

# Comprehensive Emissions Test Report

Pine Bend Refinery  
Petroleum Refinery  
Emissions Information Collection Testing

Testing Date(s): July 26-29, 2011  
Report Date: November 30, 2011  
Revision Date: No revision to date



## Subject Facility:

Flint Hills Resources Pine Bend LLC  
Pine Bend Refinery  
12555 Clark Road  
Rosemount , MN 55068

Regulatory Permit No.:  
03700011-007

Subject Emission Sources:  
FCC

EU 228

## Test Locations:

Afterburner/ESP Stack

SV 019

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Pace Project No. 1108-200

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## Introduction

On July 26-29, 2011, Pace Analytical Services, Inc. personnel conducted Petroleum Refinery Emissions Information Collection testing on the FCCU at the Pine Bend refinery located in Rosemount, Minnesota. James Trowbridge, Terry Borgerding, Mike Walter, Matt McDermott, Joey Erickson, Matt Nelson, Bret Erickson, Alex Rowan and Aaron Fredrikson performed on-site testing activities. James Trowbridge provided administrative project management. Christopher Koerner with Flint Hills Resources Pine Bend, LLC coordinated plant activities during testing. On-site activities consisted of the following measurements:

- Dioxin/Furan & PCBs, three independent 160 minute samplings.
- Particulate Matter, three independent 160 minute samplings.
- Metals, three independent 160 minute samplings.
- Mercury, three independent two-hour samplings.
- Hexavalent Chromium, three independent 160 minute samplings.
- Aldehydes, three independent 64 minute samplings.
- Particulate Matter <2.5 $\mu$ m, three independent ~four-hour samplings.
- Mercury, three independent two-hour samplings.
- Total Hydrocarbon, three independent one-hour monitoring periods.
- HCl, HF, Cl<sub>2</sub> & NH<sub>3</sub>, three independent 96 minute samplings.
- Hydrogen Cyanide, three independent 64 minute samplings.
- Volatile Organic HAPs, six independent one-hour samplings (3 Tube – 3 Bag).
- Semi- Volatile Organic HAPs, three independent 176 minute samplings.
- Methanol, three independent one-hour samplings.
- Orsat gas composition, integrated gas samples collected concurrent with above.
- Volumetric airflow, measurements collected in conjunction with isokinetic testing.

The project objectives were to quantify emission constituents as requested by the Petroleum Refinery Emissions Information Collection request. These measurements were performed at normal operating condition. Quality protocols comply with regulatory compliance testing requirements.

Subsequent sections summarize the test results and provide descriptions of the process and test methods. Supporting information and raw data are in the appendices.

## Results Summary

Results of emission constituent determinations are summarized in Table 1-14. Subsequent tables provide expanded detail of the testing results. The airflow results reported in Table 32 were preliminary measurements used to develop testing protocol details and are not used in emissions determinations. Integrated bag samples were collected in one train each day for orsat analysis and applied to all runs conducted during the appropriate time frames. Bag 1 from the 7-28-11 sampling leaked and an average of Run 2 and Run 3 was calculated and used in place of the missing data.

As discussed with Enthalpy (an ICR analytical laboratory) and as approved in the Petroleum Refinery Emission Information Collection documentation, multiple sampling methods were combined into single sampling trains in order to maximize efficiency. EPA Method 23 (Dioxin/Furan) was combined with sampling for PCBs and the sample was split prior to analysis. EPA Method 5 (front half only) was performed from the filterable catch in the EPA Method 29 train.  $\text{NH}_3$  was performed by EPA CTM 27 in the same train as the EPA Method 26A (HCL, HF &  $\text{Cl}_2$ ).

The dry catch (EPA Method 201A), organic wet catch and inorganic wet catch (EPA Method 202) were combined to report PM-2.5. Run 2 results showed an anomalously high condensable level.

During the operation of the EPA Other Test Method 29 train, modification to both nozzle size and run durations were necessary. Run 1 was attempted with a 0.250" nozzle resulting in a sampling rate that was too great for the train/reagents to accommodate. The result was the impinger solution became excessively coagulated and plugged the impingers. This run was halted after collecting 27.03 cubic feet in 33 minutes (short of minimum volume of 31.78 cubic feet). This run was discarded and three additional runs were performed. Run 2 used a nozzle size of 0.226" and was halted after 48 minutes. This run had a volume of 32.44 cubic feet and was kept and used in the final results. A third nozzle size of 0.189 was used for Runs 3 & 4. These runs were able to run the entire 64 minutes and had volumes >31.8 cubic feet.

## Results Summary Cont.

The original results submitted to US EPA Petroleum Refinery ICR for method 18 compounds collected in the Tedlar bags had included the sum of the detection limits for the knock-out impinger and the bag. These detection limits were added together resulting in a high <DL result. When data was noticed to be an order of magnitude higher than other facilities, inquiries were made and it was discovered that the impinger fraction was typically not being included. During testing a slight condensate film was noted in the impingers. While there was not enough to actually pour (<1ml), a rinse of the impinger was performed. This rinse was then collected into a 40ml VOA vile. As the target compounds were volatile the head-space of the vile was zeroed. The results were calculated based on a reporting unit of <X µ/ml. When the added volume from the rinse and from zeroing the head-space is factored in the detection limits are inordinately biased high. The new results submitted to US EPA did not include the knock-out impinger and are more similar to the other facilities tested in both sampling and results. Tables 12c and 12d show the Method 18 results of the knockout impingers for the Tedlar bag samples. Tables 12e and 12f show the Method 18 results of the Tedlar bags.

All analytical method details or deviations are located in each individual laboratory results reports. These reports are located in Appendix B. The data in this report are indicative of emission characteristics of the measured sources for process conditions at the time of the test. Representations to other sources and test conditions are beyond the scope of this report.

## Summary Tables

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Rosemount , MN  
Pace Project No. 1108-200

## Table 1

### Dioxin/Furan Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/27/11	7/27/11	7/27/11	
Time of Run	0820-1121	1220-1515	1621-1933	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	365,000	364,000	370,000	366,000
DSCFM	173,000	173,000	173,000	173,000
Gas Temperature, °F	460	460	462	461
Gas Moisture Content, %v/v	14.0	13.6	14.8	14.2
Gas Composition, %v/v, dry				
Carbon Dioxide, CO2	13.6	13.7	13.6	13.6
Oxygen, O2	3.9	3.8	3.8	3.9
Nitrogen, N2 (by difference)	82.5	82.5	82.6	82.5
Constituent Concentration, pg/dscm				
2,3,7,8-TCDD	<1.49	<1.36	<1.29	<1.38
Sum Individual Target Isomers	≤24.58	≤22.04	≤26.86	≤24.49
Sum Congener Groups	≤55.97	≤45.45	≤74.05	≤58.49
Toxicity Equivalency - TEQ	≤4.11	≤3.77	≤3.97	≤3.95
Constituent Mass Rate, LB/HR				
2,3,7,8-TCDD	<9.6E-10	<8.8E-10	<8.4E-10	<8.9E-10
Sum Individual Target Isomers	≤1.6E-08	≤1.4E-08	≤1.7E-08	≤1.6E-08
Sum Congener Groups	≤3.6E-08	≤2.9E-08	≤4.8E-08	≤3.8E-08
Toxicity Equivalency - TEQ	≤2.7E-09	≤2.4E-09	≤2.6E-09	≤2.6E-09

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

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## Table 2

### PCBs Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/27/11	7/27/11	7/27/11	
Time of Run	0820-1121	1220-1515	1621-1933	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	365,000	365,000	370,000	366,000
DSCFM	173,000	173,000	173,000	173,000
Constituent Concentration, ng/dscm				
PCB-77 33'44'-TeCB	0.089	0.070	0.127	0.095
PCB-81 344'5'-TeCB	<0.010	<0.009	<0.011	<0.010
PCB-105 233'44'-PeCB	0.20	0.13	0.29	0.21
PCB-114 2344'5'-PeCB	≤0.027	0.019	≤0.037	≤0.028
PCB-118 23'44'5'-PeCB	0.43	0.27	0.65	0.45
PCB-123 2'344'5'-PeCB	<0.009	<0.009	<0.011	<0.010
PCB-126 33'44'5'-PeCB	<0.012	<0.012	<0.013	<0.012
PCB-156 233'44'5'-HxCB	0.024	0.018	0.032	0.025
PCB-157 233'44'5'-HxCB	≤0.0062	<0.0051	≤0.0089	≤0.0067
PCB-167 23'44'55'-HxCB	≤0.012	0.0082	0.018	≤0.013
PCB-169 33'44'55'-HxCB	<0.0071	<0.0072	<0.0082	<0.008
PCB-189 233'44'55'-HpCB	<0.010	<0.011	<0.014	<0.012
Constituent Mass Rate, LB/HR				
PCB-77 33'44'-TeCB	5.8E-08	4.5E-08	8.2E-08	6.2E-08
PCB-81 344'5'-TeCB	<6.3E-09	<5.5E-09	<7.3E-09	<6.4E-09
PCB-105 233'44'-PeCB	1.3E-07	8.6E-08	1.9E-07	1.4E-07
PCB-114 2344'5'-PeCB	≤1.8E-08	1.2E-08	2.4E-08	≤1.8E-08
PCB-118 23'44'5'-PeCB	2.8E-07	1.8E-07	4.2E-07	2.9E-07
PCB-123 2'344'5'-PeCB	<5.5E-09	<6.0E-09	<7.2E-09	<6.2E-09
PCB-126 33'44'5'-PeCB	<7.7E-09	<8.0E-09	<8.4E-09	<8.0E-09
PCB-156 233'44'5'-HxCB	1.6E-08	1.2E-08	2.1E-08	1.6E-08
PCB-157 233'44'5'-HxCB	≤4.0E-09	<3.3E-09	≤5.8E-09	≤4.9E-09
PCB-167 23'44'55'-HxCB	≤7.7E-09	5.3E-09	1.1E-08	≤8.0E-09
PCB-169 33'44'55'-HxCB	<4.6E-09	<4.7E-09	<5.3E-09	<4.9E-09
PCB-189 233'44'55'-HpCB	<6.3E-09	<7.2E-09	<8.9E-09	<7.5E-09

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## Table 3

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### Particulate Matter Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/28/11	7/28/11	7/28/11	
Time of Run	0710-1009	1037-1335	1400-1701	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	372,000	373,000	366,000	370,000
DSCFM	176,000	177,000	174,000	176,000
Gas Temperature, °F	466	464	463	464
Gas Moisture Content, %v/v	14.0	13.9	13.5	13.8
Gas Composition, %v/v, dry				
Carbon Dioxide, CO <sub>2</sub>	13.5	13.4	13.4	13.4
Oxygen, O <sub>2</sub>	4.3	4.1	4.1	4.2
Nitrogen, N <sub>2</sub> (by difference)	82.2	82.5	82.5	82.4
Particulate Mass Rate, LB/HR				
Dry Catch Particulate	3.27	3.98	3.35	3.53
Dry Catch + Organic Wet Catch	NA	NA	NA	NA
Dry Catch + M-202 (PM-10 Eq.)	NA	NA	NA	NA
Particulate Concentration, GR/DSCF				
Dry Catch Particulate	0.0022	0.0026	0.0022	0.0023
Dry Catch + Organic Wet Catch	NA	NA	NA	NA
Dry Catch + M-202 (PM-10 Eq.)	NA	NA	NA	NA

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## Table 4

### Metals Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/28/11	7/28/11	7/28/11	
Time of Run	0710-1009	1037-1335	1400-1701	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	372,000	373,000	366,000	370,000
DSCFM	176,000	177,000	174,000	176,000
Gas Temperature, °F	466	464	463	464
Gas Moisture Content, %v/v	14.0	13.9	13.5	13.8
Gas Composition, %v/v, dry				
Carbon Dioxide, CO2	13.5	13.4	13.4	13.4
Oxygen, O2	4.3	4.1	4.1	4.2
Nitrogen, N2 (by difference)	82.2	82.5	82.5	82.4
Constituent Mass Rate, LB/HR				
Antimony	≤0.000050	≤0.000044	≤0.000033	≤0.000042
Arsenic	<0.000033	<0.000033	<0.000033	<0.000033
Beryllium	<0.000008	<0.000008	<0.000008	<0.000008
Cadmium	0.00058	0.00078	≤0.00003	≤0.00047
Chromium	0.00131	0.00019	0.00036	0.00062
Cobalt	≤0.000056	≤0.000056	≤0.000048	≤0.000053
Lead	0.00044	0.00019	0.00026	0.00029
Manganese	0.00124	0.00059	0.00071	0.00085
Nickel	0.00079	0.00027	0.00054	0.00053
Selenium	<0.000033	≤0.000040	<0.000033	≤0.000035

