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REPORT ON COMPLIANCE AND RATA MEASUREMENT SERVICES

Detroit Hydrogen Plant

Heater Stack

Air Products and Chemicals, Inc.

7201 Hamilton Boulevard

Allentown, PA 18195

Client Reference No. 4506050430

CleanAir Project No. 14978

A2LA ISO 17025 Certificate No. 4342.01

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COMMITMENT TO QUALITY

To the best of our knowledge, the data presented in this report are accurate, complete, error free 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.

Report Submittal:

8/28/2023

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I hereby certify that the information contained within the final test report has been reviewed and, to the best of my ability, verified as accurate.

Independent Report Review:

8/28/2023

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REPORT REVISION HISTORY

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ACRONYMS & ABBREVIATIONS

AAS (atomic absorption spectrometry)
acfm (actual cubic feet per minute)
ACI (activated carbon injection)
ADL (above detection limit)
AIG (ammonia injection grid)
APC (air pollution control)
AQCS (air quality control system(s))
ASME (American Society of Mechanical Engineers)
ASTM (American Society for Testing and Materials)
BDL (below detection limit)
Btu (British thermal units)
CAM (compliance assurance monitoring)
CARB (California Air Resources Board)
CCM (Controlled Condensation Method)
CE (capture efficiency)
°C (degrees Celsius)
CEMS (continuous emissions monitoring system(s))
CFB (circulating fluidized bed)
CFR (Code of Federal Regulations)
cm (centimeter(s))
COMS (continuous opacity monitoring system(s))
CT (combustion turbine)
CTI (Cooling Technology Institute)
CTM (Conditional Test Method)
CVAAS (cold vapor atomic absorption spectroscopy)
CVAFS (cold vapor atomic fluorescence spectrometry)
DI H_2O (de-ionized water)
%dv (percent, dry volume)
DLL (detection level limited)
DE (destruction efficiency)
DCI (dry carbon injection)
DGM (dry gas meter)
dscf (dry standard cubic feet)
dscfm (dry standard cubic feet per minute)
dscm (dry standard cubic meter)
ESP (electrostatic precipitator)
FAMS (flue gas adsorbent mercury speciation)
°F (degrees Fahrenheit)
FB (field blank)
FCC (fluidized catalytic cracking)
FCCU (fluidized catalytic cracking unit)
FEGT (furnace exit gas temperatures)
FF (fabric filter)
FGD (flue gas desulfurization)
FIA (flame ionization analyzer)
FID (flame ionization detector)
FPD (flame photometric detection)
FRB (field reagent blank)
FSTM (flue gas sorbent total mercury)
ft (feet or foot)
ft^2 (square feet)
ft^3 (cubic feet)
ft/sec (feet per second)
FTIR (Fourier Transform Infrared Spectroscopy)
FTRB (field train reagent blank)
g (gram(s))
GC (gas chromatography)
GFAAS (graphite furnace atomic absorption spectroscopy)
GFC (gas filter correlation)
gr/dscf (grains per dry standard cubic feet)
> (greater than)/ ≥ (greater than or equal to)
g/s (grams per second)
H_2O (water)
HAP(s) (hazardous air pollutant(s))
HI (heat input)
hr (hour(s))
HR GC/MS (high-resolution gas chromatography and mass spectrometry)
HRVOC (highly reactive volatile organic compounds)
HSRG(s) (heat recovery steam generator(s))
HVT (high velocity thermocouple)
IC (ion chromatography)
IC/PCR (ion chromatography with post column reactor)
ICP/MS (inductively coupled argon plasma mass spectroscopy)
ID (induced draft)
in. (inch(es))
in. H_2O (inches water)
in. Hg (inches mercury)
IPA (isopropyl alcohol)
ISE (ion-specific electrode)
kg (kilogram(s))
kg/hr (kilogram(s) per hour)
< (less than)/ ≤ (less than or equal to)
L (liter(s))
lb (pound(s))
lb/hr (pound per hour)
lb/MMBtu (pound per million British thermal units)
lb/TBtu (pound per trillion British thermal units)
lb/lb-mole (pound per pound mole)
LR GC/MS (low-resolution gas chromatography and mass spectrometry)
m (meter)
m^3 (cubic meter)
MACT (maximum achievable control technology)
MASS® (Multi-Point Automated Sampling System)
MATS (Mercury and Air Toxics Standards)
MDL (method detection limit)
µg (microgram(s))
min. (minute(s))
mg (milligram(s))
ml (milliliter(s))
MMBtu (million British thermal units)
MW (megawatt(s))
NCASI (National Council for Air and Stream Improvement)
ND (non-detect)
NDIR (non-dispersive infrared)
NDO (natural draft opening)
NESHAP (National Emission Standards for Hazardous Air Pollutants)
ng (nanogram(s))
Nm^3 (Normal cubic meter)
% (percent)
PEMS (predictive emissions monitoring systems)
PFGC (pneumatic focusing gas chromatography)
pg (picogram(s))
PJFF (pulse jet fabric filter)
ppb (parts per billion)
PPE (personal protective equipment)
ppm (parts per million)
ppmdv (parts per million, dry volume)
ppmwv (parts per million, wet volume)
PSD (particle size distribution)
psi (pound(s) per square inch)
PTE (permanent total enclosure)
PTFE (polytetrafluoroethylene)
QA/QC (quality assurance/quality control)
QI (qualified individual)
QSTI (qualified source testing individual)
QSTO (qualified source testing observer)
RA (relative accuracy)
RATA (relative accuracy test audit)
RB (reagent blank)
RE (removal or reduction efficiency)
RM (reference method)
scf (standard cubic feet)
scfm (standard cubic feet per minute)
SCR (selective catalytic reduction)
SDA (spray dryer absorber)
SNCR (selective non-catalytic reduction)
STD (standard)
STMS (sorbent trap monitoring system)
TBtu (trillion British thermal units)
TEOM (Tapered Element Oscillating Microbalance)
TEQ (toxic equivalency quotient)
ton/hr (ton per hour)
ton/yr (ton per year)
TSS (third stage separator)
USEPA or EPA (United States Environmental Protection Agency)
UVA (ultraviolet absorption)
WFGD (wet flue gas desulfurization)
%wv (percent, wet volume)

1. PROJECT OVERVIEW

TEST PROGRAM SUMMARY

Air Products and Chemicals, Inc. (Air Products) contracted CleanAir Engineering (CleanAir) to perform measurements on the Heater Stack at the Hydrogen Plant, located within the Marathon Petroleum Company's refinery in Detroit, Michigan. The test program included the following objectives:

- perform a relative accuracy test audit (RATA) on the unit's continuous emissions monitoring system (CEMS)
- perform various test methods to demonstrate compliance with the facility's renewable Michigan Department of Environmental Quality (MDEQ) operating permit No. MI-ROP-A9831-2012c

A summary of the permit limits is shown below. Test program information, including the test parameters, on-site schedule and a project discussion follow.

Table 1-1:
Summary of Results - RATA

Source Constituent	Reference Method (USEPA)	Relative Accuracy (%)[1]	Units	Applicable Specification	Specification Limit[2]
H_2 Plant Heater Stack					
Flow rate (dscfm)	M-2	13.4%	% of RM	PS6	20% of RM
O_2 (% dv)	M-3A	0.28%	%dv	PS3	±1.0% dv
H_2O (% wv)	Mod. M-4	5.40%	% of RM	N/A[3]	N/A
NO_X (ppmdv)	M-7E	2.3%	% of RM	PS2	20% of RM
NO_X (lb/MMBtu)	M-7E	9.3%	% of RM	PS2	20% of RM
NO_X (ppmdv @ 0% O_2)	M-7E	1.0%	% of RM	PS2	20% of RM
CO (ppmdv)	M-10	0.5	ppmdv	PS4A[3]	±5 ppmdv
CO (lb/hr)	M-10	0.3%	% of Std.	PS4A[4]	5% of Standard

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

[2] Specification limits obtained from 40 CFR 60, Appendix B, Performance Specifications, unless otherwise noted.

