CleanAir

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REPORT ON COMPLIANCE TESTING

Performed for:
MARATHON PETROLEUM COMPANY LP
DETROIT REFINERY

FCCU REGENERATOR STACK (SVFCCU)

Client Reference No: 4100356132
CleanAir Project No: 12806
Revision 0: October 28, 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.

Submitted by,

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PROJECT OVERVIEW

INTRODUCTION

Marathon Petroleum Company LP (MPC) contracted Clean Air Engineering (CleanAir) to perform emission measurements at the Detroit Refinery for compliance purposes.

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 (DEQ). 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:

Crystal Davis – MPC
Joe Reidy – MPC
Thomas Gasloli – Michigan DEQ
Chad Eilering – CleanAir

Test Program Parameters

The testing was performed at the FCCU Regenerator Stack (Emission Unit ID No. EU11-FCCU-S1; Stack ID No. SVFCCU) on August 11-12, 2015 and September 1, 2015, and included the following emissions measurements:

- particulate matter (PM), assumed equivalent to non-sulfate filterable particulate matter (NSFPM)
- total particulate matter less than or equal to 10 microns (μm) in diameter (Total PM_{10}), assumed equivalent to the sum of the following constituents:
  - non-sulfate filterable particulate matter (NSFPM)
  - condensable particulate matter (CPM)
- sulfuric acid (H_2SO_4)
- ammonia (NH_3)
- volatile organic compounds (VOCs), assumed equivalent to total hydrocarbons (THC) minus the following constituents:
  - methane (CH_4)
  - ethane (C_2H_6)
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas flow rate
- flue gas velocity decay (wall effects)

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	FCCU Regenerator Stack	USEPA Method 5F/202	NSFPM/CPM	08/11/15	14:36	15:53
2	FCCU Regenerator Stack	USEPA Method 5F/202	NSFPM/CPM	08/11/15	18:31	19:47
3	FCCU Regenerator Stack	USEPA Method 5F/202	NSFPM/CPM	08/12/15	09:20	10:38
1	FCCU Regenerator Stack	USEPA CTM-027	NH_3	08/11/15	14:36	15:53
2	FCCU Regenerator Stack	USEPA CTM-027	NH_3	08/11/15	18:31	19:47
3	FCCU Regenerator Stack	USEPA CTM-027	NH_3	08/12/15	09:20	10:38
0	FCCU Regenerator Stack	Draft ASTM CCM	Sulfuric Acid	08/12/15	14:26	15:26
1	FCCU Regenerator Stack	Draft ASTM CCM	Sulfuric Acid	08/12/15	16:18	17:24
2	FCCU Regenerator Stack	Draft ASTM CCM	Sulfuric Acid	08/12/15	18:14	19:14
3	FCCU Regenerator Stack	Draft ASTM CCM	Sulfuric Acid	08/12/15	19:51	20:51
1	FCCU Regenerator Stack	USEPA Method 3A/18/25A	$O_2/CO_2/CH_4/C_2H_6$/THC	08/11/15	14:37	15:53
2	FCCU Regenerator Stack	USEPA Method 3A/18/25A	$O_2/CO_2/CH_4/C_2H_6$/THC	08/11/15	18:32	19:49
3	FCCU Regenerator Stack	USEPA Method 3A/18/25A	$O_2/CO_2/CH_4/C_2H_6$/THC	08/12/15	09:17	10:38
1	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/11/15	10:35	10:49
2	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/11/15	16:32	16:56
3	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/11/15	20:17	20:34
4	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/12/15	08:17	08:39
5	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/12/15	11:06	11:23
6	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/12/15	16:41	17:06
7	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/12/15	18:28	18:48
8	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	08/12/15	19:56	20:16
4	FCCU Regnerator Stack	USEPA Method 5F/202	NSFPM/CPM	09/01/15	09:37	11:03
5	FCCU Regnerator Stack	USEPA Method 5F/202	NSFPM/CPM	09/01/15	13:01	14:12
6	FCCU Regnerator Stack	USEPA Method 5F/202	NSFPM/CPM	09/01/15	16:07	17:23
4	FCCU Regenerator Stack	USEPA CTM-027	NH_3	09/01/15	09:37	11:03
5	FCCU Regenerator Stack	USEPA CTM-027	NH_3	09/01/15	13:01	14:12
6	FCCU Regenerator Stack	USEPA CTM-027	NH_3	09/01/15	16:07	17:23
9	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	09/01/15	07:54	08:11
10	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	09/01/15	11:40	12:03
11	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	09/01/15	14:40	15:03
12	FCCU Regenerator Stack	USEPA Method 2F	3-D Velocity & Flow Rate	09/01/15	17:41	18:01

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Results Summary

Tables 1-2 through 1-4 and Figures 1-1 through 1-2 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 2-5.

