Casting Emission Reduction Program
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FY 2003 Tasks

Emission Comparison of PCS Parting Spray Greensand Systems
Hill & Griffith Aqua Part II® - Graphite

Technikon # 1410-116 FV

August 2004
(revised for public distribution)

United States Environmental Protection Agency

CISA

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Emission Comparison of PCS Parting Spray Greensand Systems

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Technikon # 1410-116 FV

This report has been reviewed for completeness and accuracy and approved for release by the following:

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The data contained in this report were developed to assess the relative emissions profile of the product or process being evaluated against a standardized baseline process profile. You may not obtain the same results in your facility. Data was not collected to assess casting quality, cost, or producibility.

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Executive Summary

This report contains the results of emission testing to evaluate the pouring, cooling, and shakeout emissions from Test FV, a coreless greensand system without seacoal, using a graphite-based liquid parting spray release agent, Hill & Griffith Aqua Part II® - Graphite. These data are compared to results from Test FI, a baseline using a standard parting spray system. All testing was conducted by Technikon, LLC in its Pre-Production foundry. The emissions results are reported in both pounds of analyte per ton of metal poured and pounds of analyte per pound of parting spray used.

The testing performed involved the collection of continuous air samples over a seventy-five minute period, including the mold pouring, cooling, shakeout, and post shakeout periods. Process and stack parameters were measured and include: the weights of the casting, mold, and parting spray; Loss on Ignition (LOI) values for the mold prior to the test; metallurgical data; and stack temperature, pressure, volumetric flow rate and moisture content. The process parameters were maintained within prescribed ranges in order to ensure the reproducibility of the test's runs. Samples were collected and analyzed for sixty-six (66) target compounds using procedures based on US EPA Method 18. Continuous monitoring of the Total Gaseous Organic Concentration (TGOC) of the emissions was conducted according to US EPA Method 25A.

The mass emission rate of each parameter or target compound was calculated using the Method 25A data or the laboratory analytical results, the measured source data, the weight of parting spray used and the weight of each casting. Results for structural isomers have been grouped and reported as a single entity. For example, ortho-, meta-, and para-xylene are the three (3) structural isomers of dimethyl benzene. The separate isomer results are available in Appendix B of this report. Other "emissions indicators," in addition to the TGOC as Propane, were also calculated. The HC as Hexane results represent the sum of all organic compounds detected and expressed as Hexane. All of the following sums are sub-groups of this measure. The "Sum of VOCs" is based on the sum of the individual target VOCs measured and includes the selected HAPs and selected Polycyclic Organic Material (POMs) listed in the Clean Air Act Amendments of 1990. The "Sum of HAPs" is the sum of the individual target HAPs measured and includes the selected POMs. Finally, the "Sum of POMs" is the sum of all of the polycyclic organic material measured.

Results for the emission indicators are shown in the following tables reported as lbs/tn of metal and lbs/lb of parting spray.

Test Plans FI and FV Emissions Indicators – Lb/Tn Metal

Analytes	TGOC as Propane	HC as Hexane	Sum of VOCs	Sum of HAPs	Sum of POMs
Test FI (Lb/Tn Metal)	0.8651	0.1680	0.0819	0.0643	0.0030
Test FV (Lb/Tn Metal)	0.4172	0.1114	0.0568	0.0494	0.0031

Test Plans FI and FV Emissions Indicators – Lb/Lb Parting Spray

Analytes	TGOC as Propane	HC as Hexane	Sum of VOCs	Sum of HAPs	Sum of POMs
Test FI (Lb/Lb Parting Spray)	0.4717	0.0895	0.0455	0.0358	0.0018
Test FV (Lb/Lb Parting Spray)	0.2138	0.0571	0.0292	0.0254	0.0016

It must be noted that the results from the reference and product testing performed are not suitable for use as emission factors or for other purposes other than evaluating the relative emission reductions associated with the use of alternative materials, equipment, or manufacturing processes. The emissions measurements are unique to the specific castings produced, materials used, and testing methodology associated with these tests. These measurements should not be used as the basis for estimating emissions from actual commercial foundry applications.

1.0 Introduction

1.1 Background

Technikon LLC is a privately held contract research organization located in McClellan, California, a suburb of Sacramento. Technikon offers emissions research services to industrial and government clients specializing in the metal casting and mobile emissions areas. Technikon operates the Casting Emission Reduction Program (CERP). CERP is a cooperative initiative between the Department of Defense (US Army) and the United States Council for Automotive Research (USCAR). Its purpose is to evaluate alternative casting materials and processes that are designed to reduce air emissions and/or produce more efficient casting processes. Other technical partners directly supporting the project include: the American Foundry Society (AFS); the Casting Industry Suppliers Association (CISA); the US Environmental Protection Agency (US EPA); and the California Air Resources Board (CARB).

1.2 Technikon Objectives

The primary objective of Technikon is to evaluate materials, equipment, and processes used in the production of metal castings. Technikon's facility was designed to evaluate alternate materials and production processes designed to achieve significant air emission reductions, especially for the 1990 Clean Air Act Amendment. The facility has two principal testing arenas: a Research Foundry designed to measure airborne emissions from individually poured molds, and a Production Foundry designed to measure air emissions in a continuous full scale production process. Each of these testing arenas has been specially designed to facilitate the collection and evaluation of airborne emissions and associated process data.

It must be noted that the reference and product testing performed is not suitable for use as emission factors or for purposes other than evaluating the relative emission reductions associated with the use of alternative materials, equipment, or processes. The emissions measurements are unique to the specific castings produced, materials used, and testing methodology associated with these tests, and should not be used as the basis for estimating emissions from actual commercial foundry applications.

1.3 Report Organization

This report has been designed to document the methodology and results of a specific test plan that was used to evaluate VOC emissions from a coreless greensand system. Section 2 of this report includes a summary of the methodologies used for data collection and analysis, emission calculations, QA/QC procedures, and data management and reduction methods. Specific data collected during this test are summarized in Section 3 of this report, with detailed data included in Appendix B of this report. Section 4 of this report contains a discussion of the results.

The raw data for this test series are included in a data binder that is maintained at the Technikon facility.

1.4 Specific Test Plan and Objectives

Table 1-1 provides a summary of the test plans. The details of the approved test plans are included in Appendix A.

Table 1-1 Test Plan Summary

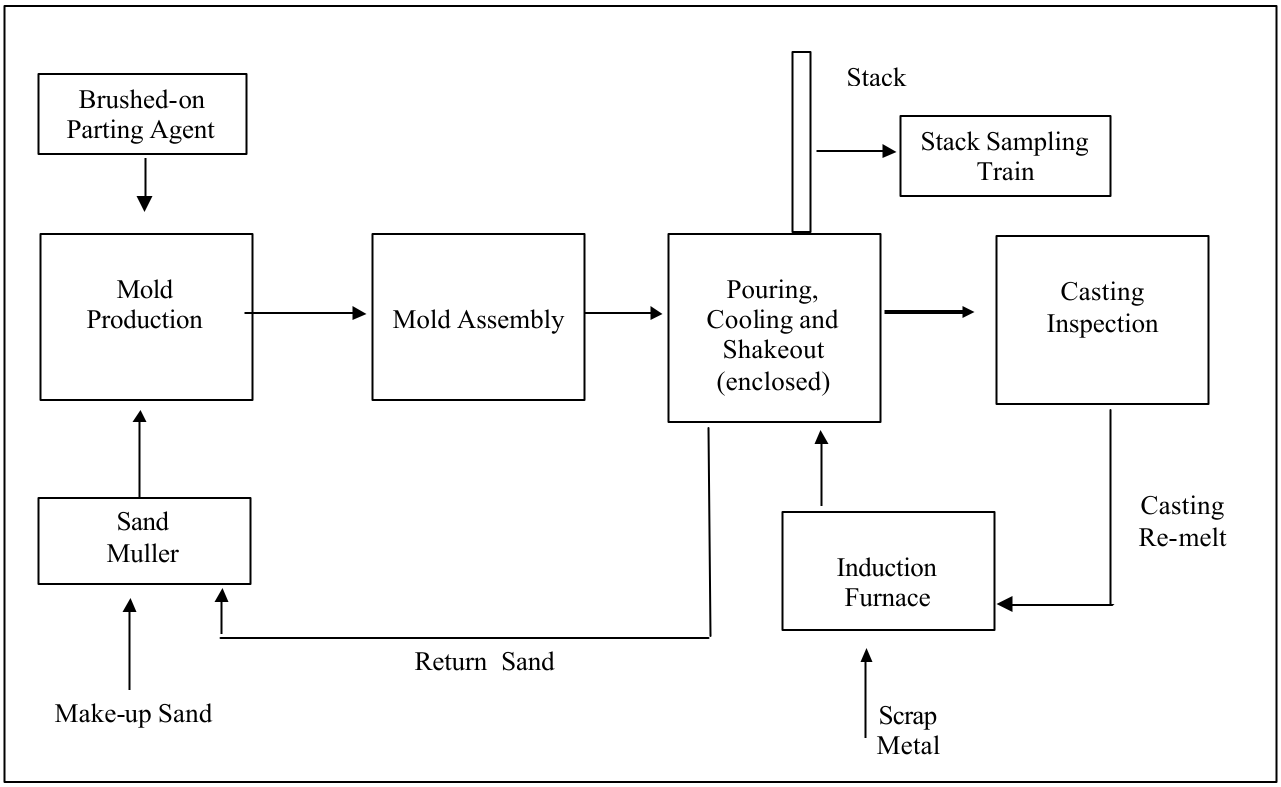
	Test Plan	Test Plan
Type of Process tested	Pattern Spray Greensand Baseline	Pattern Spray Greensand Product Test
Test Plan Number	1410 121 FI	1410 116 FV
Parting Spray System	H & G Y-250	H & G AQUA PART II® - Graphite
Metal Poured	Iron	Iron
Casting Type	4-on Star	4-on Star
Number of molds poured	9	9
Test Dates	7/14/03 > 7/17/03	4/19/04 > 4/23/04
Emissions Measured	TGOC as Propane, HC as Hexane, 66 Organic HAPs and VOCs	TGOC as Propane, HC as Hexane, 66 Organic HAPs and VOCs
Process Parameters Measured	Total Casting, Mold, and Parting Spray Weights; Metallurgical data, % LOI; Stack Temperature, Moisture Content, Sand Temperature, Pressure, and Volumetric Flow Rate	Total Casting, Mold, and Parting Spray Weights; Metallurgical data, % LOI; Stack Temperature, Moisture Content, Sand Temperature, Pressure, and Volumetric Flow Rate

2.0 Test Methodology

2.1 Description of Process and Testing Equipment

Figure 2-1 is a diagram of the Pre-Production Foundry process equipment.

Figure 2-1 Pre-Production Foundry Layout Diagram

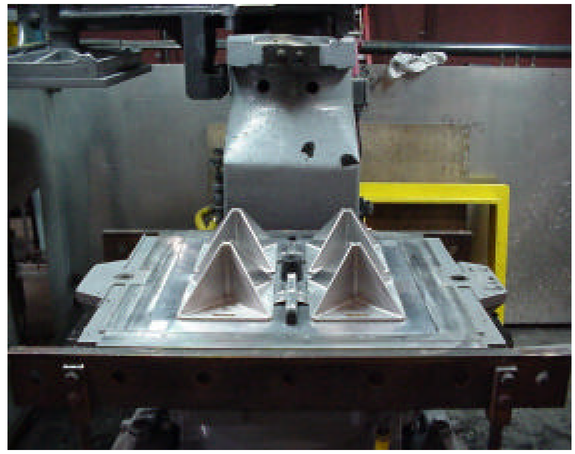


2.2 Description of Testing Program

The specific steps used in this sampling program are summarized below:

1. **Test Plan Review and Approval:** The proposed test plan was reviewed and approved by the Technikon staff.

2. **Mold and Metal Preparation:** The 4-on star greensand (without seacoal) molds are prepared to a standard composition by the Technikon production team. The parting spray is applied to the mold pattern at approximately forty (40) grams per mold. Iron is melted in a 1000 lb. Ajax induction furnace. The amount of metal melted is determined from the poured weight of the casting and the number of molds to be poured. The metal composition is prescribed by a metal composition worksheet. The weight of metal poured into each mold is recorded on the process data summary sheet.

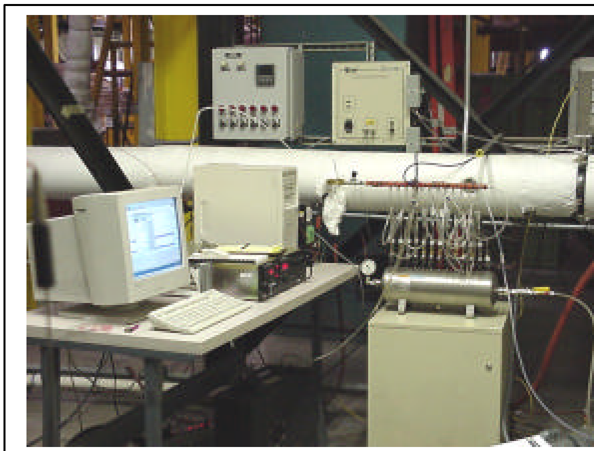


4-On Star Pattern

Total Enclosure Test Stand

3. **Individual Sampling Events:** Replicate tests are performed on nine (9) mold packages. The mold packages are placed into an enclosed test stand heated to approximately 85°F. Iron is poured through an opening in the top of the emission enclosure.

Continuous air samples are collected during the forty-five minute pouring and cooling process, during the fifteen minute shakeout of the mold, and for an additional fifteen minute period following shakeout. The total sampling time is seventy-five minutes.



Method 25A (TGOC) and
Method 18 Sampling Train

4. **Process Parameter Measurements:** Table 2-1 lists the process parameters that are monitored during each test. The analytical equipment and methods used are also listed.

Table 2-1 Process Parameters Measured

Parameter	Analytical Equipment and Methods
Mold Weight	Cardinal 748E platform scale (Gravimetric)
Casting Weight	Cardinal 748E platform scale (Gravimetric)
Muller water weight	Ohaus MP2 Scale (Gravimetric)
Parting Liquid Weight	Mettler SB12001 Scale (Gravimetric)
Volatiles	Mettler SB12001 Scale (AFS Procedure 2213-00-S)
LOI, % at Mold and Shakeout	Denver Instruments XE-100 Analytical Scale (AFS procedure 5100-00-S)
Metallurgical Parameters	
Pouring Temperature	Electro-Nite DT 260 (T/C Immersion Pyrometer)
Carbon/Silicon Fusion Temperature	Electro-Nite Datacast 2000 (Thermal Arrest)
Alloy Weights	Ohaus MP2 Scale
Mold Compactability	Dietert 319A Sand Squeezer (AFS Procedure 2221-00-S)

5. **Air Emissions Analysis:** The specific sampling and analytical methods used in the Pre-Production Foundry tests are based on the US EPA reference methods shown in Table 2-2. The details of the specific testing procedures and their variance from the reference methods are included in the Technikon Standard Operating Procedures.

Table 2-2 Sampling and Analytical Methods

Measurement Parameter	Test Method*
Port Location	EPA Method 1
Number of Traverse Points	EPA Method 1
Gas Velocity and Temperature	EPA Method 2
Gas Density and Molecular Weight	EPA Method 3a
Gas Moisture	EPA Method 4, gravimetric
HAPs Concentration	EPA Method 18, TO11
VOCs Concentration	EPA Method 18, 25A, TO11

*These methods were specifically modified to meet the testing objectives of the CERP Program.

6. **Data Reduction, Tabulation and Preliminary Report Preparation:** The analytical results of the emissions tests provide the mass of each analyte in the sample. The total mass of the analyte emitted is calculated by multiplying the mass of analyte in the sample times the ratio of total stack gas volume to sample volume. The total stack gas volume is calculated from the measured stack gas velocity and duct diameter, and corrected to dry standard conditions using the measured stack pressures, temperatures, gas molecular weight and moisture content. The total mass of analyte is then divided by the weight of the parting spray and/or the weight of the casting used to provide emissions data in pounds of analyte per pound of parting spray and pounds of analyte per ton of metal.

   The results of each of the sampling events are included in Appendix B of this report. The results of each test are also averaged and are shown in Tables 3-1 and 3-2.

7. **Report Preparation and Review:** The Preliminary Draft Report is reviewed by the Process Team and Emissions Team to ensure its completeness, consistency with the test plan, and adherence to the prescribed QA/QC procedures. Appropriate observations, conclusions and recommendations are added to the report to produce a Draft Report. The Draft Report is reviewed by the Vice President-Measurement Technologies, the Vice President-Operations, the Manager-Process Engineering, and the Technikon President. Comments are incorporated into a draft Final Report prior to final signature approval and distribution.

2.3 Quality Assurance and Quality Control (QA/QC) Procedures

Detailed QA/QC and data validation procedures for the process parameters, stack measurements, and laboratory analytical procedures are included in the Technikon Emissions Testing and Analytical Testing Standard Operating Procedures. In order to ensure the timely review of critical quality control parameters, the following procedures are followed:

- Immediately following the individual sampling events performed for each test, specific process parameters are reviewed by the Manager - Process Engineering to ensure that the parameters are maintained within the prescribed control ranges. Where data are not within the prescribed ranges, the Manager - Process Engineering and the Vice President - Operations determine whether the individual test samples should be invalidated or flagged for further analysis following review of the laboratory data.

- The source (stack) and sampling parameters, analytical results and corresponding laboratory QA/QC data are reviewed by the Emissions Measurement Team to confirm the validity of the data. The VP-Measurement Technologies reviews and approves the recommendation, if any, that individual sample data should be invalidated. Invalidated data are not used in subsequent calculations.

3.0 Test Results

The average emission results, in pounds per ton of metal and pounds per pound of parting spray are presented in Tables 3-1 and 3-2 respectively. The tables include the individual target compounds that comprise at least 95% of the total VOCs measured, along with the corresponding Sum of VOCs, Sum of HAPs, and Sum of POMs. The tables also include carbon dioxide, carbon monoxide, TGOC as propane, and HC as hexane.

Table 3-3 compares the average process parameter for the baseline FI and the current test FV.

Figures 3-1 to 3-3 present the five emissions indicators and selected individual HAP and VOC emissions data from Table 3-1 in graphical form based on metal weight.

Figures 3-4 to 3-6 present the five emission indicators and selected individual HAP and VOC emissions data from Table 3-2 in graphical form based on parting spray weight.

Appendix B contains the detailed data including the results for all analytes measured. Table 3-3 includes the averages of the key process parameters. Detailed process data are presented in Appendix C.

Method 25A charts for the tests are included in Appendix D of this report. The charts are presented to show the VOC profile of emissions for each pour.

Table 3-1 Summary of Test Plans FI and FV Average Results – Lb/Tn Metal

Analytes	Test FI (Lb/Tn Metal)	Test FV (Lb/Tn Metal)	% Change From Test FI
TGOC as Propane	0.8651	0.4172	**-52**
HC as Hexane	0.1680	0.1114	**-34**
Sum of VOCs	0.0819	0.0568	**-31**
Sum of HAPs	0.0643	0.0494	**-23**
Sum of POMs	0.0030	0.0031	3
Individual Organic HAPs			
Benzene	0.0304	0.0256	**-16**
Toluene	0.0106	0.0068	**-36**
o,m,p-Xylene	0.0095	0.0055	**-42**
Acetaldehyde	0.0030	0.0041	**37**
Naphthalene	0.0023	0.0023	0
Hexane	0.0023	0.0012	**-48**
Formaldehyde	0.0018	0.0013	**-28**
Ethylbenzene	0.0015	0.0011	**-27**
Styrene	0.0010	0.0013	**30**
Methylnaphthalenes	0.0008	0.0008	0
Other VOCs			
Trimethylbenzenes	0.0044	0.0027	**-39**
Heptane	0.0044	0.0015	**-66**
Tetradecane	0.0029	0.0018	**-38**
Octane	0.0022	ND	**NA**
Ethyltoluenes	0.0018	0.0008	**-56**
Other Analytes			
Carbon Dioxide	18.72	3.107	**-83**
Carbon Monoxide	ND	1.354	**NA**

ND: Non Detect; NA: Not Applicable

Individual results constitute >95% of mass of all detected VOCs.

