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Source Test Report

Delayed Coking Unit Atmospheric Depressurization Vent

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Prepared for:

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1.0 Introduction

Marathon Petroleum Company LLC, Michigan Refining Division (MPC Detroit), operates a petroleum refinery in Detroit, Michigan. The MPC-Detroit Refinery is a petroleum refinery with the capacity to convert approximately 120,000 barrels of crude oils per calendar day (bbl/cd) into finished products. The new EG70-Coker delayed coking unit (DCU) was commissioned in November 2012 and is covered under the Michigan Department of Environmental Quality (MDEQ) Permit to Install 63-08C.

The Test Plan describes the sampling and analytical methodologies to be employed to measure non-methane, non-ethane volatile organic compounds (NMNE VOCs), hydrogen sulfide (H2S), and total filterable particulate matter (FPM) mass emission rates from the DCU Vent during a normal venting cycle. Molecular weight and moisture (H2O) concentrations and DCU Vent exhaust gas flow rate will also be measured to develop target compound mass emission rates.

MPC Detroit engaged URS Corporation (URS) to conduct the 2013 Source Test for measuring the emissions of target compounds from a DCU atmospheric depressurization vent. The Test Plan describes the sampling and analytical methodologies employed to measure mass emission rates of target analytes (see Section 1.2 for the full list) from the DCU atmospheric depressurization vents. Molecular weight, moisture (H2O) concentrations, and exhaust gas flow rates were also measured to develop target compound mass emission rates.

Because of the unique nature of this intermittent process vent, modifications to existing U.S. EPA-approved reference methods have been made to collect accurate and precise data from this source. Due to the extremely high moisture content (greater than 99%) and the high velocity (greater than 200 mph) of the gas stream, the dynamic nature of the gas stream's characteristics, and the variable batch nature of the delayed coking process, URS implemented the modified reference methods and alternative quality assurance/quality control (QA/QC) criteria discussed in the Test Plan (see Section 5.0).

This *Source Test Report for Atmospheric Depressurization Vent* presents the results of the 2013 Source Test in the following sections:

- Section 2.0 – Summary of Results;
- Section 3.0 – Sampling and Analytical Procedures;
- Section 4.0 – Calculations; and
- Section 5.0 – Quality Assurance Objectives for Measurement Data.

Report appendices provide copies of raw data, including chain-of-custody forms, sampling logs, raw analytical instrument output, laboratory reports, DCU process data, and sampling equipment calibration forms. General information regarding the testing is summarized in Table 1-1.

Table 1-1. Source Test Information

Facility Name	Marathon Petroleum Company, Michigan Refining Division
Contact Person(s)	Crystal Davis
Telephone Number	313-297-6115
Facility Address	1300 South Fort Street, Detroit, Michigan 48217
Types of Process Sampled	DCU Atmospheric Depressurization Vent Gas Stream
Person Responsible for Conducting Source Test	Jesse Rocha
Telephone Number	512-419-5726
Testing Company Name	URS Corporation
Testing Company Address	9400 Amberglen Boulevard Austin, Texas 78729
Person(s) Conducting Source Test	Jesse Rocha Meggen DeLollis Carl Galloway Alex Bellon Noah Prescott
Modified U.S. EPA Reference Methods Performed	U.S. EPA Methods 1, 2, 3, 4, 5, 18, and 25A U.S. EPA Other Test Method 12
Dates of Source Testing	July 18 through 21, 2013

1.1 Delayed Coking Unit – Process Description

The EG70 Delayed Coker converts Vacuum Resid (Crude Vacuum Tower Bottoms), a product normally sold as asphalt or blended into residual fuel oil, into lighter, more valuable products. The Vacuum Resid feedstock is heated before it enters the main fractionator, where lighter material vaporizes. The fractionator bottoms are routed through a fired heater (Coker Charge Heater) and then into a coke drum. The heat within the coke drum causes cracking reactions to produce the coke, which accumulates in the coke drum, and hydrocarbon vapors which are carried overhead from the coke drum back to the fractionator. The fractionator produces gasoil, distillate, and naphtha streams which are sent to downstream units for additional processing. The fractionator overhead is directed to the Coker Gas Plant where it is separated into LPG and offgas streams. The LPG and offgas streams are sent to downstream units for additional processing.

