Casting Emission Reduction Program

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*US Army Contract DAAE30-02-C-1095*
*FY 2004*
**WBS # 1.1.1**

# Product Test: Pouring, Cooling, Shakeout of Coated ECOLOTEC® Core (Greensand without Seacoal, Iron)

## Technikon #1411-111 GE

**November 2004**
*Revised for public distribution.*

United States Environmental Protection Agency

CISA

AMERICAN FOUNDRY SOCIETY, INC.

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# Product Test: Pouring, Cooling, Shakeout of Coated ECOLOTEC® Core (Greensand without Seacoal, Iron)

## 1411-111 GE

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

| | | |
|---|---|---|
| Research Chemist | Carmen Hornsby | 11-18-04<br>Date |
| Process Engineering Manager | Steven M. Knight | 11-18-04<br>Date |
| V.P. Measurement Technology | Clifford R. Glowacki, CIH | 12-08-04<br>Date |
| V.P. Operations | George Crandell | 12-15-04<br>Date |
| President | William Walden | 12/16/04<br>Date |

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

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## Executive Summary

This report contains the results of emission testing to evaluate the pouring, cooling, and shakeout emissions from Test GE, a coated Foseco ECOLOTEC® core in greensand-without-seacoal product test. Test GE will be compared to Test FQ, a baseline using a coated standard core in greensand without seacoal system. All testing was conducted by Technikon, LLC in its Research foundry. The emissions results are reported in both pounds of analyte per pound of binder and pounds of analyte per ton of metal poured.

The testing performed involved the collection of continuous air samples over a seventy-five minute period, including the mold pouring, cooling, shakeout, and post shakeout periods. Process and stack parameters were measured and include: the weights of the casting, mold, and binder; Loss on Ignition (LOI) values for the mold prior to the test; metallurgical data; and stack temperature, pressure, volumetric flow rate, and moisture content. The process parameters were maintained within prescribed ranges in order to ensure the reproducibility of the tests runs. Samples were collected and analyzed for seventy (70) target compounds using procedures based on US EPA Method 18. Continuous monitoring of the Total Gaseous Organic Concentration (TGOC) of the emissions was conducted according to US EPA Method 25A. Carbon monoxide, carbon dioxide, and nitrogen oxides were monitored according to US EPA Methods 10, 3A, and 7E, respectively.

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

Results for the emission indicators are shown in the following table reported in both lbs/lb of binder and lbs/tn of metal.

**Test Plans FQ and GE Emissions Indicators – Lb/Lb Binder**

| Analytes | TGOC as Propane | HC as Hexane | Sum of Target Analytes | Sum of HAPs | Sum of POMs |
|---|---|---|---|---|---|
| **Test FQ Lb/Lb Binder** | 0.0974 | 0.0232 | 0.0341 | 0.0327 | 0.0055 |
| **Test GE Lb/Lb Binder** | 0.0319 | 0.0127 | 0.0147 | 0.0127 | 0.0002 |

### Test Plans FQ and GE Emissions Indicators – Lb/Tn Metal

| Analytes | TGOC as Propane | HC as Hexane | Sum of Target Analytes | Sum of HAPs | Sum of POMs |
|---|---|---|---|---|---|
| **Test FQ Lb/Tn Metal** | 0.7255 | 0.1726 | 0.2737 | 0.2630 | 0.0411 |
| **Test GE Lb/Tn Metal** | 0.3010 | 0.1204 | 0.1409 | 0.1217 | 0.0010 |

A pictorial casting record was made of cavity # 3 from each mold. The pictures are shown in Appendix C. The castings were free of core fines that were prevalent on the reference castings but significant gas holes were found that did not exist on the reference castings. Otherwise, the surface texture was similar to the reference castings

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

# 1.0 Introduction

## 1.1 BACKGROUND

Technikon LLC is a privately held contract research organization located in McClellan, California, a suburb of Sacramento. Technikon offers emissions research services to industrial and government clients specializing in the metal casting and mobile emissions areas. Technikon operates the Casting Emission Reduction Program (CERP). CERP is a cooperative initiative between the Department of Defense (US Army) and the United States Council for Automotive Research (USCAR). 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 Amendments. The facility has two principal testing arenas: a Pre-Production Foundry designed to measure airborne emissions from individually poured molds, and a Production Foundry designed to measure air emissions in a continuous full scale production process. Each of these testing arenas has been specially designed to facilitate the collection and evaluation of airborne emissions and associated process data.