All "Other Analytes" are not included in the sum of HAPs or VOCs.

"Percent Change from Test FI" values in bold have a 95% probability that the differences in the average values were not from test variability.

Table 3-2 Summary of Test Plans FI and FV Average Results – Lb/Lb Parting Spray

Analytes	Test FI (Lb/Lb Parting Spray)	Test FV (Lb/Lb Parting Spray)	%Change From Test FI
TGOC as Propane	0.4717	0.2138	**-55**
HC as Hexane	0.0895	0.0571	**-36**
Sum of VOCs	0.0455	0.0292	**-36**
Sum of HAPs	0.0358	0.0254	**-29**
Sum of POMs	0.0018	0.0016	-11
Individual Organic HAPs			
Benzene	0.0167	0.0132	**-21**
Toluene	0.0058	0.0035	**-40**
o,m,p-Xylene	0.0052	0.0028	**-46**
Acetaldehyde	0.0016	0.0021	**31**
Hexane	0.0014	0.0006	**-57**
Naphthalene	0.0013	0.0012	-8
Formaldehyde	0.0010	0.0007	**-30**
Ethylbenzene	0.0008	0.0006	**-25**
Styrene	0.0005	0.0007	**40**
Other VOCs			
Trimethylbenzenes	0.0024	0.0014	**-42**
Heptane	0.0024	0.0008	**-67**
Tetradecane	0.0017	0.0009	**-47**
Octane	0.0012	ND	NA
Ethyltoluenes	0.0010	0.0004	**-60**
Other Analytes			
Carbon Dioxide	10.29	1.602	**-84**
Carbon Monoxide	ND	0.6960	**NA**

ND: Non Detect; NA: Not Applicable

Individual results constitute >95% of mass of all detected VOCs.

All "Other Analytes" are not included in the sum of HAPs or VOCs.

"Percent Change from Test FI" values in bold have a 95% probability that the differences in the average values were not from test variability.

Table 3-3 Summary of Test Plans FI and FV Average Process Parameters

No Coal Greensand PCS Pattern Spray Tests	Test FI	Test FV
Cast Weight- All Metal Inside Mold (lbs.)	97.9	89.9
Pouring Time (sec.)	17	19
Pouring Temp (°F)	2682	2634
Pour Hood Process Air Temp at Start of Pour (°F)	88	88
Muller Batch Weight (lbs.)	902	899
GS Mold Sand Weight (lbs.)	658	659
Mold Compactability (%)	48	52
Mold Temperature (°F)	89	72
Average Green Compression (psi)	13.58	13.27
GS Compactability (%)	44	43
GS Moisture Content (%)	1.92	1.75
GS Clay Content (%)	6.94	6.76
MB Clay reagent, ml	27.3	27.1
1800°F LOI - Mold Sand (%)	1.11	0.80
900°F Volatiles (%)	0.39	0.38
Liquid Parting Spray (grams)	40.6	39.8

Rank Order		FK Run #	FV Run #
Best	1	1	5
	2	2	4
	3	3	
	4	6	
	5	8	9
	6	5	7
	7	9	8
	8	7	10
Worst	9	4	6
			12
			11

Figure 3-1 Emission Indicators from Test Series FI and FV – Lb/Tn Metal

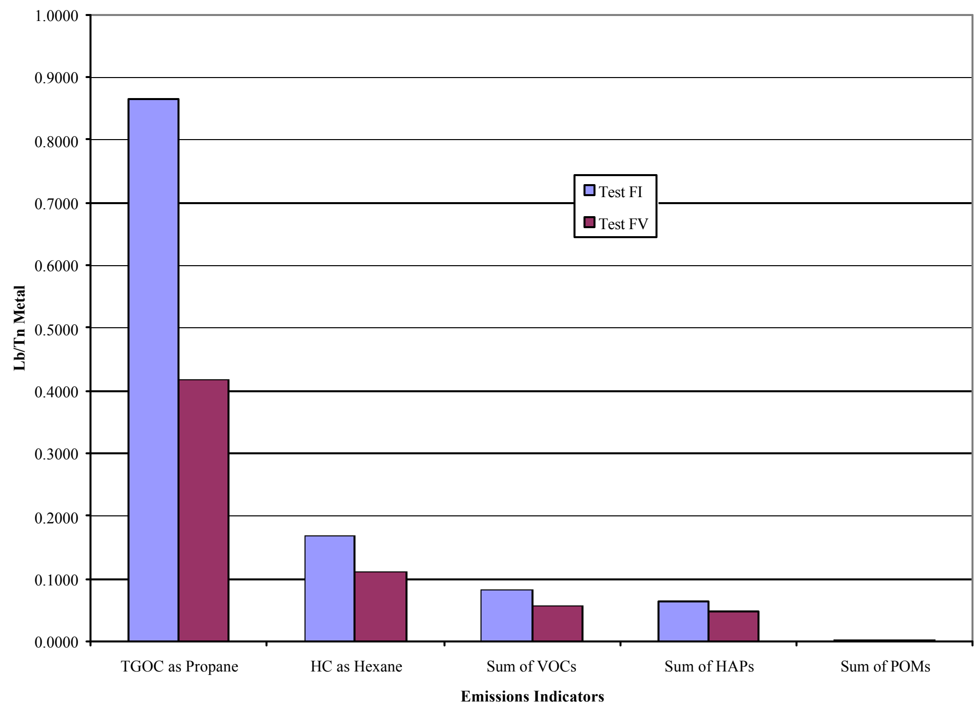


Figure 3-2 Selected HAP Emissions from Test Series FI and FV – Lb/Tn Metal

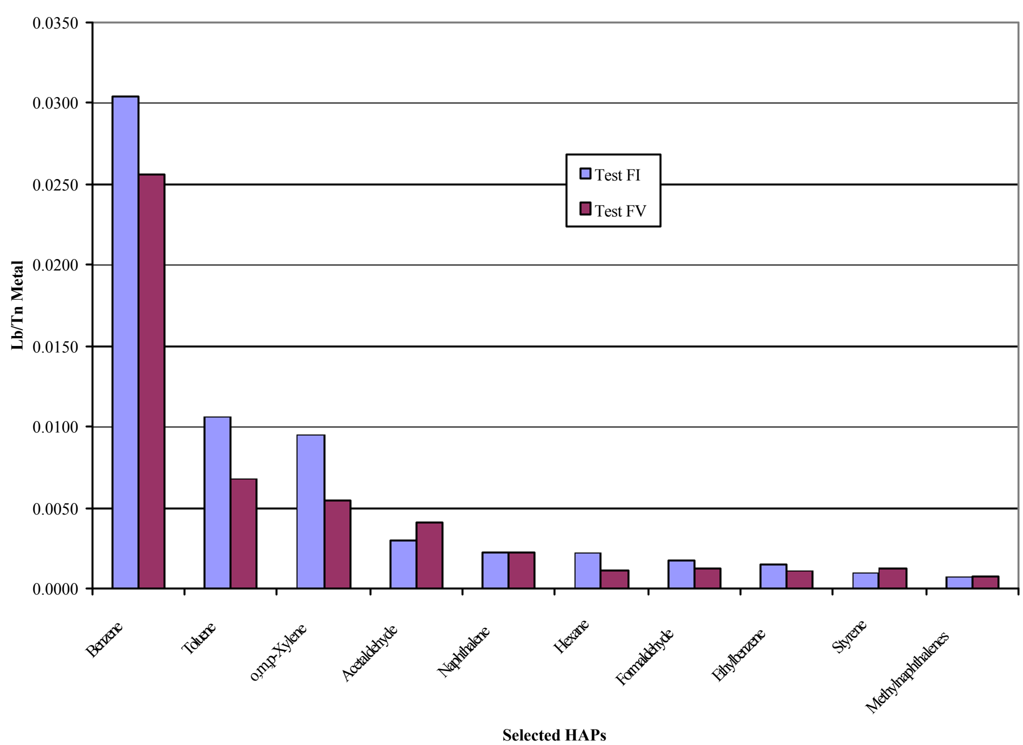


Figure 3-3 Selected VOC Emissions from Test Series FI and FV – Lb/Tn Metal

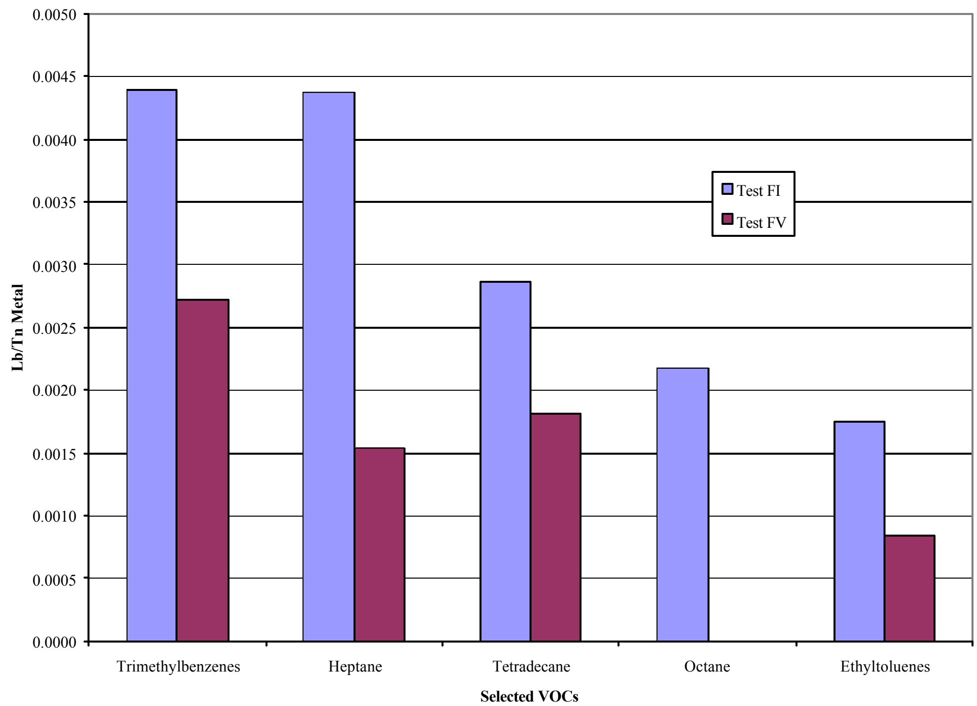


Figure 3-4 Emission Indicators from Test Series FI and FV – Lb/Lb Parting Spray

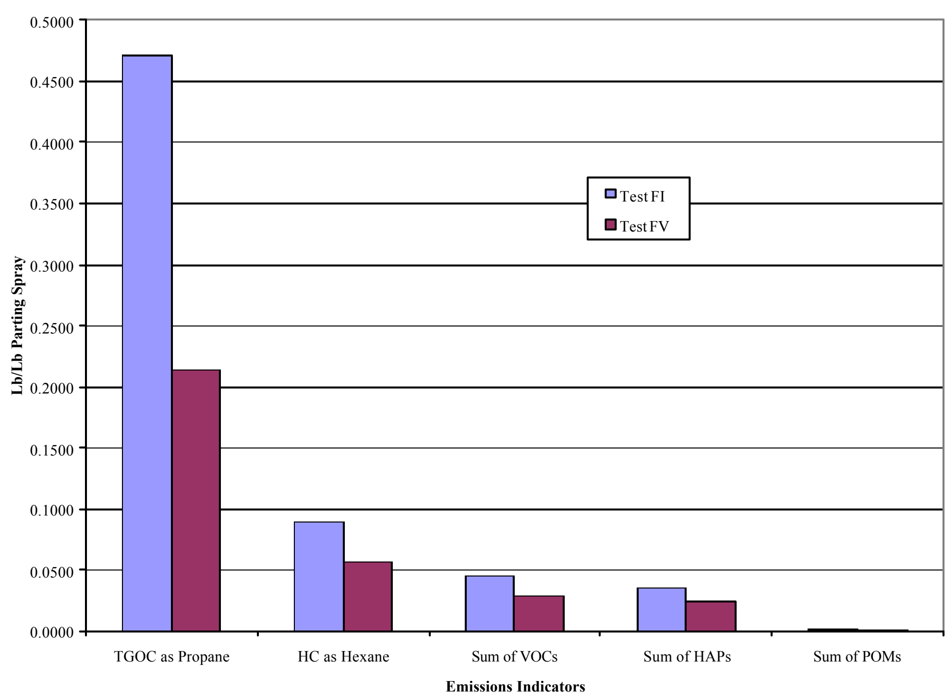


Figure 3-5 Selected HAP Emissions from Test Series FI and FV – Lb/Lb Parting Spray

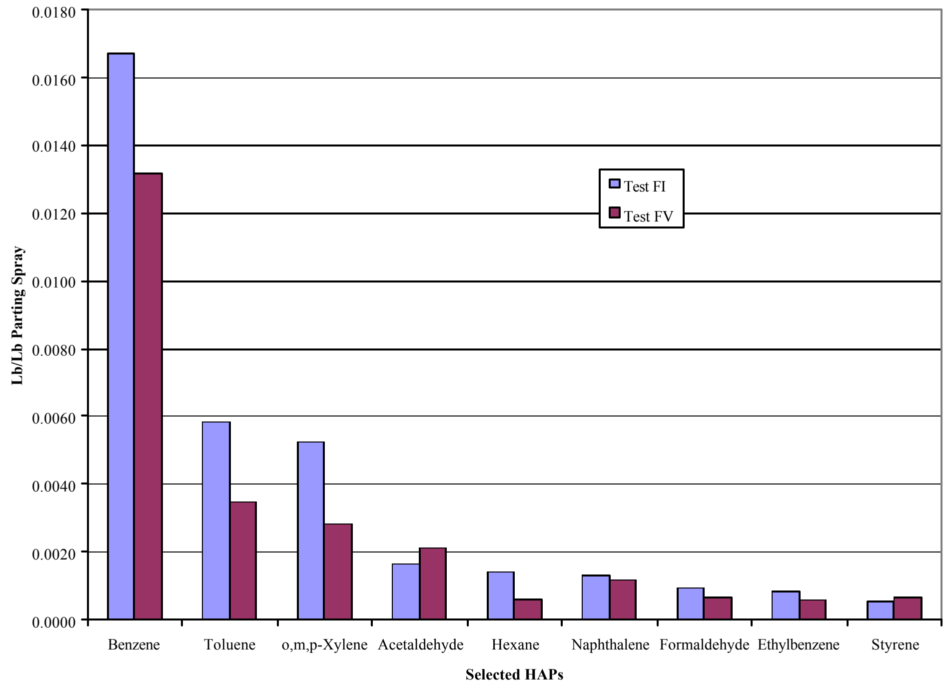
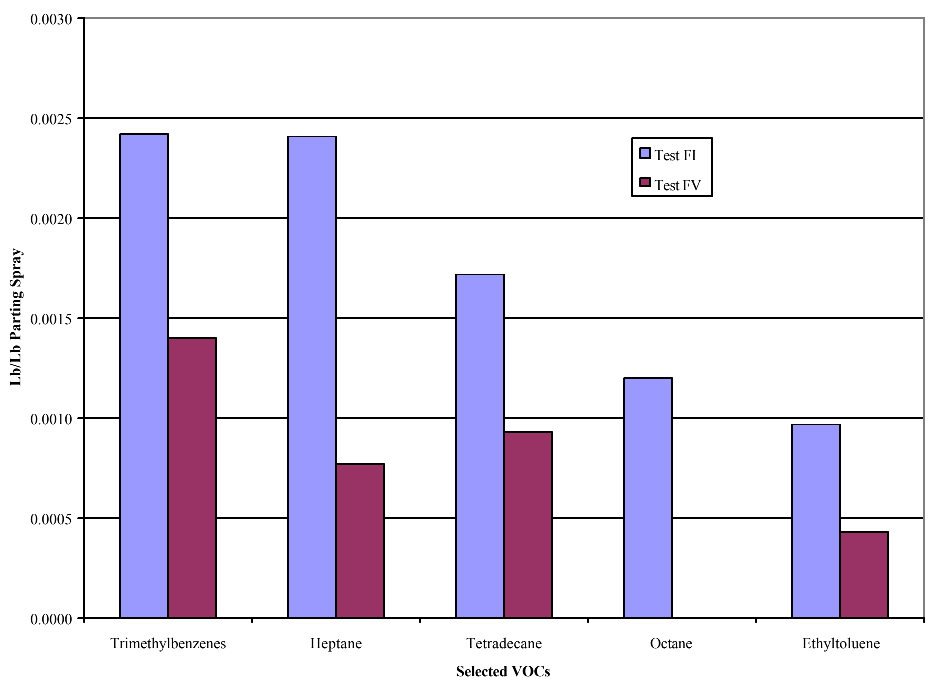


Figure 3-6 Selected VOC Emissions from Test Series FI and FV – Lb/Lb Parting Spray



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4.0 Discussion of Results

The sampling and analytical methodologies were the same for Test Plans FI and FV except for the determination of carbon monoxide and carbon dioxide. These analytes were collected in a Tedlar bag for offsite analysis on Test FI and were determined on-line with NIST traceable monitors for Test FV. The on-line monitors provide significantly more accurate data than the bag samples.

Observation of measured process parameters indicates that the tests were run within an acceptable range. In Tables 3-1 and 3-2 (and the paragraph below), the "% Change from Test FI" emissions values presented in **bold** letters have a greater than 95% probability that the differences in the average values were not the result of variability in the test protocol determined from T-Statistic calculations. Tables showing the T-Statistics calculated are found in Appendix B.

The results of the tests performed for the comparison of Test FV to Test FI show a **52%** reduction in TGOC (THC) as propane, a **34%** reduction in HC as hexane, a **31%** reduction in Sum of VOCs, a **23%** reduction in Sum of HAPs, and a **3%** increase in Sum of POMs when expressed in pounds per ton of metal. Benzene was found to be the largest contributor to the total HAPs and VOCs for both Tests FI and FV and a **16%** reduction in benzene was found for Test FV compared to the baseline Test FI.

Two methods were employed to measure undifferentiated hydrocarbon emissions, TGOC (THC) as propane, performed in accordance with EPA Method 25A, and HC as hexane. EPA Method 25A, TGOC (as propane), is weighted to the detection of more volatile hydrocarbon species, beginning at C1 (methane), with results calibrated against a three-carbon alkane (propane). HC as hexane is weighted to the detection of relatively less volatile compounds. This method detects hydrocarbon compounds in the alkane range between C6 and C16, with results calibrated against a six-carbon alkane (hexane).

Target analyte reporting limits expressed in both pounds per ton of metal and pounds per pound of parting spray are shown in Appendix B.

See Appendix C for a visual comparison of castings produced with Aquapart II – graphite compared to the combination greensand baseline FK.

Casting surface appearance was somewhat inferior to the casting appearance baseline FK. Comparison was made to FK for casting appearance rather than FI because the purpose of this pattern release material is to provide a good casting surface while reducing emissions.