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Rosemount, MN  
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## Table 5

Hg Results Summary  
FCC Afterburner/ESP Stack  
Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/27/11	7/27/11	7/27/11	
Time of Run	0820-1111	1215-1455	1620-1920	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	368,000	356,000	365,000	363,000
DSCFM	174,000	168,000	171,000	171,000
Gas Temperature, °F	465	464	466	465
Gas Moisture Content, %v/v	13.7	14.0	14.1	13.9
Gas Composition, %v/v, dry				
Carbon Dioxide, CO <sub>2</sub>	13.3	13.5	13.5	13.4
Oxygen, O <sub>2</sub>	3.9	3.7	3.7	3.8
Nitrogen, N <sub>2</sub> (by difference)	82.8	82.8	82.8	82.8
Constituent Concentration, µg/dscm				
Filter (Hg)	<0.0017	<0.0017	<0.0017	<0.0017
Front Rinse (Hg)	<0.0034	<0.0035	<0.0034	<0.0034
KCl (Hg)	<0.030	<0.031	<0.031	<0.031
H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub> (Hg)	<0.0044	<0.0045	<0.0044	<0.0044
KMnO <sub>4</sub> (Hg)	0.018	0.098	≤0.016	≤0.044
Total (Hg)	≤0.018	≤0.098	≤0.016	≤0.044
Constituent Mass Rate, LB/HR				
Filter (Hg)	<1.1E-06	<1.1E-06	<1.1E-06	<1.1E-06
Front Rinse (Hg)	<2.2E-06	<2.2E-06	<2.2E-06	<2.2E-06
KCl (Hg)	<2.0E-05	<2.0E-05	<2.0E-05	<2.0E-05
H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub> (Hg)	<2.8E-06	<2.8E-06	<2.8E-06	<2.8E-06
KMnO <sub>4</sub> (Hg)	1.1E-05	6.1E-05	≤1.0E-05	≤2.8E-05
Total (Hg)	≤1.1E-05	≤6.1E-05	≤1.0E-05	≤2.8E-05

Non-detect results are shown as less than (<) the Lower Reporting Limit.

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Rosemount , MN  
Pace Project No. 1108-200

## Table 6

### Chromium (VI) Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/27/11	7/27/11	7/27/11	
Time of Run	0820-1121	1215-1518	1620-1937	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	378,000	375,000	374,000	376,000
DSCFM	179,000	178,000	177,000	178,000
Gas Temperature, °F	467	469	470	469
Gas Moisture Content, %v/v	12.9	13.0	13.1	13.0
Gas Composition, %v/v, dry				
Carbon Dioxide, CO2	13.3	13.5	13.5	13.4
Oxygen, O2	3.9	3.7	3.7	3.8
Nitrogen, N2 (by difference)	82.8	82.8	82.8	82.8
Constituent Concentration, µg/dscm				
Chromium(VI)	0.086	<0.050	<0.045	≤0.060
Constituent Mass Rate, LB/HR				
Chromium(VI)	0.000058	<0.000033	<0.000030	≤0.000040

Non-detect results are shown as less than (<) the Lower Reporting Limit.

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Rosemount , MN  
Pace Project No. 1108-200

## Table 7

### Aldehydes Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	1208-1320	1350-1513	1540-1652	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	366,000	356,000	358,000	360,000
DSCFM	177,000	172,000	172,000	174,000
Constituent Concentration, µg/dscm				
Formaldehyde	54.7	7.0	4.3	22.0
Acetaldehyde	<1.19	<1.09	<0.83	<1.04
Propionaldehyde	<1.18	<1.08	<0.82	<1.03
Constituent Mass Rate, LB/HR				
Formaldehyde	0.036	0.005	0.003	0.015
Acetaldehyde	<0.00079	<0.00071	<0.00054	<0.00068
Propionaldehyde	<0.00079	<0.00070	<0.00053	<0.00067

Non-detect results are shown as less than (<) the Lower Reporting Limit.

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## Table 8

Pine Bend Refinery

Rosemount , MN

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### Particulate Matter <2.5 µm Results Summary

FCC Afterburner/ESP Stack

Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/28/11	7/28/11	7/29/11	
Time of Run	0710-1132	1155-1601	0725-1133	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	382,000	379,000	375,000	379,000
DSCFM	182,000	182,000	181,000	182,000
Gas Temperature, °F	459	457	455	457
Gas Moisture Content, %v/v	13.9	13.3	13.5	13.6
Gas Composition, %v/v, dry				
Carbon Dioxide, CO <sub>2</sub>	13.5	13.4	13.5	13.5
Oxygen, O <sub>2</sub>	4.3	4.1	4.4	4.3
Nitrogen, N <sub>2</sub> (by difference)	82.2	82.5	82.1	82.3
Particulate Concentration, GR/DSCF				
< 2.5 µm Particulate Matter	0.016	0.037	0.018	0.024
< 2.5 µm Filterable PM	0.0022	0.0019	0.0012	0.0018
Combined Condensible PM	0.014	0.035	0.016	0.022
Particulate Mass Rate, LB/HR				
< 2.5 µm Particulate Matter	25.6	57.5	27.3	36.8
< 2.5 µm Filterable PM	3.4	3.0	1.9	2.7
Combined Condensible PM	22.2	54.5	25.4	34.0
Regulatory Units, mg/dscm				
< 2.5 µm Particulate Matter	37.5	84.2	40.2	53.9
< 2.5 µm Filterable PM	4.9	4.4	2.8	4.0
Combined Condensible PM	32.5	79.8	37.4	49.9

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## Table 9

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

### Total Hydrocarbon Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-100	1040-1140	1250-1350	
Sample Duration (Minutes)	60	60	60	
Stack Temperature (°F)	460	460	460	460
Duct Moisture Content (%v/v)	14.0	14.0	13.6	13.9
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	365,000	365,000	364,000	365,000
SCFM	201,000	201,000	200,000	201,000
DSCFM	173,000	173,000	173,000	173,000
Total Hydrocarbon Concentration, PPMv - Wet				
THC as Propane	2.4	1.8	1.7	2.0
THC as Methane <sup>1</sup>	7.3	5.4	5.2	6.0
THC as Carbon	7.3	5.4	5.2	6.0
Total Hydrocarbon Concentration, PPMv - Dry				
THC as Propane	2.82	2.10	2.00	2.31
THC as Methane <sup>1</sup>	8.45	6.31	6.01	6.92
THC as Carbon	8.45	6.31	6.01	6.92
Total Hydrocarbon Mass Rate, LB/HR				
THC as Propane	3.35	2.50	2.38	2.74
THC as Methane <sup>1</sup>	3.65	2.73	2.60	2.99
THC as Carbon	2.73	2.04	1.95	2.24

<sup>1</sup> Linear alkane response factor derived from  
number of carbon atoms

# Flint Hills Resources Pine Bend LLC

## Table 10

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

### Speciated Constituent Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/28/11	7/28/11	7/28/11	
Time of Run	710-942	1045-1320	1340-1537	
Sample Duration (Minutes)	96	96	96	
Stack Temperature (°F)	464	461	460	462
Duct Moisture Content (%v/v)	14.0	15.5	14.0	14.5
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	375,000	374,000	370,000	373,000
SCFM	206,000	206,000	204,000	206,000
DSCFM	177,000	174,000	176,000	176,000
Constituent Concentration, PPMv - Dry				
Hydrogen Chloride	2.0	1.9	2.0	2.0
Hydrogen Fluoride	<0.079	<0.080	<0.081	<0.080
Chlorine	<0.018	<0.017	<0.018	<0.018
Ammonia	12.6	12.1	10.7	11.8
Constituent Concentration, mg/dscm				
Hydrogen Chloride	3.1	2.9	3.0	3.0
Hydrogen Fluoride	<0.066	<0.066	<0.067	<0.066
Chlorine	<0.026	<0.025	<0.026	<0.026
Ammonia	8.9	8.6	7.6	8.4
Constituent Mass Rate, LB/HR				
Hydrogen Chloride	2.04	1.93	2.00	1.99
Hydrogen Fluoride	<0.044	<0.043	<0.044	<0.044
Chlorine	<0.017	<0.017	<0.017	<0.017
Ammonia	5.94	5.60	4.98	5.50

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).



# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 11 HCN Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 2	Run 3	Run 4	Average
Date of Run	7/28/11	7/28/11	7/28/11	
Time of Run	1005-1102	1230-1425	1535-1656	
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	366,000	362,000	358,000	362,000
DSCFM	174,000	173,000	172,000	173,000
Gas Temperature, °F	461.8	460.6	459.3	461
Gas Moisture Content, %v/v	13.9	13.3	13.3	13.5
Gas Composition, %v/v, dry				
Carbon Dioxide, CO <sub>2</sub>	13.5	13.4	13.4	13.4
Oxygen, O <sub>2</sub>	4.3	4.1	4.1	4.2
Nitrogen, N <sub>2</sub> (by difference)	82.2	82.5	82.5	82.4
Constituent Concentration, µg/dscm				
HCN	4930	5279	5199	5136
Constituent Mass Rate, LB/HR				
HCN	3.21	3.43	3.35	3.33

# Flint Hills Resources Pine Bend LLC

## Table 12a

Pine Bend Refinery

Rosemount, MN

Pace Project No. 1108-200

### M18 Tube Speciated Volatile Organic HAPs Results Summary

FCC Afterburner/ESP Stack

Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-1000	1040-1140	1250-1350	
Sample Duration (Minutes)	60	60	60	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	357,000	357,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Rate, LB/HR				
Acetonitrile	<0.27	<0.28	<0.29	<0.28
Acrylonitrile	<0.22	<0.23	<0.24	<0.23
Chlorobenzene	<0.064	<0.065	<0.067	<0.066
Cumene	<0.046	<0.047	<0.049	<0.048
Ethyl Benzene	<0.047	<0.048	<0.050	<0.048
Methyl Isobutyl Ketone	<0.049	<0.050	<0.052	<0.050
Methyl tert-butyl ether	<0.046	<0.047	<0.049	<0.048
Nitrobenzene	<0.070	<0.072	<0.074	<0.072
2-Nitropropane	<0.43	<0.44	<0.45	<0.44
Styrene	<0.051	<0.052	<0.054	<0.052
Constituent Concentration, µg/dscm				
Acetonitrile	<430	<441	<445	<438
Acrylonitrile	<354	<363	<366	<361
Chlorobenzene	<101	<103	<104	<103
Cumene	<73.1	<74.9	<75.6	<74.5
Ethyl Benzene	<74.4	<76.3	<76.9	<75.9
Methyl Isobutyl Ketone	<77.0	<79.0	<79.7	<78.5
Methyl tert-butyl ether	<73.1	<74.9	<75.6	<74.5
Nitrobenzene	<111	<113	<114	<113
2-Nitropropane	<678	<695	<701	<691
Styrene	<80.3	<82.3	<83.1	<81.9

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 12b

Pine Bend Refinery

Rosemount , MN

Pace Project No. 1108-200

### M18 Tube Speciated Volatile Organic HAPs Results Summary

FCC Afterburner/ESP Stack

Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-1000	1040-1140	1250-1350	
Sample Duration (Minutes)	60	60	60	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	356,000	356,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Rate, LB/HR				
2,2,4-Trimethylpentane	<0.040	<0.041	<0.042	<0.041
m/p-Xylenes	<0.046	<0.047	<0.048	<0.047
O-Xylenes	<0.048	<0.049	<0.050	<0.049
Xylenes (total)	<0.093	<0.096	<0.099	<0.096
Constituent Concentration, µg/dscm				
2,2,4-Trimethylpentane	<62.5	<64.1	<64.6	<63.7
m/p-Xylenes	<72.4	<74.2	<74.9	<73.8
O-Xylenes	<75.0	<76.9	<77.6	<76.5
Xylenes (total)	<147	<151	<153	<150

