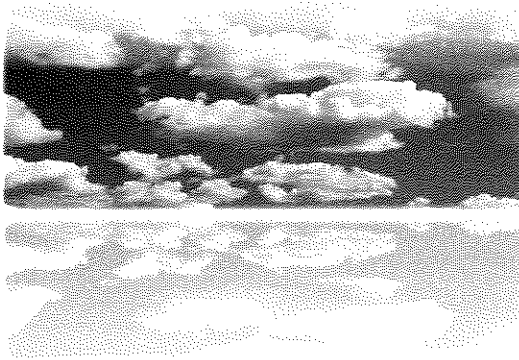




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REPORT ON RATA &
COMPLIANCE TESTING

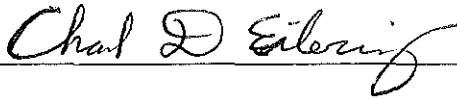
Detroit Refinery
B&W Boiler Stack (SV-B&WBoiler1)

Marathon Petroleum Company LP
1300 South Fort Street
Detroit, MI 48217
Client Reference No. 4101004604

CleanAir Project No. 13240-1
STAC Certificate No. 2007.002.0113.1217
Revision 0, Final Report
May 24, 2017

COMMITMENT TO QUALITY

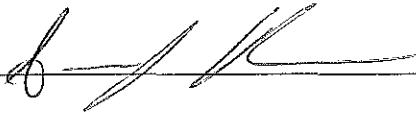
To the best of our knowledge, the data presented in this report are accurate, complete, error free and representative of the actual emissions during the test program. Clean Air Engineering operates in conformance with the requirements of ASTM D7036-04 Standard Practice for Competence of Air Emission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



May 24, 2017

Chad Eilering
Field Test Leader
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Date



May 24, 2017

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Date

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



May 24, 2017

Peter Kaufmann, QSTI
Project Manager
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Date

1. PROJECT OVERVIEW

Test Program Summary

Marathon Petroleum Company LP contracted Clean Air Engineering (CleanAir) to successfully complete testing on the B&W Boiler Stack at the Detroit Refinery. The test program included the following objectives:

- Perform particulate matter (PM), sulfuric acid mist (H₂SO₄), and volatile organic compound (VOC) testing to demonstrate compliance with the MDEQ Permit No. MI-ROP-A9831-2012c;
- Perform a relative accuracy test audit (RATA) on the facility continuous emissions monitoring system (CEMS) for oxygen (O₂) and nitrogen oxides (NO_x).

A summary of the test program results is presented below. Section 2 Results provides a more detailed account of the test conditions and data analysis. Test program information, including the test parameters, on-site schedule and a project discussion, begins on page 2.

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

| Source | Constituent (Units) | Sampling Method | Average Emission | Permit Limit ¹ |
|-----------------------------|---|-----------------|------------------|---------------------------|
| <i>B&W Boiler Stack</i> | | | | |
| | PM (lb/MMBtu) | USEPA 5 | 0.0012 | 0.0019 |
| | H ₂ SO ₄ (ppm dv) | Draft ASTM CCM | 0.10 | N/A |
| | H ₂ SO ₄ (lb/MMBtu) | Draft ASTM CCM | 0.00030 | N/A |
| | VOC (lb/MMBtu) | USEPA 25A/ 18 | <0.00065 | 0.0055 |

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

**Table 1-2:
Summary of Results – CEMS RATA**

| Source | Reference Method | Relative Accuracy (%) ¹ | Applicable Specification | Standard Used | Specification Limit |
|-----------------------------|------------------|------------------------------------|--------------------------|---------------|---------------------|
| <i>B&W Boiler Stack</i> | | | | | |
| | USEPA 3A | 0.06 | 40 CFR 75, APP. A | abs. diff. | ± 1.0% |
| | USEPA 7E | 4.7 | 40 CFR 75, APP. A | % of RM | 10% |

¹ Relative Accuracy is expressed in terms of comparison to the reference method (% RM) or avg. absolute difference. The specific expression used depends on the specification limit cited.

Test Program Details

Parameters

The test program included the following emissions measurements:

- particulate matter (PM), assumed equivalent to filterable particulate matter (FPM) only
- nitrogen oxide (NO_x)
- volatile organic compounds (VOCs), assumed equivalent to total hydrocarbons (THCs) minus the following constituents:
 - methane (CH₄)
 - ethane (C₂H₆)
- sulfuric acid mist (H₂SO₄)
- flue gas composition (e.g., O₂, CO₂, H₂O)
- flue gas temperature
- flue gas flow rate

Schedule

The on-site schedule followed during the test program is outlined in Table 1-3.

