Casting Emission Reduction Program

Prepared by:
TECHNIKON LLC
5301 Price Avenue ▼ McClellan, CA, 95652 ▼ (916) 929-8001
www.technikonllc.com

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Emission Comparison of Phenolic Urethane Binders with Standard Solvents and Naphthalene-Depleted Solvents

Technikon # 1409-125 FB and 1409-117 FC

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EPA United States Environmental Protection Agency

CISA

AFS AMERICAN FOUNDRY SOCIETY, INC.

USCAR UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH
DaimlerChrysler Ford Motor Company General Motors

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Emission Comparison of Phenolic Urethane Binders with Standard Solvents and Naphthalene-Depleted Solvents

1409-1.2.5 FB
1409-1.1.7 FC

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

Research Chemist	*// Original Signed //* Carmen Hornsby	Date
Process Engineering Manager	*// Original Signed //* Steven M. Knight	Date
V. P. Measurement Technology	*// Original Signed //* Clifford R. Glowacki, CIH	Date
V. P. Operations	*// Original Signed //* George Crandell	Date
President	*// Original Signed //* William Walden	Date

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 FC core binder system containing a "naphthalene depleted" solvent in greensand mold with seacoal. These data are compared to results from Test FB, a baseline using a standard binder system with naphthalene. 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 binder. The results show that the use of "naphthalene depleted" solvents do not reduce the total HAP emissions.

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, binder; 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 tests runs. Samples were collected and analyzed for over seventy (70) 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 binder 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. Several "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 Lb/Tn of metal and Lb/Lb of binder.

Test Plans FB and FC Emissions Indicators – Lb/Tn Metal

Analytes	TGOC as Propane	HC as Hexane	Sum of VOCs	Sum of HAPs	Sum of POMs
Test FB	1.782	0.3267	0.4274	0.3967	0.0369
Test FC	1.890	0.4129	0.4987	0.4632	0.0241

Test Plans FB and FC Emissions Indicators – Lb/Lb Binder

Analytes	TGOC as Propane	HC as Hexane	Sum of VOCs	Sum of HAPs	Sum of POMs
Test FB	0.1871	0.0347	0.0458	0.0425	0.0047
Test FC	0.1901	0.0418	0.0502	0.0465	0.0024

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.

1.0 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 Pre-Production 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.

The Production Foundry provides simultaneous detailed individual emission measurements using methods based on US EPA protocols for the melting, pouring, sand preparation, mold making, and core making processes.

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.

1.3 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 the No-Bake mold making process. 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. The rationale for choosing these systems is as follows: The standard solvent system is a CERP baseline material. The Naphthalene depleted resin was specifically formulated by Ashland for this test. There is no commercially available Naphthalene depleted product at this time.

Table 1-1 Test Plan Summary

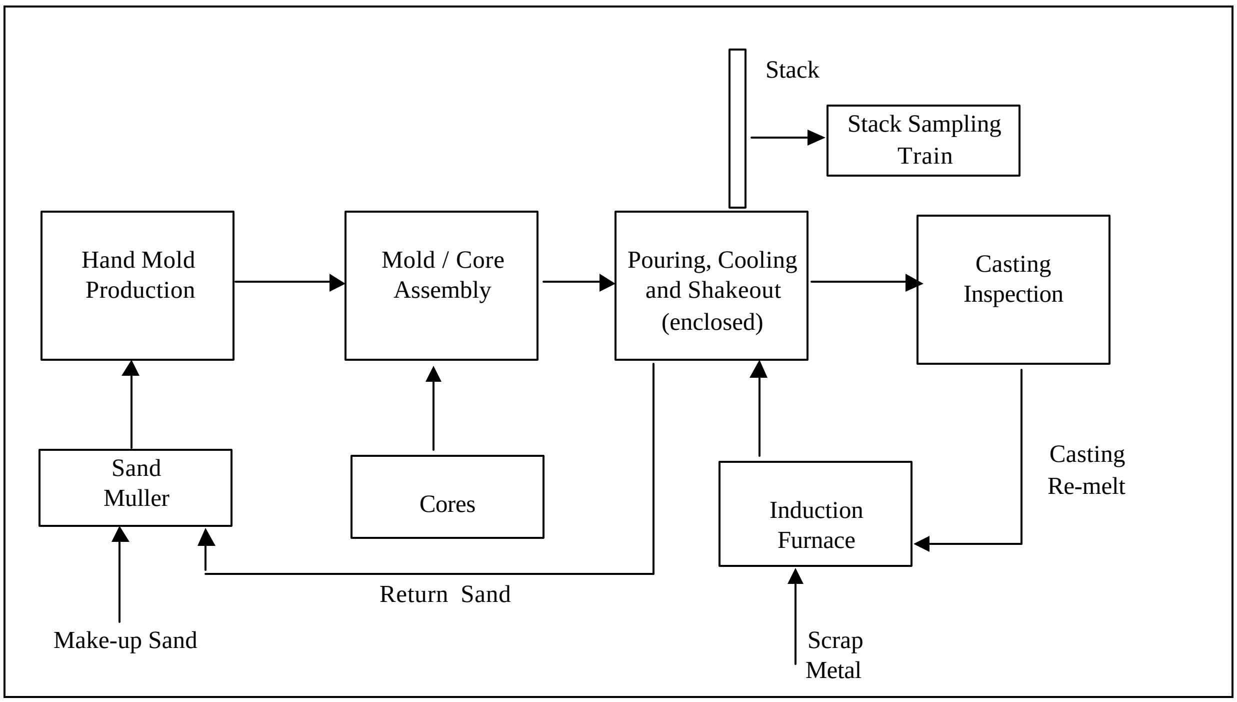
	Test Plan	Test Plan
Type of Process tested	Greensand Phenolic Urethane Baseline	Greensand Phenolic Urethane Product Test
Test Plan Number	1409 125 FB	1409 117 FC
Core Binder System	Ashland ISOCURE ® 305/904 (standard solvent system)	Ashland ISOCURE ® 305-904 (naphthalene depleted solvent system)
Metal Poured	Iron	Iron
Casting Type	Step Cores	Step Cores
Number of molds poured	6	6
Test Dates	5/22/03 > 6/2/03	5/23/03 > 5/28/03
Emissions Measured	TGOC as Propane, HC as Hexane, 75 Organic HAPs and VOCs	TGOC as Propane, HC as Hexane, 75 Organic HAPs and VOCs
Process Parameters Measured	Total Casting, Mold, and Binder Weights; Metallurgical data, % LOI; Stack Temperature, Moisture Content, Sand Temperature, Pressure, and Volumetric Flow Rate	Total Casting, Mold, and Binder 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. **<u>Test Plan Review and Approval:</u>** The proposed test plan was reviewed and approved by the Technikon staff.

2. **<u>Mold, Core and Metal Preparation:</u>** The molds and cores are prepared to a standard composition by the Technikon production team. The cores are made either by hand (if sodium silicate) or blown by a Redford core blower, and relevant process data are collected. If new

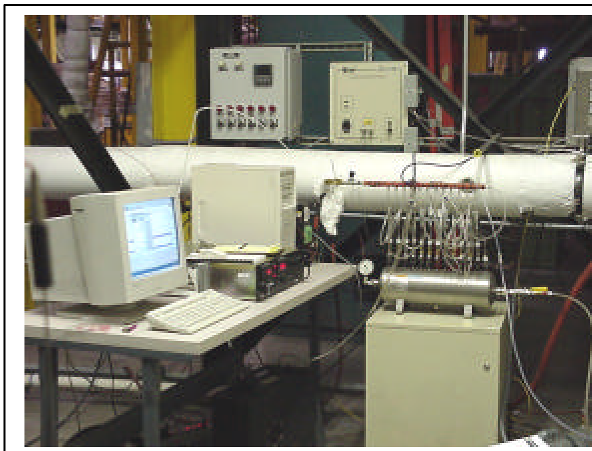
core processes are being tested, the cores are placed in new lake sand/clay/water molds without other organic material such as coal. If new mold binder systems or processes are being evaluated, organic free sodium silicate step cores are placed into the molds. Iron is melted in a 1000 lb. Ajax induction 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.

Setting of Step Cores in Mold

Total Enclosure Test Stand

3. **Individual Sampling Events:** Replicate tests are performed on six (6) mold/core packages. The mold/core 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
Core Weight	Mettler PJ8000 Digital Scale (Gravimetric)
Mold Weight	Acme 4260 Crane Scale (Gravimetric)
Casting Weight	Westweigh PP2847 Platform Scale (Gravimetric)
Seacoal Weight	Toledo PAC-DPC-606050 balance (Gravimetric)
Binder Weight	Mettler PJ8000 Digital Scale (Gravimetric)
Volatiles	Mettler PB302 Scale (AFS procedure 2213-00-S)
LOI, % at Mold and Shakeout	Denver Instruments XE-100 Analytical Scale (AFS procedure 5100-00-S)
Core LOI, %	Denver Instruments XE-100 Analytical Scale (AFS procedure 5100-00-S)
Clay, % at Mold and Shakeout	Dietert 535A MB Clay Tester (AFS Procedure 2210-00-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
Mold Compactability	Dietert 319A Sand Squeezer (AFS procedure 2221-00-S)
Carbon/Silicon	Baird Foundry Mate Optical Emissions Spectrometer

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, NIOSH 2002
VOCs Concentration	EPA Method 18, 25A, TO11, NIOSH 2002

*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 binder and/or the weight of the casting used to provide emissions data in pounds of analyte per pound of binder 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 poured and pounds per pound of binder, 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 the TGOC as Propane, HC as Hexane, methane, carbon monoxide, and carbon dioxide (both emitted and ambient).

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. Figures 3-4 to 3-6 present the five emissions indicators and selected individual HAP and VOC emissions data from Table 3-2.

Appendix B contains the detailed data including the results for all analytes measured. Table 3-3 includes the averages of the key process and source parameters. Detailed process and source 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 FB and FC Average Results – Lb/Tn Metal

Analytes	Test FB Lb/Tn Metal	Test FC Lb/ Tn Metal	% Change from Test FB
TGOC as Propane	1.782	1.890	6
HC as Hexane	0.3267	0.4129	**26**
Sum of VOCs	0.4274	0.4987	**17**
Sum of HAPs	0.3967	0.4632	**17**
Sum of POMs	0.0369	0.0241	**-35**
Individual Organic HAPs			
Benzene	0.1417	0.1823	**29**
Phenol	0.0970	0.1214	**25**
Toluene	0.0390	0.0493	**26**
Aniline	0.0273	0.0286	5
o,m,p-Cresol	0.0223	0.0297	**33**
o,m,p-Xylene	0.0210	0.0208	-1
Methylnaphthalenes	0.0195	0.0093	**-52**
Naphthalene	0.0142	0.0134	-6
Hexane	0.0040	0.0047	**17**
Other VOCs			
Trimethylbenzenes	0.0105	0.0110	5
Ethyltoluenes	0.0082	0.0078	-4
Dimethylphenols	0.0047	0.0060	28
Other Analytes			
Carbon Dioxide	20.51	21.23	4
Methane	0.0230	0.0340	48

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 FB" values in bold indicate a 95% probability that the differences in the average values were not from test variability.

Background Methane and Carbon Dioxide were found at 0.0291 and 23.74 Lb/Tn Metal respectively.

Table 3-2 Summary of Test Plans FB and FC Average Results – Lb/Lb Binder

Analytes	Test FB Lb/Lb Binder	Test FC Lb/Lb Binder	% Change from Test FB
TGOC as Propane	0.1871	0.1901	2
HC as Hexane	0.0347	0.0418	**17**
Sum of VOCs	0.0458	0.0502	9
Sum of HAPs	0.0425	0.0465	9
Sum of POMs	0.0047	0.0024	**-96**
Individual Organic HAPs			
Benzene	0.0148	0.0183	19
Phenol	0.0101	0.0122	17
Toluene	0.0041	0.0050	18
Aniline	0.0028	0.0029	2
Methylnaphthalenes	0.0025	0.0009	**-169**
o,m,p-Cresol	0.0025	0.0029	**16**
o,m,p-Xylene	0.0022	0.0025	13
Naphthalene	0.0017	0.0013	-28
Dimethylnaphthalenes	0.0005	0.0001	-255
Hexane	0.0004	0.0005	11
Other VOCs			
Trimethylbenzenes	0.0011	0.0011	1
Ethyltoluenes	0.0009	0.0008	-11
Dimethylphenols	0.0005	0.0006	19
Other Analytes			
Carbon Dioxide	2.161	2.134	-1
Methane	0.0029	0.0034	16

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 FB" values in bold indicate a 95% probability that the differences in the average values were not from test variability.

Background Methane and Carbon Dioxide were found at 0.0030 and 2.501 Lb/Lb Binder respectively.

Table 3-3 Summary of Test Plans FB and FC Average Process Parameters

Greensand Pouring, Cooling, Shakeout	Test FC Average	Test FB Average
Calculated Standard % Core Binder	1.725	1.711
Cores / Cavities Used per Mold	8	8
Total Core Weight (lbs.)	58.17	57.97
Calc. Total Binder Weight (lbs.)	1.00	0.992
GS Mold Sand Weight, (lbs.)	1407	1416
Cast Weight- All Metal Inside Mold (lbs.)	201.3	206.8
Core Age at Time of Pour (days)	12	14
Pouring Time (sec.)	33	33
Pouring Temp (°F)	2628	2631
Sand Temp in Hood (°F)	80	80
Average Green Compression (psi)	19.82	16.74
GS Compactability (%)	39	40
GS Moisture Content (%)	2.06	2.04
GS Clay Content (%)	6.96	6.78
1800°F LOI - Mold Sand (%)	3.31	3.37
1800°F LOI - Core Sand (%)	1.66	1.68
900°F Volatiles (%)	0.63	0.63
Pour Hood Average Process Air Temp, F	89	87