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

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

## 1.3 REPORT ORGANIZATION

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

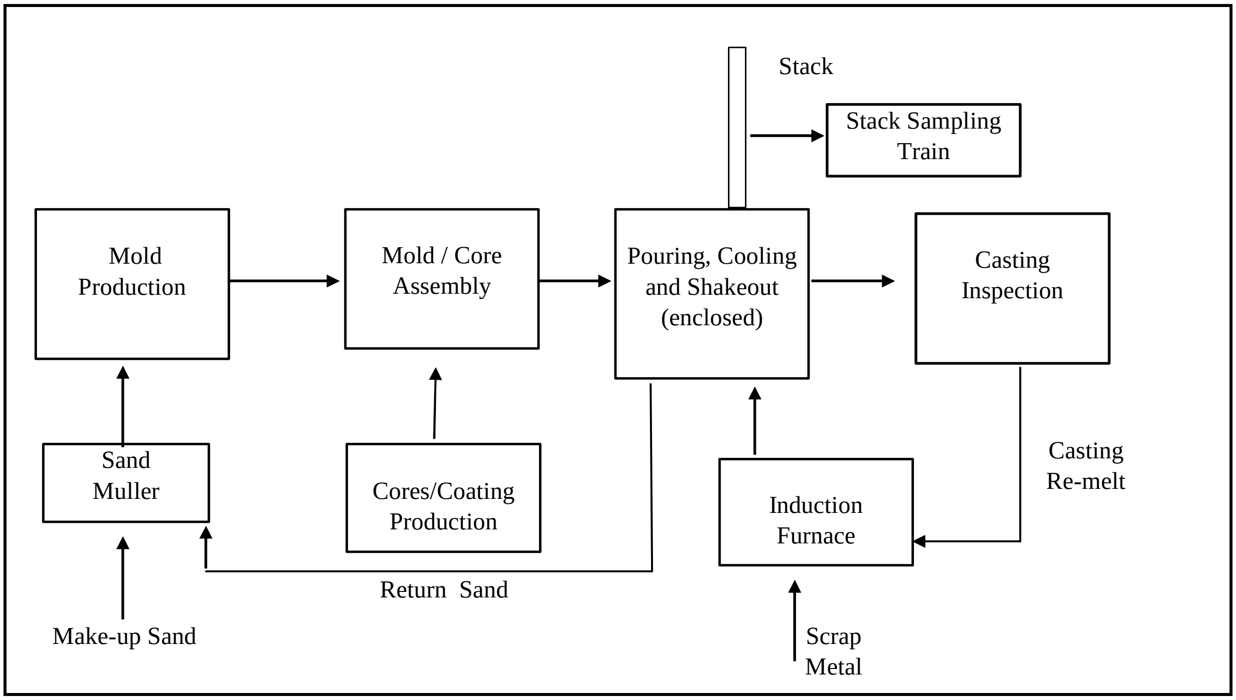
| | Test Plan | Test Plan |
|---|---|---|
| **Type of Process tested** | Coated Phenolic Urethane Core, Greensand without Seacoal, Iron PCS Baseline | Coated ECOLOTEC® Core, Greensand without Seacoal, Iron PCS Product Test |
| **Test Plan Number** | 1410 124 FQ | 1411 111 GE |
| **Greensand System** | Wexford W450, Western and Southern Bentonite | Wexford W450, Western and Southern Bentonite |
| **Metal Poured** | Iron | Iron |
| **Casting Type** | 4-on Step Core | 4-on Step Core |
| **Core** | 1.4% Ashland ISOCURE® 305/904 | 2% Foseco ECOLOTEC ® 750 |
| **Core Coating** | Ashland Velvaplast® CGW 9022SL | Foseco RHEOTEC® XL-40 |
| **Number of molds poured** | 3 Conditioning + 9 Sampling | 3 Conditioning + 9 Sampling |
| **Test Dates** | 12/18/03 < 12/23/03 | 8/24/04 < 8/27/04 |
| **Emissions Measured** | TGOC as Propane, HC as Hexane, 69 Organic HAPs and VOCs | TGOC as Propane, HC as Hexane, 70 Organic HAPs and VOCs |
| **Process Parameters Measured** | Total Casting, Mold, Binder Weights; Metallurgical data, % LOI; Stack Temperature, Moisture Content, Sand Temperature, Pressure, and Volumetric Flow Rate | Total Casting, Mold, Binder Weights; Metallurgical data, % LOI; Stack Temperature, Moisture Content, Sand Temperature, Pressure, and Volumetric Flow Rate |