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

[4] CO Standard = 13 Ton/yr = 56.9 lb/hr (assuming 8,760 operating hours/year)

Table 1-2:
Summary of Results - Compliance

Source Constituent	Sampling Method	Average Emission	Permit Limit[1]
H_2 Plant Heater Stack			
PM (lb/MMBtu)	USEPA M-5	0.0004	0.0034
PM (ton/yr)	USEPA M-5	0.89	6.86
PM_{10} (lb/MMBtu)	USEPA M-5 / 202	0.0012	0.010
H_2SO_4 (lb/MMBtu)	CTM-013	0.00004	N/A
VOC (lb/MMBtu)	USEPA M-25A	0.00099	0.0055
NO_X (lb/MMBtu)	USEPA M-7E	0.0054	0.013
NO_X (ppmdv @ 0% O_2)	USEPA M-7E/3A	4.98	60
CO (ton/yr)	USEPA M-10	<0.18	13

[1] Permit limits obtained from MDEQ Permit No. MI-ROP-A9831-2012c.

TEST PROGRAM DETAILS

PARAMETERS

The test program included the following measurements:

- particulate matter (PM) as filterable particulate matter (FPM)
- particulate matter less than 10 microns in diameter (PM_{10}), assumed equivalent to the sum of:
  - FPM
  - condensable particulate matter (CPM)
- sulfuric acid mist (H_2SO_4)
- nitrogen oxides (NO_X)
- carbon monoxide (CO)
- volatile organic compounds (VOCs), assumed equivalent to total hydrocarbons (THCs)
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas temperature
- flue gas flow rate

SCHEDULE

Testing was performed on July 19 and 20, 2023. Table 1-3 outlines the on-site schedule followed during the test program.

Table 1-3:
Test Schedule

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	H_2 Plant Heater Stack	USEPA Method 5/202	FPM/CPM	07/19/23	07:34	09:45
1	H_2 Plant Heater Stack	USEPA Method 3A, 25A	O_2, CO_2, VOC	07/19/23	07:45	08:45
2	H_2 Plant Heater Stack	USEPA Method 3A, 25A	O_2, CO_2, VOC	07/19/23	09:02	10:02
3	H_2 Plant Heater Stack	USEPA Method 3A, 25A	O_2, CO_2, VOC	07/19/23	10:11	11:11
2	H_2 Plant Heater Stack	USEPA Method 5/202	FPM/CPM	07/19/23	10:14	12:26
3	H_2 Plant Heater Stack	USEPA Method 5/202	FPM/CPM	07/19/23	12:43	14:55
1	H_2 Plant Heater Stack	Modified USEPA Method CTM-013	H_2SO_4 / Moisture	07/20/23	07:51	08:51
1	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	07:51	08:12
1	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	07:53	08:08
2	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	08:13	08:34
2	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	08:15	08:26
3	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	08:35	08:47
3	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	08:35	08:56
2	H_2 Plant Heater Stack	Modified USEPA Method CTM-013	H_2SO_4 / Moisture	07/20/23	09:35	10:35
4	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	09:36	09:48
4	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	09:37	09:58
5	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	09:59	10:20
5	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	10:00	10:10
6	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	10:21	10:31
6	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	10:21	10:42
3	H_2 Plant Heater Stack	Modified USEPA Method CTM-013	H_2SO_4 / Moisture	07/20/23	11:01	12:01
7	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	11:01	11:22
7	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	11:03	11:17
8	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	11:24	11:45
8	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	11:25	11:38
9	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	11:46	11:57
9	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	11:46	12:07
10	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	12:22	12:43
1	H_2 Plant Heater Stack	USEPA Method 4	Moisture	07/20/23	12:22	01:22
10	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	12:24	12:40
11	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	12:44	13:05
11	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	12:45	12:56
12	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	13:06	13:19
12	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	13:06	13:27
13	H_2 Plant Heater Stack	USEPA Method 2	Velocity & Flow Rate	07/20/23	13:38	13:50
13	H_2 Plant Heater Stack	USEPA Method 3A, 7E, 10	O_2, CO_2, NO_X, CO	07/20/23	13:38	13:59

DISCUSSION

Project Synopsis

CleanAir conducted the sample program over a two-day span. During the first test day, three EPA Method 5/202 test runs were conducted along with three EPA Method 25A test runs.

The RATA was conducted during the second test day, along with EPA Method 2 traverses for flow measurements and three modified Conditional Test Method 013 (CTM-013) test runs for H_2SO_4 mist. The CTM-013 test runs were used for moisture determination for the coinciding flow measurement calculations. A standalone Method 4 was performed for the RATA Runs 10, 11, 12 and 13 moistures.

A cyclonic flow check, per EPA Method 1, Section 11.4, was performed during every CleanAir-performed test program from 2013 to 2018. The sampling location met method criteria during all previous cyclonic flow checks and no modifications had been made to the test location. Due to this fact, no cyclonic flow check was performed during this mobilization.

USEPA Method 5/202

For this test program, the PM emission rate is assumed equivalent to the FPM emission rate. The PM_{10} emission rate is assumed equivalent to the sum of FPM and CPM emission rates (units of lb/hr, Ton/yr, or lb/MMBtu for all constituents).

The analytical procedures in Method 202 include an ammonium titration of the inorganic sample fractions with pH less than 7.0 to neutralize acids with hygroscopic properties (such as H_2SO_4) that may be present in the sample. This step speeds up the sample desiccation process and allows the samples to come to a constant weight prior to weighing. The weight of ammonium added to the sample because of the titration is subtracted from the analytical result.

CleanAir Analytical Services in Palatine, Illinois, performed the gravimetric analysis and determined that only samples with an initial pH less than 4.5 require a significant amount of ammonium neutralization, resulting in a correction more than 0.5 mg. Based on this observation, the laboratory altered its procedures to read that a sample must have a pH lower than 4.5 in order to be titrated. All samples collected had pH's over 4.5 and therefore did not require neutralization. The filter weights for all three runs were below the method detection limit (MDL) therefore the filter MDL was used for all calculations.

The results for each parameter were expressed as the average of three runs and were below the permit limits for both PM and PM_{10}.

Modified Conditional Test Method 13

Three test runs were performed on July 20. The result is expressed as the average of three valid runs (Runs 1, 2, and 3).

USEPA Method 25A

Three valid EPA Method 25A test runs for THCs were performed concurrently with the Method 5/202 test runs on July 19. The results for each parameter are expressed as the average of three (3) valid runs (Runs 1, 2, and 3). The Method 5/202 moistures were used to correct the THC ppmwv to ppmdv.

Method 25A states that the mid-range calibration gas should be used for the drift checks between runs. Because the flue gas contained very low levels of hydrocarbons, the operator used the low-level calibration gas for the drift checks.

