CleanAir

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# REPORT ON MEASUREMENT SERVICES

Performed for:
**AIR PRODUCTS AND CHEMICALS, INC.**
**DETROIT HYDROGEN PLANT**

**HYDROGEN PLANT HEATER STACK**

Client Reference No: 4503337956
CleanAir Project No: 12678
Revision 0: April 29, 2015

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

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## PROJECT OVERVIEW



### INTRODUCTION

Air Products and Chemicals, Inc. (Air Products) contracted Clean Air Engineering (CleanAir) to perform emission measurements at the Detroit Hydrogen Plant in Detroit, Michigan.

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

#### *Key Project Participants*

Individuals responsible for coordinating and conducting the test program were:

Jennifer Creitz – Air Products
Sondra Klipp – Air Products
Nathaniel Hude – MDEQ
Andy Obuchowski – CleanAir

#### *Test Program Parameters*

The testing was performed at the Hydrogen ($H_2$) Plant Heater Stack on March 17 through 19, 2015, and included the following emissions measurements:

- particulate matter (PM), assumed equivalent to filterable particulate matter (FPM) only
- total particulate matter less than 10 microns (µm) in diameter (Total $PM_{10}$), assumed equivalent to the sum of the following constituents:
  - filterable particulate matter (FPM)
  - condensable particulate matter (CPM)
- sulfuric acid ($H_2SO_4$)
- volatile organic compounds (VOCs), assumed equivalent to total hydrocarbons (THC) minus the following constituents:
  - methane ($CH_4$)
  - ethane ($C_2H_6$)
- nitrogen oxides ($NO_X$)
- carbon monoxide (CO)
- flue gas composition (e.g., $O_2$, $CO_2$, $H_2O$)
- flue gas flow rate

# PROJECT OVERVIEW

## TEST PROGRAM SYNOPSIS

### *Test Schedule*

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

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

| Run Number | Location | Method | Analyte | Date | Start Time | End Time |
|---|---|---|---|---|---|---|
| 1 | $H_2$ Plant Heater Stack | USEPA Method 5/202 | FPM/CPM | 03/17/15 | 15:37 | 18:19 |
| 2 | $H_2$ Plant Heater Stack | USEPA Method 5/202 | FPM/CPM | 03/18/15 | 07:53 | 10:16 |
| 3 | $H_2$ Plant Heater Stack | USEPA Method 5/202 | FPM/CPM | 03/18/15 | 11:25 | 13:50 |
| 1 | $H_2$ Plant Heater Stack | USEPA Method 18/25A | VOC | 03/18/15 | 11:25 | 12:25 |
| 2 | $H_2$ Plant Heater Stack | USEPA Method 18/25A | VOC | 03/18/15 | 12:37 | 13:37 |
| 3 | $H_2$ Plant Heater Stack | USEPA Method 18/25A | VOC | 03/18/15 | 16:09 | 17:09 |
| 0 | $H_2$ Plant Heater Stack | Draft ASTM CCM | Sulfuric Acid | 03/18/15 | 16:10 | 17:10 |
| 1 | $H_2$ Plant Heater Stack | Draft ASTM CCM | Sulfuric Acid | 03/19/15 | 08:32 | 09:32 |
| 2 | $H_2$ Plant Heater Stack | Draft ASTM CCM | Sulfuric Acid | 03/19/15 | 10:18 | 11:18 |
| 3 | $H_2$ Plant Heater Stack | Draft ASTM CCM | Sulfuric Acid | 03/19/15 | 12:07 | 13:07 |
| 1 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 08:32 | 08:53 |
| 2 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 09:03 | 09:24 |
| 3 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 10:19 | 10:40 |
| 4 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 10:49 | 11:10 |
| 5 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 12:07 | 12:28 |
| 6 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 12:37 | 12:58 |
| 7 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 13:43 | 14:04 |
| 8 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 14:12 | 14:33 |
| 9 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 14:42 | 15:03 |
| 10 | $H_2$ Plant Heater Stack | USEPA Method 3A/7E/10 | $O_2/NO_X/CO$ | 03/19/15 | 15:11 | 15:32 |
| 1 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/18/15 | 16:20 | 16:40 |
| 2 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 08:33 | 08:45 |
| 3 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 09:03 | 09:15 |
| 4 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 10:20 | 10:34 |
| 5 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 10:50 | 11:00 |
| 6 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 12:08 | 12:22 |
| 7 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 12:38 | 12:47 |
| 8 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 13:43 | 13:52 |
| 9 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 14:12 | 14:25 |
| 10 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 14:45 | 14:57 |
| 11 | $H_2$ Plant Heater Stack | USEPA Method 2 | Velocity & Flow Rate | 03/19/15 | 15:14 | 15:22 |
| 1 | $H_2$ Plant Heater Stack | USEPA Method 4 | $H_2O$ | 03/19/15 | 13:43 | 15:32 |

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## PROJECT OVERVIEW



### *Results Summary*

Table 1-2 and Table 1-3 summarize the results of the test program. A more detailed presentation of the test conditions and results of analysis are shown on pages 2-1 through 2-15.

**Table 1-2:**
**Summary of Emission Compliance Test Results**

| Source Constituent | (Units) | Sampling Method | Average Emission | Permit Limit[1] |
|---|---|---|---|---|
| $H_2$ Plant Heater Stack | | | | |
| PM | (lb/MMBtu) | USEPA M-5 | 0.0020 | 0.0034 |
| PM | (Ton/yr) | USEPA M-5 | 3.33 | 6.86 |
| $PM_{10}$ | (lb/MMBtu) | USEPA M-5 / 202 | 0.0034 | 0.010 |
| $H_2SO_4$ | (ppmdv) | Draft ASTM CCM | 0.02 | N/A |
| $H_2SO_4$ | (lb/MMBtu) | Draft ASTM CCM | 0.0001 | N/A |
| VOC | (lb/MMBtu) | USEPA M-25A / 18 | <7.30E-04 | 0.0055 |
| $NO_X$ | (lb/MMBtu) | USEPA M-7E | 0.010 | 0.013 |
| $NO_X$ | (ppmdv @ 0% $O_2$) | USEPA M-7E | 9.1 | 60 |
| CO | (Ton/yr) | USEPA M-10 | < 0.71 | 13 |

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

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**Table 1-3:**
**Summary of RATA Results**

| Source Constituent (Units) | Reference Method (USEPA) | Relative Accuracy[1] | Units | Applicable Specification | Specification Limit[2] |
|---|---|---|---|---|---|
| $H_2$ Plant Heater Stack | | | | | |
| Flow rate (dscfm) | M-2 | 5.5 | % of RM | PS6 | 20% of RM |
| $O_2$ (% dv) | M-3A | 0.2 | %dv | PS3 | ±1.0% dv |
| $H_2O$ (% wv) | M-4 | 3.8 | % of RM | N/A | N/A |
| NOx (ppmdv) | M-7E | 2.2 | % of RM | PS2 | 20% of RM |
| NOx (lb/MMBtu) | M-7E | 5.0 | % of RM | PS2 | 20% of RM |
| NOx (ppmdv @ 0%O2) | M-7E | 1.1 | % of RM | PS2 | 20% of RM |
| CO (ppmdv) | M-10 | 0.4 | ppmdv | PS4A[3] | ±5 ppmdv |
| CO (lb/hr) | M-10 | 0.2 | % of Std. | PS4A[3] | 5% of Standard[4] |

[1] Relative Accuracy is expressed in terms of comparison to the reference method (% RM) or applicable emission standard (% Std.), equivalent to the permit limit in Table 1-2. 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% of RM, < 5% of Standard, or ± 5 ppmv (abs. average difference plus 2.5 x confidence coefficient).
[4] CO Standard = 13 Ton/yr = 56.9lb/hr (assuming 8,760 operating hours/year)

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## *Discussion of Test Program*

### *FPM and CPM Testing - USEPA Method 5/202*

For this test program, PM emission rate is assumed equivalent to FPM emission rate and $PM_{10}$ 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 EPA 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 as a result of the titration is subtracted from the analytical result.