Petroleum (pet) coke eventually fills the coke drum; subsequently the drum is isolated, purged of hydrocarbon vapors, cooled, and opened. A typical Delayed Coker uses at least two coking drums so that one can be filled while the other is being de-coked.

At the end of each coke drum filling cycle, the full coke drum is switched off-line, stripped with steam to remove residual hydrocarbons, flooded with quench water, and depressured. Coke is cut from the drum with high pressure water jets.

The MPC Detroit coker includes two redundant vapor recovery compressors. The compressors allow the coke drums to be vented to atmosphere only after the drum pressure decreases to two pounds per square inch gauge (psig).

1.2 Source Test Objectives

The objective of the source test is to quantify emissions from the DCU vent. The DCU vent gas stream will be tested pursuant to the Test Plan using direct source testing methodologies. The sampling and analytical methods employed during the source test and any modifications to the EPA-approved reference methods (RMs) are presented in subsequent sub-sections.

The DCU vent gas stream was sampled pursuant to the Test Plan using direct source testing methodologies to quantify the emissions of the following target compounds:

- NMNE VOC;
- Methane;
- Ethane;
- Hydrogen sulfide (H_2S); and

- Total particulate matter (Total PM).

Table 1-2 presents the sampling durations for each target compound during the batch cycle of the DCU vent.

Valid gas samples were collected during four (4) separate venting cycles of the DCU. A complete set of valid results for Run 1 was not collected due to power issues.

1.3 Source Test Strategy

A venting cycle is defined in the Test Plan as the period of time between the activation of the vent (i.e., opening) and the optimal depressurization of a coke drum to atmosphere that is necessary before the draining and coke-cutting cycles can begin.

Table 1-2 presents the test run durations of each modified sampling system during a given test run. Modified sampling methods are described in detail in Section 3.0. URS began collecting all gas samples within one (1) minute of vent activation during each test run unless otherwise noted. Gas samples were collected until the coke drum reached optimal depressurization, for as long as the sampling equipment remained operable within acceptable performance ranges, or until health and safety limitations were encountered.

Results for Run 1 are not reported because a complete set of valid samples was not collected during this sampling interval.

Section 2.0 of this report presents the averages of target compound mass emission rates measured during each venting condition.

Table 1-2. Sampling Train Durations

Run No.	Date	Time	Sampling Duration (min)	Sampling Method
2	7/18/13	15:05-15:34	29	U.S. EPA Method 5
	7/18/13	15:05-15:34	29	U.S. EPA Methods 18/25A/OTM 12
3	7/19/13	14:53-16:34	101	U.S. EPA Method 5
	7/19/13	15:02:30-16:34	91.5	U.S. EPA Methods 18/25A/OTM 12
4	7/20/13	14:37-14:47	10	U.S. EPA Method 5
	7/20/13	14:37-14:47	10	U.S. EPA Methods 18/25A/OTM 12
5	7/21/13	14:38-15:28	50	U.S. EPA Method 5
	7/21/13	14:38-15:28	50	U.S. EPA Methods 18/25A/OTM 12

1.4 Quality Assurance Summary

Any sampling and/or analytical QA/QC issues associated with the data obtained through the 2013 Source Test are described in Section 5.0. Table 1-3 presents QA summaries for each of the modified U.S. EPA reference methods performed on the DCU.

A review of the data quality associated with the measurements performed during all runs indicates that these data are supportable and usable for the purpose intended. A full set of data could not be obtained during Run 1 due to PM sampling system power issues.