**Table 1-3:
Test Schedule**

| Run Number | Location | Method | Analyte | Date | Start Time | End Time |
|------------|------------------|--------------------------------|----------------------------------|----------|------------|----------|
| 1 | B&W Boiler Stack | USEPA Method 5 | FPM | 04/03/17 | 13:54 | 15:58 |
| 2 | B&W Boiler Stack | USEPA Method 5 | FPM | 04/03/17 | 17:40 | 19:59 |
| 3 | B&W Boiler Stack | USEPA Method 5 | FPM | 04/04/17 | 08:40 | 10:59 |
| 1 | B&W Boiler Stack | USEPA Method 3A and 25A | O ₂ / THC | 04/03/17 | 13:54 | 14:54 |
| 2 | B&W Boiler Stack | USEPA Method 3A and 25A | O ₂ / THC | 04/03/17 | 15:16 | 16:16 |
| 3 | B&W Boiler Stack | USEPA Method 3A and 25A | O ₂ / THC | 04/03/17 | 17:42 | 18:42 |
| 1 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 09:00 | 10:00 |
| 2 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 11:00 | 12:00 |
| 3 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 12:00 | 13:00 |
| 4 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 13:00 | 14:00 |
| 5 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 15:00 | 16:00 |
| 6 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 16:00 | 17:00 |
| 7 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/04/17 | 18:00 | 19:00 |
| 8 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/05/17 | 09:00 | 10:00 |
| 9 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/05/17 | 10:00 | 11:00 |
| 10 | B&W Boiler Stack | USEPA Method 3A and 7E | O ₂ / NO _x | 04/05/17 | 11:00 | 12:00 |
| 0 | B&W Boiler Stack | CTM-013 (mod) / Draft ASTM CCM | H ₂ SO ₄ | 04/04/17 | 12:48 | 13:49 |
| 1 | B&W Boiler Stack | CTM-013 (mod) / Draft ASTM CCM | H ₂ SO ₄ | 04/04/17 | 14:25 | 15:25 |
| 2 | B&W Boiler Stack | CTM-013 (mod) / Draft ASTM CCM | H ₂ SO ₄ | 04/04/17 | 15:56 | 16:56 |
| 3 | B&W Boiler Stack | CTM-013 (mod) / Draft ASTM CCM | H ₂ SO ₄ | 04/04/17 | 17:23 | 18:23 |

Discussion

Project Synopsis

FPM Testing – USEPA Method 5

For this test program, PM emission rate is assumed equivalent to FPM emission rate. Three (3) 120-minute Method 5 test runs were performed on April 3 and 4, 2017. The result was expressed as the average of three valid runs.

H₂SO₄ Testing – Draft ASTM Controlled Condensation Method

Four (4) 60-minute test runs, one conditioning test (Run 0) followed by three official tests (Runs 1-3) were performed on April 4. The result was expressed as the average of three valid runs.

VOC Testing – USEPA Methods 25A and 18

Three (3) 60-minute Method 25A test runs for total hydrocarbons (THCs) were performed concurrently with three (3) 60-minute Method 18 bag collections for CH₄ and C₂H₆. The results for each parameter were expressed as the average of three valid runs.

The VOC emission rate is considered to be equivalent to THC emission rate, minus CH₄ and C₂H₆ emission rate. For Run 1, after subtracting the emission rate of CH₄ and C₂H₆, the result was below the calibration span of the THC instrument. Therefore, VOC emissions are reported as a value “less than” 1% of the calibration span of THC instrument.

For Run 2, the calculated emission rate of CH₄ and C₂H₆ detected through analysis of each Method 18 sample bag exceeded the amount of THCs measured by the online THC analyzer. This is likely due to variations in the calibration standards, measurement and analytical technique. The VOC emissions are reported as a value “less than” 1% of the calibration span of the THC instrument.

For Run 3, the non-detect result for C₂H₆ was considered zero when calculating the VOC concentration. The resultant VOC concentration is reported as “less than” the difference of THCs and CH₄.

RATA Testing – USEPA Methods 3A, 7E, and 10

Minute-average data points for O₂, carbon dioxide (CO₂), and NO_x (dry basis) were collected over a period of 60 minutes for each RATA Reference Method (RM) run. The average result for each RM run was calculated and compared to the average result from the facility CEMS over an identical time interval in order to calculate relative accuracy (RA). (Note: The facility CEMS is not on daylight saving time.)

The final result was expressed as the average of nine (9) of the 10 RATA runs performed.

The RATA for NO_x and O₂ was conducted per 40 CFR Part 75.

Prior to conducting the RATA, MPC performed a linearity test which will be reported separately.

All tests were completed while the facility CEMS was operated in a “hands-off” manner. The boiler was operated at its normal steam load, as that term is defined in 40 CFR Part 75, Appendix A. The “normal” load is the mid-range of operation, or a steam production rate between 50,000 and 152,000 pounds per hour.

The facility CEMS data acquisition system used for NO_x (Cirrus System) is different than the “normal” data acquisition systems. The Cirrus System is restricted to taking a reading every hour on the hour.

In lieu of performing a stratification test, sampling was performed at the three points along the “long measurement line”, as described in 40 CFR 60, Appendix B, PS2, §8.1.3 (16.7, 50.0 and 83.3% of the way across the stack), for each test run.

Bias tests were performed on all of the NO_x RATA data sets. The CEMS data was found to be biased high in comparison to the RM data in all instances. Since the mean difference between the RM and CEMS data was less than or equal to the absolute value of the confidence coefficient for all runs, the CEMS passed the bias test and a bias adjustment factor (BAF) was not applied to any of the emissions results. Per 40 CFR Part 75, bias is only applicable when the CEMS data is biased low in relation to the RM data.

Calculation of Final Results

Emission results in units of dry volume-based concentration (lb/dscf, ppm_{dv}) were converted to units of pounds per million Btu (lb/MMBtu) by calculating a combination oxygen-based fuel factor (F_d) for natural gas and refinery gas per USEPA Method 19 specifications.

- For natural gas, the volume-based gross heat content (GCV_v) was obtained from a gas analysis report provided by MPC. The natural gas F_d factor was obtained from 40 CFR Part 75, Appendix F, Table 1. This approach should yield worst-case calculated emission results.
- For refinery gas, the heat content and F_d factor were calculated from percent volume composition analytical data provided by MPC and tabulated heating values for each of the measured constituents.