The laboratory performing the gravimetric analysis (Clean Air Analytical Services) has determined that only samples with an initial pH less than 4.5 require a significant amount of ammonium neutralization, resulting in a correction in excess of 0.5 mg. Based on this observation, the laboratory has altered their procedures to read that a sample must have a pH lower than 4.5 in order to be titrated.

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Since none of the inorganic sample fractions collected during this test program had a pH less than 4.5, they were not titrated per Clean Air Analytical Services' modified procedure. The sample fraction was observed to come to a constant weight without having to titrate the sample.

Three (3) 120-minute Method 5/202 test runs were performed. Run 1 was performed on March 17; Runs 2 and 3 were performed on March 18.

The final results for each parameter were expressed as the average of three (3) valid runs and were below the permit limits for both PM and $PM_{10}$. Individually, Run 1 exceeded the permit limit for both PM and $PM_{10}$.

### *$H_2SO_4$ Testing - Draft ASTM Controlled Condensation Method*

Prior to the first official test run, a 60-minute sample conditioning run was performed on March 18 in order to minimize the absorption capacity of the front-half components of the sample train (upstream of the $H_2SO_4$-collection portion of the sample train). The conditioning run was recovered in the same manner as the official test runs, but is not included in the results.

Three (3) 60-minute test runs were performed on March 19. The final result was expressed as the average of three (3) valid runs.

### *VOC Testing - USEPA Method 25A and Method 18*

Three (3) 60-minute Method 25 test runs for THC were performed concurrently with three (3) 60-minute Method 18 bag collections for $CH_4$ and $C_2H_6$ on March 18. The final results for each parameter were expressed as the average of three (3) valid runs.

VOC emission rate is normally equivalent to THC emission rate, minus $CH_4$ and $C_2H_6$ emission rate (units of lb/hr, Ton/yr, or lb/MMBtu for all constituents). For $CH_4$ and $C_2H_6$, a non-detectable result was obtained for all runs, so no correction was made to the THC results. Therefore, VOC emissions are equivalent to THC emissions.

### *Flow Rate, Moisture, $O_2$, $NO_X$, and CO RATA Testing - USEPA Methods 2, 3A, 4,7E, and 10; Performance Specifications 2, 3, 4/4A, and 6*

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 Relative Accuracy Test Audit (RATA) Reference Method (RM) run.

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The average result for each RM run was calculated and compared to the average result from the facility continuous emissions monitoring system (CEMS) over identical time intervals in order 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 final result was below the limit of ±1.0%dv set by PS3.
- For $NO_X$ (ppmdv) concentration, RA is expressed as the percent difference between RM and facility CEMS runs. The final result was below the limit of 20% of the RM set by PS2.
- For $NO_X$ (lb/MMBtu) diluent, RA is expressed as the percent difference between RM and facility CEMS runs. The final result was below the limit of 20% of the RM set by PS2.
- For $NO_X$ (ppmdv @ 0% $O_2$) diluent, RA is expressed as the percent difference between RM and facility CEMS runs. The final result was below the limit of 20% of the RM set by PS2.
- 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 final result was below the limit of ±5 ppmdv set by PS4A, 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 final result was below the limit of 5% of the standard (permit limit listed in Table 1-3) set by PS4A.
- $CO_2$ data was collected only as supplemental information.

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

For flow rate, RA is expressed as the percent difference between RM and facility CEMS data. The final results were below the limit of 20% of the RM set by PS6.

Moisture data was used to convert flow rate from dry basis to wet basis and was obtained from concurrently operated Draft ASTM CCM test runs or Modified Method 4 test runs:

- For RATA Run 1 and 2, $H_2O$ data was obtained from Draft ASTM CCM Run 1.
- For RATA Run 3 and 4, $H_2O$ data was obtained from Draft ASTM CCM Run 2.
- For RATA Run 5 and 6, $H_2O$ data was obtained from Draft ASTM CCM Run 3.
- For RATA Runs 7, 8, 9 and 10, $H_2O$ data was obtained from modified Method 4 Run 1.

$NO_X$ 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 final results for each parameter were expressed as the average of all ten (10) RATA runs. The final 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 pounds per million Btu (lb/MMBtu) by first calculating mass-based emissions in units of pounds per hour (lb/hr), and then applying the total heat input to the unit over each test interval (MMBtu/hr). Heat input data was 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 are incorporated into the sampling procedures.
- For Method 18/25A, flow rate measurements from the most nearly concurrent Method 5/202 test run or Method 2 test run were used.
- For Draft ASTM CCM, two (2) flow rate measurements, per Method 2 specifications, was performed concurrently with each test run. An average of the 2 flow measurements was used.
- For Method 7E/10, a flow rate measurement, per Method 2 specifications, was performed concurrently with each test run.

### *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 systems. The plant time is 60 minutes earlier than actual Eastern Time.

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*End of Section 1 – Project Overview*

# RESULTS



## Table 2-1:
## FPM, CPM and Total $PM_{10}$ Emissions (USEPA M-5/202)

| Run No. | | 1 | 2 | 3 | Average |
|---|---|---|---|---|---|
| Date (2015) | | Mar 17 | Mar 18 | Mar 18 | |
| Start Time (approx.) | | 15:37 | 07:53 | 11:25 | |
| Stop Time (approx.) | | 18:19 | 10:16 | 13:50 | |
| **Process Conditions** | | | | | |
| $P_1$ | Hydrogen production (Mscf/day) | 46.6 | 45.7 | 45.7 | **46.0** |
| $P_2$ | Aqueous $NH_3$ feed to SCR (lb/hr) | 20.1 | 19.5 | 19.5 | **19.7** |
| $P_3$ | SCR Inlet temperature (°F) | 574.8 | 571.9 | 571.9 | **572.9** |
| $H_i$ | Actual heat input (MMBtu/hr) | 393.4 | 374.6 | 374.6 | **380.9** |
| Cap | Capacity factor (hours/year) | 8,760 | 8,760 | 8,760 | **8,760** |
| **Gas Conditions** | | | | | |
| $O_2$ | Oxygen (dry volume %)[1] | 3.0 | 2.9 | 3.0 | **2.9** |
| $CO_2$ | Carbon dioxide (dry volume %)[1] | 18.8 | 19.0 | 18.8 | **18.9** |
| $T_s$ | Sample temperature (°F) | 316 | 317 | 317 | **317** |
| $B_w$ | Actual water vapor in gas (% by volume) | 14.8 | 15.9 | 15.1 | **15.3** |
| **Gas Flow Rate** | | | | | |
| $Q_{std}$ | Volumetric flow rate, dry standard (dscfm) | 89,700 | 83,300 | 82,700 | **85,200** |
| **Sampling Data** | | | | | |
| $V_{mstd}$ | Volume metered, standard (dscf) | 55.36 | 53.27 | 52.73 | **53.78** |
| %I | Isokinetic sampling (%) | 98.0 | 101.6 | 101.3 | **100.3** |
| **Laboratory Data** | | | | | |
| $m_n$ | Total FPM (g) | 0.00492 | 0.00299 | 0.00293 | |
| $m_{CPM}$ | Total CPM (g) | 0.00402 | 0.00217 | 0.00158 | |
| $m_{Part}$ | Total particulate (expressed as PM-10) (g) | 0.00894 | 0.00516 | 0.00451 | |
| $n_{MDL}$ | Number of non-detectable fractions | N/A | N/A | 1 out of 2 | |
| DLC | Detection level classification | ADL | ADL | DLL | |
| **FPM Results** | | | | | |
| $C_{sd}$ | Particulate Concentration (lb/dscf) | 1.96E-07 | 1.24E-07 | 1.23E-07 | **1.47E-07** |
| $E_{lb/hr}$ | Particulate Rate (lb/hr) | 1.05 | 0.618 | 0.608 | **0.760** |
| $E_{T/yr}$ | Particulate Rate (Ton/yr) | 4.62 | 2.71 | 2.66 | **3.33** |
| $E_{Hi}$ | Particulate Rate - Heat Input-based (lb/MMBtu) | 0.0027 | 0.0017 | 0.0016 | **0.0020** |
| **CPM Results** | | | | | |
| $C_{sd}$ | Particulate Concentration (lb/dscf) | 1.60E-07 | 8.97E-08 | 6.59E-08 | **1.05E-07** |
| $E_{lb/hr}$ | Particulate Rate (lb/hr) | 0.862 | 0.448 | 0.327 | **0.546** |
| $E_{T/yr}$ | Particulate Rate (Ton/yr) | 3.78 | 1.96 | 1.43 | **2.39** |
| $E_{Hi}$ | Particulate Rate - Heat Input-based (lb/MMBtu) | 0.0022 | 0.0012 | 0.0009 | **0.0014** |
| **Total Particulate (as $PM_{10}$) Results** | | | | | |
| $C_{sd}$ | Particulate Concentration (lb/dscf) | 3.56E-07 | 2.13E-07 | 1.88E-07 | **2.53E-07** |
| $E_{lb/hr}$ | Particulate Rate (lb/hr) | 1.92 | 1.07 | 0.935 | **1.31** |
| $E_{T/yr}$ | Particulate Rate (Ton/yr) | 8.40 | 4.67 | 4.09 | **5.72** |
| $E_{Hi}$ | Particulate Rate - Heat Input-based (lb/MMBtu) | 0.0049 | 0.0028 | 0.0025 | **0.0034** |

