4.50E-09	<4.50E-09	<4.50E-09
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ethane Results					
C_{sd}	Concentration (ppmdv)	<0.119	<0.119	<0.119	<0.119
C_{sd}	Concentration (lb/dscf)	<9.29E-09	<9.29E-09	<9.29E-09	<9.29E-09
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	< 0.0001	< 0.0001	< 0.0001	< 0.0001
VOC Results					
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	<0.0007	<0.0007	<0.0007	< 0.0007

Average includes 3 runs.

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[1] Moisture data used for ppmwv to ppmdv correction obtained from nearly-concurrent M-5 runs.

For THC and VOC, '<' indicates a measured response below the detection limit (assumed to be 1% of the instrument calibration span).

For methane and ethane, '<' indicates a measured response below the analytical detection limit determined by the laboratory.

RESULTS

Table 2-4:
Crude/Vacuum Heater Stack – NO_X Emissions (USEPA M-7E)

Run No.		1	2	3	4	5	6
Date (2014)		Jun 24	Jun 24	Jun 24	Jun 24	Jun 24	Jun 24
Start Time (approx.)		11:19	12:10	12:43	13:14	13:48	15:37
Stop Time (approx.)		11:40	12:31	13:04	13:35	14:09	15:58
Process Conditions							
F_d	Oxygen-based F-factor (dscf/MMBtu)	7,889	7,889	7,889	7,889	7,889	7,889
H_i	Heat input (MMBtu/hr)	290	289	289	290	289	293
Gas Conditions							
O_2	Oxygen (dry volume %)	7.8	7.6	7.7	7.7	7.7	7.5
CO_2	Carbon dioxide (dry volume %)	6.7	6.8	6.7	6.7	6.8	6.8
Nitrogen Oxides Results							
C_{sd}	Concentration (ppmdv)	21.6	20.7	21.1	21.5	21.6	21.1
C_{sd}	Concentration (lb/dscf)	2.58E-06	2.48E-06	2.51E-06	2.57E-06	2.58E-06	2.52E-06
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	0.0324	0.0307	0.0313	0.0321	0.0321	0.0310

Run No.		7	8	9	10	Average
Date (2014)		Jun 24	Jun 24	Jun 24	Jun 24	
Start Time (approx.)		16:13	17:01	17:43	18:19	
Stop Time (approx.)		16:34	17:22	18:04	18:40	
Process Conditions						
F_d	Oxygen-based F-factor (dscf/MMBtu)	7,889	7,889	7,889	7,889	**7,889**
H_i	Heat input (MMBtu/hr)	292	286	284	284	**289**
Gas Conditions						
O_2	Oxygen (dry volume %)	7.6	7.7	7.8	7.8	**7.7**
CO_2	Carbon dioxide (dry volume %)	6.8	6.8	6.7	6.7	**6.7**
Nitrogen Oxides Results						
C_{sd}	Concentration (ppmdv)	21.0	21.1	21.6	21.6	**21.3**
C_{sd}	Concentration (lb/dscf)	2.50E-06	2.52E-06	2.58E-06	2.58E-06	**2.54E-06**
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	0.0309	0.0315	0.0324	0.0326	**0.0317**

Average includes 10 runs.

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RESULTS

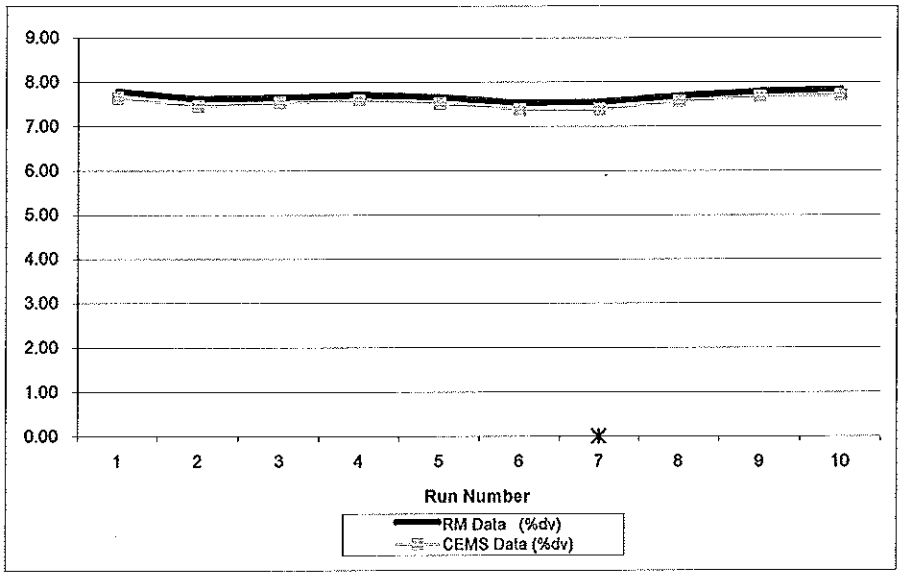
Table 2-5:
Crude/Vacuum Heater Stack – O_2 Relative Accuracy (USEPA M-3A / PS3)