Figure 3-1 Emission Indicators from Test Series FB and FC – Lb/Tn Metal

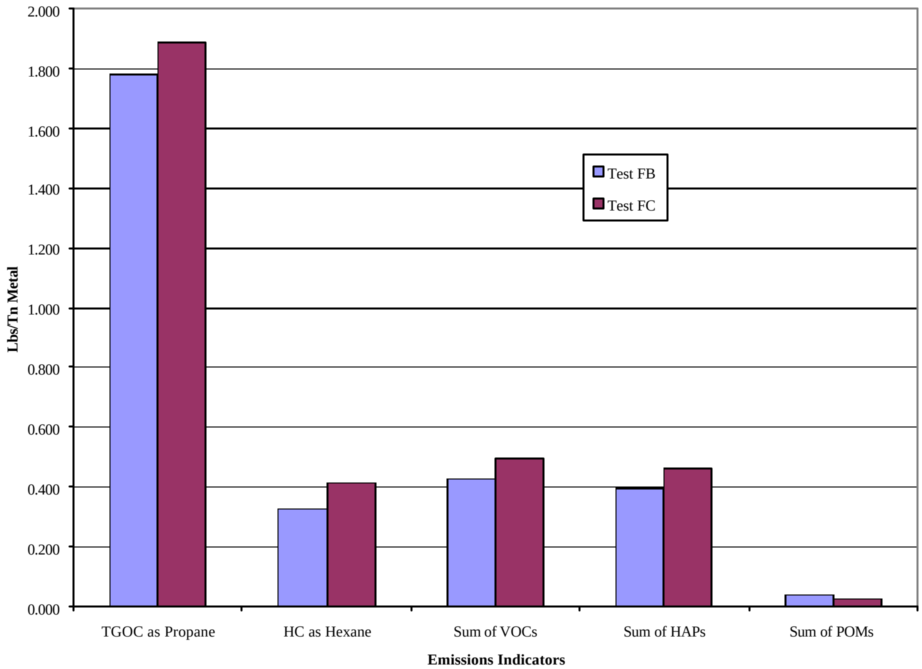


Figure 3-2 Selected HAP Emissions from Test Series FB and FC – Lb/Tn Metal

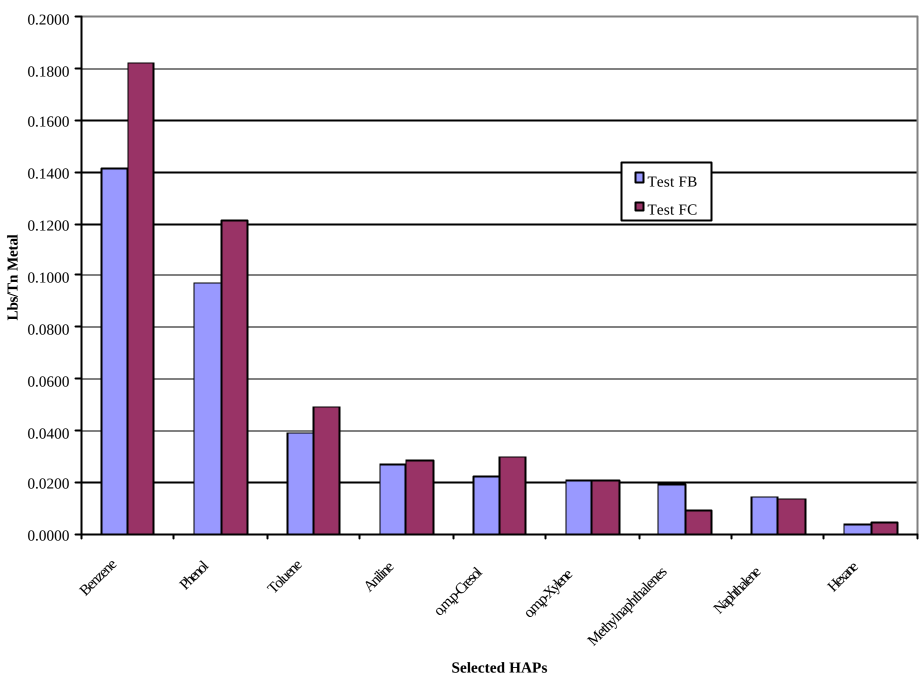


Figure 3-3 Selected VOC Emissions from Test Series FB and FC – Lb/Tn Metal

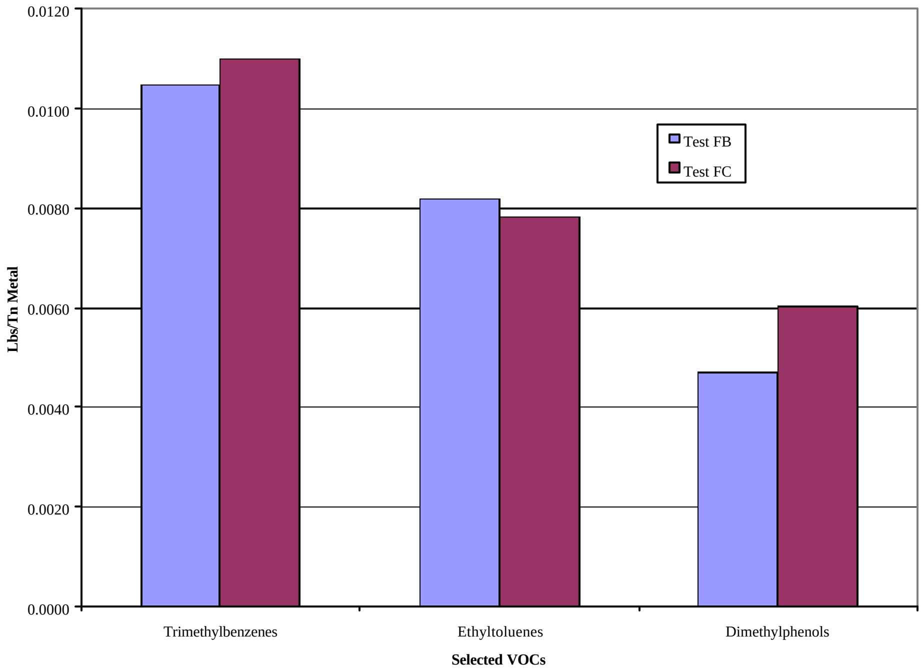


Figure 3-4 Emission Indicators from Test Series FB and FC – Lb/Lb Binder

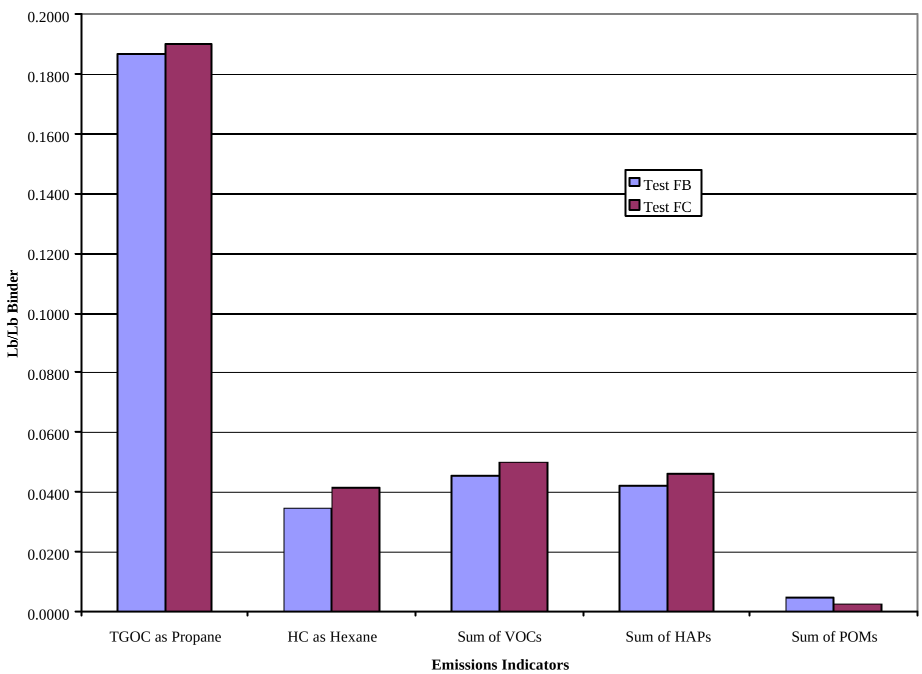


Figure 3-5 Selected HAP Emissions from Test Series FB and FC – Lb/Lb Binder

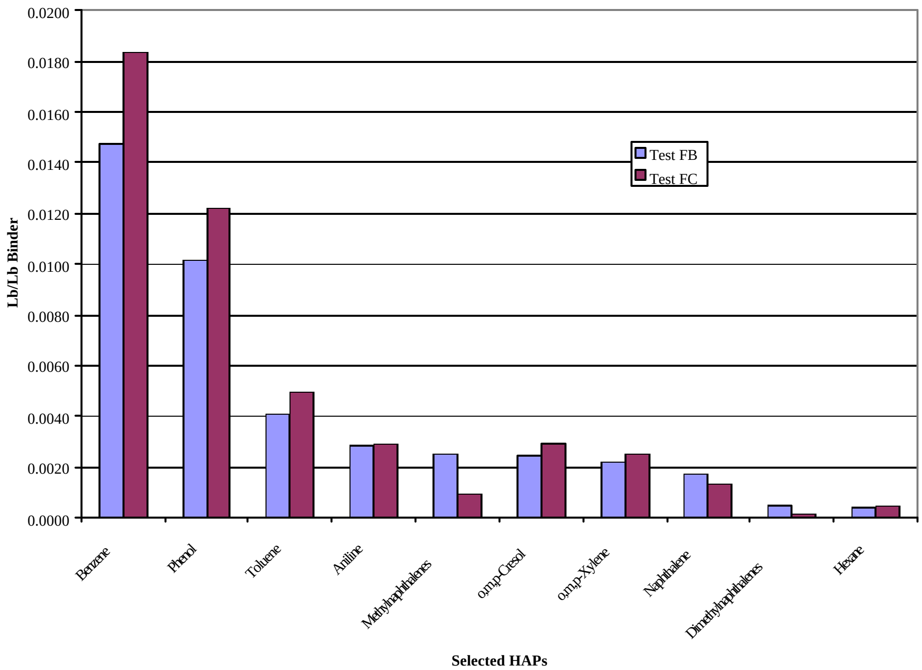
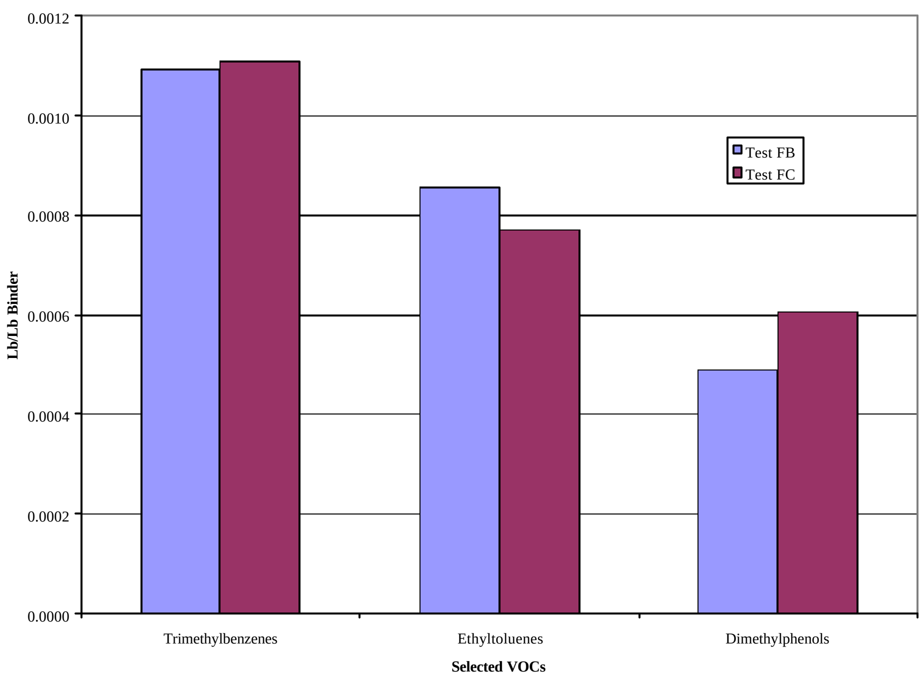


Figure 3-6 Selected VOC Emissions from Test Series FB and FC – Lb/Lb Binder



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4.0 Discussion of Results

The sampling and analytical methodologies were the same for Test Plans FB and FC.

Observation of measured process parameters indicates that the tests were run within an acceptable range. In Tables 3-1 and 3-2, the "% Change from Test FB" emissions values presented in **bold** letters indicate 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 FB to Test FC show a **6%** increase in TGOC (THC) as propane, a **26%** increase in HC as hexane, a **17%** increase in both VOCs and HAPs, and a **35%** reduction in POMs when expressed in pounds per ton of metal.

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 binder are shown in Appendix B.

The sample chromatograms for Tests FB and FC were closely reviewed and showed that compounds with boiling points similar to and higher than naphthalene were present in smaller amounts for the "naphthalene depleted" solvent system compared to the standard solvent system. This would have the effect of enriching the more volatile components of the "naphthalene depleted" solvent mixture and result in higher emissions for all species except the POMs. Naphthalene is a known product of the thermal decomposition of cold box binders. This is the probable source of the naphthalene found in test FC.

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APPENDIX A APPROVED TEST PLAN AND SAMPLE PLAN FOR TEST SERIES FB AND FC

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TECHNIKON TEST PLAN

- **CONTRACT NUMBER:** 1409 **TASK NUMBER:** 1.2.5 **Series:** FB
- **WORK ORDER NUMBER**: 1176
- **SAMPLE EVENTS**: 001 thru 009
- **SITE**: X **PRE-PRODUCTION** ___ **FOUNDRY**
- **TEST TYPE:** Core greensand Baseline
- **METAL TYPE**: Class 30 gray iron
- **MOLD TYPE:** 6-on Step mold, system sand with residual LOI, hand rammed
- **NUMBER OF MOLDS**: 9
- **CORE TYPE**: Step core made with regular Ashland ISOCURE® 305/904 binder at 1.75 %
- **TEST DATE:** **START:** 7 May 2003
  FINISHED: 14 May 2003

TEST OBJECTIVES:

Update the Core in greensand Baseline to include the 238 facility and improved measurement methods designed to reduce variability so as to make a reference for test FC.

VARIABLES:

The pattern will be the standard 6-on step mold. The mold will be made with Wexford W450 system sand, 7% western and southern bentonite in a 5:2 ratio, and no additional seacoal, tempered to 45-51% compactability, hand rammed. The cores will be made one day ahead with W450 sand and Ashland regular 305/904 binder in a 55:45 ratio.

The total binder will be 1.75% (BOS). The cores and mold will be maintained at 80-90^{o}F prior to pouring. A new 1500-1600 pound batch of system sand will be used for each mold. Molds will be poured with iron at 2630 +/- 10^{o}F. Mold cooling will be 45minutes follow by 15 minutes of shakeout, or until no more material remains to be shaken out, followed buy 15 minutes of post-shakeout emission collection.

Emissions will be monitored continuously as TGOC by THC and selected HAPs and VOCs by absorption tubes.

BRIEF OVERVIEW:

Movement to a new venue requires revalidation of existing baselines. It is appropriate to include improvements aimed at reducing variation in the process and measurement. The process improvements will include more 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. The emission measurement improvements include improved stack gas mixing, continuous versus discrete stack gas temperature, pressure, and velocity. Additionally the testing hood is now totally insulated and pouring is done through a continuously open air curtain versus an opened and closed door.

SPECIAL CONDITIONS:

None

____________________________ ____________________________

Process Engineering Manager (Technikon) — Date

V.P. Measurement Technology (Technikon) — Date

V.P. Operations (Technikon) — Date

Test Design Committee Representative — Date

Emission Committee Representative — Date

Process instructions FB

Greensand Organic Core Emission Baseline

A. Experiment: Green Sand Organic Core Emission Baseline

1. Mold sand: Normalized Technikon system greensand containing Wexford W450 Lake sand, Western & Southern Bentonite in a 5:2 ratio & seacoal.
2. Core: Step core made with Virgin Wexford W450 sand and 1.75% Ashland Isocure® LF305/52-904GR regular binder in a 55/45 ratio, TEA catalyzed.
3. Metal: Class 30 Gray cast iron.

B. Briefing:

1. The Process Engineer, Emissions Engineer, and the area Supervisor will brief the operating personnel on the requirements of the test at least one (1) day prior to the test.

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

C. ISOCURE® regular Step Cores:

1. Clean the core sand mixer.
2. Turn on the Kloster heater-cooler and set the set-point at 80°F.
   - **a.** Wait until the sand temperature reaches the set-point to mix sand.
3. Mount the CERP Step-Core core box on the Carver/Redford core machine.
4. Start the core machine auxiliary equipment per the <u>Production Foundry OSI</u> for that equipment.
5. Set up the core machine in the cold box mode with gassing and working pressures and gas and purge time according to the core recipe sheet.
6. Weigh out the binder Part I and Part II according to the core recipe sheet.
7. Weigh 200 pounds of sand to load into the Simpson Technologies core sand mixer.
8. Add the part I and part II components separately to the sand in the mixer taking about 30 second to dispense each component. Allow 30 seconds after the addition of part I before adding Part II. Avoid the formation of resin balls. Mix for 2 minutes after the part II is in.
9. Discharge the mixed sand to the core machine conveyor belt for delivery to the Redford Carver core machine.
10. Core process setup
    - **a.** Set the TEA to a nominal 5 grams per blow (gas time 0.75 sec (R/C), flow .019 lbs/sec. (Luber).
    - **b.** Set the blow pressure to 30+/-2 psi for 3 seconds (R/C).
    - **c.** Set the max purge pressure to 45 psi on the Luber gas generator.
    - **d.** Purge for 20 seconds(R/C) with a 10 second rise time (Luber).
    - **e.** Total cycle time approximately 1 minute.

11. Run the core machine for three (3) cycles and discard the cores. When the cores appear good begin test core manufacture. Eight good cores are required for each mold. Make four (4) 200 pound sand batches and run the sand out making core. A minimum of 90 cores are required. One half hour to 1 hour after manufacture randomly perform a scratch hardness test on the outer edge of the blow surface on 10 % of the cores and record the results on the Core Production Log. Values less than 25 shall be marked with a HOLD TAG until they can be 100 % scratch hardness tested to re-qualify. Contact the Process Engineer for disposition on all cores with values less than 15 after 1 hour. Weigh each core and log the results.

12. The sand lab will sample, at the time of manufacture, one (1) core from each row of each shelf (1 of 11) on each core rack. Those cores will be tested for LOI using the standard 1800 ^oF core LOI test method and reported out associated with the core rack shelf it represents. Qualified cores receiving the green **Quality Checked** tag must have **LOI** values between 1.50-1.80 %. Individual rows that qualify may have the **Quality Checked** tag affixed. Only cores with the green Quality Tag bearing the current test series and dates and signature of the lab technician and core rack/shelf/position on shelf may be taken to the mold assembly area.

Note: the core rack position from the Quality Checked tag shall be transferred to the mold assembly check list with the core weights**.**

13. The sand lab will sample one (1) core from the core rack for each mold produced just prior to the emission test to represent the eight cores placed in that mold. Those cores will be tested for LOI using the standard 1800 ^oF core LOI test method and reported out associated with the test mold it is to represent.

D. Sand preparation

1. All sand batches

- **a.** System sand normalized during test EO will be used. At the conclusion of test EO the nominal MB clay content was 7.7 +/-0.2%. The nominal LOI was 3.0+/-0.2% and most of the low temperature volatiles were distilled out of the sand. The current sand temperature is 65+/3^{o}F.
- **b.** Thoroughly clean the sand system muller and mold hopper.
- **c.** Weigh 5000 pounds of system sand and charge the muller.
- **d.** Add potable water to the muller to suppress dust and begin tempering the sand.
- **e.** Add no new clay or coal.
- **f.** Mull for about 1 minute to allow for water distribution and begin testing the sand for compactability. Target compactability shall be 45-51%.
- **g.** Continue to add water incrementally and re-mulling for at least an additional 30 seconds before retesting until the compactability is read twice within the target range. Compactability tests shall be separated by at least 30 seconds.
- **h.** Discharge the entire batch into the mold hopper. This should be enough sand for three (3) molds
- **i.** Record the total sand weight mixed, the total water used, and all compactability.