Table 1-3. Quality Assurance Summary

Parameter	Deviations from the Test Plan and Quality Assurance/Quality Control Issues
Sampling Points, Velocity and Volumetric Flow Rate, Dry Gas Molecular Weight, and Moisture Concentration	None
Total Particulate Matter Determination	The Test Plan describes a single PM sampling train per vent cycle. During the 2013 Source Test, two PM sampling trains (A and B for each run) were collected simultaneously in order to minimize the potential for collecting an incomplete set of data for a given vent cycle. The replicate sample that resulted in the greater sample volume was chosen for analysis, and the other sample was archived by the laboratory. As a result, the reported PM results from Runs 2, 3, 4, and 5 were derived using samples 2B, 3A, 4B, and 5B, respectively. Minor temperature excursions for condenser exit temperature and probe temperature during Run 3. Volume during Run 4 (0.203 dscf) was below the specification (>0.25 dscf) Field blank results for probe and nozzle rinse are similar to the results for the vent gas. Vent gas results are considered conservative and are not qualified.
Methane and Ethane, Concentrations and Dilution Sampling System	Sampling during Run 3 began approximately 10 minutes late. This was due to a malfunction in the dilution sampling system, which was swiftly resolved. No data are qualified based on this delay.
Hydrogen Sulfide Concentrations and Dilution Sampling System	Sampling during Run 3 began approximately 10 minutes late. This was due to a malfunction in the dilution sampling system, which was swiftly resolved. No data are qualified based on this delay.
Total Hydrocarbon Concentration and Dilution Sampling System	Sampling during Run 3 began approximately 10 minutes late. This was due to a malfunction in the dilution sampling system, which was swiftly resolved. No data are qualified based on this delay. The THC2 analyzer response to the low-level calibration gas at the conclusion of Run 4 was slightly outside of the 3.0% drift check criteria (3.1%). However, the THC concentration during the run never went above the THC1 analyzer's range, so the THC2 analyzer concentration data was not used for Run 4. The THC1 analyzer passed its drift checks, so no data are qualified or invalidated based on this finding.

2.0 Summary of Results

This section presents a summary of process operations during the Source Test as well as selected NMNE VOC, methane, ethane, hydrogen sulfide, and PM emissions data. Valid PM results could not be obtained during Run 1 due to sampling system power issues. For this run, because it was determined that a complete set of data for all target compounds could not be collected, the valid NMNE VOC, methane, ethane, and hydrogen sulfide samples that were collected were not analyzed.

2.1 DCU Process Operations

The DCU was operated at conditions reflective of "normal" unit operations during the source test. During the source test, the DCU was vented to atmosphere after the internal pressure of the coke drum reached approximately 2 psig. This venting pressure is consistent with the normal operation of the DCU.

Sampling durations were determined using the venting cycle start and end times recorded by URS scientists. The venting cycle start times corresponded to the initial differential pressure increase within the vent duct, as reported by sampling instrumentation, rounded to the nearest whole minute. In many cases, the venting cycle end times corresponded to the measurement of zero (0) differential pressure in the vent pipe using U.S. EPA Method 2, "*Determination of Stack Gas Velocity and Flow Rate from Stationary Sources (Type-S Pitot Tube).*"

2.2 Data Reduction Approach

Mass emission rates are typically expressed using an industry standard of mass per unit time, such as pounds per hour (lbs/hr), by relating the average concentration of a target compound to the average volumetric flow rate of a gas stream through a stack or vent. However, the use of a simple average is inappropriate for developing an emissions profile for the intermittent and dynamic characteristics of the atmospheric depressurization vent source, so the duration and profile of each complete venting cycle varied according to the batch process.

The data reduction approach used in this report integrates target compound mass emission rates as pounds per minute (lbs/min) throughout the complete venting cycle, starting at the point of vent activation and ending at the point of optimal depressurization of the coke drum. Total mass emission rates are expressed in this report as mass per batch cycle (lbs/cycle).

2.3 Results for Vent Gas Volumetric Flow Rate

Vent gas volumetric flow rate was measured according to modified U.S. EPA Methods 2, "*Determination of Stack Gas Velocity and Volumetric Flow Rate,*" 3, "*Gas Analysis for the Determination of Dry Molecular Weight,*" and 4, "*Determination of Moisture Content in Stack*

Gases." These methods were performed in conjunction with each modified U.S. EPA Method 5 sampling train. Table 2-1 presents average volumetric flow rate and other operating data associated with the modified sampling train.