# 2.0 Test Methodology

## 2.1 DESCRIPTION OF PROCESS AND TESTING EQUIPMENT

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

**Figure 2-1 Pre-Production Foundry Layout Diagram**




## 2.2 DESCRIPTION OF TESTING PROGRAM

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

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


*Coated Step Cores*

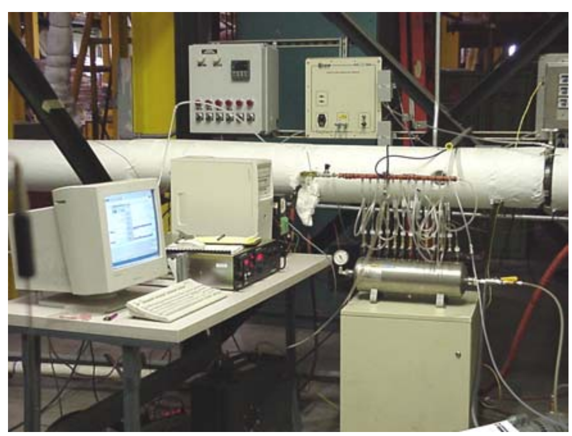
2. **Mold, Core and Metal Preparation:** The molds and cores were prepared to a standard composition by the Technikon production team. The cores were blown in a Redford/Carver core blower and then coated with the vendor supplied core coating. Relevant process data were collected and recorded. Iron was 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.

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

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

*Mold and Step Cores*

*Total Enclosure Test Stand*



*Method 25A (TGOC) and Method 18 Sampling Train*

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

### Table 2-1 Process Parameters Measured

| Parameter | Analytical Equipment and Methods |
|---|---|
| Mold Weight | Cardinal 748E platform scale (Gravimetric) |
| Casting Weight | Cardinal 748E platform scale (Gravimetric) |
| Muller water weight | Cardinal 748E platform scale (Gravimetric) |
| Binder Weight | Mettler SB12001 Digital Scale (Gravimetric) |
| Volatiles | Mettler PB302 Scale (AFS Procedure 2213-00-S) |
| LOI, % at Mold and Shakeout | Denver Instruments XE-100 Analytical Scale (AFS procedure 5100-00-S) |
| **Metallurgical Parameters** | |
| Pouring Temperature | Electro-Nite DT 260 (T/C Immersion Pyrometer) |
| Carbon/Silicon Fusion Temperature | Electro-Nite DataCast 2000 (Thermal Arrest) |
| Alloy Weights | Ohaus MP2 Scale |
| Mold Compactability | Dietert 319A Sand Squeezer (AFS Procedure 2221-00-S) |
| Carbon/Silicon | Electro-Nite DataCast 2000 (thermal arrest) |

