erthwrks

AIR EMISSIONS TESTING FOR INDUSTRY

Relative Accuracy Test Audit and Compliance Test

for

Marathon Petroleum Company LP

at the

Marathon Detroit Refinery in Detroit, MI

on the

North Plant Incinerator (CX-6 SRU)
Unit: EU72-SULRBLOCK2-S1
Permit No. MI-ROP-A9831-2012c

Prepared for:

MARATHON

Marathon Petroleum Company LP

Test Date: August 21, 2024
Erthwrks Project No. 9565.1.C2

STAC STACK TESTING ACCREDITATION COUNCIL

ACCREDITED TO ASTM D7036 ONLY CERT #6147.01

Louisiana Environmental Lab Accreditation Program LELAP

CARB

Endorsement Page

This report was developed in accordance with the requirements designated in the applicable regulatory permit(s) and/or regulatory rules. To the best of my knowledge the techniques, instrumentation, and calculations presented in this report will serve to accurately and efficiently detail the results of the test campaign requirements.

Erthwrks, Inc.

Name: Jason Dunn

Title: QAQC Manager

Signature:

This report has been reviewed for accuracy and completeness. The actions presented in this report are, to the best of my knowledge, an accurate representation of the results and findings of the test campaign. Erthwrks, Inc. operates in conformance with the requirements on ASTM D7036-04 Standard Practice for Competence of Air Emission Testing Bodies and is accredited as such by the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA).

Erthwrks, Inc.

Name: John Wood

Title: Technical Director

Signature:

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1.0 INTRODUCTION

1.1 Identification, location and dates of tests

Erthwrks, Inc. was contracted to conduct emissions testing on the North Plant SRU in operation at the Marathon Detroit Refinery, located in Detroit Michigan. The testing program was conducted on August 21, 2024.

1.2 Purpose of Testing

The exhaust from North Plant SRU was sampled and analyzed to determine the relative accuracy of the associated sulfur dioxide (SO_2) and oxygen (O_2) continuous emissions monitoring system (CEMS) in accordance with the requirements in the Marathon Permit No. MI-ROP-A9831-2012c and the Title 40 CFR Part 60, Appendix F.

In addition to the RATA, a compliance test was conducted for carbon monoxide (CO).

1.3 Description of Source

Marathon Petroleum Company LP operates the North Plant SRU (EU72-SULRBLOCK2-S1) under EGLE Renewable Operating Permit No. MI-ROP-A9831-2012c and is required to conduct an annual RATA to demonstrate the relative accuracy of the CEMS associated with this unit.

Table 1.1—Marathon North Plant SRU CEMS Details

North Plant SRU CEMS	Manufacturer	Model No.	S/N	Install Date
SO_2	ABB	Limas 11	3.342682.1	2012
O_2	ABB	Magnos 206	3.342283.1	2012

1.4 Contact Information

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Facility Location:
Marathon Petroleum Company LP
Detroit Refinery
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Detroit, MI 48217

2.0 SUMMARY OF RESULTS

Table 2.1— Marathon NP SRU (EU72-SULRBLOCK2-S1) CEMS RATA Results

Pollutant Measured	Performance Specification	Relative Accuracy	Applicable Limit	Pass/Fail
SO_2 (ppmvd @ 0% O_2)	Performance Spec. 2	0.2% RA_{AS}	10%	Pass
O_2 (%vd)	Performance Spec. 3	0.3% RA_{MD}	1%	Pass

Table 2.2— Marathon NP SRU (EU72-SULRBLOCK2-S1) Compliance Test Results

Pollutant Measured	Methodology	Measured Result	Applicable Limit	Pass/Fail
CO	EPA Method 10	0.0053 lb/MMBtu	0.04 lb/MMBtu	n/a

3.0 SOURCE DESCRIPTION

3.1 Description of the process

Marathon Petroleum Company LP produces refined petroleum products from crude oil and is required to demonstrate that select process emission sources are operating in compliance with permitted emissions limits.

The North Plant Incinerator, or Sulfur Recovery Unit, removes H_2S from the acid gas and converts it into elemental sulfur using the Claus Process (Trains A and B), the SCOT Tail Gas Treating Unit process (Train No. 1 and No. 2), and associated amine treating equipment. Tail gas is routed to a thermal oxidizer, or incinerator, which oxidizes the remaining H2S in the tail gas to SO_2 before exhausting to the atmosphere via the SRU Incinerator Stack (SV72-V22). The emission group also consists of process vessels, heaters, tanks, containers, compressors, seals, process valves, flanges, connectors, etc.

3.2 Applicable permit and source designation

Marathon Petroleum Company LP operates the North Plant SRU (EU72-SULRBLOCK2-S1) under EGLE Renewable Operating Permit No. MI-ROP-A9831-2012c and is required to conduct an annual RATA to demonstrate the relative accuracy of the CEMS associated with this unit.