End of Section

2. RESULTS

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

**Table 2-1:
B&W Boiler Stack – FPM Emissions (USEPA Method 5)**

| Run No. | | 1 | 2 | 3 | Average |
|---------------------------|---|-----------|-----------|-----------|-----------|
| Date (2017) | | Apr 3 | Apr 3 | Apr 4 | |
| Start Time (approx.) | | 13:54 | 17:40 | 08:40 | |
| Stop Time (approx.) | | 15:58 | 19:59 | 10:59 | |
| Process Conditions | | | | | |
| R _p | Steam production (Mlb/hr) | 107 | 112 | 141 | 120 |
| P ₁ | Fuel gas flow rate (Mscf/day) | 2,731 | 2,873 | 3,650 | 3,085 |
| P ₂ | Natural gas flow rate (Mscf/day) | 154 | 154 | 155 | 154 |
| F _d | Oxygen-based F-factor (dscf/MMBtu) | 8,311 | 8,310 | 8,337 | 8,319 |
| Cap | Capacity factor (hours/year) | 8,760 | 8,760 | 8,760 | 8,760 |
| Gas Conditions | | | | | |
| O ₂ | Oxygen (dry volume %) | 6.8 | 6.6 | 6.2 | 6.5 |
| CO ₂ | Carbon dioxide (dry volume %) | 8.1 | 8.2 | 8.8 | 8.4 |
| T _s | Sample temperature (°F) | 318 | 316 | 334 | 323 |
| B _w | Actual water vapor in gas (% by volume) | 15.4 | 15.5 | 15.3 | 15.4 |
| Gas Flow Rate | | | | | |
| Q _a | Volumetric flow rate, actual (acfm) | 57,500 | 57,100 | 73,000 | 62,500 |
| Q _s | Volumetric flow rate, standard (scfm) | 37,900 | 38,200 | 46,300 | 40,800 |
| Q _{std} | Volumetric flow rate, dry standard (dscfm) | 32,100 | 32,300 | 39,300 | 34,600 |
| Q _a | Volumetric flow rate, actual (acf/hr) | 3,450,000 | 3,420,000 | 4,380,000 | 3,750,000 |
| Q _s | Volumetric flow rate, standard (scf/hr) | 2,270,000 | 2,290,000 | 2,780,000 | 2,450,000 |
| Q _{std} | Volumetric flow rate, dry standard (dscf/hr) | 1,920,000 | 1,940,000 | 2,360,000 | 2,070,000 |
| Sampling Data | | | | | |
| V _{mstd} | Volume metered, standard (dscf) | 77.40 | 77.31 | 94.63 | 83.11 |
| %I | Isokinetic sampling (%) | 103.0 | 102.1 | 102.9 | 102.7 |
| Laboratory Data | | | | | |
| m _{filter} | Matter collected on filter(s) (g) | 0.00119 | 0.00155 | 0.00140 | |
| m _s | Matter collected in solvent rinse(s) (g) | 0.00262 | 0.00196 | 0.00217 | |
| m _n | Total FPM (g) | 0.00381 | 0.00351 | 0.00357 | |
| FPM Results | | | | | |
| C _{sd} | Particulate Concentration (lb/dscf) | 1.09E-07 | 1.00E-07 | 8.32E-08 | 9.73E-08 |
| E _{lb/hr} | Particulate Rate (lb/hr) | 0.21 | 0.19 | 0.20 | 0.20 |
| E _{T/yr} | Particulate Rate (Ton/yr) | 0.91 | 0.85 | 0.86 | 0.87 |
| E _{Fd} | Particulate Rate - F _d -based (lb/MMBtu) | 0.0013 | 0.0012 | 0.0010 | 0.0012 |

**Table 2-2:
B&W Boiler Stack – Sulfuric Acid Mist Emissions (Draft ASTM CCM)**

| Run No. | 1 | 2 | 3 | Average |
|---|----------|----------|----------|-----------------|
| Date (2017) | Apr 4 | Apr 4 | Apr 4 | |
| Start Time (approx.) | 14:25 | 15:56 | 17:23 | |
| Stop Time (approx.) | 15:25 | 16:56 | 18:23 | |
| Process Conditions | | | | |
| R _p Steam Production (Mlb/hr) | 149 | 170 | 138 | 152 |
| P ₁ Fuel gas flow rate (Mscf/day) | 3,810 | 4,238 | 3,266 | 3,771 |
| P ₂ Natural gas flow rate (Mscf/day) | 155 | 309 | 411 | 291 |
| F _d Oxygen-based F-factor (dscf/MMBtu) | 8,338 | 8,350 | 8,368 | 8,352 |
| Gas Conditions | | | | |
| O ₂ Oxygen (dry volume %) | 6.0 | 6.0 | 6.0 | 6.0 |
| CO ₂ Carbon dioxide (dry volume %) | 9.0 | 9.0 | 9.0 | 9.0 |
| T _s Sample temperature (°F) | 341 | 358 | 333 | 344 |
| B _w Actual water vapor in gas (% by volume) | 15.5 | 16.1 | 15.9 | 15.8 |
| Sampling Data | | | | |
| V _{mstd} Volume metered, standard (dscf) | 27.36 | 27.53 | 27.06 | 27.32 |
| Laboratory Data (Ion Chromatography) | | | | |
| m _n Total H ₂ SO ₄ collected (mg) | 0.2663 | 0.3815 | 0.2968 | |
| Sulfuric Acid Vapor (H₂SO₄) Results | | | | |
| C _{sdl} H ₂ SO ₄ Concentration (lb/dscf) | 2.15E-08 | 3.06E-08 | 2.42E-08 | 2.54E-08 |
| C _{sdl} H ₂ SO ₄ Concentration (ppmdv) | 0.084 | 0.12 | 0.095 | 0.10 |
| E _{Fd} H ₂ SO ₄ Rate - Fd-based (lb/MMBtu) | 0.00025 | 0.00036 | 0.00028 | 0.00030 |