2. Prepare a sand lab sample from three samples of the mold sand from each mold as it is being made. The prepared sand will be tested for 1800^{o}F LOI, 900^{o}F Volatiles, MB clay, compactability, and moisture content and reported associated with the mold (test number, FB00x) from which it was taken. Additionally the prepared sand will be tested for Green compressive strength.

E. Molding: Step block pattern.

1. Pattern preparation:

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

2. Making the green sand mold.

a. Lightly rub parting oil from a damp oil rag on the pattern particularly in the corners and recesses.

Caution: Do not pour gross amounts of parting oil on the pattern to be blown of with air. This practice will leave sufficient oil at the parting line to be adsorbed by the sand weakening it and the burning oil will be detected by the emission samplers.

b. Riddle 4 inches of loose sand on the pattern and ram all pockets and the perimeter tightly using only vertical strokes.

Note: non- vertical ramming strokes will move blocks of compacted sand leaving voids which may cause the mold to fail. Do not ram all the sand to form a parting plane surface or the mold can fail.

c. Measure the sand temperature with the dial thermometer. Record the sand temperature on the sand preparation log.
d. Add sand in increments of 4-6 inches of loose sand ramming tightly around the pattern.
e. When the rammed sand covers the pattern by 3 or more inches the sand can be rammed less tightly but still avoid lamination planes.
f. Level off the cope and drag mold surfaces opposite the pattern to minimize metal splatter and allow the mold to be fully supported.
g. Cut the pour basin smoothly to reduce the amount of sand prone to get washed down the sprue.
h. Remove the pattern with a combination of vertical hoisting, mechanical vibration, and plastic hammer tapping from the back side of the pattern.
i. Inspect and blow out the mold, and set the cores in the drag. Verify that the cores are fully set in their prints. If a piece of the mold is missing contact your supervision for a decision on the acceptability of the mold.
j. Vent the cope with ¼ vents according to the template.
k. Close the mold straight being careful not to crush anything.
l. Bolt the flask halves together, attach the cleats, and deliver the mold to the pouring area.
m. Weigh the assembled un-poured flask, mold, and cores. Record the weight on the melt log.

Note: Prior to mold making weight the empty flasks. When weighing the flask assembly first tare (zero) the scale without the lifting bail touching the scale. The net mold sand plus core weight should not vary by more than 30 pounds.

n. At the end of each day discard all prepared and used molding sand from the poured flasks.

3. Pig molds

a. Each day make a 900 pound capacity pig mold for the following days use.

F. Emission hood:

1. Loading.

a. Hoist the mold onto the shakeout deck within the emission hood.
b. Close, seal, and lock the emission hood
c. Adjust the ambient air heater control so that the measured temperature entering the hood is 85-90°F.

2. Shakeout.

a. After the 45 minute cooling time prescribed in the emission test plan has elapsed turn on the shakeout unit and run for it the 30 minutes prescribed in the emission test plan or until the sand has all fallen through the grating.
b. Sample the emissions for 30 minutes after the start of shakeout.
c. Turn off the shakeout, open the hood, remove the flask with casting, and recover the sand.
d. Weigh and record the cast metal weight and the sand weight by difference on the melt log.
e. Discard the used mold sand.

G. Melting:

1. Initial iron 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 G.1.e

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 iron into the cold ladle.
- **b.** Carefully 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 2630 +/- 10°F.
- **h.** Commence pouring keeping the sprue full.
- **i.** Upon completion return the extra metal to the furnace, and cover the ladle.
- **j.** Record the pour temperature and pour time on the heat log.

Steven M. Knight
Mgr. Process Engineering

FB - Series Sample Plan

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/22/2003											
RUN 1											
THC	FB-00101	X									TOTAL
M-18	FB-00102		1						20	1	Carbopak charcoal
M-18	FB-00103				1				0		Carbopak charcoal
M-18 MS	FB-00104		1						20	2	Carbopak charcoal
M-18 MS	FB-00105			1					20	3	Carbopak charcoal
Gas, CO, CO2	FB-00106		1						60	4	Tedlar Bag
Gas, CO, CO2	FB-00107				1				0		Tedlar Bag
NIOSH 2002	FB-00108		1						500	5	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FB-00109				1				0		150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FB-00110		1						800	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FB-00111				1				0		100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FB-00112		1						1000	10	DNPH SKC 226-119
TO11	FB-00113			1					1000	11	DNPH SKC 226-119
TO11	FB-00114				1				0		DNPH SKC 226-119
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FB - Series Sample Plan

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/22/2003											
RUN 2											
THC	FB-00201	X									TOTAL
M-18	FB-00202		1						20	1	Carbopak charcoal
M-18	FB-00203			1					20	2	Carbopak charcoal
	Excess								20	3	Excess
Gas, CO, CO2	FB-00204		1						60	4	Tedlar Bag
NIOSH 2002	FB-00205		1						500	5	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FB-00206			1					500	6	150/75 mg Silica Gel (SKC 226-10)
NIOSH 1500	FB-00207		1						800	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FB-00208			1					800	8	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	9	Excess
	Excess								1000	10	Excess
TO11	FB-00209		1						1000	11	DNPH SKC 226-119
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FB - Series Sample Plan

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/23/2003											
RUN 3											
THC	FB-00301	X									TOTAL
M-18	FB-00302		1						20	1	Carbopak charcoal
M-18	FB-00303					1			20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FB-00304		1						60	4	Tedlar Bag
NIOSH 2002	FB-00305		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FB-00306		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FB-00307		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess
5/29/2003											
RUN 4											
THC	FB-00401	X									TOTAL
M-18	FB-00402		1						20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FB-00403		1						60	4	Tedlar Bag
NIOSH 2002	FB-00404		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FB-00405		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FB-00406		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FB - Series Sample Plan

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/29/2003											
RUN 5											
THC	FB-00501	X									TOTAL
M-18	FB-00502		1						20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FB-00503		1						60	4	Tedlar Bag
NIOSH 2002	FB-00504		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FB-00505		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FB-00506		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess
6/2/2003											
RUN 6											
THC	FB-00601	X									TOTAL
M-18	FB-00602		1						20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FB-00603		1						60	4	Tedlar Bag
NIOSH 2002	FB-00604		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FB-00605		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FB-00606		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

TECHNIKON TEST PLAN

- > **CONTRACT NUMBER:** 1409 **TASK NUMBER:** 1.1.7 **Series:** FC
- > **WORK ORDER NUMBER:** 1177
- > **SAMPLE EVENTS:** 001 thru 009
- > **SITE:** X **PRE-PRODUCTION** ___ **FOUNDRY**
- > **TEST TYPE:** Core in greensand product test
- > **METAL TYPE:** Class 30 gray iron
- > **MOLD TYPE:** 6-on Step mold, system sand, hand rammed
- > **NUMBER OF MOLDS:** 9
- > **CORE TYPE:** Step core made with Ashland 305/904 Naphthalene depleted binder at 1.75 %
- > **TEST DATE:** **START:** 14 May 2003

  FINISHED: 25 May2003

TEST OBJECTIVES:

Measure HAP & VOC emissions from naphthalene depleted core binder in greensand step mold made with system sand.

VARIABLES:

The pattern will be the standard 6-on step mold. The mold will be made with Wexford W450 system sand, 7 % western and southern bentonite in a 5:2 ratio, and no additional seacoal, tempered to 45-51% compactability, hand rammed. The cores will be made one day ahead with W450 sand and Ashland naphthalene depleted 305/904 binder in a 55:45 ratio. The total binder will be 1.75% (BOS). The cores and mold will be maintained at 80-90 ^oF prior to pouring. A new 1550-1600 pounds batch of system sand will be used for each mold. Molds will be poured with iron at 2630 +/- 10 ^oF. Mold cooling will be 45 minutes follow by 15 minutes of shakeout, or until no more material remains to be shaken out, followed buy 15 minutes of post-shakeout emission collection.

Emissions will be monitored continuously as TGOC by THC and selected HAPs and VOCs by absorption tubes.

BRIEF OVERVIEW

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. The emission measurements include improved stack gas mixing, continuous versus discrete stack gas temperature, pressure, and velocity. Additionally the testing hood is totally insulated and pouring is done through a continuously open air curtain versus an opened and closed door.

SPECIAL CONDITIONS:

None

Process Engineering Manager (Technikon)	Date
V.P. Measurement Technology (Technikon)	Date
V.P. Operations (Technikon)	Date
Test Design Committee Representative	Date
Emission Committee Representative	Date

Series FC - Process Instructions

Greensand Organic Core Emission:
Naphthalene Depleted Comparison

A. Experiment: Green Sand Organic Core Emission comparison to baseline FB

1. Mold sand: Normalized Technikon system greensand containing Wexford W450 Lake sand, Western & Southern Bentonite in a 5:2 ratio & seacoal.
2. Core: Step core made with Virgin Wexford W450 sand and 1.75% Ashland Isocure® LF305/52-904GR "special" Naphthalene depleted binder in a 55/45 ratio, TEA catalyzed.
3. Metal: Class 30 gray cast iron.

B. Briefing:

1. The Process Engineer, Emissions Engineer, and the area Supervisor will brief the operating personnel on the requirements of the test at least one (1) day prior to the test.

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

C. ISOCURE® "Special" Step Cores:

1. Clean the core sand mixer.
2. Turn on the Kloster heater-cooler and set the set-point at 80°F.
   a. Wait until the sand temperature reaches the set-point to mix sand.
3. Mount the CERP Step-Core core box on the Carver/Redford core machine.
4. Start the core machine auxiliary equipment per the Production Foundry OSI for that equipment.
5. Set up the core machine in the cold box mode with gassing and working pressures and gas and purge time according to the core recipe sheet.
6. Weigh out the binder Part I and Part II according to the core recipe sheet.
7. Weigh 200 pounds of sand to load into the Simpson Technologies core sand mixer.
8. Add the part I and part II components separately to the sand in the mixer taking about 30 second to dispense each component. Allow 30 seconds after the addition of part I before adding Part II. Avoid the formation of resin balls. Mix for 2 minutes after the part II is in.
9. Discharge the mixed sand to the core machine conveyor belt for delivery to the Redford Carver core machine.
10. Core process setup
    a. Set the TEA to a nominal 5 grams per blow (gas time 0.75 sec (R/C), flow .019 lbs/sec (Luber).
    b. Set the blow pressure to 30+/-2 psi for 3 seconds (R/C).
    c. Set the max purge pressure to 45 psi on the Luber gas generator.
    d. Purge for 20 seconds(R/C) with a 10 second rise time (Luber).

e. Total cycle time approximately 1 minute.

11. Run the core machine for three (3) cycles and discard the cores. When the cores appear good begin test core manufacture. Eight good cores are required for each mold. Make four (4) 200 pound sand batches and run the sand out making core. A minimum of 90 cores are required. One half hour to 1 hour after manufacture randomly perform a scratch hardness test on the outer edge of the blow surface on 10% of the cores and record the results on the Core Production Log. Values less than 25 shall be marked with a HOLD TAG until they can be 100% scratch hardness tested to re-qualify. Contact the Process Engineer for disposition on all cores with values less than 15 after 1 hour. Weigh each core and log the results.

12. The sand lab will sample, at the time of manufacture, one (1) core from each row of each shelf (1 of 11) on each core rack. Those cores will be tested for LOI using the standard 1800°F core LOI test method and reported out associated with the core rack shelf it represents. Qualified cores receiving the green **Quality Checked** tag must have **LOI** values between 1.50-1.80%. Individual rows that qualify may have the **Quality Checked** tag affixed. Only cores with the green Quality Tag bearing the current test series and dates and signature of the lab technician and core rack/shelf/position on shelf may be taken to the mold assembly area.

Note: The core rack position from the Quality Checked tag shall be transferred to the mold assembly check list with the core weights.

13. The sand lab will sample one (1) core from the core rack for each mold produced just prior to the emission test to represent the eight cores placed in that mold. Those cores will be tested for LOI using the standard 1800°F core LOI test method and reported out associated with the test mold it is to represent.

D. Sand preparation

1. All sand batches

a. System sand normalized during test EO will be used. At the conclusion of test EO the nominal MB clay content was 7.7 +/-0.2%. The nominal LOI was 3.0+/-0.2% and most of the low temperature volatiles were distilled out of the sand. The current sand temperature is 65+/3°F.

b. Thoroughly clean the sand system muller and mold hopper.

c. Weigh 5000 pounds of system sand and charge the muller.

d. Add potable water to the muller to suppress dust and begin tempering the sand.

e. Add no new clay or coal.

f. Mull for about 1 minute to allow for water distribution and begin testing the sand for compactability. Target compactability shall be 45-51%.

g. Continue to add water incrementally and re-mulling for at least an additional 30 seconds before retesting until the compactability is read twice within the target range. Compactability tests shall be separated by at least 30 seconds.

h. Discharge the entire batch into the mold hopper. This should be enough sand for three (3) molds

i. Record the total sand weight mixed, the total water used, and all compactability.

2. Prepare a sand lab sample from three samples of the mold sand from each mold as it is being made. The prepared sand will be tested for 1800°F LOI, 900°F Volatiles, MB clay, compactability, and moisture content and reported associated with the mold (test number, FB00x) from which it was taken. Additionally the prepared sand will be tested for Green compressive strength.

E. Molding: Step block pattern.

1. Pattern preparation:

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

2. Making the green sand mold.

a. Lightly rub parting oil from a damp oil rag on the pattern particularly in the corners and recesses.

Caution: Do not pour gross amounts of parting oil on the pattern to be blown of with air. This practice will leave sufficient oil at the parting line to be adsorbed by the sand weakening it and the burning oil will be detected by the emission samplers.

b. Riddle 4 inches of loose sand on the pattern and ram all pockets and the perimeter tightly using only vertical strokes.

Note: Non- vertical ramming strokes will move blocks of compacted sand leaving voids which may cause the mold to fail. Do not ram all the sand to form a parting plane surface or the mold can fail.

c. Measure the sand temperature with the dial thermometer. Record the sand temperature on the sand preparation log.
d. Add sand in increments of 4-6 inches of loose sand ramming tightly around the pattern.
e. When the rammed sand covers the pattern by 3 or more inches the sand can be rammed less tightly but still avoid lamination planes.
f. Level off the cope and drag mold surfaces opposite the pattern to minimize metal splatter and allow the mold to be fully supported.
g. Cut the pour basin smoothly to reduce the amount of sand prone to get washed down the sprue.
h. Remove the pattern using a combination of vertical hoisting, mechanical vibration, and plastic hammer tapping on the back side of the pattern.
i. Inspect and blow out the mold, and set the cores in the drag. Verify that the cores are fully set in their prints. If a piece of the mold is missing contact your supervision for a decision on the acceptability of the mold.
j. Vent the cope with ¼ vents according to the template.
k. Close the mold straight being careful not to crush anything.
l. Bolt the flask halves together, attach the cleats, and deliver the mold to the pouring area.
m. Weigh the assembled un-poured flask, mold, and cores. Record the weight on the melt log.

Note: Prior to mold making weight the empty flasks. When weighing the flask assembly first tare (zero) the scale without the lifting bail touching the scale. The net mold sand plus core weight should not vary by more than 30 pounds**.**

- **n.** At the end of each day discard all prepared and used molding sand from the poured flasks.

3. Pig molds

- **a.** Each day make a 900 pound capacity pig mold for the following days use.

F. Emission hood:

1. Loading.

- **a.** Hoist the mold onto the shakeout deck within the emission hood.
- **b.** Close, seal, and lock the emission hood
- **c.** Adjust the ambient air heater control so that the measured temperature entering the hood is 85-90°F.

2. Shakeout.

- **a.** After the 45 minute cooling time prescribed in the emission test plan has elapsed turn on the shakeout unit and run for it the 30 minutes prescribed in the emission test plan or until the sand has all fallen through the grating.
- **b.** Sample the emissions for 30 minutes after the start of shakeout.
- **c.** Turn off the shakeout, open the hood, remove the flask with casting, and recover the sand.
- **d.** Weigh and record the cast metal weight and the sand weight by difference on the melt log.
- **e.** Discard the used mold sand.