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APPENDIX A APPROVED TEST PLANS AND SAMPLE PLANS FOR TEST SERIES FI AND FV

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TECHNIKON TEST PLAN

> **CONTRACT NUMBER:** 1410 **TASK NUMBER:** 1.2.1 **Series:** FI
> **SAMPLE EVENTS:** Estimated 9
> **SITE**: X **PRE-PRODUCTION** ___ **FOUNDRY**
> **TEST TYPE:** Pattern spray greensand baseline
> **METAL TYPE:** Class 30 gray iron
> **MOLD TYPE:** 4-on coreless star greensand with no seacoal and petroleum oil liquid parting
> **NUMBER OF MOLDS**: 9 + pattern spray conditioning.
> **CORE TYPE:** None
> **TEST DATE:** **START**: 07 July 2003
FINISHED: 18 July 2003

TEST OBJECTIVES:

Create Pouring, Cooling, and Shakeout emissions baseline for liquid parting with coal-less greensand mix. Results shall be reported as pounds of emission/pound of liquid parting and pounds of emission /ton of metal poured.

VARIABLES:

The pattern will be the 4-on star. The mold will be made with Wexford W450 sand, 7% western and southern bentonite in a 5:2 ratio, no seacoal, tempered to 40-45% compactability, mechanically compacted. An oil based liquid parting Hill & GriffithY-250 will be used. The molds will be maintained at 80-90^{o}F prior to pouring. The sand heap will be maintained at 900 pounds. Molds will be poured with iron at 2680 +/- 10^{o}F. Mold cooling will be 45minutes follow by 15 minutes of shakeout, or until no more material remains to be shaken out. The initial process air temperature will be maintained at 85-90^{o}F. Emission testing will be 75 minutes.

BRIEF OVERVIEW:

The 4 on star pattern is a new test pattern that will be used as a baseline for pattern release agent product comparisons. The new Osborn Jolt squeeze machine will be an improvement over previously hand rammed molds, which are inherently inconsistent. This test is to establish baseline line emissions for this pattern and the Osborn machine combination with parting oil and no seacoal.

SPECIAL CONDITIONS:

The process will include rigorous maintenance of the size of sand heap and maintenance of the material and testing environmental temperatures to reduce seasonal and daily temperature-dependent influence on the emissions

Series FI

PCS Pattern Spray Baseline with No-coal Greensand & Mechanized Molding

Process Instructions

A. Experiment:

1. Create an emission baseline for pattern spray.

   a. The molds shall be started with all virgin Wexford W450 sand, bonded with 7% Western & Southern Bentonite in the ratio of 5:2.
   b. The molds shall be tempered with potable water to 40-45% compactability, poured at constant weight, temperature, surface area, & shape factor. This test will recycle the same mold material, replacing burned clay with new materials after each casting cycle.

B. Materials:

1. Mold sand: Virgin mix of Wexford W450 lake sand, western and southern bentonites in ratio of 5:2, and potable water per recipe. No seacoal.
2. Core: None
3. Metal: Class 30-35 gray cast iron poured at 2680^{o}F.
4. Pattern Spray: Hill & GriffithY-250 petroleum based.

Caution: Observe all safety precautions attendant to these operations as delineated in the Pre-production operating and safety instruction manual.

5. The following test shall be conducted:

   a. Sand batch: Single sand batch to be used for all FI molds.
   b. The recycled sand heap shall be maintained at 900+-10 pounds
   c. FI001: Virgin mix as described above, un-vented mold.
   d. FI002-FI0XX: Re-mulled, reconstituted greensand, potable water, un-vented molds.
   e. 20 grams of Hill & GriffithY-250 parting spray shall be brushed on each mold half.
   f. Emission absorption tube sampling will begin after THC determination of stability of parting spray content.

C. Sand preparation

1. Start up batch: make 1, FI001.

   a. Thoroughly clean the pre-production muller elevator and molding hoppers.

- **b.** Weigh and add 1225 +/- 10 pounds of new Wexford W450 Lakesand, per the recipe, to the running pre-production muller.
- **c.** Add 5 pounds of potable to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.
- **d.** Add the clays slowly to the muller to allow them to be distributed throughout the sand mass in proportion to the sand weight per the recipe for this test.
- **e.** Dry mull for about 3 minutes to allow distribution and some grinding of the clays to occur.
- **f.** Temper the sand-clay mixture slowly, with potable water, to allow for distribution.
- **g.** After about 2 gallons of water have been added allow 30 seconds of mixing then start taking compactability test samples.
- **h.** Based on each test add water incrementally to adjust the temper. Allow 1 minute of mixing. Retest. Repeat until the compactability is in the range 40-45%.
- **i.** Discharge the sand into the mold station elevator.
- **j.** Grab sufficient sample after the final compactability test to fill a quart zip-lock bag. Label bag with the test series and sequence number, date, and time of day and deliver it immediately to the sand lab for analysis
- **k.** Record the total sand mixed in the batch, the total of each type of clay added to the batch, the amount of water added, the total mix time, the final compactability and sand temperature at charge and discharge.
- **l.** The sand will be immediately characterized for Methylene Blue Clay, Moisture content, Compactability, Green Compression strength, 1800^{o}F loss on ignition (LOI), and 900^{o}F volatiles. Each volatile and LOI test requires a separate 50 gram sample from the collected sand.
- **m.** Empty the extra greensand from the mold hopper into a clean empty dump hopper whose tare weight is known. Set this sand aside to be used to maintain the recycled batch at 900+/-10 pounds

2. Re-mulling: FI002

- **a.** Add to the sand recovered from poured mold FI001sufficient pre-blended sand so that the sand batch weight is 900 +/- 10 pounds. Record the sand weight.
- **b.** Return the sand to the muller and dry blend for about one minute.
- **c.** Add the clays, as directed by the process engineering staff, slowly to the muller to allow them to be distributed throughout the sand mass.
- **d.** Add 5 pounds of water to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.
- **e.** Follow the above procedure beginning at B.1.f.

3. Re-mulling: FI003-FI0XX

- **a.** Add to the sand recovered from the previous poured mold, mold machine spill sand, the residual mold hopper sand and sufficient pre-blended sand to total 900 +/- 10 pounds.
- **b.** Return the sand to the muller and dry blend for about one minute.

c. Add the clays, as directed by the process engineering staff, slowly to the muller to allow them to be distributed throughout the sand mass.
d. Add 5 pounds of water to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.
e. Follow the above procedure beginning at B.1.f.

D. Molding: 4- on star pattern.

1. Pattern preparation:

a. Inspect and tighten all loose pattern and gating pieces.
b. Repair any damaged pattern or gating parts.

2. Mount the drag 4-on star pattern with gating into the mold machine bolster and bolt it down tightly.

a. Weigh a 500 ml beaker, 200 ml of Hill & GriffithY-250 parting spray and a 1-inch brush immersed in the parting spray.
b. Incrementally brush parting spray evenly over each side of the entire pattern until the gross weight of the beaker, residual parting spray, and the immersed brush are twenty (20) grams lighter that in C.2.a.
c. Repeat for the other side of the pattern in turn.
d. Repeat C.2.b-c for each mold cycle.

3. Mount a cope follower board containing a pour cup pattern to the underside of the squeeze head plate.
4. Check the alignment of the pour cup by manually raising the table using the squeeze by-pass valve at the bottom rear of the machine until the sprue pierces the pour cup pattern. Move the pour cup pattern as necessary.
5. Remove the sprue if making a mold drag half. Leave it attached if making a cope half.
6. Use the overhead crane to place the pre-weighed drag/cope flask on the mold machine table, parting line surface down.
7. Locate a 24 x 24 x4 inch deep wood upset on top of the flask.
8. Make the green sand mold on the Osborn Whisper Ram Jolt-Squeeze mold machine

WARNING: Only properly trained personnel may operate this machine. Proper personal protective equipment must be worn at all times while operating this equipment, including safety glasses with side shields and a properly fitting hard hat. Industrial type boots are highly recommended.

WARNING: Stand clear of the mold machine table and swinging head during the following operation or serious injury or death could result.

a. Open the air supply to the mold machine.

WARNING: The squeeze head may suddenly swing to the outboard side or forward. Do not stand in the outer corners of the molding enclosure.

- **b.** On the operator's panel turn the POWER switch to ON.
- **c.** Turn the RAM-JOLT-SQUEEZE switch to ON.
- **d.** Turn the DRAW UP switch to AUTO
- **e.** Set the PRE-JOLT timer to 4-5 seconds.
- **f.** Set the squeeze timer to 8 seconds.
- **g.** Manually riddle a half to one inch or so of sand on the pattern using a ¼ inch mesh riddle. Source the sand from the overhead mold sand hopper by actuating the CHATTER GATE valve located under the operators panel.
- **h.** Fill the 24 x 24 x 10 inch flask and the upset with greensand from the overhead molding hopper.
- **i.** Manually level sand in the upset. By experience manually adjust the sand depth so that the resulting compacted mold is fractionally above the flask only height.

WARNING: Failure to stand clear of the molding table and flasks in the following operations could result in serious injury as this equipment is about to move up and down with great force.

- **j.** Initiate the settling of the sand in the flask by pressing the PRE-JOLT push button. Allow this cycle to stop before proceeding.

WARNING: Stand clear of the entire mold machine during the following operations. Several of the machine parts will be moving.
Failure to stand clear could result in severe injury even death.

- **k.** Using both hands initiate the automatic machine sequence by simultaneously pressing and releasing the green push buttons on either side of the operators panel. The machine will squeeze and jolt the sand in the flask and then move the squeeze head to the side.

WARNING: Do no re-approach the machine until the squeeze head has stopped at the side of the machine.

- **l.** Remove the upset and set it aside.
- **m.** Screed the bottom of the mold flat if required.
- **n.** Press and release the LOWER DRAW/STOP push button to separate the flask and mold from the pattern.
- **o.** Use the overhead crane to lift the mold half and remove it from the machine.
- **p.** Finally, press and release the draw down pushbutton to cause the draw frame to return to the start position.

9. If the mold half is a drag, roll it parting line side up, set it on the floor, blow it out, and cover it to keep it clean.
10. Close the cope over the drag being careful not to crush anything.
11. Clamp the flask halves together.
12. Weigh and record the weight of the closed un-poured mold, the pre-weighed flask, and the sand weight by difference

13. Deliver the mold to the previously cleaned shakeout to be poured. Do not cover the mold with the emission hood.

E. Shakeout.

1. After the cooling time prescribed in the test plan turn on the shakeout unit and run it for until the greensand has passed into the hopper below.
2. Turn off the shakeout, remove the flask with casting, and recover the sand from the hopper and surrounding floor.
3. Weigh and record the metal poured and the total sand weight recovered and rejoined with the left over mold sand from the molding hopper.

F. Melting:

1. Initial charge:

   a. Charge the furnace according to the heat recipe.
   b. Place part of the steel scrap on the bottom, followed by carbon alloys, and the balance of the steel.
   c. Place a pig on top on top.
   d. Bring the furnace contents to the point of beginning to melt over a period of 1 hour at reduced power.
   e. Add the balance of the metallics under full power until all is melted and the temperature has reached 2600 to 2700°F.
   f. Slag the furnace and add the balance of the alloys.
   g. Raise the temperature of the melt to 2700°F and take a DataCast 2000 sample. The temperature of the primary liquidus (TPL) must be in the range of 2200-2350°F.
   h. Hold the furnace at 2500-2550°F until near ready to tap.
   i. When ready to tap raise the temperature to 2700°F and slag the furnace.
   j. Record all metallic and alloy additions to the furnace, tap temperature, and pour temperature. Record all furnace activities with an associated time.

2. Back charging.

   a. Back charge the furnace according to the heat recipe,
   b. Charge a few pieces of steel first to make a splash barrier, followed by the carbon alloys.
   c. Follow the above steps beginning with E.1.e.

G. Emptying the furnace.

1. Pig the extra metal only after the last emission measurement is complete to avoid contaminating the air sample.
2. Cover the empty furnace with ceramic blanket to cool.

H. Pouring:

1. Preheat the ladle.

- **a.** Tap 400 pounds more or less of 2700°F metal into the cold ladle.
- **b.** Casually pour the metal back to the furnace.
- **c.** Cover the ladle.
- **d.** Reheat the metal to 2780 +/- 20°F.
- **e.** Tap 450 pounds of iron into the ladle while pouring inoculating alloys onto the metal stream near its base.
- **f.** Cover the ladle to conserve heat.
- **g.** Move the ladle to the pour position, and wait until the metal temperature reaches 2680 +/- 10°F.
- **h.** Commence pouring keeping the sprue full.
- **i.** Upon completion return the extra metal to the furnace, and cover the ladle.

Steven Knight
Mgr. Process Engineering

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/9/2003											FI CONDITIONING - RUN 1
FI CR-1											
THC		x									

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/10/2003											FI CONDITIONING - RUN 2
FI CR-2											
THC		x									

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/10/2003											FI CONDITIONING - RUN 3
FI CR-3											
THC		x									

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/10/2003											FI CONDITIONING - RUN 4
FI CR-4											
THC		x									

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/14/2003											
RUN 1											
THC	FI001	X									TOTAL
M-18	FI00101		1						60	1	Carbopak charcoal
M-18	FI00102				1				0		Carbopak charcoal
M-18 MS	FI00103		1						60	2	Carbopak charcoal
M-18 MS	FI00104			1					60	3	Carbopak charcoal
Gas, CO, CO2	FI00105		1						60	4	Tedlar Bag
Gas, CO, CO2	FI00106				1				0		Tedlar Bag
	Excess								500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00107		1						1000	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FI00108				1				0		100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00109		1						1000	9	DNPH Silica Gel (SKC 226-119)
TO11	FI00110				1				0		DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/14/2003											
RUN 2											
THC	FI002	X									TOTAL
M-18	FI00201		1						60	1	Carbopak charcoal
M-18	FI00202			1					60	2	Carbopak charcoal
	Excess								60	3	Excess
Gas, CO, CO2	FI00203		1						60	4	Tedlar Bag
	Excess								500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00204		1						1000	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FI00205			1					1000	8	100/50 mg Charcoal (SKC 226-01)
TO11	FI00206		1						1000	9	DNPH Silica Gel (SKC 226-119)
TO11	FI00207			1					1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/15/2003											
RUN 3											
THC	FI003	X									TOTAL
M-18	FI00301		1						60	1	Carbopak charcoal
M-18	FI00302					1			60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00303		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00304		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00305		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/15/2003											
RUN 4											
THC	FI004	X									TOTAL
M-18	FI00401		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00402		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00403		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00404		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/15/2003											
RUN 5											
THC	FI005	X									TOTAL
M-18	FI00501		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00502		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00503		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00504		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/16/2003											
RUN 6											
THC	FI006	X									TOTAL
M-18	FI00601		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00602		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00603		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00604		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/16/2003											
RUN 7											
THC	FI007	X									TOTAL
M-18	FI00701		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00702		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00703		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00704		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/16/2003											
RUN 8											
THC	FI008	X									TOTAL
M-18	FI00801		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00802		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00803		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00804		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
7/17/2003											
RUN 9											
THC	FI009	X									TOTAL
M-18	FI00901		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
Gas, CO, CO2	FI00902		1						60	4	Tedlar Bag
	Excess		1						500	5	Excess
	Excess								500	6	Excess
NIOSH 1500	FI00903		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FI00904		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

TECHNIKON TEST PLAN

- > **CONTRACT NUMBER:** 1410 **TASK NUMBER:** 1.1.6 **Series:** FV
- > **SAMPLE EVENTS:** 9
- > **SITE**: ______X **PRE-PRODUCTION** ______ **FOUNDRY**
- > **TEST TYPE:** Product Test on H & G AQUATPART® II Graphite based Liquid Parting
- > **METAL TYPE:** Class 30 gray iron
- > **MOLD TYPE:** 4-on coreless star greensand and graphite based liquid parting with no seacoal
- > **NUMBER OF MOLDS:** 9 + 3 pattern release conditioning.
- > **CORE TYPE:** None
- > **TEST DATE:** **START:** 12 April 2004
  FINISHED: 16 April 2004

TEST OBJECTIVES:

Measure Pouring, Cooling, and Shakeout emissions from liquid parting with coal-less greensand mix. Compare to liquid parting baseline FI. Results shall be reported as pounds of emission/pound of liquid parting and pounds of emission /ton of metal poured.

VARIABLES:

The pattern will be the 4-on star. The mold will be made with Wexford W450 sand, 7 % western and southern bentonite in a 5:2 ratio, no seacoal, tempered to 40-45% compactability, mechanically compacted. A graphite based liquid parting Hill & GriffithAQUATPART® II will be used. A measured twenty grams (20 gm), more or less, will be applied uniformly by brush to each cope and drag pattern. The molds will be maintained at 70-80 ^{o}F prior to pouring. The sand heap will be maintained at 900 pounds. Molds will be poured with iron at 2680 +/- 10 ^{o}F. Mold cooling will be 45minutes follow by 15 minutes of shakeout, or until no more material remains to be shaken out. The initial process air temperature will be maintained at 85-90 ^{o}F. Emission testing will include the pouring, 45 minutes of cooling, 15 minutes of shakeout, and 15 minutes of the post shakeout period for a total of 75 minutes.

BRIEF OVERVIEW:

The 4 on star pattern is relatively new test pattern that is used for greensand baselines and product comparisons. An Osborn Jolt squeeze machine has been demonstrated to be an improvement over previously hand rammed molds, which are inherently inconsistent. This test will measure the product emissions compared to the baseline emissions for this pattern and the Osborn mold machine in combination with liquid parting and no seacoal.

SPECIAL CONDITIONS:

The process will include rigorous maintenance of the size of sand heap and maintenance of the material and testing environmental temperatures to reduce seasonal and daily temperature dependent influence on the emissions

Series FV

PCS Liquid Pattern Release Product test with No-coal Greensand & Mechanized Molding

Process Instructions

A. Experiment:

1) Measure emissions from a no coal greensand mold with liquid pattern release applied. Compare to baseline FI. The molds shall be started with all virgin Wexford W450 sand, bonded with 7% Western & Southern Bentonite in the ratio of 5:2. The molds shall be tempered with potable water to 40-45% compactability, poured at constant weight, temperature, surface area, & shape factor. This test will recycle the same mold material, replacing burned clay with new materials after each casting cycle.

B. Materials:

1) Mold sand:

a) Virgin mix of Wexford W450 lake sand, western and southern bentonites in ratio of 5:2, and potable water per recipe. No seacoal.

2) Core:

a) None

3) Metal:

a) Class 30-35 gray cast iron poured at 2680^{o}F.

4) Pattern release:

a) Hill & GriffithAQUATPART® II graphite based liquid parting.

Caution: Observe all safety precautions attendant to these operations as delineated in the Pre-production operating and safety instruction manual.

C. The following test shall be conducted:

1) Sand batch :

a) Single sand batch to be used for all FV molds.

2) The recycled sand heap shall be maintained at 900+-10 pounds

3) FV001: Virgin mix as described above, un-vented mold.

4) FV002-FV0XX: Re-mulled, reconstituted greensand, potable water, vented molds.

5) 20 grams of Hill & GriffithAQUATPART® II parting spray shall be brushed on each mold half.

6) Emission absorption tube sampling will begin after THC determination of emission stability from liquid pattern release content.