3.3 Type and quantity of materials processed during tests

During the emission testing on August 21, 2024, at the Marathon Petroleum Company LP Refinery, the North Plant SRU was tested while operating at load conditions representative of normal conditions. The load conditions during the testing were documented by Marathon Detroit Refinery and provided in Appendix F.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Gaseous Sampling – CO, SO_2 and O_2

For the gaseous sampling, Erthwrks utilized a stainless-steel probe, of sufficient length to reach all sampling points, inserted into a sampling port that is located on the stack in accordance with EPA Method 1. The sample is extracted through the probe, a heated Teflon sampling line, to a heating filter. The sample then enters a minimum contact sample conditioner that cools and removes moisture from the gas matrix prior to entering the Erthwrks sampling manifold.

Erthwrks followed all quality assurance and quality control procedures as defined in US EPA 40 CFR 60 Appendix A. The Calibration Error (CE) Test was conducted as specified in EPA Method 7E §8.2.3. In accordance with this requirement, a three-point analyzer calibration error test was conducted prior to sampling. The CE test was conducted by introducing the low, mid, and high-level calibration gasses (as defined in EPA Method 7E §3.3.1-3) sequentially and the response was recorded. The results of the CE test are acceptable if the calculated calibration error is within ±2.0% of calibration span (or ≤ 0.5 ppmv).

The Initial System Bias and System Calibration Error Check was conducted in accordance with EPA Method 7E §8.2.5. The upscale calibration gas was introduced at the probe upstream of all sample system components and the response recorded. The procedure was repeated with the low-level gas and the response recorded. During this activity, the sample system response time was also recorded. This specification is acceptable if the calculated values of the system calibration error check are within ±5.0% of the calibration span value (or ≤0.5 ppmv).

After each test run, the sample system bias check is conducted to validate the run data. The low-level and upscale drift are calculated using Equation 7E-4. The run data is valid if the calculated drift is within ±3.0% of the calibration span value (or ≤0.5 ppmv).

After each test run, the corrected effluent gas concentration was calculated as specified in EPA Method 7E §12.6. The arithmetic average of all valid concentration values are adjusted for bias using equation 7E-5B.

EPA Method 19 was used to calculate CO emissions lb/MMBtu. A fuel analysis was provided by the facility in order to determine the F-factor.

The figure below details the Erthwrks gaseous sampling system:

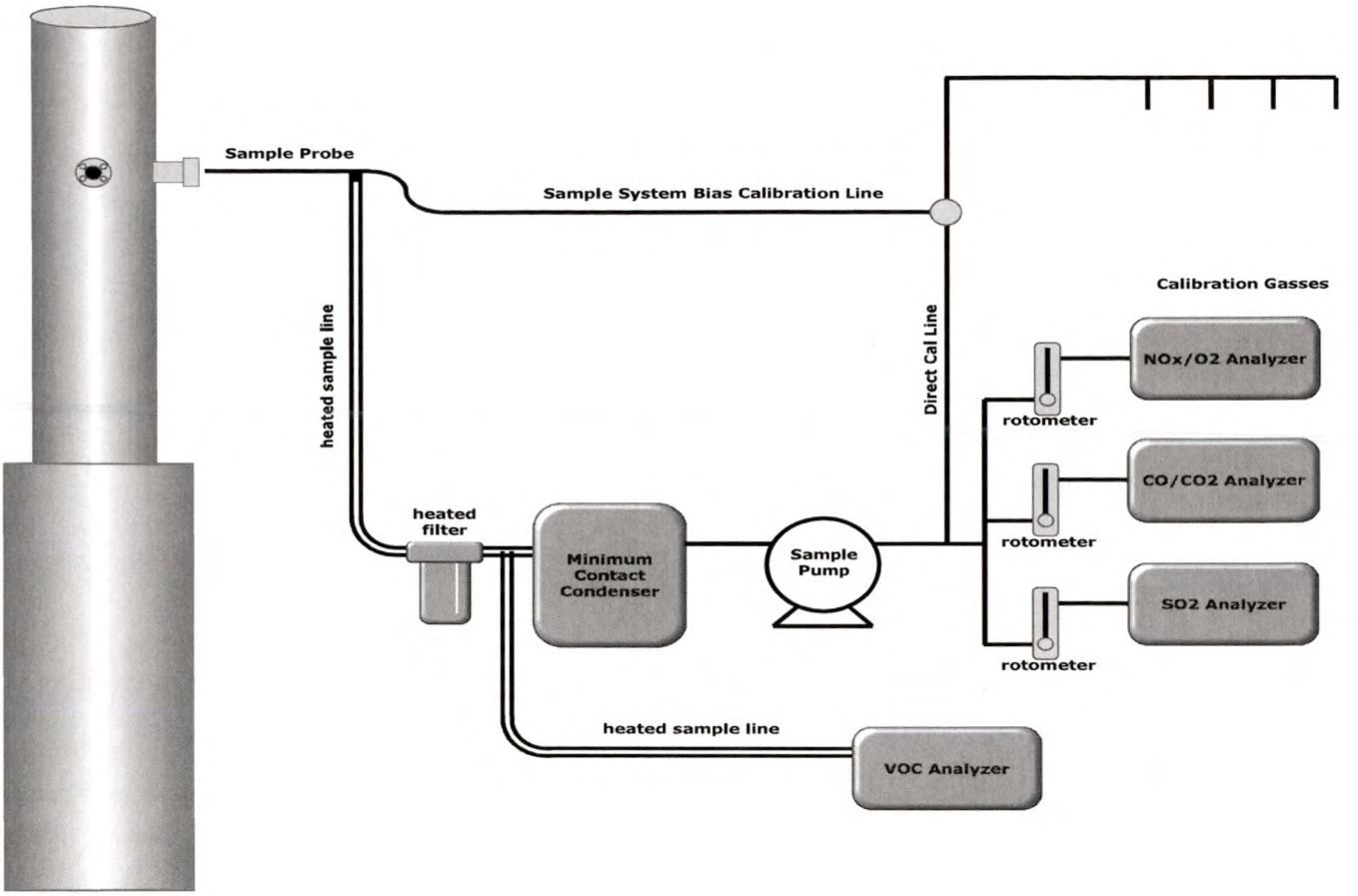


Figure 1: Example Erthwrks Gaseous Sampling System Diagram

4.2 RATA Procedures

The RATA testing was conducted following the sampling and measurement procedures found in the EPA Part 60, Appendix B, Performance Specifications which requires that EPA Reference Methods, from EPA Part 60, Appendix A, be utilized to conduct independent stack emissions measurements for comparison with installed CEMS readings. The following performance specifications will be used during this testing program.

- EPA Performance Specification 2 for SO_2 relative accuracy
- EPA Performance Specification 3 for O_2 relative accuracy

As required by these methods, the use EPA Protocol 1 gases are mandatory and were used for this portion of the project.

The RATA test is a direct comparison of the CEMS monitoring data with that data collected from an independently operated EPA Reference Method tests for each pollutant, following all the quality assurance and quality control procedures as required in the reference method. The following EPA reference methods were utilized to complete this testing program:

- EPA Method 3A for the determination of O_2 concentration
- EPA Method 6C for the determination of SO_2 concentration

For this testing program, Erthwrks utilized a calibration gas dilution system, operated in accordance with EPA Method 205, for the generation of the calibration gases used to calibrate the reference method analyzers. This gas dilution system is calibration annual in accordance with section 2.1.1 of this method. This documentation is located in Attachment E. In addition, the gas diluter accuracy was verified on the day of the test in accordance with the Field Evaluation procedure defined in Section 3.2 of the method. This activity is documented in Attachment B and the raw data logs are located in Attachment D.

The reference method sampling locations are defined in the Erthwrks QA/QC worksheet located in Attachment B. Three sampling points were used in accordance with the EPA Performance Specification 2, §8.1.3.2, located at 16.7, 50.0 and 83.3 percent of the stack inner diameter from the port location. Erthwrks sampled at each traverse point individually for 7-minutes per point for each 21-minute test run.

A minimum of nine (9) RATA test runs were conducted at each exhaust stack for a minimum duration of twenty-one (21) minutes for each run. A 3-point traverse located at 16.7%, 50.0%, and 83.3% of the way across the stack (or 0.4, 1.2, and 2.0 meters from the stack wall) was conducted during each RATA test run (7 minutes per point). The results of the reference method tests were compared to CEMS measurement data from the same time periods to determine the relative accuracy of the CEMS.

For SO_2, the results of the RATA test are considered acceptable if the calculated relative accuracy does not exceed 20.0% as calculated by Equation 2-6 in Performance Specification 2. Alternatively, for affected units where the average of the reference method measurements is less than 50 percent of the emission standard (emission limit), the relative accuracy must not exceed 10% when the applicable emission standard is used in the denominator of Eq. 2-6.

For O_2, the results of the RATA test are considered acceptable if the calculated relative accuracy does not exceed 20.0% as calculated by Equation 3.1 in Performance Specification 3. The results are also acceptable if the result of Equation 3-2 is less than or equal to 1.0 percent.

4.3 Discussion of sampling procedure or operational variances

Erthwrks, Inc. conducted the emissions testing with no sampling or procedural variances.