Because on average <2% of the total gas sample is dry, it was not practicable to measure the oxygen or carbon dioxide concentrations in the sample gas using U.S. EPA Method 3. Therefore, the molecular weight of the dry fraction of the DCU gas was assumed to be equal to methane (16.0 g/g-mol), the most abundant compound detected in the vent gas stream after water. Because the average moisture concentrations were in excess of 99%, the estimated dry gas molecular weight had an insignificant impact on the calculation of wet gas molecular weight.

Table 2-1. Isokinetic Sampling Data

Run No.	Analytical Parameter	Average Vent Temperature (°F)	Velocity (ft/sec)	Vent Gas Moisture (%)	Avg Flow Rate (acfm)	Avg Flow Rate (dscfm)	Volume at Meter (dscf)	Isokinetic Sampling Rate (%)
2	Particulate Matter	241	355	99.6	16,718	46.7	0.326	109
3	Particulate Matter	242	250	99.7	11,765	25.7	0.840	63.8
4	Particulate Matter	234	360	99.4	16,964	77.7	0.190	49.8
5	Particulate Matter	241	290	99.5	13,667	51.1	0.759	60.5

2.4 Results for Methane, Ethane, and Hydrogen Sulfide Emissions

Methane, ethane, and hydrogen sulfide concentrations were measured according to modified U.S. EPA Method 18, "*Measurement of Gaseous Organic Compound Emissions by Gas Chromatography*" and the dilution sampling system procedures described in U.S. EPA Other Test Method 12, "*Protocol for the Source Testing, Analysis, and Reporting of VOC Emissions from Hot Mix Asphalt Plant Dryers*."

2.4.1 Results for Methane and Ethane

Bag samples were collected from the same dilution sampling system used for the measurement of total hydrocarbon (THC) concentrations by modified U.S. EPA Method 25A, "*Determination of Total Gaseous Organic Concentrations Using a Flame Ionization Analyzer*," and modified Other Test Method 12. Two (2) integrated bag samples of vent gas were collected simultaneously during a venting cycle. One bag was analyzed for methane and ethane by gas chromatograph with flame ionization detector (GC/FID) and for hydrogen sulfide (H_2S) by a gas chromatograph with flame photometric detector (GC/FPD). The second bag was only analyzed if there was an issue with the first. All analyses were performed in triplicate. Concentration results are presented as parts per million by volume, wet basis (ppmvw).

Raw GC/FID results were multiplied by the dilution ratios (DR) developed on a test run-specific basis through the operation of the dilution sampling system (see Section 2.5).

Based on past practices, URS assumed methane/propane and ethane/propane equivalency factors to be 1/3 and 2/3, respectively. These factors were multiplied by the methane and ethane concentrations (quantified by GC/FID), respectively, to determine methane/propane equivalent and ethane/propane equivalent concentrations. Methane/propane equivalent and ethane/propane equivalent concentrations were then subtracted from average THC concentrations to develop average NMNE VOC concentrations during a given sampling interval.

The methane and ethane concentration data from each test run are presented in Table 2-2. Methane/propane and ethane/propane equivalent concentrations are presented in Table 2-3. A full set of data could not be obtained during Run 1 due to PM sampling system power issues. See Section 5.0 for details. Raw data associated with the operation of the GC/FID, including all chromatograms, are included in Appendix 2-1.

Methane and ethane mass emission rates are presented in Tables 2-4 and 2-5, respectively. Section 2.2 discusses the development of target compound mass emission rates. Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). All ethane mass emission rates calculated from these maxima are also reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw are used instead.

Table 2-2. Concentration Results for Methane and Ethane

Run No.	Date	Sampling Interval (hh:mm)	Methane Conc. (ppmvw)	Ethane Conc. (ppmvw)[a]
2	7/18/13	15:05-15:34	403	<141
3	7/19/13	14:53-16:34[b]	1,515	274
4	7/20/13	14:37-14:47	1,086	<145
5	7/21/13	14:38-15:28	552	<138

[a] Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). All ethane mass emission rates calculated from these maxima are also reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw ethane are used instead.