Table 1-2:
Summary of NSFPM, CPM and Total PM_{10} Results (USEPA 5F/202)

FCCU Regenerator Stack			NSFPM Rate (lb/Mlb coke)	CPM Rate (lb/Mlb coke)	Total PM_{10} Rate (lb/Mlb coke)
Mobilization 2: 9/1/15					
Coke Burn Rate (lb/hr)	**22,835**	Run 4	0.233	0.433	0.666
FCC Rate (bpd)	**40,990**	Run 5	0.316	0.448	0.764
Aqueous NH_3 Injection (lb/hr)	**29.1**	Run 6	0.306	0.388	0.695
ESP Operation	**Both/LPR**	**Average**	**0.285**	**0.423**	**0.708**
		Limit	**0.8**		**1.1**

Note: Results from Runs 1-3 can be found in Appendix C. 10/27/2015 14:58

Table 1-3:
Summary of NH_3 Results (USEPA CTM-027)

FCCU Regenerator Stack			NH_3 Conc. (ppmdv)	NH_3 Slip (lb/hr)	NH_3 Slip (lb/Mlb coke)
Mobilization 2: 9/1/15					
Coke Burn Rate (lb /hr)	**22,835**	Run 4	12.0	2.20	0.096
FCC Rate (bpd)	**40,990**	Run 5	14.5	2.72	0.120
Aqueous NH_3 Injection (lb/hr)	**29.1**	Run 6	8.94	1.74	0.076
ESP Operation	**Both/LPR**	**Average**	**11.8**	**2.22**	**0.097**