D. Sand preparation

1) Start up batch: make 1, FV001.

a) Thoroughly clean the pre-production muller elevator and molding hoppers.

b) Weigh and add 1225 +/- 10 pounds of new Wexford W450 Lakesand, per the recipe, to the running pre-production muller.

c) Add 5 pounds of potable to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.

d) Add the clays slowly to the muller to allow them to be distributed throughout the sand mass in proportion to the sand weight per the recipe for this test.

e) Dry mull for about 3 minutes to allow distribution and some grinding of the clays to occur.

f) Temper the sand-clay mixture slowly, with potable water, to allow for distribution.

g) After about 2 gallons of water have been added allow 30 seconds of mixing then start taking compactability test samples.

h) Based on each test add water incrementally to adjust the temper. Allow 1 minute of mixing. Retest. Repeat until the compactability is in the range 40-45%.

i) Discharge the sand into the mold station elevator.

j) Grab sufficient sand sample after the final compactability test to fill a quart zip-lock bag. Label the bag with the test series and sequence number, date, and time of day and deliver it immediately to the sand lab for analysis

k) Record the total sand mixed in the batch, the total of each type of clay added to the batch, the amount of water added, the total mix time, the final compactability and sand temperature at charge and discharge.

l) The sand will be immediately characterized for Methylene Blue Clay, Moisture content, Compactability, Green Compression strength, 1800 oF loss on ignition (LOI), and 900 oF volatiles. Each volatile test requires 30 grams and LOI test requires a separate 50 gram sample from the collected sand.

m) Empty the extra greensand from the mold hopper into a clean empty dump hopper whose tare weight is known. Set this sand aside to be used to maintain the recycled batch at 900+/-10 pounds

2) Re-mulling: FV002

a) Add to the sand recovered from poured mold FV001

- Sufficient pre-blended sand so that the sand batch weight is 900 +/- 10 pounds. Record the sand weight.

b) Return the sand to the muller and dry blend for about one minute.

c) Add the clays, as directed by the process engineering staff, slowly to the muller to allow them to be distributed throughout the sand mass.

d) Add 5 pounds of water to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.

e) Follow the above procedure

3) Re-mulling: FV003-FV0XX

a) Add to the sand recovered from the previous poured mold, mold machine spill sand, the residual mold hopper sand and sufficient pre-blended sand to total 900 +/- 10 pounds.

b) Return the sand to the muller and dry blend for about one minute.

c) Add the clays, as directed by the process engineering staff, slowly to the muller to allow them to be distributed throughout the sand mass.

d) Add 5 pounds of water to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.

e) Follow the above procedure

E. Molding: 4-on star pattern.

1) Pattern preparation:

a) Inspect and tighten all loose pattern and gating pieces.

b) Repair any damaged pattern or gating parts.

c) Both cope and drag are made on the same machine. In-gates should exist on the two diagonally opposite cavities only. When the drag half is turned over all cavities will be gated.

2) Mount the 4-on star pattern with gating into a single mold machine bolster and bolt it down tightly.

a) Weigh a 500 ml beaker, 200 ml of Hill & GriffithAQUATPART® II liquid pattern release and a 1-inch brush immersed in the parting spray.

b) Incrementally brush the pattern release evenly over each side of the entire pattern until the gross weight of the beaker, residual parting spray, and the immersed brush are twenty (20) grams lighter.

c) Repeat for the other half of the pattern in turn.

d) Repeat for each mold cycle.

3) Remove the sprue if making a mold drag half. Leave it attached if making a cope half.

4) Use the overhead crane to place the pre-weighed drag/cope flask on the mold machine table, parting line surface down.

5) Locate a 24 x 24 x4 inch deep wood upset on top of the flask.

6) Make the green sand mold on the Osborn Whisper Ram Jolt-Squeeze mold machine

WARNING: Only properly trained personnel may operate this machine. Proper personal protective equipment must be worn at all times while operating this equipment, including safety glasses with side shields and a properly fitting hard hat. Industrial type boots are highly recommended.

WARNING: Stand clear of the mold machine table and swinging head during the following operation or serious injury or death could result.

a) Open the air supply to the mold machine.

WARNING: The squeeze head may suddenly swing to the outboard side or forward. Do not stand in the outer corners of the molding enclosure.

b) On the operator's panel turn the POWER switch to ON.
c) Turn the RAM-JOLT-SQUEEZE switch to ON.
d) Turn the DRAW UP switch to AUTO
e) Set the PRE-JOLT timer to 4-5 seconds.
f) Set the squeeze timer to 8 seconds.
g) Manually riddle a half to one inch or so of sand on the pattern using a ¼ inch mesh riddle. Source the sand from the overhead mold sand hopper by actuating the CHATTER GATE valve located under the operators panel.
h) Fill the 24 x 24 x 10 inch flask and the upset with greensand from the overhead molding hopper.
i) Manually level sand in the upset. By experience manually adjust the sand depth so that the resulting compacted mold is fractionally above the flask only height.

WARNING: Failure to stand clear of the molding table and flasks in the following operations could result in serious injury as this equipment is about to move up and down with great force.

j) Initiate the settling of the sand in the flask by pressing the PRE-JOLT push button. Allow this cycle to stop before proceeding.

WARNING: Stand clear of the entire mold machine during the following operations. Several of the machine parts will be moving. Failure to stand clear could result in severe injury even death.

k) Using both hands initiate the automatic machine sequence by simultaneously pressing and releasing the green push buttons on either side of the operators panel. The machine will squeeze and jolt the sand in the flask and then move the squeeze head to the side.

WARNING: Do no re-approach the machine until the squeeze head has stopped at the side of the machine.

l) Remove the upset and set it aside.
m) Screed the bottom of the mold flat if required.
n) Press and release the LOWER DRAW/STOP push button to separate the flask and mold from the pattern.
o) Use the overhead crane to lift the mold half and remove it from the machine.

p) Finally, press and release the DRAW DOWN pushbutton to cause the draw frame to return to the start position.

7) If the mold half is a drag, roll it parting line side up, set it on the floor, blow it out, and cover it to keep it clean.
8) Close the cope over the drag being careful not to crush anything.
9) Clamp the flask halves together.
10) Weigh and record the weight of the closed un-poured mold, the pre-weighed flask, and the sand weight by difference
11) Deliver the mold to the previously cleaned shakeout to be poured.
12) Cover the mold with the emission hood.

F. Shakeout.
1) After the cooling time prescribed in the test plan turn on the shakeout unit and run it until the greensand has passed into the hopper below.
2) Turn off the shakeout, remove the flask with casting, and recover the sand from the hopper and surrounding floor.
3) Weigh and record the metal poured and the total sand weight recovered and rejoined with the left over mold sand from the molding hopper.

G. Melting:
1) Initial charge:
a) Charge the furnace according to the heat recipe.
b) Place part of the steel scrap on the bottom, followed by carbon alloys, and the balance of the steel.
c) Place a pig on top.
d) Bring the furnace contents to the point of beginning to melt over a period of 1 hour at reduced power.
e) Add the balance of the metallics under full power until all is melted and the temperature has reached 2600 to 2700 oF.
f) Slag the furnace and add the balance of the alloys.
g) Raise the temperature of the melt to 2700 oF and take a DataCast 2000 sample. The temperature of the primary liquidus (TPL) must be in the range of 2200-2350oF.
h) Hold the furnace at 2500-2550oF until near ready to tap.
i) When ready to tap raise the temperature to 2700oF and slag the furnace.
j) Record all metallic and alloy additions to the furnace, tap temperature, and pour temperature. Record all furnace activities with an associated time.

2) Back charging.
a) Back charge the furnace according to the heat recipe,
b) Charge a few pieces of steel first to make a splash barrier, followed by the carbon alloys.
c) Follow the above steps

3) Emptying the furnace.

a) Pig the extra metal only after the last emission measurement is complete to avoid contaminating the air sample.
b) Cover the empty furnace with ceramic blanket to cool.

H. Pouring:
1) Preheat the ladle.
a) Tap 400 pounds more or less of 2700°F metal into the cold ladle.
b) Casually pour the metal back to the furnace.
c) Cover the ladle.
d) Reheat the metal to 2780 +/- 20°F.
e) Tap 450 pounds of iron into the ladle while pouring inoculating alloys onto the metal stream near its base.
f) Cover the ladle to conserve heat.
g) Move the ladle to the pour position, and wait until the metal temperature reaches 2680 +/- 10°F.
h) Commence pouring keeping the sprue full.
i) Upon completion return the extra metal to the furnace, and cover the ladle.

I. Rank order evaluation.
1) The supervisor shall select a group of three persons to make a collective subjective judgment of the casting relative surface appearance.
2) Review the general appearance of the castings and select specific casting features to compare.
3) For cavity 3 only:
a) Place each casting initially in sequential mold number order.
b) Beginning with casting from mold FV001, compare it to castings from mold FV002.
c) Place the better appearing casting in the first position and the lesser appearing casting in the second position.
d) Repeat this procedure with FV001 to its nearest neighbors until all castings closer to the beginning of the line are better appearing than FV001 and the next casting farther down the line is inferior.
e) Repeat this comparison to next neighbors for each casting number.
f) When all casting numbers have been compared go to the beginning of the line and begin again comparing each casting to its nearest neighbor. Move the castings so that each casting is inferior to the next one closer to the beginning of the line and superior to the one next toward the tail of the line.
g) Repeat this comparison until all concur with the ranking order.

4) Record mold number by rank-order series for this cavity.

Steven Knight
Mgr. Process Engineering

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/19/2004											**FJ CONDITIONING - RUN 1**
FV CR-1											
THC		x									
CO, CO2		x									

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/19/2004											**FJ CONDITIONING - RUN 2**
FV CR-2											
THC		x									
CO, CO2		x									

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/19/2004											**FJ CONDITIONING - RUN 3**
FV CR-3											
THC		x									
CO, CO2		x									

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/20/2004											
RUN 1											
THC	FV001	X									TOTAL
CO, CO2	FV001	X									TOTAL
M-18	FV00101		1						60	1	Carbopak charcoal
M-18	FV00102				1				0		Carbopak charcoal
M-18 MS	FV00103		1						60	2	Carbopak charcoal
M-18 MS	FV00104			1					60	3	Carbopak charcoal
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00105		1						1000	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FV00106				1				0		100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00107		1						1000	9	DNPH Silica Gel (SKC 226-119)
TO11	FV00108				1				0		DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/20/2004											
RUN 2											
THC	FV002	X									TOTAL
CO, CO2	FV002	X									TOTAL
M-18	FV00201		1						60	1	Carbopak charcoal
M-18	FV00202			1					60	2	Carbopak charcoal
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00203		1						1000	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FV00204			1					1000	8	100/50 mg Charcoal (SKC 226-01)
TO11	FV00205		1						1000	9	DNPH Silica Gel (SKC 226-119)
TO11	FV00206			1					1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/20/2004											
RUN 3											
THC	FV003	X									TOTAL
CO, CO2	FV003	X									TOTAL
M-18	FV00301		1						60	1	Carbopak charcoal
M-18	FV00302					1			60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								40	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00303		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00304		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/21/2004											
RUN 4											
THC	FV004	X									TOTAL
CO, CO2	FV004	X									TOTAL
M-18	FV00401		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00402		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00403		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/21/2004											
RUN 5											
THC	FV005	X									TOTAL
CO, CO2	FV005	X									TOTAL
M-18	FV00501		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00502		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00503		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/21/2004											
RUN 6											
THC	FV006	X									TOTAL
CO, CO2	FV006	X									TOTAL
M-18	FV00601		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00602		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00603		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/22/2004											
RUN 7											
THC	FV007	X									TOTAL
CO, CO2	FV007	X									TOTAL
M-18	FV00701		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00702		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00703		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/22/2004											
RUN 8											
THC	FV008	X									TOTAL
CO, CO2	FV008	X									TOTAL
M-18	FV00801		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00802		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00803		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FV - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
4/22/2004											
RUN 9											
THC	FV009	X									TOTAL
CO, CO2	FV009	X									TOTAL
M-18	FV00901		1						60	1	Carbopak charcoal
	Excess								60	2	Excess
	Excess								60	3	Excess
	Excess								60	4	Excess
	Excess								1000	5	Excess
	Excess								1000	6	Excess
NIOSH 1500	FV00902		1						1000	7	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	8	Excess
TO11	FV00903		1						1000	9	DNPH Silica Gel (SKC 226-119)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

APPENDIX B TEST SERIES FI AND FV DETAILED EMISSION RESULTS

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Test Plan FI Individual Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FI001	FI002	FI003	FI004	FI005	FI006	FI007	FI008	FI009	Average	STDEV
		Test Dates	7/14/03	7/14/03	7/15/03	7/15/03	7/15/03	7/16/03	7/16/03	7/16/03	7/17/03		
		TGOC as Propane	7.96E-01	9.11E-01	9.08E-01	8.37E-01	I	8.60E-01	9.29E-01	8.63E-01	8.18E-01	8.65E-01	4.76E-02
		HC as Hexane	1.53E-01	1.80E-01	1.84E-01	1.67E-01	1.67E-01	1.55E-01	1.64E-01	1.67E-01	1.74E-01	1.68E-01	1.02E-02
		Sum of VOCs	8.40E-02	9.46E-02	8.69E-02	8.74E-02	7.27E-02	7.74E-02	7.99E-02	I	7.19E-02	8.19E-02	7.85E-03
		Sum of HAPs	6.78E-02	7.56E-02	6.87E-02	6.92E-02	5.61E-02	6.02E-02	6.12E-02	I	5.59E-02	6.43E-02	7.04E-03
		Sum of POMs	2.57E-03	3.38E-03	3.25E-03	3.36E-03	3.41E-03	2.81E-03	2.99E-03	I	2.49E-03	3.03E-03	3.74E-04
		Individual Organic HAPs											
x		Benzene	3.18E-02	3.58E-02	3.31E-02	3.31E-02	2.49E-02	2.81E-02	2.91E-02	I	2.73E-02	3.04E-02	3.64E-03
x		Toluene	1.13E-02	1.22E-02	1.14E-02	1.09E-02	9.59E-03	1.04E-02	9.99E-03	I	9.20E-03	1.06E-02	1.00E-03
x		m,p-Xylene	7.89E-03	8.08E-03	6.87E-03	7.83E-03	6.93E-03	6.47E-03	6.38E-03	I	5.51E-03	7.00E-03	8.92E-04
x		Acetaldehyde	3.02E-03	3.49E-03	3.08E-03	2.85E-03	3.08E-03	2.86E-03	2.61E-03	3.18E-03	3.19E-03	3.04E-03	2.51E-04
x		o-Xylene	2.57E-03	2.87E-03	2.63E-03	2.60E-03	2.29E-03	2.44E-03	2.47E-03	I	2.30E-03	2.52E-03	1.90E-04
x	z	Naphthalene	1.91E-03	2.56E-03	2.44E-03	2.55E-03	2.57E-03	2.10E-03	2.24E-03	I	1.87E-03	2.28E-03	2.92E-04
x		Hexane	2.72E-03	2.57E-03	2.50E-03	2.52E-03	I	2.31E-03	2.36E-03	I	8.20E-04	2.26E-03	6.48E-04
x		Formaldehyde	1.84E-03	2.38E-03	1.82E-03	1.70E-03	2.06E-03	1.51E-03	1.40E-03	1.70E-03	1.77E-03	1.80E-03	2.89E-04
x		Ethylbenzene	1.65E-03	1.75E-03	1.54E-03	1.69E-03	1.47E-03	1.40E-03	1.45E-03	I	1.30E-03	1.53E-03	1.57E-04
x		Styrene	9.22E-04	1.21E-03	1.01E-03	1.07E-03	9.22E-04	9.45E-04	9.47E-04	I	9.52E-04	9.98E-04	1.00E-04
x		Propionaldehyde	6.19E-04	7.50E-04	5.84E-04	6.17E-04	6.26E-04	6.14E-04	5.71E-04	7.19E-04	7.08E-04	6.45E-04	6.36E-05
x		Phenol	6.43E-04	7.33E-04	6.02E-04	6.20E-04	5.86E-04	ND	6.44E-04	I	0.00E+00	4.79E-04	2.99E-04
x	z	2-Methylnaphthalene	3.66E-04	4.64E-04	4.59E-04	4.56E-04	4.65E-04	3.91E-04	4.12E-04	I	3.51E-04	4.20E-04	4.68E-05
x	z	1-Methylnaphthalene	2.91E-04	3.54E-04	3.57E-04	3.53E-04	3.81E-04	3.13E-04	3.36E-04	I	2.74E-04	3.32E-04	3.66E-05
x		2-Butanone	2.80E-04	3.37E-04	3.24E-04	2.89E-04	2.85E-04	2.67E-04	2.70E-04	3.07E-04	3.18E-04	2.98E-04	2.51E-05
x	z	1,2-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	1,3-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	1,5-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	1,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	1,8-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	2,3,5-Trimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	2,3-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	2,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	2,7-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	Acenaphthalene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x		Biphenyl	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x		m,p-Cresol	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x		o-Cresol	ND	ND	ND	ND	ND	ND	ND	I	I	ND	NA
x		Acrolein	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FI Individual Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FI001	FI002	FI003	FI004	FI005	FI006	FI007	FI008	FI009	Average	STDEV
		Test Dates	7/14/03	7/14/03	7/15/03	7/15/03	7/15/03	7/16/03	7/16/03	7/16/03	7/17/03		
		Other VOCs											
		Heptane	3.97E-03	4.10E-03	4.39E-03	4.62E-03	4.00E-03	4.41E-03	4.99E-03	I	4.48E-03	4.37E-03	3.44E-04
		Tetradecane	2.28E-03	2.85E-03	3.06E-03	3.09E-03	3.29E-03	2.59E-03	3.13E-03	I	2.64E-03	2.87E-03	3.39E-04
		1,2,4-Trimethylbenzene	2.51E-03	3.29E-03	3.05E-03	2.99E-03	2.59E-03	2.98E-03	2.84E-03	I	2.65E-03	2.86E-03	2.64E-04
		Octane	2.11E-03	2.21E-03	2.18E-03	2.28E-03	2.04E-03	2.16E-03	2.31E-03	I	2.11E-03	2.18E-03	9.25E-05
		3-Ethyltoluene	1.51E-03	1.71E-03	1.41E-03	1.45E-03	1.37E-03	1.29E-03	1.50E-03	I	1.17E-03	1.43E-03	1.62E-04
		1,3,5-Trimethylbenzene	7.95E-04	9.69E-04	8.78E-04	8.49E-04	7.73E-04	8.35E-04	8.76E-04	I	7.14E-04	8.36E-04	7.73E-05
		1,2,3-Trimethylbenzene	6.36E-04	8.45E-04	7.08E-04	7.18E-04	6.86E-04	6.92E-04	7.09E-04	I	6.17E-04	7.01E-04	6.83E-05
		Indene	7.32E-04	9.34E-04	7.96E-04	7.57E-04	7.42E-04	7.05E-04	6.77E-04	I	0.00E+00	6.68E-04	2.81E-04
		Benzaldehyde	3.66E-04	4.26E-04	3.28E-04	3.64E-04	3.69E-04	3.36E-04	3.66E-04	3.61E-04	4.13E-04	3.70E-04	3.16E-05
		Butyraldehyde/Methacrolein	3.43E-04	4.26E-04	3.43E-04	3.52E-04	3.54E-04	3.34E-04	3.19E-04	3.80E-04	3.98E-04	3.61E-04	3.39E-05
		2-Ethyltoluene	3.54E-04	4.29E-04	3.76E-04	3.74E-04	ND	3.58E-04	3.87E-04	I	3.37E-04	3.27E-04	1.35E-04
		Pentanal	1.90E-04	2.37E-04	1.87E-04	1.91E-04	1.86E-04	1.69E-04	1.68E-04	2.01E-04	1.92E-04	1.91E-04	2.04E-05
		Hexaldehyde	1.68E-04	2.09E-04	1.35E-04	1.63E-04	1.53E-04	1.40E-04	1.61E-04	1.67E-04	1.59E-04	1.62E-04	2.11E-05
		Undecane	2.59E-04	1.36E-04	ND	ND	ND	2.34E-04	2.36E-04	I	1.95E-04	1.32E-04	1.16E-04
		o,m,p-Tolualdehyde	ND	3.17E-04	3.62E-04	ND	ND	ND	ND	ND	ND	7.55E-05	1.50E-04
		1,3-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FI Individual Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FI001	FI002	FI003	FI004	FI005	FI006	FI007	FI008	FI009	Average	STDEV
		Test Dates	**7/14/03**	**7/14/03**	**7/15/03**	**7/15/03**	**7/15/03**	**7/16/03**	**7/16/03**	**7/16/03**	**7/17/03**		
		Other Analytes											
		Acetone	1.79E-03	1.94E-03	1.79E-03	1.78E-03	1.69E-03	1.61E-03	1.72E-03	1.72E-03	1.84E-03	1.76E-03	9.56E-05
		Carbon Dioxide	1.92E+01	1.83E+01	1.99E+01	1.89E+01	1.73E+01	1.91E+01	1.95E+01	1.89E+01	1.75E+01	1.87E+01	8.60E-01
		Methane	1.74E-02	3.16E-02	3.16E-02	3.07E-02	3.40E-02	3.02E-02	3.36E-02	3.16E-02	3.45E-02	3.06E-02	5.15E-03
		Carbon Monoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Ethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Butane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Neopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Pentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

I: Data rejected based on data validation considerations.
ND: Non Detect; NA: Not Applicable
All "Other Analytes" are not included in the Sum of VOCs or HAPs.