G. Melting:

1. Initial iron 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 G.1.e

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 iron into the cold ladle.
- **b.** Carefully 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 2630 +/- 10°F.
- **h.** Commence pouring keeping the sprue full.
- **i.** Upon completion return the extra metal to the furnace, and cover the ladle.
- **j.** Record the pour temperature and pour time on the heat log

Steven M. Knight
Mgr. Process Engineering

FC - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/23/2003											**LF 305/52-904 GR**
RUN 1											
THC	FC-00101	X									TOTAL
M-18	FC-00102		1						20	1	Carbopak charcoal
M-18	FC-00103				1				0		Carbopak charcoal
M-18 MS	FC-00104		1						20	2	Carbopak charcoal
M-18 MS	FC-00105			1					20	3	Carbopak charcoal
Gas, CO, CO2	FC-00106		1						60	4	Tedlar Bag
Gas, CO, CO2	FC-00107				1				0		Tedlar Bag
NIOSH 2002	FC-00108		1						500	5	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FC-00109				1				0		150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FC-00110		1						800	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FC-00111				1				0		100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FC-00112		1						1000	10	DNPH SKC 226-119
TO11	FC-00113			1					1000	11	DNPH SKC 226-119
TO11	FC-00114				1				0		DNPH SKC 226-119
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FC - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/27/2003											**LF 305/52-904 GR**
RUN 2											
THC	FC-00201	X									TOTAL
M-18	FC-00202		1						20	1	Carbopak charcoal
M-18	FC-00203			1					20	2	Carbopak charcoal
	Excess								20	3	Excess
Gas, CO, CO2	FC-00204		1						60	4	Tedlar Bag
NIOSH 2002	FC-00205		1						500	5	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FC-00206			1					500	6	150/75 mg Silica Gel (SKC 226-10)
NIOSH 1500	FC-00207		1						800	7	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FC-00208			1					800	8	100/50 mg Charcoal (SKC 226-01)
	Excess								1000	9	Excess
	Excess								1000	10	Excess
TO11	FC-00209		1						1000	11	DNPH SKC 226-119
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FC - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/27/2003											**LF 305/52-904 GR**
RUN 3											
THC	FC-00301	X									TOTAL
M-18	FC-00302		1						20	1	Carbopak charcoal
M-18	FC-00303					1			20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FC-00304		1						60	4	Tedlar Bag
NIOSH 2002	FC-00305		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FC-00306		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FC-00307		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FC - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/28/2003											**LF 305/52-904 GR**
RUN 4											
THC	FC-00401	X									TOTAL
M-18	FC-00402		1						20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FC-00403		1						60	4	Tedlar Bag
NIOSH 2002	FC-00404		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FC-00405		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FC-00406		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess
5/28/2003											**LF 305/52-904 GR**
RUN 5											
THC	FC-00501	X									TOTAL
M-18	FC-00502		1						20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FC-00503		1						60	4	Tedlar Bag
NIOSH 2002	FC-00504		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FC-00505		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FC-00506		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

FC - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
5/28/2003											**LF 305/52-904 GR**
RUN 6											
THC	FC-00601	X									TOTAL
M-18	FC-00602		1						20	1	Carbopak charcoal
	Excess								20	2	Excess
	Excess								20	3	Excess
Gas, CO, CO2	FC-00603		1						60	4	Tedlar Bag
NIOSH 2002	FC-00604		1						500	5	150/75 mg Silica Gel (SKC 226-10)
	Excess								500	6	Excess
NIOSH 1500	FC-00605		1						800	7	100/50 mg Charcoal (SKC 226-01)
	Excess								800	8	Excess
	Excess								1000	9	Excess
TO11	FC-00606		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

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APPENDIX B TEST SERIES FB AND FC DETAILED RESULTS

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Test FB Individual Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**05/22/03**	**05/22/03**	**05/23/03**	**05/29/03**	**05/29/03**	**06/02/03**		
		TGOC as Propane	1.87E+00	1.70E+00	1.55E+00	1.86E+00	1.90E+00	1.82E+00	1.78E+00	1.32E-01
		HC as Hexane	4.01E-01	3.67E-01	2.96E-01	3.02E-01	2.90E-01	3.04E-01	3.27E-01	4.60E-02
		Sum of VOCs	5.21E-01	4.35E-01	3.82E-01	4.13E-01	4.06E-01	4.09E-01	4.27E-01	4.87E-02
		Sum of HAPs	4.84E-01	4.04E-01	3.46E-01	3.81E-01	3.80E-01	3.86E-01	3.97E-01	4.67E-02
		Sum of POMs	4.74E-02	3.11E-02	5.39E-02	3.12E-02	2.83E-02	2.78E-02	3.66E-02	1.11E-02
		Individual Organic HAPs								
x		**Benzene**	1.74E-01	1.67E-01	8.95E-02	1.25E-01	1.64E-01	1.32E-01	1.42E-01	3.24E-02
x		**Phenol**	1.23E-01	8.81E-02	8.52E-02	9.95E-02	7.90E-02	1.07E-01	9.70E-02	1.63E-02
x		**Toluene**	4.69E-02	4.31E-02	3.49E-02	3.85E-02	3.85E-02	3.22E-02	3.90E-02	5.37E-03
x		**Aniline**	2.99E-02	1.91E-02	2.52E-02	2.99E-02	2.30E-02	3.64E-02	2.73E-02	6.10E-03
x		**o-Cresol**	2.09E-02	1.82E-02	1.91E-02	1.69E-02	1.57E-02	1.80E-02	1.81E-02	1.80E-03
x		**m,p-Xylene**	1.83E-02	1.60E-02	1.59E-02	1.66E-02	1.33E-02	1.24E-02	1.54E-02	2.19E-03
x	z	**Naphthalene**	1.83E-02	1.34E-02	2.06E-02	1.17E-02	1.12E-02	9.84E-03	1.42E-02	4.31E-03
x	z	**2-Methylnaphthalene**	1.57E-02	1.02E-02	1.77E-02	1.11E-02	9.81E-03	1.01E-02	1.24E-02	3.39E-03
x	z	**1-Methylnaphthalene**	8.91E-03	5.84E-03	1.01E-02	6.28E-03	5.55E-03	5.73E-03	7.07E-03	1.93E-03
x		**o-Xylene**	6.11E-03	5.61E-03	5.67E-03	6.37E-03	5.07E-03	4.38E-03	5.53E-03	7.22E-04
x		**m,p-Cresol**	4.34E-03	4.09E-03	4.00E-03	4.86E-03	3.62E-03	4.03E-03	4.16E-03	4.16E-04
x		**Hexane**	4.42E-03	4.06E-03	3.93E-03	3.85E-03	4.35E-03	3.55E-03	4.03E-03	3.26E-04
x		**Ethylbenzene**	3.41E-03	3.07E-03	3.17E-03	3.24E-03	2.58E-03	2.42E-03	2.98E-03	3.93E-04
x		**Acetaldehyde**	2.71E-03	2.59E-03	2.47E-03	2.84E-03	I	2.77E-03	2.68E-03	1.48E-04
x	z	**1,3-Dimethylnaphthalene**	2.57E-03	1.69E-03	3.22E-03	2.20E-03	1.78E-03	2.04E-03	2.25E-03	5.69E-04
x		**Styrene**	1.58E-03	1.31E-03	1.34E-03	1.46E-03	1.30E-03	1.07E-03	1.34E-03	1.72E-04
x		**Formaldehyde**	5.38E-04	6.35E-04	8.57E-04	6.02E-04	3.35E-04	6.42E-04	6.01E-04	1.69E-04
x		**2-Butanone**	4.31E-04	4.79E-04	4.64E-04	3.92E-04	3.84E-04	4.71E-04	4.37E-04	4.12E-05
x	z	**2,6-Dimethylnaphthalene**	9.41E-04	ND	1.16E-03	ND	ND	ND	3.49E-04	5.45E-04
x	z	**2,7-Dimethylnaphthalene**	9.41E-04	ND	1.16E-03	ND	ND	ND	3.49E-04	5.45E-04
x		**Propionaldehyde**	2.29E-04	2.24E-04	2.06E-04	3.05E-04	2.07E-04	2.61E-04	2.39E-04	3.81E-05

Test FB Individual Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**05/22/03**	**05/22/03**	**05/23/03**	**05/29/03**	**05/29/03**	**06/02/03**		
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**Acenapthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x		**Biphenyl**	ND	ND	ND	ND	ND	ND	ND	NA
x		**Cumene**	ND	ND	ND	ND	ND	ND	ND	NA
x		**p-cymene**	ND	ND	ND	ND	ND	ND	ND	NA
x		**N,N-Dimethylaniline**	ND	ND	ND	ND	ND	ND	ND	NA
x		**Acrolein**	ND	ND	ND	ND	ND	ND	ND	NA
		Other VOCs								
		1,2,4-Trimethylbenzene	1.30E-02	1.25E-02	1.17E-02	9.95E-03	8.54E-03	7.08E-03	1.05E-02	2.35E-03
		3-Ethyltoluene	6.48E-03	4.64E-03	4.49E-03	4.97E-03	3.94E-03	5.37E-03	4.98E-03	8.77E-04
		Heptane	3.38E-03	2.70E-03	2.28E-03	3.28E-03	3.45E-03	2.88E-03	2.99E-03	4.56E-04
		2,6-Dimethylphenol	ND	1.15E-03	3.88E-03	3.82E-03	3.53E-03	2.90E-03	2.55E-03	1.61E-03
		2-Ethyltoluene	3.01E-03	2.58E-03	2.51E-03	2.45E-03	1.94E-03	1.71E-03	2.37E-03	4.69E-04
		2,4-Dimethylphenol	1.83E-03	2.30E-03	2.11E-03	2.40E-03	2.26E-03	2.10E-03	2.17E-03	1.99E-04
		Nonane	1.87E-03	1.01E-03	1.77E-03	2.06E-03	1.82E-03	ND	1.42E-03	7.84E-04
		4-Ethyltoluene	2.04E-03	1.10E-03	1.87E-03	ND	ND	ND	8.36E-04	9.69E-04
		Indene	ND	ND	2.11E-03	1.98E-03	ND	ND	6.81E-04	1.06E-03
		1,3-Diethylbenzene	1.85E-03	1.25E-03	ND	ND	ND	ND	5.16E-04	8.22E-04
		Undecane	2.41E-03	ND	3.79E-04	ND	ND	ND	4.65E-04	9.66E-04
		Butyraldehyde/Methacrolein	4.11E-04	4.83E-04	4.09E-04	4.48E-04	3.55E-04	3.77E-04	4.14E-04	4.62E-05
		Tridecane	ND	ND	1.70E-03	ND	ND	ND	2.84E-04	6.95E-04
		Benzaldehyde	1.98E-04	1.67E-04	2.10E-04	1.98E-04	1.65E-04	2.14E-04	1.92E-04	2.11E-05

Test FB Individual Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**05/22/03**	**05/22/03**	**05/23/03**	**05/29/03**	**05/29/03**	**06/02/03**		
		Pentanal	1.58E-04	1.52E-04	1.86E-04	I	1.45E-04	1.91E-04	1.66E-04	2.09E-05
		o,m,p-Tolualdehyde	ND	4.90E-04	4.48E-04	ND	ND	ND	1.56E-04	2.43E-04
		Crotonaldehyde	1.33E-04	1.18E-04	ND	1.35E-04	ND	1.71E-04	9.28E-05	7.40E-05
		Hexaldehyde	6.02E-05	ND	ND	ND	ND	1.17E-04	2.95E-05	4.91E-05
		1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,2-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3-Diisopropylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,4-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3,5-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,3-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,4,6-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		a-Methylstyrene	ND	ND	ND	ND	ND	ND	ND	NA
		Anthracene	ND	ND	ND	ND	ND	ND	ND	NA
		Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	I	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	NA
		sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA

Test FB Individual Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**05/22/03**	**05/22/03**	**05/23/03**	**05/29/03**	**05/29/03**	**06/02/03**		
		Tetradecane	ND	ND	ND	ND	ND	ND	ND	NA
		Other Analytes								
		Acetone	2.55E-03	2.63E-03	2.56E-03	2.49E-03	2.29E-03	2.33E-03	2.47E-03	1.37E-04
		Carbon Dioxide	2.12E+01	2.09E+01	2.09E+01	1.94E+01	NA	2.02E+01	2.05E+01	7.07E-01
		Methane	ND	3.33E-02	3.54E-02	3.34E-02	NA	3.58E-02	2.76E-02	1.55E-02
		Carbon Monoxide	ND	ND	ND	ND	NA	ND	ND	NA
		Ethane	ND	ND	ND	ND	NA	ND	ND	NA
		Propane	ND	ND	ND	ND	NA	ND	ND	NA
		Isobutane	ND	ND	ND	ND	NA	ND	ND	NA
		Butane	ND	ND	ND	ND	NA	ND	ND	NA
		Neopentane	ND	ND	ND	ND	NA	ND	ND	NA
		Isopentane	ND	ND	ND	ND	NA	ND	ND	NA
		Pentane	ND	ND	ND	ND	NA	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 HAPs or VOCs.

Test FB Individual Test Results - Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**5/22/03**	**5/22/03**	**5/23/03**	**5/29/03**	**5/29/03**	**6/2/03**		
		TGOC as Propane	2.00E-01	1.78E-01	1.71E-01	1.92E-01	1.91E-01	1.91E-01	1.87E-01	1.08E-02
		HC as Hexane	4.30E-02	4.20E-02	3.10E-02	3.14E-02	2.92E-02	3.18E-02	3.47E-02	6.09E-03
		Sum of VOCs	5.61E-02	5.18E-02	4.01E-02	4.31E-02	4.10E-02	4.27E-02	4.58E-02	6.56E-03
		Sum of HAPs	5.20E-02	4.79E-02	3.63E-02	3.98E-02	3.84E-02	4.03E-02	4.25E-02	6.12E-03
		Sum of POMs	5.09E-03	8.66E-03	5.64E-03	3.24E-03	2.85E-03	2.90E-03	4.73E-03	2.26E-03
		Individual Organic HAPs								
x		**Benzene**	1.86E-02	1.74E-02	9.37E-03	1.29E-02	1.65E-02	1.38E-02	1.48E-02	3.43E-03
x		**Phenol**	1.32E-02	9.22E-03	8.92E-03	1.03E-02	7.95E-03	1.12E-02	1.01E-02	1.88E-03
x		**Toluene**	5.04E-03	4.52E-03	3.65E-03	3.99E-03	3.88E-03	3.36E-03	4.07E-03	6.11E-04
x		**Aniline**	3.24E-03	2.00E-03	2.64E-03	3.10E-03	2.32E-03	3.80E-03	2.85E-03	6.59E-04
x		**o-Cresol**	2.24E-03	2.11E-03	2.10E-03	2.07E-03	1.74E-03	1.94E-03	2.03E-03	1.75E-04
x	z	**Naphthalene**	1.97E-03	2.78E-03	2.15E-03	1.21E-03	1.12E-03	1.03E-03	1.71E-03	7.03E-04
x		**m,p-Xylene**	1.97E-03	1.68E-03	1.67E-03	1.72E-03	1.34E-03	1.30E-03	1.61E-03	2.53E-04
x	z	**2-Methylnaphthalene**	1.69E-03	2.92E-03	1.85E-03	1.15E-03	9.87E-04	1.06E-03	1.61E-03	7.32E-04
x	z	**1-Methylnaphthalene**	9.57E-04	1.65E-03	1.06E-03	6.51E-04	5.59E-04	5.99E-04	9.12E-04	4.14E-04
x		**o-Xylene**	6.56E-04	5.88E-04	5.93E-04	6.60E-04	5.10E-04	4.57E-04	5.77E-04	8.05E-05
x		**m,p-Cresol**	4.66E-04	4.29E-04	4.18E-04	5.04E-04	3.65E-04	4.21E-04	4.34E-04	4.74E-05
x		**Hexane**	4.75E-04	4.26E-04	4.11E-04	3.99E-04	4.38E-04	3.70E-04	4.20E-04	3.56E-05
x		**Ethylbenzene**	3.66E-04	3.21E-04	3.32E-04	3.36E-04	2.60E-04	2.53E-04	3.11E-04	4.53E-05
x	z	**1,3-Dimethylnaphthalene**	2.76E-04	5.86E-04	3.37E-04	2.28E-04	1.80E-04	2.13E-04	3.03E-04	1.49E-04
x		**Acetaldehyde**	2.91E-04	2.71E-04	2.58E-04	2.94E-04	I	2.90E-04	2.81E-04	1.54E-05
x		**Styrene**	1.70E-04	1.37E-04	1.41E-04	1.51E-04	1.31E-04	1.12E-04	1.40E-04	1.95E-05
x	z	**2,6-Dimethylnaphthalene**	1.01E-04	1.85E-04	1.21E-04	ND	ND	ND	6.78E-05	7.93E-05