USEPA Methods 2, 3A, 4, 7E, and 10 – Performance Specifications 2, 3, 4A, and 6

Sample Approach

One-minute average data points for O_2, CO_2, 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 identical time intervals to calculate relative accuracy (RA):

- For O_2 (%dv), RA is expressed as the average absolute difference between the RM and facility CEMS runs. The result was below the limit of ± 1.0% dv set by Performance Specification (PS) 3.
- For NO_X (ppmdv) concentration, RA is expressed as the percent difference between RM and facility CEMS runs. The result was below the limit of 20% of the RM set by PS 2.
- For NO_X (lb/MMBtu) emission rate, RA is expressed as the percent difference between RM and facility CEMS runs. The result was below the limit of 20% of the RM set by PS 2.
- For NO_X (ppmdv @ 0% O_2) concentration, RA is expressed as the percent difference between RM and facility CEMS runs. The result was below the limit of 20% of the RM set by PS 2.
- For CO (ppmdv) concentration, the RA limit is expressed as the average absolute difference between the RM and facility CEMS runs, plus 2.5 times the confidence coefficient. The result was below the limit of ± 5 ppmdv set by PS 4A, which is applicable to sources that emit less than 200 ppmv of CO.
- For CO (lb/hr) diluent, RA is expressed as the percent difference between RM and facility CEMS runs. The result was below the limit of 5% of the standard (permit limit listed in Table 1-2 on page 2) set by PS 4A.
- CO_2 data was collected only as supplemental information.
- The flow rate, RA, is expressed as the percent difference between RM and facility CEMS data. The results were below the limit of 20% of the RM set by PS 6.
- Moisture data presented in Table 2-6 on page 13 is for comparison purposes only.

All CO concentrations measured were below the instrument reportable response (considered to be 1% of instrument span, 0.449 ppm, dv). For RATA calculations the CO was considered zero and for CO compliance it was considered less than the detection limit (DL).

Facility flow rate CEMS were evaluated using EPA Method 2 as the RM. A complete flow and temperature traverse were performed during each 21-minute RATA run, converted to units of dry standard cubic feet per hour (dscfh), and then compared to the facility CEMS results over the corresponding 21-minute intervals.

Moisture data was used to convert flow rate from wet basis to dry basis and was obtained from concurrently operated CTM-013 test runs:

- For RATA Runs 1 2 and 3, H_2O data was obtained from CTM-013 Run 1.
- For RATA Runs 4, 5, and 6, H_2O data was obtained from CTM-013 Run 2.
- For RATA Runs 7, 8 and 9, H_2O data was obtained from CTM-013 Run 3.
- For RATA Runs 10, 11, 12, 13 H_2O data was obtained from EPA Method 4.

NO_X and CO results from the RATA were converted from units of dry volume-based concentration (ppmdv) to mass-based emission rate units (lb/hr, Ton/yr, and lb/MMBtu) to demonstrate compliance with permit limits. The results for each parameter were expressed as an average of thirteen (13) RATA runs. The results were below the permit limits.

Calculation of Final Results

Emission results in units of dry volume-based concentration (lb/dscf, ppmdv) were converted to units of lb/MMBtu using the F_d factor method. Fuel F_d factors were provided by Air Products. Flow rates used in calculating lb/hr emissions were obtained in the following manner:

- For Method 5/202, flow rate measurements were incorporated into the sampling procedures.
- For Method 25A, flow rate measurements from the most nearly concurrent Method 5/202 test runs were used.
- For Method 7E/10, a flow rate measurement, per Method 2 specifications, was performed concurrently with each test run.
- For CTM-013, the flow rate measurements made concurrently with the Method 7E/10 run that most closely corresponded were used.

General Considerations

All run times listed throughout this report correspond to the plant time utilized by Air Products. Plant time is the time of the Air Products CEMS and data acquisition system.

No Method 18 gas sample was collected due to the THC concentrations for all three runs being below the analyzer's detection limit of 1% of scale.

End of Section

2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices.

Table 2-1:
H_2SO_4 Emissions (CTM-013)

Run No.		1	2	3	Average
Date (2023)		Jul 20	Jul 20	Jul 20	
Start Time (approx.)		07:51	09:35	11:01	
Stop Time (approx.)		08:51	10:35	12:01	
Process Conditions					
R_P	Hydrogen Production Rate (Mscf/day)	51.2	51.2	51.1	**51.2**
P_1	Aqueius NH_3 feed to SCR (lb/hr)	25.4	24.8	24.4	**24.9**
P_2	SCR Inlet temperature (°F)	585	586	586	**586**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,102	9,105	9,105	**9,104**
H_i	Actual heat input (MMBtu/hr)	441	441	447	**443**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	3.8	3.8	3.8	**3.8**
CO_2	Carbon dioxide (dry volume %)	18.9	18.9	18.9	**18.9**
T_s	Stack temperature (°F)	314	314	312	**313**
B_w	Actual water vapor in gas (% by volume)	14.4	16.4	15.1	**15.3**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	165,000	164,000	164,000	**165,000**
Q_s	Volumetric flow rate, standard (scfm)	110,000	110,000	110,000	**110,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	94,500	91,700	93,400	**93,200**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	30.61	34.36	33.85	**32.94**
Laboratory Data (Ion Chromatography)					
m_n	Total H2SO4 collected (mg)	0.0876	0.0393	0.0368	
Sulfuric Acid (H2SO4) Results					
C_{sd}	H2SO4 Concentration (lb/dscf)	6.310E-09	2.523E-09	2.394E-09	**3.742E-09**
C_{sd}	H2SO4 Concentration (ppmdv)	0.0248	0.00992	0.00941	**0.0147**
$E_{lb/hr}$	H2SO4 Rate (lb/hr)	0.0358	0.0139	0.0134	**0.0210**
$E_{T/yr}$	H2SO4 Rate (Ton/yr)	0.157	0.061	0.059	**0.092**
E_{Fd}	H2SO4 Rate - Fd-based (lb/MMBtu)	0.00007	0.00003	0.00003	**0.00004**

Table 2-2:
FPM, CPM, and Total PM_{10} Emissions (EPA Method 5/202)

Run No.		1	2	3	Average
Date (2023)		Jul 19	Jul 19	Jul 19	
Start Time (approx.)		07:34	10:14	12:43	
Stop Time (approx.)		09:45	12:26	14:55	
Process Conditions					
P_1	Hydrogen Pproduction Rate (Mcscf/hr)	56.9	57.1	57.1	**57.0**
P_2	Aqueous NH3 feed to SCR (lb/hr)	31.2	31.2	30.9	**31.1**
P_3	SCR Inlet temperature (°F)	610	611	611	**611**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,104	9,104	9,102	**9,103**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	4.1	3.5	3.8	**3.8**
CO_2	Carbon dioxide (dry volume %)	18.0	18.6	18.2	**18.3**
T_s	Stack temperature (°F)	316	314	314	**315**
B_w	Actual water vapor in gas (% by volume)	21.1	21.2	21.1	**21.1**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	191,000	190,000	191,000	**190,000**
Q_s	Volumetric flow rate, standard (scfm)	128,000	127,000	128,000	**127,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	101,000	100,000	101,000	**101,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	66.94	69.56	68.74	**68.42**
%I	Isokinetic sampling (%)	104.7	108.9	106.7	**106.8**
Laboratory Data					
m_n	Total FPM (g)	0.00118	0.00134	0.00061	
m_{CPM}	Total CPM (g)	0.00103	0.00235	0.00353	
m_{Part}	Total particulate matter (g)	0.00221	0.00369	0.00414	
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	3.90E-08	4.25E-08	1.96E-08	**3.37E-08**
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.236	0.255	0.118	**0.203**
$E_{T/yr}$	Particulate Rate (Ton/yr)	1.033	1.117	0.518	**0.889**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0004	0.0005	0.0002	**0.0004**
CPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	3.39E-08	7.44E-08	1.13E-07	**7.39E-08**
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.205	0.446	0.686	**0.446**
$E_{T/yr}$	Particulate Rate (Ton/yr)	0.898	1.954	3.003	**1.952**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0004	0.0008	0.0013	**0.0008**
Total Particulate Matter Results					
C_{sd}	Particulate Concentration (lb/dscf)	7.29E-08	1.17E-07	1.33E-07	**1.08E-07**
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.441	0.701	0.804	**0.649**
$E_{T/yr}$	Particulate Rate (Ton/yr)	1.931	3.071	3.521	**2.841**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0008	0.0013	0.0015	**0.0012**