Note: Results from Runs 1-3 can be found in Appendix C. 10/27/2015 14:58

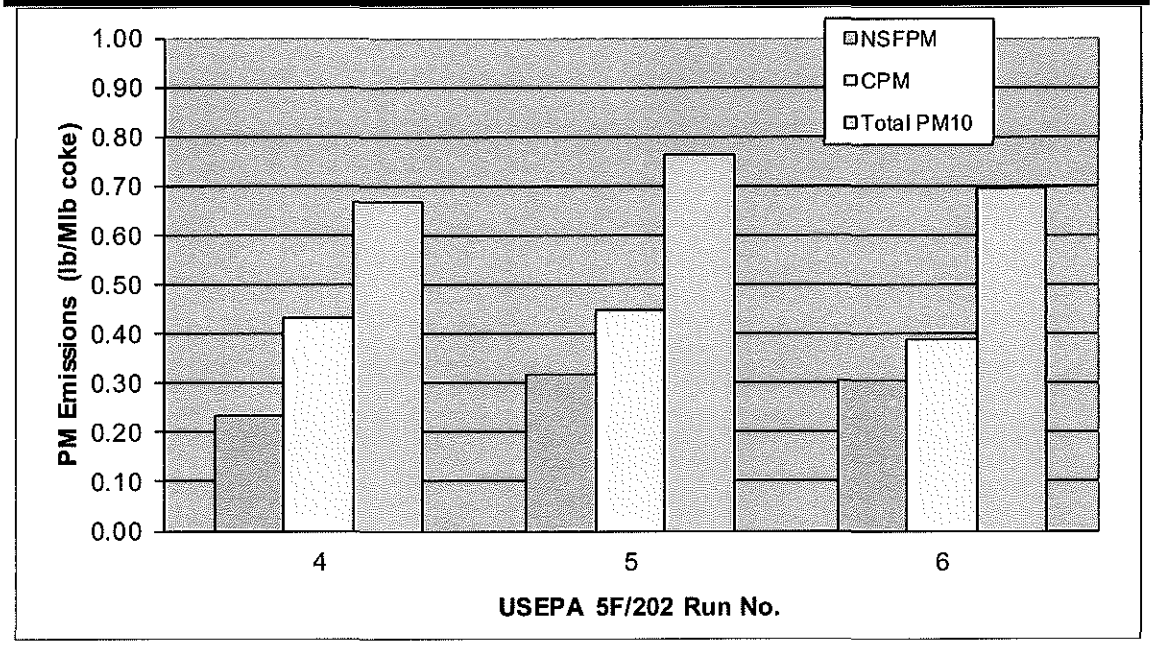

Figure 1-1: NSFPM, CPM and Total PM_{10} Results

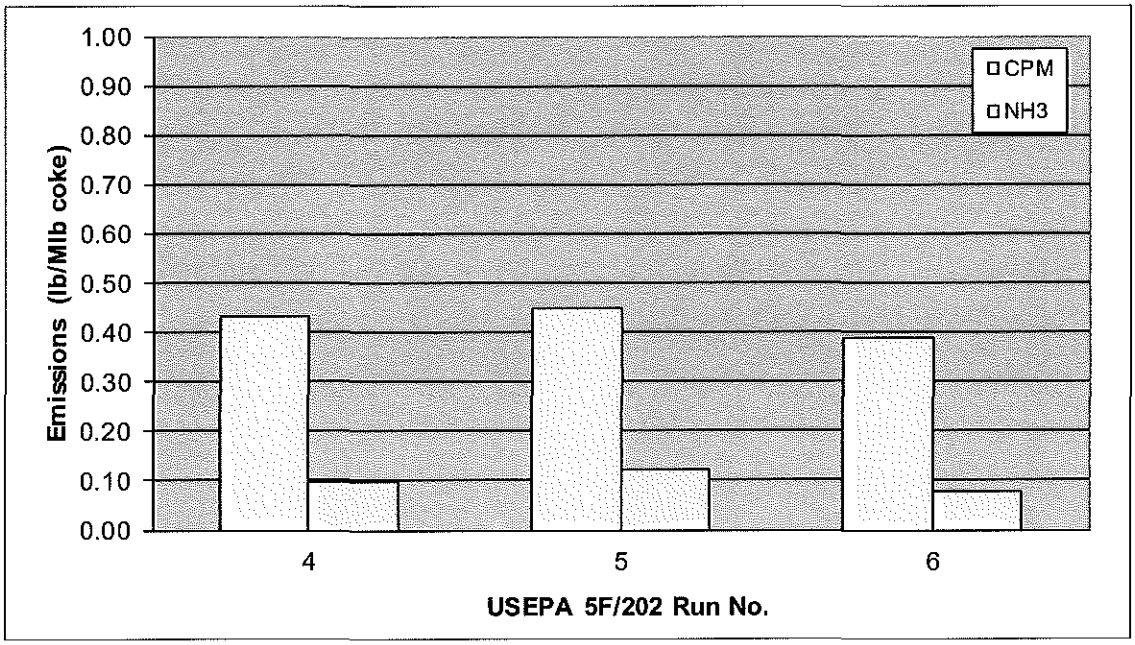

Figure 1-2: CPM and NH_3 Results

Table 1-4:
Summary of H_2SO_4 and VOC Results (Draft ASTM CCM & USEPA 18/25A)

Source Constituent	(Units)	Sampling Method	Average Emission	Permit Limit[1]
FCCU Regenerator Stack				
H_2SO_4	(lb/Mlb coke)	Draft ASTM CCM	0.011	N/A
VOC	(Ton/yr)	USEPA 25A / 18	4.8	21
VOC	(lb/Mlb coke)	USEPA 25A / 18	0.048	N/A

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

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Discussion of Test Program

Flow Rate Measurements

A wall-effects correction factor (WEF) was determined per Method 2H prior to the start of the first test run for each mobilization.

3-D flow traverses per Method 2F were performed before and after each Method 5F/202, Method 3A/18/25A, and CTM-027 test runs and during each Draft ASTM CCM test runs.

The data acquisition system did not accurately record the temperature readings for Method 2F traverses 1 through 8. Instead, the temperature measurements from the respective traverse points were obtained from the nearest Method 5F/202 test run.

NSFPM and CPM Testing - USEPA Method 5F/202

For this test program, PM emission rate is assumed equivalent to NSFPM emission rate and PM_{10} emission rate is assumed equivalent to the sum of NSFPM and CPM emission rates (units of lb/hr, Ton/yr, or lb/Mlb coke for all constituents). For emissions inventory purposes, MPC applies a correction factor to NSFPM to eliminate particles with a diameter less than 10 microns. Application of that correction factor is not included in this test report.