Average includes 3 runs.

Detection level classifications are defined as follows:

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

DLL = Detection Level Limited - some fractions are below detection limit

[1] $O_2/CO_2$ data obtained from concurrenlty operated Method 3A CEMS testing.

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## RESULTS



**Table 2-2:**
**Uncertainty Analysis – FPM, CPM and Total $PM_{10}$ (USEPA M-5/202)**

| | | FPM Results (lb/MMBtu) | | CPM Results (lb/MMBtu) | | Total PM (as PM10) Results (lb/MMBtu) |
|---|---|---|---|---|---|---|
| **Method** | | **5/202** | | **5/202** | | **5/202** |
| **Run No.** | **1** | 0.0027 | **1** | 0.0022 | **1** | 0.0049 |
| | **2** | 0.0017 | **2** | 0.0012 | **2** | 0.0028 |
| | **3** | 0.0016 | **3** | 0.0009 | **3** | 0.0025 |
| **SD** | | 0.0006 | | 0.0007 | | 0.0013 |
| **AVG** | | **0.0020** | | **0.0014** | | **0.0034** |
| **RSD** | | 30.4% | | 48.4% | | 37.7% |
| **N** | | 3 | | 3 | | 3 |
| **SE** | | 0.0003 | | 0.0004 | | 0.0007 |
| **RSE** | | 17.5% | | 27.9% | | 21.8% |
| **P** | | 95.0% | | 95.0% | | 95.0% |
| **TINV** | | 4.303 | | 4.303 | | 4.303 |
| **CI +** | | 0.0035 | | 0.0031 | | 0.0066 |
| **AVG** | | **0.0020** | | **0.0014** | | **0.0034** |
| **CI -** | | 0.0005 | | -0.0003 | | 0.0002 |
| **TB +** | | 0.0066 | | 0.0067 | | 0.0132 |

AVG (average) is the mean value of the runs; N is the number of individual runs.
SD (standard deviation) and RSD (relative standard deviation) are measures of the variability of individual runs.
SE (standard error) and RSE (relative standard error) are measures of the variability of the average of the runs.
P (probability) is the confidence level associated with the two-tailed Student's t-distribution.
TINV (t-value) is the value of the Student's t-distrubution as a function of P (probability) and N-1 (degrees of freedom).
CI (confidence interval) indicates that if the test is conducted again under the same conditions, the average would be expected to fall within the interval (CI- to CI+) about 95% of the time.
TB+ (upper tolerance bound) is the value below which 95% of future runs are expected to fall (assuming testing at the same conditions).

## RESULTS



**Table 2-3:**
**$H_2SO_4$ Emissions (Draft ASTM CCM)**

| Run No. | | 1 | 2 | 3 | Average |
|---|---|---|---|---|---|
| Date (2015) | | Mar 19 | Mar 19 | Mar 19 | |
| Start Time (approx.) | | 08:32 | 10:18 | 12:07 | |
| Stop Time (approx.) | | 09:32 | 11:18 | 13:07 | |
| **Process Conditions** | | | | | |
| $P_1$ | Hydrogen production (Mscf/day) | 45.0 | 45.0 | 45.0 | **45.0** |
| $P_2$ | Aqueous $NH_3$ feed to SCR (lb/hr) | 16.8 | 16.8 | 16.8 | **16.8** |
| $P_3$ | SCR Inlet temperature (°F) | 569.7 | 569.7 | 569.7 | **569.7** |
| $H_i$ | Actual heat input (MMBtu/hr) | 421.9 | 421.9 | 421.9 | **421.9** |
| Cap | Capacity factor (hours/year) | 8,760 | 8,760 | 8,760 | **8,760** |
| **Gas Conditions** | | | | | |
| $O_2$ | Oxygen (dry volume %)[1] | 3.0 | 3.0 | 3.0 | **3.0** |
| $CO_2$ | Carbon dioxide (dry volume %)[1] | 18.7 | 18.8 | 18.9 | **18.8** |
| $T_s$ | Sample temperature (°F) | 328 | 327 | 328 | **328** |
| $B_w$ | Actual water vapor in gas (% by volume) | 16.3 | 16.8 | 16.7 | **16.6** |
| **Gas Flow Rate** | | | | | |
| $Q_{std}$ | Volumetric flow rate, dry standard (dscfm)[2] | 78,000 | 75,200 | 80,000 | **77,754** |
| **Sampling Data** | | | | | |
| $V_{mstd}$ | Volume metered, standard (dscf) | 25.14 | 25.02 | 25.02 | **25.06** |
| **Laboratory Data (Ion Chromatography)** | | | | | |
| $m_n$ | Total H2SO4 collected (mg) | 0.0648 | 0.0410 | 0.0626 | |
| **Sulfuric Acid Vapor (H2SO4) Results** | | | | | |
| $C_{sd}$ | H2SO4 Concentration (lb/dscf) | 5.68E-09 | 3.61E-09 | 5.52E-09 | **4.94E-09** |
| $C_{sd}$ | H2SO4 Concentration (ppmdv) | 0.0223 | 0.0142 | 0.0217 | **0.0194** |
| $E_{lb/hr}$ | H2SO4 Rate (lb/hr) | 0.0266 | 0.0163 | 0.0265 | **0.0231** |
| $E_{T/yr}$ | H2SO4 Rate (Ton/yr) | 0.117 | 0.0714 | 0.116 | **0.101** |
| $E_{Hi}$ | H2SO4 Rate - Heat Input-based (lb/MMBtu) | 6.31E-05 | 3.86E-05 | 6.28E-05 | **5.48E-05** |

Average includes 3 runs.

[1] $O_2/CO_2$ data obtained from concurrently operated Method 3A CEMS testing.

[2] Flow rate obtained from the average of the concurrently operated Method 2 test run(s).

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## RESULTS



**Table 2-4:**
**Uncertainty Analysis – $H_2SO_4$ (Draft ASTM CCM)**

| | | H2SO4 Results (ppmdv) | | H2SO4 Results (lb/MMBtu) |
|---|---|---|---|---|
| **Method** | | **CCM** | | **CCM** |
| **Run No.** | **1** | 0.0223 | **1** | 6.31E-05 |
| | **2** | 0.0142 | **2** | 3.86E-05 |
| | **3** | 0.0217 | **3** | 6.28E-05 |
| **SD** | | 0.0045 | | 1.40E-05 |
| **AVG** | | **0.0194** | | **5.48E-05** |
| **RSD** | | 23.3% | | 25.6% |
| **N** | | 3 | | 3 |
| **SE** | | 0.0026 | | 8.10E-06 |
| **RSE** | | 13.5% | | 14.8% |
| **P** | | 95.0% | | 95.0% |
| **TINV** | | 4.303 | | 4.303 |
| **CI +** | | 0.0307 | | 8.97E-05 |
| **AVG** | | **0.0194** | | **5.48E-05** |
| **CI -** | | 0.0082 | | 2.00E-05 |
| **TB +** | | 0.054 | | 1.62E-04 |

AVG (average) is the mean value of the runs; N is the number of individual runs.
SD (standard deviation) and RSD (relative standard deviation) are measures of the variability of individual runs.
SE (standard error) and RSE (relative standard error) are measures of the variability of the average of the runs.
P (probability) is the confidence level associated with the two-tailed Student's t-distribution.
TINV (t-value) is the value of the Student's t-distrubution as a function of P (probability) and N-1 (degrees of freedom).
CI (confidence interval) indicates that if the test is conducted again under the same conditions, the average would be expected to fall within the interval (CI- to CI+) about 95% of the time.
TB+ (upper tolerance bound) is the value below which 95% of future runs are expected to fall (assuming testing at the same conditions).