Test FB Individual Test Results - Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**5/22/03**	**5/22/03**	**5/23/03**	**5/29/03**	**5/29/03**	**6/2/03**		
x	z	**2,7-Dimethylnaphthalene**	1.01E-04	1.85E-04	1.21E-04	ND	ND	ND	6.78E-05	7.93E-05
x		**Formaldehyde**	5.78E-05	6.64E-05	8.97E-05	6.24E-05	3.37E-05	6.70E-05	6.29E-05	1.81E-05
x		**2-Butanone**	4.63E-05	5.01E-05	4.86E-05	4.06E-05	3.87E-05	4.92E-05	4.56E-05	4.81E-06
x	z	**1,6-Dimethylnaphthalene**	ND	1.97E-04	ND	ND	ND	ND	3.29E-05	8.06E-05
x	z	**2,3-Dimethylnaphthalene**	ND	1.57E-04	ND	ND	ND	ND	2.62E-05	6.42E-05
x		**Propionaldehyde**	2.46E-05	2.35E-05	2.16E-05	3.16E-05	2.08E-05	2.72E-05	2.49E-05	4.01E-06
x		**Acrolein**	ND	ND	ND	ND	ND	ND	ND	NA
x		**Dimethylaniline**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**Acenapthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x		**Biphenyl**	ND	ND	ND	ND	ND	ND	ND	NA
x		**p-Cymene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,3-Diisopropylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA
x		**Cumene**	ND	ND	ND	ND	ND	ND	ND	NA
		Other VOCs								
		1,2,4-Trimethylbenzene	1.40E-03	1.31E-03	1.23E-03	1.03E-03	8.59E-04	7.39E-04	1.09E-03	2.61E-04
		3-Ethyltoluene	6.96E-04	4.85E-04	4.70E-04	5.15E-04	3.97E-04	5.61E-04	5.20E-04	1.02E-04
		Heptane	3.63E-04	2.83E-04	2.38E-04	3.40E-04	3.47E-04	3.01E-04	3.12E-04	4.67E-05
		2,6-Dimethylphenol	0.00E+00	1.20E-04	4.06E-04	3.96E-04	3.56E-04	3.03E-04	2.63E-04	1.66E-04
		2-Ethyltoluene	3.23E-04	2.70E-04	2.63E-04	2.54E-04	1.96E-04	1.78E-04	2.47E-04	5.29E-05
		2,4-Dimethylphenol	1.97E-04	2.40E-04	2.21E-04	2.49E-04	2.28E-04	2.20E-04	2.26E-04	1.81E-05
		Nonane	2.00E-04	1.06E-04	1.85E-04	2.14E-04	1.83E-04	ND	1.48E-04	8.17E-05

Test FB Individual Test Results - Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**5/22/03**	**5/22/03**	**5/23/03**	**5/29/03**	**5/29/03**	**6/2/03**		
		Undecane	2.59E-04	2.76E-04	3.97E-05	ND	ND	ND	9.57E-05	1.34E-04
		4-Ethyltoluene	2.19E-04	1.15E-04	1.96E-04	ND	ND	ND	8.84E-05	1.03E-04
		Indene	ND	ND	2.21E-04	2.05E-04	ND	ND	7.09E-05	1.10E-04
		Tridecane	ND	1.77E-04	1.78E-04	ND	ND	ND	5.93E-05	9.18E-05
		1,3-Diethylbenzene	1.99E-04	1.31E-04	ND	ND	ND	ND	5.49E-05	8.77E-05
		Butyraldehyde/Methacrolein	4.41E-05	5.05E-05	4.28E-05	4.64E-05	3.58E-05	3.94E-05	4.32E-05	5.19E-06
		Benzaldehyde	2.12E-05	1.75E-05	2.20E-05	2.05E-05	1.66E-05	2.23E-05	2.00E-05	2.40E-06
		Dodecane	ND	1.14E-04	ND	ND	ND	ND	1.91E-05	4.67E-05
		Tetradecane	ND	1.04E-04	ND	ND	ND	ND	1.73E-05	4.24E-05
		o,m,p-Tolualdehyde	ND	5.13E-05	4.69E-05	ND	ND	ND	1.64E-05	2.54E-05
		Pentanal	1.70E-05	1.59E-05	1.95E-05	I	1.46E-05	1.99E-05	1.74E-05	2.31E-06
		Crotonaldehyde	1.43E-05	1.23E-05	ND	1.40E-05	ND	1.79E-05	9.74E-06	7.76E-06
		Hexaldehyde	6.47E-06	ND	ND	ND	ND	1.22E-05	3.11E-06	5.15E-06
		alpha-Methylstyrene	ND	ND	ND	ND	ND	ND	ND	NA
		Anthracene	ND	ND	ND	ND	ND	ND	ND	NA
		n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	NA
		1,2-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,4-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA

Test FB Individual Test Results - Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FB001	FB002	FB003	FB004	FB005	FB006	Average	STDEV
		Test Dates	**5/22/03**	**5/22/03**	**5/23/03**	**5/29/03**	**5/29/03**	**6/2/03**		
		3,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	I	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	NA
		1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3,5-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,4,6-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		Other Analytes								
		Acetone	2.74E-04	2.76E-04	2.68E-04	2.58E-04	2.30E-04	2.43E-04	2.58E-04	1.81E-05
		Carbon Dioxide	2.27E+00	2.18E+00	2.30E+00	2.01E+00	NA	2.03E+00	2.16E+00	1.33E-01
		Methane	ND	3.49E-03	3.89E-03	3.47E-03	NA	3.60E-03	2.89E-03	1.62E-03
		Carbon Monoxide	ND	ND	ND	ND	NA	ND	ND	NA
		Ethane	ND	ND	ND	ND	NA	ND	ND	NA
		Propane	ND	ND	ND	ND	NA	ND	ND	NA
		Isobutane	ND	ND	ND	ND	NA	ND	ND	NA
		Butane	ND	ND	ND	ND	NA	ND	ND	NA
		Neopentane	ND	ND	ND	ND	NA	ND	ND	NA
		Isopentane	ND	ND	ND	ND	NA	ND	ND	NA
		Pentane	ND	ND	ND	ND	NA	ND	ND	NA

I: Data rejected based on data validation considerations.

ND: Non Detect**;** **NA:** Not Applicable

Test FC Individual Test Results - Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/2003**	**5/27/2003**	**5/27/2003**	**5/28/2003**	**5/28/2003**	**5/28/2003**		
		TGOC as Propane	1.69E+00	1.78E+00	1.90E+00	1.97E+00	1.88E+00	2.11E+00	1.89E+00	1.46E-01
		HC as Hexane	3.83E-01	4.06E-01	I	4.14E-01	4.03E-01	4.58E-01	4.13E-01	2.79E-02
		Sum of VOCs	4.53E-01	4.80E-01	4.51E-01	4.91E-01	5.75E-01	5.41E-01	4.99E-01	4.97E-02
		Sum of HAPs	4.18E-01	4.43E-01	4.15E-01	4.54E-01	5.33E-01	5.16E-01	4.63E-01	5.00E-02
		Sum of POMs	3.47E-02	2.92E-02	1.86E-02	1.67E-02	1.93E-02	2.62E-02	2.41E-02	7.06E-03
		Individual Organic HAPs								
x		**Benzene**	1.36E-01	1.69E-01	1.74E-01	1.87E-01	2.16E-01	2.12E-01	1.82E-01	2.97E-02
x		**Phenol**	1.14E-01	1.06E-01	1.15E-01	1.07E-01	1.39E-01	1.47E-01	1.21E-01	1.71E-02
x		**Toluene**	3.87E-02	4.63E-02	4.72E-02	4.88E-02	5.58E-02	5.88E-02	4.93E-02	7.17E-03
x		**Aniline**	2.87E-02	2.63E-02	I	3.32E-02	2.70E-02	2.77E-02	2.86E-02	2.72E-03
x		**o-Cresol**	2.72E-02	2.40E-02	2.16E-02	2.19E-02	2.81E-02	2.95E-02	2.54E-02	3.33E-03
x		**m,p-Xylene**	1.54E-02	1.78E-02	1.78E-02	1.90E-02	2.21E-02	I	1.84E-02	2.42E-03
x	z	**Naphthalene**	1.76E-02	1.58E-02	1.11E-02	9.29E-03	1.12E-02	1.52E-02	1.34E-02	3.27E-03
x		**o-Xylene**	5.67E-03	6.62E-03	6.43E-03	6.51E-03	7.38E-03	I	6.52E-03	6.09E-04
x	z	**2-Methylnaphthalene**	9.12E-03	7.05E-03	4.00E-03	3.96E-03	4.35E-03	5.88E-03	5.73E-03	2.06E-03
x		**Hexane**	3.86E-03	4.87E-03	4.72E-03	4.39E-03	4.87E-03	5.47E-03	4.70E-03	5.40E-04
x		**m,p-Cresol**	5.89E-03	5.16E-03	4.34E-03	1.94E-03	5.20E-03	3.07E-03	4.27E-03	1.49E-03
x	z	**1-Methylnaphthalene**	5.78E-03	4.49E-03	2.53E-03	2.54E-03	2.72E-03	3.65E-03	3.62E-03	1.31E-03
x		**Ethylbenzene**	3.02E-03	3.52E-03	3.47E-03	3.69E-03	3.80E-03	I	3.50E-03	3.00E-04
x		**Acetaldehyde**	2.41E-03	1.16E-03	I	2.33E-03	2.18E-03	2.88E-03	2.19E-03	6.32E-04
x		**Styrene**	1.36E-03	1.81E-03	1.69E-03	I	1.97E-03	2.31E-03	1.83E-03	3.52E-04
x	z	**1,3-Dimethylnaphthalene**	2.20E-03	1.85E-03	9.53E-04	9.50E-04	1.01E-03	1.44E-03	1.40E-03	5.29E-04
x		**Formaldehyde**	6.19E-04	2.80E-04	I	4.25E-04	4.50E-04	5.97E-04	4.74E-04	1.39E-04
x		**2-Butanone**	4.44E-04	2.38E-04	I	3.89E-04	4.16E-04	4.94E-04	3.96E-04	9.67E-05
x		**Propionaldehyde**	2.19E-04	1.27E-04	I	1.99E-04	ND	1.89E-04	1.47E-04	8.90E-05
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA

Test FC Individual Test Results - Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	5/23/2003	5/27/2003	5/27/2003	5/28/2003	5/28/2003	5/28/2003		
x	z	1,5-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,8-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,3,5-Trimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,3-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,7-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	Acenapthalene	ND	ND	ND	ND	ND	ND	ND	NA
x		Biphenyl	ND	ND	ND	ND	ND	ND	ND	NA
x		Cumene	ND	ND	ND	ND	ND	ND	ND	NA
x		p-Cymene	ND	ND	ND	ND	ND	ND	ND	NA
x		N,N-Dimethylaniline	ND	ND	ND	ND	ND	ND	ND	NA
x		Acrolein	ND	ND	ND	ND	ND	ND	ND	NA
		Other VOCs								
		1,2,4-Trimethylbenzene	1.04E-02	1.30E-02	1.26E-02	1.31E-02	1.69E-02	I	1.32E-02	2.35E-03
		3-Ethyltoluene	4.75E-03	4.32E-03	4.61E-03	4.50E-03	5.78E-03	6.11E-03	5.01E-03	7.45E-04
		Heptane	3.15E-03	3.71E-03	3.47E-03	3.70E-03	2.82E-03	4.40E-03	3.54E-03	5.42E-04
		2,6-Dimethylphenol	4.40E-03	3.23E-03	4.15E-03	3.98E-03	4.74E-03	0.00E+00	3.42E-03	1.75E-03
		2,4-Dimethylphenol	3.46E-03	2.20E-03	2.57E-03	2.32E-03	2.59E-03	2.52E-03	2.61E-03	4.43E-04
		1,3-Diethylbenzene	ND	2.55E-03	2.59E-03	2.35E-03	2.87E-03	3.76E-03	2.35E-03	1.26E-03
		2-Ethyltoluene	1.79E-03	2.25E-03	2.15E-03	2.37E-03	3.00E-03	I	2.31E-03	4.40E-04
		Nonane	1.97E-03	2.23E-03	2.05E-03	2.06E-03	2.01E-03	2.52E-03	2.14E-03	2.09E-04
		4-Ethyltoluene	ND	9.58E-04	ND	1.73E-03	ND	2.63E-03	8.86E-04	1.11E-03
		Undecane	2.72E-04	1.71E-03	4.92E-04	6.47E-04	7.85E-04	I	7.80E-04	5.52E-04
		Decane	ND	1.06E-03	ND	ND	ND	1.94E-03	5.00E-04	8.24E-04
		Indene	2.46E-03	ND	ND	ND	ND	ND	4.11E-04	1.01E-03
		Butyraldehyde/Methacrolein	3.52E-04	ND	I	3.40E-04	3.15E-04	4.53E-04	2.92E-04	1.71E-04
		Tridecane	1.38E-03	ND	ND	ND	ND	ND	2.30E-04	5.65E-04

Test FC Individual Test Results - Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/2003**	**5/27/2003**	**5/27/2003**	**5/28/2003**	**5/28/2003**	**5/28/2003**		
		Benzaldehyde	1.65E-04	ND	3.63E-04	2.23E-04	1.95E-04	2.14E-04	1.93E-04	1.17E-04
		Pentanal	6.50E-05	ND	2.84E-04	1.46E-04	1.24E-04	1.81E-04	1.33E-04	9.76E-05
		o,m,p-Tolualdehyde	3.94E-04	ND	3.51E-04	ND	ND	ND	1.24E-04	1.93E-04
		Hexaldehyde	ND	ND	1.63E-04	1.38E-04	1.24E-04	ND	7.07E-05	7.85E-05
		Crotonaldehyde	7.79E-05	ND	1.25E-04	ND	ND	ND	3.39E-05	5.46E-05
		1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,2-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3-Diisopropylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,4-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3,5-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,3-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,4,6-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		a-Methylstyrene	ND	ND	ND	ND	ND	ND	ND	NA
		Anthracene	ND	ND	ND	ND	ND	ND	ND	NA
		Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	NA
		sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Tetradecane	ND	ND	ND	ND	ND	ND	ND	NA

Test FC Individual Test Results - Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/2003**	**5/27/2003**	**5/27/2003**	**5/28/2003**	**5/28/2003**	**5/28/2003**		
		Other Analytes								
		Acetone	2.78E-03	1.58E-03	I	2.79E-03	2.41E-03	2.96E-03	2.50E-03	5.56E-04
		Carbon Dioxide	2.11E+01	2.00E+01	2.18E+01	2.24E+01	2.02E+01	2.20E+01	2.12E+01	9.77E-01
		Methane	1.91E-02	3.73E-02	4.24E-02	3.41E-02	3.50E-02	3.62E-02	3.40E-02	7.86E-03
		Butane	ND	ND	ND	ND	ND	ND	ND	NA
		Carbon Monoxide	ND	ND	ND	ND	ND	ND	ND	NA
		Ethane	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutane	ND	ND	ND	ND	ND	ND	ND	NA
		Isopentane	ND	ND	ND	ND	ND	ND	ND	NA
		Neopentane	ND	ND	ND	ND	ND	ND	ND	NA
		Pentane	ND	ND	ND	ND	ND	ND	ND	NA
		Propane	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 HAPs or VOCs.