Three (3) 60-minute Method 5F/202 test runs were performed during the first mobilization on August 11-12, 2015. Following Run 3, the front half of the Method 5F filter holder was inadvertently rinsed into a sample container which already contained the probe liner rinse from the Run 3 CTM-027 sample train. The reagent used for both of these rinses was deionized water.

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During analysis, the laboratory performed an additional gravimetric analysis on this "combined" sample. The "combined" sample results were added to the results of the remaining front half rinse (probe liner and nozzle) which was recovered properly. This approach would yield a worst-case scenario as it would also contain particulate present in the CTM-027 liner rinse sample.

The Method 202 Run 3 inorganic rinse was found to contain a foreign object which is believed to be a glass chip. This object became introduced into the sample during the recovery of the sample train glassware while on-site. The final analysis weight used to calculate the results included the foreign object. This would yield a worst-case scenario as it would contain a fragment that was not representative of the flue gas sampled.

The final results from the first mobilization, Runs 1 through 3, can be found in Appendix C.

Based on the above occurrences, a second mobilization followed in which three (3) 60-minute Method 5F/202 test runs were performed on September 1, 2015. A fourth Method 5F/202 test run was started on September 2, 2015; however, it was aborted after approximately 30-minutes because the FCCU was unable to maintain the necessary operating rate. The contents of this sample train were recovered, and the samples were archived without analysis.

The final results from the second mobilization were expressed as the average of three (3) test runs, Runs 4 through 6.

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. Only samples with a pH lower than 4.5 are titrated.

All of the inorganic sample fractions from Runs 1 through 6 had a pH less than 4.5 and were titrated. The field train reagent blanks had a pH above 4.5 and were not titrated. The sample fractions were observed to come to a constant weight without having to titrate the sample.

NH_3 Testing – USEPA CTM-027 - Stack

Three (3) 60-minute CTM-027 test runs were performed during the first mobilization on August 8-11, 2015. Each test run was performed concurrently with Method 5F/202 testing.

While removing the sample probe from the duct following Run 1, the sample probe liner cracked. The Run 1 post-test leak rate exceeded the allowable limit because the cracked liner disallowed for a leak-tight seal. Based on the consistent O_2/CO_2 and moisture measured during the test run it is believed that the results from Run 1 are accurate.

The final results from the first mobilization, Runs 1 through 3, can be found in Appendix C.

A portion of the sample from Run 3 became compromised when it was combined with a portion of the Run 3 Method 5F samples as outlined earlier. The final result for CTM-027 Run 3 does not include the probe liner rinse which was instead analyzed and evaporated with the combined Run 3 Method 5F sample.

Three (3) 60-minute CTM-027 test runs were performed during the second mobilization on September 1, 2015. A fourth CTM-027 test run was started on September 2, 2015, however, it was aborted after approximately 30-minutes because the FCCU was unable to maintain the necessary operating rate. The contents of this sample train were recovered, and the samples were archived without analysis.

The final results from the second mobilization were expressed as the average of three (3) test runs, Runs 4 through 6.

H_2SO_4 Testing - Draft ASTM Controlled Condensation Method

Prior to the first official test run on August 12, 2015, 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 H_2SO_4-collecting portion of the sample train). The conditioning run was recovered and analyzed in the same manner as the official test runs, but was not included in the final results.

Following the conditioning run on August 12, 2015, three (3) official 60-minute test runs were performed. The final results were expressed as the average of three (3) official runs.

VOC Testing - USEPA Method 25A and Method 18

Three (3) approximately 60-minute Method 25 test runs for THC were performed concurrently with three (3) approximately 60-minute Method 18 bag collections for CH_4 and C_2H_6. Two (2) test runs were performed on August 11, 2015, and one (1) test run was performed on August 12, 2015.

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. The final VOC results were expressed as the average of three (3) runs.

Calculation of Final Results

Sample flow rates as determined by EPA Method 2 without the WEF corrections factor were used to calculate isokinetic sampling conditions.

Mass-based emission rates in units of pounds per hour (lb/hr) for Method 5F/202, Method 18/25A, and CTM-027 were calculated using the average (pre-run and post run) flow rate determined by Method 2F combined with the respective WEF correction factor. Mass-based emission rates in units of pounds per hour (lb/hr) for Draft ASTM CMM were calculated using the concurrently measured flow rate determined by Method 2F combined with the respective WEF correction factor.

