Casting Emission Reduction Program
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Product Test: HA International Enviroset®22 Furan No-Bake®; Mix/Make/Cure; Storage; Pouring/Cooling/Shakeout

Technikon # 1411-113 GI

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United States Environmental Protection Agency

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Product Test: HA International Enviroset®22 Furan No-Bake®; Mix/ Make/Cure; Storage; Pouring/Cooking/Shakeout

1411-113 GI

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

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The data contained in this report were developed to asses 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 you 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 emissions from Test GI, a furan No-Bake® binder. Results are compared to previously established baselines. Test GI was divided into three test segments: mix/make/cure (MMC); storage; and pouring/cooling/shakeout (PCS). The mix/make/cure and storage segments evaluated the emissions from the mold making process and the results were compared to the baseline Test EY. The pouring/cooling/shakeout segment was compared to the baseline Test FL. Both baselines used phenolic urethane No-Bake® binder systems chosen because of their common use in the industry. All testing was conducted by Technikon, LLC in its Research Foundry. The emission results are reported in pounds of analyte per pound of binder, pounds of analyte per ton of sand, and pounds of analyte per ton of metal poured where applicable.

Continuous emission samples were collected over the entire process period for each test segment. The first two test segments were part of the continuous mold making process, and lasted a total of two hours. The MMC portion consisted of the initial ten minutes after the sand was introduced into the mold flask. The removal of the flask initiated the commencement of the storage portion of the test, and emissions continued to be collected for the remainder of the two-hour period. The third testing segment was conducted over a seventy-five minute period. It included the metal pouring/cooling/shakeout, and post shakeout phases. For this segment, process and stack parameters were measured. They included the weights of the casting, mold, and 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.

Emission samples were collected and analyzed for specific target compounds dependent on the starting material and test process. All sampling procedures were 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 for all test segments. Carbon monoxide, carbon dioxide, and nitrogen oxides, recorded for the PCS portion of GI, were monitored according to US EPA Methods 10, 3A, and 7E, respectively. Additional target analytes such as furfuryl alcohol and furfural were collected and analyzed according to the appropriate NIOSH and OSHA methods, and are defined in Appendix A.

Mass emission rates for all analytes were calculated using continuous monitoring data, laboratory analytical results, measured source data and appropriate process data. Results are presented in detail in Appendix B. Individual analyte emissions were calculated in addition to five emission indicators. These indicators include TGOC as propane, hydrocarbons (HC) as hexane, the sum of target analytes, the sum of target HAPS, and the sum of target polycyclic organic matter (POM). Detailed descriptions of these indicators can be found in the Results section of this report.

A pictorial casting record was made of the castings from the third cavity of each mold. The pictures are shown in Appendix C.

Test Plans EY and GI Mix/Make/Cure Emissions Indicators

Analytes	TGOC as Propane	HC as hexane	Sum of Target Analytes	Sum of Target HAPs	Sum of Target POMs
(Lb/Lb Binder)					
Test EY	0.0069	0.0069	0.0005	0.0005	0.0003
Test GI	0.0023	0.0014	0.0036	<0.0001[1]	NT[2]
(Lb/Tn Sand)					
Test EY	0.1781	0.1761	0.0140	0.0140	0.0065
Test GI	0.0601	0.0360	0.0932	0.0007	NT[2]

Test Plans EY and GI Storage Emissions Indicators

Analytes	TGOC as Propane	HC as hexane	Sum of Target Analytes	Sum of Target HAPs	Sum of Target POMs
(Lb/Lb Binder)					
Test EY	0.0118	0.0129	0.0018	0.0018	0.0021
Test GI	0.0004	0.0003	0.0002	<0.0001[1]	NT[2]
(Lb/Tn Sand)					
Test EY	0.3022	0.3316	0.0450	0.0450	0.0533
Test GI	0.0095	0.0076	0.0063	0.0003	NT[2]

Test Plans FL and GI Pouring/Cooling/Shakeout Emissions Indicators

Analytes	TGOC as Propane	HC as hexane	Sum of Target Analytes	Sum of Target HAPs	Sum of Target POMs
(Lb/Lb Binder)					
Test FL	0.2094	0.0670	0.0428	0.0303	0.0007
Test GI	0.0234	0.0176	0.0140	0.0138	<0.0001
(Lb/Tn Metal)					
Test FL	12.67	4.043	2.488	1.763	0.0401
Test GI	1.658	0.9350	0.7987	0.7890	0.0028

[1] Values reported as <0.0001 are measured as being above the detection limits, but below the reporting limit of 0.0001.
[2] No POMs were among targeted analytes.

It must be noted that the emissions results from the testing performed are not suitable for use as emission factors or for purposes other than evaluating the relative emission changes 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. They should not be used as the basis for estimating emissions from actual commercial foundry applications.

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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). The parties to the CERP Cooperative Research and Development Agreement (CRADA) include The Environmental Research Consortium (ERC), a Michigan partnership of DaimlerChrysler Corporation, Ford Motor Company, and General Motors Corporation; the U.S. Army Research, Development and Engineering Command – Armament Research, Development and Engineering Center (RDECOM-ARDEC), a laboratory of the United States Army; the American Foundry Society; and the Casting Industry Suppliers Association.

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 Research Foundry designed to measure airborne emissions from individually poured molds, and a Production Foundry designed to measure air emissions in a continuous full-scale production process. Each of these testing arenas has been specially designed to facilitate the collection and evaluation of airborne emissions and associated process data. 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 purposes other than evaluating the relative emission changes 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 process emissions from a No-Bake® binder system. Section 2 of this report includes a summary of the methodologies used for data collection and analysis, emission calculations, QA/QC procedures, and data management and reduction methods. Specific data collected during this test are summarized in Section 3 of this report, with detailed data included in the appendices 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 folder that is maintained at the Technikon facility.

1.4 SPECIFIC TEST PLAN AND OBJECTIVES

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

Table 1-1 Test Plan Summary

Test Plan Number	1409-124 EY	1411-113 GI	1410-123 FL	1411-113 GI
Type of Process Tested	Phenolic Urethane No-Bake® Mix/Make/Cure, Storage Baseline	Furan No-Bake® Mix/Make/Cure, Storage Product Test	Phenolic Urethane No-Bake® PCS Baseline	Furan No-Bake®, PCS Product Test
Binder System	HA Int'l TECHNISET® 20-665/23-635/17-727	HA Int'l ENVIROSET 22®/TC-50	HA Int'l TECHNISET® 6000/6433/17-727	HA Int'l ENVIROSET 22®/TC-50
Metal Poured	NA	NA	Iron	Iron
Mold Type	19 x 20 x 6 inch Snap Flask	19 x 20 x 6 inch Snap Flask	4-on Gear	4-on Gear
Sand Type	Wexford W450 sand	Wexford W450 sand	Wexford W450 sand	Wedron 530 sand
Number of Molds	6 MMC/Storage	6 MMC/Storage	9 PCS	9 PCS
Test Dates	2/19/03 to 2/24/03	10/11/04 to 10/13/04	9/17/03 to 9/24/03	10/19/04 to 10/22/04
Emissions Measured	• TGOC as Propane • HC as hexane • 5 Target Analytes	• TGOC as Propane • HC as hexane • 4 Target Analytes	• TGOC as Propane • HC as hexane • CO • CO_2 • 57 Target Analytes	• TGOC as Propane • HC as hexane • CO • CO_2 • NOx • SO_2 • 57 Target Analytes
Process Parameters Measured	• Total Mold Weight • Binder Weights • % LOI • Sand Temperature • Stack Temperature • Moisture Content • Pressure • Volumetric Flow Rate	• Total Mold Weight • Binder Weights • % LOI • Sand Temperature • Stack Temperature • Moisture Content • Pressure • Volumetric Flow Rate	• Total Casting Weight • Mold Weight • Binder Weights • Metallurgical data • % LOI • Sand Temperature • Stack Temperature • Moisture Content • Pressure • Volumetric Flow Rate	• Total Casting Weight • Mold Weight • Binder Weights • Metallurgical data • % LOI • Sand Temperature • Stack Temperature • Moisture Content • Pressure • Volumetric Flow Rate

2.0 Test Methodology

2.1 DESCRIPTION OF PROCESS AND TESTING EQUIPMENT

The mold making process was conducted within a chamber designed to meet the criteria for a temporary total enclosure (TTE) as specified in US EPA Method 204. Sand mixing was performed using a Kloster paddle-type sand mixer and dispensed either into a pair of 19 x 20 x 6 inch snap flasks housed in the enclosure, or into No-Bake® 4-on gear molds for the MMC and Storage or PCS segments, respectively.

Figure 2-1 and 2-2 are diagrams of the Pre-Production Research Foundry process equipment.

Figure 2-1 Pre-Production Research Foundry No-Bake® Mold Making Layout Diagram

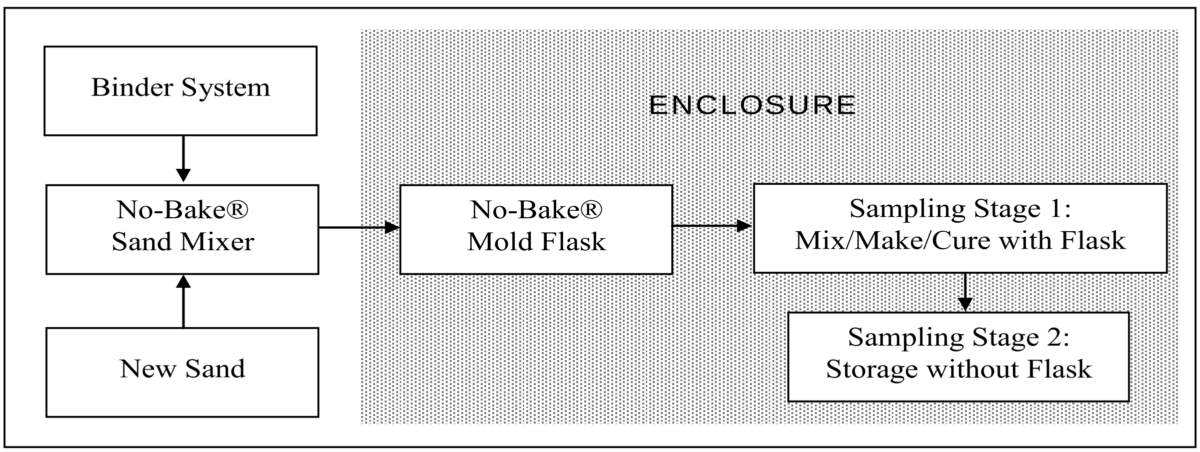
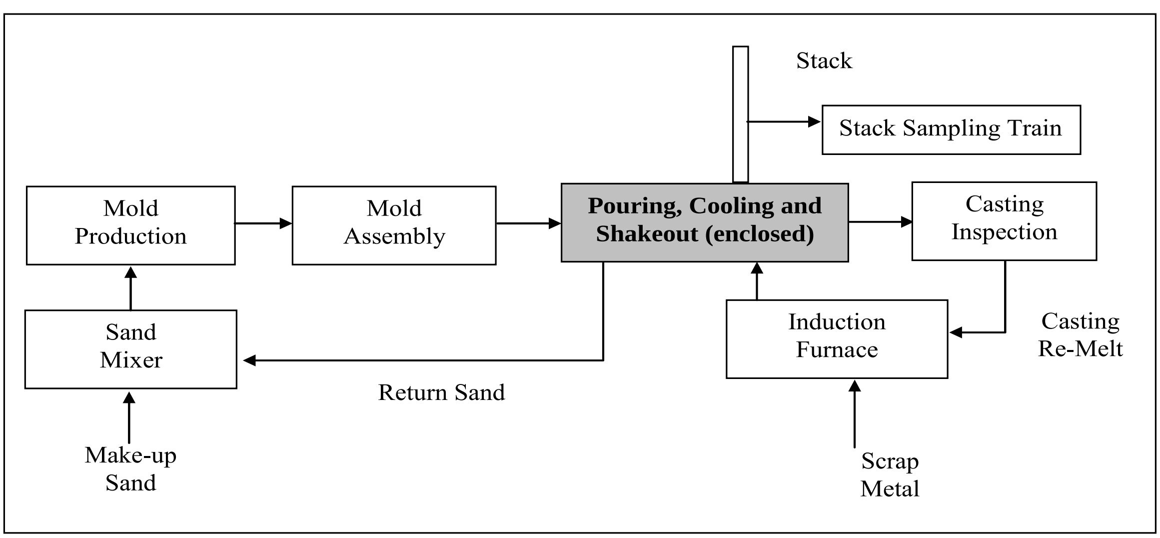


Figure 2-2 Pre-Production Research Foundry Layout Diagram



2.2 DESCRIPTION OF TESTING PROGRAM

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

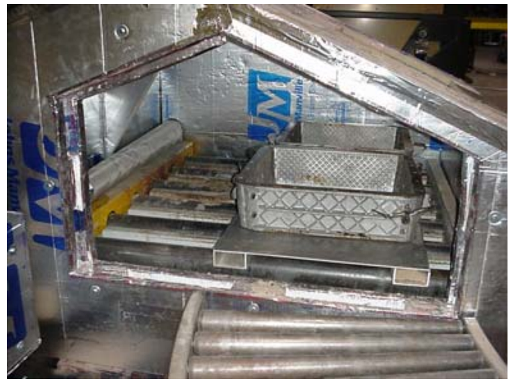
1. **Test Plan Review and Approval:** The proposed test plan was reviewed and approved by the Technikon staff.

2. **Mix/Make/Cure, and Storage:**

   a. **Sand Preparation:** Sands were mixed with quantities of designated binders in a Kloster paddle mixer. The sand was preheated or cooled as required to a standard temperature range. The sand was mixed thoroughly and then dispensed at approximately 100 lbs/min into two 19 x 20 x 6 inch flasks that were housed in a temporary total enclosure conforming to US EPA Method 204.

   b. **Mold Preparation:** Mixed sand was dispensed into snap-flasks. Once the flasks were about one-half full, the vibration table was started to compact the mixed sand and it continued for an additional five seconds after the flask was full. The excess sand was struck off and removed from the test enclosure to reduce test-to-test variability.

   c. **Individual Sampling Events:** Six replicate mold-making tests were performed. Sampling to determine the No-Bake® mold making emissions consisted of two segments. Sampling for both test segments was performed utilizing the same temporary total enclosure unit and exhaust stack. The mix/make/cure segment was defined as the first ten minutes after the sand was initially introduced into the flask. The mixed sand was discharged from the Kloster mixer into the flask over approximately one minute and then the mold was allowed to cure in the flask until ten minutes had elapsed. Emission



US EPA Method 204
Temporary Total Enclosure
Mix, Make, Cure, Storage

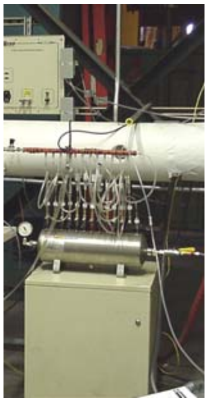
Mix/Make/Cure Storage Molds

Method 18 Sampling
Mix/Make/Cure and Storage

samples were collected during the entire mix/make/cure segment. Emission sampling was accomplished via a heated sample probe located in the centroid of the exhaust duct.

Once the ten-minute mix/make/cure segment had elapsed, the storage segment immediately began. The snap-flask was removed from the mold and set aside within the enclosure to allow air to pass freely over the mold for the duration of the test. A second set of emission samples were collected during this segment utilizing the same sample train used for the mix/make/cure segment ensuring a smooth transition between the two test sampling events. Storage sampling continued until a total of two hours had passed from when the mixed sand was first introduced into the flask.

Total Enclosure Test Stand



Method 18 Sampling Train

Continuous Monitoring Instruments

3. **Pouring, Cooling, and Shakeout:**

    a. **Mold and Metal Preparation:** The No-Bake® molds were prepared to a standard composition by the Technikon production team. Relevant process data was collected and recorded. Iron was melted in a 1000 lb. Ajax induction furnace. The amount of metal melted was determined from the poured weight of the casting and the number of molds to be poured. The metal composition was Class-30 Gray Iron as prescribed by a metal composition worksheet. The weight of metal poured into each mold was recorded on the process data summary sheet.

    b. **Individual Sampling Events:** Replicate tests were performed on nine mold packages. The mold packages were placed into an enclosed test stand heated to approximately 85°F. Iron was poured into the mold through an opening in the top of the emission enclosure, after which the opening was closed.

    Continuous emission samples were collected during the forty-five minute pouring and cooling processes, during the fifteen-minute shakeout of the mold, and for an additional fifteen-minute period following shakeout. The total sampling time was seventy-five minutes.

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

Table 2-1 Process Parameters Measured

Parameter	Analytical Equipment and Methods
Mold Weight	Cardinal 748E platform scale (Gravimetric)
Casting Weight	Cardinal 748E platform scale (Gravimetric)
Binder Weight	Mettler SB12001 Digital Scale (Gravimetric)
Volatiles	Mettler PB302 Scale (AFS Procedure 2213-00-S)
Loss on Ignition	Mettler PB302 Scale (AFS Procedure 2213-00-S)
Metallurgical Parameters	
Pouring Temperature	Electro-Nite DT 260 (T/C Immersion Pyrometer)
Carbon/Silicon Fusion Temperature	Electro-Nite DataCast 2000 (Thermal Arrest)
Alloy Weights	Ohaus MP2 Scale

a. **Foundry Emissions Analysis:** The specific sampling and analytical methods used in the Research 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 and POMs Concentration	EPA Method 18, TO11, NIOSH 1500, NIOSH 2002
VOCs Concentration	EPA Method 18, 25A, TO11, NIOSH 1500, NIOSH 2002, OSHA 72
Sulfur Dioxide*	OSHA ID200
Carbon Monoxide*	EPA Method 10
Carbon Dioxide	EPA Method 3A
Nitrogen Oxides*	EPA Method 7E

* Criteria Pollutants.

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

b. **Data Reduction, Tabulation and Preliminary Report Preparation:** The analytical results of the emissions tests provide the mass of each analyte in the collected sample. The total mass of the analyte emitted is calculated by multiplying the mass of analyte in the collected sample times the ratio of total stack gas volume to sample volume. The total stack gas volume is calculated from the measured mean stack gas velocity and duct diameter, and then 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 used, the weight of the sand used, and/or the weight of the casting poured to provide emissions data in pounds of analyte per pound of binder, pounds of analyte per ton of sand, and pounds of analyte per ton of metal.

   The results of each of the sampling events are included in the appendices of this report. The emissions results are also averaged and are shown in Tables 3-1A, 3-1B, 3-2A, 3-2B, 3-3A, and 3-3B.

5. **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.

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3.0 Test Results

The average mass emission rates in pounds per pound of binder, pounds per ton of sand, and/or pounds per ton of metal for individual target analytes and emission indicators are presented in Tables 3-1 through 3-3. In addition, these tables also include the percent change in emissions from Test EY for MMC and Storage or Test FL for PCS (the baseline tests) to test GI. Compounds that are structural isomers have been grouped together and are reported as a single quantity. For example, ortho-, meta-, and para-xylene are the three structural isomers of dimethyl benzene and their sum is reported as o,m,p-xylene. Trimethylbenzenes and dimethylphenols are also treated and reported in a similar manner. Individual target compounds included in these tables are those that comprise at least 95% of the total target analytes detected as well as carbon monoxide, carbon dioxide, nitrogen oxides, HC as hexane and TGOC as propane.

Two methods were employed to measure undifferentiated hydrocarbon emissions as emission indicators: TGOC as propane, performed in accordance with EPA Method 25A, and HC as hexane, performed in accordance with NIOSH Method 1500. EPA Method 25A is weighted to the detection of the more volatile hydrocarbon species, beginning at C_1 (methane), with results calibrated against the three-carbon alkane (propane). The HC as hexane method detects hydrocarbon compounds in the alkane range between C_6 and C_{16}, with results calibrated against the six-carbon alkane (hexane).

Other emissions Indicators, in addition to TGOC as propane and HC as hexane, were calculated and are presented in these tables. The emissions indicator “Sum of Target Analytes” is the sum of all the individual target analytes detected and includes targeted HAPs and POMs, as well as other targeted VOCs (volatile organic compounds). By definition, HAPs are specific compounds listed in the Clean Air Act Amendments of 1990. The term POM defines not one compound, but a broad class of compounds based on chemical structure and boiling point. POMs as a class are a listed HAP. A subset of the 188 listed EPA HAPs was targeted for collection and analysis. These individual target HAPs (which may also be POMs by nature of their chemical properties) detected in the samples are summed together and defined as the “Sum of Target HAPs,” while the “Sum of Target POMs” only sums those HAPs that are also defined as POMs.

Table 3-4 includes the averages of the key process parameters. Detailed process data are presented in Appendix C.

The comparative ranking of casting appearance is presented in Table 3-5. Each casting from the third cavity of the mold from the baseline test FL was compared to the other third cavity castings produced in this test. Three benchmark visual casting quality rankings consisting of the best, the median, and the worst casting were then assigned to three of the nine castings. The “best” designation means that a casting is the best appearing casting of the lot of nine, and is given a rank of “1”. The “median” designation, given a rank of “5”, means that four castings are better in appearance and four are worse. The “worst” designation is assigned to that casting which is of the poorest quality, and is assigned a rank of “9”. The castings from Test GI underwent the same evaluative procedure. The three-benchmark castings from Test FL then were compared and collated to the benchmark castings from Test GI.

Figures 3-1 to 3-4 present the five emissions indicators and selected HAP and VOC emissions data from Tables 3-1A and 3-1B in graphical form based on binder weight.

Figures 3-5 to 3-8 present the five emissions indicators and selected HAP and VOC emissions data from Tables 3-2A and 3-2B in graphical form based on sand weight.

Figures 3-9 to 3-12 present the five emissions indicators selected HAP and VOC emissions data, and Criteria Pollutant data from Table 3-3A in graphical form based on binder weight.

Figures 3-13 to 3-16 present the five emissions indicators, selected HAP and VOC emissions data, and Criteria Pollutant data from Table 3-3B in graphical form based on metal weight.

Appendix B contains the detailed emissions data including the results for all targeted analytes measured and detected.

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

Casting quality pictures are shown in Appendix C.

Table 3-1A Summary of Test Plans EY and GI Mix/Make/Cure Results – Lb/Lb Binder

Analytes	(Lb/Lb Binder)		From Baseline#
Emission Indicators	**Test EY**	**Test GI**	**% Change**
TGOC as Propane	0.0069	0.0023	**-67**[1]
HC as hexane	0.0069	0.0014	**-80**
Sum of Target Analytes	0.0005	0.0036	**620**
Sum of Target HAPs	0.0005	<0.0001	NA
Sum of Target POMs	0.0003	NT	NA
Individual Target HAPs and VOCs			
Phenol	0.0003	ND	NA
Naphthalene	0.0001	NT	NA
1-Methylnaphthalene	0.0001	NT	NA
Formaldehyde	<0.0001[2]	<0.0001	NA
2-Methylnaphthalene	ND[3]	NT	NA
Furfuryl Alcohol	NT	0.0034	NA
Furfural	NT	0.0001	NA

Table 3-1B Summary of Test Plans EY and GI Storage Results – Lb/Lb Binder

Analytes	(Lb/Lb Binder)		from Baseline#
Emission Indicators	**Test EY**	**Test GI**	**% Change**
TGOC as Propane	0.0118	0.0004	**-97**
HC as hexane	0.0129	0.0003	**-98**
Sum of Target Analytes	0.0018	0.0002	**-89**
Sum of Target HAPs	0.0018	<0.0001	NA
Sum of Target POMs	0.0021	NA	NA
Individual Target HAPs and VOCs			
1-Methylnaphthalene	0.0017	NT	NA
Naphthalene	0.0004	NT	NA
Phenol	0.0002	ND	NA
Formaldehyde	0.0001	<0.0001	NA
2-Methylnaphthalene	ND	NT	NA
Furfuryl Alcohol	NT	0.0002	NA
Furfural	NT	ND	NA

[1] Bold numbers indicate those compounds whose calculated t-statistic is significant at alpha=0.05
[2] Values reported as <0.0001 are above the detection limits but below the reporting limit of 0.0001
[3] ND: Non Detect; NA: Not Applicable; NT: Not Tested

Table 3-2A Summary of Test Plans EY and GI Mix/Make/Cure Results – Lb/Tn Sand

Analytes	(Lb/Tn Sand)		from Baseline#
Emission Indicators	**Test EY**	**Test GI**	**% Change**
TGOC as Propane	0.1781	0.0601	**-66**[1]
HC as hexane	0.1761	0.0360	**-80**
Sum of Target Analytes	0.0140	0.0932	**566**
Sum of Target HAPs	0.0140	0.0007	**-95**
Sum of Target POMs	0.0065	NT	NA
Individual Target HAPs and VOCs			
Phenol	0.0076	ND	NA
Naphthalene	0.0033	NT	NA
1-Methylnaphthalene	0.0032	NT	NA
Formaldehyde	0.0011	0.0007	**-36**
2-Methylnaphthalene	ND[2]	NT	NA
Furfuryl Alcohol	NT	0.0892	NA
Furfural	NT	0.0032	NA

Table 3-2B Summary of Test Plans EY and GI Storage Results – Lb/Tn Sand

Analytes	(Lb/Tn Sand)		from Baseline#
Emission Indicators	**Test EY**	**Test GI**	**% Change**
TGOC as Propane	0.3022	0.0095	**-97**
HC as hexane	0.3316	0.0076	**-98**
Sum of Target Analytes	0.0450	0.0063	**-86**
Sum of Target HAPs	0.0450	0.0003	**-99**
Sum of Target POMs	0.0533	NT	NA
Individual Target HAPs and VOCs			
1-Methylnaphthalene	0.0442	NT	NA
Naphthalene	0.0093	NT	NA
Phenol	0.0051	ND	NA
Formaldehyde	0.0019	0.0003	**-84**
2-Methylnaphthalene	ND	NT	NA
Furfuryl Alcohol	NT	0.0061	NA
Furfural	NT	ND	NA

[1] Bold numbers indicate those compounds whose calculated t-statistic is significant at alpha=0.05
[2] ND: Non Detect; NA: Not Applicable; NT: Not Tested

Table 3-3A Summary of Test Plans FL and GI Pouring/Cooling/Shakeout Results – Lb/Lb Binder

Analytes	(Lb/Lb Binder)		From Baseline #
Emission Indicators	**Test FL**	**Test GI**	**% Change**
TGOC as Propane	0.2094	0.0234	**-89**[1]
HC as Hexane	0.0670	0.0176	**-74**
Sum of Target Analytes	0.0428	0.0140	**-67**
Sum of HAPs	0.0303	0.0138	**-54**
Sum of POMs	0.0007	<0.0001	**-92**
Individual Target Organic HAPs and VOCs[2]			
o,m,p-Cresol	0.0148	0.0001	**-99**
Phenol	0.0088	0.0004	**-96**
Benzene	0.0044	0.0065	50
Toluene	0.0010	0.0063	**544**
o,m,p-Xylene	0.0008	0.0001	**-81**
Formaldehyde	0.0002	0.0002	9[3]
Acetaldehyde	<0.0001[4]	0.0006	**1096**
Dodecane	0.0064	ND	NA
Trimethylbenzenes	0.0033	ND	NA
1,3-Diethylbenzene	0.0014	ND	NA
Indan	0.0008	ND	NA
Dimethylphenols	0.0005	ND	NA
Criteria Pollutants and Greenhouse Gases			
Carbon Dioxide[5]	0.5568	0.0990	**-82**
Carbon Monoxide	0.0011	0.0633	**5412**
Sulfur Dioxide	NT[6]	0.0190	NA
Nitrogen Oxides	NT	<0.0001	NA

[1] Bold numbers indicate those compounds whose calculated t-statistic is significant at alpha=0.05.
[2] Individual results constitute > 95% of mass of all detected target analytes.
[3] Discrepancies apparent in change calculations are due to rounding. Calculations were performed on number prior to rounding for four decimal places.
[4] Values reported as <0.0001 were measured as being above the detection limit but were below the reporting limit of 0.0001.
[5] The carbon dioxide and carbon monoxide results were generated via the collection of bag samples for Test FL. These results do not have the accuracy of the continuous monitoring results in Test GI.
[6] ND: Non Detect; NA: Not Applicable; NT: Not Tested.