Test FC Individual Test Results - Lb/Lb Binder

HAPs	POMs	Compound/Sample Number	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/03**	**5/27/03**	**5/27/03**	**5/28/03**	**5/28/03**	**5/28/03**		
		TGOC as Propane	1.65E-01	1.81E-01	1.83E-01	2.00E-01	1.99E-01	2.12E-01	1.90E-01	1.68E-02
		HC as Hexane	3.73E-02	4.14E-02	I	4.20E-02	4.27E-02	4.57E-02	4.18E-02	3.01E-03
		Sum of VOCs	4.41E-02	4.93E-02	4.31E-02	4.98E-02	6.07E-02	5.40E-02	5.02E-02	6.54E-03
		Sum of HAPs	4.07E-02	4.52E-02	3.96E-02	4.60E-02	5.62E-02	5.15E-02	4.65E-02	6.35E-03
		Sum of POMs	3.38E-03	2.98E-03	1.77E-03	1.70E-03	2.04E-03	2.61E-03	2.41E-03	6.85E-04
		Individual Organic HAPs								
x		**Benzene**	1.33E-02	1.72E-02	1.66E-02	1.90E-02	2.29E-02	2.11E-02	1.83E-02	3.42E-03
x		**Phenol**	1.11E-02	1.08E-02	1.10E-02	1.09E-02	1.47E-02	1.46E-02	1.22E-02	1.92E-03
x		**Toluene**	3.78E-03	4.72E-03	4.50E-03	4.95E-03	5.91E-03	5.86E-03	4.95E-03	8.21E-04
x		**Aniline**	2.80E-03	2.68E-03	I	3.37E-03	2.86E-03	2.76E-03	2.89E-03	2.72E-04
x		**o-Cresol**	2.56E-03	2.50E-03	2.11E-03	2.20E-03	2.73E-03	2.96E-03	2.51E-03	3.21E-04
x		**m,p-Xylene**	1.51E-03	1.81E-03	1.70E-03	1.93E-03	2.34E-03	I	1.86E-03	3.12E-04
x	z	**Naphthalene**	1.71E-03	1.61E-03	1.06E-03	9.43E-04	1.19E-03	1.52E-03	1.34E-03	3.17E-04
x		**o-Xylene**	5.53E-04	6.75E-04	6.13E-04	6.60E-04	7.82E-04	I	6.57E-04	8.46E-05
x	z	**2-Methylnaphthalene**	8.90E-04	7.19E-04	3.82E-04	4.02E-04	4.61E-04	5.86E-04	5.73E-04	2.00E-04
x		**Hexane**	3.76E-04	4.96E-04	4.50E-04	4.46E-04	5.16E-04	5.46E-04	4.72E-04	6.04E-05
x		**m,p-Cresol**	5.74E-04	5.26E-04	4.14E-04	1.97E-04	5.51E-04	3.06E-04	4.28E-04	1.51E-04
x	z	**1-Methylnaphthalene**	5.63E-04	4.58E-04	2.41E-04	2.58E-04	2.88E-04	3.64E-04	3.62E-04	1.27E-04
x		**Ethylbenzene**	2.94E-04	3.59E-04	3.30E-04	3.74E-04	4.03E-04	I	3.52E-04	4.15E-05
x		**Acetaldehyde**	2.35E-04	1.18E-04	I	2.36E-04	2.31E-04	2.87E-04	2.22E-04	6.21E-05

Test FC Individual Test Results - Lb/Lb Binder

HAPs	POMs	Compound/Sample Number	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	5/23/03	5/27/03	5/27/03	5/28/03	5/28/03	5/28/03		
x		Styrene	1.32E-04	1.84E-04	1.61E-04	I	2.08E-04	2.31E-04	1.83E-04	3.86E-05
x	z	1,3-Dimethylnaphthalene	2.14E-04	1.89E-04	9.09E-05	9.64E-05	1.07E-04	1.44E-04	1.40E-04	5.17E-05
x		Formaldehyde	6.04E-05	2.85E-05	I	4.32E-05	4.77E-05	5.95E-05	4.79E-05	1.31E-05
x		2-Butanone	4.34E-05	2.42E-05	I	3.95E-05	4.41E-05	4.92E-05	4.01E-05	9.52E-06
x		Propionaldehyde	2.14E-05	1.29E-05	I	2.02E-05	ND	1.89E-05	1.47E-05	8.82E-06
x		Acrolein	ND	ND	ND	ND	ND	ND	ND	NA
x		Dimethylaniline	ND	ND	ND	ND	ND	ND	ND	NA
x	z	Acenapthalene	ND	ND	ND	ND	ND	ND	ND	NA
x		Biphenyl	ND	ND	ND	ND	ND	ND	ND	NA
x		p-Cymene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,2-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,5-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	1,8-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,3-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,6-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,7-Dimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
x		Cumene	ND	ND	ND	ND	ND	ND	ND	NA
x	z	2,3,5-Trimethylnaphthalene	ND	ND	ND	ND	ND	ND	ND	NA
		Other VOCs								
		1,2,4-Trimethylbenzene	1.02E-03	1.33E-03	1.20E-03	1.33E-03	1.79E-03	I	1.33E-03	2.87E-04
		3-Ethyltoluene	4.63E-04	4.40E-04	4.40E-04	4.57E-04	6.13E-04	6.09E-04	5.04E-04	8.36E-05

Test FC Individual Test Results - Lb/Lb Binder

HAPs	POMs	Compound/Sample Number	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/03**	**5/27/03**	**5/27/03**	**5/28/03**	**5/28/03**	**5/28/03**		
		Heptane	3.07E-04	3.78E-04	3.30E-04	3.76E-04	2.99E-04	4.38E-04	3.55E-04	5.29E-05
		2,6-Dimethylphenol	4.29E-04	3.30E-04	3.96E-04	4.04E-04	5.02E-04	ND	3.43E-04	1.77E-04
		2,4-Dimethylphenol	3.37E-04	2.24E-04	2.45E-04	2.35E-04	2.75E-04	2.52E-04	2.61E-04	4.09E-05
		1,3-Diethylbenzene	ND	2.60E-04	2.47E-04	2.39E-04	3.04E-04	3.75E-04	2.37E-04	1.27E-04
		2-Ethyltoluene	1.74E-04	2.30E-04	2.05E-04	2.41E-04	3.17E-04	I	2.34E-04	5.34E-05
		Nonane	1.92E-04	2.28E-04	1.95E-04	2.09E-04	2.13E-04	2.52E-04	2.15E-04	2.22E-05
		Undecane	2.65E-05	1.74E-04	4.69E-05	6.57E-05	8.31E-05	3.77E-04	1.29E-04	1.32E-04
		4-Ethyltoluene	ND	9.76E-05	ND	1.76E-04	ND	I	5.46E-05	7.97E-05
		Tridecane	1.35E-04	1.81E-04	ND	ND	ND	ND	5.27E-05	8.29E-05
		Decane	ND	1.08E-04	ND	ND	ND	1.94E-04	5.03E-05	8.25E-05
		Indene	2.40E-04	ND	ND	ND	ND	ND	4.01E-05	9.82E-05
		Butyraldehyde/Methacrolein	3.43E-05	ND	I	3.45E-05	3.34E-05	4.51E-05	2.95E-05	1.72E-05
		Benzaldehyde	1.61E-05	ND	3.46E-05	2.26E-05	2.07E-05	2.13E-05	1.92E-05	1.13E-05
		Dodecane	ND	1.03E-04	ND	ND	ND	ND	1.72E-05	4.22E-05
		Pentanal	6.34E-06	ND	2.71E-05	1.48E-05	1.31E-05	1.81E-05	1.32E-05	9.38E-06
		o,m,p-Tolualdehyde	3.84E-05	ND	3.35E-05	ND	ND	ND	1.20E-05	1.86E-05
		Hexaldehyde	ND	ND	1.55E-05	1.40E-05	1.31E-05	ND	7.10E-06	7.82E-06
		Crotonaldehyde	7.60E-06	ND	1.19E-05	ND	ND	ND	3.26E-06	5.23E-06
		Anthracene	ND	ND	ND	ND	ND	ND	ND	NA
		alpha-Methylstyrene	ND	ND	ND	ND	ND	ND	ND	NA
		n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA

Test FC Individual Test Results - Lb/Lb Binder

HAPs	POMs	Compound/Sample Number	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/03**	**5/27/03**	**5/27/03**	**5/28/03**	**5/28/03**	**5/28/03**		
		tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	NA
		1,2-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,4-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3-Diisopropylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		3,5-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		Tetradecane	ND	ND	ND	ND	ND	ND	ND	NA
		1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	NA
		2,3,5-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
		2,4,6-Trimethylphenol	ND	ND	ND	ND	ND	ND	ND	NA
			Other Analytes							
		Acetone	2.71E-04	1.61E-04	I	2.83E-04	2.55E-04	2.95E-04	2.53E-04	5.37E-05
		Carbon Dioxide	2.05E+00	2.04E+00	2.09E+00	2.27E+00	2.14E+00	2.21E+00	2.13E+00	9.17E-02
		Methane	1.87E-03	3.80E-03	4.08E-03	3.46E-03	3.71E-03	3.63E-03	3.42E-03	7.90E-04

Test FC Individual Test Results - Lb/Lb Binder

HAPs	POMs	Compound/Sample Number	FC001	FC002	FC003	FC004	FC005	FC006	Average	STDEV
		Test Dates	**5/23/03**	**5/27/03**	**5/27/03**	**5/28/03**	**5/28/03**	**5/28/03**		
		Carbon Monoxide	ND	ND	ND	ND	ND	ND	ND	NA
		Ethane	ND	ND	ND	ND	ND	ND	ND	NA
		Propane	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutane	ND	ND	ND	ND	ND	ND	ND	NA
		Butane	ND	ND	ND	ND	ND	ND	ND	NA
		Neopentane	ND	ND	ND	ND	ND	ND	ND	NA
		Isopentane	ND	ND	ND	ND	ND	ND	ND	NA
		Pentane	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 HAPs or VOCs.

FB and FC Average Test Results with T-Statistics – Lb/Tn Metal

Analytes	Test FB Lb/Tn Metal	Test FC Lb/Tn Metal	T-Statistic
TGOC as Propane	1.782	1.890	-1.3
HC as Hexane	0.3267	0.4129	-3.9
Sum of VOCs	0.4274	0.4987	-2.5
Sum of HAPs	0.3967	0.4632	-2.4
Sum of POMs	0.0369	0.0241	2.4
Individual Organic HAPs			
Benzene	0.1417	0.1823	-2.3
Phenol	0.0970	0.1214	-2.5
Toluene	0.0390	0.0493	-2.8
Aniline	0.0273	0.0286	-0.5
o,m,p-Cresol	0.0223	0.0297	-4.0
o,m,p-Xylene	0.0210	0.0208	0.0
Methylnaphthalenes	0.0195	0.0093	3.9
Naphthalene	0.0142	0.0134	0.4
Hexane	0.0040	0.0047	-2.6
Other VOCs			
Trimethylbenzenes	0.0105	0.0110	-0.2
Ethyltoluenes	0.0082	0.0078	0.4
Dimethylphenols	0.0047	0.0060	-1.2
Other Analytes			
Carbon Dioxide	20.51	21.23	-1.5
Methane	0.0230	0.0340	-1.4

FB and FC Average Test Results with T-Statistics – Lb/Lb Binder

Analytes	Test FB Lb/Lb Binder	Test FC Lb/Lb Binder	T-Statistic
TGOC as Propane	0.1871	0.1901	-0.37
HC as Hexane	0.0347	0.0418	-2.56
Sum of VOCs	0.0458	0.0502	-1.16
Sum of HAPs	0.0425	0.0465	-1.14
Sum of POMs	0.0047	0.0024	2.40
Individual Organic HAPs			
Benzene	0.0148	0.0183	-1.81
Phenol	0.0101	0.0122	-1.88
Toluene	0.0041	0.0050	-2.11
Aniline	0.0028	0.0029	-0.15
Methylnaphthalenes	0.0025	0.0009	3.26
o,m,p-Cresol	0.0025	0.0029	-2.62
o,m,p-Xylene	0.0022	0.0025	-1.55
Naphthalene	0.0017	0.0013	1.18
Dimethylnaphthalenes	0.0005	0.0001	2.02
Hexane	0.0004	0.0005	-1.81
Other VOCs			
Trimethylbenzenes	0.0011	0.0011	-0.06
Ethyltoluenes	0.0009	0.0008	0.82
Dimethylphenols	0.0005	0.0006	-1.09
Other Analytes			
Carbon Dioxide	2.161	2.134	0.41
Methane	0.0029	0.0034	-0.73

FB and FC Reporting Limits – Lb/Tn Metal

Analytes	Lb/Tn Metal
1,2,3-Trimethylbenzene	3.36E-04
1,2,4-Trimethylbenzene	3.36E-04
1,3,5-Trimethylbenzene	3.36E-04
1,3-Dimethylnaphthalene	3.36E-04
1-Methylnaphthalene	3.36E-04
2-Ethyltoluene	3.36E-04
2-Methylnaphthalene	3.36E-04
Benzene	3.36E-04
Ethylbenzene	3.36E-04
Hexane	3.36E-04
m,p-Xylene	3.36E-04
Naphthalene	3.36E-04
o-Xylene	3.36E-04
Styrene	3.36E-04
Toluene	3.36E-04
Undecane	3.36E-04
1,2-Diethylbenzene	1.68E-03
1,2-Dimethylnaphthalene	1.68E-03
1,3-Diethylbenzene	1.68E-03
1,3-Diisopropylbenzene	1.68E-03
1,4-Diethylbenzene	1.68E-03
1,5-Dimethylnaphthalene	1.68E-03
1,6-Dimethylnaphthalene	1.68E-03
1,8-Dimethylnaphthalene	1.68E-03
2,3,5-Trimethylnaphthalene	1.68E-03
2,3,5-Trimethylphenol	1.68E-03
2,3-Dimethylnaphthalene	1.68E-03
2,3-Dimethylphenol	1.68E-03
2,4,6-Trimethylphenol	1.68E-03

Analytes	Lb/Tn Metal
2,4-Dimethylphenol	1.68E-03
2,5-Dimethylphenol	1.68E-03
2,6-Dimethylnaphthalene	1.68E-03
2,6-Dimethylphenol	1.68E-03
2,7- Dimethylnaphthalene	1.68E-03
3,4-Dimethylphenol	1.68E-03
3,5-Dimethylphenol	1.68E-03
3-Ethyltoluene	1.68E-03
4-Ethyltoluene	1.68E-03
Acenaphthalene	1.68E-03
a-Methylstyrene	1.68E-03
Biphenyl	1.68E-03
Butylbenzene	1.68E-03
Cumene	1.68E-03
Cyclohexane	1.68E-03
Decane	1.68E-03
Dodecane	1.68E-03
Heptane	1.68E-03
Indan	1.68E-03
Indene	1.68E-03
Isobutylbenzene	1.68E-03
m,p-Cresol	1.68E-03
Nonane	1.68E-03
o-Cresol	1.68E-03
Octane	1.68E-03
p-Cymene	1.68E-03
Phenol	1.68E-03
Propylbenzene	1.68E-03
sec-Butylbenzene	1.68E-03

Analytes	Lb/Tn Metal
Tetradecane	1.68E-03
tert-Butylbenzene	1.68E-03
Tridecane	1.68E-03
HC as Hexane	4.29E-03
2-Butanone	1.18E-04
Acetaldehyde	1.18E-04
Acetone	1.18E-04
Acrolein	1.18E-04
Benzaldehyde	1.18E-04
Butyraldehyde	1.18E-04
Crotonaldehyde	1.18E-04
Formaldehyde	1.18E-04
Hexaldehyde	1.18E-04
Butyraldehyde/Methacrolein	1.96E-04
o,m,p-Tolualdehyde	3.13E-04
Pentanal	1.18E-04
Propionaldehyde	1.18E-04
N,N-Dimethyl Aniline	3.08E-03
Aniline	1.54E-03

FB and FC Reporting Limits – Lb/Lb Binder

Analytes	Lb/Lb Binder
1,2,3-Trimethylbenzene	3.53E-05
1,2,4-Trimethylbenzene	3.53E-05
1,3,5-Trimethylbenzene	3.53E-05
1,3-Dimethylnaphthalene	3.53E-05
1-Methylnaphthalene	3.53E-05
2-Ethyltoluene	3.53E-05
2-Methylnaphthalene	3.53E-05
Benzene	3.53E-05
Ethylbenzene	3.53E-05
Hexane	3.53E-05
m,p-Xylene	3.53E-05
Naphthalene	3.53E-05
o-Xylene	3.53E-05
Styrene	3.53E-05
Toluene	3.53E-05
Undecane	3.53E-05
1,2-Diethylbenzene	1.77E-04
1,2-Dimethylnaphthalene	1.77E-04
1,3-Diethylbenzene	1.77E-04
1,3-Diisopropylbenzene	1.77E-04
1,4-Diethylbenzene	1.77E-04
1,5-Dimethylnaphthalene	1.77E-04
1,6-Dimethylnaphthalene	1.77E-04
1,8-Dimethylnaphthalene	1.77E-04
2,3,5-Trimethylnaphthalene	1.77E-04
2,3,5-Trimethylphenol	1.77E-04
2,3-Dimethylnaphthalene	1.77E-04
2,3-Dimethylphenol	1.77E-04
2,4,6-Trimethylphenol	1.77E-04

Analytes	Lb/Lb Binder
2,4-Dimethylphenol	1.77E-04
2,5-Dimethylphenol	1.77E-04
2,6-Dimethylnaphthalene	1.77E-04
2,6-Dimethylphenol	1.77E-04
2,7- Dimethylnaphthalene	1.77E-04
3,4-Dimethylphenol	1.77E-04
3,5-Dimethylphenol	1.77E-04
3-Ethyltoluene	1.77E-04
4-Ethyltoluene	1.77E-04
Acenaphthalene	1.77E-04
a-Methylstyrene	1.77E-04
Biphenyl	1.77E-04
Butylbenzene	1.77E-04
Cumene	1.77E-04
Cyclohexane	1.77E-04
Decane	1.77E-04
Dodecane	1.77E-04
Heptane	1.77E-04
Indan	1.77E-04
Indene	1.77E-04
Isobutylbenzene	1.77E-04
m,p-Cresol	1.77E-04
Nonane	1.77E-04
o-Cresol	1.77E-04
Octane	1.77E-04
p-Cymene	1.77E-04
Phenol	1.77E-04
Propylbenzene	1.77E-04
sec-Butylbenzene	1.77E-04

Analytes	Lb/Lb Binder
Tetradecane	1.77E-04
tert-Butylbenzene	1.77E-04
Tridecane	1.77E-04
HC as Hexane	4.51E-04
2-Butanone	1.24E-05
Acetaldehyde	1.24E-05
Acetone	1.24E-05
Acrolein	1.24E-05
Benzaldehyde	1.24E-05
Butyraldehyde	1.24E-05
Crotonaldehyde	1.24E-05
Formaldehyde	1.24E-05
Hexaldehyde	1.24E-05
Butyraldehyde/Methacrolein	2.06E-05
o,m,p-Tolualdehyde	3.30E-05
Pentanal	1.24E-05
Propionaldehyde	1.24E-05
N,N-Dimethyl Aniline	3.24E-04
Aniline	1.62E-04
Carbon Monoxide	3.36E-02
Methane	1.92E-03
Carbon Dioxide	5.29E-02
Ethane	3.60E-02
Propane	5.29E-02
Isobutane	6.97E-02
Butane	6.97E-02
Neopentane	8.65E-02
Isopentane	8.65E-02
Pentane	8.65E-02