Test Plan FI Individual Emission Test Results – Lb/Lb Parting Spray

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FI001	FI002	FI003	FI004	FI005	FI006	FI007	FI008	FI009	Average	STDEV
		Test Dates	**7/14/03**	**7/14/03**	**7/15/03**	**7/15/03**	**7/15/03**	**7/16/03**	**7/16/03**	**7/16/03**	**7/17/03**		
		TGOC as Propane	4.53E-01	4.84E-01	4.89E-01	4.44E-01	I	4.85E-01	5.04E-01	4.61E-01	4.54E-01	4.72E-01	2.11E-02
		HC as Hexane	8.67E-02	9.26E-02	8.27E-02	8.50E-02	8.74E-02	9.13E-02	9.14E-02	9.57E-02	9.32E-02	8.95E-02	4.28E-03
		Sum of VOCs	4.80E-02	5.19E-02	4.68E-02	4.66E-02	4.35E-02	4.38E-02	4.35E-02	I	4.02E-02	4.55E-02	3.58E-03
		Sum of HAPs	3.87E-02	4.07E-02	3.70E-02	3.69E-02	3.42E-02	3.40E-02	3.34E-02	I	3.12E-02	3.58E-02	3.12E-03
		Sum of POMs	1.47E-03	2.62E-03	1.76E-03	1.79E-03	1.93E-03	1.59E-03	1.63E-03	I	1.39E-03	1.77E-03	3.84E-04
		Individual Organic HAPs											
x		**Benzene**	1.82E-02	1.91E-02	1.79E-02	1.77E-02	1.41E-02	1.59E-02	1.59E-02	I	1.52E-02	1.67E-02	1.72E-03
x		**Toluene**	6.43E-03	6.50E-03	6.13E-03	5.83E-03	5.42E-03	5.89E-03	5.44E-03	I	5.14E-03	5.85E-03	4.94E-04
x		**m,p-Xylene**	4.50E-03	4.31E-03	3.71E-03	4.18E-03	3.92E-03	3.66E-03	3.47E-03	I	3.08E-03	3.85E-03	4.71E-04
x		**Acetaldehyde**	1.72E-03	1.72E-03	1.63E-03	1.52E-03	1.65E-03	1.61E-03	1.44E-03	1.70E-03	1.78E-03	1.64E-03	1.08E-04
x		**Hexane**	1.55E-03	1.37E-03	1.35E-03	1.35E-03	2.66E-03	1.31E-03	1.28E-03	I	4.58E-04	1.42E-03	6.00E-04
x		**o-Xylene**	1.47E-03	1.53E-03	1.42E-03	1.39E-03	1.30E-03	1.38E-03	1.34E-03	I	1.29E-03	1.39E-03	8.36E-05
x	z	**Naphthalene**	1.09E-03	1.87E-03	1.32E-03	1.36E-03	1.45E-03	1.19E-03	1.22E-03	I	1.04E-03	1.32E-03	2.60E-04
x		**Formaldehyde**	1.05E-03	1.05E-03	9.61E-04	9.04E-04	1.10E-03	8.51E-04	7.70E-04	9.14E-04	9.90E-04	9.55E-04	1.06E-04
x		**Ethylbenzene**	9.44E-04	9.35E-04	8.30E-04	9.03E-04	8.29E-04	7.94E-04	7.90E-04	I	7.24E-04	8.44E-04	7.76E-05
x		**Styrene**	5.27E-04	6.47E-04	5.47E-04	5.69E-04	5.21E-04	5.34E-04	5.16E-04	I	5.31E-04	5.49E-04	4.28E-05
x		**Propionaldehyde**	3.54E-04	3.54E-04	3.08E-04	3.29E-04	3.35E-04	3.47E-04	3.14E-04	3.85E-04	3.95E-04	3.47E-04	2.94E-05
x		**Phenol**	3.67E-04	3.91E-04	3.25E-04	3.31E-04	3.31E-04	ND	3.51E-04	I	ND	2.62E-04	1.63E-04
x	z	**2-Methylnaphthalene**	2.09E-04	4.46E-04	2.48E-04	2.43E-04	2.63E-04	2.21E-04	2.24E-04	I	1.96E-04	2.56E-04	7.96E-05
x	z	**1-Methylnaphthalene**	1.66E-04	3.07E-04	1.93E-04	1.88E-04	2.15E-04	1.77E-04	1.83E-04	I	1.53E-04	1.98E-04	4.80E-05
x		**2-Butanone**	1.60E-04	1.60E-04	1.71E-04	1.54E-04	1.53E-04	1.51E-04	1.49E-04	1.64E-04	1.78E-04	1.60E-04	9.69E-06
x		**Acrolein**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**Acenaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x		**Biphenyl**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x		**Cresol, mp-**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x		**Cresol, o-**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**1,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA

Test Plan FI Individual Emission Test Results – Lb/Lb Parting Spray

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FI001	FI002	FI003	FI004	FI005	FI006	FI007	FI008	FI009	Average	STDEV
		Test Dates	7/14/03	7/14/03	7/15/03	7/15/03	7/15/03	7/16/03	7/16/03	7/16/03	7/17/03		
x	z	**2,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**2,7-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Other VOCs											
		Heptane	2.27E-03	2.18E-03	2.37E-03	2.47E-03	2.26E-03	2.49E-03	2.72E-03	I	2.50E-03	2.41E-03	1.72E-04
		Tetradecane	1.30E-03	2.64E-03	1.65E-03	1.65E-03	1.86E-03	1.46E-03	1.70E-03	I	1.47E-03	1.72E-03	4.10E-04
		1,2,4-Trimethylbenzene	1.43E-03	1.75E-03	1.65E-03	1.59E-03	1.46E-03	1.68E-03	1.55E-03	I	1.48E-03	1.58E-03	1.14E-04
		Octane	1.20E-03	1.18E-03	1.18E-03	1.22E-03	1.15E-03	1.22E-03	1.26E-03	I	1.18E-03	1.20E-03	3.35E-05
		3-Ethyltoluene	8.61E-04	9.15E-04	7.60E-04	7.73E-04	7.73E-04	7.28E-04	8.18E-04	I	6.54E-04	7.85E-04	8.02E-05
		1,3,5-Trimethylbenzene	4.54E-04	5.17E-04	4.74E-04	4.53E-04	4.37E-04	4.72E-04	4.77E-04	I	3.99E-04	4.60E-04	3.44E-05
		1,2,3-Trimethylbenzene	3.63E-04	4.51E-04	3.82E-04	3.83E-04	3.88E-04	3.91E-04	3.86E-04	I	3.44E-04	3.86E-04	3.04E-05
		Indene	4.18E-04	4.98E-04	4.30E-04	4.04E-04	4.20E-04	3.99E-04	3.68E-04	I	ND	3.67E-04	1.53E-04
		Benzaldehyde	2.09E-04	2.09E-04	1.73E-04	1.94E-04	1.97E-04	1.90E-04	2.01E-04	1.94E-04	2.31E-04	2.00E-04	1.58E-05
		Butyraldehyde/Methacrolein	1.96E-04	1.96E-04	1.81E-04	1.88E-04	1.90E-04	1.89E-04	1.76E-04	2.04E-04	2.22E-04	1.93E-04	1.36E-05
		2-Ethyltoluene	2.02E-04	2.29E-04	2.03E-04	1.99E-04	ND	2.02E-04	2.11E-04	I	1.88E-04	1.79E-04	7.34E-05
		Pentanal	1.08E-04	1.08E-04	9.86E-05	1.02E-04	9.93E-05	9.58E-05	9.22E-05	1.08E-04	1.07E-04	1.02E-04	6.13E-06
		Hexaldehyde	9.61E-05	9.61E-05	7.15E-05	8.69E-05	8.16E-05	7.93E-05	8.87E-05	8.94E-05	8.89E-05	8.65E-05	7.95E-06
		Undecane	1.48E-04	7.24E-05	ND	ND	ND	1.32E-04	1.28E-04	I	1.09E-04	7.37E-05	6.48E-05
		Indan	ND	1.88E-04	ND	ND	ND	ND	ND	I	ND	2.35E-05	6.64E-05
		o,m,p-Tolualdehyde	ND	ND	1.91E-04	ND	ND	ND	ND	ND	ND	2.13E-05	6.38E-05
		Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		1,3-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
		Propylbenzene	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA

Test Plan FI Individual Emission Test Results – Lb/Lb Parting Spray

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FI001	FI002	FI003	FI004	FI005	FI006	FI007	FI008	FI009	Average	STDEV
		Test Dates	7/14/03	7/14/03	7/15/03	7/15/03	7/15/03	7/16/03	7/16/03	7/16/03	7/17/03		
		Other Analytes											
		Acetone	1.02E-03	1.02E-03	9.44E-04	9.47E-04	9.02E-04	9.09E-04	9.45E-04	9.20E-04	1.03E-03	9.60E-04	5.05E-05
		Carbon Dioxide	1.09E+01	9.78E+00	1.07E+01	1.01E+01	9.77E+00	1.08E+01	1.06E+01	1.01E+01	9.80E+00	1.03E+01	4.79E-01
		Methane	9.95E-03	1.68E-02	1.70E-02	1.64E-02	1.92E-02	1.71E-02	1.83E-02	1.70E-02	1.93E-02	1.68E-02	2.77E-03
		Carbon Monoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Ethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Butane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Neopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Pentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

I: Data rejected based on data validation considerations.

ND: Non Detec; NA: Not Applicable

All "Other Analytes" are not included in the Sum of HAPs or VOCs.

Test Plan FV Individual Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FV001	FV002	FV003	FV004	FV005	FV006	FV007	FV008	FV009	Average	STDEV
		Test Dates	4/20/04	4/20/04	4/20/04	4/21/04	4/21/04	4/21/04	4/22/04	4/22/04	4/22/04		
		TGOC as Propane	4.65E-01	4.50E-01	3.91E-01	3.68E-01	4.07E-01	5.17E-01	3.57E-01	3.67E-01	4.33E-01	4.17E-01	5.37E-02
		HC as Hexane	1.29E-01	1.16E-01	1.00E-01	9.97E-02	1.03E-01	1.32E-01	9.74E-02	1.03E-01	1.21E-01	1.11E-01	1.36E-02
		Sum of VOCs	5.65E-02	6.29E-02	5.59E-02	5.32E-02	5.34E-02	6.55E-02	5.17E-02	6.01E-02	5.23E-02	5.68E-02	4.92E-03
		Sum of HAPs	5.00E-02	5.34E-02	4.85E-02	4.62E-02	4.61E-02	5.50E-02	4.66E-02	5.33E-02	4.51E-02	4.94E-02	3.73E-03
		Sum of POMs	I	3.79E-03	2.87E-03	2.99E-03	2.67E-03	3.69E-03	2.89E-03	3.08E-03	3.06E-03	3.13E-03	3.99E-04
			Individual Organic HAPs										
x		Benzene	2.69E-02	2.58E-02	2.39E-02	2.21E-02	2.23E-02	2.79E-02	2.30E-02	2.73E-02	3.13E-02	2.56E-02	3.06E-03
x		Toluene	7.15E-03	7.11E-03	6.36E-03	6.01E-03	6.11E-03	7.55E-03	6.38E-03	7.50E-03	I	6.77E-03	6.24E-04
x		Acetaldehyde	3.94E-03	4.19E-03	4.21E-03	4.19E-03	3.93E-03	4.25E-03	4.16E-03	4.11E-03	I	4.12E-03	1.23E-04
x		m,p-Xylene	4.16E-03	4.35E-03	3.67E-03	3.39E-03	3.55E-03	4.36E-03	3.53E-03	4.22E-03	4.82E-03	4.01E-03	4.87E-04
x	z	Naphthalene	I	2.71E-03	2.16E-03	2.33E-03	2.00E-03	2.71E-03	2.19E-03	2.23E-03	2.23E-03	2.32E-03	2.56E-04
x		o-Xylene	1.57E-03	1.60E-03	1.38E-03	1.28E-03	1.34E-03	1.66E-03	1.30E-03	1.59E-03	1.82E-03	1.50E-03	1.89E-04
x		Styrene	1.57E-03	1.50E-03	1.24E-03	9.83E-04	1.16E-03	1.54E-03	1.09E-03	1.29E-03	1.51E-03	1.32E-03	2.18E-04
x		Formaldehyde	1.35E-03	1.28E-03	1.55E-03	1.38E-03	1.29E-03	1.15E-03	1.22E-03	1.18E-03	I	1.30E-03	1.27E-04
x		Hexane	1.47E-03	1.39E-03	1.60E-03	1.22E-03	1.28E-03	8.24E-04	1.23E-03	9.85E-04	8.67E-04	1.21E-03	2.67E-04
x		Ethylbenzene	1.14E-03	1.16E-03	9.96E-04	9.23E-04	9.87E-04	1.24E-03	9.97E-04	1.23E-03	1.42E-03	1.12E-03	1.61E-04
x	z	2-Methylnaphthalene	I	6.84E-04	4.45E-04	4.05E-04	3.78E-04	6.57E-04	4.39E-04	5.52E-04	5.18E-04	5.10E-04	1.14E-04
x		Propionaldehyde	5.76E-04	ND	5.17E-04	5.13E-04	5.04E-04	6.21E-04	5.53E-04	5.92E-04	3.17E-04	4.66E-04	1.95E-04
x		Phenol	I	1.00E-03	ND	1.10E-03	8.49E-04	ND	ND	ND	ND	3.68E-04	5.12E-04
x	z	1-Methylnaphthalene	I	3.99E-04	2.58E-04	2.51E-04	2.86E-04	3.24E-04	2.65E-04	2.98E-04	3.06E-04	2.98E-04	4.76E-05
x		2-Butanone	1.69E-04	1.86E-04	1.95E-04	2.00E-04	1.61E-04	2.22E-04	1.94E-04	2.00E-04	I	1.91E-04	1.93E-05
x	z	1,2-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,3-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,5-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,8-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,3,5-Trimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,3-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,7-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	Acenaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		m,p-Cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		o-Cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		Acrolein	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FV Individual Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FV001	FV002	FV003	FV004	FV005	FV006	FV007	FV008	FV009	Average	STDEV
		Test Dates	**4/20/04**	**4/20/04**	**4/20/04**	**4/21/04**	**4/21/04**	**4/21/04**	**4/22/04**	**4/22/04**	**4/22/04**		
			Other VOCs										
		Tetradecane	2.44E-03	1.87E-03	1.42E-03	1.35E-03	1.44E-03	2.15E-03	1.71E-03	1.99E-03	1.97E-03	1.82E-03	3.68E-04
		1,2,4-Trimethylbenzene	2.03E-03	1.74E-03	1.53E-03	1.43E-03	1.50E-03	1.75E-03	1.44E-03	1.71E-03	1.95E-03	1.68E-03	2.18E-04
		Heptane	ND	2.69E-03	2.42E-03	2.24E-03	2.52E-03	3.13E-03	ND	ND	8.23E-04	1.54E-03	1.31E-03
		1,3,5-Trimethylbenzene	I	8.19E-04	7.17E-04	7.44E-04	6.67E-04	9.61E-04	7.61E-04	6.53E-04	6.17E-04	7.42E-04	1.10E-04
		3-Ethyltoluene	8.21E-04	8.34E-04	ND	ND	ND	8.81E-04	ND	7.86E-04	9.56E-04	4.75E-04	4.53E-04
		1,2,3-Trimethylbenzene	I	5.32E-04	3.76E-04	4.62E-04	3.90E-04	5.00E-04	4.26E-04	3.70E-04	4.42E-04	4.37E-04	5.87E-05
		2-Ethyltoluene	4.08E-04	4.18E-04	3.65E-04	2.90E-04	3.26E-04	4.14E-04	3.09E-04	3.64E-04	4.74E-04	3.74E-04	5.95E-05
		Butyraldehyde/Methacrolien	2.66E-04	2.99E-04	3.03E-04	3.16E-04	2.91E-04	3.55E-04	3.39E-04	3.55E-04	I	3.15E-04	3.20E-05
		Benzaldehyde	1.66E-04	ND	1.42E-04	1.52E-04	1.37E-04	1.78E-04	1.56E-04	1.68E-04	ND	1.22E-04	7.05E-05
		Pentanal	1.85E-04	1.56E-04	1.42E-04	ND	ND	1.61E-04	ND	1.60E-04	ND	8.94E-05	8.55E-05
		Undecane	1.91E-04	8.63E-05	ND	ND	ND	ND	ND	1.90E-04	ND	5.19E-05	8.35E-05
		1,3-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indene	ND	ND	ND	ND	ND	I	ND	ND	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Hexaldehyde	ND	ND	ND	ND	ND	I	ND	ND	ND	ND	NA
		o,m,p-Tolualdehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
			Other Analytes										
		Acetone	1.88E-03	1.99E-03	1.67E-03	I	1.33E-03	1.63E-03	1.41E-03	1.46E-03	6.90E-04	1.51E-03	4.01E-04
		Carbon Dioxide	3.41E+00	2.77E+00	3.60E+00	2.23E+00	3.14E+00	3.37E+00	3.25E+00	3.04E+00	3.14E+00	3.11E+00	4.06E-01
		Carbon Monoxide	1.46E+00	1.39E+00	1.32E+00	1.25E+00	1.28E+00	1.47E+00	1.36E+00	1.33E+00	1.32E+00	1.35E+00	7.38E-02

I: Data rejected based on data validation considerations.

ND: Non Detect; NA: Not Applicable

All "Other Analytes" are not included in the Sum of VOCs or HAPs.