**Table 2-3:
B&W Boiler Stack – VOC Emissions (USEPA Methods 25A & 18)**

| Run No. | | 1 | 2 | 3 | Average |
|---------------------------|---|----------|----------|----------|--------------------|
| Date (2017) | | Apr 3 | Apr 3 | Apr 3 | |
| Start Time (approx.) | | 13:54 | 15:16 | 17:42 | |
| Stop Time (approx.) | | 14:54 | 16:16 | 18:42 | |
| Process Conditions | | | | | |
| R _P | Steam Production (Mlb/hr) | 111 | 102 | 103 | 105 |
| P ₁ | Fuel gas flow rate (Mscf/day) | 2,818 | 2,612 | 2,632 | 2,687 |
| P ₂ | Natural gas flow rate (Mscf/day) | 154 | 154 | 154 | 154 |
| F _d | Oxygen-based F-factor (dscf/MMBtu) | 8,310 | 8,312 | 8,312 | 8,311 |
| Gas Conditions | | | | | |
| O ₂ | Oxygen (dry volume %) | 6.4 | 6.5 | 6.8 | 6.6 |
| CO ₂ | Carbon dioxide (dry volume %) | 8.6 | 8.6 | 8.4 | 8.5 |
| B _w | Actual water vapor in gas (% by volume) ¹ | 15.4 | 15.5 | 15.3 | 15.4 |
| THC Results | | | | | |
| C _{sd} | Concentration (ppmdv as C ₃ H ₈) | 2.1 | 1.4 | 1.2 | 1.6 |
| C _{sd} | Concentration (lb/dscf) | 2.4E-07 | 1.6E-07 | 1.4E-07 | 1.8E-07 |
| E _{Fd} | Emission Rate - F _d -based (lb/MMBtu) | 0.0029 | 0.0019 | 0.0018 | 0.0022 |
| Methane Results | | | | | |
| C _{sd} | Concentration (ppmdv) | 3.7 | 2.9 | 2.2 | 2.9 |
| C _{sd} | Concentration (lb/dscf) | 1.5E-07 | 1.2E-07 | 9.2E-08 | 1.2E-07 |
| E _{Fd} | Emission Rate - F _d -based (lb/MMBtu) | 0.0018 | 0.0014 | 0.0011 | 0.0015 |
| Ethane Results | | | | | |
| C _{sd} | Concentration (ppmdv) | 1.1 | 0.78 | <0.22 | <0.71 |
| C _{sd} | Concentration (lb/dscf) | 8.9E-08 | 6.1E-08 | <1.7E-08 | <5.6E-08 |
| E _{Fd} | Emission Rate - F _d -based (lb/MMBtu) | 0.0011 | 0.00074 | <0.00021 | <0.00067 |
| VOC Results | | | | | |
| C _{sd} | Concentration (ppmdv as C ₃ H ₈) | <0.45 | <0.45 | <0.50 | <0.47 |
| E _{Fd} | Emission Rate - F _d -based (lb/MMBtu) | <0.00061 | <0.00062 | <0.00071 | <0.00065 |

¹ Moisture data used for ppmw v to ppmdv correction obtained from nearly-concurrent M-5 runs.

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

For VOCs, '<' indicates either at least one non-detectable fraction was used in the calculations or the difference between THC and the sum of methane and ethane was less than 1% of the THC instrument span. In those cases, VOC is reported as less than 1% of the THC instrument span.

For all calculated averages, "<" values are treated as the entire value of the detection limit.

For methane and ethane, "<" values are treated as zero when calculating VOC.

**Table 2-4:
 B&W Boiler Stack – O₂ (%dv) Relative Accuracy (USEPA Method 3A)**

| Run No. | Start Time | Date (2017) | RM Data (%dv) | CEMS Data (%dv) | Difference (%dv) | Difference Percent |
|----------------|------------|-------------|---------------|-----------------|------------------|--------------------|
| 1 | 09:00 | Apr 4 | 6.07 | 6.00 | 0.07 | 1.2% |
| 2 | 11:00 | Apr 4 | 5.92 | 5.80 | 0.12 | 2.0% |
| 3 * | 12:00 | Apr 4 | 6.04 | 5.90 | 0.14 | 2.3% |
| 4 | 13:00 | Apr 4 | 5.91 | 5.80 | 0.11 | 1.9% |
| 5 | 15:00 | Apr 4 | 5.91 | 5.80 | 0.11 | 1.9% |
| 6 | 16:00 | Apr 4 | 5.94 | 5.90 | 0.04 | 0.7% |
| 7 | 18:00 | Apr 4 | 5.83 | 5.80 | 0.03 | 0.5% |
| 8 | 09:00 | Apr 5 | 6.86 | 6.90 | -0.04 | -0.6% |
| 9 | 10:00 | Apr 5 | 6.55 | 6.50 | 0.05 | 0.8% |
| 10 | 11:00 | Apr 5 | 6.51 | 6.50 | 0.01 | 0.2% |
| Average | | | 6.17 | 6.11 | 0.06 | 1.0% |

