

# 1. PROJECT OVERVIEW

## Test Program Summary

Marathon Petroleum Company LP (MPC) contracted CleanAir Engineering (CleanAir) to successfully complete testing at the Vacuum 2 Heater (EU04-VAC2HTR-S1) at the Detroit Refinery, located in Detroit, Michigan. The test program included a relative accuracy test audit (RATA) on the facility's continuous emissions monitoring system (CEMS) for oxygen (O<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>).

A summary of the test program results is presented below. Section 2 Results provides a more detailed account of the test conditions and data analysis.

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

<u>Source</u> Constituent	<u>Reference</u> Method	<u>Relative</u> <u>Accuracy (%)</u> <sup>1</sup>	<u>Applicable</u> <u>Specification</u>	<u>Specification</u> <u>Limit</u> <sup>2</sup>
<u>Vacuum 2 Heater</u>				
O <sub>2</sub> (% dv)	3A	0.7	PS3	±1.0 % dv
NO <sub>x</sub> (ppm @ 0% O <sub>2</sub> )	7E	3.5	PS2	20% of RM
NO <sub>x</sub> (lb/MMBtu)	7E	3.5	PS2	20% of RM

<sup>1</sup> 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 cited.

<sup>2</sup> Specification limits obtained from 40 CFR 60, Appendix B, Performance Specifications.

## Test Program Details

### Parameters

The test program included the following measurements:

- nitrogen oxides (NO<sub>x</sub>)
- oxygen (O<sub>2</sub>)
- carbon dioxide (CO<sub>2</sub>)

## Schedule

Testing was performed on June 13, 2019. The on-site schedule followed during the test program is outlined in Table 1-2.

**Table 1-2:  
Test Schedule**

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	07:53	08:14
2	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	08:24	08:45
3	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	08:56	09:17
4	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	09:27	09:48
5	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	09:58	10:19
6	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	10:47	11:08
7	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	11:17	11:38
8	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	11:48	12:09
9	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	12:18	12:39
10	Vacuum 2 Heater	USEPA Method 3A / 7E	O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	06/13/19	12:48	13:09

## Discussion

### *Project Synopsis*

#### O<sub>2</sub> and NO<sub>x</sub> RATA Testing

Minute-average data points for O<sub>2</sub> and NO<sub>x</sub> (dry basis) were collected over a period of 21 minutes for each run utilizing EPA Methods 3A and 7E. Relative accuracy was determined based on nine (9) of 10 total runs conducted per procedures outlined in Performance Specification (PS) 2, Section 8.4.4.

Sampling occurred at the three (3) points as specified in Section 8.1.3.2 of PS 2 during each run. The average result for each run was converted to identical units of measurement as the facility's CEMS and compared for relative accuracy.

#### Fuel Analysis

Emission results in units of dry volume-based concentration (lb/dscf, ppm<sub>dv</sub>) were converted into units of pounds per million Btu (lb/MMBtu) by applying an oxygen-based fuel factor (F<sub>d</sub>) provided by MPC for each test run.

#### Test Conditions

The unit was operated at the maximum normal operating capacity during each of the RATA test runs. MPC was responsible for logging any relevant process-related data and providing it to CleanAir for inclusion in the test report.

## 2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices, specifically Appendix C Parameters.

**Table 2-1:  
 Vacuum 2 Heater – O<sub>2</sub> (%dv) Relative Accuracy**

Run No.	Start Time	Date (2019)	RM Data (%dv)	CEMS Data (%dv)	Difference (%dv)	Difference Percent
1	07:53	Jun 13	5.16	5.91	-0.74	-14.4%
2	08:24	Jun 13	5.26	6.00	-0.74	-14.0%
3	08:56	Jun 13	5.25	5.99	-0.74	-14.1%
4	09:27	Jun 13	5.21	5.97	-0.76	-14.5%
5	09:58	Jun 13	5.04	5.78	-0.74	-14.6%
6	10:47	Jun 13	5.18	5.92	-0.75	-14.4%
7 *	11:17	Jun 13	4.97	5.72	-0.75	-15.1%
8	11:48	Jun 13	4.95	5.69	-0.74	-15.0%
9	12:18	Jun 13	4.85	5.58	-0.73	-15.0%
10	12:48	Jun 13	5.08	5.79	-0.71	-14.1%
<b>Average</b>			<b>5.11</b>	<b>5.85</b>	<b>-0.74</b>	<b>-14.4%</b>