Attachment A
Detailed Results of Emission Test

Erthwrks Relative Accuracy Test Audit--SO_2 RATA
Performance Specification 2

North Plant Incinerator								SO_2 CEMS RATA - O_2 Corrected	
							Corrected to:	0	% O_2
Test Run	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
Date	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**
Start Time	9:10	9:31	9:52	10:35	10:56	11:17	12:00	12:21	12:42
End Time	9:31	9:52	10:13	10:56	11:17	11:38	12:21	12:42	13:03
RM SO_2 Results (ppmvd)	9.25	9.12	9.43	10.94	11.42	11.90	13.08	13.08	13.92
RM O_2 Results (%vd)	2.74	2.74	2.77	2.74	2.76	2.77	2.77	2.77	2.78
RM SO_2 Result (ppmvd @ 0% O_2)	**10.65**	**10.50**	**10.87**	**12.59**	**13.16**	**13.72**	**15.08**	**15.08**	**16.06**
CEMS SO_2 Result (ppmvd @ 0% O_2)	**11.75**	**11.35**	**11.28**	**12.36**	**12.99**	**13.85**	**15.00**	**15.19**	**15.25**
Difference	-1.10	-0.85	-0.41	0.23	0.17	-0.13	0.07	-0.11	0.81
Accept or Reject	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*

Applicable Standard (ppmvd @ 0% O_2)	250	
Mean of the Difference (d_{avg})	-0.15	
Standard Deviation (S_d)	0.579	
Confidence Coefficient (CC)	0.45	
Relative Accuracy via AS, RA_{AS} †	**0.24%**	← ***Pass***

† RA_{AS} *(Applicable Standard) must be less then 10%*

Erthwrks Relative Accuracy Test Audit--O_2 RATA
Performance Specification 3

North Plant Incinerator									O_2 CEMS RATA
Test Run	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**	**Run 7**	**Run 8**	**Run 9**
Date	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**	**8/21/2024**
Start Time	9:10	9:31	9:52	10:35	10:56	11:17	12:00	12:21	12:42
End Time	9:31	9:52	10:13	10:56	11:17	11:38	12:21	12:42	13:03
RM O_2 Result (%vd)	**2.74**	**2.74**	**2.77**	**2.74**	**2.76**	**2.77**	**2.77**	**2.77**	**2.78**
CEMS O_2 Data (%vd)	**3.02**	**3.02**	**3.06**	**3.04**	**3.05**	**3.05**	**3.04**	**3.05**	**3.04**
Difference	-0.28	-0.28	-0.29	-0.30	-0.29	-0.28	-0.27	-0.28	-0.26
Accept or Reject	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*	*Accept*

Mean of the Difference (d_{avg})	-0.28	
Standard Deviation (S_d)	0.01	
Confidence Coefficient (CC)	0.01	
Relative Accuracy via RM, RA_{MD}*	**0.28%**	← Pass

*****RA_{MD} *(Mean Difference) Must be less than 1.0%*

Summary of Results

Client: Marathon Petroleum Company
Facility: Detroit Refinery
Unit ID: North Plant Incinerator

Run Information				
Run Number	**Run 1**	**Run 2**	**Run 3**	
Date	8/21/2024	8/21/2024	8/21/2024	
Run Start Time	9:10	9:31	9:52	
Run End Time	9:31	9:52	10:13	
Operating Conditions				**Average**
Incinerator Temp (°F)	1553.3	1547.5	1552.3	1551.0
Unit Fuel Flow Data				**Averages**
Fuel F Factor (Fd) (scf/MMBtu)	8599.5	8599.5	8599.5	8599.5
Emission Concentrations				
CO (ppmvd)	7.17	7.85	7.06	7.36
O_2 (%vd)	2.74	2.74	2.77	2.75
Emission Rates				
CO (lb/scf)	5.21E-07	5.71E-07	5.13E-07	5.35E-07
CO (lb/MMBtu)	0.0052	0.0056	0.0051	0.0053

*Run 1 is the average of RATA runs 1-3
*Run 2 is the average of RATA runs 4-6
*Run 3 is the average of RATA runs 7-9

Attachment B
Quality Control Documentation

Erthwrks Method 1 Traverse Point Location Worksheet

Client: Marathon Petroleum Company
Project #: 9565.1.C2
Facility: Detroit Refinery
Unit ID: North Plant Incinerator
Technician: M. Oleszko

Stack ID Measurements

Stack ID + Port (inches):	91
Port Extension (inches):	8.5
Stack Diameter (inches):	82.5