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

Table 2-3. Methane/Propane and Ethane/Propane Equivalent Concentrations

Run No.	Date	Sampling Interval (hh:mm)	Methane Conc. (ppmvw)	Methane/ Propane Equivalent Conc. (ppmvw)	Ethane Conc. (ppmvw)[a]	Ethane/ Propane Equivalent Conc. (ppmvw)
2	7/18/13	15:05-15:34	403	134	<141	<94
3	7/19/13	14:53-16:34[b]	1,515	505	274	183
4	7/20/13	14:37-14:47	1,086	362	<145	<97
5	7/21/13	14:38-15:28	552	184	<138	<92

[a] Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). All ethane mass emission rates calculated from these maxima are also reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw ethane are used instead.

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

Table 2-4. Mass Emission Rate Results for Methane

Run No.	Date	Sampling Interval (hh:mm)	Sampling Duration (min)	Wet Methane Conc. (ppmvw)	Vent Gas Moisture (%)	Dry Methane Conc. (ppmvd)	Volumetric Flow Rate (dscfm)	Methane Mass Emission Rate (lbs/min)	Methane Mass Emission Rate (lbs/cycle)
2	7/18/13	15:05-15:34	29	403	99.6	104,005	46.7	0.201	5.84
3	7/19/13	14:53-16:34[a]	101	1,515	99.7	500,268	25.7	0.535	54.0
4	7/20/13	14:37-14:47	10	1,086	99.4	172,642	77.7	0.557	5.57
5	7/21/13	14:38-15:28	50	552	99.5	107,419	51.1	0.228	11.4

[a] Method 5 train sampling interval and duration used in all calculations for Run 3.

Table 2-5. Mass Emission Rate Results for Ethane

Run No.	Date	Sampling Interval (hh:mm)	Sampling Duration (min)	Wet Ethane Conc. (ppmvw)[a]	Vent Gas Moisture (%)	Dry Ethane Conc. (ppmvd)[a]	Volumetric Flow Rate (dscfm)	Ethane Mass Emission Rate (lbs/min)[a]	Ethane Mass Emission Rate (lbs/cycle)[a]
2	7/18/13	15:05-15:34	29	<141	99.6	<36,397	46.7	<0.13	<3.8
3	7/19/13	14:53-16:34[b]	101	274	99.7	90,613	25.7	0.182	18.3
4	7/20/13	14:37-14:47	10	<145	99.4	<23,105	77.7	<0.14	<1.4
5	7/21/13	14:38-15:28	50	<138	99.5	<26,758	51.1	<0.11	<5.3

[a] Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). All ethane mass emission rates calculated from these maxima are also reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw ethane are used instead.

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

2.4.2 Results for Hydrogen Sulfide

Bag samples were collected from the same dilution sampling system used for the measurement of total hydrocarbon (THC) concentrations by modified U.S. EPA Method 25A, "*Determination of Total Gaseous Organic Concentrations Using a Flame Ionization Analyzer*," and modified Other Test Method 12. As discussed earlier, two (2) integrated bag samples of vent gas were collected simultaneously during a venting cycle. One bag was analyzed for methane and ethane by gas chromatograph with flame ionization detector (GC/FID) and for hydrogen sulfide (H_2S) by a gas chromatograph with flame photometric detector (GC/FPD). The second bag was only analyzed if there was an issue with the first. All analyses were performed in triplicate. Concentration results are presented as parts per million by volume, wet basis (ppmvw).

Raw GC/FPD results were multiplied by the dilution ratios (DR) developed on a test run-specific basis through the operation of the dilution sampling system (see Section 2.5).

The hydrogen sulfide concentration data from each test run are presented in Table 2-6. Raw data associated with the operation of the GC/FPD, including all chromatograms, are included in Appendix 2-2.