Table 3-3B Summary of Test Plans FL and GI Pouring/Cooling/Shakeout Results – Lb/Tn Metal

Analytes	(Lb/Tn Metal)		From Baseline #
Emission Indicators	**Test FL**	**Test GI**	**% Change**
TGOC as Propane	12.67	1.6575	**-87**[1]
HC as Hexane	4.043	0.9350	**-77**
Sum of Target Analytes	2.488	0.7987	**-68**
Sum of HAPs	1.763	0.7890	**-55**
Sum of POMs	0.0401	0.0028	**-93**
Individual Organic HAPs and VOCs[2]			
o,m,p-Cresol	0.8654	0.0067	**-99**
Phenol	0.5106	0.0197	**-96**
Benzene	0.2521	0.3063	21
Toluene	0.0575	0.4450	**674**
o,m,p-Xylene	0.0453	0.0093	**-79**
Formaldehyde	0.0128	0.0124	-4[3]
Acetaldehyde	0.0030	0.0329	**1009**
Dodecane	0.3726	ND	NA
Trimethylbenzenes	0.1911	ND	NA
1,3-Diethylbenzene	0.0822	ND	NA
Indan	0.0476	ND	NA
Dimethylphenols	0.0265	ND	NA
Criteria Pollutants and Greenhouse Gases			
Carbon Dioxide[4]	33.67	6.941	**-79**
Carbon Monoxide	0.0683	4.440	**6396**
Sulfur Dioxide	NT[5]	0.0010	NA
Nitrogen Oxides	NT	0.0040	NA

[1] Bold numbers indicate those compounds whose calculated t-statistic is significant at alpha=0.05.
[2] Individual results constitute >95% of mass of all detected target analytes.
[3] Discrepancies apparent in change calculations are due to rounding. Calculations were performed on number prior to rounding for four decimal places.
[4] The carbon dioxide and carbon monoxide results were generated via the collection of bag samples for Test FL. These results do not have the accuracy of the continuous monitoring results in Test GI.
[5] ND: Non Detect; NA: Not Applicable; NT: Not Tested.

Table 3-4A Summary of Test Plans EY and GI Average Process Parameters

No-Bake® Mold Mix/Make/Cure & Storage Test Dates 10/11-12/04	Test EY Average	Test GI Average
Total dispensed binder-coated sand weight, Lbs.	277	233
Total binder dispensing rate, Lbs/15 sec	0.40	0.38
Calculated Total Binder weight, Lbs.	3.55	3.06
Calculated % Binder (BOS)	1.30	1.30
Calculated standard % binder[1]	1.29	1.29
1800 deg. F LOI, %	1.33[2]	1.12 [3]
Ambient temperature, deg. F	64	73
Dogbone Tensile, 1-hour Strength, psi	ND	45[4]
Dogbone Core, 2-hour tensile strength, psi	75[5]	66 [4]
Dogbone Strain Rate, in./min.	ND	0.3
Mix/Make/Cure Test length, minutes	10	10
Storage Test Length, minutes	170	110[6]

Table 3-4B Summary of Test Plans FL and GI Average Process Parameters

No-Bake® Make for Pouring/Cooling/Shakeout Test Dates: 10/18-21/04	Test FL Average	Test GI Average
Sand Dispensing Rate, lbs/15 sec	30	29
Binder Part 1 + Part 3 Dispensing Rate, gms/15 sec	84.9	122.3
Binder Part 2 Dispensing Rate, gms/15 sec	63.5	52.3
Calculated Standard % Binder	1.08	1.29[7]
Calculated % Binder (BOS)[1]	1.09	1.30
Mold Weight, lbs	331	327
Calculated Total Binder Weight, lbs	3.570	4.206
1800 deg. F LOI, %	1.10[3]	1.19[2]
Sand Temperature, deg. F	82	82
Dogbone Core 1-hr. Tensile Strength, psi	ND	31[4]
Dogbone Core 2-hr. Tensile Strength, psi	42[5]	90[4]
Dogbone Strain Rate, in./min.	ND	0.3

[1] See binders listed in Table 1-1.
[2] Wexford W450 sand. Contains $CaCO_3$ as seashells, adds 0.2-0.4% to LOI.
[3] Wedron 530 sand.
[4] Thwing-Albert tensile tester.
[5] Dietert 405 Universal tensile tester.
[6] Test stopped after two hours because emission concentration reached background level.
[7] Part three of Furan system is a significant fraction of total binder.

Table 3-4C Summary of Test Plans FL and GI Average Process Parameters

No-Bake® Pouring/Cooling/Shakeout Test Dates: 10/19-22/04	Test GI Average	Test FL Average
Pouring Temp, deg. F	2629	2632
Pouring Time, sec.	40	33
Cast Weight (all metal inside mold), Lbs.	119.9	117.9
Process Air Temperature in Hood, deg. F	88	87
Ambient air temperature, deg. F	72	75
Mold Age When Poured, hr	25.5	23.8
Test Length, Min	75	75

Table 3-5 Visual Comparative Casting Rank Order Between Test FL and GI

Rank Order of Appearance; Overall Best Casting to Overall Worst	Mold Cavity 3 Test ID	Within Test Benchmark	
		Test FL	Test GI
1	FL002	1 - Best	
2	GI009		1 – Best
3	FL004	5 – Median	
4	GI011		
5	GI007		
6	GI003		
7	FL007	9 – Worst	
8	GI005		5 – Median
9	GI008		
10	GI010		
11	GI002		
12	GI001		9 - Worst

Figure 3-1 Emission Indicators from Test Plan EY and GI MMC– Lb/Lb Binder

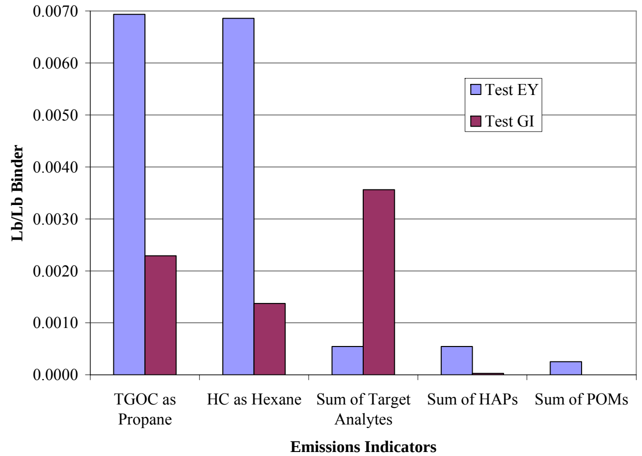


Figure 3-3 Emissions Indicators from Test Plans EY and GI Storage– Lb/Lb Binder

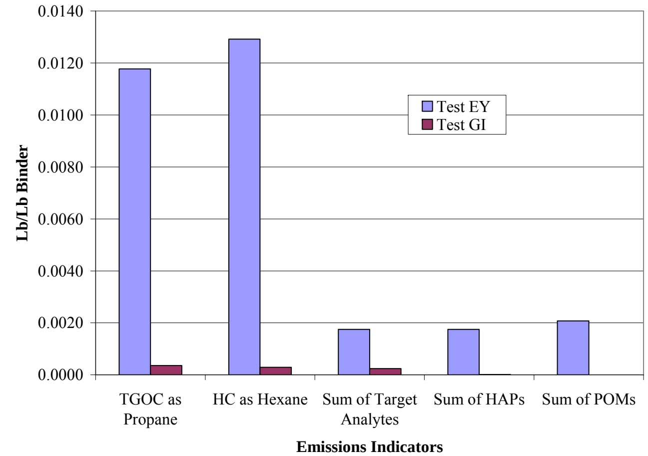


Figure 3-2 Selected HAP and VOC Emissions from Test Plans EY and GI MMC – Lb/Lb Binder

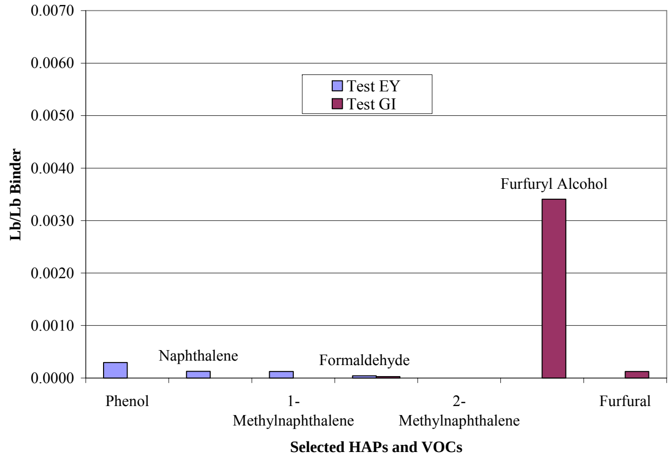


Figure 3-4 Selected HAPs and VOCs from Test Plans EY and GI Storage – Lb/Lb Binder

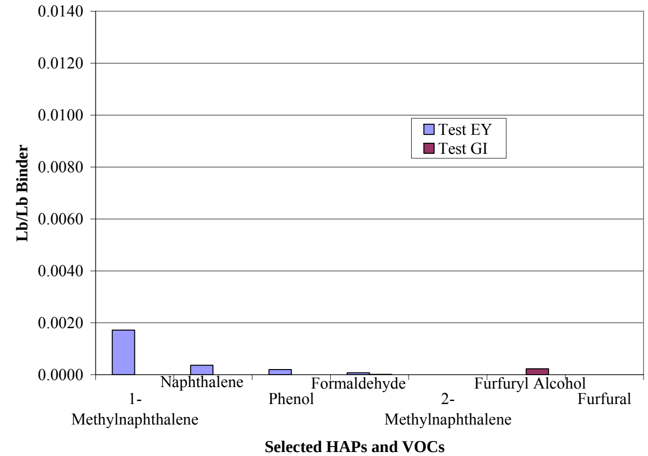


Figure 3-5 Emissions Indicators from Test Plans EY and GI MMC – Lb/Tn Sand

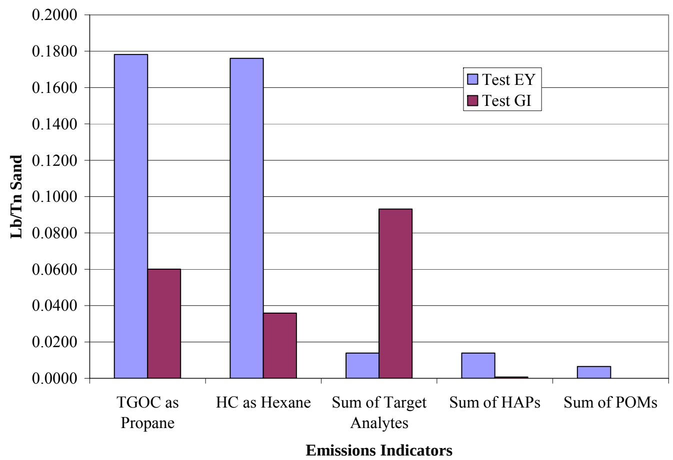


Figure 3-7 Emissions Indicators from Test Plans EY and GI Storage – Lb/Tn Sand

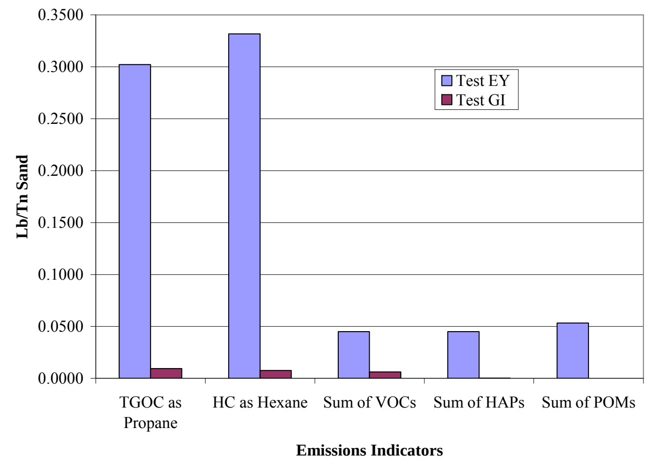


Figure 3-6 Selected HAP and VOC Emissions from Test Plans EY and GI MMC– Lb/Tn Sand

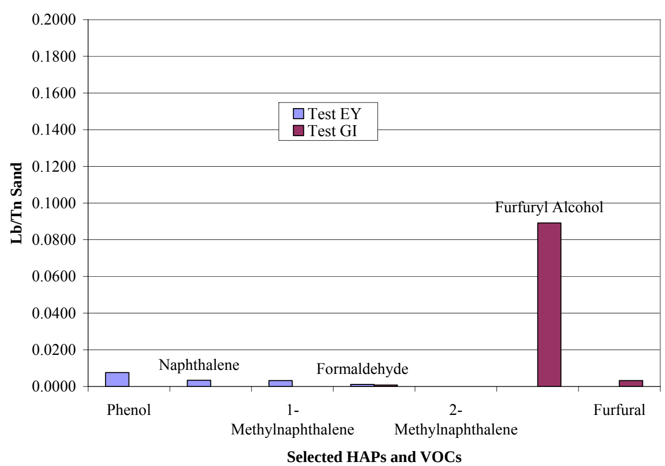


Figure 3-8 Selected HAP and VOC Emissions from Test Plans EY and GI Storage – Lb/Tn Sand

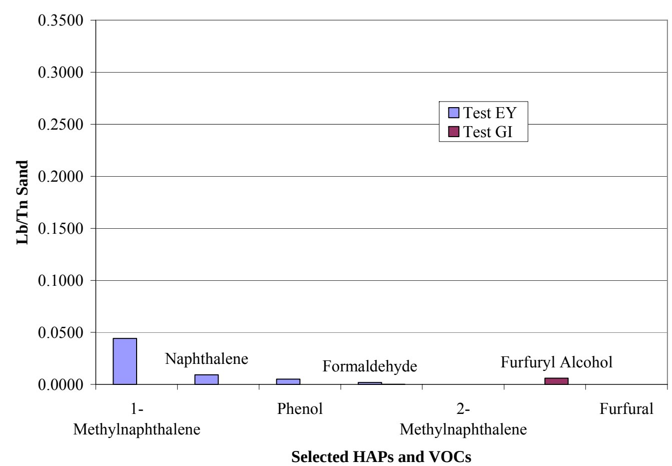


Figure 3-9 Emissions Indicators from Test Plans FL and GI PCS – Lb/Lb Binder

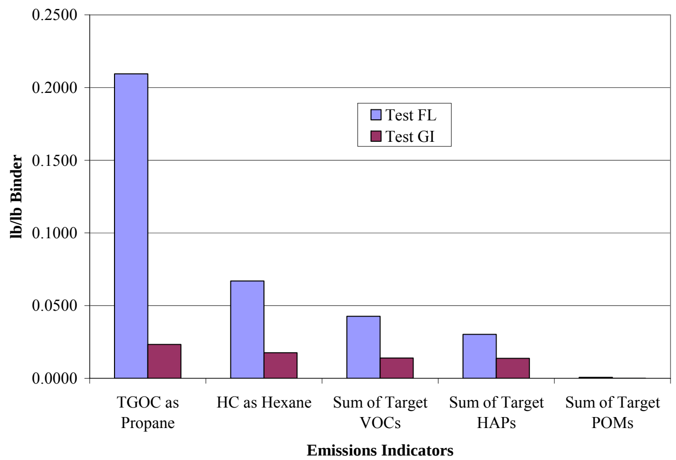


Figure 3-11 Selected VOC Emissions from Test Plans FL and GI PCS – Lb/Lb Binder

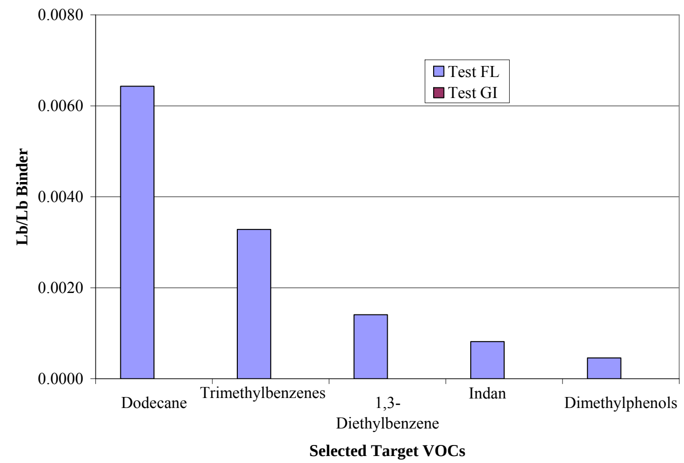


Figure 3-10 Selected HAP Emissions from Test Plans FL and GI PCS – Lb/Lb Binder

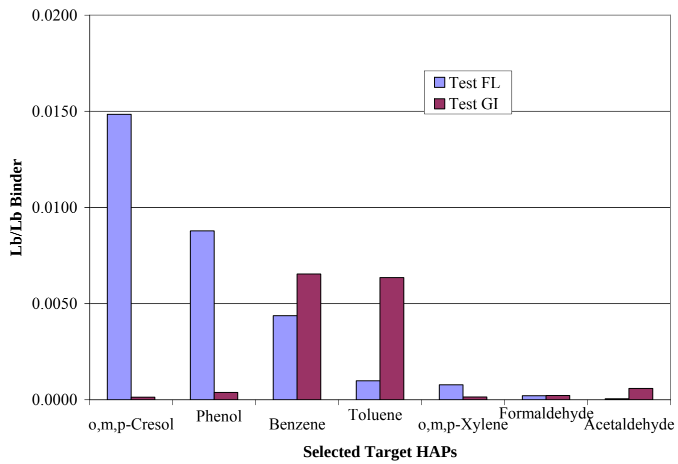


Figure 3-12 Criteria Pollutants & Greenhouse Gases from Test Plans FL and GI PCS – Lb/Lb Binder

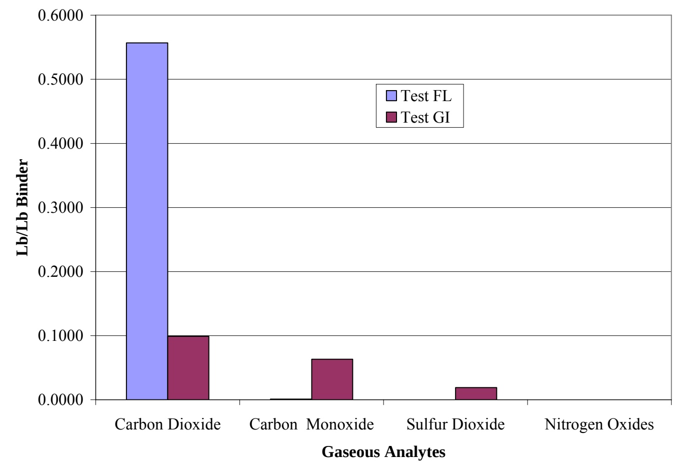


Figure 3-13 Emissions Indicators from Test Plans FL and GI PCS – Lb/Tn Metal

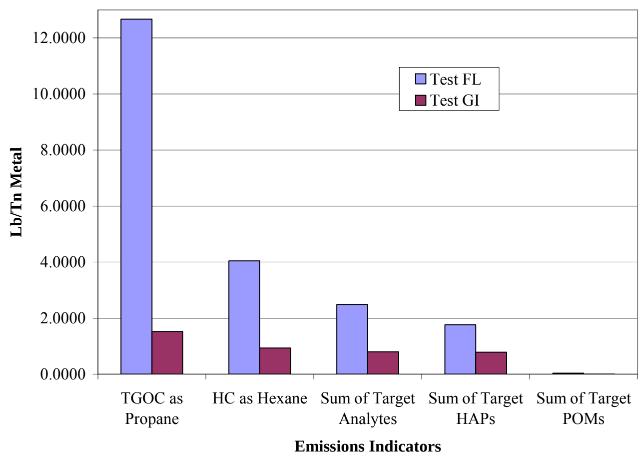


Figure 3-15 Selected VOC Emissions from Test Plans FL and GI PCS – Lb/Tn Metal

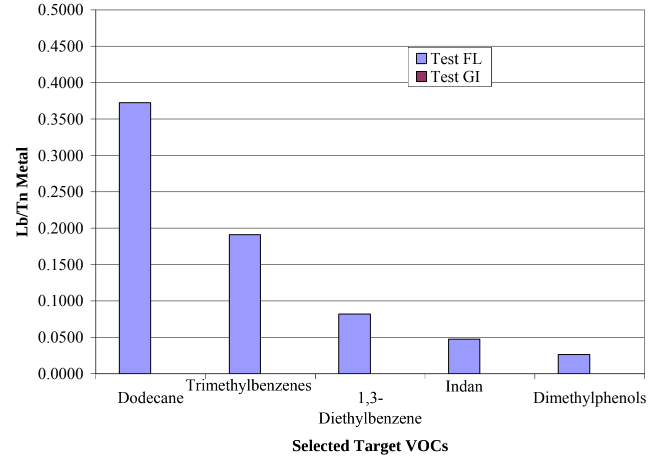


Figure 3-14 Selected HAP Emissions from Test Plans FL and GI PCS – Lb/Tn Metal

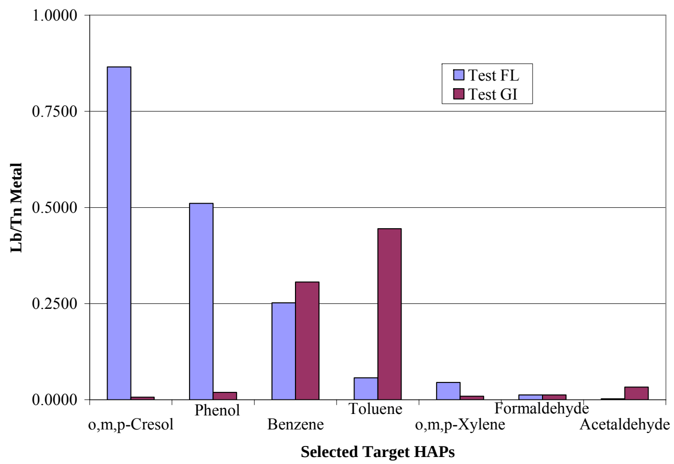
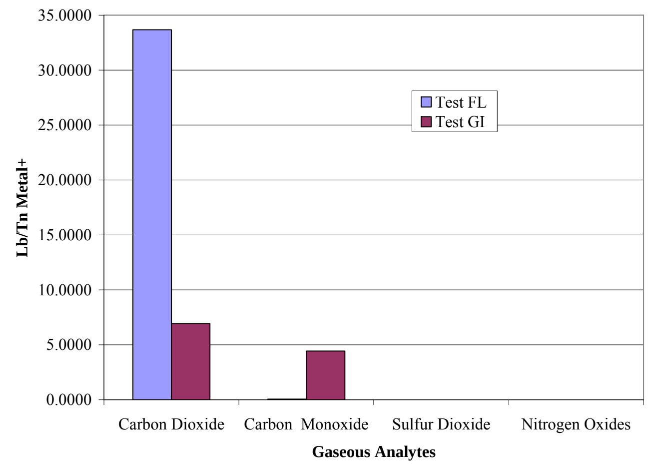


Figure 3-16 Criteria Pollutants & Greenhouse Gases from Test Plans FL and GI PCS – Lb/Tn Metal



4.0 Discussion of Results

Evaluation and comparison of the measured emissions in Test GI, a furan No-Bake® binder, to previously established baseline, required the division of the testing into three test segments: mix/make/cure, storage, and pouring/cooling/shakeout. The mix/make/cure and storage segments compared emissions from the mold making process to the baseline Test EY whereas emissions from the pouring/cooling/shakeout segment were compared to the baseline Test FL. The mold mix/make/cure and mold-storage test segments consisted of six replicate runs, each divided into two contiguous periods. Nine replicate runs were performed for the pouring/cooling/shakeout segment.

The mix/make/cure and storage emissions represent those compounds released to the environment from the time the mold is made until it is used to produce a casting. Although No-Bake® binder systems were used in each test, the target analyte list for the baseline Test EY differed from that of Test GI because the binder system chemistry was different for each. For example, the binder system used for Test GI did not contain naphthalenes, so these compounds were not targeted for sampling under Test GI. Similarly, furfural, furfuryl alcohol and SO_2 were not binder components in Test EY so these compounds were not sampled in that test, although they were present in Test GI.

The sampling and analytical methodologies were similar for the PCS baseline FL and product test GI, differing only in the collection and monitoring of carbon monoxide, carbon dioxide, and nitrogen oxides. Carbon monoxide (CO) and carbon dioxide (CO_2) were collected in a Tedlar bag for offsite analysis for Test FL, but were determined on-line using NIST traceable monitors for Test GI. The on-line monitors provide significantly more accurate data than the bag samples. Similarly, the nitrogen oxides (NOx) were not tested for under Test FL, but were determined on-line for Test GI. Therefore, NOx, CO and CO_2 should not be compared between the tests. CO, CO_2 and other analytes are presented for Test FL for completeness. See Appendix B for detailed results.

Measured process parameters indicated that all tests were run within acceptable established limits, and replicate tests were conducted following similar procedures. A determination of whether the means of the baseline test and the current test were different was made by calculating a statistical T-test at a 95% significance level ($\alpha = 0.05$). Results of the T-test indicate that there is a 95% probability that the mean values for GI are not equivalent to those of EY. Therefore, it may be said that the differences in the average emission values are real differences. Details of the T-Statistics calculation are found in Appendix B.
.

Mix/Make/Cure: Comparing Emission Indicator results from the mold mix/make/cure segment of Test GI to Test EY show large differences due to the differences in binder chemistry. Reductions of 67 and 80% were measured in TGOC as propane and in HC as hexane, respectively, when reported as either lb/lb of binder or lb per ton of sand. In addition, Test EY targeted five analytes while Test GI had four analytes. Two of these analytes from the furan binder used in GI were HAPs and none were POMs, whereas all five-target analytes were HAPs from the No-

Bake® phenolic urethane binder used in Test EY. Three of those five were also classified as POMs. This dissimilarity in materials results in a complete reduction in emitted POMs for Test GI (with an associated approximate 95% reduction in the Sum of HAPs), but more than a five fold increase in the sum of amount of target analytes emitted, due to the Furfuryl Alcohol which is not a regulated analyte.

Storage: Similar results were obtained for the storage segment comparison of emissions from Test GI to Test EY in four of the five Emission Indicators. In this case, slightly larger reductions were achieved in TGOC as propane (97%) and in HC as hexane (98%**)**, with an equivalent complete reduction in emitted POMs and HAPs. For this process segment, however, there was also an almost 90% decrease in total target analytes emitted compared to Test EY.

Although during MMC and storage the total amount of targeted analytes emitted from the furan binder test GI increased compared to the phenolic urethane binder used in the baseline test EY, the emitted compounds are not regulated HAPs. In addition, most of the emissions occurred during the MMC segment of test GI, while those from the phenolic urethane binder used in Test EY were released during storage.

Pouring/Cooling/Shakeout: For the comparison between the pouring/cooling/shakeout segments of Test GI and Test FL, the chemical compounds targeted for collection and analysis were identical. Emission Indictor results also show large reductions in emissions for the furan binder as compared to the phenolic urethane binder. For this process segment, there was a 90% reduction in TGOC as propane, a 74% reduction in HC as hexane, a 67% reduction in the Sum of Target Analytes, a 54% reduction in the Sum of Target HAPs, and an 86% reduction in the Sum of Target POMs when presented as lb/lb binder.

The gaseous analytes were collected by two different methods for Test FL and Test GI. Carbon dioxide and methane were detected in the ambient sample for Test FL. However, these results were generated via the collection of bag samples and do not have the accuracy of the continuous monitoring results in Test GI. Therefore, no Test FL samples were background corrected. However, because on-line monitoring results are more accurate, carbon dioxide and carbon monoxide found in the ambient air were background corrected for all samples in Test GI.

Target analyte reporting limits expressed in lb/lb binder, lb/tn sand, and lb/tn metal, are shown in Appendix B.

The storage Test for GI (Furan) was terminated after a total elapsed time of two hours instead of the three hours planned and executed in Test EY (phenolic urethane) because the TGOC concentration had fallen to approximately 2 ppm – essentially the background level. The TGOC after two hours in Test EY remained at approximately 7 ppm and dropped to only 5 ppm after three hours.

The binder content of PCS baseline Test FL was normally 1.10%, whereas the comparator was 1.30%. These differences also need to be taken into consideration when comparing the emissions from Test GI and Test FL. The GI PCS emissions were significantly less despite the higher binder content.