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 12c

Pine Bend Refinery **M18 Bag KO Imp Speciated Volatile Organic HAPs Results Summary**  
 Rosemount , MN **FCC Afterburner/ESP Stack**  
 Pace Project No. 1108-200 **Test 1**

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-948	1040-1125	1250-1337	
Sample Duration (Minutes)	48	45	47	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	357,000	357,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Rate, LB/HR				
Acetone	2.36	3.05	3.14	2.85
Acrolein	<1.78	<1.93	<1.91	<1.87
Benzene	<1.53	<1.66	<1.64	<1.61
1,3-Butadiene	<1.79	<1.95	<1.93	<1.89
Carbon Disulfide	<0.59	<0.65	<0.64	<0.63
1,2-Dibromoethane	<4.16	<4.51	<4.47	<4.38
Hexane	<1.28	<1.39	<1.38	<1.35
Methylene chloride	3.22	<3.37	<3.33	≤3.31
Pentane	<2.81	<3.05	<3.02	<2.96
Constituent Concentration, µg/dscm				
Acetone	3,728	4,812	4,849	4,463
Acrolein	<2807	<3049	<2955	<2937
Benzene	<2412	<2620	<2540	<2524
1,3-Butadiene	<2829	<3073	<2979	<2960
Carbon Disulfide	<939	<1019	<988	<982
1,2-Dibromoethane	<6556	<7122	<6904	<6861
Hexane	<2026	<2201	<2133	<2120
Methylene chloride	5087	<5312	<5149	≤5183
Pentane	<4429	<4812	<4664	<4635

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 12d

Pine Bend Refinery **M18 Bag KO Imp Speciated Volatile Organic HAPs Results Summary**  
 Rosemount , MN **FCC Afterburner/ESP Stack**  
 Pace Project No. 1108-200 **Test 1**

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-948	1040-1125	1250-1337	
Sample Duration (Minutes)	48	45	47	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	357,000	357,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Rate, LB/HR				
Tetrachloroethene	<8.26	<8.97	<8.87	<8.70
Toluene	<3.00	<3.26	<3.23	<3.16
Trichloroethylene	<1.74	<1.89	<1.87	<1.83
Constituent Concentration, µg/dscm				
Tetrachloroethene	<13025	<14149	<13715	<13630
Toluene	<4736	<5145	<4987	<4956
Trichloroethylene	<2741	<2977	<2886	<2868

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 12e

Pine Bend Refinery

M18 Bag Speciated Volatile Organic HAPs Results Summary

Rosemount, MN

FCC Afterburner/ESP Stack

Pace Project No. 1108-200

Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-948	1040-1125	1250-1337	
Sample Duration (Minutes)	48	45	47	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	357,000	357,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Rate, LB/HR				
Methane	0.39	0.28	0.38	0.35
Ethane	<0.34	<0.34	<0.34	<0.34
Acetone	<0.55	<0.55	1.00	≤0.70
Acrolein	<0.41	<0.41	<0.42	<0.41
Benzene	<0.49	<0.49	<0.50	<0.49
1,3-Butadiene	<0.40	<0.40	<0.41	<0.40
Carbon Disulfide	0.34	<0.09	<0.09	≤0.17
1,2-Dibromoethane	<1.27	<1.27	<1.30	<1.28
Hexane	<0.52	<0.52	0.70	≤0.58
Methylene chloride	<2.26	<2.26	3.02	≤2.51
Constituent Concentration, µg/dscm				
Methane	615	434	580	543
Ethane	<530	<530	<530	<530
Acetone	<860	<860	1,540	≤1087
Acrolein	<646	<646	<646	<646
Benzene	<766	<766	<766	<766
1,3-Butadiene	<634	<634	<634	<634
Carbon Disulfide	535	<136	<136	≤269
1,2-Dibromoethane	<2007	<2007	<2007	<2007
Hexane	<828	<828	1,075	≤910
Methylene chloride	<3566	<3566	4,660	≤3931

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Table 12f

Pine Bend Refinery

M18 Bag Speciated Volatile Organic HAPs Results Summary

Rosemount , MN

FCC Afterburner/ESP Stack

Pace Project No. 1108-200

Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-948	1040-1125	1250-1337	
Sample Duration (Minutes)	48	45	47	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	357,000	357,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Rate, LB/HR				
Pentane	<0.49	<0.49	<0.50	<0.49
Tetrachloroethene	<1.27	<1.27	<1.30	<1.28
Toluene	<0.56	<0.56	<0.57	<0.56
Trichloroethylene	<1.20	<1.20	<1.22	<1.21
Constituent Concentration, µg/dscm				
Pentane	<771	<771	<771	<771
Tetrachloroethene	<2006	<2006	<2006	<2006
Toluene	<877	<877	<877	<877
Trichloroethylene	<1890	<1890	<1890	<1890

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 13

Pine Bend Refinery  
Rosemount, MN  
Pace Project No. 1108-200

### Methanol Constituent Results Summary FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3	Average
Date of Run	7/26/11	7/26/11	7/26/11	
Time of Run	900-1000	1040-1140	1250-1350	
Sample Duration (Minutes)	60	60	60	
Stack Temperature (°F)	457	457	459	457
Duct Moisture Content (%v/v)	14.7	14.7	12.5	14.0
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	356,000	356,000	356,000	356,000
SCFM	198,000	198,000	197,000	198,000
DSCFM	169,000	169,000	173,000	170,000
Constituent Mass Collected, mg				
Methanol	<0.033	<0.033	<0.033	<0.033
Constituent Mass Rate, LB/HR				
Methanol	<1.29	<1.29	<1.42	<1.33
Constituent Concentration, µg/dscm				
Methanol	<2035	<2038	<2199	<2091

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).



# Flint Hills Resources Pine Bend LLC

## Table 14a

Pine Bend Refinery

Semivolatile Organic HAPs Concentration Results Summary

Rosemount, MN

FCC Afterburner/ESP Stack

Pace Project No. 1108-200

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/26/11	7/26/11	7/26/11
Time of Run	0755-1107	1138-1450	1517-1826
Sample Duration, Minutes	176	176	176
Average Flue Gas Temperature, °F	456.5	459.4	459.4
Moisture Content of Flue Gas, %v/v	14.7	12.5	13.0
Sample Volume, Meter Conditions, Ft <sup>3</sup>	147.03	146.46	150.57
Sample Volume, Dry Standard, Ft <sup>3</sup>	137.19	135.63	139.43
Sample Volume, Dry Standard, m <sup>3</sup>	3.89	3.84	3.95
Constituent Concentration, µg/dscm			
Acenaphthene	<0.026	0.072	<0.025
Acenaphthylene	<0.026	0.069	0.091
Aniline	<8.93	<9.03	<8.79
Anthracene	<0.030	0.04	1.97
Benzidine	<293	<296	<288
Benzo(a)anthracene	<0.026	0.044	0.3
Benzo(a)pyrene	<0.026	<0.026	0.088
Benzo(b)fluoranthene	<0.026	0.054	<0.025
Benzo(e)pyrene	<0.026	<0.026	0.045
Benzo(g,h,i)perylene	<0.026	<0.026	<0.025
Benzo(k)fluoranthene	<0.026	0.053	0.102
Biphenyl	<12.9	<13.0	<12.7
Cresols (total)	<16.3	20.4	<16.1
Chrysene	<0.030	0.26	0.57
Dibenz(a,h)anthracene	<0.026	<0.026	<0.025
Dibenzofuran	<8.85	<8.96	<8.71
Dibenzo(a,e)pyrene	<0.13	<0.13	<0.13
3,3'-Dimethoxybenzidine	<12.9	<13.0	<12.7
Dimethylaminoazobenzene	<12.9	<13.0	<12.7
7,12-Dimethylbenz(a) anthracene	<0.051	<0.052	<0.051
3,3'-Dimethylbenzidine	<139	<140	<136
α,α-Dimethylphenethylamine	<12.9	<13.0	<12.7
2,4-Dimethylphenol	<9.37	<9.48	<9.22
Fluoranthene	0.06	0.12	0.38
Fluorene	<0.026	0.683	<0.025

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 14b

Pine Bend Refinery

Semivolatile Organic HAPs Mass Rate Results Summary

Rosemount, MN

FCC Afterburner/ESP Stack

Pace Project No. 1108-200

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/26/11	7/26/11	7/26/11
Time of Run	0755-1107	1138-1450	1517-1826
Sample Duration, Minutes	176	176	176
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	357,000	356,000	356,000
SCFM	198,000	197,000	198,000
DSCFM	169,000	173,000	172,000
Constituent Mass Rate, LB/HR			
Acenaphthene	<1.6E-05	4.6E-05	<1.6E-05
Acenaphthylene	<1.6E-05	4.5E-05	5.9E-05
Aniline	<5.7E-03	<5.8E-03	<5.7E-03
Anthracene	<1.6E-05	2.8E-05	1.3E-03
Benidine	<1.9E-01	<1.9E-01	<1.9E-01
Benzo(a)anthracene	<1.6E-05	2.8E-05	1.9E-04
Benzo(a)pyrene	<1.6E-05	<1.7E-05	5.7E-05
Benzo(b)fluoranthene	<1.6E-05	3.50E-05	<1.6E-05
Benzo(e)pyrene	<1.6E-05	<1.7E-05	2.9E-05
Benzo(g,h,i)perylene	<1.6E-05	<1.7E-05	<1.6E-05
Benzo(k)fluoranthene	<1.6E-05	3.4E-05	6.6E-05
Biphenyl	<8.2E-03	<8.4E-03	<8.2E-03
Cresols (total)	<1.0E-02	1.3E-02	<1.0E-02
Chrysene	<1.6E-05	1.7E-04	3.6E-04
Dibenz(a,h)anthracene	<1.6E-05	<1.7E-05	<1.6E-05
Dibenzofuran	<5.6E-03	<5.8E-03	<5.6E-03
Dibenzo(a,e)pyrene	<8.2E-05	<8.4E-05	<8.2E-05
3,3'-Dimethoxybenzidine	<8.2E-03	<8.4E-03	<8.2E-03
Dimethylaminoazobenzene	<8.2E-03	<8.4E-03	<8.2E-03
7,12-Dimethylbenz(a) anthracene	<3.3E-05	<3.4E-05	<3.3E-05
3,3'-Dimethylbenzidine	<8.8E-02	<9.1E-02	<8.8E-02
α,α-Dimethylphenethylamine	<8.2E-03	<8.4E-03	<8.2E-03
2,4-Dimethylphenol	<5.9E-03	<6.1E-03	<5.9E-03
Fluoranthene	3.6E-05	7.8E-05	2.5E-04
Fluorene	<1.6E-05	4.4E-04	<1.6E-05

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 14c

Pine Bend Refinery

Rosemount , MN

Pace Project No. 1108-200

### Semivolatile Organics Concentration Results Summary

FCC Afterburner/ESP Stack

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/26/11	7/26/11	7/26/11
Time of Run	0755-1107	1138-1450	1517-1826
Sample Duration, Minutes	176	176	176
Average Flue Gas Temperature, °F	456.5	459.4	461.2
Moisture Content of Flue Gas, %v/v	14.7	12.5	13.0
Sample Volume, Meter Conditions, Ft <sup>3</sup>	147.03	146.46	150.57
Sample Volume, Dry Standard, Ft <sup>3</sup>	137.19	135.63	139.30
Sample Volume, Dry Standard, m <sup>3</sup>	3.89	3.84	3.95
Constituent Concentration, µg/dscm			
Indeno(1,2,3-cd) pyrene	<0.026	<0.026	0.048
Isophorone	<9.63	<9.74	<9.48
3-Methylchloranthrene	<0.13	<0.13	<0.13
2-Methylnaphthalene	0.05	1.89	4.93
Naphthalene	0.92	1.36	2.11
Perylene	<0.026	<0.026	0.059
Phenanthrene	0.04	0.21	0.48
Phenol	<8.37	15.99	<8.24
1,4-Phenylenediamine	<12.9	<13.0	<12.7
Pyrene	0.11	0.6	1.46
o-Toluidine	<12.9	<13.0	<12.7