Emission rates in units of tons per year (Ton/yr) were calculated using an assumed capacity factor of 8,760 operating hours per year. Emission rates in units of pounds per 1,000 pounds of coke burn (lb/Mlb coke) were calculated using coke burn rate data provided by MPC.

Ammonia (NH_3) injection rates shown in Tables 2-1 through 2-4 and Tables 2-6 through 2-7 is the aqueous ammonia, (11FC2032), times 0.2.

End of Section 1 – Project Overview

RESULTS

Table 2-1:
NSFPM, CPM and Total PM_{10} (USEPA 5F/202) – Runs 4-6

Run No.		4	5	6	Average
Date (2015)		Sep 1	Sep 1	Sep 1	
Start Time (approx.)		09:37	13:01	16:07	
Stop Time (approx.)		11:03	14:12	17:23	
Process Conditions					
R_P	Coke burn rate (lb/hr)	22,856	22,729	22,919	**22,835**
P_1	FCC charge rate (bpd)	40,996	40,999	40,975	**40,990**
P_2	NH3 Injection (lb/hr)	5.81	5.82	5.83	**5.82**
P_3	ESP Operation	Both/LPR	Both/LPR	Both/LPR	
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	1.7	2.1	1.9	**1.9**
CO_2	Carbon dioxide (dry volume %)	15.7	14.4	14.7	**14.9**
T_s	Sample temperature (°F)	533	533	534	**534**
B_w	Actual water vapor in gas (% by volume)	12.9	13.1	12.7	**12.9**
Gas Flow Rate[1]					
Q_a	Volumetric flow rate, actual (acfm)	148,000	151,000	153,000	**151,000**
Q_s	Volumetric flow rate, standard (scfm)	79,100	81,200	84,200	**81,500**
Q_{sd}	Volumetric flow rate, dry standard (dscfm)	68,900	70,600	73,500	**71,000**
Sampling Data					
V_{msd}	Volume metered, standard (dscf)	42.68	46.77	47.45	**45.63**
%I	Isokinetic sampling (%)[2]	101.8	104.8	105.3	**104.0**
Laboratory Data					
m_n	Total NSFPM (g)	0.02494	0.03601	0.03427	
m_{CPM}	Total CPM (g)	0.04629	0.05094	0.04345	
m_{Part}	Total particulate (expressed as PM-10) (g)	0.07123	0.08695	0.07772	
DLC	Detection level classification	ADL	ADL	ADL	
NSFPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	1.29E-06	1.70E-06	1.59E-06	**1.53E-06**
$E_{lb/hr}$	Particulate Rate (lb/hr)	5.33	7.19	7.02	**6.51**
$E_{T/yr}$	Particulate Rate (Ton/yr)	23.3	31.5	30.7	**28.5**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb coke)	0.233	0.316	0.306	**0.285**
CPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	2.39E-06	2.40E-06	2.02E-06	**2.27E-06**
$E_{lb/hr}$	Particulate Rate (lb/hr)	9.89	10.2	8.90	**9.65**
$E_{T/yr}$	Particulate Rate (Ton/yr)	43.3	44.6	39.0	**42.3**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb coke)	0.433	0.448	0.388	**0.423**
Total Particulate (as PM10) Results					
C_{sd}	Particulate Concentration (lb/dscf)	3.68E-06	4.10E-06	3.61E-06	**3.80E-06**
$E_{lb/hr}$	Particulate Rate (lb/hr)	15.2	17.4	15.9	**16.2**
$E_{T/yr}$	Particulate Rate (Ton/yr)	66.7	76.1	69.7	**70.8**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb coke)	0.666	0.764	0.695	**0.708**

Average includes 3 runs.

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Detection level classifications are defined as follows:

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

[1] Gas flow rates obtained from bracketing Method 2F test runs combined with the WAF determined by Method 2H.