APPENDIX A APPROVED TEST PLANS AND SAMPLE PLANS FOR TEST SERIES EY, FL, AND GI

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TECHNIKON TEST PLAN

> **CONTRACT NUMBER**: 1409 **TASK NUMBER:** 1.2.4

> **WORK ORDER NUMBER:** 1173 **Series:** EY

> **SAMPLE EVENTS**: 6 mix/make/cure, 6 store

> **SITE:** X **PRE-PRODUCTION (238)__ Core Room (238)**

> **TEST TYPE:** No-Bake® sand mixing/mold making/mold curing, & mold storage: a base-line.

> **METAL TYPE:** None

> **MOLD TYPE:** No-Bake® 19 x 20 x 6 block; HA International 20-665 Part I resin, 23-635 co-reactant Part II, & 17-727 Activator Part III Phenolic Urethane binder at 1.3% (BOS); part I, 55%; part II, 45%, part III 5 % of part I.

> **NUMBER OF TESTS:** 6 mix/make/cure, 6 storage.

> **CORE TYPE:** N/A

> **TEST DATE** **START:** 7 Feb 2003
FINISHED: 12 Feb 2003

TEST OBJECTIVES:

Use THC to certify No-Bake® emission collection facility. Balance air flows to make enclosure conform to US EPA method 204 for temporary total enclosures.

Use TGOC to determine order-of-magnitude concentrations for development of sample plan.

Measure TGOC and selected VOCs & HAPs from fugitive emissions from No-Bake® sand mixing/mold making/mold curing & mold storage. Conduct Six (6) mix/make/cure test runs and six (6) storage runs on six (6) No-Bake® molds. The mix/make/cure test will consist of filling and compacting a 19 x 20 x 6 inch deep mold with sand heated to 85-90^{o}F dispensed from a calibrated Kloster ribbon mixer over approximately one minute and allowing the mold to cure within its flask until 10 minutes have elapsed. After 10 total minutes have elapsed then the flask shall be removed from the mold and the Storage test will commence for an additional two hours 50 minutes until a total lapsed time of three (3) hours. All tests will be conducted in a temporary total emission enclosure conforming to US EPA method 204 maintained at a standard temperature.

A set of 12 dogbone tensile specimens shall be made from the material from each mold. Six (6) dogbones each will be weighed and tensile tested after one (1) and two (2) hours of curing at 80 degrees F.

VARIABLES:

No-Bake® sand mixing: The uncoated sand shall be Wexford W450 Lakesand. It shall be preheated or cooled to maintain a temperature of 85 +/- 5 degrees Fahrenheit. The binder shall be 1.30 +/-0.013% total HA 20-665 part I resin and HA23-635 part II co-reactant mixed Part I/Part II in the ratio of 55/45 & HA 17-727 activator at 5% of part I. The sand will be mixed in the Kloster ribbon mixer and immediately dispensed.

No-Bake® mold making: Coated sand shall be dispensed at a rate of 100 pounds per minute, total approximately 120-140 pounds, into a 19 x 20 x 6 inch snap flask for curing. The mold shall be compacted by vibration and struck off level. Excess materials shall be removed from the emission enclosure. The emission enclosure shall be maintained at 80+/-5^{o}F.

No-Bake® mold curing: The mold shall be cured in-situ in the heated enclosure with the snap flask in place for a period of ten (10) total elapsed minutes from the time when flask filling commenced. End mix/make/cure emission sampling.

No-Bake® mold storage: After 10 minutes of elapsed time, begin the storage emission sample. Immediately remove the snap flask and set it aside within the enclosure. Continue storage sampling until a total elapsed time of three (3) hours since the filling of the flask commenced.

BRIEF OVERVIEW:

No-Bake® manufacturing has, like other core making processes, multi-step continuous emission. Assignment of whether emissions are associated with one-step or another is not clearly delineated in the process. For the purpose of standardization where no clear delineation exists the mixing, making, and curing will be treated as one multi-step continuous process with one emission. Since the curing step requires the retention of the molding flask, curing will be defined as having been completed when the flask is removed. Simultaneously the storage segment will begin as a separate emission sample and continue until sufficient data is collected to create a characteristic concentration-time curve.

SPECIAL CONDITIONS:

The emission-enclosure air temperature and incoming sand temperature will be maintained to standardize the test for repeatability of both the emission process and the emission sampling technique.

Series EY

No-Bake® Mixing, Making, Curing Combination and Storage Baseline 2003US Army 1409, WO 1173

Process Instruction

A. Emission Enclosure Certification:
   1. Use THC to determine airflow rates that effect complete emission-capture.

B. Calibration:
   1. Use THC to determine order-of-magnitude concentrations for typical test mold to create a sample plan.

C. Experiment:
   1. Measure selected HAP and VOC emissions to create a No-Bake® mold-manufacturing baseline.

D. No-Bake® sand mold:
   1. WEXFORD W450 Lake Sand
   2. HA International Techniset 20-665 Resin, 23-635 Co-reactant, & 17-727 activator.

E. Metal:
   1. None

Caution: Observe all safety precautions attendant to these operations as delineated in the Pre-production operating and safety instruction manual as applicable to bldg. 238.

F. Mold requirements:
   1. Make twelve (12) No-Bake® molds, two (2) for each run, in a 19 x 20 x 6 inch deep snap flask clamped to an aluminum pallet.

G. Phenolic urethane No-Bake® Mold Sand preparation:
   1. The phenolic urethane No-Bake® sand shall be 1.3% total binder (BOS), Part I/Part II ratio 55/45, Part III at 5% of Part I.
   2. Weigh contents of a Part I resin container. Add 5% of that weight as Part III to that container and mix thoroughly.
   3. Calibrate the Kloster No-Bake® sand mixer to dispense 100 pounds/min more or less.
   4. Calibrate the resin pumps:
      a. Part I + 5% Part III: Based on the actual measured sand dispensing rate calibrate the Part I resin to be 56.20% of 1.3 % total binder.
      b. Part II: Based on the actual measured sand dispensing rate calibrate the Part II co-reactant to be 43.80% of 1.3% total binder.

   5. All calibrations to have a tolerance of +/- 1% of the calculated value.

H. No-Bake® mold making and emission sampling:

1. A 19 x 20 by 6-inch cope snap flask is to be used. Make sure the clamps are closed.
2. The pattern to be used is a featureless aluminum pallet to which the snap flask is clamped.
3. Inspect the flask and pattern for damage. Repair before use.
4. Prepare the mold flask and pattern with a light coating of Ashland Zipslip® IP 78. Allow to fully dry.
5. Place the cope flask, parting line down, on the pallet and clamp in place.
6. Place the assembly on the Kloster vibrating compaction table via the south wall port. Start the THC.
7. Run 15-20 pounds of waste sand then begin filling the box without stopping the mixer. Start the run time clock. Start the sample train. Measure sand temperature in the waste bucket and record on the Process Log
8. When the flask is about half full start the table vibration.
9. Manually spread the sand around the box as it is filling.
10. Slightly overfill the flask. Minimize the sand spillage. Record when the mixer is stopped.
11. Allow the vibrator to run an additional 5 seconds after the box is full.
12. Strike off the flask when it is full to standardize the weight. Remove as much struck off sand from the emission enclosure as practicable. Record when the mold is finished.
13. Allow the mold to cure for a total elapsed time of 10 minutes from the start of filling.
14. At 10 minutes total lapsed time:
15. Stop the mix/make/cure sample train. Start the storage sample train.
16. Remove the mold flask from the mold by unclamping the corner clamps and lifting the flask off the mold. Set the flask aside within the enclosure.

I. Use the last of the wasted sand to make 12 dogbone tensile test samples. (approx. 3 pounds)

1. Take dogbones to temperature controlled area (70-80oF) to cure.
2. Cure dogbones until hard then remove from the core box. (about 15 minutes)
3. Immediately weight the dogbones to the nearest 0.1 grams.
4. Store in desiccating cabinet.
5. At one (1) hour break six (6) bones on the Universal 405 tensile tester and record the values on the Dogbone Tensile Log
6. At two (2) hours break six (6) bones on the Universal 405 tensile tester and record the values on the Dogbone Tensile log.
7. Run dry sand through the mixer to clean it. Remove this sand from the test area.
8. Continue the storage sampling for a total lapsed time of three (3) hours from commencement of mold filling. Stop the sample train at three hours total lapsed time.
9. Remove the mold through the entry/exit port in the south wall of the emission enclosure.
10. Weigh and record the net weight of the closed mold on the Process Log.

J. Emission hood cleaning:

1. After each run loosen all sand stuck to vibratory table.
2. Blow all the spill sand to the floor inside the emission hood.
3. Lift the hood (about 10 inches) and block up in place.

4. Sweep the spill sand from the floor under the hood, weigh it, and record the weight on the Process Log.
5. Lower the hood to the floor.
6. Check for alignment.
7. Place the next mold into the hood through the entry/exit port in the south wall of the emission enclosure.
8. Replace the exit port cover.

Steven Knight
Mgr. Process Engineering

CORE MIX, MAKE, CURE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/19/2003											
EVENT 1											
THC	EY10101	X									TOTAL
	STOR								80	1	
	STOR								80	2	
	STOR								200	3	
	STOR								200	4	
	STOR								200	5	
TO11	EY10102		1						450	6	DNPH SKC 226-119
TO11	EY10103			1					450	7	DNPH SKC 226-119
TO11	EY10104				1				0		DNPH SKC 226-119
NIOSH 1500	EY10105		1						850	8	100/50 mg Charcoal SKC 226-01
NIOSH 1500	EY10106			1					850	9	100/50 mg Charcoal SKC 226-01
NIOSH 1500	EY10107				1				0		100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY10108		1						850	10	150/75 mg Silica SKC 226-10
NIOSH 2002	EY10109			1					850	11	150/75 mg Silica SKC 226-10
NIOSH 2002	EY10110				1				0		150/75 mg Silica SKC 226-10
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE MIX, MAKE, CURE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/19/2003											
EVENT 2											
THC	EY10201	X									TOTAL
	STOR								80	1	
	STOR								80	2	
	STOR								200	3	
	STOR								200	4	
	STOR								200	5	
TO11	EY10202		1						450	6	DNPH SKC 226-119
	Excess								450	7	Excess
NIOSH 1500	EY10203		1						850	8	100/50 mg Charcoal SKC 226-01
	Excess								850	9	Excess
NIOSH 2002	EY10204		1						850	10	150/75 mg Silica SKC 226-10
	Excess								850	11	Excess
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE MIX, MAKE, CURE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/20/2003											
EVENT 3											
THC	EY10301	X									TOTAL
	STOR								80	1	
	STOR								80	2	
	STOR								200	3	
	STOR								200	4	
	STOR								200	5	
TO11	EY10302		1						450	6	DNPH SKC 226-119
	Excess								450	7	Excess
NIOSH 1500	EY10303		1						850	8	100/50 mg Charcoal SKC 226-01
	Excess								850	9	Excess
NIOSH 2002	EY10304		1						850	10	150/75 mg Silica SKC 226-10
	Excess								850	11	Excess
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE MIX, MAKE, CURE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/20/2003											
EVENT 4											
THC	EY-10401	X									TOTAL
	STOR								80	1	
	STOR								80	2	
	STOR								200	3	
	STOR								200	4	
	STOR								200	5	
TO11	EY10402		1						450	6	DNPH SKC 226-119
	Excess								450	7	Excess
NIOSH 1500	EY10403		1						850	8	100/50 mg Charcoal SKC 226-01
	Excess								850	9	Excess
NIOSH 2002	EY10404		1						850	10	150/75 mg Silica SKC 226-10
	Excess								850	11	Excess
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE MIX, MAKE, CURE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/24/2003											
EVENT 5											
THC	EY-10501	X									TOTAL
	STOR								80	1	
	STOR								80	2	
	STOR								200	3	
	STOR								200	4	
	STOR								200	5	
TO11	EY10502		1						450	6	DNPH SKC 226-119
	Excess								450	7	Excess
NIOSH 1500	EY10503		1						850	8	100/50 mg Charcoal SKC 226-01
	Excess								850	9	Excess
NIOSH 2002	EY10504		1						850	10	150/75 mg Silica SKC 226-10
	Excess								850	11	Excess
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE MIX, MAKE, CURE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/24/2003											
EVENT 6											
THC	EY-10601	X									TOTAL
	STOR								80	1	
	STOR								80	2	
	STOR								200	3	
	STOR								200	4	
	STOR								200	5	
TO11	EY10602		1						450	6	DNPH SKC 226-119
	Excess								450	7	Excess
NIOSH 1500	EY10603		1						850	8	100/50 mg Charcoal SKC 226-01
	Excess								850	9	Excess
NIOSH 2002	EY10604		1						850	10	150/75 mg Silica SKC 226-10
	Excess								850	11	Excess
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE STORAGE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/19/2003											
EVENT 1											
THC	EY-30101	X									TOTAL
TO11	EY-30102		1						80	1	DNPH SKC 226-119
TO11	EY-30103			1					80	2	DNPH SKC 226-119
NIOSH 1500	EY-30104		1						200	3	100/50 mg Charcoal SKC 226-01
NIOSH 1500	EY-30105			1					200	4	100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY-30106		1						200	5	150/75 mg Silica SKC 226-10
	MMC								450	6	
	MMC								450	7	
	MMC								850	8	
	MMC								850	9	
	MMC								850	10	
	MMC								850	11	
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE STORAGE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/19/2003											
EVENT 2											
THC	EY-30201	X									TOTAL
TO11	EY-30202		1						80	1	DNPH SKC 226-119
	Excess								80	2	Excess
NIOSH 1500	EY-30203		1						200	3	100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY-30204		1						200	4	150/75 mg Silica SKC 226-10
NIOSH 2002	EY-30205			1					200	5	150/75 mg Silica SKC 226-10
	MMC								450	6	
	MMC								450	7	
	MMC								850	8	
	MMC								850	9	
	MMC								850	10	
	MMC								850	11	
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE STORAGE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/20/2003											
EVENT3											
THC	EY-30301	X									TOTAL
TO11	EY-30302		1						80	1	DNPH SKC 226-119
	Excess								80	2	Excess
NIOSH 1500	EY-30303		1						200	3	100/50 mg Charcoal SKC 226-01
NIOSH 1500	EY-30304			1					200	4	100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY-30305		1						200	5	150/75 mg Silica SKC 226-10
	MMC								450	6	
	MMC								450	7	
	MMC								850	8	
	MMC								850	9	
	MMC								850	10	
	MMC								850	11	
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE STORAGE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/20/2003											
EVENT 4											
THC	EY-30401	X									TOTAL
TO11	EY-30402		1						80	1	DNPH SKC 226-119
	Excess								80	2	Excess
NIOSH 1500	EY-30403		1						200	3	100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY-30404		1						200	4	150/75 mg Silica SKC 226-10
	Excess								200	5	Excess
	MMC								450	6	
	MMC								450	7	
	MMC								850	8	
	MMC								850	9	
	MMC								850	10	
	MMC								850	11	
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE STORAGE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/24/2003											
EVENT 5											
THC	EY-30501	X									TOTAL
TO11	EY-30502		1						80	1	DNPH SKC 226-119
TO11	EY-30505		1						80	2	BACKGROUND NO FLOW
NIOSH 1500	EY-30503		1						200	3	100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY-30504		1						200	4	150/75 mg Silica SKC 226-10
NIOSH 1500	EY30506		1						200	5	BACKGROUND NO FLOW
	MMC								450	6	
	MMC								450	7	
	MMC								850	8	
	MMC								850	9	
	MMC								850	10	
	MMC								850	11	
	Excess								400	12	Excess
	Excess								9500	13	Excess

CORE STORAGE EY - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
2/24/2003											
EVENT 6											
THC	EY-30601	X									TOTAL
TO11	EY-30602		1						80	1	DNPH SKC 226-119
	Excess								80	2	Excess
NIOSH 1500	EY-30603		1						200	3	100/50 mg Charcoal SKC 226-01
NIOSH 2002	EY-30604		1						200	4	150/75 mg Silica SKC 226-10
NIOSH 2002	EY-30605		1						200	5	BACKGROUND NO FLOW
	MMC								450	6	
	MMC								450	7	
	MMC								850	8	
	MMC								850	9	
	MMC								850	10	
	MMC								850	11	
	Excess								400	12	Excess
	Excess								9500	13	Excess

Technikon Test Plan

- > **CONTRACT NUMBER:** 1410 **TASK NUMBER:** 1.2.3 **Series:** FL
- > **SITE:** Pre-production No-Bake® molding and pour, cool, shakeout enclosure.
- > **TEST TYPE:** Baseline: Iron No-Bake® pouring, cooling, & shakeout.
- > **METAL TYPE:** Class 30 gray iron.
- > **MOLD TYPE:** 4-on No-Bake® gear; HA 6000, 6433, 17-727 binder
- > **NUMBER OF MOLDS:** 9
- > **CORE TYPE:** None
- > **SAMPLE RUNS:** 9
- > **TEST DATE:** **START:** 29 Sep 2003
  FINISHED: 11 Oct 2003

TEST OBJECTIVES:

Measure selected HAP and VOC emissions using absorption tubes and TGOC using THC for pouring/cooling/shakeout for a total of 75 minutes to update the iron No-Bake® baseline in the revised facility. Measure the emissions for the standard iron phenolic urethane No-Bake® HA 6000/6433/17-727 binder system.

VARIABLES:

The pattern shall be the 4-on gear. The mold shall be made with Wexford W450 sand. The No-Bake® mold binder will be 1.1% total binder (BOS) in 55/45 ratio of part I/part II and the activator is 10% of part 1. Molds will be poured with iron at 2630 +/- 10^{o}F. Mold cooling will be 45 minutes followed by 15 minutes of shakeout, or until no more material remains to be shaken out. The emission sampling shall be a total of 75 minutes.

BRIEF OVERVIEW:

The emission collection procedure has been updated with a new emission collection system that provides independence from reasonable daily and seasonal ambient temperature changes with improved exhaust homogenization and real time data collection.

SPECIAL CONDITIONS:

The initial sand temperature into the emission collection hood shall be maintained at 80-90^{o}F. The initial process air temperature shall be 85-90^{o}F.

Series FL

Iron No-Bake® Baseline 2003
Process Instructions

A. Experiment:
  1. Measure emissions from an Iron No-Bake® Phenolic Urethane binder to update the iron No-Bake® baseline in the revised facilities.

B. Materials:
  1. No-Bake® molds: Wexford W450 Lakesand and
  2. 1.1 % HA International Techniset ® No-Bake® Phenolic-Urethane core binder composed of number 6000 part I resin (55%), 6433 part II co-reactant (45%), & 17-727 part III activator@ 7% of part 1. This binder is designed for iron applications.
  3. Metal:
    a. Class-30 Gray cast iron.

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

C. Mold requirements
  1. Make nine (9) molds according to standards determined in test series CW & CP capability studies.

D. Phenolic Urethane No-Bake® Core Sand preparation:
  1. Load the Kloster core sand mixer with 80-90^o F Wexford sand.
  2. The phenolic urethane No-Bake® sand shall be 1.1 % total resin (BOS), Part I/Part II ratio 55/45, Part III at 5% of Part I.
  3. Calibrate the Kloster No-Bake® sand mixer to dispense 240 pounds of sand /min more or less.
  4. Calibrate the resin pumps:
    a. Premix Part I resin and Part III activator in a 20:1 weight ratio.
    b. Part I +Part III: Based on the actual measured sand dispensing rate calibrate the Part I resin + Part III activator to be 56.20% of 1.1% (0.618% BOS) total binder.
    c. Part II: Based on the actual measured sand dispensing rate calibrate the
    d. Part II co-reactant to be 43.80% of 1.1% (0.482% BOS) total binder.
    e. All calibrations to have a tolerance of +/- 1% of the calculated value.

E. Dog bones:
  1. Make 12 dogbones for each mold according to the protocol establish in capability study CW.
  2. Place the core box on the vibrating compaction table.
  3. Start the Kloster mixer and waste a few pounds of sand.
  4. Flood the core box with sand then stop the mixer.
  5. Strike off the core box to ½ inch deep

6. Turn on the vibrating compaction table for 10 seconds.
7. Screed off most of the excess sand.
8. Screed the core box a second time moving very slowly in a back and forth manner to remove all excess sand.

Note: It is important to neither gouge the sand nor leave excess sand in center neck portion of the dogbone or the test results will be affected

9. Set aside for about 6-7 minutes or until hard to the touch.
10. Carefully remove the cores from the core box by separating the corebox components.
11. Perform tensile tests on 12 bones at 2 hours after the dogbone manufacture.
12. Report the average and standard deviation for each set of twelve (12) for each mold.
13. Weigh each dogbone and record the weight to the nearest 0.1 grams using the PJ 4000 electronic scale at the time it is tensile tested.

Note: maintain the correlation between the reported weight of a dogbone and its tensile strength and scratch hardness.

14. Bag three (3) dogbones, after tensile testing, from each mold for running 1800^{o}F core LOI.
15. Report the average value for each mold.

F. No-Bake® mold making: 4 on gear core box.

1. Inspect the box for cracks and other damage. Repair before use.
2. Prepare the core box halves with a light coating of Ashland Zipslip ® IP 78. Allow to fully dry.
3. Place the drag core box on the vibrating compaction table.
4. Begin filling the box.
5. When the box is about half full start the table vibration.
6. Manually spread the sand around the box as it is filling.
7. Strike off the box until it is full.
8. Allow the vibrator to run an additional 10 seconds after the box is full.
9. Strike off the core box so that the core mold is 5-1/2 inches thick.
10. Set the core box aside for 5 to 6 minutes or until it is hard to the touch.
11. Invert the box and place on a transport pallet. The pallet itself being on steel tie straps and in turn on a piece of polyethylene film big enough to wrap it up.
12. Remove the pivot-hole pins.
13. Remove the core mold half by tapping lightly on the box with a soft hammer.
14. Set the drag core box aside.
15. Immediately roll the drag mold half parting line up and return to the transport pallet.
16. Place the cope core box on the vibrating compaction table.
17. Follow steps F3-F13 except that the cope mold is 5 inches thick.
18. Rotate the unboxed core to set it on edge.
19. Drill vent-holes as per template.
20. Blow out both mold halves.

21. Apply a 1/4-3/8 inch glue bead of Foseco Core Fix 8 one inch (1) in from the outer edge of the mold.
22. Immediately close cope onto drag. Visually check for closure.
23. Install two (2) steel straps, one on either side of the pouring cup, with 4 metal corner protectors each to hold the mold tightly closed.
24. Prior to pouring, glue a pouring basin over the sprue hole with Foseco CoreFix 8 or equivalent no emission water base refractory adhesive
25. Weigh and record the weight of the sand only from the closed mold and pour basin.
26. Wrap and seal the mold with polyethylene film until time to load the mold into the emission hood.
27. Store the mold for next day use at 80-90 oF .

G. Emission hood:

1. Loading.
- **a.** Hoist the mold onto the shakeout deck fixture within the emission hood with the pouring cup side toward the furnace.
- **b.** Install ½ re-rod hanger in each riser vent and hand over shakeout supports.
- **c.** Close and seal the emission hood and lock the ducts together.
- **d.** Attach the heated ambient air duct to plenum
- **e.** Wait to pour until the process air thermocouple is in the range 85-90^{o}F.
- **f.** Record the ambient & process ambient air temperature.

2. Shakeout.
- **a.** After 45 minutes of cooling time has elapsed turn on the shakeout unit and run for a full 15 minutes as prescribed in the emission test plan.
- **b.** Turn off the shakeout. The emission sampling will continue for an additional 15 minutes or a total of 75 minutes
- **c.** Wait for the emission team to signal that they are finished sampling.
- **d.** Open the hood, remove the castings
- **e.** Clean core sand out of the waste sand box, off the shakeout, and the floor.
- **f.** Weigh and record cast metal weight adjusted for the re-rod hanger weight.
- **g.** Immediately load the next prepared mold and close the hood.

3. Melting:
- **a.** Initial charge:
- **b.** Charge the furnace according to the Generic Start-up Charge for Pre-production heat recipe bearing effectivity date 18 Mar 1999.
- **c.** Place part of the steel scrap on the bottom, followed by carbon alloys, and the balance of the steel.
- **d.** Place a pig on top on top.
- **e.** Bring the furnace contents to the point of beginning to melt over a period of 1 hour at reduced power.
- **f.** Add the balance of the metallics under full power until all is melted and the temperature has reached 2600 to 2700^{o}F.
- **g.** Slag the furnace and add the balance of the alloys.

h. Raise the temperature of the melt to 2700^{o}F and take a DataCast 2000 sample. The temperature of the primary liquidus (TPL) must be in the range of 2200-2350^{o}F.
i. Hold the furnace at 2500-2550^{o}F until near ready to tap.
j. When ready to tap raise the temperature to 2700^{o}F and slag the furnace.
k. Record all metallic and alloy additions to the furnace & tap temperature. Record all furnace activities with an associated time. Record Data Cast TPL, TPS, CE, C, & Si.

4. Back charging.
a. If additional iron is desired back charge according to the Generic Pre-production Last Melt heat recipe bearing effectivity date 18 Mar 1999.
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 H.1.e

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

I. Pouring:
1. Preheat the ladle.
2. Tap 400 pounds more or less of 2700^{o}F metal into the cold ladle.
3. Casually pour the metal back to the furnace.
4. Cover the ladle.
5. Reheat the metal to 2780 +/- 20^{o}F.
6. Tap 450 pounds more or less of iron into the ladle while pouring inoculating alloys onto the metal stream near its base.
7. Cover the ladle to conserve heat.
8. Move the ladle to the pour position, open the emission hood pour door and wait until the metal temperature reaches 2630 +/- 10 oF.
9. Commence pouring keeping the sprue full.
10. Upon completion close the hood door, return the extra metal to the furnace, and cover the ladle.
11. Record Pouring temperature and pour duration.

J. Casting cleaning
1. Spin blast set up.
a. Load the spin blast shot storage bin with 460 steel shot.
b. Turn on the spin blast bag house.
c. Turn on the spin blast machine.
d. Increase the magnetic feeder so that the motor amperage just turns to 12 amps from 11 amps.
e. Record the shot flow and the motor amperage for each wheel

2. Cleaning castings.
a. Place the four (4) castings from a single mold on one (1) casting basket.

b. Process each rotating basket for eight (8) minutes.
c. Remove and remark casting ID on each casting.

K. Rank order evaluation.

1. The supervisor shall select a group of four or five persons to make a collective subjective judgment of the casting's relative surface appearance.

2. Review the general appearance of the castings and select specific casting features to compare. Generally for the gear mold the material related casting features should be metal penetration, veining, expansion defects and texture (tactile feel). Defects arising from loose sand, slag, broken molds, double striking, and shrinkage should be disregarded.

3. For each cavity casting:

a. Place each casting initially in sequential mold number order.
b. Beginning with casting from cavity 1 mold FL001 compare it to castings from cavity 1 mold FL002.
c. Place the better appearing casting in the first position and the lesser appearing casting in the second position.
d. Repeat this procedure with cavity 1 mold FL001 to its nearest neighbors until all castings closer to the beginning of the line are better appearing than cavity 1 mold FL001 and the next casting farther down the line is inferior.
e. Repeat this comparison to next neighbors for each cavity 3 casting number.
f. When all casting numbers have been compared go to the beginning of the line and begin again comparing each casting to its nearest neighbor. Move the castings so that each casting is inferior to the next one closer to the beginning of the line and superior to the one next toward the tail of the line.
g. Repeat this comparison until all evaluators concur with the ranking order.
h. Record cavity 1 mold number by rank-order series.
i. Save the best, median, and worst castings of Cavity 1 for photographing and archiving.
j. Repeat for each cavity.