Test Plan FV Individual Emission Test Results – Lb/Lb Parting Spray

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FV001	FV002	FV003	FV004	FV005	FV006	FV007	FV008	FV009	Average	STDEV
		Test Dates	4/20/04	4/20/04	4/20/04	4/21/04	4/21/04	4/21/04	4/22/04	4/22/04	4/22/04		
		TGOC as Propane	2.38E-01	2.10E-01	2.05E-01	1.88E-01	2.23E-01	2.38E-01	1.92E-01	2.06E-01	2.25E-01	2.14E-01	1.83E-02
		HC as Hexane	6.62E-02	5.43E-02	5.23E-02	5.09E-02	5.65E-02	6.10E-02	5.25E-02	5.80E-02	6.26E-02	5.71E-02	5.24E-03
		Sum of VOCs	2.89E-02	2.93E-02	2.93E-02	2.72E-02	2.92E-02	3.02E-02	2.79E-02	3.38E-02	2.71E-02	2.92E-02	2.00E-03
		Sum of HAPs	2.56E-02	2.49E-02	2.54E-02	2.36E-02	2.52E-02	2.53E-02	2.51E-02	3.00E-02	2.34E-02	2.54E-02	1.89E-03
		Sum of POMs	I	1.45E-03	1.54E-03	1.58E-03	1.53E-03	1.68E-03	1.62E-03	1.76E-03	1.48E-03	1.58E-03	1.03E-04
			Individual Organic HAPs										
x		**Benzene**	1.37E-02	1.21E-02	1.25E-02	1.13E-02	1.22E-02	1.28E-02	1.24E-02	1.54E-02	1.62E-02	1.32E-02	1.64E-03
x		**Toluene**	3.66E-03	3.32E-03	3.33E-03	3.07E-03	3.35E-03	3.47E-03	3.44E-03	4.21E-03	I	3.48E-03	3.40E-04
x		**Acetaldehyde**	2.01E-03	1.95E-03	2.20E-03	2.14E-03	2.15E-03	1.96E-03	2.24E-03	2.31E-03	I	2.12E-03	1.34E-04
x		**m,p-Xylene**	2.13E-03	2.03E-03	1.92E-03	1.73E-03	1.94E-03	2.01E-03	1.90E-03	2.37E-03	2.50E-03	2.06E-03	2.41E-04
x	z	**Naphthalene**	I	1.26E-03	1.13E-03	1.19E-03	1.10E-03	1.25E-03	1.18E-03	1.26E-03	1.16E-03	1.19E-03	6.13E-05
x		**o-Xylene**	8.02E-04	7.49E-04	7.20E-04	6.51E-04	7.35E-04	7.66E-04	7.01E-04	8.92E-04	9.46E-04	7.74E-04	9.35E-05
x		**Styrene**	8.02E-04	6.99E-04	6.50E-04	5.02E-04	6.36E-04	7.11E-04	5.85E-04	7.27E-04	7.84E-04	6.77E-04	9.54E-05
x		**Formaldehyde**	6.89E-04	6.00E-04	8.11E-04	7.04E-04	7.04E-04	5.31E-04	6.56E-04	6.65E-04	I	6.70E-04	8.20E-05
x		**Hexane**	7.49E-04	6.50E-04	8.36E-04	6.20E-04	6.99E-04	3.79E-04	6.61E-04	5.54E-04	4.50E-04	6.22E-04	1.43E-04
x		**Ethylbenzene**	5.84E-04	5.42E-04	5.21E-04	4.71E-04	5.40E-04	5.73E-04	5.37E-04	6.90E-04	7.38E-04	5.78E-04	8.46E-05
x	z	**2-Methylnaphthalene**	I	3.20E-04	2.33E-04	2.06E-04	2.07E-04	3.02E-04	2.37E-04	3.10E-04	2.69E-04	2.61E-04	4.61E-05
x		**Propionaldehyde**	2.94E-04	ND	2.70E-04	2.62E-04	2.76E-04	2.86E-04	2.98E-04	3.33E-04	1.65E-04	2.43E-04	1.02E-04
x		**Phenol**	I	4.67E-04	ND	5.59E-04	4.65E-04	ND	ND	ND	ND	1.86E-04	2.59E-04
x	z	**1-Methylnaphthalene**	I	1.86E-04	1.35E-04	1.28E-04	1.57E-04	1.49E-04	1.43E-04	1.68E-04	1.59E-04	1.53E-04	1.86E-05
x		**2-Butanone**	8.62E-05	8.67E-05	1.02E-04	1.02E-04	8.79E-05	1.02E-04	1.05E-04	1.12E-04	I	9.80E-05	9.74E-06
x	z	**Acenaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Biphenyl**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**m,p-Cresol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**o-Cresol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,7-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Acrolein**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FV Individual Emission Test Results – Lb/Lb Parting Spray

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FV001	FV002	FV003	FV004	FV005	FV006	FV007	FV008	FV009	Average	STDEV
		Test Dates	**4/20/04**	**4/20/04**	**4/20/04**	**4/21/04**	**4/21/04**	**4/21/04**	**4/22/04**	**4/22/04**	**4/22/04**		
			Other VOCs										
		Tetradecane	1.25E-03	8.74E-04	7.43E-04	6.89E-04	7.91E-04	9.90E-04	9.24E-04	1.12E-03	1.02E-03	9.33E-04	1.82E-04
		1,2,4-Trimethylbenzene	1.04E-03	8.12E-04	8.01E-04	7.28E-04	8.22E-04	8.07E-04	7.76E-04	9.63E-04	1.01E-03	8.62E-04	1.11E-04
		Heptane	ND	1.26E-03	1.26E-03	1.15E-03	1.38E-03	1.44E-03	ND	ND	4.27E-04	7.69E-04	6.47E-04
		1,3,5-Trimethylbenzene	I	3.82E-04	3.75E-04	3.80E-04	3.65E-04	4.43E-04	4.10E-04	3.67E-04	3.20E-04	3.80E-04	3.56E-05
		3-Ethyltoluene	4.20E-04	3.89E-04	ND	ND	ND	4.06E-04	ND	4.42E-04	4.96E-04	2.39E-04	2.29E-04
		1,2,3-Trimethylbenzene	I	2.48E-04	1.97E-04	2.36E-04	2.14E-04	2.30E-04	2.30E-04	2.08E-04	2.29E-04	2.24E-04	1.66E-05
		2-Ethyltoluene	2.09E-04	1.95E-04	1.91E-04	1.48E-04	1.78E-04	1.90E-04	1.67E-04	2.05E-04	2.46E-04	1.92E-04	2.76E-05
		Butyraldehyde/Methacrolein	1.36E-04	1.40E-04	1.58E-04	1.61E-04	1.59E-04	1.64E-04	1.83E-04	1.99E-04	I	1.62E-04	2.08E-05
		Benzaldehyde	8.51E-05	ND	7.42E-05	7.76E-05	7.49E-05	8.22E-05	8.42E-05	9.47E-05	ND	6.36E-05	3.66E-05
		Pentanal	9.47E-05	7.30E-05	7.42E-05	ND	ND	7.41E-05	ND	9.00E-05	ND	4.51E-05	4.34E-05
		Undecane	9.78E-05	4.03E-05	ND	ND	ND	ND	ND	1.07E-04	ND	2.72E-05	4.46E-05
		Indene	ND	ND	ND	ND	ND	I	ND	ND	ND	ND	NA
		Hexaldehyde	ND	ND	ND	ND	ND	I	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,3-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		o,m,p-Tolualdehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
			Other Analytes										
		Acetone	9.63E-04	9.29E-04	8.75E-04	1.57E-03	7.26E-04	7.50E-04	7.62E-04	8.20E-04	3.58E-04	8.62E-04	3.19E-04
		Carbon Dioxide	1.74E+00	1.29E+00	1.89E+00	1.14E+00	1.71E+00	1.55E+00	1.75E+00	1.71E+00	1.63E+00	1.60E+00	2.40E-01
		Carbon Monoxide	7.44E-01	6.50E-01	6.91E-01	6.39E-01	6.98E-01	6.77E-01	7.33E-01	7.48E-01	6.82E-01	6.96E-01	3.93E-02

I: Data rejected based on data validation considerations.

ND: Non Detect; NA: Not Applicable

All "Other Analytes" are not included in the Sum of VOCs or HAPs.

Test Plan FI Quantitation Limits – Lb/Tn Metal

Analytes	Lb/Tn Metal
1,2,3-Trimethylbenzene	1.31E-04
1,2,4-Trimethylbenzene	1.31E-04
1,3,5-Trimethylbenzene	1.31E-04
1,3-Dimethylnaphthalene	1.31E-04
1-Methylnaphthalene	1.31E-04
2-Ethyltoluene	1.31E-04
2-Methylnaphthalene	1.31E-04
Benzene	1.31E-04
Ethylbenzene	1.31E-04
Hexane	1.31E-04
m,p-Xylene	1.31E-04
Naphthalene	1.31E-04
o-Xylene	1.31E-04
Styrene	1.31E-04
Toluene	1.31E-04
Undecane	1.31E-04
1,2-Dimethylnaphthalene	6.55E-04
1,3-Diethylbenzene	6.55E-04
1,5-Dimethylnaphthalene	6.55E-04
1,6-Dimethylnaphthalene	6.55E-04
1,8-Dimethylnaphthalene	6.55E-04
2,3,5-Trimethylnaphthalene	6.55E-04
2,3-Dimethylnaphthalene	6.55E-04
2,4-Dimethylphenol	6.55E-04
2,6-Dimethylnaphthalene	6.55E-04
2,6-Dimethylphenol	6.55E-04
2,7- Dimethylnaphthalene	6.55E-04
3-Ethyltoluene	6.55E-04
Acenaphthalene	6.55E-04

Analytes	Lb/Tn Metal
Biphenyl	6.55E-04
Cyclohexane	6.55E-04
Decane	6.55E-04
Dodecane	6.55E-04
Heptane	6.55E-04
Indan	6.55E-04
Indene	6.55E-04
m,p-Cresol	6.55E-04
Nonane	6.55E-04
o-Cresol	6.55E-04
Octane	6.55E-04
Phenol	6.55E-04
Propylbenzene	6.55E-04
Tetradecane	6.55E-04
2-Butanone (MEK)	1.14E-04
Acetaldehyde	1.14E-04
Acetone	1.14E-04
Acrolein	1.14E-04
Benzaldehyde	1.14E-04
Butyraldehyde	1.14E-04
Crotonaldehyde	1.14E-04
Formaldehyde	1.14E-04
Hexaldehyde	1.14E-04
Butyraldehyde/Methacrolein	1.90E-04
o,m,p-Tolualdehyde	3.04E-04
Pentanal (Valeraldehyde)	1.14E-04
Propionaldehyde (Propanal)	1.14E-04
HC as Hexane	3.67E-03

Analytes	Lb/Tn Metal
Carbon Monoxide	3.09E-01
Methane	1.76E-02
Carbon Dioxide	4.85E-01
Ethane	3.31E-01
Propane	4.85E-01
Isobutane	6.39E-01
Butane	6.39E-01
Neopentane	7.94E-01
Isopentane	7.94E-01
Pentane	7.94E-01

Test Plan FI Quantitation Limits – Lb/Lb Parting Spray

Analytes	Lb/Lb Parting Spray
1,2,3-Trimethylbenzene	7.13E-05
1,2,4-Trimethylbenzene	7.13E-05
1,3,5-Trimethylbenzene	7.13E-05
1,3-Dimethylnaphthalene	7.13E-05
1-Methylnaphthalene	7.13E-05
2-Ethyltoluene	7.13E-05
2-Methylnaphthalene	7.13E-05
Benzene	7.13E-05
Ethylbenzene	7.13E-05
Hexane	7.13E-05
m,p-Xylene	7.13E-05
Naphthalene	7.13E-05
o-Xylene	7.13E-05
Styrene	7.13E-05
Toluene	7.13E-05
Undecane	7.13E-05
1,2-Dimethylnaphthalene	3.56E-04
1,3-Diethylbenzene	3.56E-04
1,5-Dimethylnaphthalene	3.56E-04
1,6-Dimethylnaphthalene	3.56E-04
1,8-Dimethylnaphthalene	3.56E-04
2,3,5-Trimethylnaphthalene	3.56E-04
2,3-Dimethylnaphthalene	3.56E-04
2,4-Dimethylphenol	3.56E-04
2,6-Dimethylnaphthalene	3.56E-04
2,6-Dimethylphenol	3.56E-04
2,7- Dimethylnaphthalene	3.56E-04
3-Ethyltoluene	3.56E-04
Acenaphthalene	3.56E-04

Analytes	Lb/Lb Parting Spray
Biphenyl	3.56E-04
Cyclohexane	3.56E-04
Decane	3.56E-04
Dodecane	3.56E-04
Heptane	3.56E-04
Indan	3.56E-04
Indene	3.56E-04
m,p-Cresol	3.56E-04
Nonane	3.56E-04
o-Cresol	3.56E-04
Octane	3.56E-04
Phenol	3.56E-04
Propylbenzene	3.56E-04
Tetradecane	3.56E-04
2-Butanone (MEK)	6.19E-05
Acetaldehyde	6.19E-05
Acetone	6.19E-05
Acrolein	6.19E-05
Benzaldehyde	6.19E-05
Butyraldehyde	6.19E-05
Crotonaldehyde	6.19E-05
Formaldehyde	6.19E-05
Hexaldehyde	6.19E-05
Butyraldehyde/Methacrolein	1.03E-04
o,m,p-Tolualdehyde	1.65E-04
Pentanal (Valeraldehyde)	6.19E-05
Propionaldehyde (Propanal)	6.19E-05
HC as Hexane	2.00E-03

Analytes	Lb/Lb Parting Spray
Carbon Monoxide	1.68E-01
Methane	9.59E-03
Carbon Dioxide	2.64E-01
Ethane	1.80E-01
Propane	2.64E-01
Isobutane	3.48E-01
Butane	3.48E-01
Neopentane	4.32E-01
Isopentane	4.32E-01
Pentane	4.32E-01

Test Plan FV Quantitation Limits – Lb/Tn Metal

Analytes	Lb/Tn Metal
1,2,3-Trimethylbenzene	1.50E-04
1,2,4-Trimethylbenzene	1.50E-04
1,3,5-Trimethylbenzene	1.50E-04
1,3-Dimethylnaphthalene	1.50E-04
1-Methylnaphthalene	1.50E-04
2-Ethyltoluene	1.50E-04
2-Methylnaphthalene	1.50E-04
Benzene	1.50E-04
Ethylbenzene	1.50E-04
Hexane	1.50E-04
m,p-Xylene	1.50E-04
Naphthalene	1.50E-04
o-Xylene	1.50E-04
Styrene	1.50E-04
Toluene	1.50E-04
Undecane	1.50E-04
1,2-Dimethylnaphthalene	7.48E-04
1,3-Diethylbenzene	7.48E-04
1,5-Dimethylnaphthalene	7.48E-04
1,6-Dimethylnaphthalene	7.48E-04

Analytes	Lb/Tn Metal
1,8-Dimethylnaphthalene	7.48E-04
2,3,5-Trimethylnaphthalene	7.48E-04
2,3-Dimethylnaphthalene	7.48E-04
2,4-Dimethylphenol	7.48E-04
2,6-Dimethylnaphthalene	7.48E-04
2,6-Dimethylphenol	7.48E-04
2,7- Dimethylnaphthalene	7.48E-04
3-Ethyltoluene	7.48E-04
Acenaphthalene	7.48E-04
Biphenyl	7.48E-04
Cyclohexane	7.48E-04
Decane	7.48E-04
Dodecane	7.48E-04
Heptane	7.48E-04
Indan	7.48E-04
Indene	7.48E-04
m,p-Cresol	7.48E-04
Nonane	7.48E-04
o-Cresol	7.48E-04
Octane	7.48E-04

Analytes	Lb/Tn Metal
Phenol	7.48E-04
Propylbenzene	7.48E-04
Tetradecane	7.48E-04
HC as Hexane	4.53E-03
2-Butanone (MEK)	1.39E-04
Acetaldehyde	1.39E-04
Acetone	1.39E-04
Acrolein	1.39E-04
Benzaldehyde	1.39E-04
Butyraldehyde	1.39E-04
Crotonaldehyde	1.39E-04
Formaldehyde	1.39E-04
Hexaldehyde	1.39E-04
Butyraldehyde/Methacrolein	2.32E-04
o,m,p-Tolualdehyde	3.72E-04
Pentanal (Valeraldehyde)	1.39E-04
Propionaldehyde (Propanal)	1.39E-04
Carbon Monoxide	3.54E-02
Carbon Dioxide	5.57E-02

Test Plan FV Quantitation Limits – Lb/Lb Parting Spray

Analytes	Lb/Lb Parting Spray
1,2,3-Trimethylbenzene	7.73E-05
1,2,4-Trimethylbenzene	7.73E-05
1,3,5-Trimethylbenzene	7.73E-05
1,3-Dimethylnaphthalene	7.73E-05
1-Methylnaphthalene	7.73E-05
2-Ethyltoluene	7.73E-05
2-Methylnaphthalene	7.73E-05
Benzene	7.73E-05
Ethylbenzene	7.73E-05
Hexane	7.73E-05
m,p-Xylene	7.73E-05
Naphthalene	7.73E-05
o-Xylene	7.73E-05
Styrene	7.73E-05
Toluene	7.73E-05
Undecane	7.73E-05
1,2-Dimethylnaphthalene	3.86E-04
1,3-Diethylbenzene	3.86E-04
1,5-Dimethylnaphthalene	3.86E-04
1,6-Dimethylnaphthalene	3.86E-04

Analytes	Lb/Lb Parting Spray
1,8-Dimethylnaphthalene	3.86E-04
2,3,5-Trimethylnaphthalene	3.86E-04
2,3-Dimethylnaphthalene	3.86E-04
2,4-Dimethylphenol	3.86E-04
2,6-Dimethylnaphthalene	3.86E-04
2,6-Dimethylphenol	3.86E-04
2,7- Dimethylnaphthalene	3.86E-04
3-Ethyltoluene	3.86E-04
Acenaphthalene	3.86E-04
Biphenyl	3.86E-04
Cyclohexane	3.86E-04
Decane	3.86E-04
Dodecane	3.86E-04
Heptane	3.86E-04
Indan	3.86E-04
Indene	3.86E-04
m,p-Cresol	3.86E-04
Nonane	3.86E-04
o-Cresol	3.86E-04
Octane	3.86E-04

Analytes	Lb/Lb Parting Spray
Phenol	3.86E-04
Propylbenzene	3.86E-04
Tetradecane	3.86E-04
HC as Hexane	2.34E-03
2-Butanone (MEK)	7.20E-05
Acetaldehyde	7.20E-05
Acetone	7.20E-05
Acrolein	7.20E-05
Benzaldehyde	7.20E-05
Butyraldehyde	7.20E-05
Crotonaldehyde	7.20E-05
Formaldehyde	7.20E-05
Hexaldehyde	7.20E-05
Butyraldehyde/Methacrolein	1.20E-04
o,m,p-Tolualdehyde	1.92E-04
Pentanal (Valeraldehyde)	7.20E-05
Propionaldehyde (Propanal)	7.20E-05
Carbon Monoxide	1.83E-02
Carbon Dioxide	2.88E-02

FI and FV Average Test Results with T-Statistics – Lb/Tn Metal

Analytes	Test FI (Lb/Tn Metal)	Test FV (Lb/Tn Metal)	T-Statistic
TGOC as Propane	0.8651	0.4172	18.7
HC as Hexane	0.1680	0.1114	10.0
Sum of VOCs	0.0819	0.0568	8.1
Sum of HAPs	0.0643	0.0494	5.6
Sum of POMs	0.0030	0.0031	-0.5
Individual Organic HAPs			
Benzene	0.0304	0.0256	3.0
Toluene	0.0106	0.0068	9.8
o,m,p-Xylene	0.0095	0.0055	9.8
Acetaldehyde	0.0030	0.0041	-10.4
Naphthalene	0.0023	0.0023	0.0
Hexane	0.0023	0.0012	4.9
Formaldehyde	0.0018	0.0013	4.7
Ethylbenzene	0.0015	0.0011	4.2
Styrene	0.0010	0.0013	-4.0
Methylnaphthalenes	0.0008	0.0008	0.0
Other VOCs			
Trimethylbenzenes	0.0044	0.0027	9.0
Heptane	0.0044	0.0015	6.5
Tetradecane	0.0029	0.0018	6.6
Octane	0.0022	ND	66.0
Ethyltoluenes	0.0018	0.0008	5.6
Other Analytes			
Carbon Dioxide	18.72	3.107	49.3
Carbon Monoxide	ND	1.354	-55.0

ND: Non Detect; NA: Not Applicable

Individual results constitute >95% of mass of all detected VOCs.