**Relative Accuracy Test Audit Results**

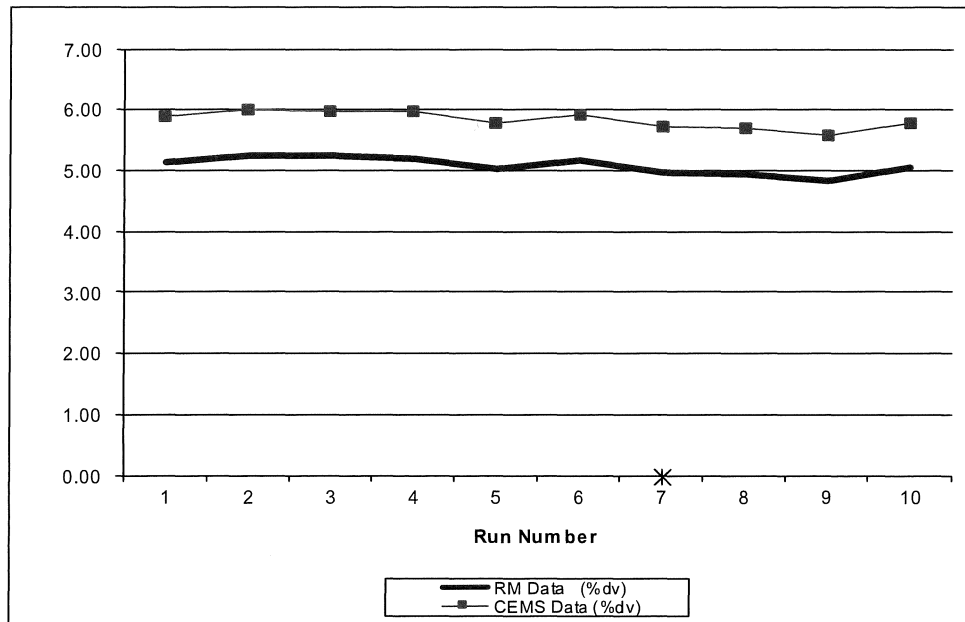
Standard Deviation of Differences	0.011835	
Confidence Coefficient (CC)	0.009097	
t-Value for 9 Data Sets	2.306	
Avg. Abs. Diff. (%dv)	<b>0.738</b>	Limit <b>1.0</b>

RM = Reference Method (CleanAir Data)

071119 105902

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

RATA calculations are based on 9 of 10 runs. \* indicates the excluded run.



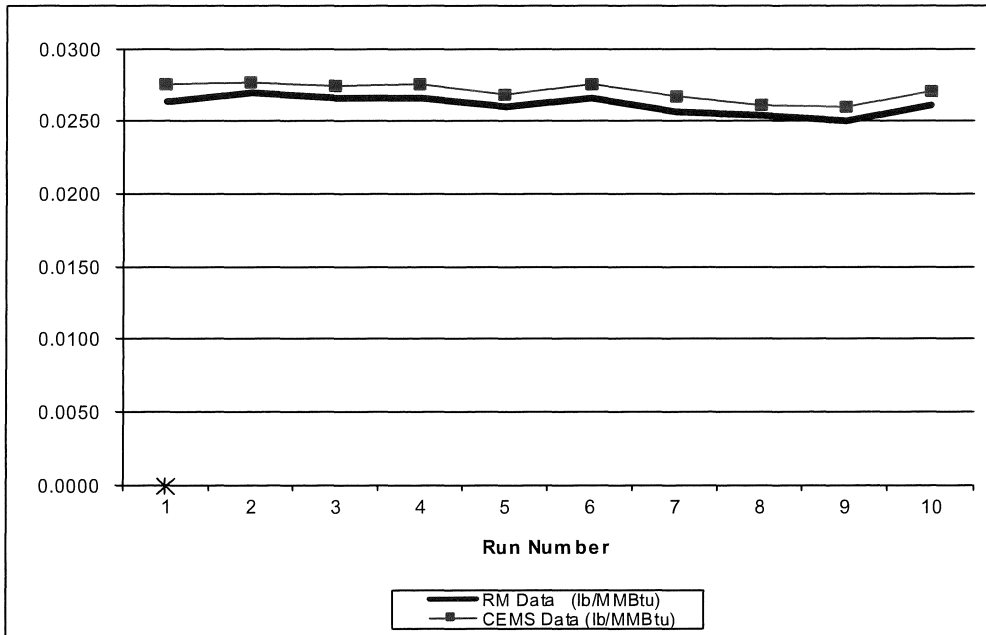
**Table 2-2:  
 Vacuum 2 Heater – NO<sub>x</sub> (lb/MMBtu) Relative Accuracy**