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 14d

Pine Bend Refinery

Rosemount , MN

Pace Project No. 1108-200

### Semivolatile Organics Mass Rate Results Summary

FCC Afterburner/ESP Stack

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/26/11	7/26/11	7/26/11
Time of Run	0755-1107	1138-1450	1517-1826
Sample Duration, Minutes	176	176	176
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	357,000	356,000	368,000
SCFM	198,000	197,000	203,000
DSCFM	169,000	173,000	177,000
Constituent Mass Rate, LB/HR			
Indeno(1,2,3-cd) pyrene	<1.6E-05	<1.7E-05	3.2E-05
Isophorone	<6.1E-03	<6.3E-03	<6.3E-03
3-Methylchloranthrene	<8.2E-05	<8.4E-05	<8.4E-05
2-Methylnaphthalene	3.4E-05	1.2E-03	3.3E-03
Naphthalene	5.9E-04	8.8E-04	1.4E-03
Perylene	<1.6E-05	<1.7E-05	3.9E-05
Phenanthrene	2.7E-05	1.3E-04	3.2E-04
Phenol	<5.3E-03	1.0E-02	<5.5E-03
1,4-Phenylenediamine	<8.2E-03	<8.4E-03	<8.4E-03
Pyrene	7.3E-05	3.9E-04	9.7E-04
o-Toluidine	<8.2E-03	<8.4E-03	<8.4E-03

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

## Detail Tables

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 15

### Major Gases and Moisture Results FCC Afterburner/ESP Stack M23 Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1220-1515	1621-1933
Major Gas Constituents - Orsat, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	13.30	13.50	13.50
Oxygen	3.90	3.70	3.70
Nitrogen (by difference)	82.80	82.80	82.80
Wet Basis (calculated)			
Carbon Dioxide	11.43	11.66	11.50
Oxygen	3.35	3.20	3.15
Nitrogen	71.17	71.51	70.52
Portable Oxygen Monitor Result			
Time Weighted Average, %O <sub>2</sub>	4.3	4.1	4.0
Moisture Collected, ml	367.0	353.0	395.0
Moisture Content, %v/v	14.04	13.64	14.83
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.28	30.31	30.31
Wet	28.56	28.63	28.48

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 16 Major Gases and Moisture Results FCC Afterburner/ESP Stack M5/29 Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/28/11
Time of Run	0710-1009	1037-1335	1400-1701
Major Gas Constituents - Orsat, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	13.45	13.40	13.40
Oxygen	4.32	4.13	4.13
Nitrogen (by difference)	82.23	82.47	82.47
Wet Basis (calculated)			
Carbon Dioxide	11.56	11.54	11.60
Oxygen	3.71	3.56	3.57
Nitrogen	70.70	71.02	71.37
Portable Oxygen Monitor Result			
Time Weighted Average, %O <sub>2</sub>	4.1	4.1	4.1
Moisture Collected, ml	491.0	488.0	462.0
Moisture Content, %v/v	14.03	13.88	13.45
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.32	30.31	30.31
Wet	28.60	28.60	28.65

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 17

### Major Gases and Moisture Results FCC Afterburner/ESP Stack OHM Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1111	1215-1455	1620-1920
Major Gas Constituents - Orsat, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	13.30	13.50	13.50
Oxygen	3.90	3.70	3.70
Nitrogen (by difference)	82.80	82.80	82.80
Wet Basis (calculated)			
Carbon Dioxide	11.48	11.61	11.59
Oxygen	3.37	3.18	3.18
Nitrogen	71.46	71.21	71.09
Portable Oxygen Monitor Result			
Time Weighted Average, %O2	4.3	4.1	4.1
Moisture Collected, ml	354.0	350.0	363.0
Moisture Content, %v/v	13.70	13.99	14.14
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.28	30.31	30.31
Wet	28.60	28.59	28.57



# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 18

### Major Gases and Moisture Results FCC Afterburner/ESP Stack M0061 Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1215-1518	1620-1937
Major Gas Constituents - Orsat, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	13.30	13.50	13.50
Oxygen	3.90	3.70	3.70
Nitrogen (by difference)	82.80	82.80	82.80
Wet Basis (calculated)			
Carbon Dioxide	11.58	11.74	11.73
Oxygen	3.40	3.22	3.22
Nitrogen	72.08	72.01	71.97
Portable Oxygen Monitor Result			
Time Weighted Average, %O <sub>2</sub>	4.1	3.9	3.9
Moisture Collected, ml	404.0	404.0	404.0
Moisture Content, %v/v	12.94	13.03	13.08
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.28	30.31	30.31
Wet	28.69	28.70	28.70

# Flint Hills Resources Pine Bend LLC

## Table 19

Pine Bend Refinery

Rosemount , MN

Pace Project No. 1108-200

**M0011 Major Gases and Moisture Results**

**FCC Afterburner/ESP Stack**

**M0011 Test 1**

<b>Parameter</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Run 4</b>
Date of Run	7/26/11	7/26/11	7/26/11	7/26/11
Time of Run	1208-1320	1350-1513	1540-1652	1713-1827
Major Gas Constituents - Orsat, % v/v				
Dry Basis (as measured)				
Carbon Dioxide	13.40	13.50	13.50	13.50
Oxygen	4.13	4.50	4.50	4.50
Nitrogen (by difference)	82.47	82.00	82.00	82.00
Wet Basis (calculated)				
Carbon Dioxide	11.76	11.86	11.80	11.76
Oxygen	3.63	3.95	3.93	3.92
Nitrogen	72.40	72.05	71.69	71.43
Portable Oxygen Monitor Result				
Time Weighted Average, %O2	4.5	4.5	4.5	4.4
Moisture Collected, ml	165.0	159.0	166.0	176.0
Moisture Content, %v/v	12.21	12.14	12.57	12.89
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole				
Dry	30.31	30.34	30.34	30.34
Wet	28.81	28.84	28.79	28.75

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 20

### Major Gases and Moisture Results FCC Afterburner/ESP Stack M201A Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/29/11
Time of Run	0710-1132	1155-1601	0725-1133
Major Gas Constituents - Orsat, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	13.45	13.40	13.50
Oxygen	4.32	4.13	4.40
Nitrogen (by difference)	82.23	82.47	82.10
Wet Basis (calculated)			
Carbon Dioxide	11.59	11.62	11.67
Oxygen	3.72	3.58	3.80
Nitrogen	70.84	71.50	70.99
Portable Oxygen Monitor Result			
Time Weighted Average, %O <sub>2</sub>	4.0	3.8	4.1
Moisture Collected, ml	301.0	265.0	267.0
Moisture Content, %v/v	13.85	13.30	13.53
Moisture Content if Saturated, %v/v	NA (T>BP)	NA (T>BP)	NA (T>BP)
Relative Humidity, % rH	NA (T>BP)	NA (T>BP)	NA (T>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.32	30.31	30.34
Wet	28.62	28.67	28.67

NA (T>BP) = Not applicable, gas temperature is greater than boiling point of water (supersaturation is possible).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 21 Major Gases and Moisture Results FCC Afterburner/ESP Stack M26A/27 Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/28/11
Time of Run	0710-0942	1045-1320	1340-1537
Major Gas Constituents - Orsat, % v/v			
Dry Basis (as measured)			
Carbon Dioxide	13.45	13.40	13.40
Oxygen	4.32	4.13	4.13
Nitrogen (by difference)	82.23	82.47	82.47
Wet Basis (calculated)			
Carbon Dioxide	11.56	11.32	11.52
Oxygen	3.71	3.49	3.55
Nitrogen	70.69	69.66	70.91
Portable Oxygen Monitor Result			
Time Weighted Average, %O <sub>2</sub>	4.3	4.1	4.1
Moisture Collected, ml	282.0	316.0	279.0
Moisture Content, %v/v	14.03	15.52	14.01
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.32	30.31	30.31
Wet	28.60	28.40	28.58

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 22

### Major Gases and Moisture Results FCC Afterburner/ESP Stack M0010 Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/26/11	7/26/11	7/26/11
Time of Run	0755-1107	1138-1450	1517-1826
Check Input Cell D15!!!			
Dry Basis (as measured)			
Carbon Dioxide	12.60	12.50	12.60
Oxygen	5.20	5.10	5.30
Nitrogen (by difference)	82.20	82.40	82.10
Wet Basis (calculated)			
Carbon Dioxide	10.75	10.94	10.96
Oxygen	4.44	4.46	4.61
Nitrogen	70.12	72.09	71.44
Portable Oxygen Monitor Result			
Time Weighted Average, %O <sub>2</sub>	4.6	4.5	4.5
Moisture Collected, ml	502.0	412.0	442.0
Moisture Content, %v/v	14.69	12.51	12.98
Moisture Content if Saturated, %v/v	NA (>BP)	NA (>BP)	NA (>BP)
Relative Humidity, % rH	NA (>BP)	NA (>BP)	NA (>BP)
Molecular Weight of Flue Gas, lb/lb-mole			
Dry	30.22	30.20	30.23
Wet	28.43	28.68	28.64

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 23a

### Dioxin/Furan Concentration Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1220-1515	1621-1933
Sample Duration, Minutes	160	160	160
Average Flue Gas Temperature, °F	459.7	460.3	461.8
Moisture Content of Flue Gas, %v/v	14.0	13.6	14.8
Sample Volume, Meter Conditions, Ft3	112.66	114.18	116.58
Sample Volume, Dry Standard, Ft3	105.73	105.24	106.78
Sample Volume, Dry Standard, m3	2.99	2.98	3.02
Constituent Concentration, pg/dscm			
2,3,7,8-TCDF	≤1.72	≤1.46	≤1.93
Total TCDF	11.53	10.59	17.92
2,3,7,8-TCDD	<1.49	<1.36	<1.29
Total TCDD	3.37	≤4.38	≤6.37
1,2,3,7,8-PeCDF	≤1.16	<1.13	≤1.29
2,3,4,7,8-PeCDF	≤1.25	<1.06	≤1.03
Total PeCDF	≤3.78	<1.09	≤3.67
1,2,3,7,8-PeCDD	<1.69	<1.56	<1.67
Total PeCDD	≤3.36	≤2.47	<1.67
1,2,3,4,7,8-HxCDF	≤1.16	≤0.88	1.25
1,2,3,6,7,8-HxCDF	1.06	≤0.98	1.37
2,3,4,6,7,8-HxCDF	<0.78	≤1.02	1.41
1,2,3,7,8,9-HxCDF	<1.01	<0.96	≤1.12
Total HxCDF	≤4.63	≤3.35	6.33
1,2,3,4,7,8-HxCDD	<1.37	<1.39	<1.32
1,2,3,6,7,8-HxCDD	<1.36	<1.40	<1.41
1,2,3,7,8,9-HxCDD	<1.43	≤1.53	≤1.65
Total HxCDD	2.49	≤1.54	≤2.90
1,2,3,4,6,7,8-HpCDF	3.75	2.72	4.18
1,2,3,4,7,8,9-HpCDF	<1.49	<1.36	<1.47
Total HpCDF	≤3.15	≤1.68	4.32
1,2,3,4,6,7,8-HpCDD	3.86	3.23	4.47
Total HpCDD	≤6.17	≤4.68	9.39
OCDF	≤4.41	≤3.29	4.32
OCDD	13.09	12.38	17.16