All "Other Analytes" are not includedin the sum of HAPs or VOCs.

FI and FV Average Test Results with T-Statistics – Lb/Lb Parting Spray

Analytes	Test FI (Lb/Lb Parting Spray)	Test FV (Lb/Lb Parting Spray)	T-Statistic
TGOC as Propane	0.4717	0.2138	27.7
HC as Hexane	0.0895	0.0571	14.4
Sum of VOCs	0.0455	0.0292	11.9
Sum of HAPs	0.0358	0.0254	8.6
Sum of POMs	0.0018	0.0016	1.5
Individual Organic HAPs			
Benzene	0.0167	0.0132	4.5
Toluene	0.0058	0.0035	11.8
o,m,p-Xylene	0.0052	0.0028	12.3
Acetaldehyde	0.0016	0.0021	-10.6
Hexane	0.0014	0.0006	3.9
Naphthalene	0.0013	0.0012	0.9
Formaldehyde	0.0010	0.0007	6.4
Ethylbenzene	0.0008	0.0006	4.2
Styrene	0.0005	0.0007	-6.0
Other VOCs			
Trimethylbenzenes	0.0024	0.0014	10.6
Heptane	0.0024	0.0008	7.6
Tetradecane	0.0017	0.0009	5.4
Octane	0.0012	ND	NA
Ethyltoluene	0.0010	0.0004	5.7
Other Analytes			
Carbon Dioxide	10.29	1.602	48.6
Carbon Monoxide	ND	0.6960	-53.1

ND: Non Detect; NA: Not Applicable

Individual results constitute >95% of mass of all detected VOCs.

All "Other Analytes" are not induded in the sum of HAPs or VOCs.

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APPENDIX C TEST SERIES FI AND FV DETAILED PROCESS DATA

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Test FI Detailed Process Data

Greensand PCS										
Pour Date	**7/14/2003**	**7/14/2003**	**7/15/2003**	**7/15/2003**	**7/15/2003**	**7/16/2003**	**7/16/2003**	**7/16/2003**	**7/17/2003**	**Average**
Emissions Sample #	**FI 001**	**FI 002**	**FI 003**	**FI 004**	**FI 005**	**FI 006**	**FI 007**	**FI 008**	**FI 009**	
Production Sample #	**FI 005**	**FI 006**	**FI 007**	**FI 008**	**FI 009**	**FI 010**	**FI 011**	**FI 012**	**FI 013**	
Cast Weight - All Metal Inside Mold (lbs.)	100.5	96.0	95.0	96.0	99.5	99.5	98.0	96.5	100.5	**97.9**
Pouring Time (sec.)	19	21	21	20	16	16	13	14	16	**17**
Pouring Temp (°F)	2679	2688	2673	2679	2690	2689	2680	2675	2689	**2682**
Pour Hood Process Air Temp at Start of Pour (°F)	87	92	87	87	90	86	87	90	85	**88**
Muller Batch Weight (lbs.)	970	900	900	900	910	900	900	840	900	**902**
GS Mold Sand Weight, (lbs.)	656	650	660	656	660	660	656	660	660	**658**
Mold Compactability, %	49	51	49	48	48	45	48	45	45	**48**
Mold Temperature (°F)	87	91	86	90	89	83	93	96	83	**89**
Average Green Compression (psi)	13.50	12.53	12.77	13.69	13.97	13.95	13.40	13.46	14.99	**13.58**
GS Compactability (%)	43	51	47	45	45	42	44	42	41	**44**
GS Moisture Content (%)	1.78	1.98	1.88	1.95	2.01	2.00	1.96	1.88	1.80	**1.92**
GS MBClay Content (%)	6.87	6.62	6.87	6.87	7.25	7.64	6.87	6.62	6.87	**6.94**
MB Clay reagent, ml	27.0	26.0	27.0	27.0	28.5	30.0	27.0	26.0	27.0	**27.3**
1800°F LOI - Mold Sand (%)	1.12	1.19	1.12	1.10	1.13	1.11	1.14	1.04	1.05	**1.11**
900°F Volatiles (%)	0.53	0.42	0.40	0.38	0.32	0.42	0.36	0.30	0.34	**0.39**
Liquid Parting Spray (grams)	40	41	40	41	40	40	41	41	41	**40.6**

Test FV Detailed Process Data

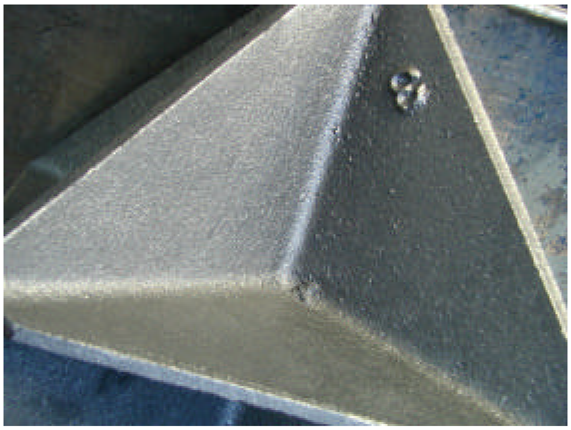
Greensand PCS															
Pour Date	**4/19/2004**	**4/19/2004**	**4/19/2004**	**4/20/2004**	**4/20/2004**	**4/20/2004**	**4/21/2004**	**4/21/2004**	**4/21/2004**	**4/22/2004**	**4/22/2004**	**4/22/2004**	**4/23/2004**	**4/23/2004**	**Average of emission sampled runs**
Emissions Sample #	**FV CR-1**	**FV CR-2**	**FV CR-3**	**FV001**	**FV002**	**FV003**	**FV004**	**FV005**	**FV006**	**FV007**	**FV008**	**FV009**	**FV010**	**FV011**	
Production Sample #	**FV001**	**FV002**	**FV003**	**FV004**	**FV005**	**FV006**	**FV007**	**FV008**	**FV009**	**FV010**	**FV011**	**FV012**	**FV013**	**FV014**	
Cast Weight- All Metal Inside Mold (lbs.)	91.6	89.9	83.9	91.0	88.7	90.0	88.8	92.0	82.9	92.7	92.2	91.3	90.3	N/D	**89.9**
Pouring Time (sec.)	20	19	15	19	17	17	23	15	16	24	19	17	18	18	**19**
Pouring Temp (°F)	2630	2633	2636	2633	2634	2633	2639	2637	2623	2637	2635	2638	2629	2638	**2634**
Pour Hood Process Air Temp at Start of Pour (°F)	86	85	88	85	88	90	85	88	91	86	86	90	85	87	**88**
Muller Batch Weight (lbs.)	1210	900	900	900	900	900	900	900	900	900	900	890	900	900	**899**
GS Mold Sand Weight (lbs.)	660	664	667	662	660	663	664	657	657	656	657	658	655	658	**659**
Mold Compactability (%)	54	54	48	53	52	50	53	52	52	53	53	50	53	51	**52**
Mold Temperature (°F)	66	69	72	70	72	77	68	72	72	66	71	76	68	75	**72**
Average Green Compression (psi)	9.80	10.45	12.52	10.04	11.81	10.45	10.56	13.81	15.11	15.10	16.14	16.43	14.07	14.99	**13.27**
GS Compactability (%)	50	50	33	50	47	39	47	43	43	42	38	35	39	35	**43**
GS Moisture Content (%)	2.22	2.27	2.28	1.71	1.48	1.56	1.45	1.49	2.17	1.96	2.03	1.89	2.12	1.71	**1.75**
GS Clay Content (%)	7.00	7.00	6.88	6.88	6.75	6.88	6.63	6.63	6.75	6.88	6.88	6.63	N/D	N/D	**6.76**
MB Clay reagent, ml	28	28	27.5	27.5	27	27.5	26.5	26.5	27	27.5	27.5	26.5	N/D	N/D	**27.1**
1800°F LOI - Mold Sand (%)	0.69	0.68	1.04	0.77	0.82	0.73	0.86	0.90	0.91	0.63	0.84	0.71	0.65	0.71	**0.80**
900°F Volatiles (%)	0.00	0.02	0.30	0.08	0.38	0.32	0.44	0.39	0.62	0.44	0.49	0.24	0.22	0.28	**0.38**
Liquid Parting Spray (grams)	39.8	39.0	39.2	40.5	43.3	39.3	39.6	38.4	40.9	38.9	37.5	39.7	40.4	39.3	**39.8**
Mold vents	3	2	1	1	1	1	1	1	1	1	1	1	4	0	
Rank order 1 = best 5 = median 9 = worst				5	4	9	7	8	10	6	12	11	13	14	

FV001 3/4 of pattern release was on drag

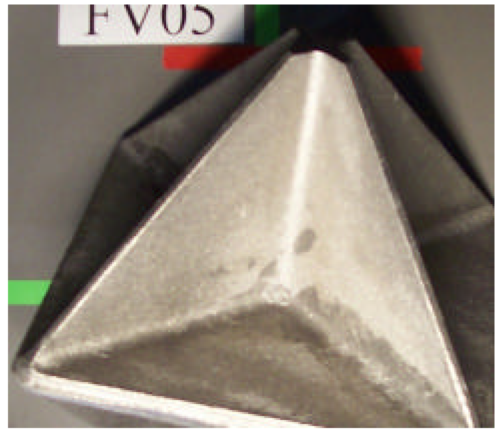
FV013,014 special test to document impact of 4 vents and 0 vents.

CASTING COMPARISON FV TO FK

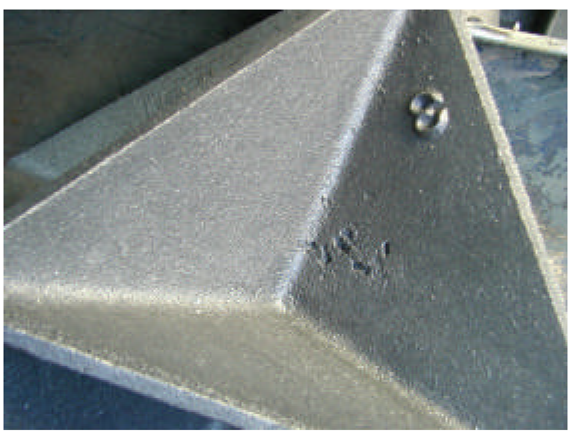
The Aquapart II pattern release is intended to be a seacoal substitute so the casting comparison is against the combination baseline with seacoal even though the emission comparison is against the pattern release baseline FI.



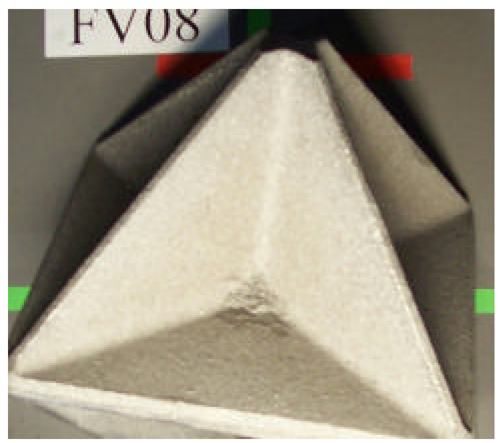
FK001 Best



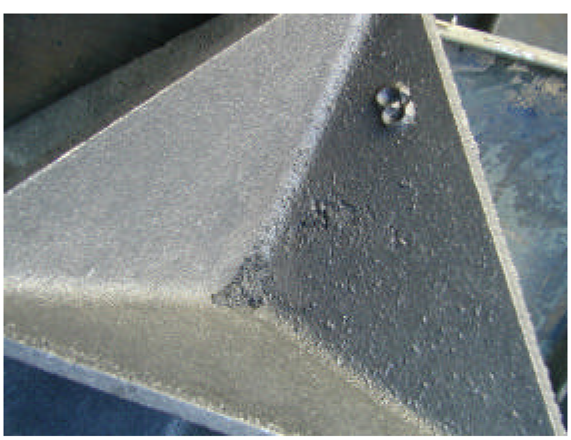
FV005 Best



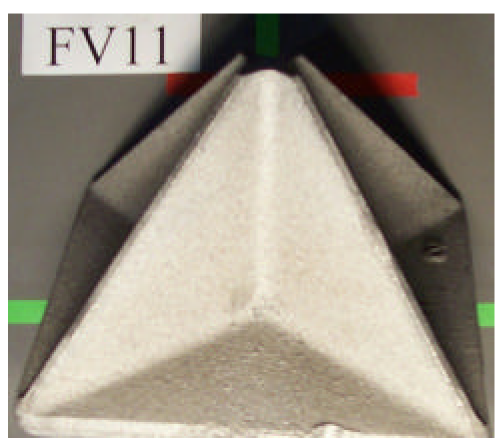
FK005 median



FV008 Median



FK004 Worst



FV011 Worst

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APPENDIX D METHOD 25A CHARTS

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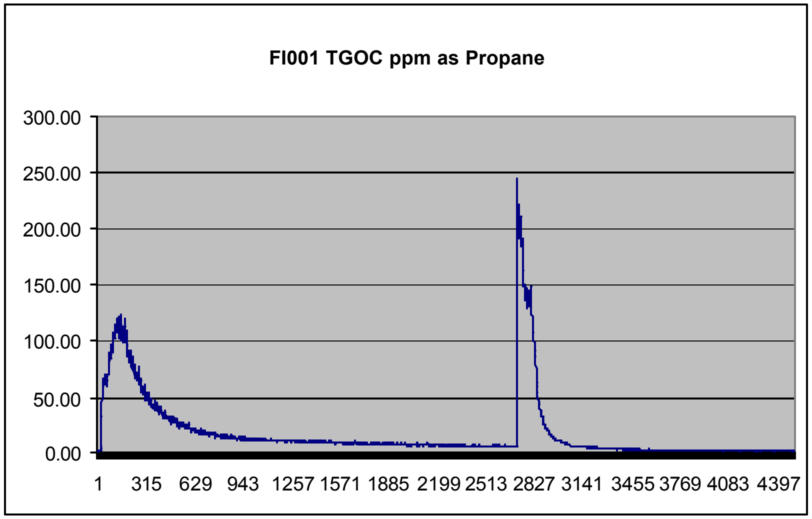
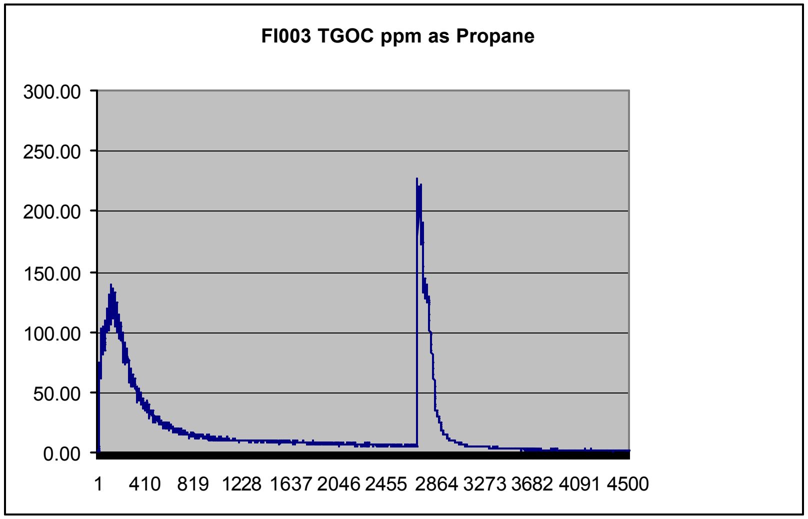
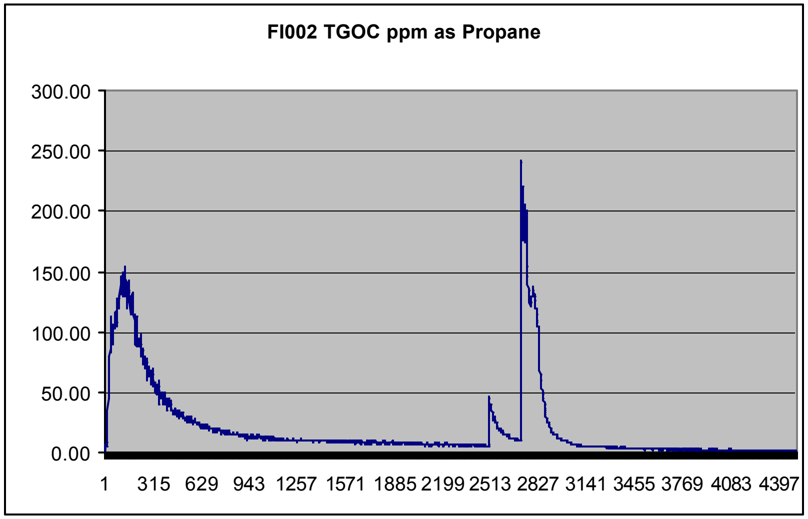
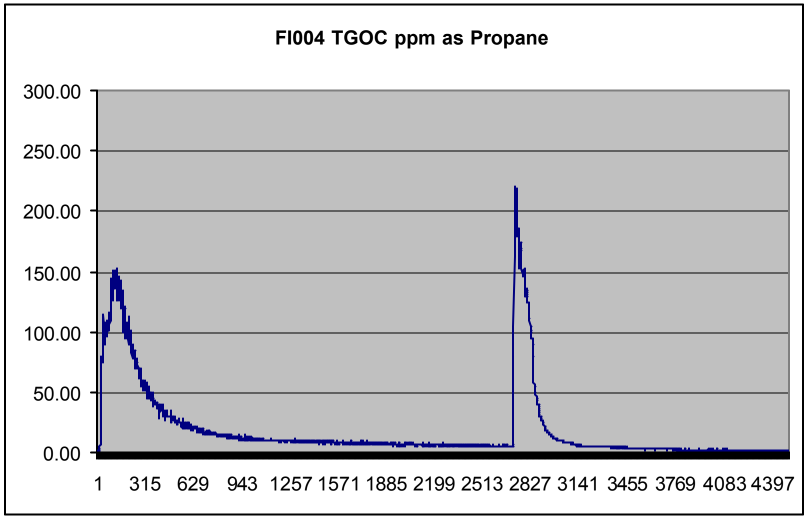
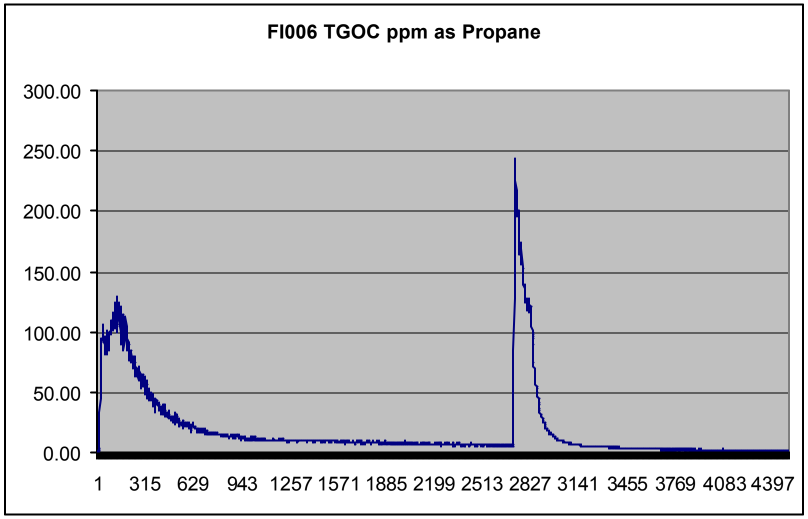
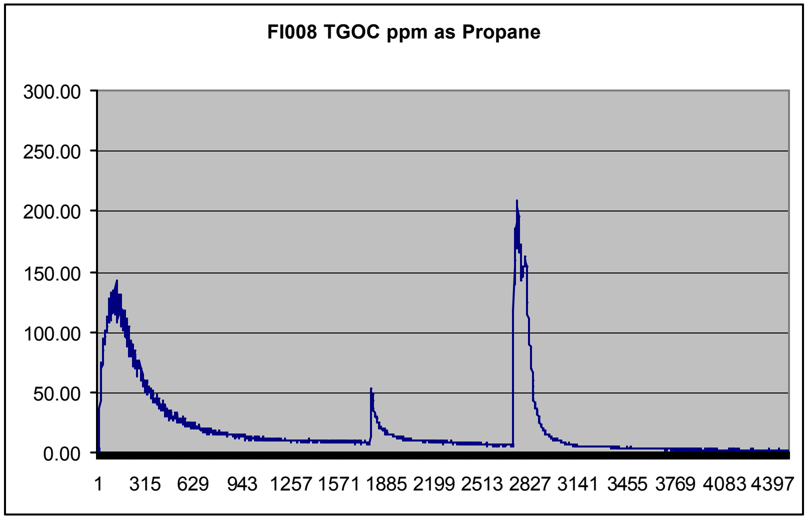