Relative Accuracy Test Audit Results

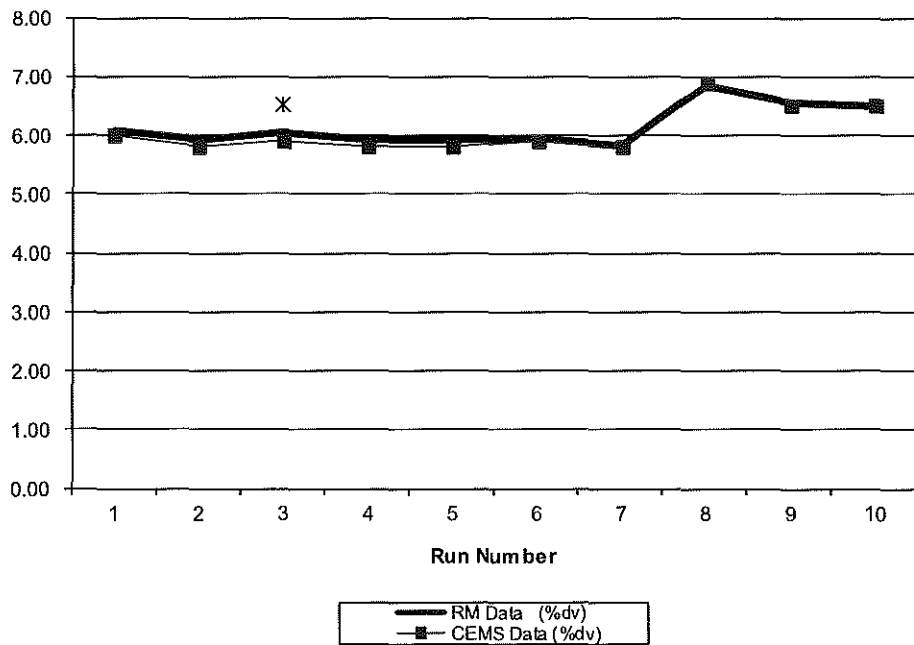
| | |
|-----------------------------------|-------------|
| Standard Deviation of Differences | 0.05294 |
| Confidence Coefficient (CC) | 0.04069 |
| t-Value for 9 Data Sets | 2.306 |
| Avg. Abs. Diff. (%dv) | 0.06 |
| Limit | 1.0 |

RM = Reference Method (CleanAir Data)

050317 10512

CEMS = Continuous Emissions Monitoring System (MPC Data)

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



**Table 2-5:
 B&W Boiler Stack – NOX (lb/MMBtu) Relative Accuracy (USEPA Method 7E)**

| Run No. | Start Time | Date (2017) | RM Data (lb/MMBtu) | CEMS Data (lb/MMBtu) | Difference (lb/MMBtu) | Difference Percent |
|----------------|------------|-------------|--------------------|----------------------|-----------------------|--------------------|
| 1 | 09:00 | Apr 4 | 0.065 | 0.067 | -0.002 | -3.1% |
| 2 | 11:00 | Apr 4 | 0.065 | 0.067 | -0.002 | -3.1% |
| 3 | 12:00 | Apr 4 | 0.067 | 0.069 | -0.002 | -3.0% |
| 4 | 13:00 | Apr 4 | 0.068 | 0.070 | -0.002 | -2.9% |
| 5 | 15:00 | Apr 4 | 0.069 | 0.071 | -0.002 | -2.9% |
| 6 * | 16:00 | Apr 4 | 0.071 | 0.075 | -0.004 | -5.6% |
| 7 | 18:00 | Apr 4 | 0.069 | 0.071 | -0.002 | -2.9% |
| 8 | 09:00 | Apr 5 | 0.073 | 0.077 | -0.004 | -5.5% |
| 9 | 10:00 | Apr 5 | 0.074 | 0.077 | -0.003 | -4.1% |
| 10 | 11:00 | Apr 5 | 0.074 | 0.078 | -0.004 | -5.4% |
| Average | | | 0.069 | 0.072 | -0.003 | -3.8% |