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 23b

### Dioxin/Furan Mass Rate Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1220-1515	1621-1933
Sample Duration, Minutes	160	160	160
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	365,000	365,000	370,000
SCFM	201,000	201,000	203,000
DSCFM	173,000	173,000	173,000
Constituent Mass Rate, LB/HR			
2,3,7,8-TCDF	≤1.1E-09	≤9.5E-10	≤1.3E-09
Total TCDF	7.5E-09	6.9E-09	1.2E-08
2,3,7,8-TCDD	<9.6E-10	<8.8E-10	<8.4E-10
Total TCDD	2.2E-09	≤2.8E-09	≤4.1E-09
1,2,3,7,8-PeCDF	≤7.5E-10	<7.3E-10	≤8.4E-10
2,3,4,7,8-PeCDF	≤8.1E-10	<6.9E-10	≤6.7E-10
Total PeCDF	≤2.4E-09	<7.1E-10	≤2.4E-09
1,2,3,7,8-PeCDD	<1.1E-09	<1.0E-09	<1.1E-09
Total PeCDD	≤2.2E-09	≤1.6E-09	<1.1E-09
1,2,3,4,7,8-HxCDF	≤7.5E-10	≤5.7E-10	8.1E-10
1,2,3,6,7,8-HxCDF	6.8E-10	≤6.3E-10	8.9E-10
2,3,4,6,7,8-HxCDF	<5.0E-10	≤6.6E-10	9.1E-10
1,2,3,7,8,9-HxCDF	<6.5E-10	<6.2E-10	≤7.2E-10
Total HxCDF	≤3.0E-09	≤2.2E-09	4.1E-09
1,2,3,4,7,8-HxCDD	<8.9E-10	<9.0E-10	<8.6E-10
1,2,3,6,7,8-HxCDD	<8.8E-10	<9.1E-10	<9.1E-10
1,2,3,7,8,9-HxCDD	<9.3E-10	≤9.9E-10	≤1.1E-09
Total HxCDD	1.6E-09	≤1.0E-09	≤1.9E-09
1,2,3,4,6,7,8-HpCDF	2.4E-09	1.8E-09	2.7E-09
1,2,3,4,7,8,9-HpCDF	<9.7E-10	<8.8E-10	<9.5E-10
Total HpCDF	≤2.0E-09	≤1.1E-09	2.8E-09
1,2,3,4,6,7,8-HpCDD	2.5E-09	2.1E-09	2.9E-09
Total HpCDD	≤4.0E-09	≤3.0E-09	6.1E-09
OCDF	≤2.8E-09	≤2.1E-09	2.8E-09
OCDD	8.5E-09	8.0E-09	1.1E-08

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 24a

Pine Bend Refinery

Rosemount , MN

Pace Project No. 1108-200

### Semivolatile Organics Concentration Results

#### FCC Afterburner/ESP Stack

#### Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1220-1515	1621-1933
Sample Duration, Minutes	160	160	160
Average Flue Gas Temperature, °F	459.7	460.3	461.8
Moisture Content of Flue Gas, %v/v	14.0	13.6	14.8
Sample Volume, Meter Conditions, Ft3	112.66	114.18	116.58
Sample Volume, Dry Standard, Ft3	105.73	105.24	106.78
Sample Volume, Dry Standard, m3	2.99	2.98	3.02
Constituent Concentration, ng/dscm			
PCB-77 33'44'-TeCB	0.089	0.070	0.127
PCB-81 344'5'-TeCB	<0.0097	<0.0085	<0.0112
PCB-105 233'44'-PeCB	0.20	0.13	0.29
PCB-114 2344'5'-PeCB	0.027	0.019	0.037
PCB-118 23'44'5'-PeCB	0.43	0.27	0.65
PCB-123 2'344'5'-PeCB	<0.0085	<0.0092	<0.0111
PCB-126 33'44'5'-PeCB	<0.0119	<0.0123	<0.0130
PCB-156 233'44'5'-HxCB	0.024	0.018	0.032
PCB-157 233'44'5'-HxCB	0.0062	<0.0051	0.0089
PCB-167 23'44'55'-HxCB	0.012	0.0082	0.0176
PCB-169 33'44'55'-HxCB	<0.0071	<0.0072	<0.0082
PCB-189 233'44'55'-HpCB	<0.0097	<0.0111	<0.0137

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).



# Flint Hills Resources Pine Bend LLC

## Table 24b

Pine Bend Refinery

Semivolatile Organics Mass Rate Results

Rosemount , MN

FCC Afterburner/ESP Stack

Pace Project No. 1108-200

Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1220-1515	1621-1933
Sample Duration, Minutes	160	160	160
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	365,000	364,000	370,000
SCFM	201,000	200,000	203,000
DSCFM	173,000	173,000	173,000
Constituent Mass Rate, LB/HR			
PCB-77 33'44'-TeCB	5.8E-08	4.5E-08	8.2E-08
PCB-81 344'5'-TeCB	<6.3E-09	<5.5E-09	<7.3E-09
PCB-105 233'44'-PeCB	1.3E-07	8.6E-08	1.9E-07
PCB-114 2344'5'-PeCB	1.8E-08	1.2E-08	2.4E-08
PCB-118 23'44'5'-PeCB	2.8E-07	1.8E-07	4.2E-07
PCB-123 2'344'5'-PeCB	<5.5E-09	<6.0E-09	<7.2E-09
PCB-126 33'44'5'-PeCB	<7.7E-09	<8.0E-09	<8.4E-09
PCB-156 233'44'5'-HxCB	1.6E-08	1.2E-08	2.1E-08
PCB-157 233'44'5'-HxCB	4.0E-09	<3.3E-09	5.8E-09
PCB-167 23'44'55'-HxCB	7.7E-09	5.3E-09	1.1E-08
PCB-169 33'44'55'-HxCB	<4.6E-09	<4.7E-09	<5.3E-09
PCB-189 233'44'55'-HpCB	<6.3E-09	<7.2E-09	<8.9E-09

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 25 Particulate Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/28/11
Time of Run	0710-1009	1037-1335	1400-1701
Sample Duration, Minutes	160	160	160
Average Flue Gas Temperature, °F	465.6	463.7	462.8
Moisture Content of Flue Gas, %v/v	14.0	13.9	13.5
Particulate Collected, mg			
Dry Catch	19.9	24.2	20.3
Inorganic Wet Catch	NR	NR	NR
Organic Wet Catch	NR	NR	NR
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	372,000	373,000	366,000
SCFM	204,000	206,000	202,000
DSCFM	176,000	177,000	174,000
Sample Volume, Meter Conditions, Ft <sup>3</sup>	150.98	153.08	151.09
Sample Volume, Dry Standard, Ft <sup>3</sup>	141.67	142.51	139.88
Particulate Concentration			
Dry Catch, GR/DSCF	0.0022	0.0026	0.0022
Inorganic Wet Catch, GR/DSCF	NR	NR	NR
Organic Wet Catch, GR/DSCF	NR	NR	NR
Dry Catch+Organic WC, GR/DSCF	NA	NA	NA
Total Particulate (PM-10 Eq.), GR/DSCF	NA	NA	NA
Particulate Emission Rate			
Dry Catch Only, LB/HR	3.27	3.98	3.35
Inorganic Wet Catch Only, LB/HR	NR	NR	NR
Organic Wet Catch Only, LB/HR	NR	NR	NR
Dry Catch+Organic WC, LB/HR	NA	NA	NA
Total Particulate (PM-10 Eq.), LB/HR	NA	NA	NA

NR=Not required or not requested.

NA = Not applicable

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 26a

### Metals Concentration Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/28/11
Time of Run	0710-1009	1037-1335	1400-1701
Sample Duration, Minutes	160	160	160
Average Flue Gas Temperature, °F	465.6	463.7	462.8
Moisture Content of Flue Gas, %v/v	14.0	13.9	13.5
Sample Volume, Meter Conditions, Ft3	150.98	153.08	151.09
Sample Volume, Dry Standard, Ft3	141.67	142.51	139.88
Sample Volume, Dry Standard, m3	4.01	4.04	3.96
Constituent Concentration, µg/dscm			
Antimony	≤0.076	≤0.066	≤0.050
Arsenic	<0.050	<0.050	<0.050
Beryllium	<0.012	<0.012	<0.013
Cadmium	0.89	1.18	≤0.05
Chromium	2.00	0.29	0.55
Cobalt	≤0.085	≤0.084	≤0.073
Lead	0.67	0.28	0.39
Manganese	1.89	0.89	1.09
Nickel	1.20	0.41	0.83
Selenium	<0.050	≤0.060	<0.050

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 26b

### Metals Mass Rate Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/28/11
Time of Run	0710-1009	1037-1335	1400-1701
Sample Duration, Minutes	160	160	160
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	372,000	373,000	366,000
SCFM	204,000	206,000	202,000
DSCFM	176,000	177,000	174,000
Constituent Mass Rate, LB/HR			
Antimony	≤0.000050	≤0.000044	≤0.000033
Arsenic	<0.000033	<0.000033	<0.000033
Beryllium	<0.000008	<0.000008	<0.000008
Cadmium	0.00058	0.00078	≤0.00003
Chromium	0.00131	0.00019	0.00036
Cobalt	≤0.00006	≤0.00006	≤0.00005
Lead	0.00044	0.00019	0.00026
Manganese	0.00124	0.00059	0.00071
Nickel	0.00079	0.00027	0.00054
Selenium	<0.00003	≤0.00004	<0.00003

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 27

### Metals Concentration Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1111	1215-1455	1620-1920
Sample Duration, Minutes	120	120	120
Average Flue Gas Temperature, °F	464.8	464.2	465.6
Moisture Content of Flue Gas, %v/v	13.7	14.0	14.1
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	368,000	356,000	365,000
SCFM	202,000	195,000	199,000
DSCFM	174,000	168,000	171,000
Sample Volume, Meter Conditions, Ft3	110.61	108.57	112.09
Sample Volume, Dry Standard, Ft3	104.98	101.25	103.72
Sample Volume, Dry Standard, m3	2.97	2.87	2.94
Constituent Concentration, µg/dscm			
Filter (Hg)	<0.0017	<0.0017	<0.0017
Front Rinse (Hg)	<0.0034	<0.0035	<0.0034
KCl (Hg)	<0.030	<0.031	<0.031
H2O2/HNO3 (Hg)	<0.0044	<0.0045	<0.0044
KMnO4 (Hg)	0.018	0.098	≤0.016
Total (Hg)	≤0.018	≤0.098	≤0.016
Constituent Mass Rate, LB/HR			
Filter (Hg)	<0.000001	<0.000001	<0.000001
Front Rinse (Hg)	<0.000002	<0.000002	<0.000002
KCl (Hg)	<0.000020	<0.000020	<0.000020
H2O2/HNO3 (Hg)	<0.000003	<0.000003	<0.000003
KMnO4 (Hg)	0.000011	0.000061	≤0.000010
Total (Hg)	≤0.000011	≤0.000061	≤0.000010

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 28

### Metals Concentration Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 1	Run 2	Run 3
Date of Run	7/27/11	7/27/11	7/27/11
Time of Run	0820-1121	1215-1518	1620-1937
Sample Duration, Minutes	160	160	160
Average Flue Gas Temperature, °F	467.2	468.6	469.9
Moisture Content of Flue Gas, %v/v	12.9	13.0	13.1
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	378,000	375,000	374,000
SCFM	206,000	204,000	204,000
DSCFM	179,000	178,000	177,000
Sample Volume, Meter Conditions, Ft3	136.35	137.27	138.18
Sample Volume, Dry Standard, Ft3	127.90	126.88	126.40
Sample Volume, Dry Standard, m3	3.62	3.59	3.58
Constituent Concentration, µg/dscm			
Chromium(VI)	0.086	<0.050	<0.045
Constituent Mass Rate, LB/HR			
Chromium(VI)	0.000058	<0.000033	<0.000030

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

## Table 29

Pine Bend Refinery

Rosemount , MN

Pace Project No. 1108-200

### Aldehydes Concentration Results

#### FCC Afterburner/ESP Stack

#### Test 1

Parameter	Run 1	Run 2	Run 3	Run 4
Date of Run	7/26/11	7/26/11	7/26/11	7/26/11
Time of Run	1208-1320	1350-1513	1540-1652	1713-1827
Sample Duration, Minutes	64	64	64	64
Volumetric Flow Rate (Rounded to 1000 CFM)				
ACFM	366,000	356,000	358,000	366,000
SCFM	202,000	196,000	197,000	201,000
DSCFM	177,000	172,000	172,000	175,000
Average Flue Gas Temperature, °F	463.8	465.1	466.1	466.6
Sample Volume, Dry Standard, m3	1.58	1.53	1.54	1.59
Constituent Concentration, µg/dscm				
Formaldehyde	54.7	7.0	4.3	373.2
Acetaldehyde	<1.19	<1.09	<0.83	<0.66
Propionaldehyde	<1.18	<1.08	<0.82	<0.65
Constituent Mass Rate, LB/HR				
Formaldehyde	3.6E-02	4.5E-03	2.8E-03	2.5E-01
Acetaldehyde	<7.9E-04	<7.1E-04	<5.4E-04	<4.3E-04
Propionaldehyde	<7.9E-04	<7.0E-04	<5.3E-04	<4.3E-04

Non-detect results are shown as less than (<) the Lower Reporting Limit.