## RESULTS



**Table 2-5:**
**THC, $CH_4$, $C_2H_6$, and VOC Emissions (USEPA M-25A/18)**

| Run No. | | 1 | 2 | 3 | Average |
|---|---|---|---|---|---|
| Date (2015) | | Mar 18 | Mar 18 | Mar 18 | |
| Start Time (approx.) | | 11:25 | 12:37 | 16:09 | |
| Stop Time (approx.) | | 12:25 | 13:37 | 17:09 | |
| **Process Conditions** | | | | | |
| $P_1$ | Hydrogen Production (Mscf/day) | 45.7 | 45.7 | 45.7 | **45.7** |
| $P_2$ | Aqueous $NH_3$ feed to SCR (lb/hr) | 19.5 | 19.5 | 19.5 | **19.5** |
| $P_3$ | SCR Inlet Temperature | 571.9 | 571.9 | 571.9 | **571.9** |
| $H_i$ | Actual heat input (MMBtu/hr) | 374.6 | 374.6 | 374.6 | **374.6** |
| Cap | Capacity factor (hours/year) | 8,760 | 8,760 | 8,760 | **8,760** |
| **Gas Conditions** | | | | | |
| $O_2$ | Oxygen (dry volume %) | 2.94 | 2.99 | 2.92 | **2.95** |
| $CO_2$ | Carbon dioxide (dry volume %) | 18.9 | 18.8 | 19.1 | **18.9** |
| $B_w$ | Actual water vapor in gas (% by volume)[1] | 15.1 | 15.1 | 16.0 | **15.4** |
| **Gas Flow Rate[2]** | | | | | |
| $Q_{std}$ | Volumetric flow rate, dry standard (dscfm) | 82,700 | 82,700 | 76,900 | **80,700** |
| **THC Results[3]** | | | | | |
| $C_{sd}$ | Concentration (ppmdv as $C_3H_8$) | <0.491 | <0.491 | <0.496 | **<0.493** |
| $C_{sd}$ | Concentration (lb/dscf) | <5.62E-08 | <5.62E-08 | <5.68E-08 | **<5.64E-08** |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | < 0.279 | < 0.279 | < 0.262 | **< 0.273** |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | < 1.22 | < 1.22 | < 1.147 | **< 1.20** |
| $E_{Hi}$ | Emission Rate - Heat input-based (lb/MMBtu) | <7.45E-04 | <7.45E-04 | <6.99E-04 | **<7.30E-04** |
| **Methane Results[4]** | | | | | |
| $C_{sd}$ | Concentration (ppmdv) | <0.0880 | <0.0880 | <0.0880 | **<0.0880** |
| $C_{sd}$ | Concentration (lb/dscf) | <3.66E-09 | <3.66E-09 | <3.66E-09 | **<3.66E-09** |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | < 0.0182 | < 0.0182 | < 0.0169 | **< 0.0178** |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | < 0.0796 | < 0.0796 | < 0.0740 | **< 0.0777** |
| $E_{Hi}$ | Emission Rate - Heat input-based (lb/MMBtu) | <4.85E-05 | <4.85E-05 | <4.51E-05 | **<4.74E-05** |
| **Ethane Results[4]** | | | | | |
| $C_{sd}$ | Concentration (ppmdv) | <0.0920 | <0.0920 | <0.0920 | **<0.0920** |
| $C_{sd}$ | Concentration (lb/dscf) | <7.18E-09 | <7.18E-09 | <7.18E-09 | **<7.18E-09** |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | < 0.0356 | < 0.0356 | < 0.0331 | **< 0.0348** |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | < 0.156 | < 0.156 | < 0.145 | **< 0.152** |
| $E_{Hi}$ | Emission Rate - Heat input-based (lb/MMBtu) | <9.51E-05 | <9.51E-05 | <8.84E-05 | **<9.29E-05** |
| **VOC Results** | | | | | |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | < 0.279 | < 0.279 | < 0.262 | **< 0.273** |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | < 1.22 | < 1.22 | < 1.147 | **< 1.20** |
| $E_{Hi}$ | Emission Rate - Heat input-based (lb/MMBtu) | <7.45E-04 | <7.45E-04 | <6.99E-04 | **<7.30E-04** |

Average includes 3 runs.

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[1] Moisture data used for ppmwv to ppmdv correction obtained from nearly-concurrent M-5/202 or Draft ASTM CCM runs.

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

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

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

## RESULTS



### Table 2-6:
### $NO_X$ and CO Emissions (USEPA M-7E/10)

| Run No. | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Date (2015) | | Mar 19 | Mar 19 | Mar 19 | Mar 19 | Mar 19 | Mar 19 |
| Start Time (approx.) | | 08:32 | 09:03 | 10:19 | 10:49 | 12:07 | 12:37 |
| Stop Time (approx.) | | 08:53 | 09:24 | 10:40 | 11:10 | 12:28 | 12:58 |
| **Process Conditions** | | | | | | | |
| $P_1$ | Hydrogen Production (Mscf/day) | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 |
| $P_2$ | Aqueous $NH_3$ feed to SCR (lb/hr) | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 |
| $P_3$ | SCR Inlet Temperature | 569.7 | 569.7 | 569.7 | 569.7 | 569.7 | 569.7 |
| $H_I$ | Actual heat input (MMBtu/hr) | 415.8 | 415.7 | 415.8 | 417.8 | 423.2 | 428.4 |
| Cap | Capacity factor (hours/year) | 8,760 | 8,760 | 8,760 | 8,760 | 8,760 | 8,760 |
| **Gas Conditions** | | | | | | | |
| $O_2$ | Oxygen (dry volume %) | 2.99 | 2.97 | 3.03 | 2.95 | 2.92 | 3.01 |
| $CO_2$ | Carbon dioxide (dry volume %) | 18.7 | 18.7 | 18.7 | 18.9 | 18.9 | 18.8 |
| $B_w$ | Actual water vapor in gas (% by volume)[1] | 16.3 | 16.3 | 16.8 | 16.8 | 16.7 | 16.7 |
| **Gas Flow Rate**[2] | | | | | | | |
| $Q_{std}$ | Volumetric flow rate, dry standard (dscfm) | 78,300 | 77,700 | 76,700 | 73,700 | 80,100 | 79,900 |
| **Nitrogen Oxides Results** | | | | | | | |
| $C_{sd}$ | Concentration (ppmdv) | 8.12 | 7.72 | 7.68 | 7.67 | 7.80 | 7.95 |
| $C_{sd-x}$ | Concentration @ 0% $O_2$ (ppmdv) | 9.47 | 9.00 | 8.98 | 8.93 | 9.07 | 9.29 |
| $C_{sd}$ | Concentration (lb/dscf) | 9.7E-07 | 9.2E-07 | 9.2E-07 | 9.2E-07 | 9.3E-07 | 9.5E-07 |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | 4.55 | 4.30 | 4.22 | 4.05 | 4.48 | 4.55 |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | 19.9 | 18.8 | 18.5 | 17.7 | 19.6 | 19.9 |
| $E_{Hi}$ | Emission Rate - Heat input-based (lb/MMBtu) | 0.0109 | 0.0103 | 0.0102 | 0.0097 | 0.0106 | 0.0106 |
| **Carbon Monoxide Results**[3] | | | | | | | |
| $C_{sd}$ | Concentration (ppmdv) | <0.478 | <0.478 | <0.478 | <0.478 | <0.478 | <0.478 |
| $C_{sd-x}$ | Concentration @ 0% $O_2$ (ppmdv) | < 0.558 | < 0.557 | < 0.559 | < 0.556 | < 0.556 | < 0.558 |
| $C_{sd}$ | Concentration (lb/dscf) | <3.47E-08 | <3.47E-08 | <3.47E-08 | <3.47E-08 | <3.47E-08 | <3.47E-08 |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | < 0.163 | < 0.162 | < 0.160 | < 0.154 | < 0.167 | < 0.167 |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | < 0.715 | < 0.710 | < 0.701 | < 0.673 | < 0.732 | < 0.730 |
| $E_{Hi}$ | Emission Rate - Heat input-based (lb/MMBtu) | <3.92E-04 | <3.90E-04 | <3.85E-04 | <3.68E-04 | <3.95E-04 | <3.89E-04 |

[1] Moisture data obtained from nearly-concurrent Draft ASTM CCM or Method 4 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).