Table 2-3:
VOC Emissions (EPA Method 25A)

Run No.		1	2	3	Average
Date (2023)		Jul 19	Jul 19	Jul 19	
Start Time (approx.)		07:45	09:02	10:11	
Stop Time (approx.)		08:45	10:02	11:11	
Process Conditions					
P1	Hydrogen Production (Mscf/day)	56.8	57.1	57.1	**57.0**
P2	Aqueous NH_3 feed to SCR (lb/hr)	31.0	31.6	31.2	**31.3**
P3	SCR Inlet Temperature	609.1	610.8	611.0	**610.3**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,104	9,104	9,102	**9,103**
H_i	Actual heat input (MMBtu/hr)	497.8	497.3	499.9	**498.3**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	3.0	3.0	-0.1	**2.0**
CO_2	Carbon dioxide (dry volume %)	19.5	19.5	18.8	**19.2**
B_w	Actual water vapor in gas (% by volume)	21.1	21.2	21.1	**21.1**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	191,000	190,000	191,000	**190,000**
Q_s	Volumetric flow rate, standard (scfm)	128,000	127,000	128,000	**127,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	101,000	100,000	101,000	**101,000**
THC Results (as Propane)[3]					
C_{sd}	Concentration (ppmdv)	0.78	<0.69	<0.68	**0.72**
$E_{lb/hr}$	Emission Rate (lb/hr)	0.54	<0.47	<0.47	**0.50**
$E_{T/yr}$	Emission Rate (Ton/yr)	2.38	<2.06	<2.07	**2.17**
E_{Fd}	Emission Rate - Fd-based (lb/MMBtu)	0.00095	<0.00083	<0.00071	**0.00083**
E_{Hi}	Emission Rate - Heat input-based (lb/MMBtu)	0.00109	<0.00095	<0.00095	**0.00099**

[1] Moisture data used for ppmwv to ppmdv correction obtained from nearly-concurrent Method 5/202 runs.

[2] Flow data used in lb/hr calculations was obtained from nearly-concurrent Method 5/202 runs .

[3] '<' indicates a measured response below the detection limit (assumed to be 1% of instrument span).

Table 2-4:
NO_X and CO Emissions (EPA Methods 7E/10)

Run No.		1*	2*	3*	4	5	6	7
Date (2023)		Jul 20	Jul 20	Jul 20	Jul 20	Jul 20	Jul 20	Jul 20
Start Time (approx.)		07:51	08:13	08:35	09:37	09:59	10:21	11:01
Stop Time (approx.)		08:12	08:34	08:56	09:58	10:20	10:42	11:22
Process Conditions								
R_P	Hydrogen Production Rate (Mscf/day)	51.2	51.2	51.2	51.1	51.1	51.2	51.2
P_1	Aqueous NH3 feed SCR (lb/hr)	25.6	25.4	25.4	25.0	24.8	24.7	24.5
P_2	SCR Inlet Temperature	584.6	584.9	585.2	585.3	586.0	586.1	586.2
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,101	9,102	9,104	9,105	9,105	9,105	9,105
H_i	Actual heat input (MMBtu/hr)	443	440	440	441	440	444	445
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	8,760	8,760	8,760	8,760
Gas Conditions								
O_2	Oxygen (dry volume %)	3.8	3.8	3.8	3.2	3.2	3.2	3.2
CO_2	Carbon dioxide (dry volume %)	18.9	18.9	18.9	19.6	19.5	19.5	19.5
B_w	Actual water vapor in gas (% by volume)	14.4	14.4	14.4	16.4	16.4	16.4	15.1
Gas Flow Rate								
Q_a	Volumetric flow rate, actual (acfm)	169,000	152,000	168,000	167,000	164,688	164,677	162,352
Q_s	Volumetric flow rate, standard (scfm)	113,000	105,000	112,000	112,000	110,053	110,303	108,597
Q_{std}	Volumetric flow rate, dry standard (dscfm)	96,900	90,000	95,900	93,300	92,049	92,258	92,203
Nitrogen Oxides (NOX)								
C_{sd}	Concentration (ppmdv)	4.09	4.04	4.08	4.06	4.15	4.17	4.30
C_{sd}	Concentration (lb/dscf)	<4.9E-07	<4.8E-07	<4.9E-07	<4.8E-07	<5.0E-07	<5.0E-07	<5.1E-07
$E_{lb/hr}$	Emission Rate (Ton/yr)	12.44	11.40	12.26	11.88	2.73	2.75	2.84
C_{sd0}	Concentration @0%O2 (ppm)	4.99	4.94	4.98	4.79	4.90	4.93	5.09
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	0.0054	0.0054	0.0054	0.0052	0.0053	0.0054	0.0055
Carbon Monoxide (CO)								
C_{sd}	Concentration (ppmdv)	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45
C_{sd}	Concentration (lb/dscf)	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08
$E_{lb/hr}$	Emission Rate (Ton/yr)	<0.83	<0.77	<0.82	<0.80	<0.18	<0.18	<0.18
E_{Fd}	Emission Rate - Fd-based (lb/MMBtu)	<3.6E-04	<3.6E-04	<3.6E-04	<3.5E-04	<3.5E-04	<3.5E-04	<3.5E-04

Average includes 9 runs. * indicates runs not included in the avergae

[1] Moisture data obtained from nearly-concurrent CTM-013 runs

[2] Flow data used in lb/hr calculations was obtained from nearly-concurrent Method 2 runs.

[3] For CO, '<' indicates a measured response below the detection limit (assumed to be 1% of the instrument calibration span).

Table 2-4 (continued):
NO_X and CO Emissions (EPA Methods 7E/10)

Run No.		8	9*	10	11	12	13	Average
Date (2023)		Jul 20	Jul 20	Jul 20	Jul 20	Jul 20	Jul 20	
Start Time (approx.)		11:24	11:46	12:22	12:44	13:06	13:38	
Stop Time (approx.)		11:45	12:07	12:43	13:05	13:27	13:59	
Process Conditions								
R_P	Hydrogen Production Rate (Mscf/day)	51.1	51.0	51.0	51.2	51.1	51.1	**51.12**
P_1	Aqueous NH3 feed SCR (lb/hr)	24.4	24.4	25.4	25.4	24.3	24.5	**24.78**
P_2	SCR Inlet Temperature	586.1	586.6	586.6	586.4	586.5	586.6	**586.20**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,104	9,105	9,106	9,103	9,103	9,103	**9,104**
H_i	Actual heat input (MMBtu/hr)	449	447	447	447	448	447	**445**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	8,760	8,760	8,760	**8,760**
Gas Conditions								
O_2	Oxygen (dry volume %)	3.2	3.3	3.2	3.2	3.2	3.2	**3.2**
CO_2	Carbon dioxide (dry volume %)	19.5	19.4	19.5	19.5	19.4	19.4	**19.5**
B_w	Actual water vapor in gas (% by volume)	15.1	15.1	15.3	15.3	15.3	15.3	**15.6**
Gas Flow Rate								
Q_a	Volumetric flow rate, actual (acfm)	164,144	164,256	165,973	163,615	165,812	163,752	**164,668**
Q_s	Volumetric flow rate, standard (scfm)	109,867	109,960	110,977	109,389	110,798	109,457	**110,160**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	93,281	93,360	94,012	92,667	93,861	92,724	**92,928**
Nitrogen Oxides (NOX)								
C_{sd}	Concentration (ppmdv)	4.16	4.36	4.23	4.22	4.25	4.21	**4.19**
C_{sd}	Concentration (lb/dscf)	<5.0E-07	<5.2E-07	<5.0E-07	<5.0E-07	<5.1E-07	<5.0E-07	**<5.0E-07**
$E_{lb/hr}$	Emission Rate (Ton/yr)	2.67	2.92	2.85	2.80	2.85	2.80	**3.80**
C_{sd0}	Concentration @0%O2 (ppm)	4.91	5.17	5.00	4.98	5.02	4.99	**4.98**
E_{Fd}	Emission Rate - F_d-based (lb/MMBtu)	0.0053	0.0056	0.0054	0.0054	0.0055	0.0054	**0.0054**
Carbon Monoxide (CO)								
C_{sd}	Concentration (ppmdv)	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	**<0.45**
C_{sd}	Concentration (lb/dscf)	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08	<3.3E-08	**<3.3E-08**
$E_{lb/hr}$	Emission Rate (Ton/yr)	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	**<0.25**
E_{Fd}	Emission Rate - Fd-based (lb/MMBtu)	<3.5E-04	<3.5E-04	<3.5E-04	<3.5E-04	<3.5E-04	<3.5E-04	**<3.5E-04**