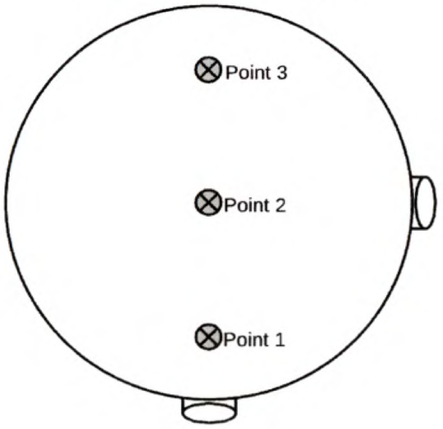
Port Location Measurements

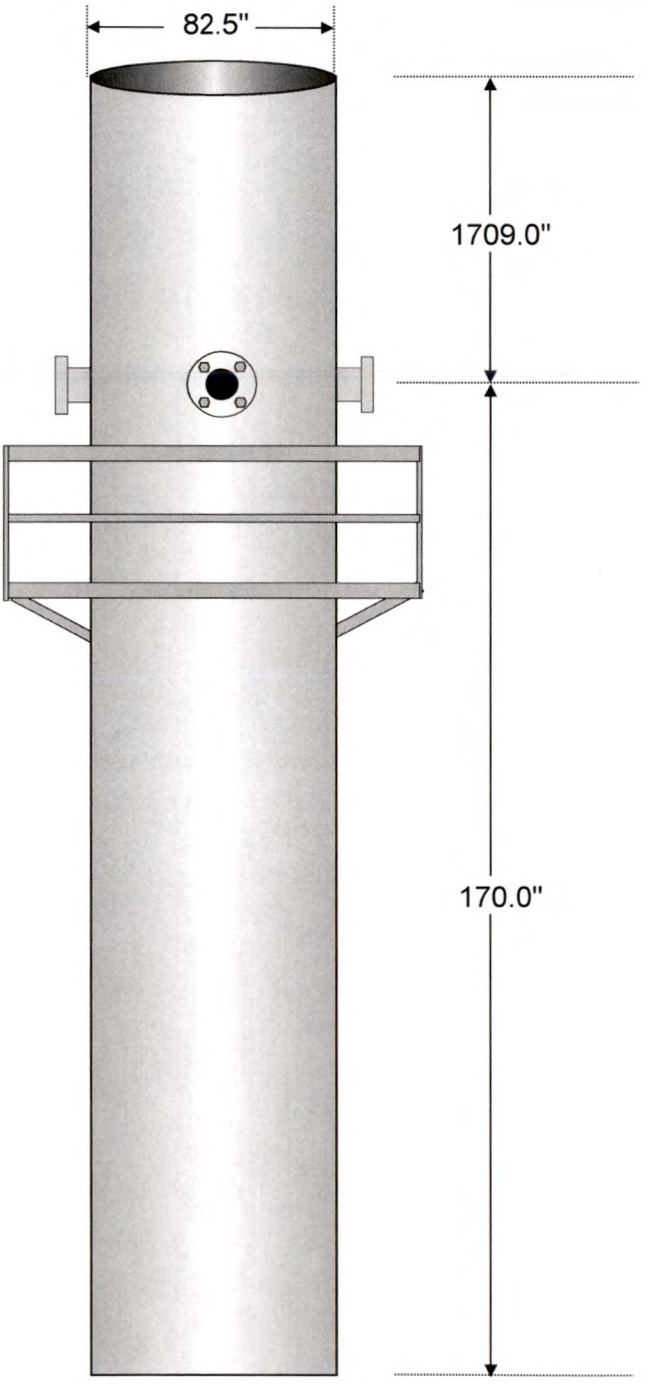
Distance Upstream (A) (inches):	1709
Distance Downstream (B) (inches):	170
Stack Diameters Upstream (A):	20.7
Stack Diameters Downstream (B):	2.1

Total Traverse Points to be used:	3
Traverse Points per Diameter:	3

Traverse Point Locations[1][2]	
Point 1:	13.78"
Point 2:	41.25"
Point 3:	68.72"

Stack Cross Section View





[1]For stack diameter >4.0 inches and <7.8 feet, stratification is measured at 16.7%, 50.0%, and 83.3" of stack diameter (M7E, §8.1.2).
[2] For stack diameter >7.8 feet, stratification is measured at 1.3, 3.9, and 6.5 feet from the stack wall (M7E, §8.1.2).

Erthwrks Gaseous Sample Collection and Quality Assurance Worksheet

Date: 8/21/2024
Client: Marathon Petroleum Company
Facility: Detroit Refinery
Project No: 9565.1.C2
Unit ID: North Plant Incinerator
Erthwrks Tech: M. Oleszko

Calibration Gas Verification

Pollutant	Low-Level Gas Conc. (C_v)	Cylinder Serial #	Mid-Level Gas Conc. (C_v)	Cylinder Serial #	High-Level Gas Conc. (C_v/CS)	Cylinder Serial #	Dilutor Root Gas
CO	n/a	n/a	12.42	CC492541	24.66	CC236941	n/a
O_2	n/a	n/a	10.14	CC5804	20	CC150919	n/a
CO_2	n/a	n/a	10.2	CC5804	19.51	CC150919	n/a
SO_2	n/a	n/a	52.36	EB0078667	94.68	EB0053553	n/a

Reference Method Analyzer Info

Make	Model	Serial No.
Teledyne	T300M	820
Teledyne	T200H	227
Teledyne	T300M	820
Teledyne	T100H	357