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

### Table 2-2 Sampling and Analytical Methods

| Measurement Parameter | Test Method |
|---|---|
| Port Location | EPA Method 1 |
| Number of Traverse Points | EPA Method 1 |
| Gas Velocity and Temperature | EPA Method 2 |
| Gas Density and Molecular Weight | EPA Method 3a |
| Gas Moisture | EPA Method 4, gravimetric |
| HAPs Concentration | EPA Method 18, TO11, NIOSH 1500, 2002, OSHA 7 |
| VOCs Concentration | EPA Method 18, 25A, TO11, NIOSH 1500, 2002, OSHA 7 |
| 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.

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

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

7. **<u>Report Preparation and Review</u>:** 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 <u>Technikon Emissions Testing and Analytical Testing Standard Operating Procedures.</u> In order to ensure the timely review of critical quality control parameters, the following procedures are followed:

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

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

## 3.0 Test Results

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

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

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

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

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

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

Casting quality pictures are shown in Appendix C.

The ranking of casting appearance is in Table 3-4.

## Table 3-1 Summary of Test Series FQ and GE Average Results – Lb/Lb Binder

| Analytes | Test FQ Lb/Lb Binder | Test GE Lb/Lb Binder | % Change from Baseline |
|---|---|---|---|
| **TGOC as Propane** | 0.0974 | 0.0319 | **-67** |
| **HC as Hexane** | 0.0232 | 0.0127 | **-45** |
| **Sum of Target Analytes** | 0.0341 | 0.0147 | **-57** |
| **Sum of HAPs** | 0.0327 | 0.0127 | **-61** |
| **Sum of POMs** | 0.0055 | 0.0002 | **-96** |
| **Individual Organic HAPs** | | | |
| **Phenol** | 0.0107 | 0.0017 | **-84** |
| **Benzene** | 0.0096 | 0.0037 | **-61** |
| **Methylnaphthalenes** | 0.0028 | ND | **NA** |
| **Aniline** | 0.0027 | ND | **NA** |
| **o,m,p-Cresol** | 0.0022 | 0.0016 | **-27** |
| **Toluene** | 0.0019 | 0.0013 | **-32** |
| **Naphthalene** | 0.0017 | 0.0001 | **-94** |
| **Dimethylnaphthalenes** | 0.0010 | ND | **NA** |
| **o,m,p-Xylene** | 0.0008 | 0.0010 | 25 |
| **Acetaldehyde** | 0.0005 | 0.0023 | **360** |
| **Formaldehyde** | 0.0001 | 0.0002 | **100** |
| **Propionaldehyde** | <0.0001 | 0.0002 | NA |
| **Ethylene Glycol Phenyl Ether** | NT | 0.0001 | NA |
| **Other VOCs** | | | |
| **Trimethylbenzenes** | 0.0005 | 0.0009 | **80** |
| **Dimethylphenols** | 0.0001 | 0.0006 | **500** |
| **Butyraldehyde/Methacrolein** | 0.0001 | 0.0003 | **200** |
| **Other Analytes** | | | |
| **Carbon Dioxide** | 2.654 | 0.5135 | **-81** |
| **Carbon Monoxide** | 0.0194 | 0.1731 | **792** |
| **Nitrogen Oxides** | NT | 0.0003 | 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 FQ. These results do not have the accuracy of the continuous monitoring results in Test GE.