Relative Accuracy Test Audit Results

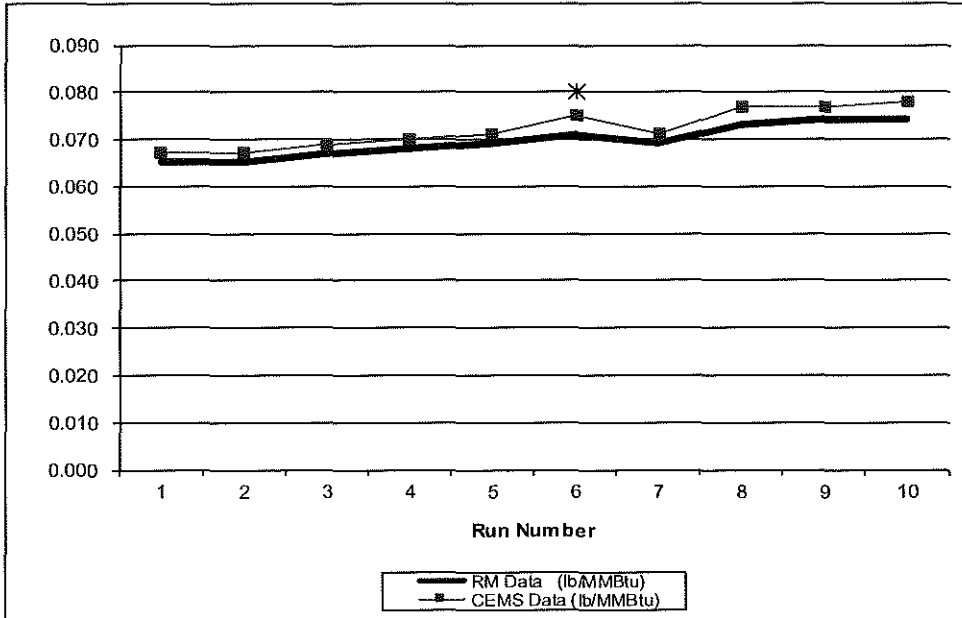
| | | |
|-----------------------------------|----------------|--------------|
| Standard Deviation of Differences | 0.0008819 | |
| Confidence Coefficient (CC) | 0.0006779 | |
| t-Value for 9 Data Sets | 2.306 | |
| | | Limit |
| Relative Accuracy (as % of RM) | 4.7% | 10.0% |
| Avg. Abs. Diff. (lb/MMBtu) | 0.003 | 0.020 |
| Bias Test | -0.003 ≤ 0.001 | |
| Bias Test Status | Pass | |

RM = Reference Method (CleanAir Data)

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CEMS = Continuous Emissions Monitoring System (MPC Data)

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



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3. DESCRIPTION OF INSTALLATION

Process Description

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

The B&W Boiler (EU27-B&WBOILER1-S1) generates steam required by other refinery process components. The unit is fired by natural gas and refinery fuel gas. Emissions are vented to the atmosphere via the B&W Boiler Stack (SV-B&WBOILER1).

Test Locations

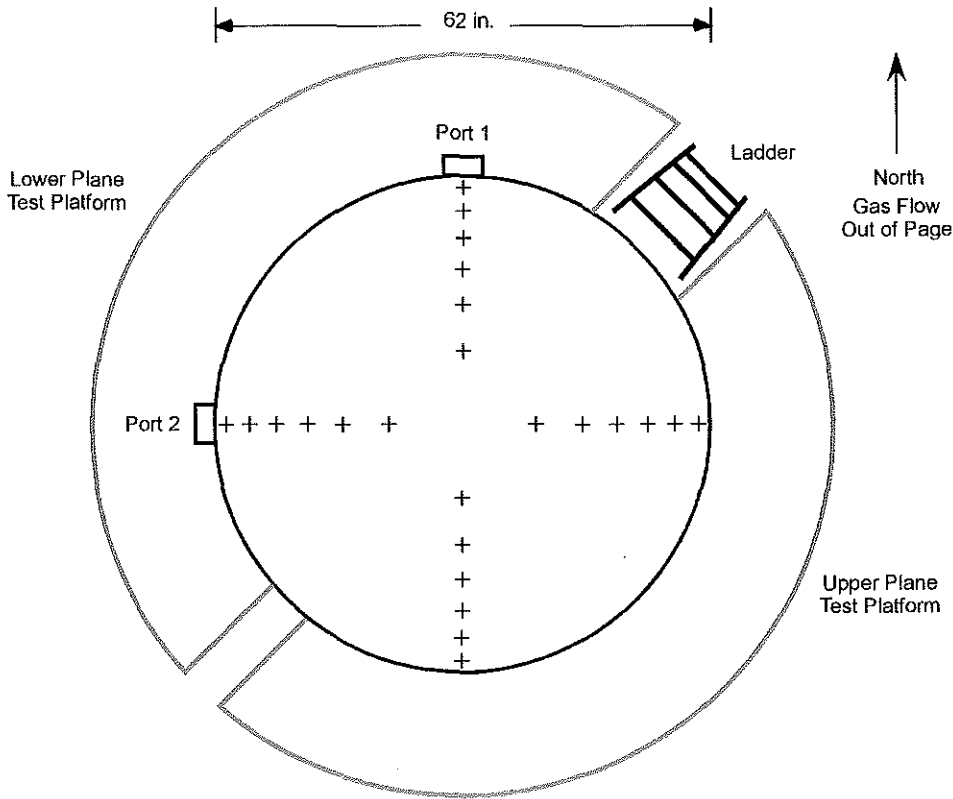
Sampling point locations were determined via EPA Method 1 and Performance Specification 2. Table 3-1 presents the sampling information for the test locations. The figures shown on pages 11 and 12 represent the layout of the test locations.

**Table 3-1:
Sampling Information**

| Source Constituent | Method (USEPA) | Run No. | Ports | Points per Port | Minutes per Point | Total Minutes | Figure |
|--|----------------|------------|-------|--------------------|----------------------|------------------|------------------|
| <i>B&W Boiler Stack</i> | | | | | | | |
| FPM | 5 | 1-3 | 2 | 12 | 5 | 120 | 3-1 |
| H ₂ SO ₄ | Draft ASTM CCM | 1-3 | 1 | 1 | 60 | 60 | N/A ¹ |
| O ₂ / CO ₂ / CH ₄ / C ₂ H ₆ / THC | 3A / 18 / 25A | 1-3 | 1 | 3 | 20 | 60 | 3-2 |
| O ₂ / NO _x (RATA) | 3A / 7E | 1-10 | 1 | 3 | 7 | 21 | 3-2 |

¹ Sampling occurred at a single point near the center of duct.