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## RESULTS



### Table 2-6 (Continued): $NO_X$ and CO Emissions (USEPA M-7E/10)

| Run No. | | 7 | 8 | 9 | 10 | Average |
|---|---|---|---|---|---|---|
| Date (2015) | | Mar 19 | Mar 19 | Mar 19 | Mar 19 | |
| Start Time (approx.) | | 13:43 | 14:12 | 14:42 | 15:11 | |
| Stop Time (approx.) | | 14:04 | 14:33 | 15:03 | 15:32 | |
| **Process Conditions** | | | | | | |
| $P_1$ | Hydrogen Production (Mscf/day) | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 |
| $P_2$ | Aqueous $NH_3$ feed to SCR (lb/hr) | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 |
| $P_3$ | SCR Inlet Temperature | 569.7 | 569.7 | 569.7 | 569.7 | 569.7 |
| $H_I$ | Actual heat input (MMBtu/hr) | 426.3 | 422.7 | 430.8 | 429.7 | 422.6 |
| Cap | Capacity factor (hours/year) | 8,760 | 8,760 | 8,760 | 8,760 | 8,760 |
| **Gas Conditions** | | | | | | |
| $O_2$ | Oxygen (dry volume %) | 3.08 | 3.06 | 2.99 | 2.96 | 2.99 |
| $CO_2$ | Carbon dioxide (dry volume %) | 18.7 | 18.8 | 18.8 | 18.9 | 18.8 |
| $B_w$ | Actual water vapor in gas (% by volume)[1] | 16.4 | 16.4 | 16.4 | 16.4 | 16.5 |
| **Gas Flow Rate**[2] | | | | | | |
| $Q_{std}$ | Volumetric flow rate, dry standard (dscfm) | 76,200 | 78,200 | 80,700 | 78,900 | 78,100 |
| **Nitrogen Oxides Results** | | | | | | |
| $C_{sd}$ | Concentration (ppmdv) | 7.97 | 7.76 | 7.88 | 7.69 | 7.82 |
| $C_{sd-x}$ | Concentration @ 0% $O_2$ (ppmdv) | 9.35 | 9.09 | 9.19 | 8.96 | 9.13 |
| $C_{sd}$ | Concentration (lb/dscf) | 9.5E-07 | 9.3E-07 | 9.4E-07 | 9.2E-07 | 9.3E-07 |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | 4.35 | 4.35 | 4.55 | 4.35 | 4.38 |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | 19.1 | 19.0 | 19.9 | 19.0 | 19.2 |
| $E_{Hb}$ | Emission Rate - Heat input-based (lb/MMBtu) | 0.0102 | 0.0103 | 0.0106 | 0.0101 | 0.0104 |
| **Carbon Monoxide Results**[3] | | | | | | |
| $C_{sd}$ | Concentration (ppmdv) | <0.478 | <0.478 | <0.478 | <0.478 | <0.478 |
| $C_{sd-x}$ | Concentration @ 0% $O_2$ (ppmdv) | < 0.560 | < 0.560 | < 0.558 | < 0.557 | <0.558 |
| $C_{sd}$ | Concentration (lb/dscf) | <3.47E-08 | <3.47E-08 | <3.47E-08 | <3.47E-08 | <3.47E-08 |
| $E_{lb/hr}$ | Emission Rate (lb/hr) | < 0.159 | < 0.163 | < 0.168 | < 0.165 | < 0.163 |
| $E_{T/yr}$ | Emission Rate (Ton/yr) | < 0.695 | < 0.714 | < 0.737 | < 0.721 | < 0.713 |
| $E_{Hb}$ | Emission Rate - Heat input-based (lb/MMBtu) | <3.72E-04 | <3.86E-04 | <3.90E-04 | <3.83E-04 | <3.85E-04 |

Average includes 10 runs.

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[1] Moisture data obtained from nearly-concurrent Draft ASTM CCM or Method 4 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).

## RESULTS



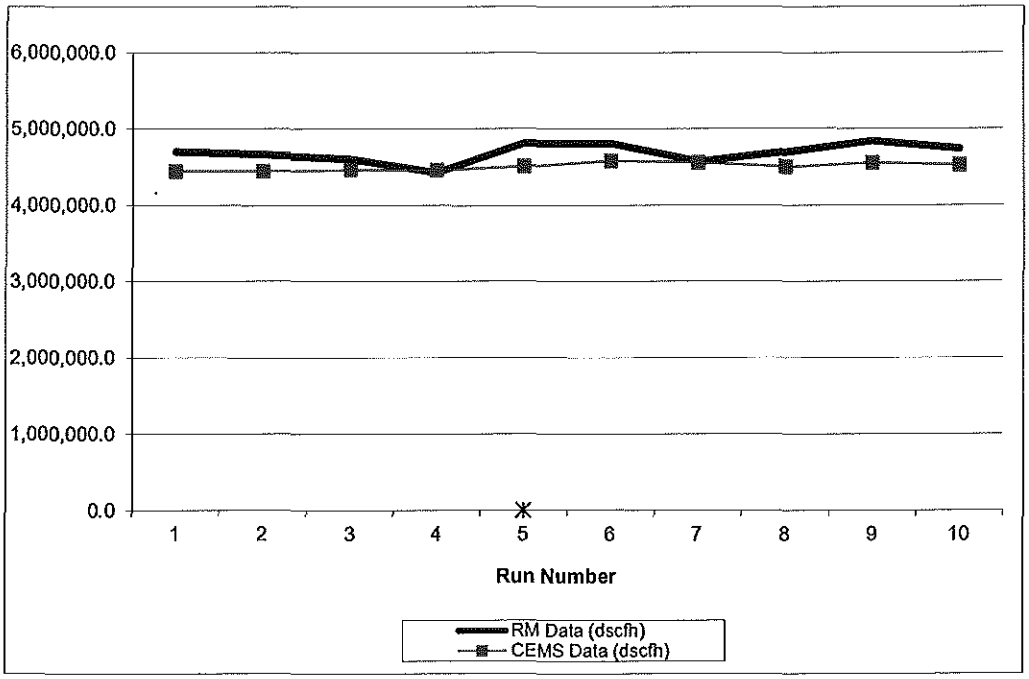
**Table 2-7:**
**Dry Standard Flow Rate RATA (USEPA M-2 / PS6)**

| Run No. | Start Time | Date (2015) | RM Data (dscfh) | CEMS Data (dscfh) | Difference (dscfh) | Difference Percent |
|---|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 4,696,223.5 | 4,440,768.7 | 255454.8 | 5.4% |
| 2 | 09:03 | Mar 19 | 4,663,411.6 | 4,439,821.2 | 223590.4 | 4.8% |
| 3 | 10:19 | Mar 19 | 4,603,750.3 | 4,462,455.9 | 141294.4 | 3.1% |
| 4 | 10:49 | Mar 19 | 4,423,664.8 | 4,454,120.2 | -30455.4 | -0.7% |
| 5 * | 12:07 | Mar 19 | 4,808,571.5 | 4,505,797.3 | 302774.2 | 6.3% |
| 6 | 12:37 | Mar 19 | 4,808,571.5 | 4,578,555.8 | 230015.7 | 4.8% |
| 7 | 13:43 | Mar 19 | 4,569,202.9 | 4,555,492.1 | 13710.8 | 0.3% |
| 8 | 14:12 | Mar 19 | 4,694,200.4 | 4,498,468.1 | 195732.3 | 4.2% |
| 9 | 14:42 | Mar 19 | 4,840,709.5 | 4,551,715.1 | 288994.4 | 6.0% |
| 10 | 15:11 | Mar 19 | 4,735,163.2 | 4,519,096.6 | 216066.6 | 4.6% |
| | **Average** | | **4670544.2** | **4500054.9** | **170489.3** | **3.7%** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 109630.5 | |
| Confidence Coefficient (CC) | 84269.3 | |
| t-Value for 9 Data Sets | 2.306 | |
| | | Limit |
| Relative Accuracy (as % of RM) | **5.5%** | **20.0%** |