APPENDIX C TEST SERIES FB AND FC DETAILED PROCESS DATA

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Test FB Detailed Process Data

Sample ID#	FB ENG2	FB001	FB002	FB003	FB004	FB005	FB006	Average FB001-FB006
Pouring Date	21-May-03	22-May-03	22-May-03	23-May 03	29-May-03	29-May-03	2-Jun-03	
Calculated standard % core binder				1.71				1.71
Cores / Cavities Used per Mold	8	8	8	8	8	8	8	8
Total Core Weight (lbs.)	57.61	58.13	57.92	57.22	58.11	58.21	58.25	57.97
Calc. Total Binder Weight (lbs.)	0.985	0.994	0.991	0.979	0.994	0.996	0.996	0.992
GS Mold Sand Weight (lbs.)	N/D	1436	1412	1440	1392	1372	1442	1416
Cast Weight- all metal inside mold (lbs.)	N/D	213.5	207.5	205.0	206.0	200.5	208.0	206.8
Core age at time of pour (days.)	9	10	10	11	17	17	21	14
Pouring Time (sec.)	37	30	36	44	30	30	26	33
Pouring Temp (°F)	2720	2638	2627	2633	2619	2634	2633	2631
Sand Temp In Hood (°F)	81	81	78	81	80	81	80	80
Average Green Compression (psi)	21.87	N/D	19.93	16.68	13.18	15.11	18.79	16.74
GS Compactability (%)	34	N/D	37	39	49	38	37	40
GS Moisture Content (%)	N/D	N/D	1.82	1.74	2.55	2.04	2.07	2.04
GS Clay Content (%)	N/D	7.00	7.26	7.13	6.35	6.35	6.61	6.78
1800°F LOI - Mold Sand (%)	3.04	3.06	3.10	3.21	4.09	3.37	3.38	3.37
1800°F LOI - Core Sand (%)	1.87	1.74	1.73	1.64	1.72	1.62	1.65	1.68
900°F Volatiles (%)	N/D	0.76	0.60	0.56	0.60	0.52	0.74	0.63
Pour hood process air temp at start of pour, F	89	92	88	85	86	88	85	87

Test FC Detailed Process Data

Sample ID#	FC001	FC002	FC003	FC004	FC005	FC006	Average FC001-FC006
Pouring Date	23-May-03	27-May-03	27-May-03	28-May-03	28-May-03	28-May-03	
Calculated Average standard % core binder	1.725						1.725
Cores / Cavities Used per Mold	8	8	8	8	8	8	8
Total Core Weight (lbs.)	58.11	58.14	58.20	58.27	58.12	58.17	58.17
Calc. Total Binder Weight (lbs.)	1.002	1.003	1.004	1.005	1.003	1.003	1.00
GS Mold Sand Weight, (lbs.)	1434	1394	1442	1394	1402	1374	1407
Cast Weight- all metal inside mold (lbs.)	195.5	204.5	191.5	204.0	212.5	200.0	201.3
Core age at time of pour (min.)	8	12	12	13	13	13	12
Pouring Time (sec.)	28	30	33	35	29	43	33
Pouring Temp (°F)	2614	2630	2637	2639	2627	2620	2628
Sand Temp In Hood (°F)	81	81	80	78	78	80	80
Average Green Compression (psi)	18.38	N/D	19.84	19.01	21.51	20.35	19.82
GS Compactability (%)	32	N/D	35	46	34	49	39
GS Moisture Content (%)	1.68	N/D	1.97	2.10	2.05	2.49	2.06
GS Clay Content (%)	6.49	7.13	7.00	7.00	6.75	7.38	6.96
1800°F LOI - Mold Sand (%)	3.37	3.27	3.44	3.18	3.21	3.38	3.31
1800°F LOI - Core Sand (%)	1.56	1.65	1.63	1.71	1.65	1.74	1.66
900°F Volatiles (%)	0.68	0.68	0.67	0.54	0.66	0.54	0.63
Pour hood process air temp at start of pour, F	90	86	90	84	88	95	89