Steven Knight
Mgr. Process Engineering

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/7/2003											
RUN 1											
THC	FL001	X									TOTAL
M-18	FL00101		1						30	1	Carbopak charcoal
M-18 MS	FL00102		1						30	2	Carbopak charcoal
M-18 MS	FL00103			1					30	3	Carbopak charcoal
Gas, CO, CO2	FL00104		1						60	4	Tedlar Bag
Gas, CO, CO2	FL00105				1				0		Tedlar Bag
NIOSH 1500	FL00106		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FL00107				1				0		100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00108		1						200	6	100/50 mg Silica Gel (SKC 226-10)
NIOSH 2002	FL00109				1				0		100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00110		1						675	9	DNPH Silica Gel (SKC 226-119)
TO11	FL00111				1				0		DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/7/2003											
RUN 2											
THC	FL002	X									TOTAL
M-18	FL00201		1						30	1	Carbopak charcoal
M-18	FL00202			1					30	2	Carbopak charcoal
M-18	FL00203				1				0		Carbopak charcoal
	Excess								30	3	Excess
Gas, CO, CO2	FL00204		1						60	4	Tedlar Bag
NIOSH 1500	FL00205		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FL00206			1					200	6	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00207		1						200	7	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	8	Excess
TO11	FL00208		1						675	9	DNPH Silica Gel (SKC 226-119)
TO11	FL00209			1					675	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/7/2003											
RUN 3											
THC	FL003	X									TOTAL
M-18	FL00301		1						30	1	Carbopak charcoal
M-18	FL00302					1			30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00303		1						60	4	Tedlar Bag
NIOSH 1500	FL00304		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00305		1						200	6	100/50 mg Silica Gel (SKC 226-10)
NIOSH 2002	FL00306			1					200	7	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	8	Excess
TO11	FL00307		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/2003											
RUN 4											
THC	FL004	X									TOTAL
M-18	FL00401		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00402		1						60	4	Tedlar Bag
NIOSH 1500	FL00403		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00404		1						200	6	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00405		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/2003											
RUN 5											
THC	FL005	X									TOTAL
M-18	FL00501		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00502		1						60	4	Tedlar Bag
NIOSH 1500	FL00503		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00504		1						200	6	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00505		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/2003											
RUN 6											
THC	FL006	X									TOTAL
M-18	FL00601		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00602		1						60	4	Tedlar Bag
NIOSH 1500	FL00603		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00604		1						200	6	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00605		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/2003											
RUN 7											
THC	FL007	X									TOTAL
M-18	FL00701		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00702		1						60	4	Tedlar Bag
NIOSH 1500	FL00703		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00704		1						200	6	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00705		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/2003											
RUN 8											
THC	FL008	X									TOTAL
M-18	FL00801		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00802		1						60	4	Tedlar Bag
NIOSH 1500	FL00803		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00804		1						200	6	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00805		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

PRE-PRODUCTION FL - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/2003											
RUN 9											
THC	FL009	X									TOTAL
M-18	FL00901		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
Gas, CO, CO2	FL00902		1						60	4	Tedlar Bag
NIOSH 1500	FL00903		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FL00904		1						200	6	100/50 mg Silica Gel (SKC 226-10)
	Excess								200	7	Excess
	Excess								200	8	Excess
TO11	FL00905		1						675	9	DNPH Silica Gel (SKC 226-119)
	Excess								675	10	Excess
	Excess								1000	11	Excess
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

Technikon Test Plan

>	**CONTRACT NUMBER:**	1411 **TASK NUMBER:** 1.1.3 **Series:** GI
>	**SITE:**	Research Foundry
>	**TEST TYPE:**	Vendor test: Part A: No-Bake® Mix/make/cure, & store; Part B: No-Bake® Pour, cool, shakeout
>	**METAL:**	Class 30 gray iron
>	**MOLD TYPE:**	Part A: Two(2) 19 x 20 x 6 inch blocks; No-Bake®
		Part B: 4-on variable tooth gear; No-Bake®
		HA International Enviroset 22 ® Furan No-Bake® resin @
		70 % of 1.3% total binder (BOS) and TC-50 mixed
		sulphonic acid catalyst @ 30 % of 1.3 % (BOS)
>	**SAMPLE EVENTS:**	Part A: 6 block pairs, mix/make/cure; same 6 block pairs, store
		Part B: 9 molds PCS
>	**ANALYTES:**	List A, furfuryl alcohol, furfural, SO2, CO, CO2, NOx, & TGOC
>	**TEST DATE:**	**START:** 4 Oct 2004
>		**FINISHED:** 22 Oct 2004

TEST OBJECTIVES:

- Measure TGOC, targeted VOCs & HAPs from fugitive emissions from No-Bake® sand mixing/mold making/mold curing, and compare to test EY.
- Measure TGOC and targeted VOCs & HAPs from fugitive emissions from No-Bake® mold storage and compare to test EY.
- Measure TGOC and targeted VOCs & HAPs emissions from PCS of No-Bake® molds and compare to test FL.

VARIABLES:

No-Bake® sand mixing: The uncoated sand shall be Wedron 530 silica sand. It shall be preheated or cooled to maintain a temperature of 75 +/- 5^{o}F. The binder shall be 1.30 +/-0.013% total (BOS) HA International Enviroset 22® resin (Part I) and TC-50 mixed sulphonic acids (Part II) combined in a ratio Part I I/Part II of 70/30. The sand will be mixed in the Kloster ribbon mixer and immediately dispensed.

No-Bake® mold making: Coated sand shall be dispensed at a rate of 100 pounds per minute, approximately 120-140 pounds total, into a pair of 19 x 20 x 6 inch snap flasks for curing. The mold shall be compacted by vibration and struck off level. Excess materials shall be removed from the emission enclosure. The emission enclosure shall be maintained at 75+/-5^{o}F.

No-Bake® mold curing: The mold shall be cured in-situ in the enclosure with the snap flask in place for a period of ten (10) total elapsed minutes from the time when flask filling commenced. End mix/make/cure emission sampling after 10 minutes.

No-Bake® mold storage: After 10 minutes elapsed time, begin the Storage emission sampling from the same molds. Immediately remove the snap flasks and set them aside within the enclosure. Continue Storage sampling until a total elapsed time of three (3) hours since the filling of the flask commenced.

No-Bake® PCS: The pattern shall be the 4-on gear. The mold shall be made with Wedron 530 sand. The binder shall be 1.30 +/-0.013% total (BOS) HA International Enviroset 22® resin (Part I) and TC-50 mixed sulphonic acids (Part II) combined in a ratio Part I I/Part II of 70/30. The sand will be mixed in the Kloster ribbon mixer and immediately dispensed. Molds will be made on the day before being poured and wrapped in plastic sheeting.

Molds will be poured with iron at 2630 +/- 10°F. Mold cooling will be 45 minutes followed by 15 minutes of shakeout, or until all material is shaken out. The emission sampling shall include the pouring/cooling/shakeout, and 15 minutes of post shakeout for a total of 75 minutes.

A set of 12 dogbone tensile specimens shall be made from the material from each block pair and mold. The dogbones each will be weighed and tensile tested after two (2) hours of curing at 75°F.

BRIEF OVERVIEW:

For the purpose of standardization where no clear delineation exists the mixing, making, and curing will be treated as one multi-step continuous process with one emission. Since the curing step requires the retention of the molding flask, curing will be defined as having been completed when the flask is removed. Simultaneously the storage segment will begin as a separate emission sample and continue until sufficient data is collected to create a characteristic concentration-time curve.

SPECIAL CONDITIONS:

All tests will be conducted in temporary total emission enclosures conforming to US EPA method 204 maintained at a standard temperature. Balance air flows to make enclosure conform to US EPA method 204 for temporary total enclosures.
The emission enclosure air-temperature and incoming sand temperature will be maintained to standardize the test for repeatability of both the emission process and the emission sampling technique.

Series GI

No-Bake® Mixing, Making, Curing Combination, Storage and Pouring Cooling & Shakeout Furan No-Bake®

Process Instructions

A. Experiment:
1. Measure selected HAP and VOC emissions from No-Bake® mixing, making & curing. Compare to test EY.
2. Measure selected HAP and VOC emissions from No-Bake® storage. Compare to test EY.
3. Measure Selected HAP and VOC emissions from No-Bake® mold Pouring/cooling/shakeout. Compare to test FL.

B. Materials.
1. No-Bake® mold:
2. Part I: HA International Enviroset 22 ® Furan No-Bake® binder.
3. Part II: HA International TC-50 sulphonic acid catalyst.
4. Wedron 530 Silica sand.

C. Metal:
1. Class 30 Grey Iron for Pouring/cooling/shakeout.

Caution: Observe all safety precautions attendant to these operations as delineated in the Pre-production operating and safety instruction manual as applicable to bldg. 238.

D. Furan No-Bake® mold sand preparation.
1. The furan No-Bake® sand shall be 1.3 % total binder (BOS), Part I/Part II ratio 70/30.
2. Calibrate the Kloster No-Bake® sand mixer to dispense 100 pounds/min more or less.
3. Calibrate the binder pumps:
   - **a.** Part I: Based on the actual measured sand dispensing rate calibrate the Part I resin to be 70.00% of 1.3 % total binder BOS.
   - **b.** Part II: Based on the actual measured sand dispensing rate calibrate the Part II catalyst to be 30.00 % of 1.3 % total binder BOS.
   - **c.** All calibrations to have a tolerance of +/- 1% of the calculated value.

E. Mold requirements.
1. Mix/make/cure & store: Make (12) No-Bake® blocks, two (2) for each run, in two 19 x 20 x 6 inch deep cope snap flasks each clamped to an aluminum pallet for emission measurement.
   - **a.** Make sure the flask clamps are closed.
   - **b.** The patterns to be used are featureless aluminum pallets to which the snap flasks are clamped.
   - **c.** Inspect the flasks and patterns for damage. Repair before use.
   - **d.** Place the flasks, parting line down, on the pallets and clamp in place.

- **e.** Place the assemblies on the Kloster vibrating compaction table via the south wall port. Start the THC.
- **f.** Run 15-20 pounds of waste sand into a bucket then begin filling the box without stopping the mixer. Start the run time clock. Start the sample train. Measure the sand temperature in the waste bucket and record it on the Process Log.
- **g.** Manually spread the sand around the boxes as they are filling.
- **h.** When the flasks are about 3/4s full start the table vibration.
- **i.** Slightly overfill the flasks. Minimize the sand spillage. Record when the mixer is stopped.
- **j.** Allow the vibrator to run an additional 5 seconds after the box is full.
- **k.** Strike off the flasks when they are full to standardize the weight. Remove as much struck off sand from the emission enclosure as practicable. Record when the mold is finished.
- **l.** Allow the molds to cure for a total elapsed time of 10 minutes from the start of filling.
- **m.** At 10 minutes total lapsed time:
  - **1)** Stop the mix/make/cure sample train. Start the storage sample train.
  - **2)** Remove the mold flasks from the molds by unclamping the corner clamps and lifting the flask off the mold. Set the flasks aside within the enclosure.

2. Emission hood cleaning: Mixing, making, curing, storage.

- **a.** After each run remove the flasks and molds through the entry/exit port in the south wall.
- **b.** Loosen all sand stuck to vibratory table.
- **c.** Blow all the spill sand to the floor inside the emission hood.
- **d.** Lift the hood (about 10 inches) and block up in place.
- **e.** Sweep the spill sand from the floor under the hood, weigh it, and record the weight on the Process Log.
- **f.** Lower the hood to the floor.
- **g.** Check for alignment.
- **h.** Place the next mold flasks into the hood through the entry/exit port in the south wall of the emission enclosure. Replace the exit port cover.
- **i.** When done making molds run raw sand through the mixer to clean it.

3. Pour, Cool & Shakeout: Make nine (9) gear molds according to standards determined in test series CW & CP capability studies.

- **a.** Remove the front and top of the emission enclosure used for mix/make/cure, & store emission sampling.
- **b.** Inspect the mold box for cracks and other damage. Repair before use.
- **c.** Use 9/16 choke sleeve on sprue.
- **d.** Insert trunnion pin in mold box.
- **e.** Prepare the mold box halves with a light coating of Ashland Zipslip ® IP 78. Allow to fully dry.
- **f.** Place the mold box drag half on the vibrating compaction table.
- **g.** Begin filling the box.
- **h.** When the box is about 3/4s full start the table vibration.
- **i.** Manually spread the sand around the box as it is filling.

j. Slightly over fill the box.
k. Allow the vibrator to run an additional 5 seconds after the box is full.
l. Strike off the mold box so that the No-Bake® drag mold is 5-1/2 inches thick, the cope mold is 5 inches thick..
m. Set the mold box with cope/drag half aside for 5 to 6 minutes or until it is hard to the touch.
n. Remove the two pivot hole patterns from the mold box and mold.
o. Place a pallet on the roller conveyor.
p. Place a transport pallet on the floor. Place a sheet of polyethylene on the transport pallet large enough to wrap the finished mold.
q. Insert the carrier frame pivot pins into the cope/drag mold box pivot holes.
r. Using the crane and carrier frame invert the cope/drag box and suspend it about 1/8 inch or less above the pallet setting on the conveyor.
s. Remove the mold box cope/drag half from the mold by tapping lightly on the box with a soft hammer as you lift with the crane.
t. Set the cope/drag mold box aside.
u. Insert the pins of the carrier into the mold pivot holes.
v. Immediately raise, re-invert the drag mold parting line up, transport, and set the drag mold to the pallet on the floor.
w. Place the cope mold box on the vibrating compaction table.
x. Follow steps D.2.e-D.2.l.
y. Remove the box from the mold as was done with the drag half (2.D.o-2.D.s).
z. Immediately, close the unboxed cope mold over the drag mold, and wrap with 4-6 mil plastic. Store the mold for next day use at 80-90^{o}F .
aa. The day the molds are to be used open the molds, rotate the cope mold to set it on edge.
bb. Drill cope vent holes per the template.
cc. Lift the drag mold and insert two steel straps under the mold. Return the drag mold to the pallet where it was.
dd. Blow out both mold halves.
ee. Apply a 1/4-3/8 inch glue bead of Foseco Core Fix 8 one inch (1) in from the outer edge of the drag mold.
ff. Immediately close cope onto drag. Visually check for closure.
gg. Connect the two (2) steel straps, one on either side of the pouring cup, with four (4) metal corner protectors each to hold the mold tightly closed.
hh. Weigh and record the weight of the sand only from the closed mold.
ii. Prior to pouring, glue a pouring basin over the sprue hole with Foseco
jj. CoreFix 8 or equivalent no emission water base refractory adhesive.

F. Tensile Dogbones:

1. Use the last of the wasted sand to make 12 dogbone tensile test samples.(approx. 3 pounds)
2. Make 12 dogbones for each mold according to the protocol establish in capability study CW.
3. Place the assembled and clamped dogbone core box on the vibrating compaction table.
4. Start the Kloster mixer and waste a few pounds of sand.

5. Flood the core box with sand then stop the mixer.
6. Strike off the core box to ½ inch deep
7. Turn on the vibrating compaction table for 5 seconds.
8. Screed off most of the excess sand.
9. Screed the core box a second time moving in a back and forth manner to remove all excess sand.

Note: It is important to neither gouge the sand nor leave excess sand in center neck portion of the dogbone or the test results will be affected

10. Set aside for about 6-7 minutes or until hard to the touch.
11. Carefully remove the cores from the core box by separating the corebox components.
12. Store dogbones in a desiccating cabinet at 70-90^{o}F.
13. At one (1) hour break six (6) bones on the Thwing-Albert tensile tester and record the values on the Dogbone Tensile Log
14. At two (2) hours break six (6) bones on the Thwing-Albert tensile tester and record the values on the Dogbone Tensile log.
15. Bag three (3) dogbones, after tensile testing, from each mold for running 1800^{o}F core LOI. Report the average value for each mold.

G. Emission hood pouring ,cooling, shakeout:
1. Loading.
a. Hoist the mold onto the shakeout deck fixture within the emission hood with the pouring cup side toward the furnace.
b. Install ½ re-rod hanger in each riser vent and hang over shakeout supports.
c. Close and seal the emission hood and lock the ducts together.
d. Attach the heated ambient air duct to plenum
e. Wait to pour until the process air thermocouple is in the range 85-90^{o}F.
f. Record the ambient & process ambient air temperature.
g. Shakeout.
h. After 45 minutes of cooling time has elapsed turn on the shakeout unit and run for a full 15 minutes as prescribed in the emission test plan.
i. Turn off the shakeout. The emission sampling will continue for an additional 15 minutes or a total of 75 minutes
j. Wait for the emission team to signal that they are finished sampling.
k. Open the hood, remove the castings
l. Clean core sand out of the waste sand box, off the shakeout, and the floor.
m. Immediately load the next prepared mold and close the hood.
n. Weigh and record cast metal weight adjusted for the re-rod hanger weight.

H. Melting:
1. Initial charge:
a. Charge the furnace according to the Generic Start Up Charge for Pre-production heat recipe bearing effectivity date 6 Apr 2004.
b. Place part of the steel scrap on the bottom, followed by carbon alloys, and the balance of the steel.

- **c.** Place a pig on top.
- **d.** Bring the furnace contents to the point of beginning to melt over a period of 1 hour at reduced power.
- **e.** Add the balance of the metallics under full power until all is melted and the temperature has reached 2600 to 2700 oF.
- **f.** Slag the furnace and add the balance of the alloys.
- **g.** Raise the temperature of the melt to 2700 oF and take a DataCast 2000 sample. The temperature of the primary liquidus (TPL) must be in the range of 2200-2350^{o}F.
- **h.** Hold the furnace at 2500-2550oF until near ready to tap.
- **i.** When ready to tap raise the temperature to 2700oF and slag the furnace.
- **j.** Record all metallic and alloy additions to the furnace & tap temperature. Record all furnace activities with an associated time. Record Data Cast TPL, TPS, CE, C, & Si.

I. Back charging.

- **1.** If additional iron is desired back charge according to the Generic Pre-production Last Melt heat recipe bearing effectivity date 18 Mar 1999.
- **2.** Charge a few pieces of steel first to make a splash barrier, followed by the carbon alloys.
- **3.** Follow the above steps beginning with G.1.e

J. Emptying the furnace.

- **1.** Pig the extra metal after pouring the last test mold.

K. Pouring:

- **1.** Preheat the ladle.
- **2.** Tap 400 pounds more or less of 2700^{o}F metal into the cold ladle.
- **3.** Casually pour the metal back to the furnace.
- **4.** Cover the ladle.
- **5.** Reheat the metal to 2780 +/- 20^{o}F.
- **6.** Tap 450 pounds more or less of iron into the ladle while pouring inoculating alloys onto the metal stream near its base.
- **7.** Cover the ladle to conserve heat.
- **8.** Move the ladle to the pour position, open the emission hood pour door and wait until the metal temperature reaches 2630 +/- 10^{o}F.
- **9.** Commence pouring keeping the sprue full.
- **10.** Upon completion close the hood door, return the extra metal to the furnace, and cover the ladle.
- **11.** Record Pouring temperature and pour duration.

L. Casting cleaning

- **1.** Spin blast set up.
  - **a.** Load the spin blast shot storage bin with 460 steel shot.
  - **b.** Turn on the spin blast bag house.
  - **c.** Turn on the spin blast machine.
  - **d.** Increase the magnetic feeder so that the motor amperage just turns to 12 amps from 11 amps.
  - **e.** Record the shot flow and the motor amperage for each wheel

2. Cleaning castings.
 a. Place the four (4) castings from a single mold on one (1) casting basket.
 b. Process each rotating basket for eight (8) minutes.
 c. Remove and remark casting ID on each casting.

M. Rank order evaluation.
 1. The supervisor shall select a group of four or five persons to make a collective subjective judgment of the casting's relative surface appearance.
 2. Review the general appearance of the castings and select specific casting features to compare. Generally for the gear mold the material related casting features should be metal penetration, veining, expansion defects and texture (tactile feel). Defects arising from loose sand, slag, broken molds, double striking, and shrinkage should be disregarded.
 3. Record cavity 3 mold number by rank-order series.
 4. Place each casting initially in sequential mold number order.
 5. Beginning with casting from cavity 1 mold GI001 compare it to castings from cavity 1 mold GI002.
 6. Place the better appearing casting in the first position and the lesser appearing casting in the second position.
 7. Repeat this procedure with cavity 1 mold GI001 to its nearest neighbors until all castings closer to the beginning of the line are better appearing than cavity 1 mold GI001 and the next casting farther down the line is inferior.
 8. Repeat this comparison to next neighbors for each cavity 3 casting number.
 9. When all casting numbers have been compared go to the beginning of the line and begin again comparing each casting to its nearest neighbor. Move the castings so that each casting is inferior to the next one closer to the beginning of the line and superior to the one next toward the tail of the line.
 10. Repeat this comparison until all evaluators concur with the ranking order.
 11. Save the best, median, and worst castings of Cavity 3 for photographing and archiving.

Steven Knight
Mgr. Process Engineering

CORE MIX, MAKE, CURE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/11/2004											
EVENT 1											
THC	GI201	X									TOTAL
	STOR								400	1	blocked
	STOR								400	2	blocked
	STOR								400	3	blocked
	STOR								400	4	blocked
	STOR								400	5	blocked
	STOR								400	6	blocked
TO11	GI20101		1						850	7	DNPH Silica Gel (SKC 226-119)
TO11	GI20102				1				0		DNPH Silica Gel (SKC 226-119)
OSHA 72	GI20103		1						850	8	100/50 mg Pet Charcoal (SKC 226-38)
OSHA 72	GI20104				1				0		100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI20105		1						850	9	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	GI20106										100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI20107		1						850	10	Sample not analyzed
NIOSH 2002	GI20108				1				0		Sample not analyzed
NIOSH 2505	GI20109		1						850	11	150/75 mg Poropak Q (SKC 226-115)
NIOSH 2505	GI20110				1				0		150/75 mg Poropak Q (SKC 226-115)
	Excess								850	12	Excess
	Excess								5000	13	Excess

CORE MIX, MAKE, CURE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/11/2004											
EVENT 2											
THC	GI202	X									TOTAL
	STOR								400	1	blocked
	STOR								400	2	blocked
	STOR								400	3	blocked
	STOR								400	4	blocked
	STOR								400	5	blocked
	STOR								400	6	blocked
TO11	GI20201		1						850	7	DNPH Silica Gel (SKC 226-119)
TO11	GI20202			1					850	8	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI20203		1						850	9	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI20204		1						850	10	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI20205		1						850	11	Sample not analyzed
NIOSH 2505	GI20206		1						850	12	150/75 mg Poropak Q (SKC 226-115)
	Excess								5000	13	Excess

CORE MIX, MAKE, CURE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/12/2004											
EVENT 3											
THC	GI203	X									TOTAL
	STOR								400	1	blocked
	STOR								400	2	blocked
	STOR								400	3	blocked
	STOR								400	4	blocked
	STOR								400	5	blocked
	STOR								400	6	blocked
TO11	GI20301		1						850	7	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI20302		1						850	8	100/50 mg Pet Charcoal (SKC 226-38)
OSHA 72	GI20303			1					850	9	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI20304		1						850	10	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI20305		1						850	11	Sample not analyzed
NIOSH 2505	GI20306		1						850	12	150/75 mg Poropak Q (SKC 226-115)
	Excess								5000	13	Excess

CORE MIX, MAKE, CURE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/12/2004											
EVENT 4											
THC	GI204	X									TOTAL
	STOR								400	1	blocked
	STOR								400	2	blocked
	STOR								400	3	blocked
	STOR								400	4	blocked
	STOR								400	5	blocked
	STOR								400	6	blocked
TO11	GI20401		1						850	7	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI20402		1						850	8	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI20403		1						850	9	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	GI20404			1					850	10	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI20405		1						850	11	Sample not analyzed
NIOSH 2505	GI20406		1						850	12	150/75 mg Poropak Q (SKC 226-115)
	Excess								5000	13	Excess

CORE MIX, MAKE, CURE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/13/2004											
EVENT 5											
THC	GI105	X									TOTAL
	STOR								400	1	blocked
	STOR								400	2	blocked
	STOR								400	3	blocked
	STOR								400	4	blocked
	STOR								400	5	blocked
	STOR								400	6	blocked
TO11	GI20501		1						850	7	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI20502		1						850	8	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI20503		1						850	9	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI20504		1						850	10	Sample not analyzed
NIOSH 2002	GI20505			1					850	11	Sample not analyzed
NIOSH 2505	GI20506		1						850	12	150/75 mg Poropak Q (SKC 226-115)
	Excess								5000	13	Excess

CORE MIX, MAKE, CURE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/13/2004											
EVENT 6											
THC	GI-106	X									TOTAL
	STOR								400	1	blocked
	STOR								400	2	blocked
	STOR								400	3	blocked
	STOR								400	4	blocked
	STOR								400	5	blocked
	STOR								400	6	blocked
TO11	GI20601		1						850	7	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI20602		1						850	8	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI20603		1						850	9	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI20604		1						850	10	Sample not analyzed
NIOSH 2505	GI20605		1						850	11	150/75 mg Poropak Q (SKC 226-115)
NIOSH 2505	GI20606			1					850	12	150/75 mg Poropak Q (SKC 226-115)
	Excess								5000	13	Excess

CORE STORAGE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/11/2004											
EVENT 1											
THC	GI-301	X									TOTAL
TO11	GI-30101		1						400	1	DNPH Silica Gel (SKC 226-119)
TO11	GI-30102			1					400	2	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI-30103		1						400	3	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI-30104		1						400	4	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI-30105		1						400	5	Sample not analyzed
NIOSH 2505	GI-30106		1						400	6	150/75 mg Poropak Q (SKC 226-115)
	MMC								850	7	Blocked
	MMC								850	8	Blocked
	MMC								850	9	Blocked
	MMC								850	10	Blocked
	MMC								850	11	Blocked
	MMC								850	12	Blocked
	Excess								5000	13	Excess

CORE STORAGE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/11/2004											
EVENT 2											
THC	GI302	X									TOTAL
TO11	GI30201		1						400	1	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI30202		1						400	2	100/50 mg Pet Charcoal (SKC 226-38)
OSHA 72	GI30203			1					400	3	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI30204		1						400	4	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI30205		1						400	5	Sample not analyzed
NIOSH 2505	GI30206		1						400	6	150/75 mg Poropak Q (SKC 226-115)
	MMC								850	7	Blocked
	MMC								850	8	Blocked
	MMC								850	9	Blocked
	MMC								850	10	Blocked
	MMC								850	11	Blocked
	MMC								850	12	Blocked
	Excess								5000	13	Excess

CORE STORAGE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/12/2004											
EVENT3											
THC	GI-303	X									TOTAL
TO11	GI-30301		1						400	1	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI-30302		1						400	2	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI-30303		1						400	3	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	GI-30304			1					400	4	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI-30305		1						400	5	Sample not analyzed
NIOSH 2505	GI-30306		1						400	6	150/75 mg Poropak Q (SKC 226-115)
	MMC								850	7	Blocked
	MMC								850	8	Blocked
	MMC								850	9	Blocked
	MMC								850	10	Blocked
	MMC								850	11	Blocked
	MMC								850	12	Blocked
	Excess								5000	13	Excess

CORE STORAGE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/12/2004											
EVENT 4											
THC	GI-304	X									TOTAL
TO11	GI-30401		1						400	1	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI-30402		1						400	2	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI-30403		1						400	3	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI-30404		1						400	4	Sample not analyzed
NIOSH 2002	GI-30405			1					400	5	Sample not analyzed
NIOSH 2505	GI-30406		1						400	6	150/75 mg Poropak Q (SKC 226-115)
	MMC								850	7	Blocked
	MMC								850	8	Blocked
	MMC								850	9	Blocked
	MMC								850	10	Blocked
	MMC								850	11	Blocked
	MMC								850	12	Blocked
	Excess								5000	13	Excess

CORE STORAGE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/13/2004											
EVENT 5											
THC	GI-305	X									TOTAL
TO11	GI-30501		1						400	1	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI-30502		1						400	2	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI-30503		1						400	3	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI-30504		1						400	4	Sample not analyzed
NIOSH 2505	GI-30505		1						400	5	150/75 mg Poropak Q (SKC 226-115)
NIOSH 2505	GI-30506			1					400	6	150/75 mg Poropak Q (SKC 226-115)
	MMC								850	7	Blocked
	MMC								850	8	Blocked
	MMC								850	9	Blocked
	MMC								850	10	Blocked
	MMC								850	11	Blocked
	MMC								850	12	Blocked
	Excess								5000	13	Excess