RM = Reference Method (CleanAir Data) 042315 121535
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



## RESULTS



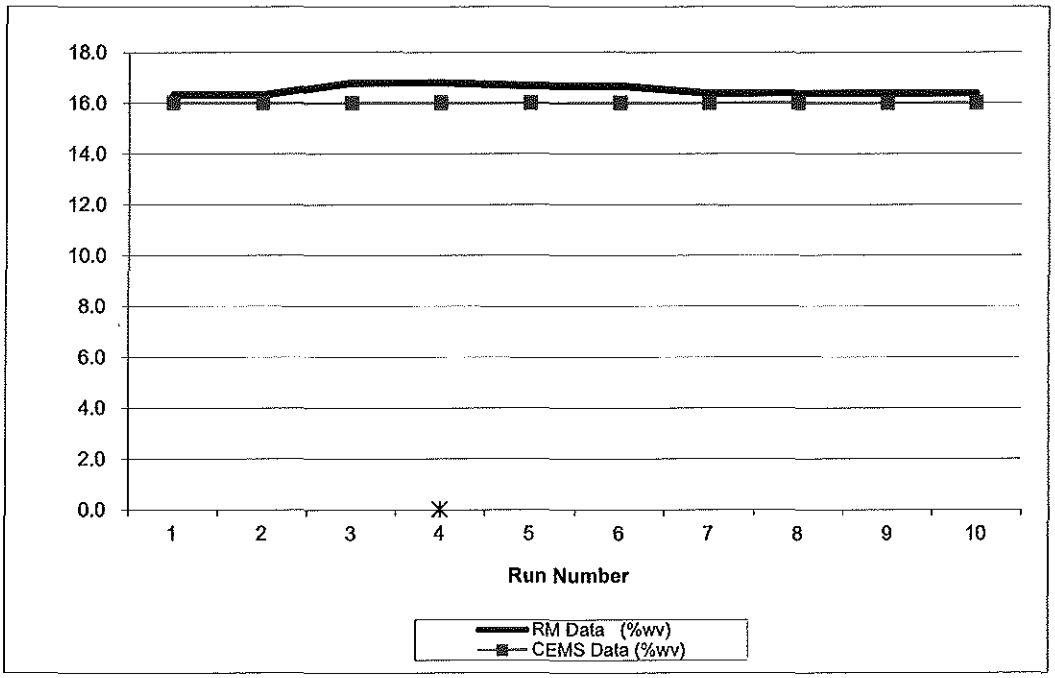
**Table 2-8:**
**$H_2O$ Concentration RATA**

| Run No. | Start Time | Date (2015) | RM Data (%wv) | CEMS Data (%wv) | Difference (%wv) | Difference Percent |
|---|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 16.3 | 16.0 | 0.3 | 1.9% |
| 2 | 09:03 | Mar 19 | 16.3 | 16.0 | 0.3 | 1.9% |
| 3 | 10:19 | Mar 19 | 16.8 | 16.0 | 0.8 | 4.8% |
| 4 * | 10:49 | Mar 19 | 16.8 | 16.0 | 0.8 | 4.8% |
| 5 | 12:07 | Mar 19 | 16.7 | 16.0 | 0.7 | 4.1% |
| 6 | 12:37 | Mar 19 | 16.7 | 16.0 | 0.7 | 4.1% |
| 7 | 13:43 | Mar 19 | 16.4 | 16.0 | 0.4 | 2.3% |
| 8 | 14:12 | Mar 19 | 16.4 | 16.0 | 0.4 | 2.3% |
| 9 | 14:42 | Mar 19 | 16.4 | 16.0 | 0.4 | 2.3% |
| 10 | 15:11 | Mar 19 | 16.4 | 16.0 | 0.4 | 2.3% |
| **Average** | | | **16.5** | **16.0** | **0.5** | **2.9%** |

**Relative Accuracy Test Audit Results**

| | |
|---|---|
| Standard Deviation of Differences | 0.188 |
| Confidence Coefficient (CC) | 0.144 |
| t-Value for 9 Data Sets | 2.306 |
| Relative Accuracy (as % of RM) | **3.8%** |

RM = Reference Method (CleanAir Data) 042115 132312
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



## RESULTS



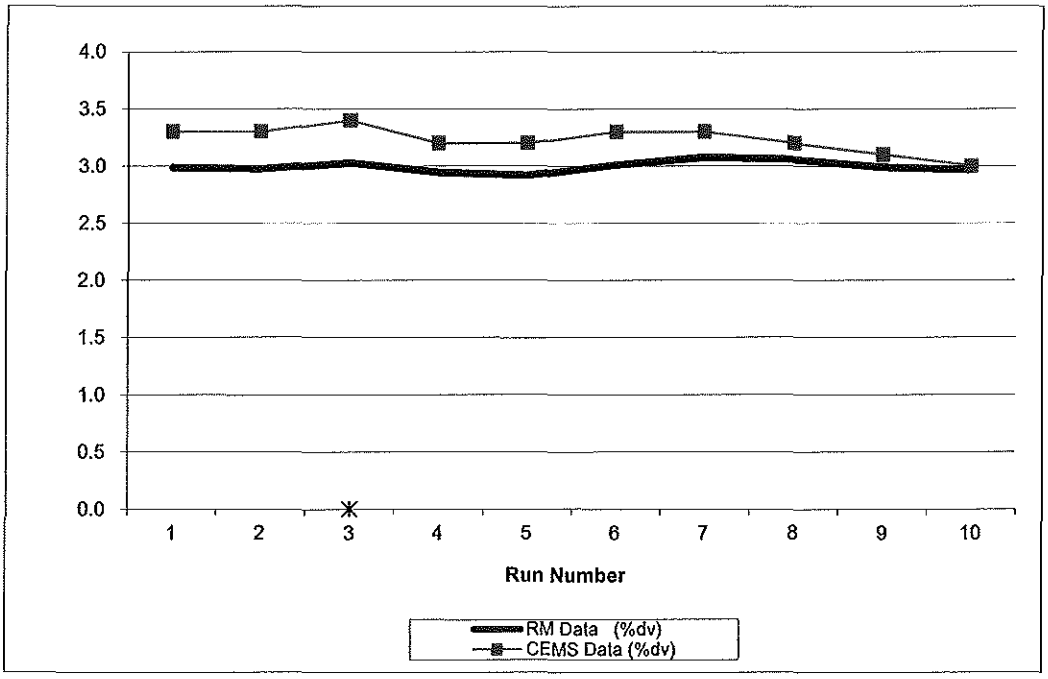
**Table 2-9:**
**$O_2$ (%dv) RATA (USEPA M-3A / PS3)**

| Run No. | Start Time | Date (2015) | RM Data (%dv) | CEMS Data (%dv) | Difference (%dv) | Difference Percent |
|---|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 3.0 | 3.3 | -0.3 | -10.5% |
| 2 | 09:03 | Mar 19 | 3.0 | 3.3 | -0.3 | -11.0% |
| 3 * | 10:19 | Mar 19 | 3.0 | 3.4 | -0.4 | -12.2% |
| 4 | 10:49 | Mar 19 | 2.9 | 3.2 | -0.3 | -8.7% |
| 5 | 12:07 | Mar 19 | 2.9 | 3.2 | -0.3 | -9.7% |
| 6 | 12:37 | Mar 19 | 3.0 | 3.3 | -0.3 | -9.6% |
| 7 | 13:43 | Mar 19 | 3.1 | 3.3 | -0.2 | -7.3% |
| 8 | 14:12 | Mar 19 | 3.1 | 3.2 | -0.1 | -4.7% |
| 9 | 14:42 | Mar 19 | 3.0 | 3.1 | -0.1 | -3.7% |
| 10 | 15:11 | Mar 19 | 3.0 | 3.0 | 0.0 | -1.2% |
| **Average** | | | **3.0** | **3.2** | **-0.2** | **-7.4%** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 0.101 | |
| Confidence Coefficient (CC) | 0.078 | |
| t-Value for 9 Data Sets | 2.306 | |
| | | Limit |
| Avg. Abs. Diff. (%dv) | **0.220** | **1.0** |