Run No.	Start Time	Date (2019)	RM Data (lb/MMBtu)	CEMS Data (lb/MMBtu)	Difference (lb/MMBtu)	Difference Percent
1 *	07:53	Jun 13	0.0265	0.0275	-0.0010	-4.0%
2	08:24	Jun 13	0.0270	0.0277	-0.0007	-2.6%
3	08:56	Jun 13	0.0267	0.0274	-0.0007	-2.6%
4	09:27	Jun 13	0.0266	0.0275	-0.0009	-3.3%
5	09:58	Jun 13	0.0260	0.0268	-0.0008	-2.9%
6	10:47	Jun 13	0.0266	0.0276	-0.0010	-3.6%
7	11:17	Jun 13	0.0257	0.0267	-0.0010	-3.9%
8	11:48	Jun 13	0.0254	0.0261	-0.0008	-3.0%
9	12:18	Jun 13	0.0251	0.0260	-0.0009	-3.5%
10	12:48	Jun 13	0.0262	0.0270	-0.0008	-3.2%
<b>Average</b>			<b>0.0261</b>	<b>0.0270</b>	<b>-0.0008</b>	<b>-3.2%</b>

**Relative Accuracy Test Audit Results**

Standard Deviation of Differences	0.000107	
Confidence Coefficient (CC)	0.000082	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	<b>3.5%</b>	<b>20.0%</b>
Relative Accuracy (as % of Appl. Std.)	<b>2.3%</b>	<b>10.0%</b>
Appl. Std. = 0.04 lb/MMBtu		

RM = Reference Method (CleanAir Data) 071119 105902  
 CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)  
 RATA calculations are based on 9 of 10 runs. \* indicates the excluded run.



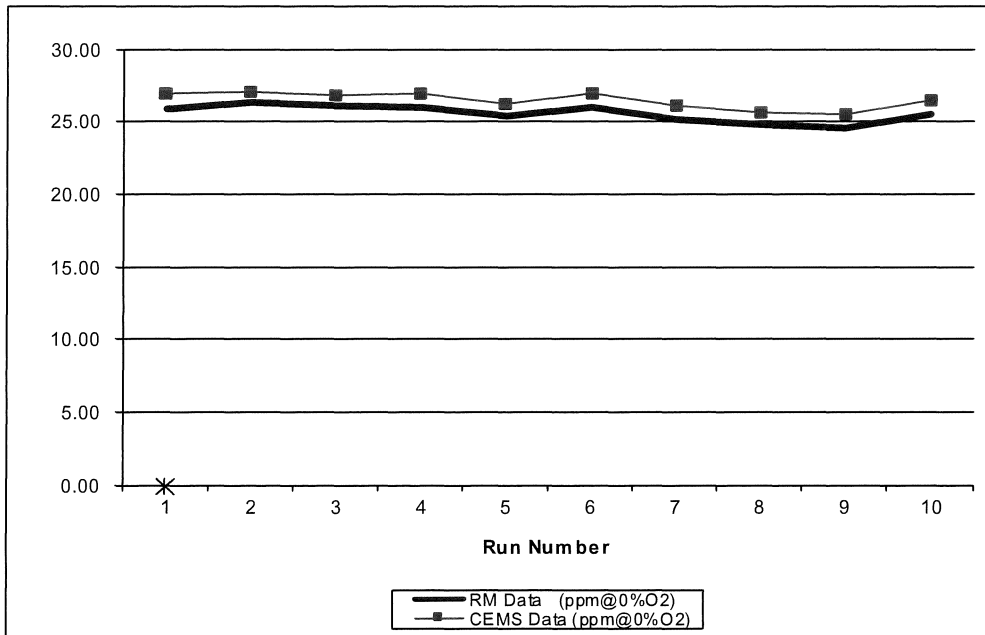
**Table 2-3:  
 Vacuum 2 Heater – NO<sub>x</sub> (ppm@0%O<sub>2</sub>) Relative Accuracy**