CORE STORAGE GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/13/2004											
EVENT 6											
THC	GI-306	X									TOTAL
TO11	GI-30601		1						400	1	DNPH Silica Gel (SKC 226-119)
OSHA 72	GI-30602		1						400	2	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 1500	GI-30603		1						400	3	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	GI-30604		1						400	4	Sample not analyzed
NIOSH 2505	GI-30605		1						400	5	150/75 mg Poropak Q (SKC 226-115)
	Excess								400	6	Excess
	MMC								850	7	Blocked
	MMC								850	8	Blocked
	MMC								850	9	Blocked
	MMC								850	10	Blocked
	MMC								850	11	Blocked
	Excess								850	12	Blocked
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/19/2004											
RUN 1											
THC, CO,CO2, SO2, NOX	GI001	X									TOTAL
M-18	GI00101		1						30	1	Carbopak charcoal
M-18	GI00102				1				0		Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
NIOSH 2002	GI00103		1						200	4	Sample not analyzed
NIOSH 2002	GI00104				1				0		Sample not analyzed
NIOSH 1500	GI00105		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	GI00106				1				0		100/50 mg Charcoal (SKC 226-01)
	Excess								200	6	Excess
OSHA 72	GI00107		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
OSHA 72	GI00108				1				0		100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00109		1						800	8	DNPH Silica Gel (SKC 226-119)
TO11	GI00110				1				0		DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00111		1						800	9	100/50 mg Carbon Bead (SKC 226-80)
OSHA ID200	GI00112				1						100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00113		1						800	10	150/75 mg Poropak Q (SKC 226-115)
NIOSH 2505	GI00114				1				0		150/75 mg Poropak Q (SKC 226-115)
NIOSH 2529	GI00115		1						800	11	150/75 mg XAD-2 (SKC 226-117)
NIOSH 2529	GI00116				1				0		150/75 mg XAD-2 (SKC 226-117)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/19/2004											
RUN 2											
THC, CO,CO2, SO2, NOX	GI002	X									TOTAL
M-18	GI00201		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
NIOSH 2002	GI00202		1						200	4	Sample not analyzed
NIOSH 1500	GI00203		1						200	5	100/50 mg Charcoal (SKC 226-01)
	Excess								200	6	Excess
OSHA 72	GI00204		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 2529	GI00205		1						800	8	150/75 mg XAD-2 (SKC 226-117)
TO11	GI00206		1						800	9	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00207		1						800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00208		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/19/2004											
RUN 3											
THC, CO,CO2, SO2, NOX	GI003	X									TOTAL
M-18	GI00301		1						30	1	Carbopak charcoal
M-18 MS	GI00302		1						30	2	Carbopak charcoal
M-18 MS	GI00303			1					30	3	Carbopak charcoal
NIOSH 2002	GI00304		1						200	4	Sample not analyzed
NIOSH 1500	GI00305		1						200	5	100/50 mg Charcoal (SKC 226-01)
	Excess								200	6	
OSHA 72	GI00306		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
NIOSH 2529	GI00307		1						800	8	150/75 mg XAD-2 (SKC 226-117)
TO11	GI00308		1						800	9	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00309		1						800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00310		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/20/2004											
RUN 4											
THC, CO,CO2, SO2, NOX	GI004	X									TOTAL
M-18	GI00401		1						30	1	Carbopak charcoal
M-18	GI00402			1					30	2	Carbopak charcoal
	Excess								30	3	Excess
NIOSH 2002	GI00403		1						200	4	Sample not analyzed
NIOSH 2002	GI00404			1					200	5	Sample not analyzed
NIOSH 1500	GI00405		1						200	6	100/50 mg Charcoal (SKC 226-01)
OSHA 72	GI00406		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
OSHA 72	GI00407			1					800	8	100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00408		1						800	9	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00409		1						800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00410		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/21/2004											
RUN 5											
THC, CO,CO2, SO2, NOX	GI005	X									TOTAL
M-18	GI00501		1						30	1	Carbopak charcoal
M-18	GI00502					1			30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	
NIOSH 2002	GI00503		1						200	4	Sample not analyzed
NIOSH 1500	GI00504		1						200	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	GI00505			1					200	6	100/50 mg Charcoal (SKC 226-01)
OSHA 72	GI00506		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00507		1						800	8	DNPH Silica Gel (SKC 226-119)
TO11	GI00508			1					800	9	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00509		1						800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00510		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/21/2004											
RUN 6											
THC, CO,CO2, SO2, NOX	GI006	X									TOTAL
M-18	GI00601		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
	Excess								200	4	Excess
NIOSH 2002	GI00602		1						200	5	Sample not analyzed
NIOSH 1500	GI00603		1						200	6	100/50 mg Charcoal (SKC 226-01)
OSHA 72	GI00604		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00605		1						800	8	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00606		1						800	9	100/50 mg Carbon Bead (SKC 226-80)
OSHA ID200	GI00607			1					800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00608		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/21/2004											
RUN 7											
THC, CO,CO2, SO2, NOX	GI007	X									TOTAL
M-18	GI00701		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
	Excess								200	4	Excess
NIOSH 2002	GI00702		1						200	5	Sample not analyzed
NIOSH 1500	GI00703		1						200	6	100/50 mg Charcoal (SKC 226-01)
OSHA 72	GI00704		1						800	7	100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00705		1						800	8	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00706		1						800	9	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00707		1						800	10	150/75 mg Poropak Q (SKC 226-115)
NIOSH 2505	GI00708			1					800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/22/2004											
RUN 8											
THC, CO,CO2, SO2, NOX	GI008	X									TOTAL
M-18	GI00801		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
	Excess								200	4	Excess
NIOSH 2002	GI00802		1						200	5	Sample not analyzed
NIOSH 1500	GI00803		1						200	6	100/50 mg Charcoal (SKC 226-01)
NIOSH 2529	GI00804		1						800	7	150/75 mg XAD-2 (SKC 226-117)
OSHA 72	GI00805		1						800	8	100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00806		1						800	9	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00807		1						800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00808		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

POURING, COOLING SHAKEOUT GI - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/22/2004											
RUN 9											
THC, CO,CO2, SO2, NOX	GI009	X									TOTAL
M-18	GI00901		1						30	1	Carbopak charcoal
	Excess								30	2	Excess
	Excess								30	3	Excess
	Excess								200	4	Excess
NIOSH 2002	GI00902		1						200	5	Sample not analyzed
NIOSH 1500	GI00903		1						200	6	100/50 mg Charcoal (SKC 226-01)
NIOSH 2529	GI00904		1						800	7	150/75 mg XAD-2 (SKC 226-117)
OSHA 72	GI00905		1						800	8	100/50 mg Pet Charcoal (SKC 226-38)
TO11	GI00906		1						800	9	DNPH Silica Gel (SKC 226-119)
OSHA ID200	GI00907		1						800	10	100/50 mg Carbon Bead (SKC 226-80)
NIOSH 2505	GI00908		1						800	11	150/75 mg Poropak Q (SKC 226-115)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

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APPENDIX B TEST SERIES EY, FL, AND GI DETAILED EMISSION RESULTS

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Individual Mold Making Results for Test EY– Lb/Lb Binder

Mix, Make, Cure

HAPs	POMs	Compound/Sample Number	EY101	EY102	EY103	EY104	EY105	EY106	Average	STDEV
		Test Dates	**2/19/03**	**2/19/03**	**2/20/03**	**2/20/03**	**2/24/03**	**2/24/03**		
		TGOC as Propane	7.32E-03	7.08E-03	6.33E-03	7.44E-03	6.54E-03	6.91E-03	6.93E-03	4.35E-04
		HC as Hexane	7.34E-03	7.38E-03	6.42E-03	6.67E-03	6.62E-03	6.71E-03	6.86E-03	4.02E-04
		Sum of VOCs	7.34E-04	6.50E-04	3.44E-04	6.33E-04	5.15E-04	3.91E-04	5.44E-04	1.55E-04
		Sum of HAPs	7.34E-04	6.50E-04	3.44E-04	6.33E-04	5.15E-04	3.91E-04	5.44E-04	1.55E-04
		Sum of POMs	3.24E-04	2.65E-04	3.03E-04	2.39E-04	2.01E-04	1.96E-04	2.55E-04	5.26E-05
			Individual HAPs and VOCs							
x		**Phenol**	3.65E-04	3.42E-04	I	3.46E-04	2.71E-04	1.51E-04	2.95E-04	8.79E-05
x	z	**Naphthalene**	1.35E-04	1.55E-04	1.18E-04	1.28E-04	1.15E-04	1.28E-04	1.30E-04	1.42E-05
x	z	**1-Methylnaphthalene**	1.90E-04	1.10E-04	1.85E-04	1.11E-04	8.54E-05	6.86E-05	1.25E-04	5.10E-05
x		**Formaldehyde**	4.53E-05	4.41E-05	4.06E-05	4.75E-05	4.37E-05	4.30E-05	4.40E-05	2.29E-06
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA

Storage

HAPs	POMs	Compound/Sample Number	EY301	EY302	EY303	EY304	EY305	EY306	Average	STDEV
		Test Dates	**2/19/03**	**2/19/03**	**2/20/03**	**2/20/03**	**2/24/03**	**2/24/03**		
		TGOC as Propane	1.24E-02	1.15E-02	1.12E-02	1.28E-02	1.12E-02	1.16E-02	1.18E-02	6.60E-04
		HC as Hexane	1.23E-02	1.44E-02	1.51E-02	1.45E-02	1.10E-02	1.01E-02	1.29E-02	2.08E-03
		Sum of VOCs	4.50E-04	1.96E-03	2.82E-03	2.28E-03	6.77E-04	2.33E-03	1.75E-03	9.63E-04
		Sum of HAPs	4.50E-04	1.96E-03	2.82E-03	2.28E-03	6.77E-04	2.33E-03	1.75E-03	9.63E-04
		Sum of POMs	I	1.66E-03	2.53E-03	1.97E-03	I	2.14E-03	2.07E-03	3.59E-04
			Individual HAPs and VOCs							
x	z	**1-Methylnaphthalene**	I	1.30E-03	2.16E-03	1.56E-03	I	1.87E-03	1.72E-03	3.74E-04
x	z	**Naphthalene**	3.76E-04	3.66E-04	3.68E-04	4.15E-04	3.90E-04	2.65E-04	3.63E-04	5.16E-05
x		**Phenol**	NA	2.23E-04	2.06E-04	2.16E-04	2.06E-04	1.50E-04	2.00E-04	2.91E-05
x		**Formaldehyde**	7.37E-05	7.82E-05	8.27E-05	9.21E-05	8.14E-05	4.31E-05	7.52E-05	1.69E-05
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA

ND: Non Detect**; NA:** Not Applicable **I:** Data rejected based on data validation considerations.

Individual Mold Making Results for Test EY – Lb/Tn Sand

Mix, Make, Cure

HAPs	POMs	Compound/Sample Number	EY101	EY102	EY103	EY104	EY105	EY106	Average	STDEV
		Test Dates	**2/19/03**	**2/19/03**	**2/20/03**	**2/20/03**	**2/24/03**	**2/24/03**		
		TGOC as Propane	1.88E-01	1.81E-01	1.63E-01	1.91E-01	1.68E-01	1.78E-01	1.78E-01	1.09E-02
		HC as Hexane	1.88E-01	1.89E-01	1.65E-01	1.71E-01	1.71E-01	1.73E-01	1.76E-01	9.96E-03
		Sum of VOCs	1.88E-02	1.66E-02	8.82E-03	1.62E-02	1.33E-02	1.01E-02	1.40E-02	3.95E-03
		Sum of HAPs	1.88E-02	1.66E-02	8.82E-03	1.62E-02	1.33E-02	1.01E-02	1.40E-02	3.95E-03
		Sum of POMs	8.31E-03	6.77E-03	7.78E-03	6.14E-03	5.17E-03	5.07E-03	6.54E-03	1.34E-03
			Individual HAPs and VOCs							
x		**Phenol**	9.35E-03	8.74E-03	I	8.87E-03	6.97E-03	3.90E-03	7.57E-03	2.24E-03
x	z	**Naphthalene**	3.45E-03	3.96E-03	3.02E-03	3.29E-03	2.97E-03	3.30E-03	3.33E-03	3.57E-04
x	z	**1-Methylnaphthalene**	4.86E-03	2.82E-03	4.76E-03	2.85E-03	2.20E-03	1.77E-03	3.21E-03	1.30E-03
x		**Formaldehyde**	1.16E-03	1.13E-03	1.04E-03	1.22E-03	1.13E-03	1.11E-03	1.13E-03	5.75E-05
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA

Storage

HAPs	POMs	Compound/Sample Number	EY301	EY302	EY303	EY304	EY305	EY306	Average	STDEV
		Test Dates	**2/19/03**	**2/19/03**	**2/20/03**	**2/20/03**	**2/24/03**	**2/24/03**		
		TGOC as Propane	3.18E-01	2.94E-01	2.86E-01	3.27E-01	2.89E-01	2.98E-01	3.02E-01	1.65E-02
		HC as Hexane	3.15E-01	3.70E-01	3.89E-01	3.71E-01	2.84E-01	2.60E-01	3.32E-01	5.29E-02
		Sum of VOCs	1.15E-02	5.04E-02	7.23E-02	5.85E-02	1.74E-02	5.99E-02	4.50E-02	2.47E-02
		Sum of HAPs	1.15E-02	5.04E-02	7.23E-02	5.85E-02	1.74E-02	5.99E-02	4.50E-02	2.47E-02
		Sum of POMs	I	4.27E-02	6.49E-02	5.06E-02	I	5.49E-02	5.33E-02	9.27E-03
			Individual HAPs and VOCs							
x	z	**1-Methylnaphthalene**	I	3.33E-02	5.54E-02	4.00E-02	I	4.81E-02	4.42E-02	9.65E-03
x	z	**Naphthalene**	9.64E-03	9.40E-03	9.45E-03	1.06E-02	1.00E-02	6.81E-03	9.33E-03	1.32E-03
x		**Phenol**	I	5.72E-03	5.30E-03	5.54E-03	5.30E-03	3.85E-03	5.14E-03	7.43E-04
x		**Formaldehyde**	1.89E-03	2.01E-03	2.13E-03	2.36E-03	2.10E-03	1.11E-03	1.93E-03	4.32E-04
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	NA

I: Data rejected based on data validation considerations.

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

Individual Mold Making Results for Test GI – Lb/Lb Binder

Mix, Make, Cure

HAPs	POMs	Compound/Sample Number	GI201	GI202	GI203	GI204	GI205	GI206	Average	STDEV
		Test Dates	**10/11/04**	**10/11/04**	**10/12/04**	**10/12/04**	**10/13/04**	**10/13/04**		
		TGOC as Propane	2.14E-03	2.59E-03	2.25E-03	1.98E-03	2.56E-03	2.24E-03	2.29E-03	2.38E-04
		HC as Hexane	1.20E-03	1.69E-03	1.24E-03	1.19E-03	1.54E-03	1.39E-03	1.37E-03	2.05E-04
		Sum of Target Analytes	3.06E-03	3.59E-03	3.64E-03	3.12E-03	4.25E-03	3.70E-03	3.56E-03	4.35E-04
		Sum of HAPs	2.53E-05	2.30E-05	2.89E-05	2.81E-05	3.37E-05	3.19E-05	2.85E-05	3.98E-06
			Individual Organic HAPs and VOCs							
x		**Formaldehyde**	2.53E-05	2.30E-05	2.89E-05	2.81E-05	3.37E-05	3.19E-05	2.85E-05	3.98E-06
x		**Phenol**	ND	ND	ND	ND	ND	ND	ND	NA
		Furfuryl Alcohol	2.92E-03	3.43E-03	3.48E-03	2.98E-03	4.08E-03	3.55E-03	3.41E-03	4.25E-04
		Furfural	1.20E-04	1.31E-04	1.32E-04	1.08E-04	1.37E-04	1.15E-04	1.24E-04	1.12E-05

Storage

HAPs	POMs	Compound/Sample Number	GI301	GI302	GI303	GI304	GI305	GI306	Average	STDEV
		Test Dates	**10/11/04**	**10/11/04**	**10/12/04**	**10/12/04**	**10/13/04**	**10/13/04**		
		TGOC as Propane	4.79E-04	3.52E-04	5.11E-04	5.45E-04	0.00E+00	2.70E-04	3.59E-04	2.04E-04
		HC as Hexane	2.96E-04	2.60E-04	2.84E-04	3.32E-04	2.84E-04	2.78E-04	2.89E-04	2.42E-05
		Sum of Target Analytes	2.85E-04	1.99E-04	2.36E-04	2.53E-04	2.67E-04	2.21E-04	2.44E-04	3.11E-05
		Sum of HAPs	2.30E-05	7.44E-06	1.18E-05	1.07E-05	1.44E-05	1.40E-05	1.35E-05	5.26E-06
			Individual Organic HAPs and VOCs							
x		**Formaldehyde**	2.30E-05	7.44E-06	1.18E-05	1.07E-05	1.44E-05	1.40E-05	1.35E-05	5.26E-06
x		**Phenol**	ND	ND	ND	ND	ND	ND	ND	NA
		Furfuryl Alcohol	2.62E-04	1.92E-04	2.25E-04	2.42E-04	2.52E-04	2.07E-04	2.30E-04	2.71E-05
		Furfural	ND	ND	ND	ND	ND	ND	ND	NA

ND: Non Detect; NA: Not Applicable

Individual Mold Making Results for Test GI – Lb/Tn Sand

Mix, Make, Cure

HAPs	Compound/Sample Number	GI201	GI202	GI203	GI204	GI205	GI206	Average	STDEV
	Test Dates	**10/11/04**	**10/11/04**	**10/12/04**	**10/12/04**	**10/13/04**	**10/13/04**		
	TGOC as Propane	6.11E-02	6.61E-02	5.79E-02	5.11E-02	6.61E-02	5.80E-02	6.01E-02	5.70E-03
	HC as Hexane	3.42E-02	4.31E-02	3.19E-02	3.08E-02	3.99E-02	3.60E-02	3.60E-02	4.75E-03
	Sum of Target Analytes	8.76E-02	9.17E-02	9.39E-02	8.05E-02	1.10E-01	9.56E-02	9.32E-02	9.80E-03
	Sum of HAPs	7.24E-04	5.87E-04	7.46E-04	7.25E-04	8.71E-04	8.23E-04	7.46E-04	9.78E-05
		Individual Organic HAPs and VOCs							
x	**Formaldehyde**	7.24E-04	5.87E-04	7.46E-04	7.25E-04	8.71E-04	8.23E-04	7.46E-04	9.78E-05
x	**Phenol**	ND	ND	ND	ND	ND	ND	ND	NA
	Furfuryl Alcohol	8.34E-02	8.77E-02	8.98E-02	7.69E-02	1.05E-01	9.18E-02	8.92E-02	9.56E-03
	Furfural	3.42E-03	3.36E-03	3.39E-03	2.80E-03	3.54E-03	2.97E-03	3.25E-03	2.93E-04

Storage

HAPs	Compound/Sample Number	GI301	GI302	GI303	GI304	GI305	GI306	Average	STDEV
	Test Dates	**10/11/04**	**10/11/04**	**10/12/04**	**10/12/04**	**10/13/04**	**10/13/04**		
	TGOC as Propane	1.37E-02	8.98E-03	1.32E-02	1.41E-02	0.00E+00	6.98E-03	9.48E-03	5.45E-03
	HC as Hexane	8.46E-03	6.64E-03	7.31E-03	8.57E-03	7.33E-03	7.17E-03	7.58E-03	7.65E-04
	Sum of Target Analytes	7.69E-03	5.09E-03	6.10E-03	6.52E-03	6.89E-03	5.72E-03	6.33E-03	9.14E-04
	Sum of HAPs	2.01E-04	1.90E-04	3.05E-04	2.76E-04	3.71E-04	3.62E-04	2.84E-04	7.72E-05
		Individual Organic HAPs and VOCs							
x	**Formaldehyde**	2.01E-04	1.90E-04	3.05E-04	2.76E-04	3.71E-04	3.62E-04	2.84E-04	7.72E-05
x	**Phenol**	ND	ND	ND	ND	ND	ND	ND	NA
	Furfuryl Alcohol	7.49E-03	4.90E-03	5.79E-03	6.24E-03	6.52E-03	5.36E-03	6.05E-03	9.18E-04
	Furfural	ND	ND	ND	ND	ND	ND	ND	NA

ND: Non Detect; NA: Not Applicable

Test Plan FL Individual PCS Emissions Results – Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FL001	FL002	FL003	FL004	FL005	FL006	FL007	FL008	FL009	Average	STDEV
		Test Dates	**10/06/03**	**10/06/03**	**10/06/03**	**10/07/03**	**10/07/03**	**10/07/03**	**10/08/03**	**10/08/03**	**10/08/03**		
		TGOC as Propane	2.17E-01	2.24E-01	2.14E-01	2.08E-01	2.12E-01	2.07E-01	1.93E-01	2.06E-01	2.04E-01	2.09E-01	8.58E-03
		HC as Hexane	I	8.22E-02	6.80E-02	6.35E-02	6.44E-02	I	5.87E-02	6.39E-02	6.85E-02	6.70E-02	7.45E-03
		Sum of VOCs	I	4.67E-02	4.34E-02	3.85E-02	5.73E-02	3.63E-02	3.94E-02	3.90E-02	4.14E-02	4.28E-02	6.69E-03
		Sum of HAPs	I	3.23E-02	3.05E-02	2.71E-02	4.04E-02	2.41E-02	2.74E-02	3.20E-02	2.87E-02	3.03E-02	4.92E-03
		Sum of POMs	I	8.10E-04	6.89E-04	5.82E-04	8.51E-04	5.85E-04	6.43E-04	7.94E-04	6.48E-04	7.00E-04	1.05E-04
		Individual Organic HAPs											
x		**m,p-Cresol**	I	1.50E-02	1.43E-02	1.24E-02	1.87E-02	1.33E-02	1.26E-02	1.47E-02	1.35E-02	1.43E-02	2.02E-03
x		**Phenol**	I	9.22E-03	8.59E-03	7.65E-03	1.19E-02	8.03E-03	7.55E-03	9.38E-03	8.00E-03	8.78E-03	1.42E-03
x		**Benzene**	4.32E-03	4.30E-03	4.23E-03	3.94E-03	5.61E-03	I	4.09E-03	4.35E-03	4.05E-03	4.36E-03	5.25E-04
x		**Toluene**	8.88E-04	9.84E-04	9.50E-04	9.37E-04	1.27E-03	8.64E-04	9.31E-04	1.00E-03	9.59E-04	9.76E-04	1.18E-04
x		**m,p-Xylene**	I	5.92E-04	5.76E-04	5.63E-04	7.72E-04	5.30E-04	5.58E-04	6.11E-04	5.80E-04	5.98E-04	7.45E-05
x		**o-Cresol**	I	6.91E-04	5.01E-04	4.95E-04	6.77E-04	4.40E-04	5.09E-04	4.97E-04	5.00E-04	5.39E-04	9.24E-05
x	z	**Naphthalene**	I	4.31E-04	3.84E-04	3.22E-04	4.83E-04	3.34E-04	3.46E-04	4.22E-04	3.60E-04	3.85E-04	5.59E-05
x		**Formaldehyde**	1.89E-04	2.87E-04	2.44E-04	2.06E-04	1.98E-04	I	1.76E-04	2.30E-04	1.76E-04	2.13E-04	3.84E-05
x	z	**2-Methylnaphthalene**	8.63E-05	2.32E-04	1.89E-04	1.61E-04	2.28E-04	1.56E-04	1.86E-04	2.28E-04	1.78E-04	1.83E-04	4.63E-05
x		**o-Xylene**	I	1.79E-04	1.75E-04	1.67E-04	2.35E-04	1.64E-04	1.67E-04	1.84E-04	1.73E-04	1.80E-04	2.29E-05
x		**Styrene**	I	1.00E-04	9.73E-05	9.08E-05	1.40E-04	9.86E-05	9.37E-05	1.10E-04	9.02E-05	1.03E-04	1.64E-05
x	z	**1-Methylnaphthalene**	4.49E-05	1.04E-04	8.56E-05	7.22E-05	1.02E-04	7.03E-05	7.98E-05	1.03E-04	8.06E-05	8.25E-05	1.92E-05
x		**Acetaldehyde**	4.54E-05	6.48E-05	5.66E-05	4.76E-05	4.29E-05	I	4.32E-05	5.07E-05	4.39E-05	4.94E-05	7.74E-06
x		**Ethylbenzene**	3.76E-05	4.15E-05	4.03E-05	4.00E-05	5.44E-05	3.89E-05	4.09E-05	4.61E-05	3.92E-05	4.21E-05	5.18E-06
x	z	**1,3-Dimethylnaphthalene**	1.90E-05	4.23E-05	3.08E-05	2.73E-05	3.74E-05	2.50E-05	3.16E-05	4.18E-05	2.97E-05	3.16E-05	7.72E-06
x		**Acrolein**	6.59E-06	1.43E-05	1.11E-05	9.14E-06	8.16E-06	I	8.70E-06	1.13E-05	9.99E-06	9.90E-06	2.34E-06
x		**2-Butanone**	6.48E-06	7.59E-06	7.37E-06	6.55E-06	5.75E-06	I	ND	5.42E-06	ND	4.89E-06	3.11E-06
x		**Propionaldehyde**	ND	5.65E-06	4.92E-06	ND	ND	I	ND	ND	ND	1.32E-06	2.45E-06
x	z	**Acenaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Biphenyl**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,7-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Hexane**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FL Individual PCS Emissions Results – Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FL001	FL002	FL003	FL004	FL005	FL006	FL007	FL008	FL009	Average	STDEV
		Test Dates	10/06/03	10/06/03	10/06/03	10/07/03	10/07/03	10/07/03	10/08/03	10/08/03	10/08/03		
			Other VOCs										
		Dodecane	3.26E-03	7.45E-03	6.57E-03	5.40E-03	8.07E-03	5.62E-03	5.82E-03	I	6.09E-03	6.04E-03	1.45E-03
		1,2,3-Trimethylbenzene	I	2.17E-03	2.10E-03	1.84E-03	2.77E-03	1.99E-03	1.84E-03	2.12E-03	1.98E-03	2.10E-03	2.95E-04
		1,3-Diethylbenzene	I	1.42E-03	1.35E-03	1.30E-03	1.78E-03	1.35E-03	1.35E-03	1.35E-03	1.37E-03	1.41E-03	1.53E-04
		1,2,4-Trimethylbenzene	I	1.20E-03	1.18E-03	1.03E-03	1.53E-03	1.12E-03	1.04E-03	1.23E-03	1.12E-03	1.18E-03	1.57E-04
		Indan	I	8.56E-04	8.20E-04	7.16E-04	1.09E-03	7.68E-04	7.08E-04	8.24E-04	7.62E-04	8.17E-04	1.21E-04
		2,4-Dimethylphenol	1.98E-04	3.31E-04	I	3.94E-04	7.64E-04	5.62E-04	5.25E-04	5.88E-04	5.07E-04	4.84E-04	1.73E-04
		Butyraldehyde/Methacrolein	2.75E-04	4.38E-04	3.69E-04	2.94E-04	2.57E-04	4.59E-04	3.14E-04	3.59E-04	3.34E-04	3.44E-04	6.96E-05
		3-Ethyltoluene	I	8.29E-05	8.04E-05	7.09E-05	1.02E-04	7.74E-05	7.18E-05	8.37E-05	7.39E-05	8.04E-05	9.93E-06
		Indene	I	5.95E-05	1.85E-04	1.08E-04	1.86E-04	1.26E-04	1.23E-04	1.97E-04	1.58E-04	1.43E-04	4.73E-05
		2-Ethyltoluene	I	8.00E-05	7.58E-05	6.51E-05	1.02E-04	7.39E-05	6.52E-05	7.84E-05	6.76E-05	7.60E-05	1.21E-05
		Tetradecane	I	7.53E-05	6.64E-05	5.24E-05	7.20E-05	5.11E-05	5.85E-05	7.52E-05	5.48E-05	6.32E-05	1.02E-05
		Decane	I	4.85E-05	4.72E-05	4.07E-05	6.08E-05	4.37E-05	3.89E-05	4.58E-05	4.30E-05	4.61E-05	6.77E-06
		Benzaldehyde	3.24E-05	5.03E-05	4.07E-05	3.00E-05	2.79E-05	I	3.27E-05	3.72E-05	3.43E-05	3.57E-05	7.10E-06
		o,m,p-Tolualdehyde	3.00E-05	4.50E-05	4.70E-05	2.96E-05	2.48E-05	I	2.97E-05	3.50E-05	3.37E-05	3.43E-05	7.82E-06
		Pentanal	2.85E-05	4.46E-05	3.51E-05	2.83E-05	2.43E-05	I	3.13E-05	3.26E-05	3.51E-05	3.25E-05	6.12E-06
		Hexaldehyde	I	1.87E-05	1.83E-05	1.11E-05	9.05E-06	2.50E-05	1.13E-05	1.44E-05	1.25E-05	1.50E-05	5.28E-06
		Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	I	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Heptane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Undecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FL Individual PCS Emissions Results – Lb/Lb Binder

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FL001	FL002	FL003	FL004	FL005	FL006	FL007	FL008	FL009	Average	STDEV
		Test Dates	**10/06/03**	**10/06/03**	**10/06/03**	**10/07/03**	**10/07/03**	**10/07/03**	**10/08/03**	**10/08/03**	**10/08/03**		
		Other Analytes											
		Acetone	4.33E-05	3.93E-05	4.48E-05	3.35E-05	3.32E-05	4.08E-05	4.93E-05	3.04E-05	3.36E-05	3.87E-05	6.41E-06
		Carbon Dioxide	6.20E-01	5.53E-01	5.76E-01	5.52E-01	5.41E-01	5.29E-01	5.63E-01	5.38E-01	5.39E-01	5.57E-01	2.77E-02
		Carbon Monoxide	1.03E-02	ND	ND	ND	ND	ND	ND	ND	ND	1.15E-03	3.45E-03
		Methane	1.29E-03	1.01E-03	1.15E-03	1.05E-03	1.01E-03	9.86E-04	1.02E-03	9.03E-04	9.31E-04	1.04E-03	1.17E-04
		Ethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Butane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Neopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Pentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

I: Data rejected based on data validation considerations.