**Figure 3-1:
 B&W Boiler Stack Sample Point Layout (EPA Method 1)**



| Sampling Point | % of Stack Diameter | Port to Point Distance (inches) |
|----------------|---------------------|---------------------------------|
| 1 | 97.9 | 60.7 |
| 2 | 93.3 | 57.8 |
| 3 | 88.2 | 54.7 |
| 4 | 82.3 | 51.0 |
| 5 | 75.0 | 46.5 |
| 6 | 64.4 | 39.9 |
| 7 | 35.6 | 22.1 |
| 8 | 25.0 | 15.5 |
| 9 | 17.7 | 11.0 |
| 10 | 11.8 | 7.3 |
| 11 | 6.7 | 4.2 |
| 12 | 2.1 | 1.3 |

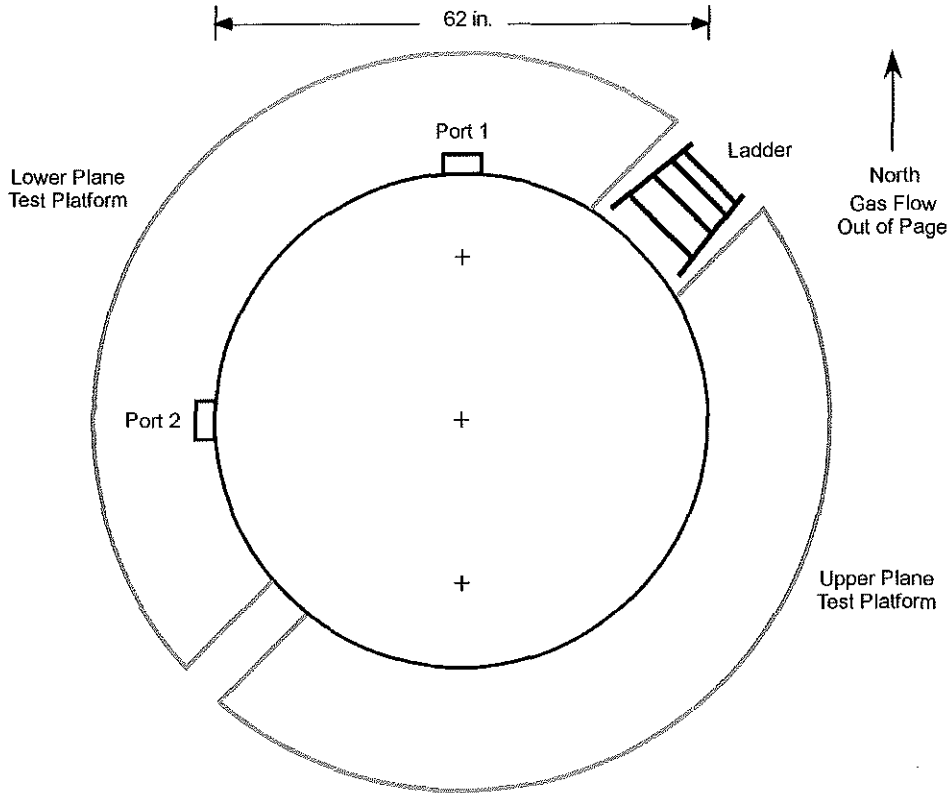
Duct diameters upstream from flow disturbance (A): 9.5

Limit: 0.5

Duct diameters downstream from flow disturbance (B): 2.3

Limit: 2.0

**Figure 3-2:
 B&W Boiler Stack Sample Point Layout (EPA Performance Specification 2)**



Note: RM test port selection may vary

| Sampling Point | % of Stack Diameter | Port to Point Distance (inches) |
|----------------|---------------------|---------------------------------|
| 1 | 83.3 | 51.6 |
| 2 | 50.0 | 31.0 |
| 3 | 16.7 | 10.4 |

Duct diameters upstream from flow disturbance (A): 9.5

Limit: 0.5

Duct diameters downstream from flow disturbance (B): 2.3

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 the Michigan Department of Environmental Quality (DEQ). These methods appear in detail in Title 40 of the CFR and at <https://www.epa.gov/emc>. Appendix A includes diagrams of the sampling apparatus, as well as specifications for sampling, recovery and analytical procedures.

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 3 | "Gas Analysis for the Determination of Dry Molecular Weight" |
| Method 3A | "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)" |
| Method 3B | "Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air" |
| 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 18 | "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography" |
| 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 NO _x 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" |

CTM-013 (Mod.)/Draft ASTM Controlled Condensation Method (Draft ASTM CCM)

"Determination of Sulfur Oxides Including Sulfur Dioxide, Sulfur Trioxide and Sulfuric Acid Vapor and Mist from Stationary Sources Using a Controlled Condensation Sampling Apparatus"

Methodology Discussion

PM Testing - EPA Method 5

The front-half of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 248°F ±25°F, and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

After exiting the filter, the flue gas passed through a Teflon line into a series of knockout jars surrounded by ice. The purpose of the knockout jars was 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.

VOC Testing - EPA Method 25A and Method 18

VOC emissions were determined using EPA Method 25A to quantify THC emissions and EPA Method 18 to quantify methane (CH₄) and ethane (C₂H₆) emissions.

The Method 25A sampling system consisted of a heated probe, heated filter and heated sample line. Flue gas was extracted near the centroid of the duct or at a point no closer than one (1) meter to the duct wall at a constant rate and delivered at 250°F to a flame ionization analyzer (FIA) which continuously measured minute-average THC concentration expressed in terms of propane (C₃H₈) on an actual (wet) basis.