RESULTS

Table 2-2:
NH_3 (USEPA CTM-027) – Runs 4-6

Run No.		4	5	6	Average
Date (2015)		Sep 1	Sep 1	Sep 1	
Start Time (approx.)		09:37	13:01	16:07	
Stop Time (approx.)		11:03	14:12	17:23	
Process Conditions					
R_P	Coke burn rate (lb/hr)	22,856	22,729	22,919	**22,835**
P_1	FCC charge rate (bpd)	41,000	41,000	41,000	**41,000**
P_2	NH3 injection (lb/hr)	5.81	5.82	5.83	**5.82**
P_3	ESP operation	Both/LPR	Both/LPR	Both/LPR	
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	1.7	1.9	1.8	**1.8**
CO_2	Carbon dioxide (dry volume %)	15.6	14.7	14.8	**15.0**
T_s	Sample temperature (°F)	533	533	534	**533**
B_w	Actual water vapor in gas (% by volume)	13.7	13.7	13.4	**13.6**
Gas Flow Rate[1]					
Q_a	Volumetric flow rate, actual (acfm)	148,000	151,000	153,000	**151,000**
Q_s	Volumetric flow rate, standard (scfm)	79,100	81,200	84,200	**81,500**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	68,900	70,600	73,500	**71,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	43.90	44.13	46.37	**44.80**
%I	Isokinetic sampling (%)[2]	99.6	100.1	101.1	**100.3**
Laboratory Data					
m_n	Total NH_3 collected (mg)	10.58182	12.83736	8.30756	
Ammonia (NH_3) Results					
C_{sd}	Ammonia Concentration (lb/dscf)	5.31E-07	6.41E-07	3.95E-07	**5.23E-07**
C_{sd}	Ammonia Concentration (ppmdv)	12.0	14.5	8.94	**11.8**
$E_{lb/hr}$	Ammonia Rate (lb/hr)	2.20	2.72	1.74	**2.22**
$E_{T/yr}$	Ammonia Rate (Ton/yr)	9.63	11.9	7.63	**9.72**
E_{Rp}	Ammonia Rate - Production-based (lb/Mlb coke)	0.0962	0.120	0.0760	**0.0972**

Average includes 3 runs.

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[1] Gas flow rates obtained from bracketing Method 2F test runs combined with the WEF determined by Method 2H.

RESULTS

Table 2-3:
Uncertainty Analysis – NSFPM, CPM and Total PM_{10} – Runs 4-6

		NSFPM Results (lb/Mlb coke)		CPM Results (lb/Mlb coke)		Total PM (as PM10) Results (lb/Mlb coke)
Method		**5F/202**		**5F/202**		**5F/202**
Run No.	**1**	0.233	**1**	0.433	**1**	0.666
	2	0.316	**2**	0.448	**2**	0.764
	3	0.306	**3**	0.388	**3**	0.695
SD		0.0454		0.0308		0.0504
AVG		**0.285**		**0.423**		**0.708**
RSD		15.9%		7.3%		7.1%
N		3		3		3
SE		0.0262		0.0178		0.0291
RSE		9.2%		4.2%		4.1%
P		95.0%		95.0%		95.0%
TINV		4.30		4.30		4.30
CI +		0.398		0.499		0.833
AVG		**0.285**		**0.423**		**0.708**
CI -		0.172		0.346		0.583
TB +		0.633		0.659		1.09

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 2-4:
H_2SO_4 Emissions (Draft ASTM CCM)

Run No.		1	2	3	Average
Date (2015)		Aug 12	Aug 12	Aug 12	
Start Time (approx.)		16:18	18:14	19:51	
Stop Time (approx.)		17:24	19:14	20:51	
Process Conditions					
R_P	Coke burn rate (lb/hr)	20,882	20,820	20,836	**20,836**
P_1	FCC charge rate (bpd)	37,998	38,010	38,000	**38,003**
P_2	NH3 Injection (lb/hr)	4.95	4.91	4.88	**4.91**
P_3	ESP Operation	Both/LPR	Both/LPR	Both/LPR	
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	3.0	2.2	2.8	**2.7**
CO_2	Carbon dioxide (dry volume %)	14.6	15.7	15.0	**15.1**
T_s	Sample temperature (°F)	521	520	520	**520**
B_w	Actual water vapor in gas (% by volume)	12.6	12.4	12.2	**12.4**
Gas Flow Rate					
Q_{std}	Volumetric flow rate, dry standard (dscfm)[1]	66,526	64,696	64,811	**65,344**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	23.50	23.45	23.22	**23.39**
Laboratory Data (Ion Chromatography)					
m_n	Total H2SO4 collected (mg)	0.5840	0.9356	0.4104	
Sulfuric Acid Vapor (H2SO4) Results					
C_{sd}	H2SO4 Concentration (lb/dscf)	5.48E-08	8.80E-08	3.90E-08	**6.06E-08**
C_{sd}	H2SO4 Concentration (ppmdv)	0.215	0.346	0.153	**0.238**
$E_{lb/hr}$	H2SO4 Rate (lb/hr)	0.219	0.342	0.152	**0.237**
$E_{T/yr}$	H2SO4 Rate (Ton/yr)	0.958	1.50	0.664	**1.04**
E_{Rp}	H2SO4 Rate - Production-based (lb/Mlb coke)	0.0105	0.0164	0.00727	**0.0114**