ND: Non Detect; NA: Not Applicable

Test Plan FL Individual PCS Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FL001	FL002	FL003	FL004	FL005	FL006	FL007	FL008	FL009	Average	STDEV
		Test Dates	**10/06/03**	**10/06/03**	**10/06/03**	**10/07/03**	**10/07/03**	**10/07/03**	**10/08/03**	**10/08/03**	**10/08/03**		
		TGOC as Propane	1.29E+01	1.30E+01	1.30E+01	1.30E+01	1.26E+01	1.29E+01	1.17E+01	1.25E+01	1.25E+01	1.27E+01	4.19E-01
		HC as Hexane	I	4.78E+00	4.12E+00	3.95E+00	3.84E+00	I	3.55E+00	3.87E+00	4.18E+00	4.04E+00	3.85E-01
		Sum of VOCs	I	2.71E+00	2.63E+00	2.40E+00	2.62E+00	2.26E+00	2.39E+00	2.36E+00	2.53E+00	2.49E+00	1.57E-01
		Sum of HAPs	I	1.87E+00	1.85E+00	1.69E+00	1.85E+00	1.50E+00	1.66E+00	1.93E+00	1.76E+00	1.76E+00	1.42E-01
		Sum of POMs	I	4.09E-02	4.18E-02	3.63E-02	3.87E-02	3.64E-02	3.89E-02	4.81E-02	3.96E-02	4.01E-02	3.77E-03
		Individual Organic HAPs											
x		**m,p-Cresol**	I	8.71E-01	8.66E-01	7.72E-01	8.52E-01	8.28E-01	7.60E-01	8.90E-01	8.22E-01	8.33E-01	4.67E-02
x		**Phenol**	I	5.36E-01	5.21E-01	4.76E-01	5.40E-01	4.99E-01	4.57E-01	5.68E-01	4.89E-01	5.11E-01	3.69E-02
x		**Benzene**	I	2.50E-01	2.56E-01	2.45E-01	2.55E-01	I	2.47E-01	2.63E-01	2.47E-01	2.52E-01	6.36E-03
x		**Toluene**	I	5.72E-02	5.76E-02	5.84E-02	5.77E-02	5.37E-02	5.63E-02	6.05E-02	5.86E-02	5.75E-02	1.97E-03
x		**o-Cresol**	I	4.10E-02	3.19E-02	3.15E-02	3.25E-02	2.84E-02	3.17E-02	3.15E-02	3.25E-02	3.26E-02	3.63E-03
x		**m,p-Xylene**	I	3.44E-02	3.49E-02	3.51E-02	3.51E-02	3.29E-02	3.38E-02	3.70E-02	3.55E-02	3.48E-02	1.20E-03
x	z	**Naphthalene**	I	2.51E-02	2.33E-02	2.00E-02	2.20E-02	2.08E-02	2.09E-02	2.55E-02	2.20E-02	2.24E-02	2.01E-03
x		**Formaldehyde**	1.13E-02	1.67E-02	1.48E-02	1.28E-02	1.18E-02	I	1.06E-02	1.39E-02	1.08E-02	1.28E-02	2.15E-03
x	z	**2-Methylnaphthalene**	I	9.93E-03	1.15E-02	1.00E-02	1.04E-02	9.70E-03	1.13E-02	1.38E-02	1.09E-02	1.09E-02	1.33E-03
x		**o-Xylene**	I	1.04E-02	1.06E-02	1.04E-02	1.07E-02	1.02E-02	1.01E-02	1.11E-02	1.06E-02	1.05E-02	3.19E-04
x		**Styrene**	I	5.84E-03	5.90E-03	5.66E-03	6.38E-03	6.13E-03	5.67E-03	6.67E-03	5.51E-03	5.97E-03	3.95E-04
x	z	**1-Methylnaphthalene**	I	4.41E-03	5.19E-03	4.50E-03	4.65E-03	4.37E-03	4.83E-03	6.23E-03	4.93E-03	4.89E-03	6.09E-04
x		**Acetaldehyde**	2.70E-03	3.76E-03	3.43E-03	2.97E-03	2.56E-03	I	2.61E-03	3.07E-03	2.68E-03	2.97E-03	4.31E-04
x		**Ethylbenzene**	I	2.41E-03	2.45E-03	2.49E-03	2.47E-03	2.41E-03	2.47E-03	I	2.40E-03	2.44E-03	3.77E-05
x	z	**1,3-Dimethylnaphthalene**	I	1.55E-03	1.87E-03	1.70E-03	1.70E-03	1.55E-03	1.91E-03	2.53E-03	1.81E-03	1.83E-03	3.14E-04
x		**Acrolein**	3.92E-04	8.29E-04	6.72E-04	5.69E-04	4.87E-04	I	5.27E-04	6.82E-04	6.10E-04	5.96E-04	1.35E-04
x		**2-Butanone**	3.86E-04	4.41E-04	4.47E-04	4.08E-04	3.43E-04	I	ND	3.28E-04	ND	2.94E-04	1.86E-04
x		**Propionaldehyde**	ND	3.28E-04	2.98E-04	ND	ND	I	ND	ND	ND	7.83E-05	1.45E-04
x	z	**1,2-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,6-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,7-Dimethylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**Acenaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Biphenyl**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Hexane**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Aniline**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**N,N-Dimethylaniline**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan FL Individual PCS Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FL001	FL002	FL003	FL004	FL005	FL006	FL007	FL008	FL009	Average	STDEV
		Test Dates	**10/06/03**	**10/06/03**	**10/06/03**	**10/07/03**	**10/07/03**	**10/07/03**	**10/08/03**	**10/08/03**	**10/08/03**		
		Other VOCs											
		Dodecane	1.94E-01	4.33E-01	3.98E-01	3.37E-01	3.67E-01	3.49E-01	3.52E-01	I	3.72E-01	3.50E-01	7.02E-02
		1,2,3-Trimethylbenzene	I	1.26E-01	1.27E-01	1.15E-01	1.26E-01	1.24E-01	1.11E-01	1.28E-01	1.21E-01	1.22E-01	6.17E-03
		1,3-Diethylbenzene	I	8.23E-02	8.20E-02	8.09E-02	8.09E-02	8.38E-02	8.19E-02	8.17E-02	8.38E-02	8.22E-02	1.13E-03
		1,2,4-Trimethylbenzene	I	6.99E-02	7.18E-02	6.45E-02	6.97E-02	6.99E-02	6.32E-02	7.42E-02	6.82E-02	6.89E-02	3.62E-03
		Indan	I	4.97E-02	4.97E-02	4.46E-02	4.95E-02	4.77E-02	4.29E-02	4.98E-02	4.66E-02	4.76E-02	2.68E-03
		2,4-Dimethylphenol	I	1.93E-02	I	2.45E-02	3.47E-02	3.49E-02	3.18E-02	3.56E-02	3.10E-02	3.03E-02	6.15E-03
		Butyraldehyde/Methacrolien	1.63E-02	2.55E-02	2.23E-02	1.83E-02	1.53E-02	2.85E-02	1.90E-02	2.17E-02	2.04E-02	2.08E-02	4.24E-03
		Indene	I	3.46E-03	1.12E-02	6.71E-03	8.44E-03	7.82E-03	7.44E-03	1.19E-02	9.66E-03	8.34E-03	2.69E-03
		3-Ethyltoluene	I	4.82E-03	4.87E-03	4.42E-03	4.63E-03	4.81E-03	4.35E-03	5.06E-03	4.52E-03	4.69E-03	2.47E-04
		2-Ethyltoluene	I	4.65E-03	4.59E-03	4.05E-03	4.65E-03	4.59E-03	3.94E-03	4.75E-03	4.13E-03	4.42E-03	3.20E-04
		Tetradecane	I	4.38E-03	4.02E-03	3.26E-03	3.28E-03	3.17E-03	3.54E-03	4.55E-03	3.35E-03	3.69E-03	5.45E-04
		Decane	I	2.82E-03	2.86E-03	2.53E-03	2.77E-03	2.71E-03	2.35E-03	2.77E-03	2.63E-03	2.68E-03	1.68E-04
		Benzaldehyde	1.93E-03	2.92E-03	2.46E-03	1.87E-03	1.67E-03	I	1.98E-03	2.25E-03	2.10E-03	2.15E-03	3.96E-04
		o,m,p-Tolualdehyde	1.79E-03	2.62E-03	2.85E-03	1.84E-03	1.48E-03	I	1.79E-03	2.12E-03	2.06E-03	2.07E-03	4.57E-04
		Pentanal	1.70E-03	2.59E-03	2.13E-03	1.76E-03	1.45E-03	I	1.89E-03	1.97E-03	2.14E-03	1.95E-03	3.45E-04
		Hexaldehyde	I	1.09E-03	1.11E-03	6.92E-04	5.40E-04	1.55E-03	6.81E-04	8.70E-04	7.61E-04	9.11E-04	3.25E-04
		1,3,5-Trimethylbenzene	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,6-Dimethylphenol	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Heptane	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Nonane	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Undecane	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Crotonaldehyde	ND	ND	ND	ND	ND	ND	ND	ND	I	ND	NA

Test Plan FL Individual PCS Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	FL001	FL002	FL003	FL004	FL005	FL006	FL007	FL008	FL009	Average	STDEV
		Test Dates	**10/06/03**	**10/06/03**	**10/06/03**	**10/07/03**	**10/07/03**	**10/07/03**	**10/08/03**	**10/08/03**	**10/08/03**		
		Other Analytes											
		Acetone	2.58E-03	2.28E-03	2.71E-03	2.09E-03	1.98E-03	2.53E-03	2.99E-03	1.84E-03	2.05E-03	2.34E-03	3.84E-04
		Carbon Dioxide	3.69E+01	3.21E+01	3.49E+01	3.44E+01	3.23E+01	3.29E+01	3.41E+01	3.26E+01	3.29E+01	3.37E+01	1.55E+00
		Carbon Monoxide	6.15E-01	ND	ND	ND	ND	ND	ND	ND	ND	6.83E-02	2.05E-01
		Methane	7.67E-02	5.85E-02	6.95E-02	6.57E-02	6.02E-02	6.13E-02	6.19E-02	5.46E-02	5.69E-02	6.28E-02	6.85E-03
		Ethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isobutane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Butane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Neopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Isopentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Pentane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

I: Data rejected based on data validation considerations.

ND: Non Detect; NA: Not Applicable

Test Plan GI Individual PCS Emission Test Results – Lb/Lb Binder

HAPs	POMs	Compound/Sample Number	GI001	GI002	GI003	GI004	GI005	GI006	GI007	GI008	GI009	Average	STDEV
		Test Dates	**10/19/04**	**10/19/04**	**10/19/04**	**10/20/04**	**10/21/04**	**10/21/04**	**10/21/04**	**10/22/04**	**10/22/04**		
		TGOC as Propane	I	I	I	2.20E-02	2.47E-02	2.22E-02	2.34E-02	2.45E-02	2.35E-02	2.34E-02	1.11E-03
		HC as Hexane	1.32E-02	1.47E-02	1.21E-02	1.26E-02	9.61E-03	1.38E-02	1.49E-02	5.34E-02	1.44E-02	1.76E-02	1.35E-02
		Sum of Target Analytes	1.27E-02	1.58E-02	9.83E-03	9.78E-03	9.08E-03	9.00E-03	1.38E-02	3.20E-02	1.37E-02	1.40E-02	7.20E-03
		Sum of HAPs	1.26E-02	1.57E-02	9.75E-03	9.65E-03	8.92E-03	8.85E-03	1.36E-02	3.17E-02	1.35E-02	1.38E-02	7.13E-03
		Sum of POMs	3.58E-05	4.18E-05	3.39E-05	4.55E-05	2.90E-05	I	4.19E-05	1.91E-04	3.81E-05	5.71E-05	5.43E-05
			Individual Target HAPs										
x		**Benzene**	5.13E-03	6.25E-03	2.30E-03	1.85E-03	2.44E-03	3.47E-03	5.28E-03	2.69E-02	5.18E-03	6.54E-03	7.81E-03
x		**Toluene**	6.28E-03	8.05E-03	6.34E-03	6.49E-03	5.20E-03	4.44E-03	7.05E-03	I	6.94E-03	6.35E-03	1.12E-03
x		**Acetaldehyde***	4.53E-04	4.94E-04	4.37E-04	3.85E-04	5.13E-04	5.03E-04	4.66E-04	1.59E-03	5.28E-04	5.97E-04	3.76E-04
x		**Phenol**	2.56E-04	2.74E-04	2.34E-04	3.42E-04	2.94E-04	1.60E-04	2.91E-04	1.35E-03	2.95E-04	3.88E-04	3.63E-04
x		**Formaldehyde***	1.62E-04	2.31E-04	1.38E-04	1.58E-04	1.97E-04	1.63E-04	1.62E-04	6.95E-04	1.79E-04	2.32E-04	1.76E-04
x		**m,p-Cresol**	6.17E-05	8.22E-05	7.78E-05	1.17E-04	8.57E-05	I	9.76E-05	4.58E-04	9.82E-05	1.35E-04	1.32E-04
x		**m,p-Xylene**	1.15E-04	1.40E-04	1.11E-04	1.20E-04	8.45E-05	7.47E-05	1.29E-04	I	1.27E-04	1.13E-04	2.24E-05
x	z	**Naphthalene**	3.58E-05	4.18E-05	3.39E-05	4.55E-05	2.90E-05	I	4.19E-05	1.91E-04	3.81E-05	5.71E-05	5.43E-05
x		**o-Xylene**	3.06E-05	4.02E-05	3.30E-05	3.75E-05	3.06E-05	I	3.62E-05	1.77E-04	3.78E-05	5.29E-05	5.03E-05
x		**Styrene**	1.61E-05	2.04E-05	1.61E-05	1.81E-05	1.51E-05	9.96E-06	1.99E-05	8.62E-05	1.81E-05	2.44E-05	2.34E-05
x		**Ethylbenzene**	1.96E-05	2.41E-05	1.86E-05	2.17E-05	1.68E-05	1.76E-05	2.37E-05	I	2.27E-05	2.06E-05	2.80E-06
x		**o-Cresol**	ND	ND	ND	2.50E-05	1.80E-05	ND	2.15E-05	9.15E-05	2.03E-05	1.96E-05	2.90E-05
x		**Biphenyl**	ND	ND	ND	2.17E-05	ND	ND	1.82E-05	8.63E-05	ND	1.40E-05	2.85E-05
x		**Propionaldehyde**	5.69E-06	4.86E-06	5.34E-06	6.53E-06	4.45E-06	6.91E-06	5.30E-06	2.09E-05	5.89E-06	7.32E-06	5.15E-06
x		**2-Butanone**	6.45E-06	2.83E-06	7.43E-06	I	ND	5.39E-06	4.54E-06	ND	4.17E-06	3.85E-06	2.76E-06
x	z	**1,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**Acenaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,7-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Hexane**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Acrolein**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan GI Individual PCS Emissions Test Results – Lb/Lb Binder

HAP	POM	Compound/Sample Number	GI001	GI002	GI003	GI004	GI005	GI006	GI007	GI008	GI009	Average	STDEV
		Test Dates	10/19/04	10/19/04	10/19/04	10/20/04	10/21/04	10/21/04	10/21/04	10/22/04	10/22/04		
			Other VOCs										
		Benzaldehyde	4.73E-05	4.68E-05	4.52E-05	4.44E-05	5.52E-05	5.67E-05	5.79E-05	1.92E-04	5.84E-05	6.71E-05	4.73E-05
		o,m,p-Tolualdehyde	7.14E-05	6.25E-05	I	5.83E-05	7.04E-05	6.27E-05	6.17E-05	6.05E-05	6.55E-05	6.41E-05	4.66E-06
		Pentanal	2.09E-05	2.10E-05	1.76E-05	1.92E-05	1.87E-05	1.92E-05	1.88E-05	6.36E-05	2.01E-05	2.44E-05	1.48E-05
		Butyraldehyde/Methacrolein	8.20E-06	6.73E-06	7.56E-06	6.45E-06	6.53E-06	6.85E-06	6.91E-06	2.17E-05	7.53E-06	8.72E-06	4.91E-06
		Crotonaldehyde	2.93E-06	I	2.05E-06	2.46E-06	2.49E-06	2.01E-06	2.66E-06	7.55E-06	2.92E-06	3.13E-06	1.82E-06
		Hexaldehyde	5.07E-06	3.91E-06	ND	ND	2.39E-06	ND	ND	ND	ND	1.26E-06	2.01E-06
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,3-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2-Ethyltoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		3-Ethyltoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Heptane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Tetradecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Undecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan GI Individual PCS Emissions Test Results – Lb/Lb Binder

HAP	POM	Compound/Sample Number	GI001	GI002	GI003	GI004	GI005	GI006	GI007	GI008	GI009	Average	STDEV
		Test Dates	10/19/04	10/19/04	10/19/04	10/20/04	10/21/04	10/21/04	10/21/04	10/22/04	10/22/04		
			Other Analytes										
		Acetone	2.29E-04	1.69E-04	2.26E-04	1.18E-04	8.63E-05	1.37E-04	1.81E-04	4.21E-04	1.78E-04	1.94E-04	9.71E-05
		Carbon Dioxide	1.00E-01	1.12E-01	8.54E-02	8.37E-02	1.04E-01	9.31E-02	9.17E-02	1.18E-01	1.03E-01	9.90E-02	1.16E-02
		Carbon Monoxide	6.61E-02	6.54E-02	6.02E-02	5.64E-02	6.78E-02	6.51E-02	5.73E-02	6.76E-02	6.39E-02	6.33E-02	4.28E-03
		Sulfur Dioxide*	I	1.44E-02	1.14E-02	1.32E-02	1.48E-02	1.32E-02	1.34E-02	5.72E-02	1.45E-02	1.90E-02	1.55E-02
		Nitrogen Oxides	3.15E-05	5.49E-05	5.27E-05	4.31E-05	8.34E-05	5.32E-05	5.64E-05	6.85E-05	6.26E-05	5.63E-05	1.47E-05

I: Data rejected based on data validation considerations.

ND: Non Detect; NA; Not Applicable

All "Other Analytes" are not included in the Sum of Target Analytes, HAPs.

*** : Results reported as a minimum due to apparent breakthrough.**

Test Plan GI Individual PCS Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	GI001	GI002	GI003	GI004	GI005	GI006	GI007	GI008	GI009	Average	STDEV
		Test Dates	**10/19/04**	**10/19/04**	**10/19/04**	**10/20/04**	**10/21/04**	**10/20/04**	**10/21/04**	**10/22/04**	**10/22/04**		
		TGOC as Propane	I	I	I	1.567	1.771	1.576	1.661	1.717	1.653	1.6575	0.0792
		HC as Hexane	8.80E-01	1.01E+00	8.45E-01	8.97E-01	6.90E-01	9.74E-01	1.06E+00	1.05E+00	1.01E+00	9.35E-01	1.19E-01
		Sum of Target Analytes	8.50E-01	1.09E+00	6.88E-01	6.97E-01	6.52E-01	6.37E-01	9.79E-01	6.31E-01	9.60E-01	7.99E-01	1.75E-01
		Sum of HAPs	8.40E-01	1.08E+00	6.83E-01	6.88E-01	6.41E-01	6.27E-01	9.69E-01	6.21E-01	9.49E-01	7.89E-01	1.75E-01
		Sum of POMs	2.39E-03	2.89E-03	2.37E-03	3.25E-03	2.08E-03	I	2.97E-03	3.74E-03	2.68E-03	2.80E-03	5.34E-04
			Individual Organic HAPs										
x		**Toluene**	4.19E-01	5.57E-01	4.44E-01	4.63E-01	3.73E-01	3.15E-01	5.01E-01	I	4.88E-01	4.45E-01	7.62E-02
x		**Benzene**	3.43E-01	4.33E-01	1.61E-01	1.32E-01	1.75E-01	2.46E-01	3.75E-01	5.28E-01	3.64E-01	3.06E-01	1.35E-01
x		**Acetaldehyde***	3.03E-02	3.42E-02	3.06E-02	2.75E-02	3.69E-02	3.57E-02	3.31E-02	3.12E-02	3.71E-02	3.29E-02	3.29E-03
x		**Phenol**	1.71E-02	1.90E-02	1.64E-02	2.44E-02	2.11E-02	1.13E-02	2.07E-02	2.64E-02	2.07E-02	1.97E-02	4.46E-03
x		**Formaldehyde***	1.08E-02	1.60E-02	9.68E-03	1.13E-02	1.42E-02	1.15E-02	1.15E-02	1.36E-02	1.26E-02	1.24E-02	1.94E-03
x		**m,p-Xylene**	7.66E-03	9.71E-03	7.77E-03	8.54E-03	6.07E-03	5.29E-03	9.14E-03	I	8.89E-03	7.88E-03	1.53E-03
x		**m,p-Cresol**	4.12E-03	5.69E-03	5.45E-03	8.37E-03	6.15E-03	I	6.93E-03	8.98E-03	6.90E-03	6.57E-03	1.58E-03
x	z	**Naphthalene**	2.39E-03	2.89E-03	2.37E-03	3.25E-03	2.08E-03	I	2.97E-03	3.74E-03	2.68E-03	2.80E-03	5.34E-04
x		**o-Xylene**	2.04E-03	2.78E-03	2.31E-03	2.68E-03	2.20E-03	I	2.57E-03	3.47E-03	2.65E-03	2.59E-03	4.39E-04
x		**Ethylbenzene**	1.31E-03	1.66E-03	1.31E-03	1.55E-03	1.21E-03	1.25E-03	1.68E-03	I	1.60E-03	1.44E-03	1.96E-04
x		**Styrene**	1.07E-03	1.41E-03	1.13E-03	1.29E-03	1.08E-03	7.06E-04	1.41E-03	1.69E-03	1.27E-03	1.23E-03	2.77E-04
x		**o-Cresol**	ND	ND	ND	1.78E-03	1.29E-03	ND	1.53E-03	1.79E-03	1.43E-03	8.69E-04	8.40E-04
x		**Biphenyl**	ND	ND	ND	1.55E-03	ND	ND	1.29E-03	1.69E-03	ND	5.04E-04	7.62E-04
x		**Propionaldehyde**	3.80E-04	3.36E-04	3.74E-04	4.66E-04	3.20E-04	4.90E-04	3.76E-04	4.10E-04	4.14E-04	3.96E-04	5.56E-05
x		**2-Butanone**	4.31E-04	1.96E-04	5.20E-04	I	ND	3.82E-04	3.22E-04	ND	2.93E-04	2.68E-04	1.91E-04
x	z	**1,2-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	I	ND	ND	NA
x	z	**1,5-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1,8-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3,5-Trimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,3-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,6-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2,7-Dimethylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**Acenaphthalene**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Hexane**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x		**Acrolein**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan GI Individual PCS Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	GI001	GI002	GI003	GI004	GI005	GI006	GI007	GI008	GI009	Average	STDEV
		Test Dates	**10/19/04**	**10/19/04**	**10/19/04**	**10/20/04**	**10/21/04**	**10/20/04**	**10/21/04**	**10/22/04**	**10/22/04**		
			Other VOCs										
		o,m,p-Tolualdehyde	4.77E-03	4.32E-03	I	4.16E-03	5.05E-03	4.44E-03	4.39E-03	4.25E-03	4.61E-03	4.50E-03	2.98E-04
		Benzaldehyde	3.16E-03	3.24E-03	3.17E-03	3.16E-03	3.97E-03	4.01E-03	4.11E-03	3.77E-03	4.10E-03	3.63E-03	4.39E-04
		Pentanal	1.40E-03	1.45E-03	1.23E-03	1.37E-03	1.34E-03	1.36E-03	1.33E-03	1.25E-03	1.41E-03	1.35E-03	7.20E-05
		Butyraldehyde/Methacrolein	5.48E-04	4.65E-04	5.29E-04	4.60E-04	4.69E-04	4.85E-04	4.91E-04	4.26E-04	5.29E-04	4.89E-04	3.95E-05
		Crotonaldehyde	1.96E-04	I	1.44E-04	1.75E-04	1.79E-04	1.42E-04	1.89E-04	1.48E-04	2.05E-04	1.72E-04	2.47E-05
		Hexaldehyde	3.39E-04	2.70E-04	ND	ND	1.72E-04	ND	ND	ND	ND	8.68E-05	1.37E-04
		1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		1,3-Diethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2,6-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		2-Ethyltoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		3-Ethyltoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Decane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Dodecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Heptane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Indene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Nonane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Octane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Tetradecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Undecane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Furfural	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
		Furfuryl Alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Test Plan GI Individual PCS Emission Test Results – Lb/Tn Metal

HAPs	POMs	COMPOUND / SAMPLE NUMBER	GI001	GI002	GI003	GI004	GI005	GI006	GI007	GI008	GI009	Average	STDEV
		Test Dates	**10/19/04**	**10/19/04**	**10/19/04**	**10/20/04**	**10/21/04**	**10/20/04**	**10/21/04**	**10/22/04**	**10/22/04**		
			Other Analytes										
		Acetone	1.53E-02	1.17E-02	1.58E-02	8.44E-03	6.20E-03	9.70E-03	1.29E-02	8.25E-03	1.25E-02	1.12E-02	3.29E-03
		Carbon Dioxide	6.68E+00	7.74E+00	5.98E+00	5.97E+00	7.45E+00	6.60E+00	6.51E+00	8.30E+00	7.23E+00	6.94E+00	7.97E-01
		Carbon Monoxide	4.41E+00	4.52E+00	4.22E+00	4.02E+00	4.87E+00	4.61E+00	4.07E+00	4.74E+00	4.49E+00	4.44E+00	2.90E-01
		Sulfur Dioxide*	I	9.97E-04	8.01E-04	9.47E-04	1.07E-03	9.11E-04	9.93E-04	1.12E-03	1.02E-03	9.82E-04	9.79E-05
		Nitrogen Oxides	2.11E-03	3.80E-03	3.69E-03	3.08E-03	5.99E-03	3.77E-03	4.00E-03	4.81E-03	4.40E-03	3.96E-03	1.08E-03

I: Data rejected based on data validation considerations.

ND: Non Detect; NA; Not Applicable

All "Other Analytes" are not included in the Sum of Target Analytes, HAPs.