FIA calibration was performed by introducing zero air, high, mid- and low range C₃H₈ calibration gases to the inlet of the sampling system's heated filter. Drift checks were performed before and after each sampling run in a similar manner.

The Method 18 sampling system consisted of a gas conditioner (for moisture removal), TFE sample lines, TFE-coated diaphragm pump, and a mass flow meter ("Direct Pump Sampling Procedure"). This system pulled a slipstream of the flue gas from the Method 25A sample delivery system to be delivered into a FlexFoil® bag at a constant rate. The moisture condensate was not collected for analysis as CH₄ and C₂H₆ are insoluble in water. Three (3) sample bags were filled over a period of 60-minutes for each test run.

Analysis for CH₄ and C₂H₆ was performed off-site by CleanAir Analytical Services using gas chromatography (GC). Since moisture was removed from the sample prior to collection, the GC analyzer measured concentration on a dry basis. At least five (5) sample injections was analyzed for each run.

Analyzer calibration was performed by generating a calibration curve from triplicate injections of three (3) distinct CH₄ and C₂H₆ concentrations introduced directly into the GC. Upon completion of calibration, a recovery study was performed by spiking one (1) of the bag samples with a known concentration of CH₄ and C₂H₆, storing the bags for the same period of time prior to analysis as the field samples, and analyzing the bags to determine percent recovery.

H₂SO₄ Testing - Draft ASTM Controlled Condensation Method

H₂SO₄ emissions were determined referencing the Draft ASTM Controlled Condensation Method.

A gas sample was extracted at a constant flow rate from the source using a quartz-lined probe maintained at a temperature of 650°F ±25°F (depending on the required probe length) and a quartz fiber filter maintained at the same temperature as the probe to remove particulate matter.

The sample was then passed through a glass coil condenser for collection of sulfuric acid vapor and/or mist. A second quartz fiber filter (referred to as the sulfuric acid mist (SAM) filter) was located at the condenser outlet for the collection of residual SAM not collected by the condenser. The condenser temperature was regulated by a water jacket and the SAM filter was regulated by a closed oven. Both the water jacket and SAM filter oven were 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 SO₂ into the H₂SO₄-collecting fraction of the sample train).

After exiting the SAM filter, the sample gas continued through a series of four (4) glass knock-out jars; two (2) containing water, one (1) empty, and one (1) 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 is determined by means of a calibrated, dry gas meter or an orifice-based flow meter.

The H₂SO₄-collecting portion of the sample train (condenser and SAM filter) was recovered into a single fraction using DI H₂O as the recovery/extraction solvent; any H₂SO₄ disassociates into sulfate ion (SO₄²⁻) and is stabilized in the H₂O matrix until analysis.

Prior to the first official test run, a 60-minute sample conditioning run was performed in order to minimize the absorption capacity of the front-half components of the sample train (upstream of the H₂SO₄-collecting portion of the sample train). The sample conditioning run is referred to as run zero (0). The conditioning run was recovered in the same manner as the official test runs; however, the condenser rinse and SAM filter were not analyzed.

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

O₂ and NO_x 40 CFR 75 RATA Testing - EPA Methods 3A and 7E

The RATA for NO_x and O₂ was conducted per 40 CFR 75, Appendix A specifications.

Prior to conducting the RATA, MPC performed a linearity test which will be reported separately.

The following tests were performed by CleanAir on the applicable CEMS:

- RATA (NO_x and O₂ CEMS)
 - The RATA was performed while the unit was combusting the normal primary or back-up fuel.
 - The RM instrument span was set equivalent to the facility CEMS span for each constituent.
 - The four (4) required range levels of calibration gas (“high-level” – 80% to 100% of span; “mid-level” – 50% to 60% of span; “low-level” – 20% to 30% of span; “zero-level” – 0% to 20% of span) was utilized during calibration error checks. For pre- and post-test system bias checks, the calibration gas that had a concentration closest to, but greater than, the actual flue gas concentration of the constituent was utilized.
 - Minute-average data points for O₂ and NO_x (dry basis) was collected over a period of 60 minutes for each RM run.
 - A total of 10 RM runs were performed. However, nine (9) of the best fit runs were used to determine the RA.
 - The average result for each RM has been calculated and compared to the average result from the facility CEMS over an identical time interval in order to calculate RA.
- Bias Test (NO_x CEMS) - This is a calculation performed on the RATA results to determine whether the CEMS is biased low compared to the RM. If low bias is found, a bias adjustment factor (BAF) is calculated and applied to the emissions results.

RM O₂ emissions were determined using a paramagnetic analyzer per EPA Method 3A. NO_x emissions were determined using a chemiluminescent analyzer per EPA Method 7E.

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

Calibration error checks were performed by introducing “high-level”, “mid-level”, “low-level” and “zero-level” calibration gases to the inlet of each analyzer during calibration error checks. Bias checks were performed before the first run and after at least every third run thereafter by introducing calibration gas to the inlet of the sampling system’s heated filter. Documentation of interference checks and NO₂ converter efficiency checks are included in the report.

Minute-average data points for O₂ and NO_x (dry basis) were collected over a period of 60 minutes for each RATA run. **Each RATA run began at the top of the hour so that it could be synchronized with MPC’s Cirrus data acquisition system.**

Per EPA Methods 3A and 7E, the average results for each run were drift-corrected. The average results for each run was converted to identical units of measurement as the facility CEMS and compared for RA.

End of Section