RM = Reference Method (CleanAir Data) 042115 110509
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



## RESULTS



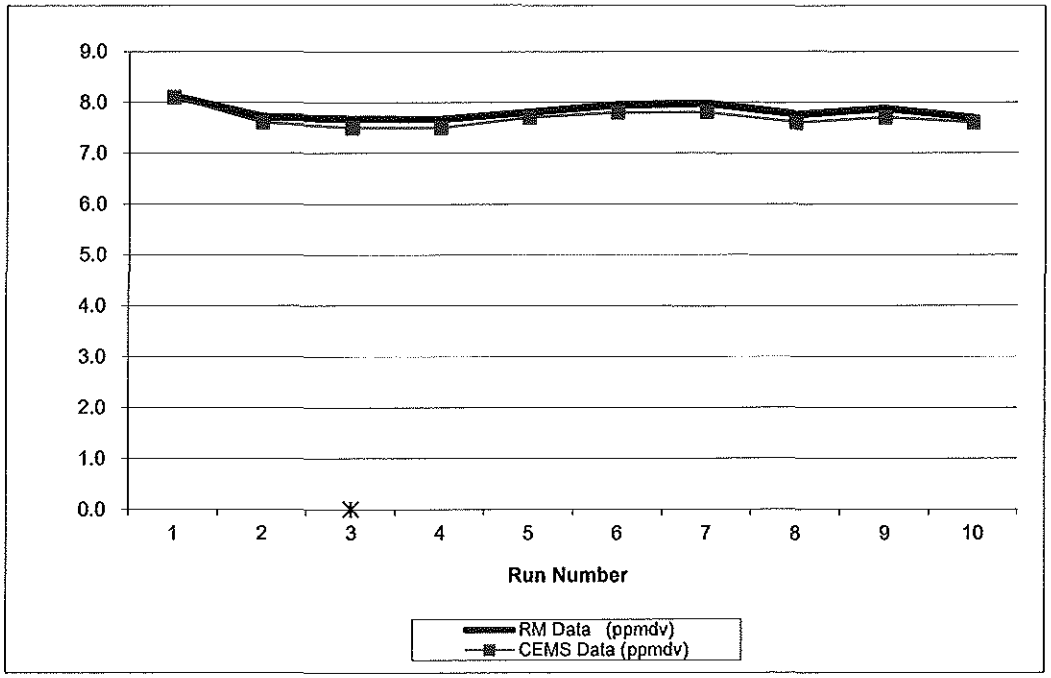
**Table 2-10:**
**$NO_X$ (ppmdv) Concentration RATA (EPA 7E / PS2)**

| Run No. | Start Time | Date (2015) | RM Data (ppmdv) | CEMS Data (ppmdv) | Difference (ppmdv) | Difference Percent |
|---|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 8.1 | 8.1 | 0.0 | 0.2% |
| 2 | 09:03 | Mar 19 | 7.7 | 7.6 | 0.1 | 1.5% |
| 3 * | 10:19 | Mar 19 | 7.7 | 7.5 | 0.2 | 2.3% |
| 4 | 10:49 | Mar 19 | 7.7 | 7.5 | 0.2 | 2.2% |
| 5 | 12:07 | Mar 19 | 7.8 | 7.7 | 0.1 | 1.3% |
| 6 | 12:37 | Mar 19 | 7.9 | 7.8 | 0.1 | 1.9% |
| 7 | 13:43 | Mar 19 | 8.0 | 7.8 | 0.2 | 2.2% |
| 8 | 14:12 | Mar 19 | 7.8 | 7.6 | 0.2 | 2.1% |
| 9 | 14:42 | Mar 19 | 7.9 | 7.7 | 0.2 | 2.2% |
| 10 | 15:11 | Mar 19 | 7.7 | 7.6 | 0.1 | 1.2% |
| **Average** | | | **7.8** | **7.7** | **0.1** | **1.6%** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 0.052 | |
| Confidence Coefficient (CC) | 0.040 | |
| t-Value for 9 Data Sets | 2.306 | |
| | | Limit |
| Relative Accuracy (as % of RM) | **2.2%** | **20.0%** |

RM = Reference Method (CleanAir Data) 042115 110509
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



## RESULTS



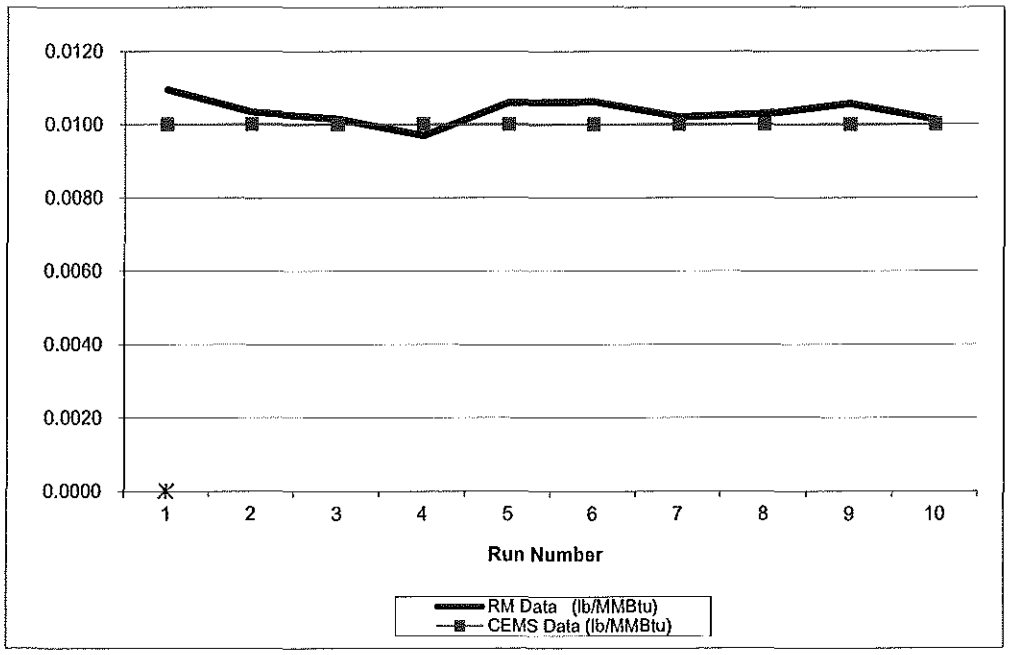
**Table 2-11:**
**$NO_X$ (lb/MMBtu) Emission Rate RATA (USEPA M-7E / PS2)**