Detection Level Limited is denoted by (≤).

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

**Table 30**  
**Particulate Results**  
**FCC Afterburner/ESP Stack**  
**Test 1**

Parameter	Run 1	Run 2	Run 3
Date of Run	7/28/11	7/28/11	7/29/11
Time of Run	0710-1132	1155-1601	0725-1133
Sample Duration, Minutes	251.1	238.7	238.2
Average Flue Gas Temperature, °F	459.2	457.1	454.8
Moisture Content of Flue Gas, %v/v	13.9	13.3	13.5
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	382,000	379,000	375,000
SCFM	211,000	210,000	210,000
DSCFM	182,000	182,000	181,000
Particulate Collected, mg <span>Blank Corrected</span>			
PM <sub>10</sub> Cyclone - >10 µm Filterable	NTP	NTP	NTP
PM <sub>2.5</sub> Cyclone - 2.5 - 10 µm Filterable	NTP	NTP	NTP
Filter Catch - <2.5 µm Filterable	12.3	10.0	6.4
CPM <sub>ORG</sub> - Organic Condensible	1.10	43.70	1.70
CPM <sub>INORG</sub> - Inorganic Condensible	80.1	140	83.3
Actual PM10 Cut Diameter, µm	10.1	10.3	10.4
Actual PM2.5 Cut Diameter, µm	2.43	2.54	2.57
Particulate Concentration, GR/DSCF			
< 2.5 µm Filterable PM	2.15E-03	1.90E-03	1.22E-03
Organic Condensible PM	1.93E-04	8.30E-03	3.27E-04
Inorganic Condensible PM	1.40E-02	2.66E-02	1.60E-02
Combined Condensible PM	1.42E-02	3.49E-02	1.63E-02
< 2.5 µm Particulate Matter	1.64E-02	3.68E-02	1.75E-02
Particulate Emission Rate, LB/HR			
< 2.5 µm Filterable PM	3.36E+00	2.97E+00	1.89E+00
Organic Condensible PM	3.01E-01	1.30E+01	5.07E-01
Inorganic Condensible PM	2.19E+01	4.15E+01	2.49E+01
Combined Condensible PM	2.22E+01	5.45E+01	2.54E+01
< 2.5 µm Particulate Matter	2.56E+01	5.75E+01	2.73E+01

NTP = Non-Target Parameter, intentionally excluded from the test protocol.



# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 31 Metals Concentration Results FCC Afterburner/ESP Stack Test 1

Parameter	Run 2	Run 3	Run 4
Date of Run	7/28/11	7/28/11	7/28/11
Time of Run	1005-1102	1230-1425	1535-1656
Sample Duration, Minutes	48	64	64
Average Flue Gas Temperature, °F	461.8	460.6	459.3
Moisture Content of Flue Gas, %v/v	13.9	13.3	13.3
Volumetric Flow Rate (Rounded to 1000 CFM)			
ACFM	366,000	362,000	358,000
SCFM	202,000	200,000	198,000
DSCFM	174,000	173,000	172,000
Sample Volume, Meter Conditions, Ft <sup>3</sup>	34.22	31.88	31.94
Sample Volume, Dry Standard, Ft <sup>3</sup>	31.84	29.39	29.01
Sample Volume, Dry Standard, m <sup>3</sup>	0.90	0.83	0.82
Constituent Concentration, µg/dscm			
HCN	4930	5279	5199
Constituent Mass Rate, LB/HR			
HCN	3.21	3.43	3.35

Non-detect results are shown as less than (<) the sum of fraction LRLs.

# Flint Hills Resources Pine Bend LLC

Pine Bend Refinery  
Rosemount , MN  
Pace Project No. 1108-200

## Table 32 Airflow Measurement Results FCC Afterburner/ESP Stack Test 1

Parameter	Preliminary
Date of Run	7/27/11
Time of Measurement	0730
Barometric Pressure, Inches Hg	28.94
Static Pressure, Inches WC	-0.95
Absolute Gas Pressure (In. Hg)	28.87
Average Gas Temperature, °F	457
Moisture Determination Procedure	Wet/Dry Bulb
Average Moisture Content, %v/v	13.4
Gas Molecular Weight (Orsat), lb/lb-mole	
Dry	30.3
Wet	28.7
Flue Gas Average Velocity, FPS	84.71
Duct Cross-sectional Area, Sq. Ft.	72.13
Volumetric Flow Rate (Rounded to 1000 CFM)	
ACFM	367,000
SCFM	204,000
DSCFM	176,000

## Process Description

One of the first steps in the refining process is the separation of the crude oil components by distillation. After desalting, atmospheric distillation is used to separate the major crude components. The crude oil is passed through a direct-fired (fuel gas) charge heater and delivered to the tall distillation column. The crude oil components separate to thermal layers based on boiling points. Propane, butane and light gases are drawn from the top of the column as vapors. Gasoline and naphtha are drawn from the top liquid layer. Successive layers are “heavier” components include kerosene/jet fuel, diesel fuel, gas oil, asphalt and bottom crude. These major components often require further processing or cleaning to make the saleable.

The heaviest components, asphalt and bottom crude, can be further separated using vacuum distillation. Vacuum distillation allows further vapor pressure separation without overheating that could lead to thermal cracking. Vacuum distillation is generally similar to atmospheric distillation but uses significantly lower pressures and longer residence times.

The purpose of the FCC is to take low value gas oil and contact it with a solid catalyst that will crack the larger gas oil molecules into lighter, more valued products. Conversion to high valued products is maximized at low pressures. The catalyst is regenerated by burning the coke formed on the catalyst as a byproduct of the cracking reaction. Regeneration gases are burned to generate steam and preheat the feed to the reactor. Reactor effluent is fractionated in the main column. Main column products are further fractionated in the clarified oil vacuum fractionator, light cycle oil stripper, and the 18 unit gas plants.

Under normal operation, the flue gases from the FCC pass through the FCC CO boilers and the ESP prior to exhausting out the main, continuously monitored, stack. The FCC also has a bypass stack between the regenerator and CO boilers for emergency relief. In December of 1999, FHR received approval from EPA for an alternative monitoring plan to satisfy the monitoring requirements of NSPS Subpart J in the event of an emergency bypass. The approval requires FHR to: 1) continue to validate & maintain the CO analyzer on the bypass stack and 2) conduct a “simple test to compare the data from the CO flue gas analyzer against data from the CO reference method” on the bypass analyzer at the time of the annual RATA on the main stack analyzers.

The emergency bypass stack is water sealed under normal operation and the water in the seal is continuously monitored. The CO/CO<sub>2</sub> analyzers are located on the process side of the seal. Since the time of the AMP approval, the FCC switched from a partial burn to a full burn operation which significantly reduced CO concentrations entering the CO boilers and the potential emissions in the event of a bypass.

## Test Procedures

**EPA Method 1** specifies test location acceptability criteria and defines the minimum number of traverse points for representative sampling. Linear measurements from upstream and downstream flow disturbances and the duct equivalent diameter are compared and the distances related to number of diameters. A flow disturbance can be defined as anything that changes or upsets the direction of flow within the duct including bends, dampers, fans, shape or size transitions and open flames. Method 1 stipulates that test ports should be located at least eight diameters downstream and two diameters upstream of any flow disturbance. The minimum acceptable criteria are two diameters downstream and 0.5 diameters upstream of flow disturbances. The test location must also be free of cyclonic or multidirectional flow. Once the distances have been determined, the values are used to select the minimum number of traverse points for representative sampling. Shorter distances require a greater number of traverse points. The test site configuration is shown in Figure 1 and has the following characteristics:

Test Location:	FCC Stack
Duct Cross-sectional Dimension:	115"
Distance From Upstream Disturbance:	733"
Number of Duct Diameters:	6.4
Distance To Downstream Disturbance:	772"
Number of Duct Diameters:	6.7
Cyclonic or Multidirectional Flow:	Absent, verified
Number of Traverse Points:	16

**EPA Method 2** defines procedures used to measure linear velocity and volumetric flow rate of a confined gas stream. Using traverse points determined by EPA Method 1, multiple differential pressure measurements (pitot impact opening versus static pressure) are made using a pitot tube and differential pressure gauge. The individual measurements are averaged and combined with the gas density to calculate the average gas velocity. The velocity and duct cross-sectional area are used to calculate the volumetric flow rate. The volumetric flow rate is expressed as actual cubic feet per minute (ACFM), standard cubic feet per minute (SCFM), and dry standard cubic feet per minute (DSCFM). The technician maintains comprehensive test records on handwritten field data sheets. Details of the equipment used to measure gas velocity include:

Pitot Tube:	S-Type
Differential Pressure Gauge:	Electronic Manometer
Temperature Device:	Type K Thermocouple
Barometer Type:	Electronic Digital Barometer
Gas Density Determination:	EPA Method 3A
Gas Moisture Determination:	EPA Method 4

**EPA Method 3B** defines procedures to quantify carbon dioxide (CO<sub>2</sub>) and oxygen (O<sub>2</sub>) concentrations from stationary combustion sources. A multi-point, integrated, gas sample is collected simultaneously with other emissions testing. Using traverse points determined from EPA Method 1, sample gases are extracted from emission stream at a constant rate. Each point is sampled for a uniform length of time over the course of a

test period equal to other test constituents. A Tedlar™, aluminized Mylar™ or other inert material bag contains the collected gas sample prior to sample analyses. An Orsat gas analyzer quantifies the CO<sub>2</sub> and O<sub>2</sub> concentrations by measuring the changes in volume after selective chemical gas adsorption. Below are the details of the procedures for measuring gas composition:

Filter Material:	Glass fiber filter or equivalent
Moisture removal:	Condenser
Bag Material:	Aluminized Mylar™
Gas Analyzer:	Orsat

**EPA Method 4** defines procedures to measure the moisture content of emissions gas streams from stationary sources. The moisture content of the gas stream is determined in conjunction with the isokinetic sampling train described below. Collected water condensate is measured from the back half of the isokinetic train. Method 4 equations convert the condensed liquid volume to a gas volume. The water vapor volume compared with the dry standard gas volume collected through the isokinetic train determines the moisture content of the emissions gas stream and is reported in percent by volume.