Run No.	Start Time	Date (2014)	RM Data (%dv)	CEMS Data (%dv)	Difference (%dv)	Difference Percent
1	11:19	Jun 24	7.79	7.64	0.15	1.9%
2	12:10	Jun 24	7.62	7.45	0.17	2.2%
3	12:43	Jun 24	7.65	7.53	0.12	1.6%
4	13:14	Jun 24	7.71	7.59	0.12	1.6%
5	13:48	Jun 24	7.66	7.51	0.15	2.0%
6	15:37	Jun 24	7.53	7.38	0.15	2.0%
7 *	16:13	Jun 24	7.55	7.38	0.17	2.3%
8	17:01	Jun 24	7.69	7.56	0.13	1.7%
9	17:43	Jun 24	7.79	7.68	0.11	1.4%
10	18:19	Jun 24	7.84	7.70	0.14	1.8%
Average			**7.70**	**7.56**	**0.14**	**1.8%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.019	
Confidence Coefficient (CC)	0.015	
t-Value for 9 Data Sets	2.306	
		Limit
Avg. Abs. Diff. (%dv)	**0.138**	**1.0**

RM = Reference Method (CleanAir Data) 072214 162703
CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



RESULTS

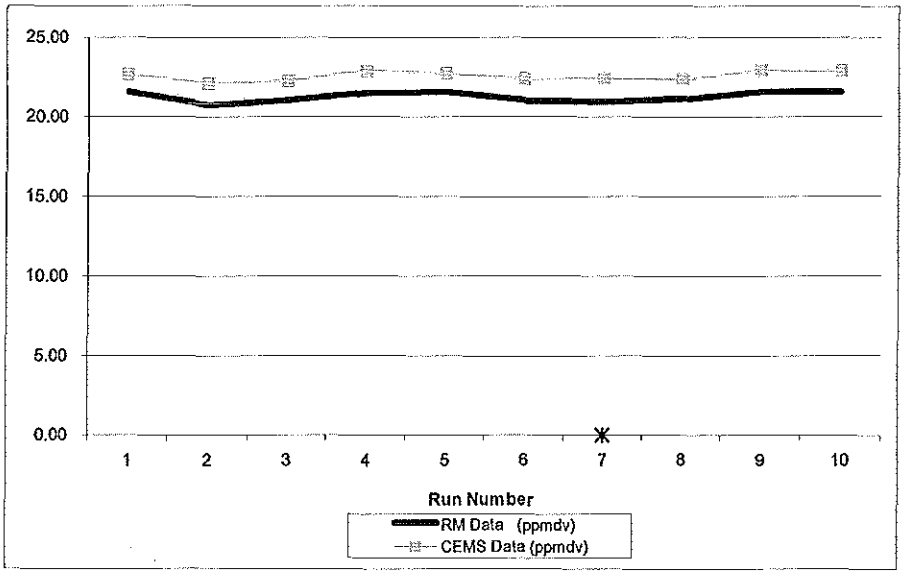
Table 2-6:
Crude/Vacuum Heater Stack – NO_X Relative Accuracy (USEPA M-7E / PS2)

Run No.	Start Time	Date (2014)	RM Data (ppmdv)	CEMS Data (ppmdv)	Difference (ppmdv)	Difference Percent
1	11:19	Jun 24	21.58	22.69	-1.11	-5.1%
2	12:10	Jun 24	20.73	22.11	-1.38	-6.7%
3	12:43	Jun 24	21.06	22.27	-1.21	-5.7%
4	13:14	Jun 24	21.52	22.93	-1.41	-6.6%
5	13:48	Jun 24	21.57	22.74	-1.17	-5.4%
6	15:37	Jun 24	21.07	22.38	-1.31	-6.2%
7 *	16:13	Jun 24	20.97	22.42	-1.45	-6.9%
8	17:01	Jun 24	21.11	22.34	-1.23	-5.8%
9	17:43	Jun 24	21.57	22.93	-1.36	-6.3%
10	18:19	Jun 24	21.60	22.90	-1.30	-6.0%
Average			**21.31**	**22.59**	**-1.28**	**-6.0%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.102	
Confidence Coefficient (CC)	0.078	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	**6.4%**	**20.0%**

RM = Reference Method (CleanAir Data) 072214 162703
CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



End of Section 2 – Results