| Run No. | Start Time | Date (2015) | RM Data (lb/MMBtu) | CEMS Data (lb/MMBtu) | Difference (lb/MMBtu) | Difference Percent |
|---|---|---|---|---|---|---|
| 1 * | 08:32 | Mar 19 | 0.0109 | 0.0100 | 0.0009 | 8.7% |
| 2 | 09:03 | Mar 19 | 0.0103 | 0.0100 | 0.0003 | 3.3% |
| 3 | 10:19 | Mar 19 | 0.0102 | 0.0100 | 0.0002 | 1.5% |
| 4 | 10:49 | Mar 19 | 0.0097 | 0.0100 | -0.0003 | -3.1% |
| 5 | 12:07 | Mar 19 | 0.0106 | 0.0100 | 0.0006 | 5.6% |
| 6 | 12:37 | Mar 19 | 0.0106 | 0.0100 | 0.0006 | 5.9% |
| 7 | 13:43 | Mar 19 | 0.0102 | 0.0100 | 0.0002 | 2.0% |
| 8 | 14:12 | Mar 19 | 0.0103 | 0.0100 | 0.0003 | 2.8% |
| 9 | 14:42 | Mar 19 | 0.0106 | 0.0100 | 0.0006 | 5.4% |
| 10 | 15:11 | Mar 19 | 0.0101 | 0.0100 | 0.0001 | 1.2% |
| **Average** | | | **0.0103** | **0.0100** | **0.0003** | **2.8%** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 0.0003 | |
| Confidence Coefficient (CC) | 0.0002 | |
| t-Value for 9 Data Sets | 2.306 | |
| | | Limit |
| Relative Accuracy (as % of RM) | **5.0%** | **20.0%** |
| Relative Accuracy (as % of Appl. Std.) | **3.9%** | **10.0%** |
| Appl. Std. = 0.013 lb/MMBtu | | |

RM = Reference Method (CleanAir Data) 042115 110509
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 10 runs. * indicates the excluded run.



## RESULTS



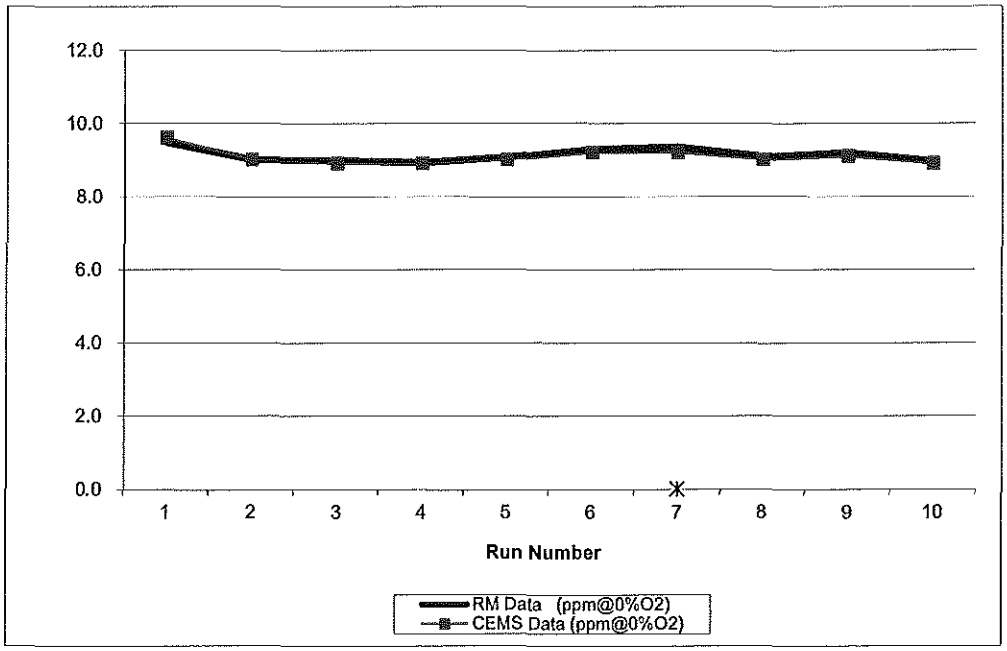
**Table 2-12:**
**$NO_X$ (ppmdv @ 0% $O_2$) Emission Rate RATA (USEPA M-7E / PS2)**

| Run No. | Start Time | Date (2015) | RM Data (ppm@0%O2) | CEMS Data (ppm@0%O2) | Difference (ppm@0%O2) | Difference Percent |
|---|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 9.5 | 9.6 | -0.1 | -1.3% |
| 2 | 09:03 | Mar 19 | 9.0 | 9.0 | 0.0 | 0.0% |
| 3 | 10:19 | Mar 19 | 9.0 | 8.9 | 0.1 | 0.9% |
| 4 | 10:49 | Mar 19 | 8.9 | 8.9 | 0.0 | 0.3% |
| 5 | 12:07 | Mar 19 | 9.1 | 9.0 | 0.1 | 0.8% |
| 6 | 12:37 | Mar 19 | 9.3 | 9.2 | 0.1 | 0.9% |
| 7 * | 13:43 | Mar 19 | 9.3 | 9.2 | 0.1 | 1.6% |
| 8 | 14:12 | Mar 19 | 9.1 | 9.0 | 0.1 | 1.0% |
| 9 | 14:42 | Mar 19 | 9.2 | 9.1 | 0.1 | 1.0% |
| 10 | 15:11 | Mar 19 | 9.0 | 8.9 | 0.1 | 0.7% |
| **Average** | | | **9.1** | **9.1** | **0.0** | **0.5%** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 0.071 | |
| Confidence Coefficient (CC) | 0.054 | |
| t-Value for 9 Data Sets | 2.306 | |
| | | Limit |
| Relative Accuracy (as % of RM) | **1.1%** | **20.0%** |
| Relative Accuracy (as % of Appl. Std.) | **0.2%** | **10.0%** |
| Appl. Std. = 60 ppm@0%O2 | | |

RM = Reference Method (CleanAir Data) 042115 110509
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on 9 of 10 runs. * Indicates the excluded run.



## RESULTS



**Table 2-13:**
**CO (ppmdv) Concentration RATA (USEPA M-10 / PS4A)**

| Run No. | Start Time | Date (2015) | RM Data (ppmdv) | CEMS Data (ppmdv) | Difference (ppmdv) |
|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 2 | 09:03 | Mar 19 | 0.0 | 0.3 | -0.3 |
| 3 | 10:19 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 4 | 10:49 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 5 | 12:07 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 6 | 12:37 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 7 | 13:43 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 8 | 14:12 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 9 | 14:42 | Mar 19 | 0.0 | 0.4 | -0.4 |
| 10 | 15:11 | Mar 19 | 0.0 | 0.4 | -0.4 |
| **Average** | | | **0.0** | **0.4** | **-0.4** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 0.032 | |
| Confidence Coefficient (CC) | 0.023 | |
| t-Value for 10 Data Sets | 2.262 | |
| | | Limit |
| Avg. Abs. Diff. + CC (ppmdv) | **0.413** | **5.0** |

RM = Reference Method (CleanAir Data) 042115 110509
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on all 10 runs.

## RESULTS



**Table 2-14:**
**CO (lb/hr) Emission Rate RATA (USEPA M-10 / PS4A)**

| Run No. | Start Time | Date (2015) | RM Data (lb/hr) | CEMS Data (lb/hr) | Difference (lb/hr) |
|---|---|---|---|---|---|
| 1 | 08:32 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 2 | 09:03 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 3 | 10:19 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 4 | 10:49 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 5 | 12:07 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 6 | 12:37 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 7 | 13:43 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 8 | 14:12 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 9 | 14:42 | Mar 19 | 0.0 | 0.1 | -0.1 |
| 10 | 15:11 | Mar 19 | 0.0 | 0.2 | -0.2 |
| | **Average** | | **0.0** | **0.1** | **-0.1** |

**Relative Accuracy Test Audit Results**

| | | |
|---|---|---|
| Standard Deviation of Differences | 0.032 | |
| Confidence Coefficient (CC) | 0.023 | |
| t-Value for 10 Data Sets | 2.262 | |
| | | Limit |
| Relative Accuracy (as % of Appl. Std.) | **0.2%** | **5.0%** |
| Appl. Std. = 56.94 lb/hr | | |

RM = Reference Method (CleanAir Data) 042115 110509
CEMS = Continuous Emissions Monitoring System (Air Products Data)
RATA calculations are based on all 10 runs.

*End of Section 2 – Results*