Probe Material:	Borosilicate glass
Filter Media:	Quartz fiber, >99.95% efficient at 0.3 µm
Impinger Train Material:	Borosilicate glass
Desiccant:	Drierite
Condensate Measure:	Graduated Cylinder
Desiccant Measure:	Electronic balance

**EPA Method 29 / Method 5** define procedures to measure metal emissions from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, 4, and 5, a sample gas stream is isokinetically drawn from the emission stream. To attain isokinetic sampling, a sampling nozzle of a known diameter points directly into the oncoming gas stream. The train operator calculates and adjusts the gas sampling rate to match the gas velocity entering the nozzle with the emission stream velocity. Isokinetic sampling eliminates biases from differing particulate aerodynamic characteristics. The particulate fraction of metals emissions collects in the sampling probe and on a quartz-fiber filter. The probe and filter components of the sampling train are heated to 248°F (± 25°) to prevent moisture condensation and preserve sample integrity. The filtered sample gas stream passes through a series of reagent-filled impingers to collect the vapor fraction of metals emissions. The first two impingers contain a 5% nitric acid/10% hydrogen peroxide solution and are followed by a dry impinger. Impingers 4 and 5 contain a 4% potassium permanganate/10% sulfuric acid absorbing solution followed by another dry impinger. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. A dry impinger may precede the reagent impingers for additional condensate capacity in high moisture sources. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on handwritten field data sheets. Details of metals testing are outlined below:

Nozzle/Probe Material:	Quartz and borosilicate glass
Filter Holder Material:	Borosilicate glass and Teflon™ filter support
Filter Media:	Quartz fiber, >99.95% efficient at 0.3 µm
Impinger Train Material:	Borosilicate glass
Impinger Reagents:	5% HNO <sub>3</sub> and 10% H <sub>2</sub> O <sub>2</sub> 4% KMnO <sub>4</sub> and 10% H <sub>2</sub> SO <sub>4</sub>
Recovery Reagents:	Acetone (front-half only) 0.1N HNO <sub>3</sub> (front-half only) 4% KMnO <sub>4</sub> and 10% H <sub>2</sub> SO <sub>4</sub> 8N HCl Deionized water
Control Train:	EPA Method 5
Analytical Technique:	Inductively Coupled Plasma/Mass Spectrometry Cold Vapor Atomic Absorption Spectroscopy

**EPA Method 18** defines procedures to measure gaseous organics emitted from industrial sources. Depending on flame hazards and source conditions, samples are collected using one of five procedures: Integrated Bag Sampling, Impinger, Sorbent Tube Sampling, Direct Interface Sampling, Dilution Interface Sampling. Through pretest screening or previous information on the source gas, the identity and approximate concentration of the compounds are determined in order to prepare the required spikes and calibration standards.

**Integrated Bag Sampling:** a gas sample is collected into a flexible bag made of Tedlar™, Teflon™, or Mylar™. An inert sampling probe and Teflon™ transfer line extract a sample of the gas stream at a constant rate and deliver it to the bag. An evacuation vessel or inert pump facilitates sample flow. The flow rate is set so the final volume of the sample is approximately 80% of the bag capacity. The collected sample is protected from sunlight and steep temperature gradients. A test protocol document outlines target parameters, sampling handling protocols, and analytical strategies.

**Impinger Sampling:** a gas sample is extracted from the source at a constant rate using a glass or Teflon™ sampling probe and Teflon™ transfer line. A filter removes particulate and a series of borosilicate glass impingers collects the target constituents by condensation or dissolution. Typically, the first and second impingers are prepared with an appropriate volume of water or other reagent, and the third impinger is initially dry. The impingers are immersed in a water/ice bath to maintain the sample stream exit temperature below 68°F. A test protocol document outlines target parameters, sampling handling protocols, and analytical strategies.

**Sorbent Tube Sampling:** a gas sample is extracted from the source at a constant rate and passed through a solid sorbent selected for the target parameters. When necessary, a heated sampling probe and Teflon™ transfer line and filter to remove particulate can be used to maintain sample integrity. When warranted by gas characteristics, a knock-out impinger to collect excess moisture can be added, which is then recovered and analyzed by gas chromatography (GC). A test protocol document outlines target parameters, sampling handling protocols, and analytical strategies.

For each of the five sampling procedures, the major components of the sample are separated by gas chromatography (GC) and individually quantified with flame ionization, photoionization, electron capture, mass spectrometry, or other appropriate detection principle. Prior to analysis, the system is calibrated with appropriate zero and span gases. The need for sample dilution (to avoid detector saturation), gas stream filtration (to eliminate particulate matter), and/or prevention of moisture condensation is determined by the pre-survey. Moisture content of the source, when needed, is determined following EPA Method 4. After sampling, recovery studies and response factors are performed and must meet method requirements. Sample data is corrected to reflect the true value using appropriate calibration curves and/or response factors. The train operator maintains comprehensive test records on the Midget Train Sampling Field Data Sheet. Details of testing are outlined below:

Stainless Steel, Pyrex Glass, or Teflon™	
Sample Lines:	Teflon™
Collection Procedure:	Tedlar™ Bags, Adsorbent Tubes, or Direct Interface

**EPA Method 23** defines procedures to measure dioxin and furan emissions from stationary sources. The sampling protocol is commonly called Modified Method 5. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, 4 and 5, a sample gas stream is isokinetically drawn from the emission stream. To attain isokinetic sampling, a sampling nozzle of a known diameter points directly into the oncoming gas stream. The train operator calculates and adjusts the gas sampling rate to match the gas velocity entering the nozzle with the emission stream velocity. Isokinetic sampling eliminates biases from differing particulate aerodynamic characteristics. Particulate bound semi-volatile constituents collect in the heated probe and on the (heated) Teflon™ filter. Gaseous semi-volatile constituents collect in the organics sampling module. The organics sampling module includes a spiral condenser, a sorbent cartridge prepared with XAD-2 resin and a condensate collection vessel. The spiral condenser continuously cools the sample gas stream entering the sorbent cartridge so that it is less than 68°F. The XAD-2 resin absorbs vapor phase dioxins and furans. A desiccant packed drying column follows the organics sampling module to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample analyses are performed by high resolution gas chromatography and high resolution mass spectrometry in accordance with EPA Method 23 and SW-846 Method 8290. Surrogate spike recoveries from the XAD-2 resin verify sample integrity during field sampling/recovery activities. The train operator maintains comprehensive test records on handwritten field data sheets. Details of dioxin/furan testing include:

Nozzle Material:	Borosilicate glass
Probe Material:	Borosilicate glass
Filter Media:	Quartz fiber, >99.95% efficient at 0.3 µm
Sorbent Media:	XAD
Impinger Train Material:	Borosilicate glass
Recovery Reagents:	Acetone Toluene
Control Train:	EPA Method 5
Analytical Technique	HRGC/HRMS

**EPA Method 25A** defines procedures used to measure total hydrocarbons from stationary sources. A stainless steel sampling probe and heat-traced Teflon™ sampling line draw a sample of the gas stream from the duct directly to an analyzer. A total hydrocarbon analyzer utilizing a flame ionization detector (FID) quantifies total hydrocarbon concentrations. Zero grade cylinder air provides zero gas and span gases include varying concentrations of EPA Protocol 1 propane (C<sub>3</sub>H<sub>8</sub>) standards. A computerized data acquisition system logs THC concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with spreadsheet software. Concentrations are expressed in terms of propane or results can be multiplied by 3 to report in terms of carbon (C<sub>1</sub>). The operator also maintains comprehensive test records on handwritten field data sheets. Equipment used for THC testing includes:

Probe Material:	Stainless Steel
Transfer Line:	Teflon™, (heated)
Analytical Technique:	Flame Ionization Detector (FID)
Calibration Gas:	EPA Protocol 1

**EPA Method 26A / CTM 27** defines procedures to measure halide, halogen and ammonia emissions from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, 4, and 5, a sample gas stream is isokinetically drawn from the emission stream. To attain isokinetic sampling, a sampling nozzle of a known diameter points directly into the oncoming gas stream. The train operator calculates and adjusts the gas sampling rate to match the gas velocity entering the nozzle with the emission stream velocity. Isokinetic sampling eliminates biases from differing particulate aerodynamic characteristics. The particulate fraction of the emissions collects in the sampling probe and on a Teflon™ mat filter. The filter and probe wash can be analyzed to determine particulate loading in conjunction with halides and halogens. The probe and filter components of the sampling train are heated to 248°F (± 25°) to prevent moisture condensation and preserve sample integrity. The filtered sample gas stream passes through a series of reagent-filled impingers to collect halide and halogen emissions. The first two impingers contain 0.05M sulfuric acid to capture hydrogen halides and are followed by a dry impinger. Impingers 4 and 5 contain 0.1M sodium hydroxide to collect halogen gases. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on handwritten field data sheets. Details of halide/halogen testing include:

Nozzle/Probe Material:	Quartz and borosilicate glass
Filter Holder Material:	Borosilicate glass and Teflon™ filter support
Filter Media:	Teflon mat, >99.95% efficient at 0.3 µm
Impinger Train Material:	Borosilicate glass
Impinger Reagents:	0.05M H <sub>2</sub> SO <sub>4</sub> 0.1M NaOH
Recovery Reagents:	Deionized water
Control Train:	EPA Method 5



**EPA Method 201A** defines procedures to measure particulate matter equal to or less than 10 microns (PM-10) and 2.5 microns (PM-2.5) from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, 4, and 5, a sample gas stream is drawn from the emission stream at a constant rate through an in-stack sizing devices: a PM-10 cyclone followed by a PM-2.5 cyclone. The cyclones separator classifies particulate matter at 10-micron ( $\mu\text{m}$ ) and 2.5-micron ( $\mu\text{m}$ ) aerodynamic cut diameters (nominal). Cyclones collect particulate matter at the cut size and larger. The omission of either cyclone excludes the measurement of that particle cut size from the method. The cyclones are followed by an in-stack glass fiber filter to collect remaining filterable particulate (less than the cut diameter). The sample gas moves through a heated sampling probe to the back half of the sampling train. This method is used in conjunction with Method 202 when the gas stream temperature exceeds 85°F to collect condensable particulate which is included as PM-2.5. See separate summary for Method 202. The back half of the train consists of glass impingers and a desiccant packed drying column to quantitatively collect water vapor. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. Sample fractions are processed from the cyclone heads into separate sample containers using a brush and acetone. Gravimetric analysis is applied to determine the particulate mass for each size fraction. The train operator maintains comprehensive test records on EPA Method 201A Field Data Sheet. Details of PM-10 and PM-2.5 particulate testing include:

Nozzle/Probe Material:	Stainless Steel
PM-2.5 Separator:	Stainless Steel Cyclone
PM-10 Separator:	Stainless Steel Cyclone
Filter Holder Material:	Stainless Steel
Filter Media:	Glass-fiber, >99.95% efficient at 0.3 $\mu\text{m}$
Impinger Train Material:	Borosilicate Glass
Recovery Reagents:	Acetone
	Deionized Water
Control Train:	EPA Method 17
Analytical Technique:	Gravimetric

**EPA Method 202** defines procedures to determine organic and inorganic condensable particulate matter (CPM) emissions from stationary sources. The CPM is collected in a condensate knock-out impinger and Teflon filter after filterable PM has been collected by either Method 5 or Method 201A. The gas stream is sample isokinetically following EPA Method 5 or Method 201A procedures. The Method 202 CPM train collects condensable and soluble particulate. The gas stream is initially cooled with a spiral condenser using recirculated cool water to maintain a sample gas temperature of 85F or less. Condensate from the spiral condenser collects in glass, stemless, dropout impingers. The intent of the condenser and dropout impinger is to minimize gas/water contact to reduce collection of unintended artifacts. The dropout impinger is followed by a second impinger to provide overflow capacity. A Teflon filter, also maintained at 85F or less is used to collect any remaining organic CPM. The filter is followed by an iced, water prepared impinger and desiccant packed drying column to quantitatively collect

remaining moisture. Immediately after sampling, the Method 202 CPM train is purged with nitrogen (N<sub>2</sub>) to liberate dissolved sulfur dioxide (SO<sub>2</sub>) gases. The contents of the dropout and backup impingers prior to the CPM filter are measured, weighed, and transferred to an appropriate sample bottle. CPM is quantitatively recovered with water, acetone, and hexane rinses. The CPM filter and water are extracted with hexane and combined with solvent rinses to determine the organic CPM. Following extraction, the water is dried and the residue measured as the inorganic CPM. The combination of both fractions represents the total condensable particulate matter (CPM). The train operator maintains comprehensive test records on appropriate Field Data Sheets.