FI001 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

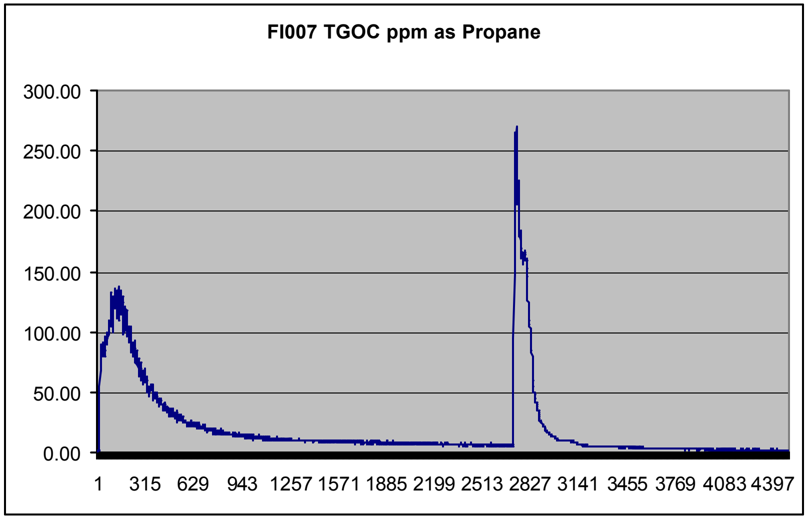

FI003 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 410 819 1228 1637 2046 2455 2864 3273 3682 4091 4500

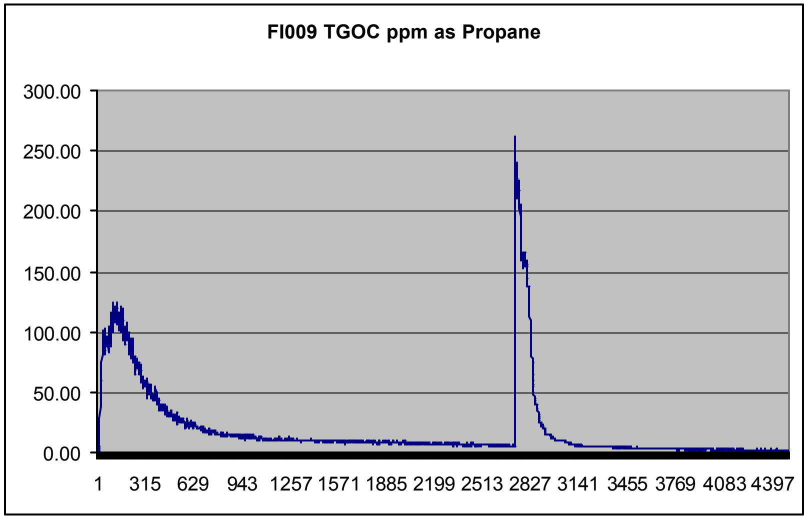

FI002 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

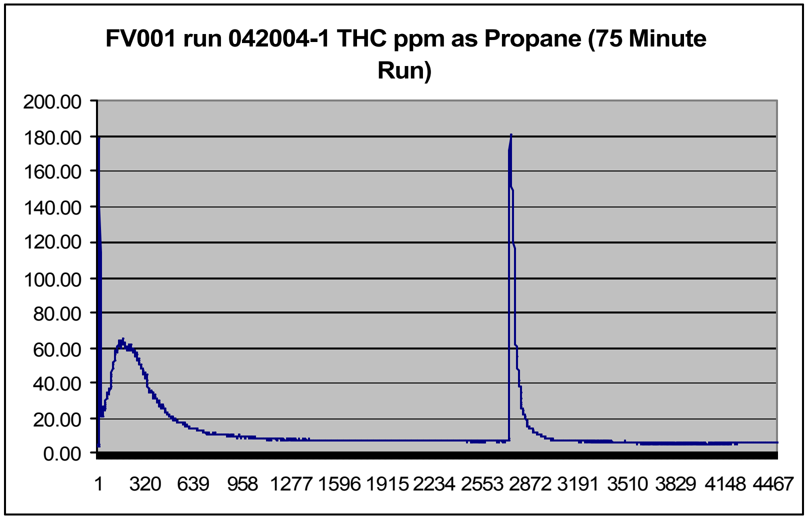

FI004 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

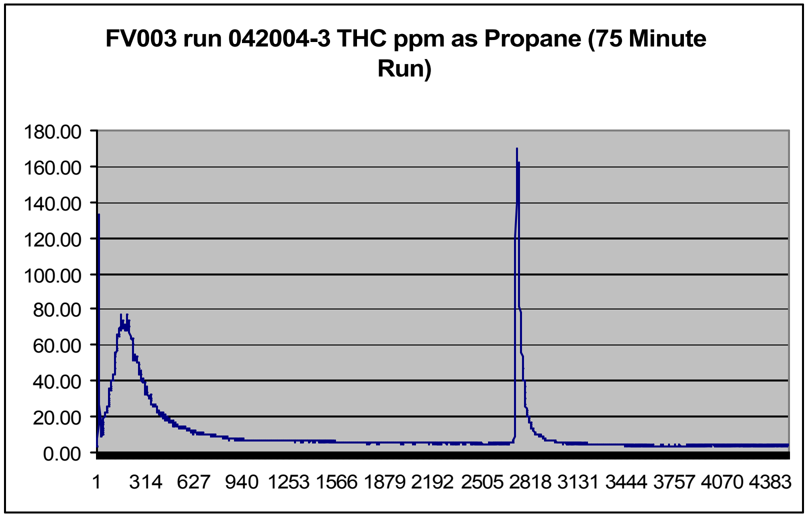

FI006 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

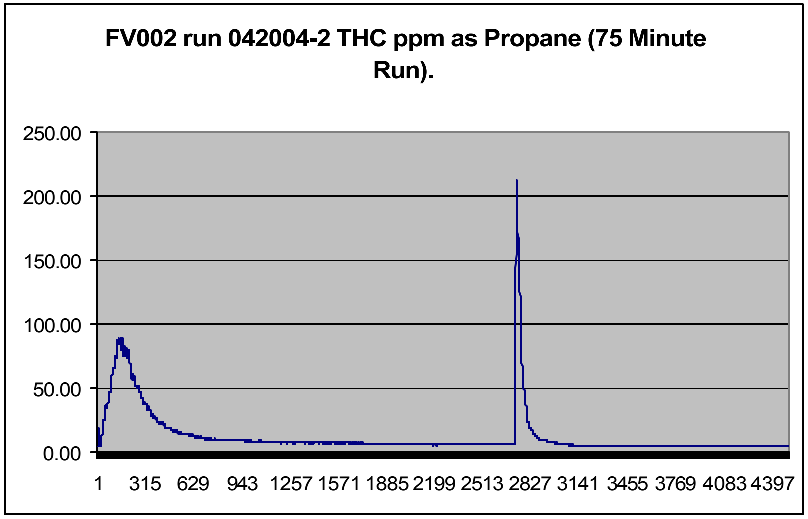

FI008 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

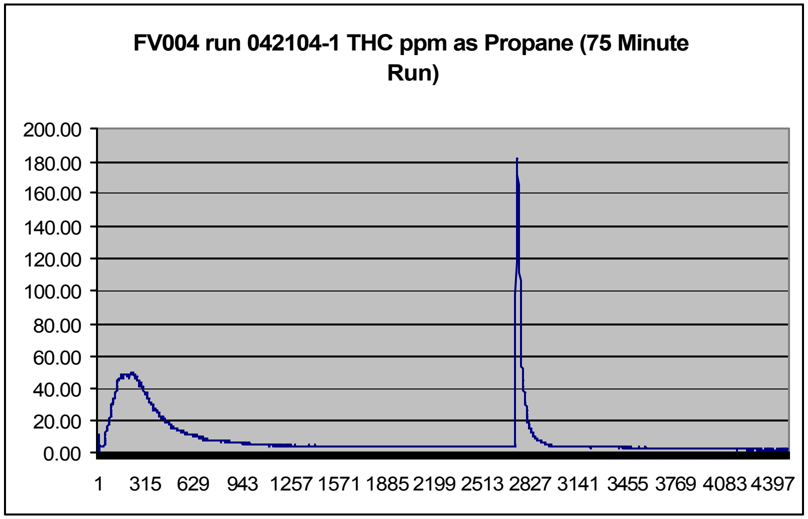

FI007 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

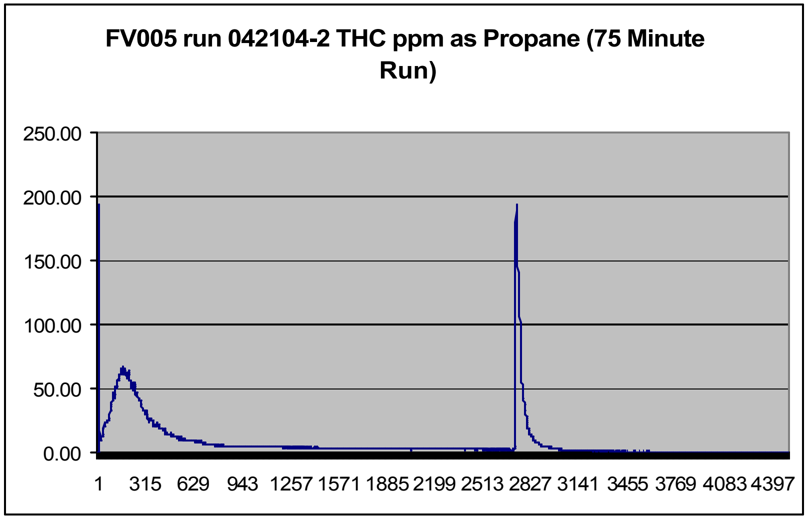

FI009 TGOC ppm as Propane
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

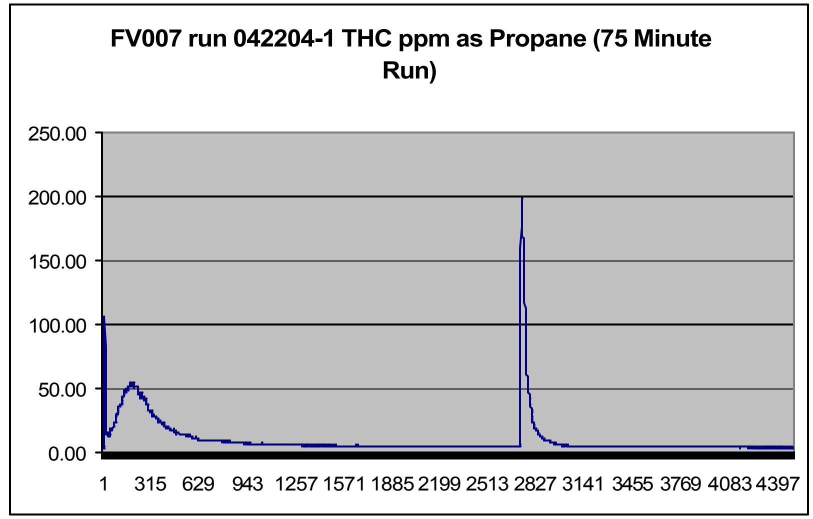

FV001 run 042004-1 THC ppm as Propane (75 Minute Run)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1 320 639 958 1277 1596 1915 2234 2553 2872 3191 3510 3829 4148 4467

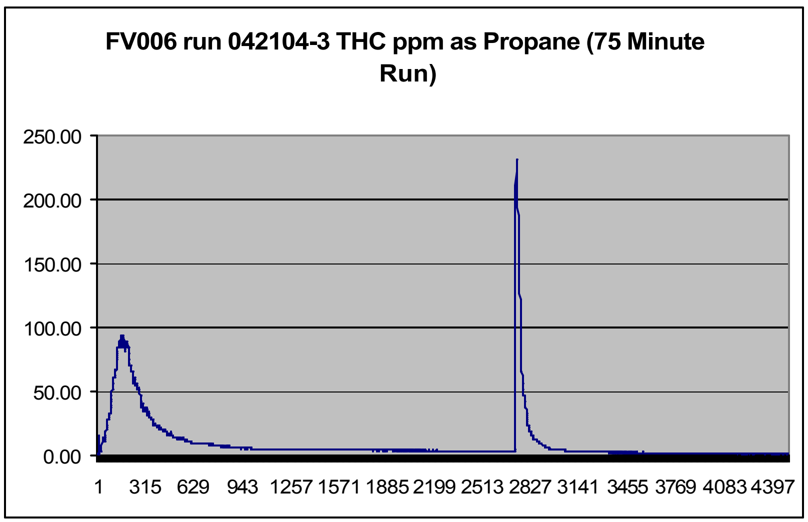

FV003 run 042004-3 THC ppm as Propane (75 Minute Run)
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1 314 627 940 1253 1566 1879 2192 2505 2818 3131 3444 3757 4070 4383

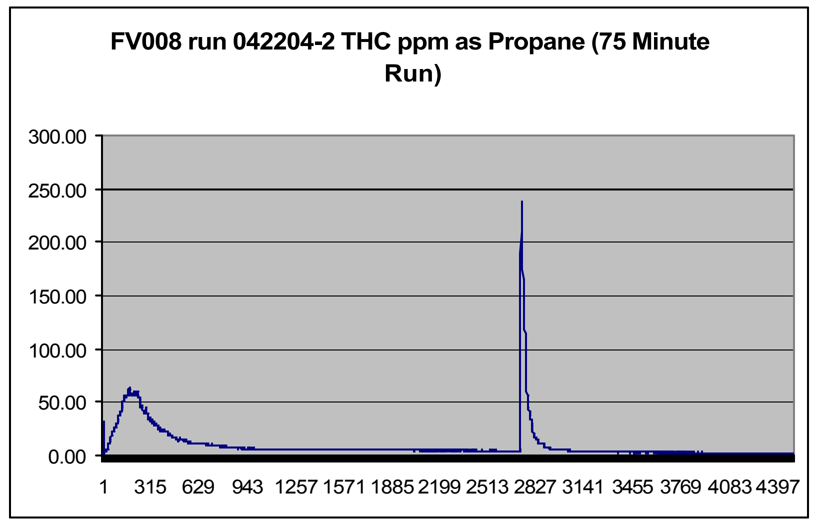

FV002 run 042004-2 THC ppm as Propane (75 Minute Run).
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

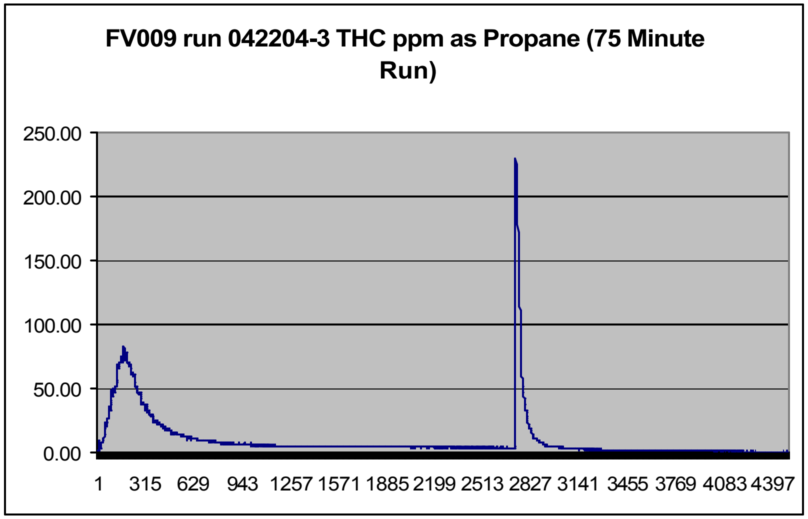

FV004 run 042104-1 THC ppm as Propane (75 Minute Run)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FV005 run 042104-2 THC ppm as Propane (75 Minute Run)
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FV007 run 042204-1 THC ppm as Propane (75 Minute Run)
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FV006 run 042104-3 THC ppm as Propane (75 Minute Run)
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FV008 run 042204-2 THC ppm as Propane (75 Minute Run)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FV009 run 042204-3 THC ppm as Propane (75 Minute Run)
250.00
200.00
150.00
100.00
50.00
0.00
1
315
629
943
1257
1571
1885
2199
2513
2827
3141
3455
3769
4083
4397

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APPENDIX E GLOSSARY

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Glossary

BO	Based on ( ).
BOS	Based on Sand.
HAP	Hazardous Air Pollutant defined by the 1990 Clean Air Act Amendment
HC as Hexane	Calculated by the summation of all area between elution of Hexane through the elution of Hexadecane. The quantity of HC is performed against a five-point calibration curve of Hexane by dividing the total area count from C6 through C16 to the area of Hexane from the initial calibration curve.
I	Data rejected based on data validation considerations
NA	Not Applicable
ND	Non-Detect
NT	Lab testing was not done
POM	Polycyclic Organic Matter (POM) including Naphthalene and other compounds that contain more than one benzene ring and have a boiling point greater than or equal to 100 degrees Celsius.
TGOC as Propane	Weighted to the detection of more volatile hydrocarbon species, beginning at C1 (methane), with results calibrated against a three-carbon alkane (propane).
VOC	Volatile Organic Compound