Average includes 9 runs. * indicates runs not included in the avergae

081723 143522

[1] Moisture data obtained from nearly-concurrent CTM-013 runs

[2] Flow data used in lb/hr calculations was obtained from nearly-concurrent Method 2 runs.

[3] For CO, '<' indicates a measured response below the detection limit (assumed to be 1% of the instrument calibration span).

Table 2-5:
Dry Standard Flow Rate RATA (EPA Method 2 / PS 6)

Run No.	Start Time	Date (2023)	RM Data (DSCFH)	CEMS Data (DSCFH)	Difference	Difference Percent
1 *	07:51	Jul 20	5,815,800	4,888,050	927,750	16.0%
2 *	08:13	Jul 20	5,398,380	4,876,148	522,232	9.7%
3 *	08:35	Jul 20	5,752,980	4,867,323	885,657	15.4%
4	09:37	Jul 20	5,600,160	4,869,254	730,906	13.1%
5	09:59	Jul 20	5,522,940	4,866,973	655,967	11.9%
6	10:21	Jul 20	5,535,480	4,863,881	671,599	12.1%
7	11:01	Jul 20	5,532,180	4,860,535	671,645	12.1%
8	11:24	Jul 20	5,596,860	4,879,281	717,580	12.8%
9 *	11:46	Jul 20	5,601,603	4,888,089	713,514	12.7%
10	12:22	Jul 20	5,640,728	4,874,593	766,136	13.6%
11	12:44	Jul 20	5,560,005	4,866,056	693,950	12.5%
12	13:06	Jul 20	5,631,635	4,871,047	760,588	13.5%
13	13:38	Jul 20	5,563,439	4,859,236	704,203	12.7%
	Average		**5,575,936**	**4,867,873**	**708,064**	**12.7%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	39255.053	
Confidence Coefficient (CC)	30174.051	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	**13.2%**	**20.0%**

RM = Reference Method (CleanAir Data) 081423 154929
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-6:
H_2O Concentration RATA (EPA Method 4)

Run No.	Start Time	Date (2023)	RM Data (%wv)	CEMS Data (%wv)	Difference	Difference Percent
1 *	07:51	Jul 20	14.40	16.00	-1.60	-11.1%
2 *	08:13	Jul 20	14.40	16.00	-1.60	-11.1%
3 *	08:35	Jul 20	14.40	16.00	-1.60	-11.1%
4	09:37	Jul 20	16.63	16.00	0.63	3.8%
5	09:59	Jul 20	16.63	16.00	0.63	3.8%
6	10:21	Jul 20	16.63	16.00	0.63	3.8%
7	11:01	Jul 20	15.10	16.00	-0.90	-6.0%
8	11:24	Jul 20	15.10	16.00	-0.90	-6.0%
9 *	11:46	Jul 20	15.10	16.00	-0.90	-6.0%
10	12:22	Jul 20	15.29	16.00	-0.71	-4.6%
11	12:44	Jul 20	15.29	16.00	-0.71	-4.6%
12	13:06	Jul 20	15.29	16.00	-0.71	-4.6%
13	13:38	Jul 20	15.29	16.00	-0.71	-4.6%
Average			**15.69**	**16.00**	**-0.31**	**-1.9%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.7059	
Confidence Coefficient (CC)	0.5426	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	**5.4%**	**NA**

RM = Reference Method (CleanAir Data) 081423 154929
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-7:
O_2 (%dv) RATA (EPA Method 3A / PS3)

Run No.	Start Time	Date (2023)	RM Data (%dv)	CEMS Data (%dv)	Difference (%dv)	Difference Percent
1 *	07:51	Jul 20	3.77	3.70	0.07	1.9%
2 *	08:13	Jul 20	3.83	3.70	0.13	3.3%
3 *	08:35	Jul 20	3.81	3.70	0.11	2.9%
4	09:37	Jul 20	3.19	3.70	-0.51	-16.1%
5	09:59	Jul 20	3.22	3.70	-0.48	-14.8%
6	10:21	Jul 20	3.21	3.50	-0.29	-8.9%
7	11:01	Jul 20	3.25	3.50	-0.25	-7.7%
8	11:24	Jul 20	3.18	3.40	-0.22	-6.9%
9 *	11:46	Jul 20	3.26	3.50	-0.24	-7.4%
10	12:22	Jul 20	3.23	3.50	-0.27	-8.2%
11	12:44	Jul 20	3.22	3.40	-0.18	-5.7%
12	13:06	Jul 20	3.22	3.40	-0.18	-5.5%
13	13:38	Jul 20	3.24	3.40	-0.16	-5.0%
Average			**3.22**	**3.50**	**-0.28**	**-8.7%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.128423	
Confidence Coefficient (CC)	0.098714	
t-Value for 9 Data Sets	2.306	
		Limit
Abs. Diff. of the Avgs. (%dv)	**0.281**	**1.0**

RM = Reference Method (CleanAir Data) 080323 142024
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-8:
NO_x (ppmdv) Concentration RATA (EPA Method 7E / PS2)

Run No.	Start Time	Date (2023)	RM Data (ppmdv)	CEMS Data (ppmdv)	Difference (ppmdv)	Difference Percent
1 *	07:51	Jul 20	4.09	4.10	-0.01	-0.2%
2 *	08:13	Jul 20	4.04	4.10	-0.06	-1.6%
3 *	08:35	Jul 20	4.08	4.10	-0.02	-0.6%
4	09:37	Jul 20	4.06	4.00	0.06	1.4%
5	09:59	Jul 20	4.15	4.10	0.05	1.1%
6	10:21	Jul 20	4.17	4.10	0.07	1.7%
7	11:01	Jul 20	4.30	4.20	0.10	2.4%
8	11:24	Jul 20	4.16	4.10	0.06	1.6%
9 *	11:46	Jul 20	4.36	4.30	0.06	1.4%
10	12:22	Jul 20	4.23	4.20	0.03	0.6%
11	12:44	Jul 20	4.22	4.10	0.12	2.8%
12	13:06	Jul 20	4.25	4.20	0.05	1.1%
13	13:38	Jul 20	4.21	4.10	0.11	2.7%
	Average		**4.19**	**4.12**	**0.07**	**1.7%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.032382	
Confidence Coefficient (CC)	0.024891	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	**2.3%**	**20.0%**

RM = Reference Method (CleanAir Data) 080323 095049
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-9:
NO_X (ppmdv @ 0% O_2) Concentration RATA (EPA Method 7E / PS2)