*** : Results reported as a minimum due to apparent breakthrough.**

Test EY Quantitation Limits – Lb/Lb Binder

Analytes	Mix/Make/Cure	Storage
HC as hexane	4.87E-05	2.32E-04
1-Methylnaphthalene	4.87E-05	2.32E-04
2-Methylnaphthalene	4.87E-05	2.32E-04
Formaldehyde	3.03E-06	1.63E-05
Naphthalene	4.87E-05	2.32E-04
Phenol	2.47E-05	1.16E-04

Test GI Quantitation Limits – Lb/Lb Binder

Analytes	Mix/Make/Cure	Storage
Furfural	1.79E-05	3.59E-05
Phenol	2.20E-05	4.45E-05
Formaldehyde	1.41E-06	2.73E-06
HC as hexane	4.42E-05	8.93E-05
Furfuryl alcohol	1.33E-05	2.67E-05

Test EY Quantitation Limits – Lb/Tn Sand

Analytes	Mix/Make/Cure	Storage
HC as hexane	1.25E-03	5.95E-03
1-Methylnaphthalene	1.25E-03	5.95E-03
2-Methylnaphthalene	1.25E-03	5.95E-03
Formaldehyde	7.77E-05	4.18E-04
Naphthalene	1.25E-03	5.95E-03
Phenol	6.33E-04	2.98E-03

Test GI Quantitation Limits – Lb/Tn Sand

Analytes	Mix/Make/Cure	Storage
Furfural	2.68E-02	2.68E-02
Phenol	3.36E-02	3.36E-02
Formaldehyde	2.01E-03	2.01E-03
HC as hexane	6.71E-02	6.71E-02
Furfuryl alcohol	2.01E-02	2.01E-02

Test GI Quantitation Limits – Lb/Lb Binder

Analytes	Lb/Lb Binder
1,2,3-Trimethylbenzene	3.73E-06
1,2,4-Trimethylbenzene	3.73E-06
1,3,5-Trimethylbenzene	3.73E-06
1,3-Dimethylnaphthalene	3.73E-06
1-Methylnaphthalene	3.73E-06
2-Ethyltoluene	3.73E-06
2-Methylnaphthalene	3.73E-06
Benzene	3.73E-06
Ethylbenzene	3.73E-06
hexane	3.73E-06
m,p-Xylene	3.73E-06
Naphthalene	3.73E-06
o-Xylene	3.73E-06
Styrene	3.73E-06
Toluene	3.73E-06
Undecane	3.73E-06
1,2-Dimethylnaphthalene	1.86E-05
1,3-Diethylbenzene	1.86E-05
1,5-Dimethylnaphthalene	1.86E-05
1,6-Dimethylnaphthalene	1.86E-05
1,8-Dimethylnaphthalene	1.86E-05

Analytes	Lb/Lb Binder
2,3,5-Trimethylnaphthalene	1.86E-05
2,3-Dimethylnaphthalene	1.86E-05
2,4-Dimethylphenol	1.86E-05
2,6-Dimethylnaphthalene	1.86E-05
2,6-Dimethylphenol	1.86E-05
2,7- Dimethylnaphthalene	1.86E-05
3-Ethyltoluene	1.86E-05
Acenaphthalene	1.86E-05
Biphenyl	1.86E-05
Cyclohexane	1.86E-05
Decane	1.86E-05
Dodecane	1.86E-05
Heptane	1.86E-05
Indan	1.86E-05
Indene	1.86E-05
m,p-Cresol	1.86E-05
Nonane	1.86E-05
o-Cresol	1.86E-05
Octane	1.86E-05
Phenol	1.86E-05
Propylbenzene	1.86E-05

Analytes	Lb/Lb Binder
Tetradecane	1.86E-05
HC as hexane	2.20E-04
2-Butanone (MEK)	1.93E-06
Acetaldehyde	1.93E-06
Acetone	1.93E-06
Acrolein	1.93E-06
Benzaldehyde	1.93E-06
Butyraldehyde	1.93E-06
Crotonaldehyde	1.93E-06
Formaldehyde	1.93E-06
Hexaldehyde	1.93E-06
Butyraldehyde/ Methacrolein	3.21E-06
o,m,p-Tolualdehyde	5.14E-06
Pentanal (Valeraldehyde)	1.93E-06
Propionaldehyde (Propanal)	1.93E-06
Furfuryl alcohol	1.86E-05
Sulfur Dioxide	2.57E-05
Furfural	2.51E-05
Carbon Monoxide	4.57E-04
Carbon Dioxide	7.18E-04
Nitrogen Oxides	4.89E-04

Test GI Quantitation Limits – Lb/Tn Metal

Analytes	Lb/Tn Metal
1,2,3-Trimethylbenzene	2.61E-04
1,2,4-Trimethylbenzene	2.61E-04
1,3,5-Trimethylbenzene	2.61E-04
1,3-Dimethylnaphthalene	2.61E-04
1-Methylnaphthalene	2.61E-04
2-Ethyltoluene	2.61E-04
2-Methylnaphthalene	2.61E-04
Benzene	2.61E-04
Ethylbenzene	2.61E-04
hexane	2.61E-04
m,p-Xylene	2.61E-04
Naphthalene	2.61E-04
o-Xylene	2.61E-04
Styrene	2.61E-04
Toluene	2.61E-04
Undecane	2.61E-04
1,2-Dimethylnaphthalene	1.31E-03
1,3-Diethylbenzene	1.31E-03
1,5-Dimethylnaphthalene	1.31E-03
1,6-Dimethylnaphthalene	1.31E-03
1,8-Dimethylnaphthalene	1.31E-03

Analytes	Lb/Tn Metal
2,3,5-Trimethylnaphthalene	1.31E-03
2,3-Dimethylnaphthalene	1.31E-03
2,4-Dimethylphenol	1.31E-03
2,6-Dimethylnaphthalene	1.31E-03
2,6-Dimethylphenol	1.31E-03
2,7- Dimethylnaphthalene	1.31E-03
3-Ethyltoluene	1.31E-03
Acenaphthalene	1.31E-03
Biphenyl	1.31E-03
Cyclohexane	1.31E-03
Decane	1.31E-03
Dodecane	1.31E-03
Heptane	1.31E-03
Indan	1.31E-03
Indene	1.31E-03
m,p-Cresol	1.31E-03
Nonane	1.31E-03
o-Cresol	1.31E-03
Octane	1.31E-03
Phenol	1.31E-03
Propylbenzene	1.31E-03

Analytes	Lb/Tn Metal
Tetradecane	1.31E-03
HC as hexane	1.31E-01
2-Butanone (MEK)	3.92E-03
Acetaldehyde	3.92E-03
Acetone	3.92E-03
Acrolein	3.92E-03
Benzaldehyde	3.92E-03
Butyraldehyde	3.92E-03
Crotonaldehyde	3.92E-03
Formaldehyde	3.92E-03
Hexaldehyde	3.92E-03
Butyraldehyde/Methacrolein	6.53E-03
o,m,p-Tolualdehyde	1.04E-02
Pentanal (Valeraldehyde)	3.92E-03
Propionaldehyde (Propanal)	3.92E-03
Furfuryl alcohol	3.92E-02
Sulfur Dioxide	5.22E-02
Furfural	5.22E-02
Carbon Monoxide	3.20E-02
Carbon Dioxide	5.03E-02
Nitrogen Oxides	3.43E-02

Test Plans EY and GI MMC T-Statistics – Lb/Lb Binder

Analytes	(Lb/Lb Binder)		
Emission Indicators	**Test EY**	**Test GI**	**T-Statistic**
TGOC as Propane	0.0069	0.0023	25.2
HC as hexane	0.0069	0.0014	30.1
Sum of Target Analytes	0.0005	0.0036	-17.0
Sum of Target HAPs	0.0005	>0.0001	6.1
Sum of Target POMs	0.0003	NA	NA
Target HAPs and VOCs			
Phenol	0.0003	ND	NA
Naphthalene	0.0001	NT	NA
1-Methylnaphthalene	0.0001	NT	NA
Formaldehyde	>0.0001	>0.0001	NA
2-Methylnaphthalene	ND	NT	NA
Furfuryl Alcohol	NT	0.0034	NA
Furfural	NT	0.0001	NA

Test Plans EY and GI MMC T-Statistics – Lb/Tn Sand

Analytes	(Lb/Tn Sand)		
Emission Indicators	**Test EY**	**Test GI**	**T-Statistic**
TGOC as Propane	0.1781	0.0601	23.50
HC as hexane	0.1761	0.0360	31.06
Sum of Target Analytes	0.0140	0.0932	-18.39
Sum of Target HAPs	0.0140	0.0007	8.35
Sum of Target POMs	0.0065	NA	NA
Target HAPs and VOCs			
Phenol	0.0076	ND	8.46
Naphthalene	0.0033	NT	NA
1-Methylnaphthalene	0.0032	NT	NA
Formaldehyde	0.0011	0.0007	6.93
2-Methylnaphthalene	ND	NT	NA
Furfuryl Alcohol	NT	0.0892	NA
Furfural	NT	0.0032	NA

Test Plans EY and GI Storage T-Statistics – Lb/Lb Binder

Analytes	(Lb/Lb Binder)		
Emission Indicators	**Test EY**	**Test GI**	**T-Statistic**
TGOC as Propane	0.0118	0.0004	38.4
HC as hexane	0.0129	0.0003	14.7
Sum of Target Analytes	0.0018	0.0002	3.9
Sum of Target HAPs	0.0018	>0.0001	4.4
Sum of Target POMs	0.0021	NA	NA
Target HAPs and VOCs			
1-Methylnaphthalene	0.0017	NT	NA
Naphthalene	0.0004	NT	NA
Phenol	0.0002	ND	NA
Formaldehyde	0.0001	>0.0001	NA
2-Methylnaphthalene	ND	NT	NA
Furfuryl Alcohol	NT	0.0002	NA
Furfural	NT	ND	NA

Test Plans EY and GI Storage T-Statistics – Lb/Tn Sand

Analytes	(Lb/Tn Sand)		
Emission Indicators	**Test EY**	**Test GI**	**T-Statistic**
TGOC as Propane	0.3022	0.0095	41.22
HC as hexane	0.3316	0.0076	15.00
Sum of Target Analytes	0.0450	0.0063	3.84
Sum of Target HAPs	0.0450	0.0003	4.43
Sum of Target POMs	0.0533	ND	NA
Target HAPs and VOCs			
1-Methylnaphthalene	0.0442	NT	NA
Naphthalene	0.0093	NT	NA
Phenol	0.0051	ND	17.85
Formaldehyde	0.0019	0.0003	9.62
2-Methylnaphthalene	ND	NT	NA
Furfuryl Alcohol	NT	0.0061	NA
Furfural	NT	ND	NA

- ND: Non Detect; NA: Not Applicable; NT: Not Applicable

Test Plans FL and GI PCS T-Statistics – Lb/Lb Binder

Analytes	(Lb/Lb Binder)		
Emission Indicators	**Test FL**	**Test GI**	**T-Statistic**
TGOC as Propane	0.2094	0.0234	62.5
HC as hexane	0.0670	0.0176	9.6
Sum of VOCs	0.0428	0.0140	8.8
Sum of Target HAPs	0.0303	0.0138	5.7
Sum of Target POMs	0.0007	0.0001	12.7
Target HAPs and VOCs			
o,m,p-Cresol	0.0148	0.0001	0.9
Phenol	0.0088	0.0004	17.3
Benzene	0.0044	0.0065	-0.8
Toluene	0.0010	0.0063	-14.4
o,m,p-Xylene	0.0008	0.0001	21.0
Formaldehyde	0.0002	0.0002	0.0
Acetaldehyde	<0.0001	0.0006	-4.7
Dodecane	0.0064	ND	19.2
Trimethylbenzenes	0.0033	ND	19.8
1,3-Diethylbenzene	0.0014	ND	21.0
Indan	0.0008	ND	24.0
Dimethylphenols	0.0005	ND	7.5
Gaseous Analytes			
Carbon Dioxide	0.5568	0.0990	45.7
Carbon Monoxide	0.0011	0.0633	-34.0
Sulfur Dioxide	NT	0.0190	NA
Nitrogen Oxides	NT	0.0001	NA

Individual results constitute >95% of mass of all detected target analytes.
ND: Non Detect; NA: Not Applicable; NT: Not Tested
The carbon dioxide and carbon monoxide results were generated via the collection of bag samples for Test FL . These results do not have the accuracy of the continuous monitoring results in Test GI.

Test Plans FL and GI Storage T-Statistics – Lb/Tn Metal

Analytes	(Lb/Tn Metal)		
Emission Indicators	**Test FL**	**Test GI**	**T-Statistic**
TGOC as Propane	12.67	1.658	71.1
HC as hexane	4.043	0.9350	23.1
Sum of Target Analytes	2.488	0.7987	21.5
Sum of Target HAPs	1.763	0.7890	13.0
Sum of Target POMs	0.040	0.0028	29.2
Target HAPs and VOCs			
o,m,p-Cresol	0.8654	0.0067	53.5
Phenol	0.5106	0.0197	39.6
Benzene	0.2521	0.3063	-1.2
Toluene	0.0575	0.4450	-15.3
o,m,p-Xylene	0.0453	0.0093	31.4
Formaldehyde	0.0128	0.0124	0.4
Acetaldehyde	0.0030	0.0329	-27.0
Dodecane	0.3726	ND	NA
Trimethylbenzenes	0.1911	ND	NA
1,3-Diethylbenzene	0.0822	ND	NA
Indan	0.0476	ND	NA
Dimethylphenols	0.0265	ND	NA
Gaseous Analytes			
Carbon Dioxide	33.67	6.941	46.0
Carbon Monoxide	0.0683	4.440	-36.9
Sulfur Dioxide	NT	0.0010	NA
Nitrogen Oxides	NT	0.0040	NA

Individual results constitute >95% of mass of all detected target analytes.
ND: Non Detect; NA: Not Applicable; NT: Not Tested
The carbon dioxide and carbon monoxide results were generated via the collection of bag samples for Test FL . These results do not have the accuracy of the continuous monitoring results in Test GI.

APPENDIX C TEST SERIES EY, FL, AND GI DETAILED PROCESS DATA

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Test EY Detailed Process Data – Phenolic Urethane

No-Bake Mold Mix/Make/Cure Test	1	2	3	4	5	6	Average 1.30 % (1-6)
Date	**2/19/2003**	**2/19/2003**	**2/20/2003**	**2/20/2003**	**2/24/2003**	**2/24/2003**	
Emission test no.	**EY101**	**EY102**	**EY103**	**EY104**	**EY105**	**EY106**	
Total dispensed binder-coated sand weight, Lbs.	259.0	284.5	279.5	281.5	281.7	274.5	**276.8**
Sand dispensing rate, Lbs/15 sec	31.2	31.2	30.5	30.5	30.0	30.0	**30.6**
Binder Part1 + Part3 dispensing rate, gms/15 sec	103.4	103.4	100.9	100.9	98.8	98.8	**101.0**
Binder Part 2 dispensing rate, gms/15 sec	80.3	80.3	78.9	78.9	78.8	78.8	**79.3**
Total binder dispensing rate, Lbs/ 15 sec	0.40	0.40	0.40	0.40	0.39	0.39	**0.40**
Calculated Total Binder weight, Lbs.	3.32	3.64	3.59	3.61	3.63	3.54	**3.55**
Calculated % Binder (BOS)	1.30	1.30	1.30	1.30	1.30	1.30	**1.30**
Calculated standard % binder	1.28	1.28	1.28	1.28	1.29	1.29	**1.28**
1800 F LOI, % (note 1)	1.27	1.37	1.35	1.34	n/d	n/d	**1.33**
Ambient temperature, Deg F	63	63	64	68	64	65	**65**
Sand temperature, Deg F	80	80	80	82	83	80	**81**
Dogbone Core 2 hr. tensile strength	74.5 psi average of 12 bones, St dev: 7.4						
Test length, minutes	10:00	10:00	10:00	10:00	10:00	10:00	**10:00**

Note 2

No-Bake Mold Storage Test	1	2	3	4	5	6	Average 1.30 % (1-6)
Date	**2/19/2003**	**2/19/2003**	**2/20/2003**	**2/20/2003**	**2/24/2003**	**2/24/2003**	
Emission test no.	**EY301**	**EY302**	**EY303**	**EY304**	**EY305**	**EY306**	
Total mold weight (dispensed less screeded) sand, Lbs	259.0	270.5	265.5	263.0	268.0	269.0	**265.8**
Calculated total binder weight, Lbs.	3.32	3.47	3.41	3.37	3.45	3.46	**3.41**
Calculated % binder (BOS)	1.30	1.30	1.30	1.30	1.30	1.30	**1.30**
Calculated standard % binder	1.28	1.28	1.28	1.28	1.29	1.29	**1.28**
Test length, minutes	170:00	170:00	170:00	170:00	170:00	170:00	170:00

Note1**:** 1800 F LOI is the net weight sample weight difference when combusted at 1800 F for 2 hours and includes decomposition of carbonates that originate in the source sand.
Note 2: mold weight only- no spill sand weight data available

Test Plan FL Detailed Process Data – Phenolic Urethane

No-Bake Mix/Make/Cure										
Test Dates	10/6/2003	10/6/2003	10/6/2003	10/7/2003	10/7/2003	10/7/2003	10/8/2003	10/8/2003	10/8/2003	Average
Emissions Sample # / Production Sample #	FL 001	FL 002	FL 003	FL 004	FL 005	FL 006	FL 007	FL 008	FL 009	
Sand Dispensing Rate, lbs/15 sec	30	30	30	30	30	30	30	30	30	**30**
Binder Part1 + Part3 Dispensing Rate, gms/15 sec	83.8	83.8	83.8	85.7	85.7	85.7	85.3	85.3	85.3	**84.9**
Binder Part 2 Dispensing Rate, gms/15 sec	61.6	61.6	61.6	64.7	64.7	64.7	64.1	64.1	64.1	**63.5**
Calculated Standard % Binder	1.06	1.06	1.06	1.09	1.09	1.09	1.09	1.09	1.09	**1.08**
Calculated % Binder (BOS)	1.07	1.07	1.07	1.10	1.10	1.10	1.10	1.10	1.10	**1.09**
Mold Weight, lbs	330.5	328.0	336.5	334.0	328.0	329.0	328.0	331.0	335.0	**331.1**
Calculated Total Binder Weight, lbs	3.49	3.46	3.55	3.65	3.58	3.59	3.56	3.59	3.63	**3.57**
1800F LOI, % (Note 1)	1.04	1.13	1.11	1.02	0.96	1.26	1.02	1.27	1.09	**1.10**
Sand Temperature, deg F	80	80	80	82	83	81	86	81	84	**82**
Dogbone Core 2 hr. Tensile Strength, psi	47	50	55	47	36	38	24	34	51	**42**

No-Bake PCS										
Test Dates	10/7/2003	10/7/2003	10/7/2003	10/8/2003	10/8/2003	10/8/2003	10/9/2003	10/9/2003	10/9/2003	Average
Emissions Sample # / Production Sample #	FL 001	FL 002	FL 003	FL 004	FL 005	FL 006	FL 007	FL 008	FL 009	
Pouring Temp, deg F	2624	2629	2628	2640	2630	2637	2636	2628	2635	**2632**
Pouring Time, sec.	34	32	34	35	35	35	30	32	31	**33**
Cast Weight (all metal inside mold), Lbs.	117.30	119.05	117.15	117.15	119.95	115.55	117.65	118.65	118.80	**117.92**
Process Air Temperature in Hood, deg F (Note 2)	86	88	90	86	85	89	85	86	86	**87**
Mold Temperature when placed in hood, deg F	79	79	77	80	80	78	81	80	77	**79**
Ambient Temperature, deg F	73	76	79	73	75	79	69	72	76	**75**
Mold Age When Poured, hr	22.8	24.2	24.5	22.4	23.6	23.7	23.5	24.8	24.6	**23.8**
Test Length, Min	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	**75.0**
Rank order cavity 'A'	8	1	2	5	6	7	9	3	4	

Note 1: 1800F LOI is the net sample weight difference when combusted at 1800F for 2 hours and includes decomposition of carbonates that originate in the source sand.

Note 2: Process air in the hood is ambient air infiltrated under the hood and controlled heated air from an oven blended at the base of the hood and measured at the level of the mold.

Test GI Detailed Process Data - Furan

No-Bake Mix/Make/Cure & Storage	GI201	GI202	GI203	GI204	GI205	GI206	
Date	**10/11/2004**	**10/11/2004**	**10/12/2004**	**10/11/2004**	**10/12/2004**	**10/12/2004**	
Emission test no.	**GI201**	**GI202**	**GI203**	**GI204**	**GI205**	**GI206**	
Production test no.	**201**	**202**	**203**	**204**	**205**	**206**	**Average (1-6)**
Total dispensed binder-coated sand weight, Lbs.	231.5	236.5	228.0	234.0	234.5	234.5	**233.2**
Sand dispensing rate, Lbs/15 sec	29.52	29.52	29.20	29.20	29.20	29.20	**29.31**
Binder Part1 + Part3 dispensing rate, gms/15 sec	122.0	121.2	121.4	121.4	121.8	121.8	**121.6**
Binder Part 2 dispensing rate, gms/15 sec	51.3	52.2	51.7	51.7	51.8	51.8	**51.8**
Total binder dispensing rate, Lbs/ 15 sec	0.382	0.382	0.382	0.382	0.383	0.383	**0.382**
Calculated Total Binder weight, Lbs.	3.31	3.02	2.94	3.02	3.03	3.03	**3.06**
Calculated % Binder (BOS)	1.29	1.29	1.31	1.31	1.31	1.31	**1.30**
Calculated standard % binder	1.28	1.28	1.29	1.29	1.29	1.29	**1.29**
1800 F LOI, % (note 1)	1.13	1.08	1.15	1.13	1.12	1.12	**1.12**
Ambient temperature, Deg F	73	77	69	72	71	74	**73**
Dogbone Tensile 1 hour Strength, psi	55	68	38	37	32	40	**45**
Dogbone Core 2 hour. tensile strength, psi	70	69	73	62	54	65	**66**
Dogbone strain rate in./min.	0.3	0.3	0.3	0.3	0.3	0.3	**0**
Mix/Make/Cure Test length, minutes	10	10	10	10	10	10	**10**
Storage Test Length, minutes Note 5	110	110	110	110	110	110	**110**

Test GI Detailed Process Data - Furan

No-Bake Make for PCS										
Test Dates	**10/18/2004**	**10/18/2004**	**10/18/2004**	**10/19/2004**	**10/20/2004**	**10/20/2004**	**10/20/2004**	**10/21/2004**	**10/21/2004**	**Average**
Emissions Sample #	**GI 001**	**GI 002**	**GI 003**	**GI 004**	**GI 005**	**GI 006**	**GI 007**	**GI 008**	**GI 009**	
Production Sample #	**GI001**	**GI002**	**GI003**	**GI005**	**GI007**	**GI008**	**GI009**	**GI010/10a**	**GI011**	
Sand Dispensing Rate, lbs/15 sec	29.57	29.57	29.57	29.57	29.45	29.45	29.45	29.35	29.35	**29**
Binder Part1 + Part3 Dispensing Rate, gms/15 sec	122.1	122.1	122.1	122.1	122.0	122.0	122.0	123.1	123.1	**122.3**
Binder Part 2 Dispensing Rate, gms/15 sec	52.5	52.5	52.5	52.4	52.4	52.4	52.4	51.9	51.9	**52.3**
Calculated Standard % Binder	1.28	1.28	1.28	1.28	1.29	1.29	1.29	1.30	1.30	**1.29**
Calculated % Binder (BOS)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.31	**1.30**
Mold Weight, lbs	314.00	323.5	329.50	335.00	332.00	328.6	328.6	323.0	324.5	**326.5**
Calculated Total Binder Weight, lbs	4.03	4.15	4.23	4.30	4.27	4.23	4.23	4.19	4.21	**4.20**
1800F LOI, % (Note 1)	1.14	1.17	1.22	1.27	1.19	1.19	1.16	1.17	ND	**1.19**
Sand Temperature, deg F	82	81	ND	ND	ND	ND	ND	ND	ND	**82**
Dogbone Core 1 hr. Tensile Strength, psi	31	36	31	28	31	25	37	30	ND	**31**
Dogbone Core 2 hr. Tensile Strength, psi	91	91	94	101	79	89	86	92	ND	**90.4**
Dogbone strain rate in./min.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	**0.3**
			Note 3			Note 4	Note 4			

NO-Bake PCS										
Test Dates	**10/19/2004**	**10/19/2004**	**10/19/2004**	**10/20/2004**	**10/21/2004**	**10/20/2004**	**10/21/2004**	**10/22/2004**	**10/22/2004**	**Average**
Emissions Sample #	**GI 001**	**GI 002**	**GI 003**	**GI 004**	**GI 005**	**GI 006**	**GI 007**	**GI 008**	**GI 009**	
Production Sample #	**GI001**	**GI002**	**GI003**	**GI005**	**GI007**	**GI008**	**GI009**	**GI010/10a**	**GI011**	
Pouring Temp, deg F	2618	2635	2621	2626	2635	2623	2631	2637	2633	**2629**
Pouring Time, sec.	37	43	35	39	40	37	40	44	43	**40**
Cast Weight (all metal inside mold), Lbs.	120.7	120.0	120.8	120.6	118.9	119.4	119.1	119.4	119.8	**119.9**
Process Air Temperature in Hood, deg F (Note 2)	86	88	88	86	89	87	87	89	88	**88**
Ambient air temperature, F	69	71	72	71	69	73	74	72	73	**72**
Mold Age When Poured, hr	22.8	23.8	23.4	23.5	25.6	25.9	26.9	33.5	24.0	**25.5**
Test Length, Min	75	75	75	75	75	75	75	75	75	**75.0**
Rank order cavity 3 Note 6	1	8	4	5	3	6	1	7	2	

Note 1: 1800F LOI is the net sample weight difference when combusted at 1800F for 2 hours and includes decomposition of carbonates that originate in the source sand.

Note 2: Process air in the hood is ambient air infiltrated under the hood and controlled heated air from an oven blended at the base of the hood and measured at the level of the mold.

Note 3: Mold support cradle rebuit in hood after two runouts.

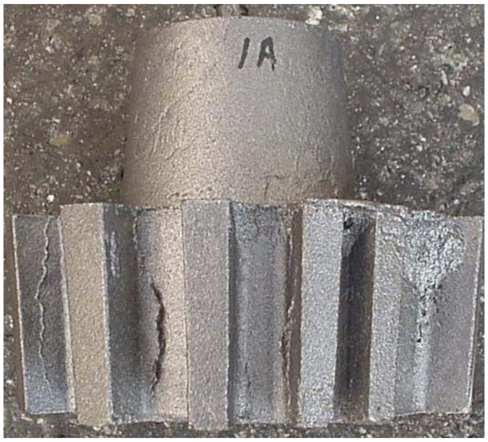
Note 4: These values are estimated because of an incomplete mold weight record for these runs. They are the the mean value of the mold weights 2 adjacent molds before and after these molds.

Note 5: The storage tests were shortened to 110 minutes because the emission level had reached the background level after this much elapsed time.

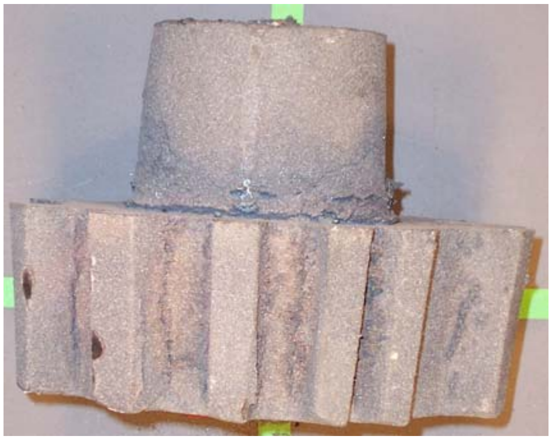
Note 6: Molds 4 & 6 ran out and were replaced by the next mold in sequence.