Average includes 3 runs (Run 0 not included in the average).

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RESULTS

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

Run No.		1	2	3	Average
Date (2015)		Aug 11	Aug 11	Aug 12	
Start Time (approx.)		14:37	18:32	09:17	
Stop Time (approx.)		15:53	19:49	10:38	
Process Conditions					
R_P	Coke burn rate (lb/hr)	22,953	22,847	23,010	**22,937**
P_1	FCC charge rate (bpd)	40,929	40,981	40,981	**40,963**
P_2	NH_3 injection (lb/hr)	5.64	5.63	5.65	**5.64**
P_3	ESP operation	Both/LPR	Both/LPR	Both/LPR	
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	1.51	1.82	1.88	**1.74**
CO_2	Carbon dioxide (dry volume %)	16.7	16.4	16.3	**16.5**
B_w	Actual water vapor in gas (% by volume)[1]	10.5	12.7	12.9	**12.0**
Gas Flow Rate[2]					
Q_{std}	Volumetric flow rate, dry standard (dscfm)	71,700	69,900	71,500	**71,000**
THC Results					
C_{sd}	Concentration (ppmdv as C_3H_8)	2.37	2.25	2.16	**2.26**
C_{sd}	Concentration (lb/dscf)	2.71E-07	2.57E-07	2.47E-07	**2.58E-07**
$E_{lb/hr}$	Emission Rate (lb/hr)	1.17	1.08	1.06	**1.10**
$E_{T/yr}$	Emission Rate (Ton/yr)	5.10	4.72	4.65	**4.82**
E_{Rp}	Emission Rate - Production-based (lb/Mlb coke)	0.0508	0.0471	0.0461	**0.0480**
Methane Results[3]					
C_{sd}	Concentration (ppmdv)	<0.133	<0.133	<0.133	**<0.133**
C_{sd}	Concentration (lb/dscf)	<5.54E-09	<5.54E-09	<5.54E-09	**<5.54E-09**
$E_{lb/hr}$	Emission Rate (lb/hr)	< 0.0238	< 0.0232	< 0.0238	**< 0.0236**
$E_{T/yr}$	Emission Rate (Ton/yr)	< 0.104	< 0.102	< 0.104	**< 0.103**
E_{Rp}	Emission Rate - Production-based (lb/Mlb coke)	< 0.00104	< 0.00102	< 0.00103	**< 0.00103**
Ethane Results[3]					
C_{sd}	Concentration (ppmdv)	<0.0946	<0.0946	<0.0946	**<0.0946**
C_{sd}	Concentration (lb/dscf)	<7.38E-09	<7.38E-09	<7.38E-09	**<7.38E-09**
$E_{lb/hr}$	Emission Rate (lb/hr)	< 0.0318	< 0.0309	< 0.0317	**< 0.0315**
$E_{T/yr}$	Emission Rate (Ton/yr)	< 0.139	< 0.136	< 0.139	**< 0.138**
E_{Rp}	Emission Rate - Production-based (lb/Mlb coke)	< 0.00138	< 0.00135	< 0.00138	**< 0.00137**
VOC Results					
$E_{lb/hr}$	Emission Rate (lb/hr)	1.17	1.08	1.06	**1.10**
$E_{T/yr}$	Emission Rate (Ton/yr)	5.10	4.72	4.65	**4.82**
E_{Rp}	Emission Rate - Production-based (lb/Mlb coke)	0.0508	0.0471	0.0461	**0.0480**

Average includes 3 runs.

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

[2] Flow data used in lb/hr calculations was obtained from the average of the Method 2F traverses that bracket each run combined with the WEF determined by Method 2H.

End of Section 2 – Results