Run No.	Start Time	Date (2023)	RM Data (ppm@0%O2)	CEMS Data (ppm@0%O2)	Difference (ppm@0%O2)	Difference Percent
1 *	07:51	Jul 20	4.99	5.00	-0.01	-0.2%
2 *	08:13	Jul 20	4.94	5.00	-0.06	-1.2%
3 *	08:35	Jul 20	4.98	5.00	-0.02	-0.3%
4	09:37	Jul 20	4.79	4.80	-0.01	-0.3%
5	09:59	Jul 20	4.90	5.00	-0.10	-2.0%
6	10:21	Jul 20	4.93	5.00	-0.07	-1.5%
7	11:01	Jul 20	5.09	5.10	-0.01	-0.1%
8	11:24	Jul 20	4.91	4.90	0.01	0.3%
9 *	11:46	Jul 20	5.17	5.20	-0.03	-0.6%
10	12:22	Jul 20	5.00	5.00	0.00	0.0%
11	12:44	Jul 20	4.98	5.00	-0.02	-0.3%
12	13:06	Jul 20	5.02	5.00	0.02	0.4%
13	13:38	Jul 20	4.99	4.90	0.09	1.8%
	Average		**4.96**	**4.97**	**-0.01**	**-0.2%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.053100	
Confidence Coefficient (CC)	0.040816	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	**1.0%**	**20.0%**

RM = Reference Method (CleanAir Data) 080323 095550
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-10:
NO_X (lb/MMBtu) Emission Rate RATA (EPA Method 7E / PS2)

Run No.	Start Time	Date (2023)	RM Data (lb/MMBtu)	CEMS Data (lb/MMBtu)	Difference (lb/MMBtu)	Difference Percent
1 *	07:51	Jul 20	0.0054	0.0050	0.0004	7.8%
2 *	08:13	Jul 20	0.0054	0.0050	0.0004	6.9%
3 *	08:35	Jul 20	0.0054	0.0050	0.0004	7.7%
4	09:37	Jul 20	0.0052	0.0050	0.0002	3.9%
5	09:59	Jul 20	0.0053	0.0050	0.0003	6.2%
6	10:21	Jul 20	0.0054	0.0050	0.0004	6.7%
7	11:01	Jul 20	0.0055	0.0060	-0.0005	-8.3%
8	11:24	Jul 20	0.0053	0.0050	0.0003	6.4%
9 *	11:46	Jul 20	0.0056	0.0060	-0.0004	-6.8%
10	12:22	Jul 20	0.0054	0.0050	0.0004	8.0%
11	12:44	Jul 20	0.0054	0.0050	0.0004	7.7%
12	13:06	Jul 20	0.0055	0.0050	0.0005	8.3%
13	13:38	Jul 20	0.0054	0.0050	0.0004	7.8%
	Average		**0.0054**	**0.0051**	**0.0003**	**5.2%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.000288	
Confidence Coefficient (CC)	0.000221	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of RM)	**9.3%**	**20.0%**

RM = Reference Method (CleanAir Data) 080323 095920
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-11:
CO (ppmdv) Concentration RATA (EPA Method 10 / PS4A)

Run No.	Start Time	Date (2023)	RM Data (ppmdv)	CEMS Data (ppmdv)	Difference (ppmdv)	Difference Percent
1 *	07:51	Jul 20	0.05	0.50	-0.45	-945.9%
2 *	08:13	Jul 20	0.05	0.50	-0.45	-913.3%
3 *	08:35	Jul 20	0.05	0.50	-0.45	-850.2%
4	09:37	Jul 20	0.02	0.50	-0.48	-2372.0%
5	09:59	Jul 20	0.02	0.50	-0.48	-2457.6%
6	10:21	Jul 20	0.02	0.50	-0.48	-3113.6%
7	11:01	Jul 20	0.04	0.50	-0.46	-1027.4%
8	11:24	Jul 20	0.04	0.50	-0.46	-1033.2%
9 *	11:46	Jul 20	0.04	0.50	-0.46	-1126.7%
10	12:22	Jul 20	0.03	0.50	-0.47	-1526.3%
11	12:44	Jul 20	0.02	0.50	-0.48	-2429.0%
12	13:06	Jul 20	0.01	0.50	-0.49	-3840.1%
13	13:38	Jul 20	0.03	0.50	-0.47	-1619.0%
	Average		**0.03**	**0.50**	**-0.47**	**-1806.0%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.011708	
Confidence Coefficient (CC)	0.009000	
t-Value for 9 Data Sets	2.306	
		Limit
Avg. Abs. Diff. + CC (ppmdv)	**0.483**	**5.0**

RM = Reference Method (CleanAir Data)

080323 095920

CEMS = Continuous Emissions Monitoring System (Air Products Data)

RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

Table 2-12:
CO (lb/hr) Emission Rate RATA (EPA Method 10 / PS4A)

Run No.	Start Time	Date (2023)	RM Data (lb/hr)	CEMS Data (lb/hr)	Difference (lb/hr)	Difference Percent
1 *	07:51	Jul 20	0.02	0.20	-0.18	-890.0%
2 *	08:13	Jul 20	0.02	0.20	-0.18	-866.4%
3 *	08:35	Jul 20	0.02	0.20	-0.18	-809.2%
4	09:37	Jul 20	0.01	0.20	-0.19	-2329.9%
5	09:59	Jul 20	0.01	0.20	-0.19	-2448.7%
6	10:21	Jul 20	0.01	0.20	-0.19	-3097.6%
7	11:01	Jul 20	0.02	0.20	-0.18	-1021.9%
8	11:24	Jul 20	0.02	0.20	-0.18	-1060.8%
9 *	11:46	Jul 20	0.02	0.20	-0.18	-1105.4%
10	12:22	Jul 20	0.01	0.20	-0.19	-1486.0%
11	12:44	Jul 20	0.01	0.20	-0.19	-2403.7%
12	13:06	Jul 20	0.01	0.20	-0.19	-3751.3%
13	13:38	Jul 20	0.01	0.20	-0.19	-1600.9%
Average			**0.01**	**0.20**	**-0.19**	**-1796.0%**

Relative Accuracy Test Audit Results

Standard Deviation of Differences	0.004605	
Confidence Coefficient (CC)	0.003540	
t-Value for 9 Data Sets	2.306	
		Limit
Relative Accuracy (as % of Appl. Std.)	**0.3%**	**5.0%**
Appl. Std. = 56.9 lb/hr		

RM = Reference Method (CleanAir Data) 080323 095920
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 13 runs. * indicates the excluded runs.

End of Section

3. DESCRIPTION OF INSTALLATION

PROCESS DESCRIPTION

Air Products owns and operates the Detroit Hydrogen Plant located within the Marathon Petroleum Company Detroit Refinery. The Hydrogen Plant supplies H_2 to the Detroit Refinery, which is utilized in the petroleum refining process. Natural gas, refinery fuel gas and/or high-pentane (C_5H_{12}) refinery streams are converted into 99.9% pure H_2 and high-pressure stream using steam/methane reforming technology. The unit consists of process vessels, a heater, compressors, pumps, piping, drains. And other various components (pump and compressor seals, process valves, pressure relief valves, flanges, connectors, etc.).

The Hydrogen Plant Heater (EG71-H2HTR) is fired by a combination of refinery gas, pressure being absorption gas, syngas and/or natural gas. The heater is equipped with a selective catalytic reduction (SCR) system to control emissions, which are vented to the atmosphere via the Hydrogen Plant Heater Stack (SV71-H1).

The testing described in this document was performed at the H_2 Plant Heater Stack.