Run No.	Start Time	Date (2019)	RM Data (ppm@0%O <sub>2</sub> )	CEMS Data (ppm@0%O <sub>2</sub> )	Difference (ppm@0%O <sub>2</sub> )	Difference Percent
1 *	07:53	Jun 13	25.89	26.91	-1.02	-4.0%
2	08:24	Jun 13	26.41	27.09	-0.69	-2.6%
3	08:56	Jun 13	26.10	26.79	-0.69	-2.6%
4	09:27	Jun 13	26.08	26.93	-0.85	-3.3%
5	09:58	Jun 13	25.49	26.23	-0.74	-2.9%
6	10:47	Jun 13	26.05	27.00	-0.95	-3.6%
7	11:17	Jun 13	25.15	26.13	-0.98	-3.9%
8	11:48	Jun 13	24.84	25.59	-0.75	-3.0%
9	12:18	Jun 13	24.60	25.45	-0.85	-3.5%
10	12:48	Jun 13	25.61	26.43	-0.82	-3.2%
<b>Average</b>			<b>25.59</b>	<b>26.40</b>	<b>-0.81</b>	<b>-3.2%</b>

**Relative Accuracy Test Audit Results**

Standard Deviation of Differences	0.104868	
Confidence Coefficient (CC)	0.080609	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	3.5%	20.0%
Relative Accuracy (as % of Appl. Std.)	2.2%	10.0%
Appl. Std. = 40 ppm@0%O <sub>2</sub>		

RM = Reference Method (CleanAir Data) 071119 10.5902  
 CEMS = Continuous Emissions Monitoring System (Marathon Petroleum Company Data)  
 RATA calculations are based on 9 of 10 runs. \* indicates the excluded run.



### 3. DESCRIPTION OF INSTALLATION

#### Process Description

MPC's facility in Detroit, Michigan, produces refined petroleum products from crude oil. MPC must continue to demonstrate that select process units are in compliance with permitted emission limits.

The Vacuum Unit (EU04-VACUUM) separates the reduced crude from the Crude Unit through the use of a vacuum column. The reduced crude is separated into light vacuum gas oil, medium vacuum gas oil, heavy vacuum gas oil and a bottoms product called flux. The various fractions are sent to other units in the refinery for further processing. The Vacuum Unit consists of process vessels (including heat exchangers and a vacuum column), two process heaters, tanks, containers, two cooling towers, flare, compressors, pumps, piping, drains, and various components (pumps and compressor seals, process valves, pressure relief valves, flanges, connectors, etc.).

The Vacuum 2 Heater (EU04-VAC2HTR-S1) is fired by refinery fuel gas. Emissions are vented to the atmosphere via the Vacuum 2 Heater Stack (SV04-H2), where testing was performed.