Note: FC002 sample was delivered to the lab too dry to perform mechanical tests

APPENDIX D METHOD 25A CHARTS

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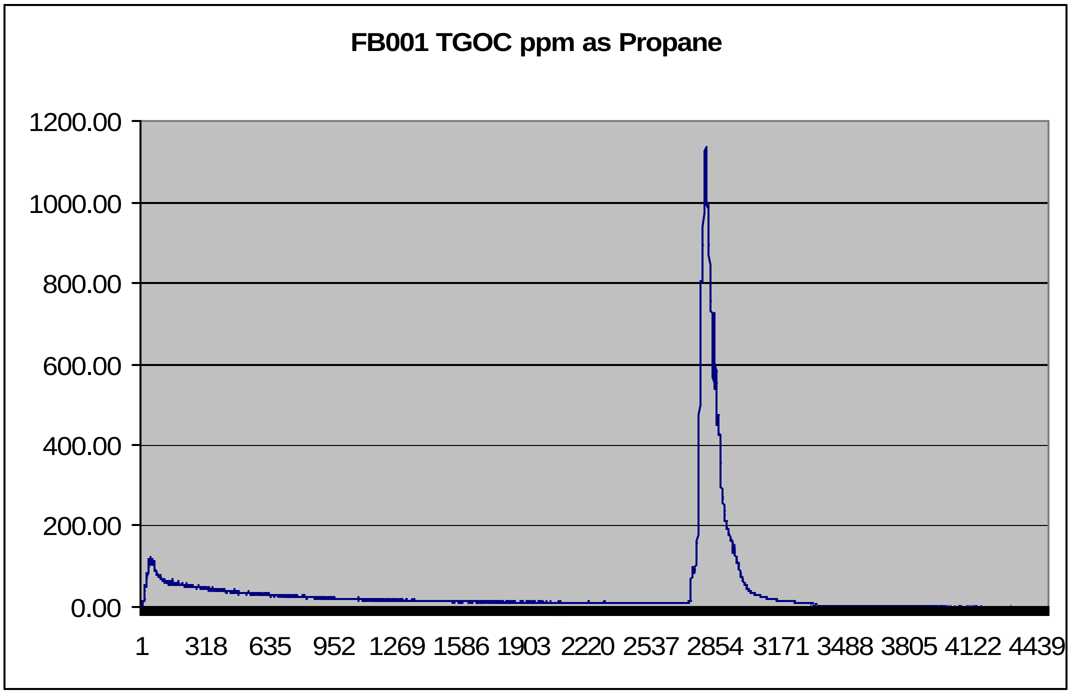
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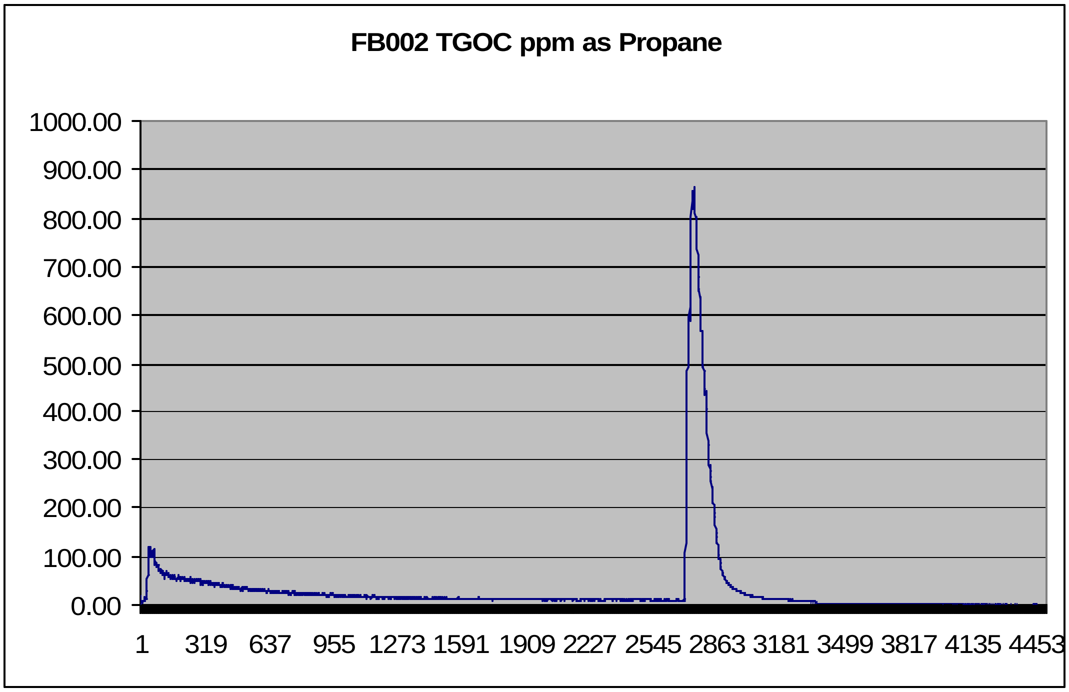
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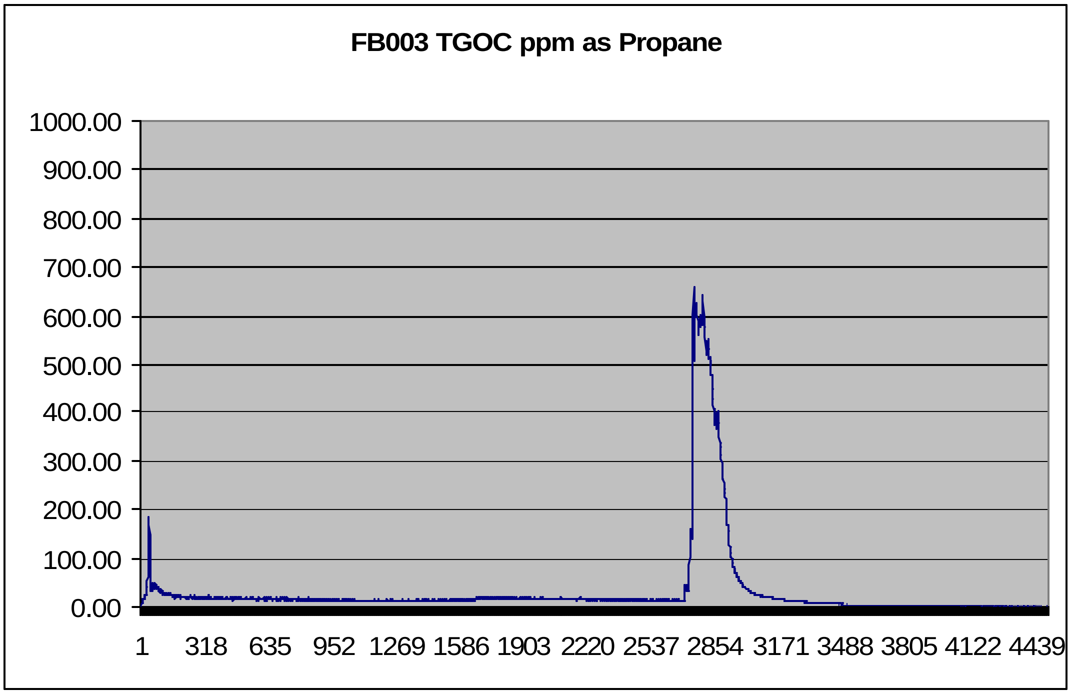
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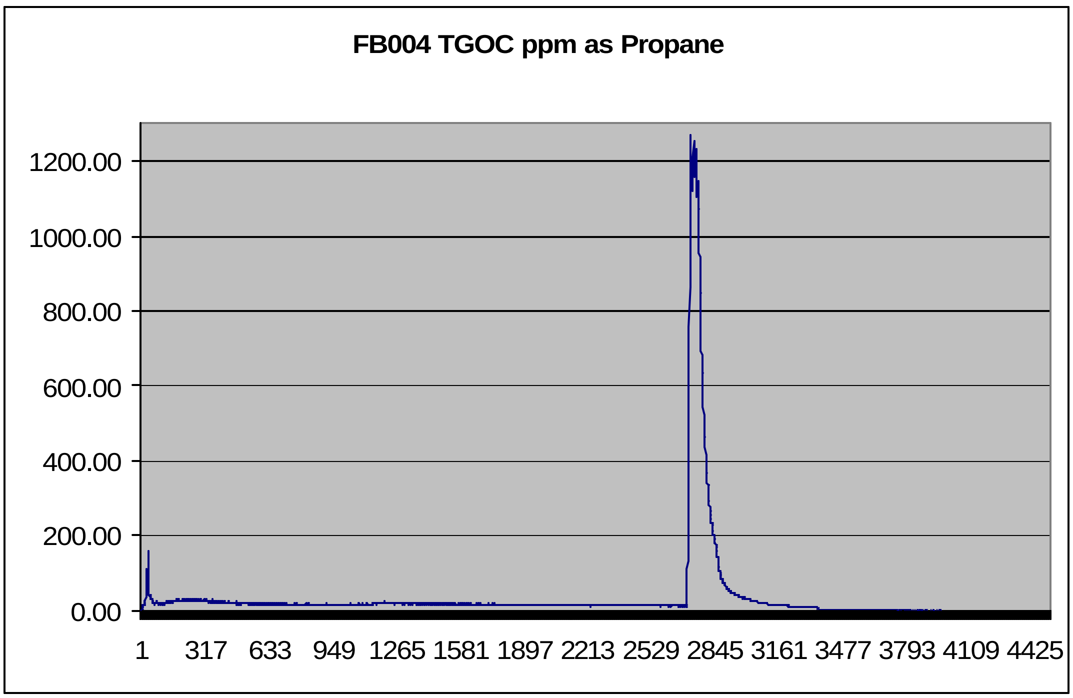
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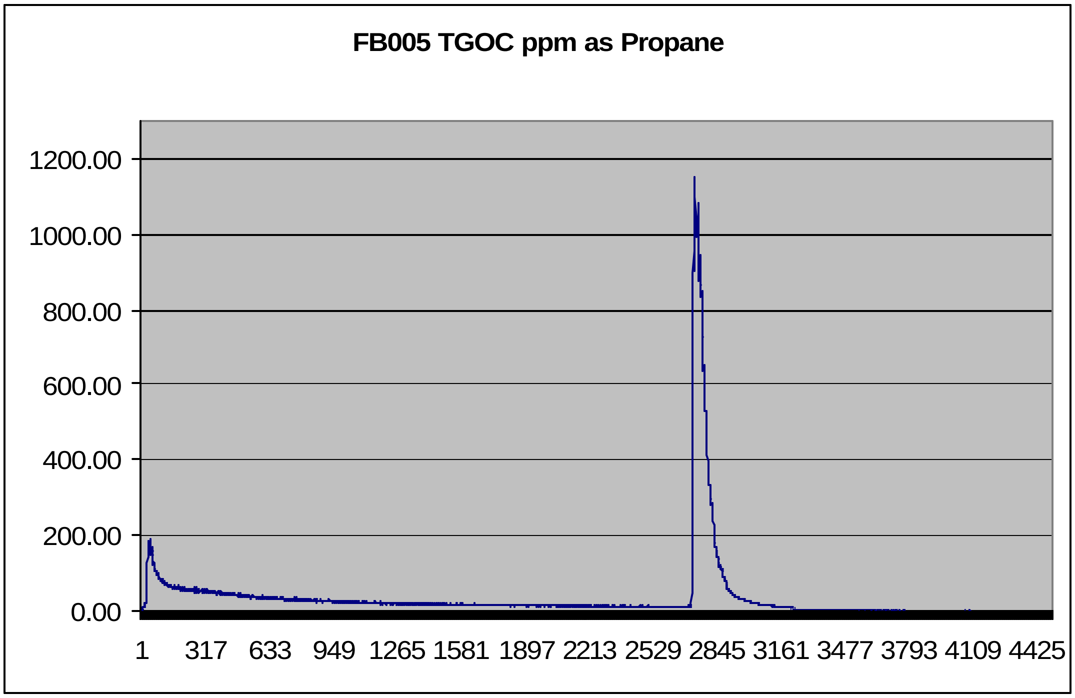
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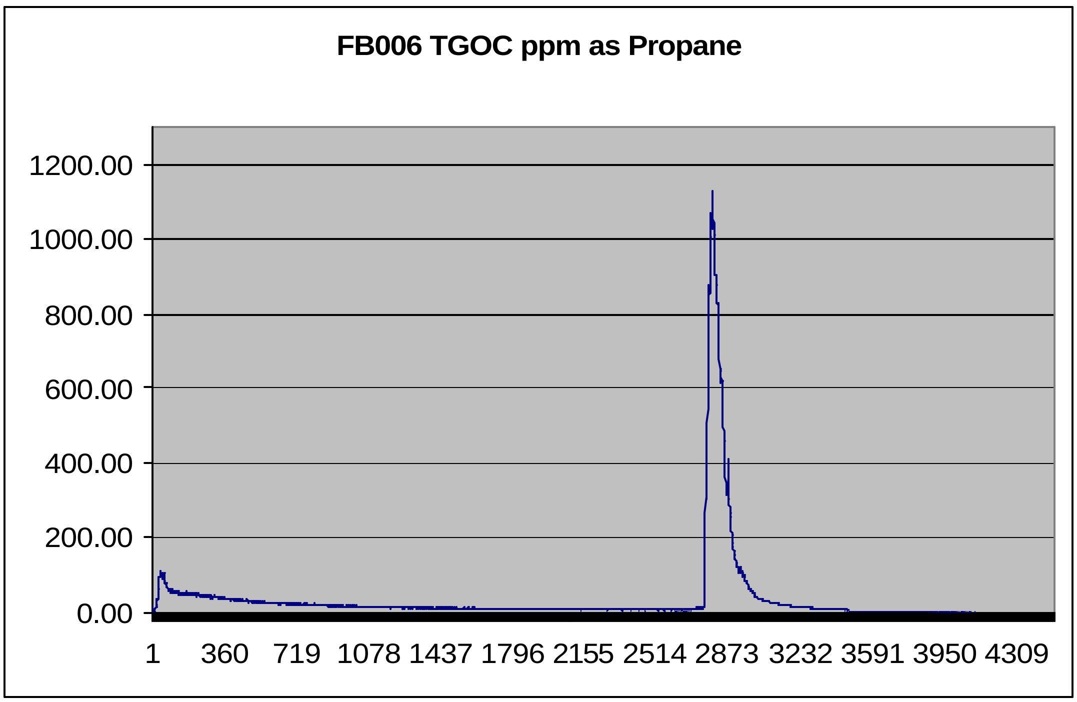
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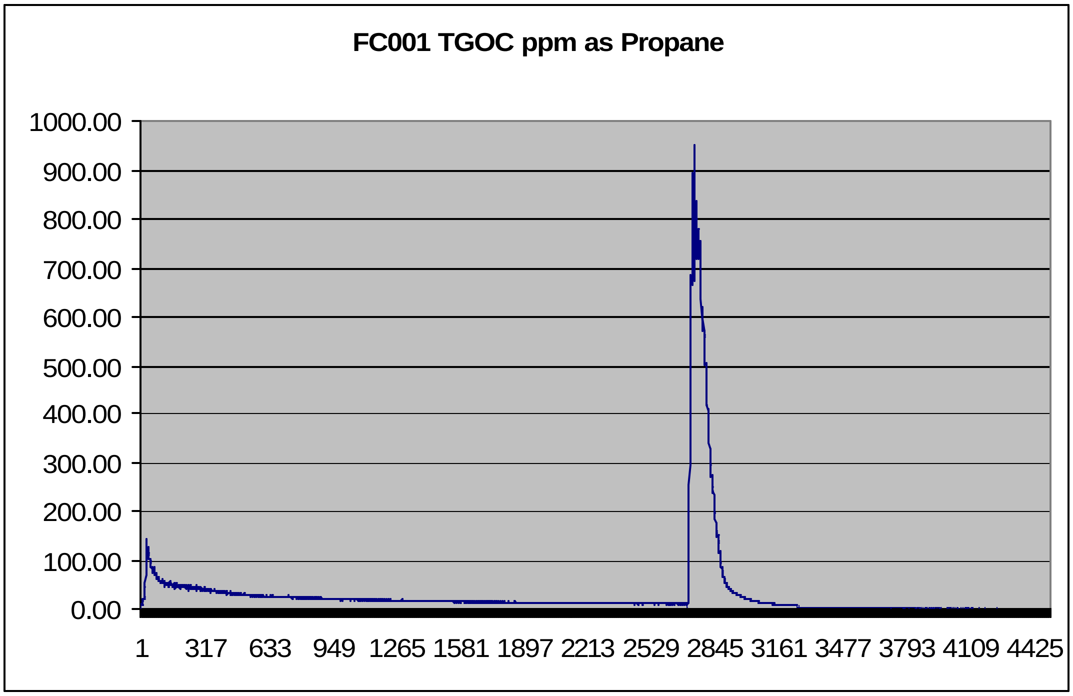
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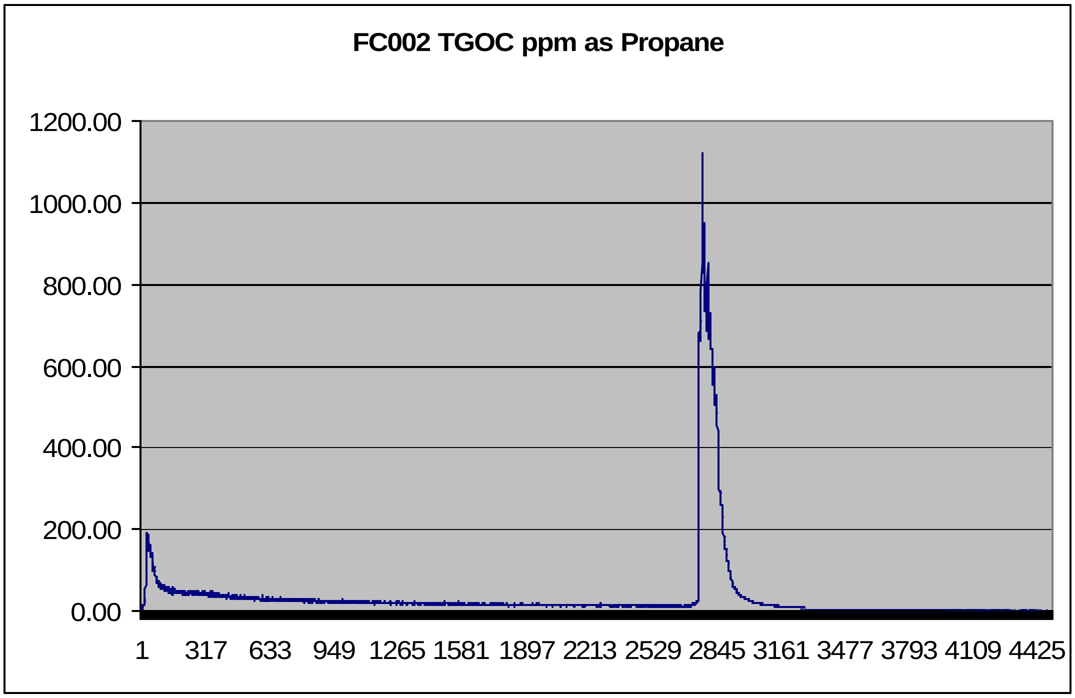
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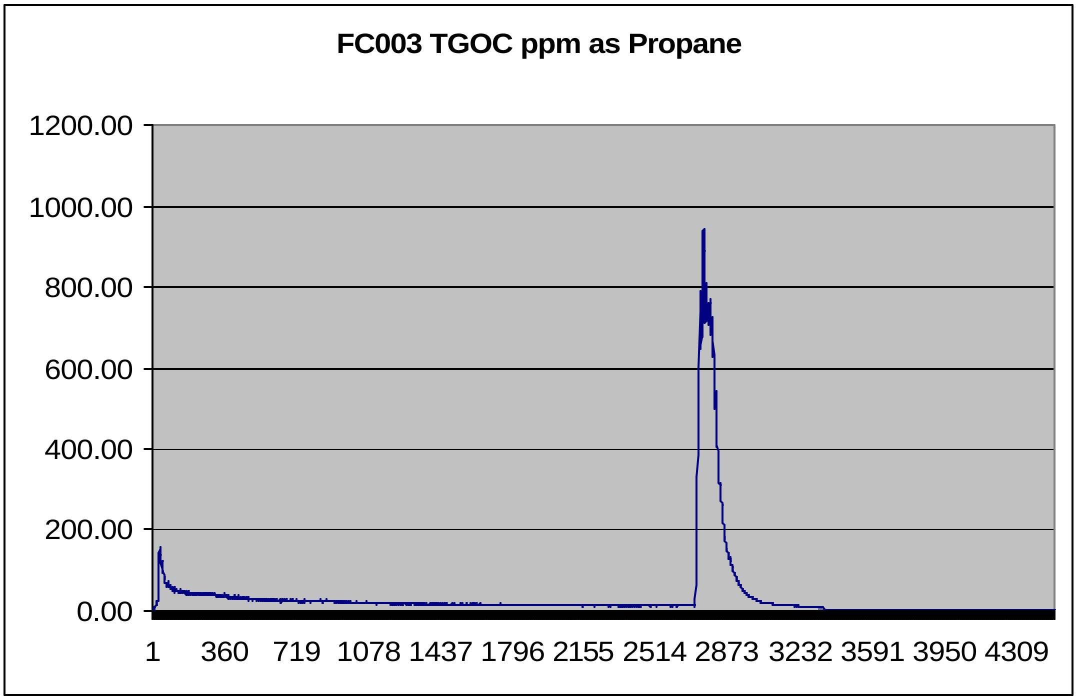
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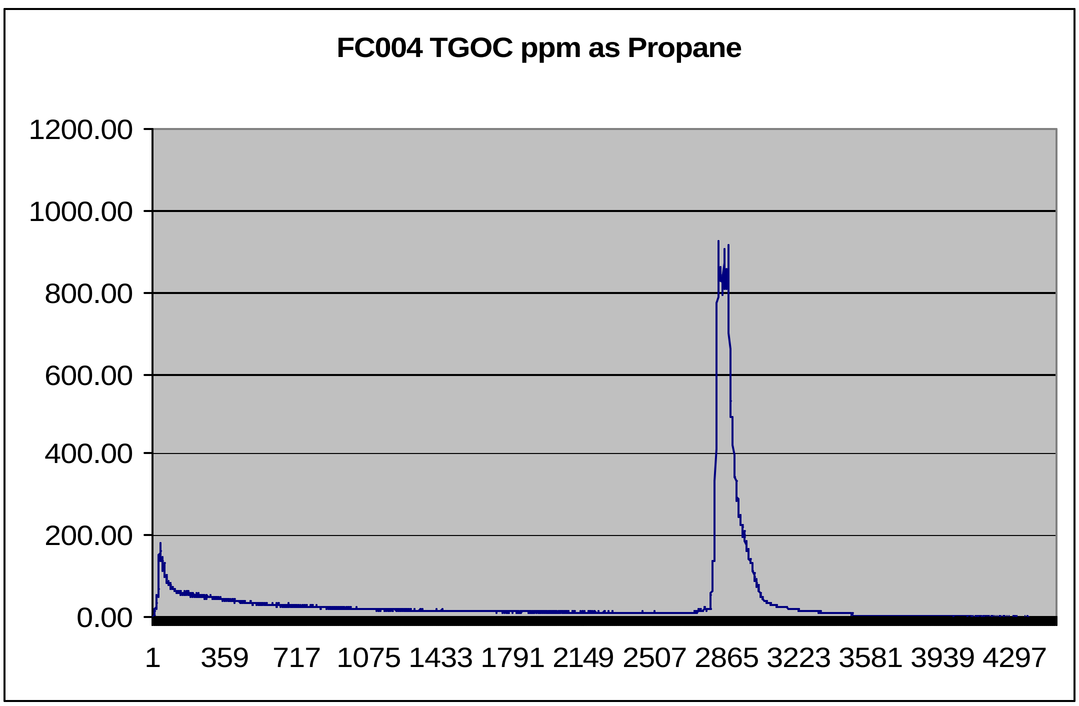
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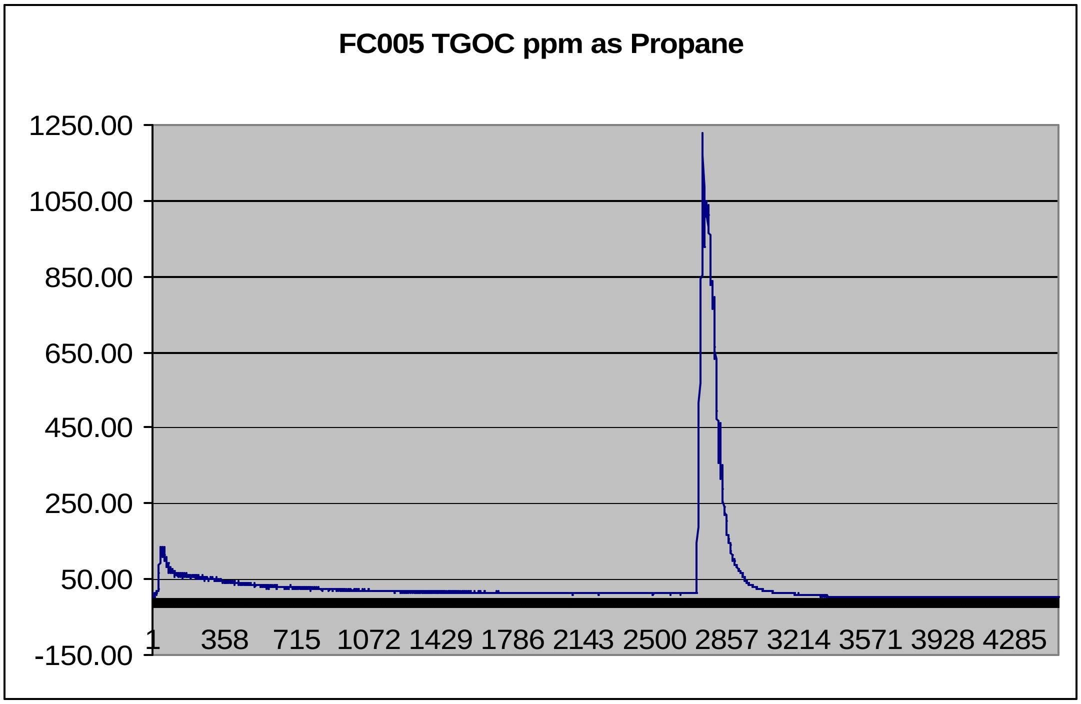
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650.00
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250.00
50.00
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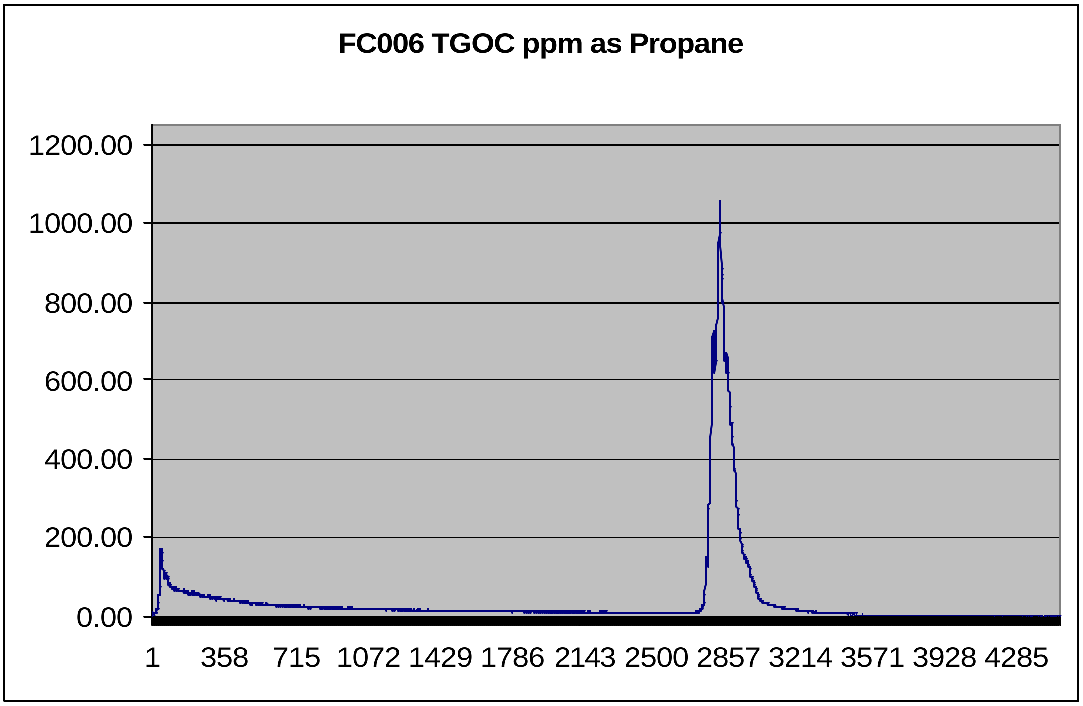
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APPENDIX E LISTING OF SUPPORT DOCUMENTS

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List of Supporting Documents

The following documents contain specific test results, procedures, and documentation used in support of this Test Plan

1. Casting Emission Reduction Program – Foundry Product Testing Guide: Reducing Emissions by Comparative Testing, May 4, 1998.

2. CERP Testing, Quality Assurance/Quality Control Procedures Manual.

3. Emission Baseline Test Results for the CERP Pre-Production Foundry Processes.

4. Evaluation of the Required Number of Replicate Tests to Provide Statistically Significant Air Emission Reduction Comparisons for the CERP Pre-Production Foundry Test Program.

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APPENDIX F 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