Hydrogen sulfide mass emission rates are presented in Table 2-7. Section 2.2 discusses the development of target compound mass emission rates. The hydrogen sulfide concentration for Run 2 was below the applicable method detection limit and is reported as a maximum ("<"). All results calculated from this maximum are also reported as maxima ("<").

Table 2-6. Concentration Results for Hydrogen Sulfide

Run No.	Date	Sampling Interval (hh:mm)	Hydrogen Sulfide Conc. (ppmvw)[a]
2	7/18/13	15:05-15:34	<5.36
3	7/19/13	14:53-16:34[b]	31.8
4	7/20/13	14:37-14:47	13.5
5	7/21/13	14:38-15:28	7.43

[a] The hydrogen sulfide concentration for Run 2 was below the applicable method detection limit and is reported as a maximum ("<"). All results calculated from this maximum are also reported as maxima ("<").

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

Table 2-7. Mass Emission Rate Results for Hydrogen Sulfide (H_2S)

Run No.	Date	Sampling Interval (hh:mm)	Sampling Duration (min)	Wet H_2S Conc. (ppmvw)[a]	Vent Gas Moisture (%)	Dry H_2S Conc. (ppmvd)[a]	Volumetric Flow Rate (dscfm)	H_2S Mass Emission Rate (lbs/min)[a]	H_2S Mass Emission Rate (lbs/cycle)[a]
2	7/18/13	15:05-15:34	29	<5.36	99.6	<1,383	46.7	<0.00569	<0.165
3	7/19/13	14:53-16:34[b]	101	31.8	99.7	10,511	25.7	0.0239	2.41
4	7/20/13	14:37-14:47	10	13.5	99.4	2,149	77.7	0.0147	0.147
5	7/21/13	14:38-15:28	50	7.43	99.5	1,445	51.1	0.00651	0.325

[a] The hydrogen sulfide concentration for Run 2 was below the applicable method detection limit and is reported as a maximum ("<"). All results calculated from this maximum are also reported as maxima ("<").

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

2.5 Results for NMNE Volatile Organic Compounds (NMNE VOC)

The total hydrocarbon (THC) concentration in the DCU gas stream was measured conservatively during the 2013 Source Test as THC using FID-based portable gas analyzers. THC concentrations were measured according to modified U.S. EPA Methods 25A, "*Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*," and the dilution sampling system procedures described in U.S. EPA OTM 12.

Samples of the DCU gas stream were extracted using the same dilution sampling system used to collect methane, ethane, and hydrogen sulfide samples by modified U.S. EPA Method 18 (see Section 2.4). The diluted sample gas was routed to two (2) gas analyzers that measured THC concentrations as parts per million by volume, wet basis (ppmvw), continuously during the venting cycle. Standards of propane in a balance of nitrogen were used to calibrate two (2) THC analyzers at three (3) different ranges (0-3,500, 0-10,000, and 0-35,000 ppmvw), and nitrogen was also used as the diluent with the dilution sampling system. The dilution ratio developed on a test run-specific basis was multiplied by the average THC concentration result per sample run.

Based on past practices, URS assumed methane/propane and ethane/propane equivalency factors to be 1/3 and 2/3, respectively. Methane/propane equivalent and ethane/propane equivalent concentrations were subtracted from THC concentrations to develop NMNE VOC concentrations during a given sample run. Section 2.4.1 describes this calculation process in detail.

Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw are used instead. THC and NMNE VOC concentrations data for each test run are presented in Table 2-8. Raw data associated with the operation of the THC analyzers is included in Appendix 2-3.

NMNE VOC (as propane) mass emission rates are presented in Table 2-9. Section 2.2 discusses the development of target compound mass emission rates.

Table 2-8. Concentration Results for NMNE VOC, as Propane

Run No.	Date	Sampling Interval (hh:mm)	THC Conc. (ppmvw, as propane)	Methane/ Propane Equivalent Conc. (ppmvw)	Ethane/ Propane Equivalent Conc. (ppmvw)[a]	NMNE VOC Conc. (ppmvw, as propane)
2	7/18/13	15:05-15:34	165	134	0	30.9
3	7/19/13	14:53-16:34[b]	918	505	183	230
4	7/20/13	14:37-14:47	588	362	0	226
5	7/21/13	14:38-15:28	281	184	0	96.8

[a] Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). All ethane mass emission rates calculated from these maxima are also reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw ethane are used instead.