TEST LOCATION

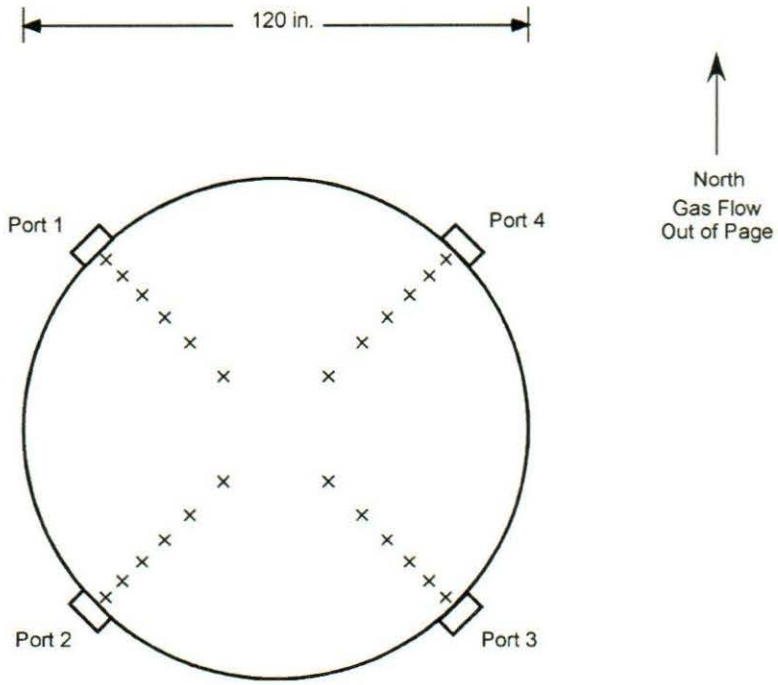
The sample point locations were determined by EPA Method 1 and Performance Specification 2 requirements. Table 3-1 presents the sampling information for the test locations. The figures shown on pages 21 and 22 represent the layout of the test location.

Table 3-1:
Sampling Information

Source Constituent	Method (USEPA)	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
H_2 Plant Heater Stack							
Total PM10	M-5/202	1-3	4	6	5	120	3-1
Velocity & Flow Rate	M-2	1-13	4	6	Varied	Varied	3-1
H_2O (Moisture)	M-4	All	1	1	60	60	N/A[1]
H_2SO_4 (Sulfuric Acid Mist)	CTM-013	1-3	1	1	60	60	N/A[1]
O_2 / CO_2 / VOC	M-3A / 25A	1-3	1	1	60	60	N/A[1]
O_2 / NO_X / CO (RATAs)	M-3A+PS3 / 7E+PS2 / 10+PS4A	1-13	1	3	7	21	3-2

[1] Sampling occured at a point at least 39.4" (1 m) from the duct wall.

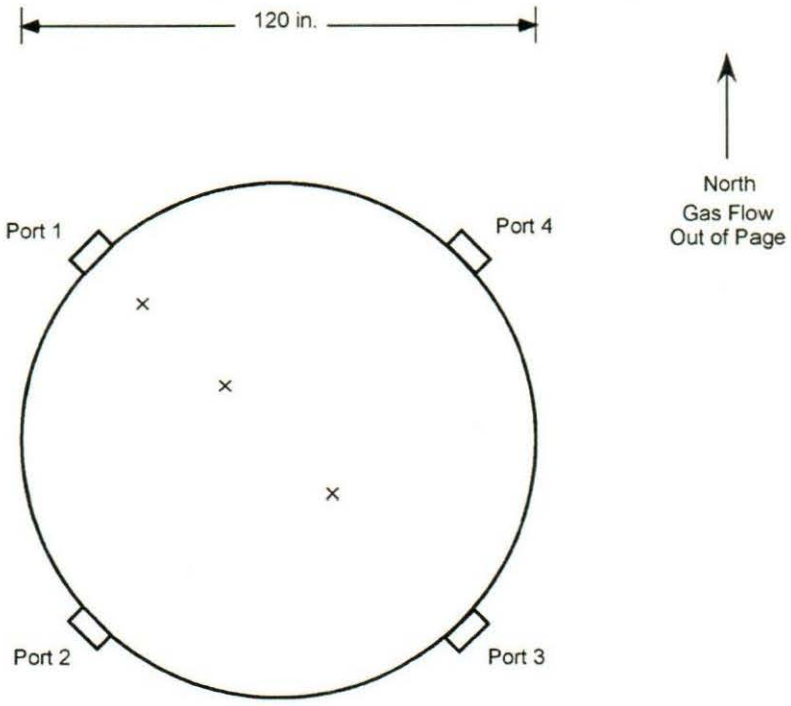
Figure 3-1:
H_2 Plant Heater Stack Sample Point Layout (EPA Method 1)



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	35.6	42.7
2	25.0	30.0
3	17.7	21.1
4	11.8	14.2
5	6.7	8.0
6	2.1	2.5

Duct diameters upstream from flow disturbance (A): 1.9	Limit: 0.5
Duct diameters downstream from flow disturbance (B): 5.9	Limit: 2.0

Figure 3-2:
H_2 Plant Heater Stack Sample Point Layout (Performance Specification 2)



Sampling Point	Meters	Port to Point Distance (inches)
1	0.4	15.7
2	1.2	47.2
3	2.0	78.7

Duct diameters upstream from flow disturbance (A): 1.9 Limit: 0.5
Duct diameters downstream from flow disturbance (B): 5.9 Limit: 2.0

End of Section

4. METHODOLOGY

PROCEDURES AND REGULATIONS

The test program sampling measurements followed procedures and regulations outlined by the USEPA and Michigan Department of Environment, Great Lakes, and Energy (EGLE). 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 1	"Sample and Velocity Traverses for Stationary Sources"
Method 2	"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
Method 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 4	"Determination of Moisture Content in Stack Gases"
Method 5	"Determination of Particulate Matter Emissions from Stationary Sources"
Method 7E	"Determination of Nitrogen Oxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 10	"Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 19	"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxide Emission Rates"
Method 25A	"Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"

TITLE 40 CFR PART 60, APPENDIX B PERFORMANCE SPECIFICATIONS

PS2	"Specifications and Test Procedures for SO_2 and NOx Continuous Emission Monitoring Systems in Stationary Sources"
PS3	"Specifications and Test Procedures for O_2 and CO_2 Continuous Emission Monitoring Systems in Stationary Sources"
PS4A	"Specifications and Test Procedures for Carbon Monoxide Continuous Emission Monitoring Systems in Stationary Sources"

PS6 "Specifications and Test Procedures for Continuous Emission Rate Monitoring Systems in Stationary Sources"

TITLE 40 CFR PART 51, APPENDIX M

Method 202 "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"

CTM-013 (METHOD 8A)

"Determination of Sulfuric Acid Vapor or Mist and Sulfur Dioxide Emissions from Kraft Recovery Furnaces"

METHODOLOGY DISCUSSION

PM AND PM_{10} TESTING – USEPA METHOD 5/202

PM and PM_{10} emissions were determined using EPA Method 5/202. For this test program, PM is assumed equivalent to FPM. PM_{10} is equivalent to the sum of FPM less than 10 micrometers (µm) in diameter (FPM_{10}) and CPM. The Method 5/202 sample train yields a front-half, FPM result and a back-half, CPM result. Where appropriate, the total PM result (FPM plus CPM) from Method 5/202 can be used as a worst-case estimation of total PM_{10} emissions since Method 5 collected all FPM present in the flue gas (regardless of particle size). Since the Hydrogen Plant Heater is fired by a combination of refinery gas, pressure swing absorption gas, syngas and/or natural gas, the worst-case assumption can safely be made that any FPM in the flue gas exists as FPM_{10} and can be collected using standard front-half filtration methods without additional 10 µm speciation.