Cavity 3 Casting Pictures by Mold Production Number

FL 001



GI 001



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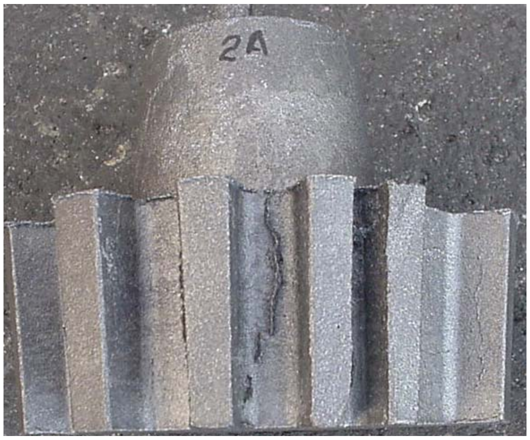

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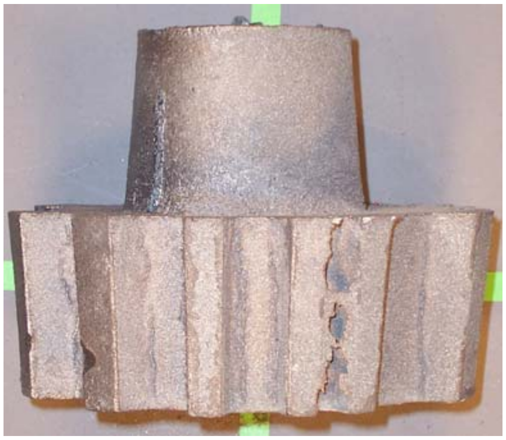

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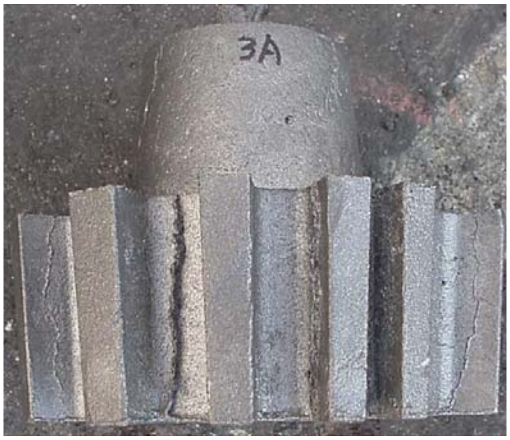

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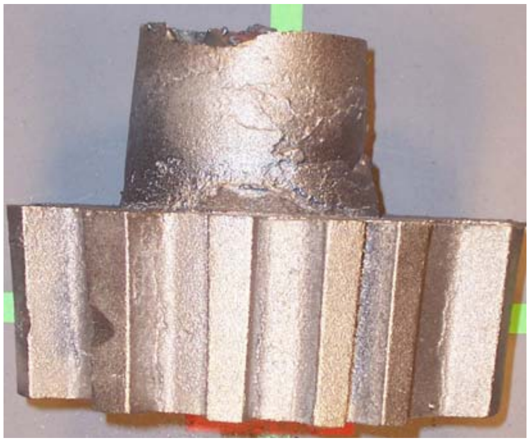

Cavity 3 Casting Pictures by Mold Production Number

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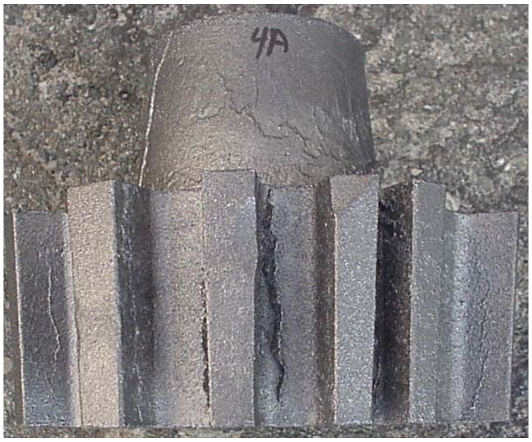

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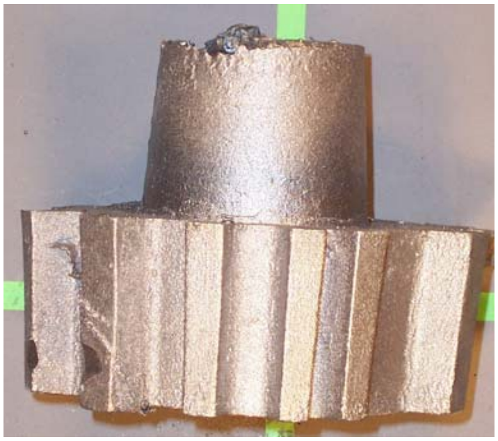

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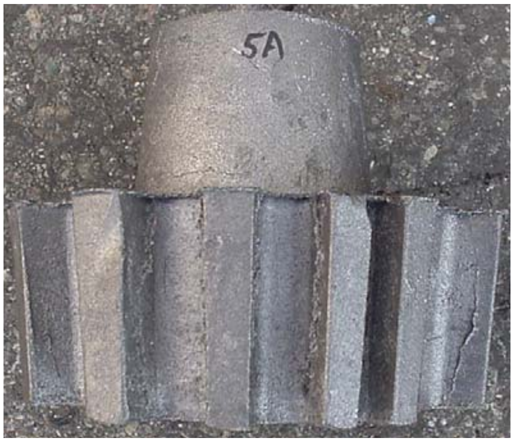

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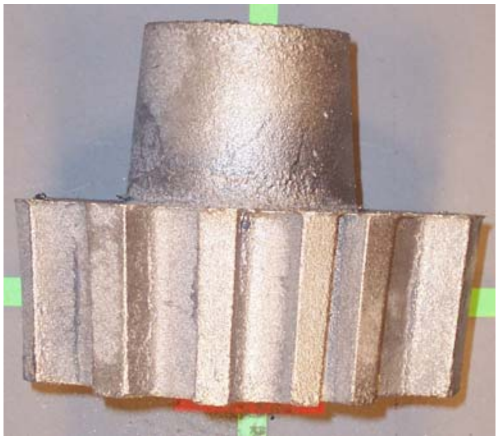
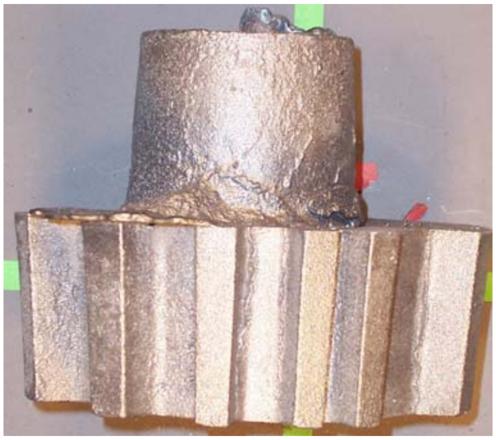


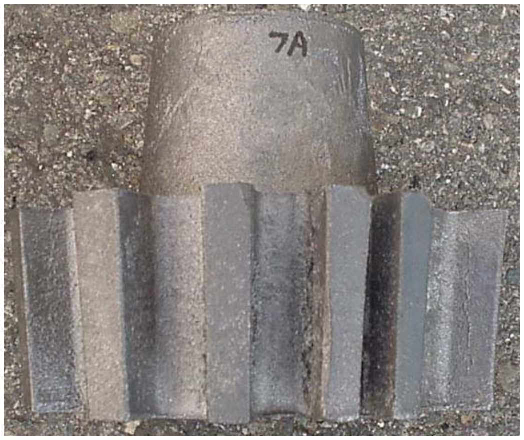
FL 006

GI 008



Cavity 3 Casting Pictures by Mold Production Number

FL 007



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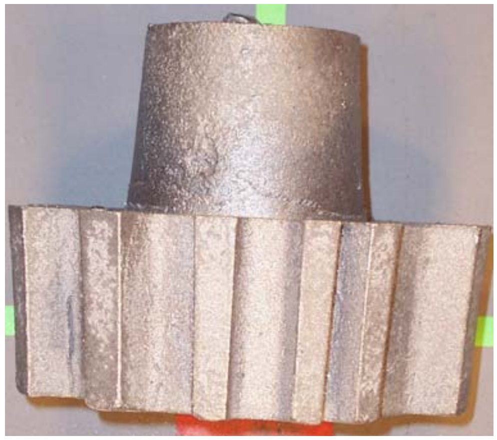
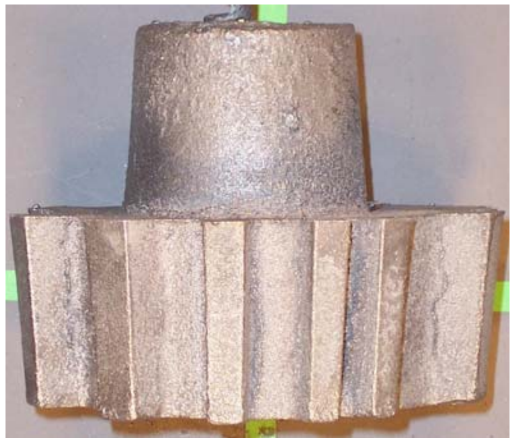


FL 008

GI 010



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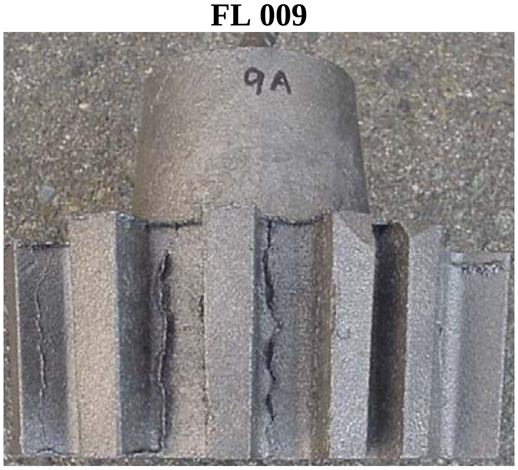

GI 011

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APPENDIX D METHOD 25A CHARTS

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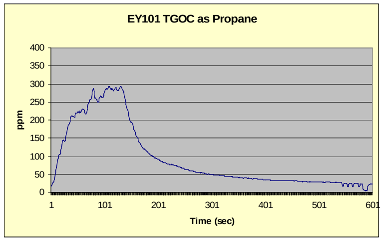
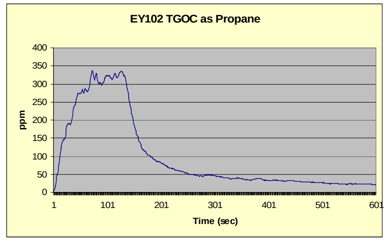
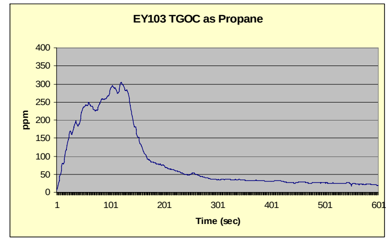
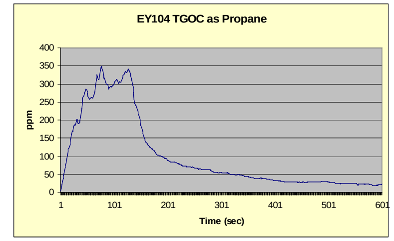
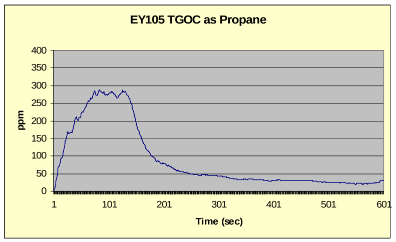
Test EY Mix/Make/Cure

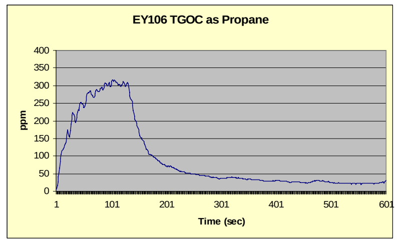




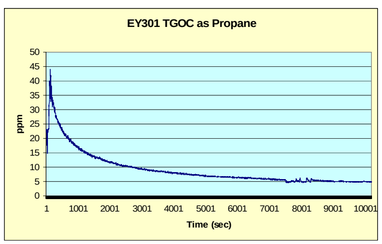


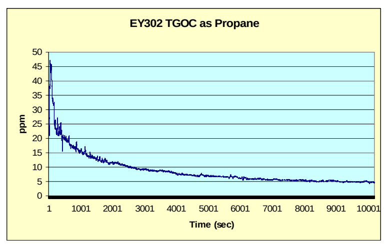


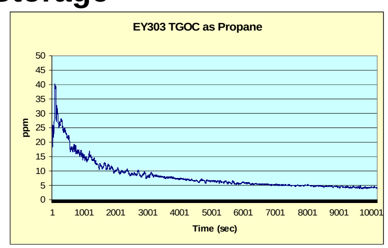


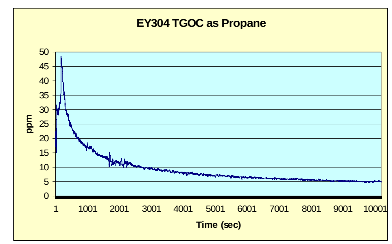


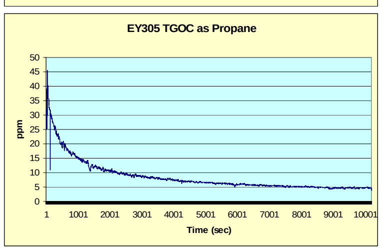
Test EY Storage

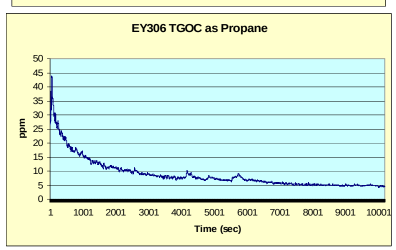




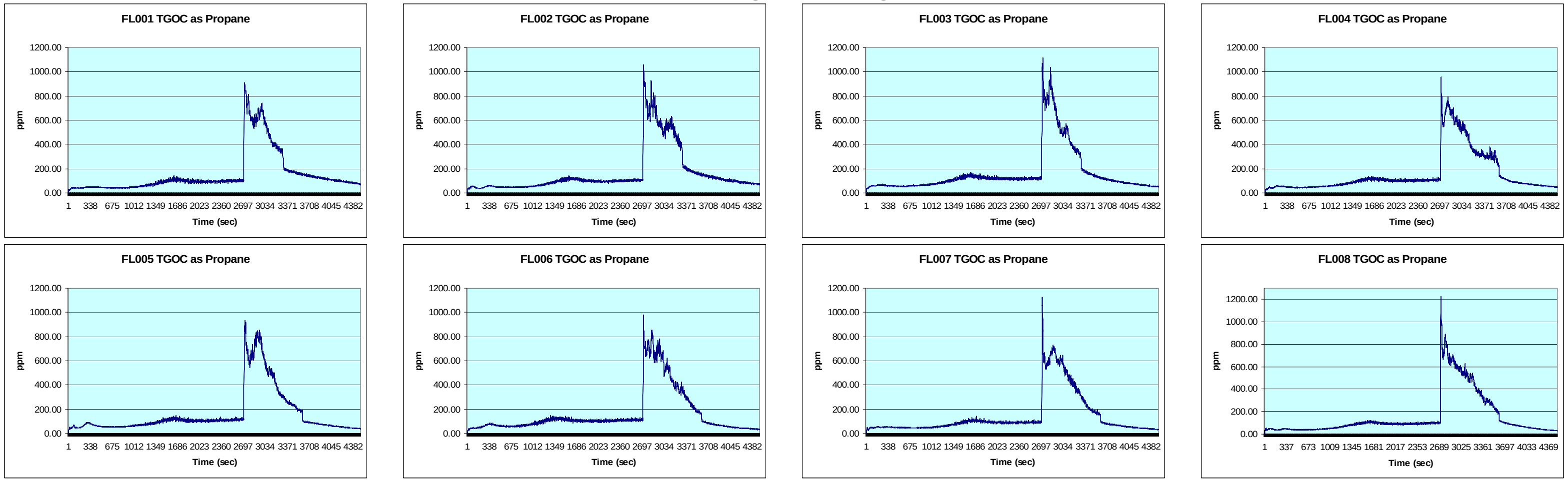








Test FL Pouring/Cooling/Shakeout



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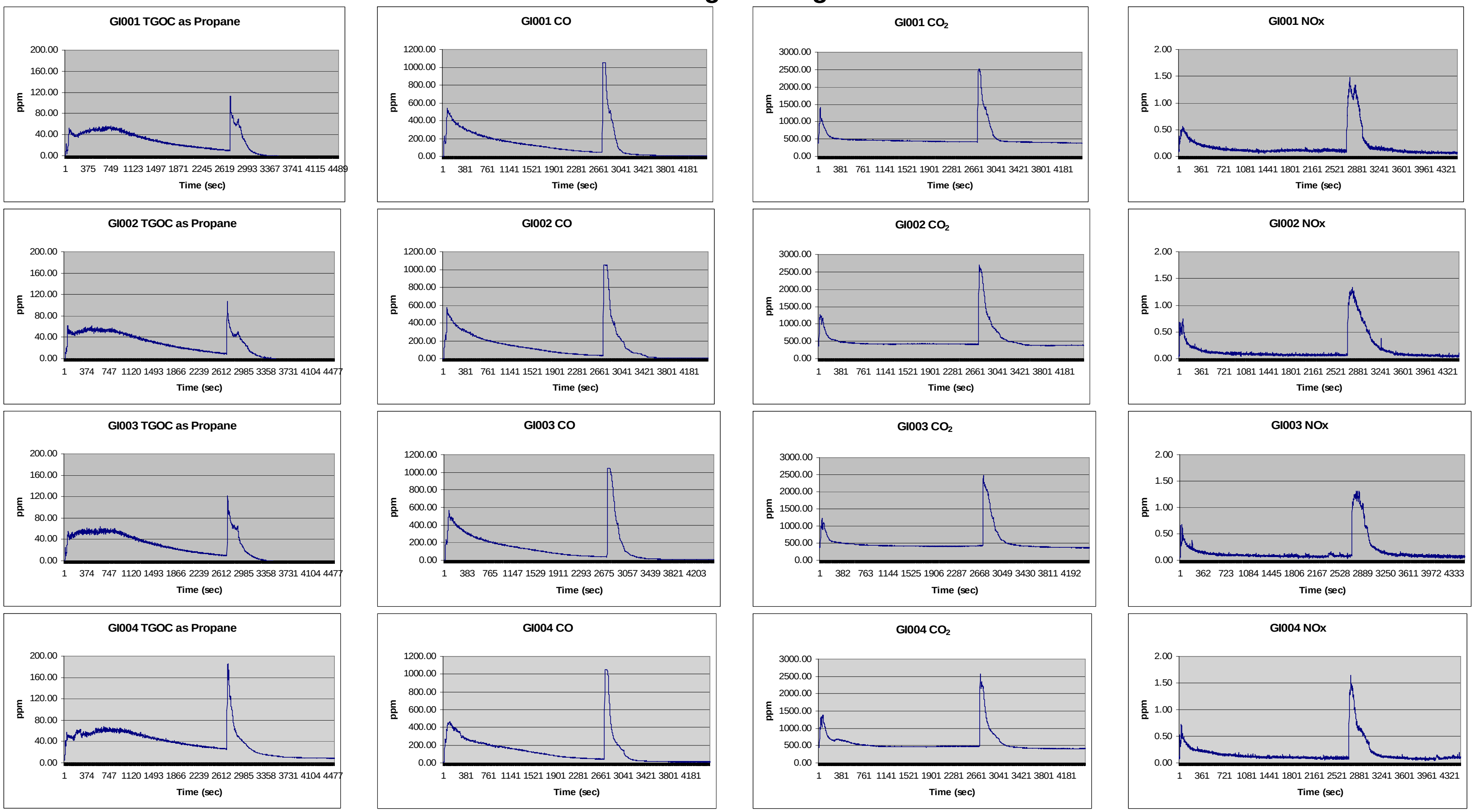

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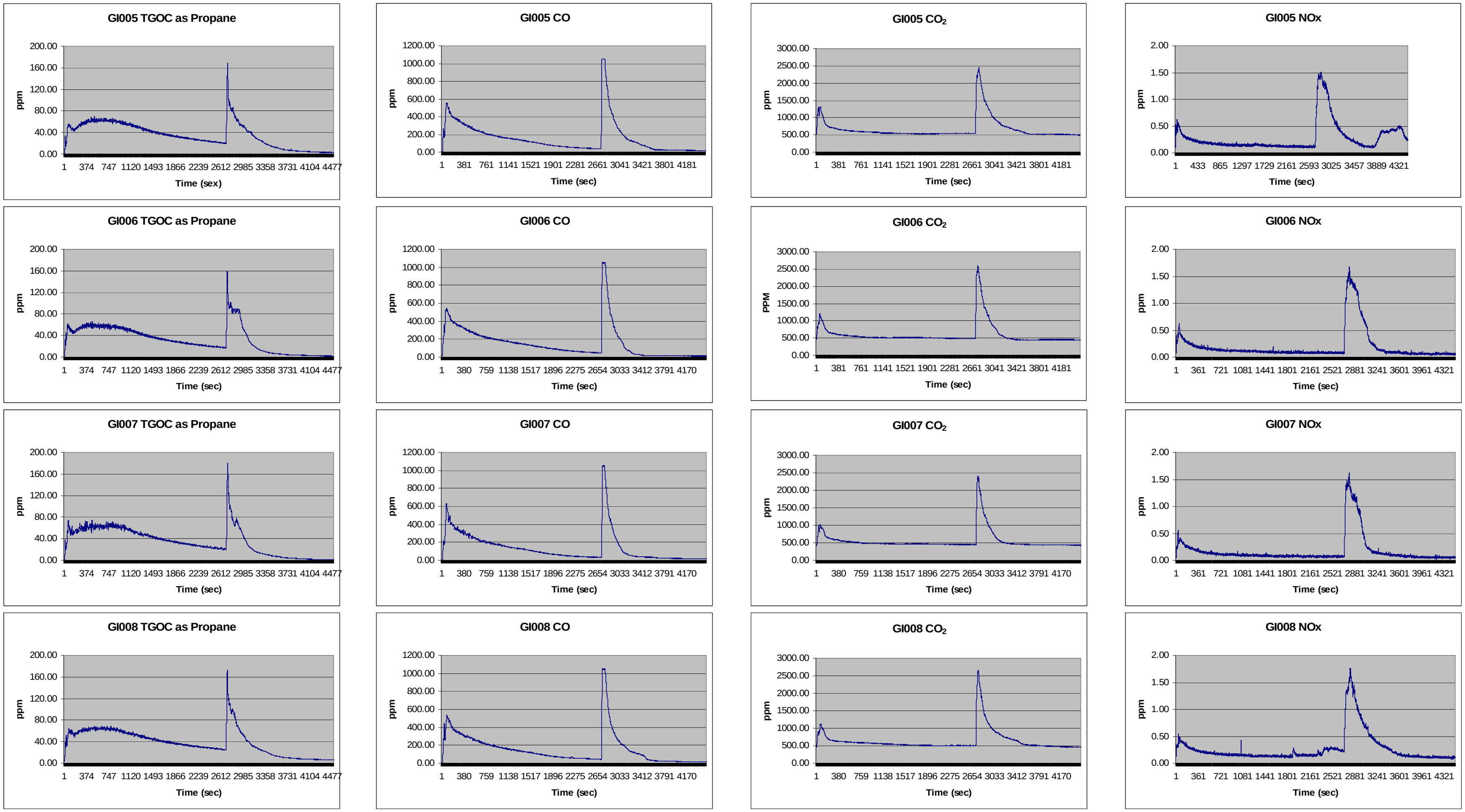

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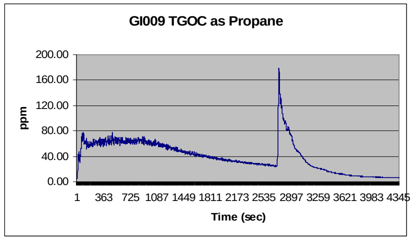
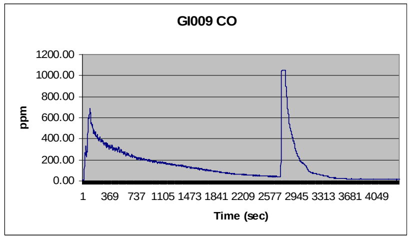
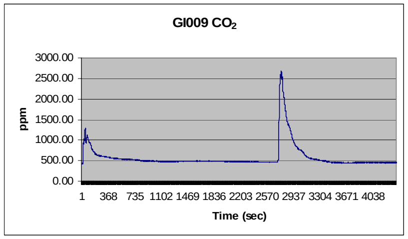
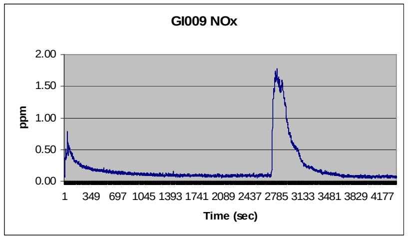
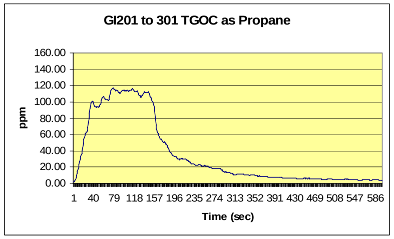


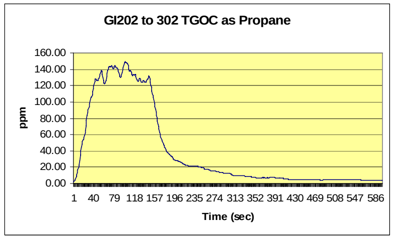


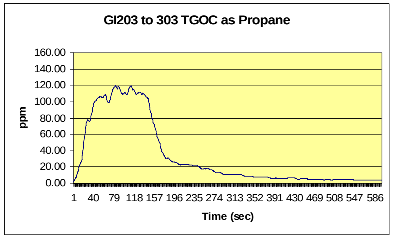


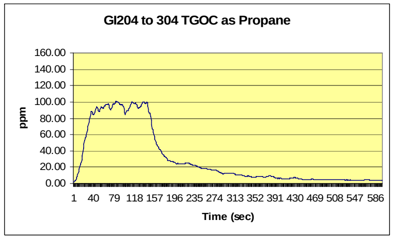


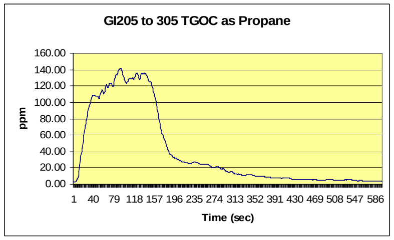
Test GI Mix/Make/Cure

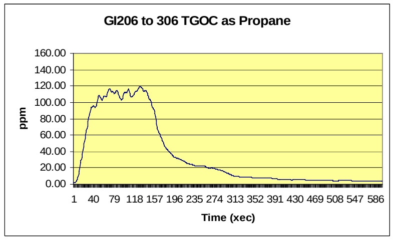




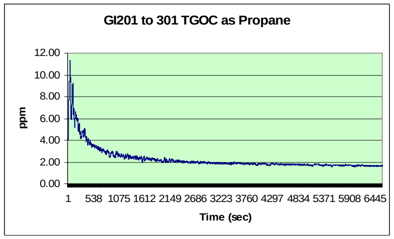


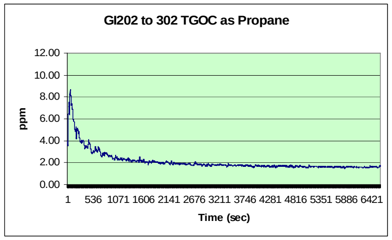


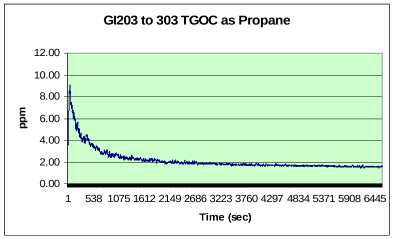


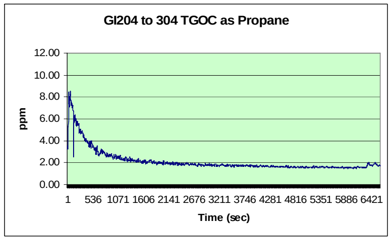


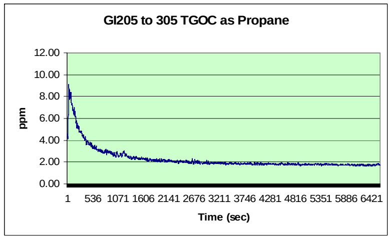
Test GI Storage

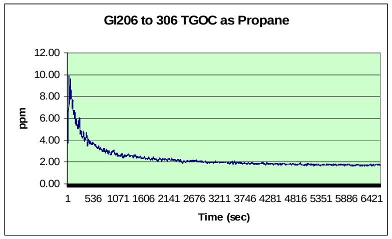












APPENDIX E GLOSSARY

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Glossary

BO	Based on ( )
BOS	Based on Sand
Emissions Indicators	Data summaries that provide an indication of a product's emissions
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 for GC/FID. The quantity of HC is performed against a five-point calibration curve of hexane by dividing the total area count from C_6 through C_{16} to the area of hexane from the initial calibration curve.
I	Data rejected based on data validation considerations
LOI	Loss On Ignition
MMC	Mix/Make/Cure
NA	Not Applicable
ND	Non-Detect
NT	Lab testing was not done
PCS	Pouring/Cooling/Shakeout
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.
Target Compounds	Compounds specifically selected for collection and analysis
TGOC as Propane	Weighted to the detection of more volatile hydrocarbon species, beginning at C_1 (methane), with results calibrated against the three-carbon alkane (propane).
VOC	Volatile Organic Compound