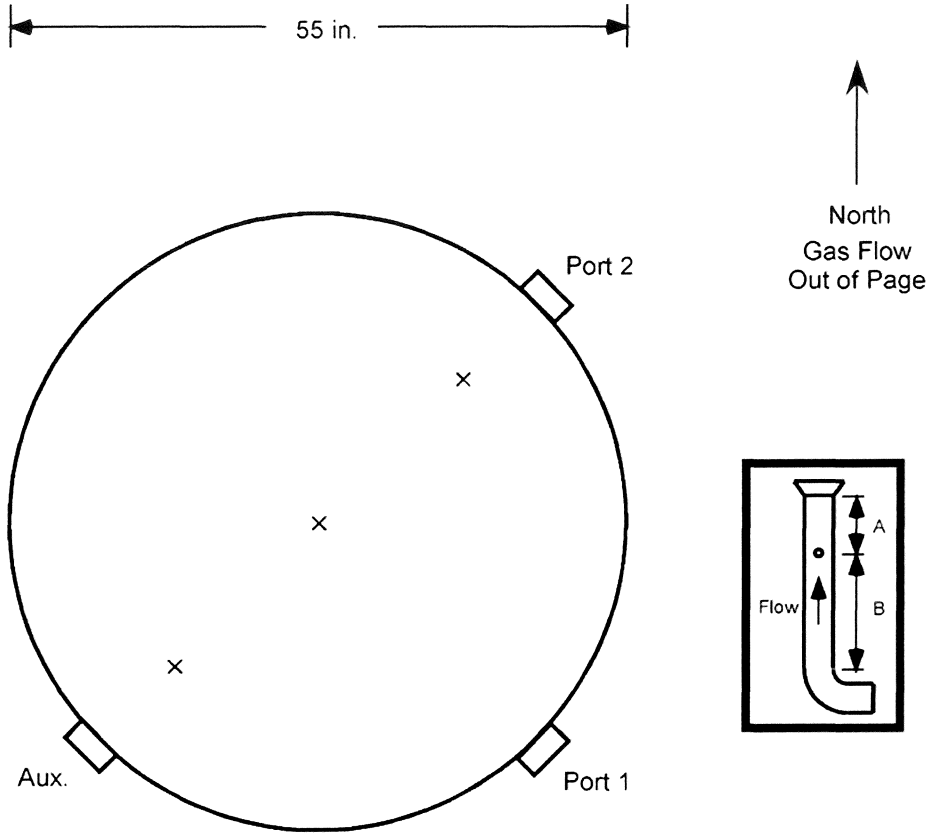
#### Test Location

The sample point locations were determined by Performance Specification 2. Table 3-1 presents the sampling information for the test location described in this report. The figure shown on page 7 represents the layout of the test location.

**Table 3-1:  
Sampling Information**

Source Constituent	Method (USEPA)	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
Vacuum 2 Heater O <sub>2</sub> / CO <sub>2</sub> / NO <sub>x</sub>	3A/7E	1-10	1	3	7	21	3-1

**Figure 3-1:**  
**O<sub>2</sub>, CO<sub>2</sub>, and NO<sub>x</sub> Sample Point Layout**



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	83.3	45.8
2	50.0	27.5
3	16.7	9.2

Duct diameters upstream from flow disturbance (A): 9.2

Limit: 0.5

Duct diameters downstream from flow disturbance (B): 12.0

Limit: 2.0

## 4. METHODOLOGY

### Procedures and Regulations

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The test program sampling measurements followed procedures and regulations outlined by the United States Environmental Protection Agency (USEPA) and the Michigan Department of Environmental Quality (DEQ). These methods appear in detail in Title 40 of the CFR and at <https://www.epa.gov/emc>.

Appendix A includes diagrams of the sampling apparatus, as well as specifications for sampling, recovery, and analytical procedures. Any modifications to standard test methods are explicitly indicated in this appendix.

In accordance with ASTM D7036 requirements, CleanAir included a description of any such modifications, along with the full context of the objectives and requirements of the test program in the test protocol submitted prior to the measurement portion of this project. Modifications to standard methods are not covered by the ISO 17025 and TNI portions of CleanAir's A2LA accreditation.

CleanAir follows specific QA/QC procedures outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods," EPA/600/R-94/038C. Appendix D contains additional QA/QC measures, as outlined in CleanAir's internal Quality Manual.

#### Title 40 CFR Part 60, Appendix A

- Method 3A "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
- Method 7E "Determination of Nitrogen Oxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)"

#### Title 40 CFR Part 60, Appendix B Performance Specifications

- PS 2 "Specifications and Test Procedures for SO<sub>2</sub> and NO<sub>x</sub> Continuous Emission Monitoring Systems in Stationary Sources"
- PS 3 "Specifications and Test Procedures for O<sub>2</sub> and CO<sub>2</sub> Continuous Emission Monitoring Systems in Stationary Sources"



## Methodology Discussion

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*O<sub>2</sub>, CO<sub>2</sub>, and NO<sub>x</sub> Testing – USEPA Methods 3A and 7E; Performance Specifications 2 and 3*  
Reference method (RM) O<sub>2</sub> concentrations were determined using a paramagnetic analyzer per EPA Method 3A. RM NO<sub>x</sub> emissions were determined using a chemiluminescent analyzer per EPA Method 7E. Carbon dioxide (CO<sub>2</sub>) concentrations were determined using an NDIR analyzer per EPA Method 3A for supplemental purposes.

Sample gas was extracted at a constant rate, conditioned to remove moisture, and delivered to an analyzer bank which measured concentration on a dry basis (units of %dv or ppmdv).

Calibration error checks were performed by introducing zero nitrogen (N<sub>2</sub>), high and mid-range calibration gases to the inlet of each analyzer during calibration error checks. Bias checks were performed before and after each sampling run by introducing calibration gas to the inlet of the sampling system's heated filter. Documentation of interference checks and NO<sub>2</sub> converter efficiency checks are included in this report. Per EPA Methods 3A and 7E, the average results for each run were drift-corrected.

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*End of Section*