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

Table 2-9. Mass Emission Rate Results for NMNE VOC, as Propane

Run No.	Date	Sampling Interval (hh:mm)	Sampling Duration (min)	Wet NMNE VOC Conc. (ppmvw, as propane)[a]	Vent Gas Moisture (%)	Dry NMNE VOC Conc. (ppmvd)	Volumetric Flow Rate (dscfm)	NMNE VOC Mass Emission Rate (lbs/min)	NMNE VOC Mass Emission Rate (lbs/cycle)
2	7/18/13	15:05-15:34	29	30.9	99.6	7,979	46.7	0.0425	1.23
3	7/19/13	14:53-16:34[b]	101	230	99.7	76,012	25.7	0.223	22.6
4	7/20/13	14:37-14:47	10	226	99.4	35,933	77.7	0.319	3.19
5	7/21/13	14:38-15:28	50	96.8	99.5	18,828	51.1	0.110	5.49

[a] Ethane concentrations for Runs 2, 4, and 5 were below the applicable method detection limit and are reported as maxima ("<"). All ethane mass emission rates calculated from these maxima are also reported as maxima ("<"). For the purposes of the NMNE VOC calculations, the conservative value of zero (0) ppmvw ethane are used instead.

[b] Method 5 train sampling interval and duration used in all calculations for Run 3.

2.6 Results for Particulate Matter

Total particulate matter was measured according to modified U.S. EPA Method 5, "*Determination of Particulate Matter Emissions from Stationary Sources.*" Particulate matter samples were extracted from the DCU gas stream isokinetically.

Following each test run, the PM samples were recovered separately into the following components:

- Front-half (nozzle, probe liner and front-half of the filter holder) rinse with acetone; and
- Quartz-fiber filter.

The minimum dry gas sample volumes typically associated with sampling for total PM were not obtained due to the limited sampling durations, the minimal dry gas fraction of the vent gas stream (less than 2%), and the large volume of water that was condensed in a relatively short period of time. As an alternative, the target wet gas sample volume of greater than 0.25 cubic feet (corrected to standard conditions) was used for this source testing project. However, per the Test Plan, the failure to meet the specified sample volume criteria did not invalidate any collected data.

Table 2-1 presents a summary of modified U.S. EPA Method 5 sampling train operating data such as dry and wet gas volumes collected and isokinetic sampling rates achieved. Particulate mass loadings are presented in Table 2-10. The full laboratory report detailing the analyses of vent gas samples for particulate loading is presented in Appendix 2-4.

Total PM mass emission rates are also presented in Table 2-10. Section 2.2 discusses the development of target compound mass emission rates.

Table 2-10. Mass Loading and Mass Emission Rate Results for Total PM

	Run 2	Run 3	Run 4	Run 5
Date	**7/18/2013**	**7/19/2013**	**7/20/2013**	**7/21/2013**
Time	**15:05-15:34**	**14:53-16:34**	**14:37-14:47**	**14:38-15:28**
Duration (mins)	29	101	10	50
Volume Collected (dscf)	0.326	0.840	0.190	0.759
Flow Rate (dscfm)	46.7	25.7	77.7	51.1
Mass Found (mg)				
PM - Filter	<0.5	1.55	0.9	6.3
PM - PNR	2.3	1.55	1.6	4.45
Particulate Matter - Total	<2.8	3.10	2.50	10.8
Stack Gas Concentration (mg/dscf)				
Particulate Matter	<8.60	3.69	13.2	14.2
Mass Emission Rate (lb/min)				
Particulate Matter	<0.000884	0.000210	0.00225	0.00159
Mass Emission Rate (lb/cycle)				
Particulate Matter	<0.0256	0.0212	0.0225	0.0797