Calibration Error Test

Pollutant	Zero Gas Response (C_{ma})	Calibration Error (ACE)*	Low-Level Response (C_{ma})	Calibration Error (ACE)*	Mid-Level Response (C_{ma})	Calibration Error (ACE)*	High-Level Response (C_{ma})	Calibration Error (ACE)*
CO	0.13	0.51%	n/a	n/a	12.40	-0.08%	24.66	-0.02%
O_2	0.03	0.16%	n/a	n/a	10.13	-0.03%	20.02	0.08%
CO_2	0.02	0.08%	n/a	n/a	10.20	-0.03%	19.63	0.59%
SO_2	0.01	0.01%	n/a	n/a	52.91	0.58%	95.07	0.41%

** ACE must either be within ± 2.0% or ≤ 0.5 ppmv absolute difference, or +-5 % for THC for the mid and low gas*

Method 7E Traverse Point Determination			
Stack ID (inches)		Trav. Location	Inside ID + Port
82.5	Point 1	13.78	22.28
Port Ext. (inches)	Point 2	41.25	49.75
8.5	Point 3	68.72	77.22

Initial Sample System Bias and Response Time

Pollutant	Upscale Gas Cert. Conc. (C_{MA})	Upscale Gas Direct (C_{ma})	Upscale Response (C_s)	Sample System Bias (SB)*	Response Time (sec)	Downscale Response (C_s)	Sample System Bias (SB)*	Response Time (sec)
CO	12.42	12.40	12.44	0.17%	60	-0.20	-1.33%	60
O_2	10.14	10.13	9.99	-0.71%	60	0.01	-0.13%	60
CO_2	10.20	10.20	10.05	-0.73%	60	0.00	-0.09%	60
SO_2	52.36	52.91	51.20	-1.81%	90	0.28	0.29%	90

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*

Sample Collection Raw Data--Pre and Post Sample System Calibration (SSC) and Raw Run Results

Run #: **Run 1**
Start Time: 9:10
End Time: 9:31

Pollutant	Initial Zero SSC (C_{sc})	Initial Upscale SSC (C_{sc})	Raw Results (C_{avg})	Final Zero SSC (C_{sc})	Final Upscale SSC (C_{sc})
CO	-0.20	12.44	5.95	0.09	11.99
O_2	0.01	9.99	2.72	0.05	10.01
CO_2	0.00	10.05	3.83	0.00	10.06
SO_2	0.28	51.20	9.20	0.21	50.67

Run #: **Run 2**
Start Time: 9:31
End Time: 9:52

Initial Zero SSC (C_{sc})	Initial Upscale SSC (C_{sc})	Raw Results (C_{avg})	Final Zero SSC (C_{sc})	Final Upscale SSC (C_{sc})
-0.20	12.44	7.04	0.09	11.99
0.01	9.99	2.72	0.05	10.01
0.00	10.05	3.77	0.00	10.06
0.28	51.20	9.07	0.21	50.67

Sample Collection Raw Data--Pre and Post Sample System Calibration (SSC) and Raw Run Results

Run #: **Run 3**
Start Time: 9:52
End Time: 10:13

Pollutant	Initial Zero SSC (C_{sc})	Initial Upscale SSC (C_{sc})	Raw Results (C_{avg})	Final Zero SSC (C_{sc})	Final Upscale SSC (C_{sc})
CO	-0.20	12.44	8.11	0.09	11.99
O_2	0.01	9.99	2.76	0.05	10.01
CO_2	0.00	10.05	3.75	0.00	10.06
SO_2	0.28	51.20	9.38	0.21	50.67

Run #: **Run 4**
Start Time: 10:35
End Time: 10:56

Initial Zero SSC (C_{sc})	Initial Upscale SSC (C_{sc})	Raw Results (C_{avg})	Final Zero SSC (C_{sc})	Final Upscale SSC (C_{sc})
0.09	11.99	7.05	-0.22	11.73
0.05	10.01	2.74	0.04	10.01
0.00	10.06	3.75	0.00	10.08
0.21	50.67	10.52	-0.29	50.31

Sample Collection Raw Data--Pre and Post Sample System Calibration (SSC) and Raw Run Results

Run #: **Run 5**
Start Time: 10:56
End Time: 11:17

Pollutant	Initial Zero SSC (C_{sc})	Initial Upscale SSC (C_{sc})	Raw Results (C_{avg})	Final Zero SSC (C_{sc})	Final Upscale SSC (C_{sc})
CO	0.09	11.99	8.45	-0.22	11.73
O_2	0.05	10.01	2.76	0.04	10.01
CO_2	0.00	10.06	3.74	0.00	10.08
SO_2	0.21	50.67	10.98	-0.29	50.31

Run #: **Run 6**
Start Time: 11:17
End Time: 11:38

Initial Zero SSC (C_{sc})	Initial Upscale SSC (C_{sc})	Raw Results (C_{avg})	Final Zero SSC (C_{sc})	Final Upscale SSC (C_{sc})
0.09	11.99	6.91	-0.22	11.73
0.05	10.01	2.77	0.04	10.01
0.00	10.06	3.77	0.00	10.08
0.21	50.67	11.44	-0.29	50.31