Filter Holder Material:	Glass, Stainless Steel (316 or equivalent), or Fluoropolymer-coated Stainless Steel
Filter Media:	Teflon, >99.95% efficient at 0.3 um
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	Deionized Water
Recovery Reagents:	Acetone
	Hexane
	Deionized Water
Control Train:	EPA Method 17
Analytical Technique:	Gravimetric

**EPA Method 308** defines procedures to measure methanol emissions from stationary sources. A Teflon™ probe and sample line extract a gas sample at a constant rate from a central sampling point in the stack. A series of midget impingers collect methanol (and ethanol) in deionized water while a silica gel sorbent tube ensures complete retention of target alcohols. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample recovery is performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on handwritten field data sheets. Details of methanol testing are outlined below:

Probe/Sample Line Material:	Teflon™
Impinger Train Material:	Borosilicate glass (midget)
Impinger Reagents:	Deionized water
Sorbent Media:	Silica gel
Control Train:	Rotameter/Dry gas meter
Analytical Technique:	GC/FID

**EPA SW-846 Method 0061** defines procedures to measure hexavalent chromium (Cr<sup>+6</sup>) emissions from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, and 4, a sample gas stream is isokinetically drawn from the emission stream. To attain isokinetic sampling, a sampling nozzle of a known diameter points directly into the oncoming gas stream. The train operator calculates and adjusts the gas sampling rate to match the gas velocity entering the nozzle with the emission stream velocity. Isokinetic sampling eliminates biases from differing particulate aerodynamic characteristics. The unheated sampling train consists a Teflon™ sampling probe and a series of Teflon™ impingers. The first impinger contains 150 mls of a 0.5 N potassium hydroxide solution while impingers 2 and 3 contain 75 mls each. These impingers are followed by two dry Teflon™ impingers and

a glass impinger prepared with desiccant. The reactive nature of  $\text{Cr}^{+6}$  requires special sampling considerations. Absorbing solution from the first impinger is recirculated to the nozzle union to induce stabilization of hexavalent chromium at initial capture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Sample recovery and train clean up are performed after each run using procedures defined by the method to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on handwritten field data sheets. Details of hexavalent chromium testing include:

Nozzle/Probe Material:	Borosilicate glass/Teflon
Impinger Train Material:	Borosilicate glass
Impinger Reagents:	0.5 N Potassium Hydroxide
Recovery Reagents:	HPLC Grade water
Control Train:	Gas meter, orifice, differential pressure gauges, pump, valves, temperature monitors and controllers
Analytical Techniques:	Ion Chromatography/Post Column Reactor (IC/PCR)

**Method 0010** defines procedures to measure principal semi-volatile organic hazardous components from incineration systems. It may also be used to determine particulate emission rates from stationary sources as per EPA Method 5. A gas stream is withdrawn isokinetically from an emission source and collected in a multi-component sampling train. The probe and filter components of the sampling train are heated to 248°F ( $\pm 25^\circ$ ) to prevent moisture condensation and preserve sample integrity. The filtered sample gas stream passes through a borosilicate glass spiral condenser to cool the gas stream to 68°F or less. The cooled gas stream and condensed water enter a water-cooled sorbent cartridge prepared with XAD-2 resin to collect vapor and condensed organics. The water condensate collects in a knock-out trap and a series of impingers. The first two impingers are prepared with deionized water and a third impinger is initially empty. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. The impinger contents are measured and can be discarded or saved for additional analyses. Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on EPA Method 0010 Field Data Sheet, Isokinetic Semi-Volatile Organics Sampling. Sample analysis is performed following EPA Method 8270. Details of particulate testing are outlined below:

Nozzle/Probe Material:	Borosilicate glass or stainless steel
Filter:	Glass-fiber; >99.95% efficient at 0.3 $\mu\text{m}$
Filter holder:	Borosilicate glass
Impinger Train Material:	Borosilicate glass
Collection Sorbent:	XAD-2 Resin
Impinger Reagents:	Deionized water
Recovery Reagents:	Deionized water Acetone Methylene Chloride/Methanol (50:50)
Control Train:	EPA Method 5
Analytical Techniques:	Gas Chromatography/Mass Spectrometry

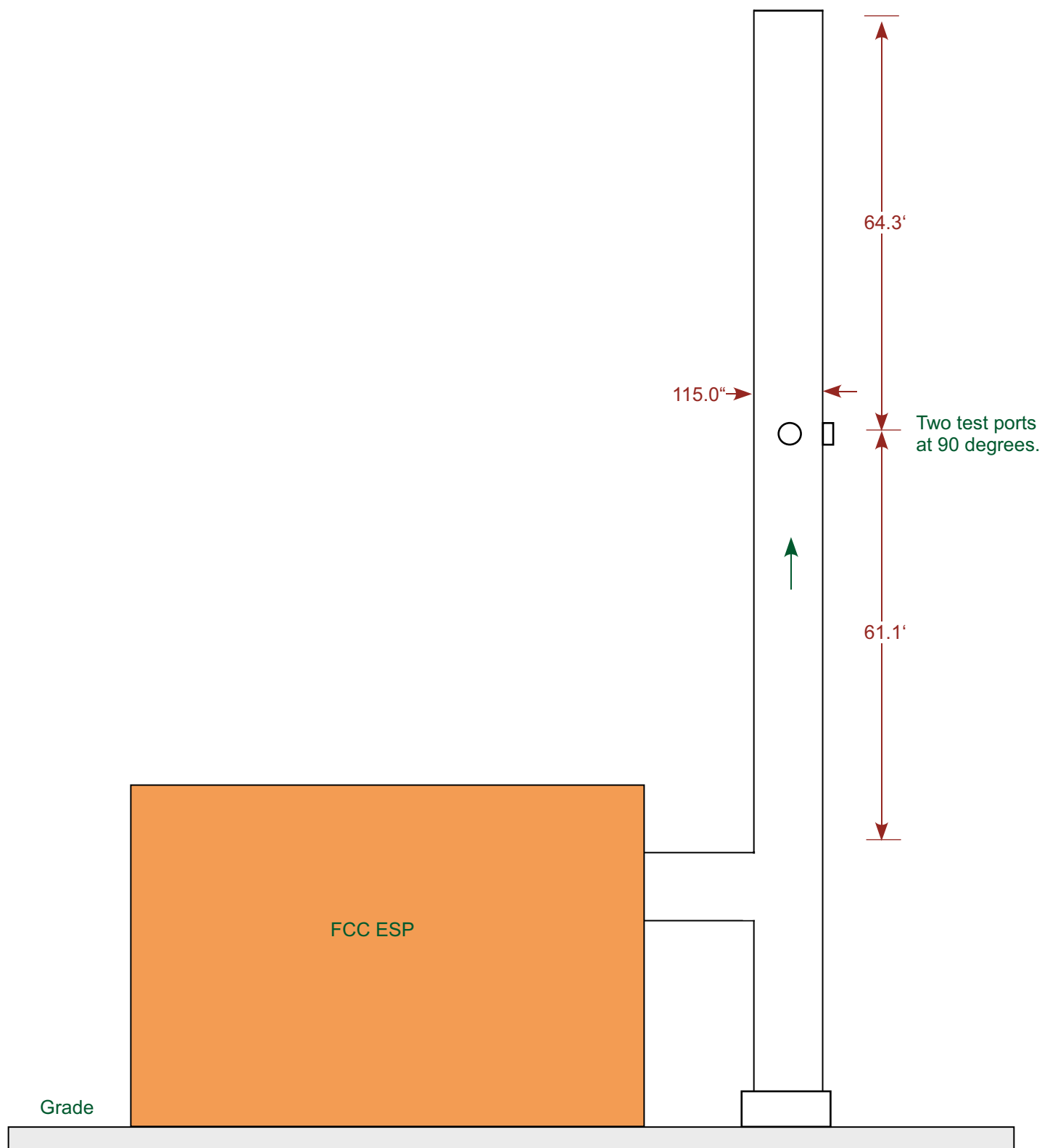
**EPA Method 0011** defines procedures to measure the Destruction and Removal Efficiency (DRE) of aldehydes and ketones emissions from stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, and 4, a sample gas stream is isokinetically drawn from the emission stream. The probe is heated to 248°F (±25°F) to prevent moisture condensation and preserve sample integrity. The sample gas stream passes through a series of impingers to condense water vapor and collect gaseous and particulate constituents. The first, second, and third impingers are prepared with 2,4-Dinitrophenylhydrazine (DNPH) reagent, and the fourth is initially dry. An unheated filter can be added after the second or third impinger of the train as a check on the survival of particulate material through the impinger system. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Impinger contents are collected, concentrated, and then analyzed by high performance liquid chromatography (HPLC). Sample recovery and train clean up are performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on appropriate field data sheets. Details of testing are outlined below:

Nozzle/Probe Material:	Stainless Steel and Borosilicate Glass
Optional Filter Media:	Any suitable medium, 95% efficient at 3 µm with a blank value <0.015 mg formaldehyde/cm <sup>2</sup> .
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	2,4-Dinitrophenylhydrazine reagent (DNPH)
Recovery Reagents:	Methylene chloride Deionized water
Control Train:	Gas meter, orifice, differential pressure gauges, pump, valves, temperature monitors and controllers
Analytical Techniques:	High performance liquid chromatography (HPLC)

**ASTM 6784-02** (Appendix 96) (Ontario Hydro Method) defines procedures to measure elemental, oxidized, particle-bound, and total mercury emissions with concentrations from 0.5 to 100 µg/Nm<sup>3</sup> from coal-fired stationary sources. Using traverse points determined from EPA Method 1 and incorporating procedures from EPA Methods 2, 3, and 4, a sample gas stream is isokinetically withdrawn from the emission stream using a Method 17 (in-stack filter) or Method 5 (out-of-stack filtration) sampling train configuration. The particulate dry fraction collects in the sampling probe and on a quartz or glass-fiber filter. The probe and filter components of the sampling train are heated to 120°C or the flue gas temperature, whichever is greater to prevent moisture condensation and preserve sample integrity. The filtered sample gas stream passes through a series of eight impingers to condense water vapor and collect gaseous constituents. The first, second, and third impingers are prepared with 1 N potassium chloride (KCl) solution to collect oxidized mercury. The fourth impinger contains 5% nitric acid (HNO<sub>3</sub>) and 10% hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), and the fifth, sixth, and seventh impingers are prepared with 4% potassium permanganate (KMnO<sub>4</sub>) and 10% sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) to collect elemental mercury. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Samples are recovered, digested, and then analyzed for mercury using cold-vapor atomic absorption (CVAAS) or fluorescence spectroscopy (CVAFS). Sample recovery and train clean up are

performed after each run using procedures to ensure sample integrity and quantitative recovery. The train operator maintains comprehensive test records on EPA Method 29 Field Data Sheet, Isokinetic Metals Sampling. Details of ASTM 6784-02 testing are outlined below:

Pitot Tube:	S-Type
Nozzle/Probe Material:	Glass
Filter Holder Material:	Borosilicate Glass or PTFE Coated Stainless Steel
Filter Media:	Glass-fiber, >99.95% efficient at 0.3 $\mu\text{m}$
Impinger Train Material:	Borosilicate Glass
Impinger Reagents:	1N KCl 5% $\text{HNO}_3$ 10% $\text{H}_2\text{O}_2$ 4% $\text{KMnO}_4$ 10% $\text{H}_2\text{SO}_4$
Recovery Reagents:	0.1 N $\text{HNO}_3$ 10% $\text{HNO}_3$ 5% $\text{KMnO}_4$ 10% $\text{HN}_2\text{OH} \cdot \text{H}_2\text{SO}_4$
Control Train:	EPA Method 17 or EPA Method 5
Analytical Techniques:	Atomic Absorption or Fluorescence Spectroscopy




## Report Signatures

Field Testing and Reporting Performed by: Pace Analytical Services, Inc.  
Field Services Division  
1700 Elm Street, Suite 200  
Minneapolis, MN 55414

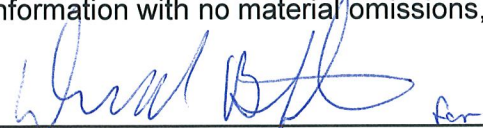
### Field Testing Affirmation

All field testing was performed in accordance with stated test methods subject to modifications and deviations listed herein. Raw field data presented in this report accurately reflects results and information as recorded at the time of tests or otherwise noted.

 for \_\_\_\_\_ Date 11/6/12  
Matt McDermott, QSTI  
Team Lead


### Report Affirmation

To the best of my knowledge, this report accurately represents the compiled field and laboratory information with no material omissions, alterations or misrepresentations.

 for \_\_\_\_\_ Date 11/6/12  
James Trowbridge, QSTI  
Project Manager

### Responsible Charge Affirmation

I have reviewed the information herein and it is approved for distribution.

 for \_\_\_\_\_ Date 11/6/12  
Terence Borgerding, QSTI  
Operations Manager, Air