The front-half (Method 5) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 250°F, and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

The back-half (Method 202) of the sampling train is designed to mimic ambient conditions and collect only the particles that would truly form CPM in the atmosphere. It minimizes the sulfur dioxide (SO_2) and NO_x interferences observed with earlier versions of the method, in which flue gas was bubbled through cold water and SO_2 and NO_x were absorbed and partially oxidized before they could be purged out with nitrogen (N_2).

Flue gas exiting the front-half heated filter passed through a coiled condenser and dry impinger system jacketed by water continually circulated at ambient temperature. Moisture was removed from the flue gas without bubbling through the condensed water. Flue gas then passed through a tetrafluoroethane (TFE) membrane filter at ambient temperature. The temperature of the flue gas at the exit of the filter was directly measured with an in-line thermocouple and maintained in the temperature range of 65°F to 85°F.

After exiting the ambient filter, the flue gas passed through two additional impingers surrounded by ice in a "cold" section of the impinger bucket. The moisture collected in these impingers was not analyzed for CPM and was only collected to determine the flue gas moisture and thoroughly dry the gas. The sample gas then flowed into a calibrated dry gas meter where the collected sample gas volume was determined.

The front-half portion of the sample train (nozzle, probe, and heated filter) was recovered per Method 5 requirements, using acetone as the recovery solvent. The back-half of the sample train (heated filter outlet, condenser, dry impingers, and TFE membrane filter) was recovered per Method 202 requirements. The impinger train was purged with N_2 at a rate of 14 liters per minute (lpm) for one hour following each test run and prior to recovery.

A field train blank was assembled, purged, and recovered as if it were an actual test sample; analysis of the field train blank was used to blank-correct the test run results. Reagent blanks were also collected to quantify

background contamination. All samples and blanks were returned to CleanAir Analytical Services for gravimetric analysis. Method 202 samples were maintained at a temperature < 85°F during transport to the laboratory.

H_2SO_4 Testing – Modified Conditional Test Method 013

H_2SO_4 emissions were determined referencing CTM-013.

A gas sample was extracted from the source at a constant flow rate using a quartz-lined probe maintained at a temperature of greater than 350°F and a quartz fiber filter maintained at a temperature of greater than 500°F to remove PM.

The sample passed through an H_2SO_4 condenser, which consisted of a Modified Grahm condenser with a sulfuric acid mist (SAM) filter, for collection of H_2SO_4 vapor and/or mist. The condenser temperature was modified to be maintained at 140°F ± 9°F plus 2°F for each 1% moisture above 16% flue gas moisture (above the water dew point, which eliminates the oxidation of dissolved SO_2 into the H_2SO_4-collecting fraction of the sample train).

After exiting the condenser, the sample gas continued through a series of four glass knock-out jars; two containing water, one empty and one containing silica gel for residual moisture removal. The exit temperature from the knock-out jar set was maintained below 68°F. The sample gas then flowed into a dry gas meter where the collected sample gas volume was determined by means of a calibrated dry gas meter or an orifice-based flow meter.

The H_2SO_4-collecting portion of the sample train was recovered into a single fraction using DI H_2O as the recovery/extraction solvent; any H_2SO_4 disassociates into sulfate ion (SO_4^{2-}) and is stabilized in the H_2O matrix until analysis.

Three (3) official 60-minute Modified CTM-013 test runs were performed. H_2SO_4 emission results have been calculated in units of lb/MMBtu. The result presented in Table 1-1 is expressed as the average of three (3) valid runs.

Reagent blanks were collected and analyzed to quantify background contamination.

Samples and blanks were returned to CleanAir Analytical Services in Palatine, Illinois, for ion chromatography (IC) analysis.

O_2, CO_2, and VOC Testing – USEPA Methods 3A, 25A

O_2 and CO_2 concentrations were determined using a paramagnetic/NDIR analyzer per EPA Method 3A. VOC emissions were determined using EPA Method 25A to quantify THC emissions.

The Method 3A/25A sampling system consisted of a heated probe, heated filter, and heated sample line. Flue gas was extracted at a constant rate and delivered at 250°F to a tee at the end of the heated sample line:

- One leg of the tee was connected to a flame ionization analyzer (FIA), which continuously measured minute-average THC concentration expressed in terms of propane (C_3H_8) on an actual (wet) basis.
- The other leg of the tee was connected to a gas conditioner, which removed moisture before delivering the gas to a flow panel, and the O_2/CO_2 analyzers, which measured concentration on a dry basis (units of %dv or ppmdv).

The THC analyzer calibration was performed by introducing zero air, high, mid-, and low range C_3H_8 calibration gases to the inlet of the sampling system's heated filter. Bias checks were performed before and after each sampling run in a similar manner.

O_2/CO_2 calibration error checks were performed by introducing zero N_2, high range, and mid-range calibration gases to the inlet of each analyzer. Bias checks were performed before and after each sampling run by introducing calibration gas to the inlet of the sampling system's heated filter. Per Method 3A, the average results for each run were drift corrected.

Flow Rate, Moisture, O_2, CO_2, CO, and NO_X – USEPA Methods 2, 3A, 4, 7E, and 10; PS 2, 3, 4A, and 6

RM flow rate measurements and RA were determined from Type-S Pitot tube traverses per EPA Method 2 and PS 6. RM O_2 and CO_2 emissions and RA were determined using a paramagnetic/NDIR analyzer per EPA Method 3A and PS 3. RM NO_X emissions and RA were determined using a chemiluminescent analyzer per EPA Method 7E and PS 2. RM CO emissions and RA were determined using an infrared analyzer per EPA Method 10 and PS 4 and/or PS 4A.

The Method 3A/7E/10 sampling system consisted of a heated probe, heated filter, and heated sample line. Flue gas was extracted at a constant rate at the points specified by the performance specification and delivered at 250°F to a gas conditioner which removed moisture. The flue gas was then delivered via a flow panel to an analyzer bank. Each analyzer measured concentration on a dry basis (units of %dv or ppmdv).

Calibration error checks were performed by introducing zero N_2, high range, and mid-range calibration gases to the inlet of each analyzer. Bias checks were performed before and after each sampling run by introducing calibration gas to the inlet of the sampling system's heated filter. Per Methods 3A, 7E, and 10, the average results for each run were drift corrected. Documentation of interference checks and NO_2 converter efficiency checks are included in Appendix D of this report.

General Considerations

O_2 and CO_2 data for the non-instrumental (wet) sampling methods (used in molecular weight calculations and calculation of F_d-based emissions) were obtained using concurrently operated Method 3A sampling.

H_2O data used for moisture correction of concentration data was obtained (when required) in the following manner during the test program:

- For Method 5/202, Method 4 measurements were incorporated into the sampling and recovery procedures.
- For Modified CTM-013, a modified Method 4 measurement was incorporated into the sampling and recovery procedures.
    - Sample gas was extracted through a heated probe at a single point at least one meter from the stack wall. Moisture stratification is not expected at test locations without free water droplets present in the flue gas.
    - Sample gas was extracted at a constant rate no greater than 0.75 cfm and at least 21 scf of flue gas was sampled.
    - After passing through the SAM condenser and filter, the sample gas was drawn through gum rubber tubing and into four iced knock-out jars for moisture collection and measurement. The knock-out jars were arranged in a series and contained identical contents as the impinger train, as prescribed by Method 4 but with gum rubber connections and stainless-steel internal components.
- For Method 25A, H_2O data was obtained from concurrently operated Method 5/202 trains.

- For RATA testing, H_2O data was obtained from concurrently operated CTM-013 trains, as outlined above, and one EPA Method 4 train used for Runs 10, 11, 12, and 13.

End of Section