Erthwrks Gaseous Sample Collection and Quality Assurance Worksheet

Date: 8/21/2024
Client: Marathon Petroleum Company
Facility: Detroit Refinery
Project No: 9565.1.C2
Unit ID: North Plant Incinerator
Erthwrks Tech: M. Oleszko

Sample Collection Raw Data--Pre and Post Sample System Calibration (SSC) and Raw Run Results

Run #: **Run 7**
Start Time: 12:00
End Time: 12:21

Pollutant	Initial Zero SSC ($C_{S,i}$)	Initial Upscale SSC ($C_{S,i}$)	Raw Results ($C_{S,m}$)	Final Zero SSC ($C_{S,f}$)	Final Upscale SSC ($C_{S,f}$)
CO	-0.22	11.73	6.38	-0.26	11.69
O_2	0.04	10.01	2.77	0.07	10.03
CO_2	0.00	10.08	3.80	0.01	10.06
SO_2	-0.29	50.31	12.67	0.48	50.54

Run #: **Run 8**
Start Time: 12:21
End Time: 12:42

Initial Zero SSC ($C_{S,i}$)	Initial Upscale SSC ($C_{S,i}$)	Raw Results ($C_{S,m}$)	Final Zero SSC ($C_{S,f}$)	Final Upscale SSC ($C_{S,f}$)
-0.22	11.73	5.96	-0.26	11.69
0.04	10.01	2.78	0.07	10.03
0.00	10.08	3.81	0.01	10.06
-0.29	50.31	12.67	0.48	50.54

Sample Collection Raw Data--Pre and Post Sample System Calibration (SSC) and Raw Run Results

Run #: **Run 9**
Start Time: 12:42
End Time: 13:03

Pollutant	Initial Zero SSC ($C_{S,i}$)	Initial Upscale SSC ($C_{S,i}$)	Raw Results ($C_{S,m}$)	Final Zero SSC ($C_{S,f}$)	Final Upscale SSC ($C_{S,f}$)
CO	-0.22	11.73	7.32	-0.26	11.69
O_2	0.04	10.01	2.78	0.07	10.03
CO_2	0.00	10.08	3.78	0.01	10.06
SO_2	-0.29	50.31	13.48	0.48	50.54

Run #: **Run 10**
Start Time:
End Time: 0:21

Initial Zero SSC ($C_{S,i}$)	Initial Upscale SSC ($C_{S,i}$)	Raw Results ($C_{S,g}$)	Final Zero SSC ($C_{S,f}$)	Final Upscale SSC ($C_{S,f}$)
-0.26	11.69		0.00	0.00
0.07	10.03		0.00	0.00
0.01	10.06		0.00	0.00
0.48	50.54		0.00	0.00

Sample Collection Raw Data--Pre and Post Sample System Calibration (SSC) and Raw Run Results

Run 1 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_{o})	Avg. Upscale Sys. Bias (C_{M})	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)†	Corrected Results (C_{gas})
CO	-1.33%	0.17%	-0.15%	-1.65%	-0.06	12.22	1.17%	1.82%	**6.07**
O_2	-0.13%	-0.71%	0.09%	-0.62%	0.03	10.00	0.22%	0.09%	**2.74**
CO_2	-0.09%	-0.73%	-0.08%	-0.69%	0.00	10.06	0.01%	0.05%	**3.89**
SO_2	0.29%	-1.81%	0.21%	-2.37%	0.24	50.93	0.08%	0.56%	**9.25**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 2 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_{o})	Avg. Upscale Sys. Bias (C_{M})	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)†	Corrected Results (C_{gas})
CO	-1.33%	0.17%	-0.15%	-1.65%	-0.06	12.22	1.17%	1.82%	**7.18**
O_2	-0.13%	-0.71%	0.09%	-0.62%	0.03	10.00	0.22%	0.09%	**2.74**
CO_2	-0.09%	-0.73%	-0.08%	-0.69%	0.00	10.06	0.01%	0.05%	**3.82**
SO_2	0.29%	-1.81%	0.21%	-2.37%	0.24	50.93	0.08%	0.56%	**9.12**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 3 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_{o})	Avg. Upscale Sys. Bias (C_{M})	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)†	Corrected Results (C_{gas})
CO	-1.33%	0.17%	-0.15%	-1.65%	-0.06	12.22	1.17%	1.82%	**8.26**
O_2	-0.13%	-0.71%	0.09%	-0.62%	0.03	10.00	0.22%	0.09%	**2.77**
CO_2	-0.09%	-0.73%	-0.08%	-0.69%	0.00	10.06	0.01%	0.05%	**3.80**
SO_2	0.29%	-1.81%	0.21%	-2.37%	0.24	50.93	0.08%	0.56%	**9.43**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 4 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_{o})	Avg. Upscale Sys. Bias (C_{M})	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)†	Corrected Results (C_{gas})
CO	-0.15%	-1.65%	-1.38%	-2.73%	-0.06	11.86	1.22%	1.07%	**7.41**
O_2	0.09%	-0.62%	0.05%	-0.64%	0.05	10.01	0.04%	0.02%	**2.74**
CO_2	-0.08%	-0.69%	-0.08%	-0.59%	0.00	10.07	0.01%	0.10%	**3.80**
SO_2	0.21%	-2.37%	-0.32%	-2.75%	-0.04	50.49	0.52%	0.38%	**10.94**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 5 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_{o})	Avg. Upscale Sys. Bias (C_{M})	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)†	Corrected Results (C_{gas})
CO	-0.15%	-1.65%	-1.38%	-2.73%	-0.06	11.86	1.22%	1.07%	**8.87**
O_2	0.09%	-0.62%	0.05%	-0.64%	0.05	10.01	0.04%	0.02%	**2.76**
CO_2	-0.08%	-0.69%	-0.08%	-0.59%	0.00	10.07	0.01%	0.10%	**3.79**
SO_2	0.21%	-2.37%	-0.32%	-2.75%	-0.04	50.49	0.52%	0.38%	**11.42**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Erthwrks Gaseous Sample Collection and Quality Assurance Worksheet

Date: 8/21/2024
Client: Marathon Petroleum Company
Facility: Detroit Refinery
Project No: 9565.1.C2
Unit ID: North Plant Incinerator
Erthwrks Tech: M. Oleszko

Run 6 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_o)	Avg. Upscale Sys. Bias (C_M)	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)	Corrected Results (C_{gas})
CO	-0.15%	-1.65%	-1.38%	-2.73%	-0.06	11.86	1.22%	1.07%	**7.27**
O_2	0.09%	-0.62%	0.05%	-0.64%	0.05	10.01	0.04%	0.02%	**2.77**
CO_2	-0.08%	-0.69%	-0.08%	-0.59%	0.00	10.07	0.01%	0.10%	**3.82**
SO_2	0.21%	-2.37%	-0.32%	-2.75%	-0.04	50.49	0.52%	0.38%	**11.90**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 7 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_o)	Avg. Upscale Sys. Bias (C_M)	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)	Corrected Results (C_{gas})
CO	-1.38%	-2.73%	-1.54%	-2.87%	-0.24	11.71	0.16%	0.15%	**6.87**
O_2	0.05%	-0.64%	0.17%	-0.53%	0.05	10.02	0.12%	0.11%	**2.77**
CO_2	-0.08%	-0.59%	-0.05%	-0.67%	0.00	10.07	0.03%	0.08%	**3.85**
SO_2	-0.32%	-2.75%	0.50%	-2.51%	0.10	50.42	0.82%	0.25%	**13.08**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 8 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_o)	Avg. Upscale Sys. Bias (C_M)	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)	Corrected Results (C_{gas})
CO	-1.38%	-2.73%	-1.54%	-2.87%	-0.24	11.71	0.16%	0.15%	**6.44**
O_2	0.05%	-0.64%	0.17%	-0.53%	0.05	10.02	0.12%	0.11%	**2.77**
CO_2	-0.08%	-0.59%	-0.05%	-0.67%	0.00	10.07	0.03%	0.08%	**3.85**
SO_2	-0.32%	-2.75%	0.50%	-2.51%	0.10	50.42	0.82%	0.25%	**13.08**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference

Run 9 **Sample Collection Calculations--Pre- and Post-Run Sample System Bias Check, Drift Assessment, Corrected Results**

Pollutant	Initial Zero Sys. Bias (SB)*	Initial Upscale Sys. Bias (SB)*	Final Zero Sys. Bias (SB)*	Final Upscale Sys. Bias (SB)*	Avg. Zero Sys. Bias (C_o)	Avg. Upscale Sys. Bias (C_M)	Zero Drift Assessment (D)†	Upscale Drift Assessment (D)	Corrected Results (C_{gas})
CO	-1.38%	-2.73%	-1.54%	-2.87%	-0.24	11.71	0.16%	0.15%	**7.86**
O_2	0.05%	-0.64%	0.17%	-0.53%	0.05	10.02	0.12%	0.11%	**2.78**
CO_2	-0.08%	-0.59%	-0.05%	-0.67%	0.00	10.07	0.03%	0.08%	**3.83**
SO_2	-0.32%	-2.75%	0.50%	-2.51%	0.10	50.42	0.82%	0.25%	**13.92**

** SB must either be within ± 5.0% or ≤ 0.5 ppmv absolute difference*
† D must either be within ± 3.0% or the pre- and post-run bias responses are ≤ 0.5 ppmv absolute difference