## Table 3-2 Summary of Test Series FQ and GE Average Results – Lb/Tn Metal

| Analytes | Test FQ Lb/Tn Metal | Test GE Lb/Tn Metal | % Change from Baseline |
|---|---|---|---|
| **TGOC as Propane** | 0.7255 | 0.3010 | **-59** |
| **HC as Hexane** | 0.1726 | 0.1204 | **-30** |
| **Sum of Target Analytes** | 0.2737 | 0.1409 | **-49** |
| **Sum of HAPs** | 0.2630 | 0.1217 | **-54** |
| **Sum of POMs** | 0.0411 | 0.0010 | **-98** |
| **Individual Organic HAPs** | | | |
| **Phenol** | 0.0794 | 0.0160 | **-80** |
| **Benzene** | 0.0717 | 0.0352 | **-51** |
| **Methylnaphthalenes** | 0.0211 | ND | **NA** |
| **Aniline** | 0.0203 | ND | **NA** |
| **o,m,p-Cresol** | 0.0165 | 0.0156 | -5 |
| **Toluene** | 0.0145 | 0.0128 | **-12** |
| **Naphthalene** | 0.0124 | 0.0010 | **-92** |
| **Dimethylnaphthalenes** | 0.0076 | ND | **NA** |
| **o,m,p-Xylene** | 0.0062 | 0.0095 | **53** |
| **Acetaldehyde** | 0.0037 | 0.0222 | **500** |
| **Formaldehyde** | 0.0008 | 0.0019 | **138** |
| **Propionaldehyde** | 0.0003 | 0.0017 | **467** |
| **Ethylene Glycol Phenyl Ether** | NT | 0.0021 | NA |
| **Other VOCs** | | | |
| **Trimethylbenzenes** | 0.0038 | 0.0083 | **118** |
| **Dimethylphenols** | 0.0009 | 0.0059 | **556** |
| **Butyraldehyde/Methacrolein** | 0.0005 | 0.0029 | **480** |
| **Other Analytes** | | | |
| **Carbon Dioxide** | 19.77 | 4.845 | **-75** |
| **Carbon Monoxide** | 0.1451 | 1.633 | **1025** |
| **Nitrogen Oxides** | NT | 0.0024 | 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 FQ. These results do not have the accuracy of the continuous monitoring results in Test GE.

## Table 3-3 Summary of Test Series FQ and GE Average Process Parameters

| Greensand PCS with Anti-Veining Core Additive | | |
|---|---|---|
| | FQ Coated Core Baseline w/o Coal | GE Foseco Core |
| Test Dates | 12/17-23/03 | 4/5-7/04 |
| Cast weight (all metal inside mold), Lbs. | 106.9 | 113.5 |
| Pouring time, sec. | 25 | 18 |
| Pouring temp ,°F | 2630 | 2635 |
| Pour hood process air temp at start of pour, °F | 87 | 88 |
| Mixer auto dispensed batch weight, Lbs | 51.40 | 50.25 |
| Calibrated auto dispensed binder weight, Lbs | 0.727 | 1.006 |
| Core binder calibrated weight, %BOS | 1.41 | 2.00 |
| Core binder calibrated weight, % | 1.39 | 1.96 |
| Total uncoated core weight in mold, Lbs. | 28.52 | 27.32 |
| Total binder weight in mold, Lbs. | 0.398 | 0.536 |
| Core coating weight, Lbs | 0.333 | 0.360 |
| Core coating sp.gr., deg. Bē | NA | 39 |
| Sand temperature. Deg F | NA | 72 |
| Core LOI, % | 1.37 | 1.02 |
| Core dogbone 2 hour tensile, psi | ND | 76 |
| Core age, hours | 133 | 73 |
| Muller batch weight, Lbs. | 900 | 900 |
| GS mold sand weight, Lbs. | 613 | 645 |
| Mold compactability, % | 55 | 55 |
| Mold temperature, °F | 76 | 82 |
| Average green compression , psi | 13.4 | 22.9 |
| GS compactability, % | 45 | 50 |
| GS moisture content, % | 1.94 | 2.42 |
| GS MB clay content, % | 6.18 | 8.26 |
| MB clay reagent, ml | 26.4 | 31.8 |
| 1800°F LOI - mold sand, % | 0.83 | 1.00 |
| 900°F volatiles , % | 0.38 | 0.36 |

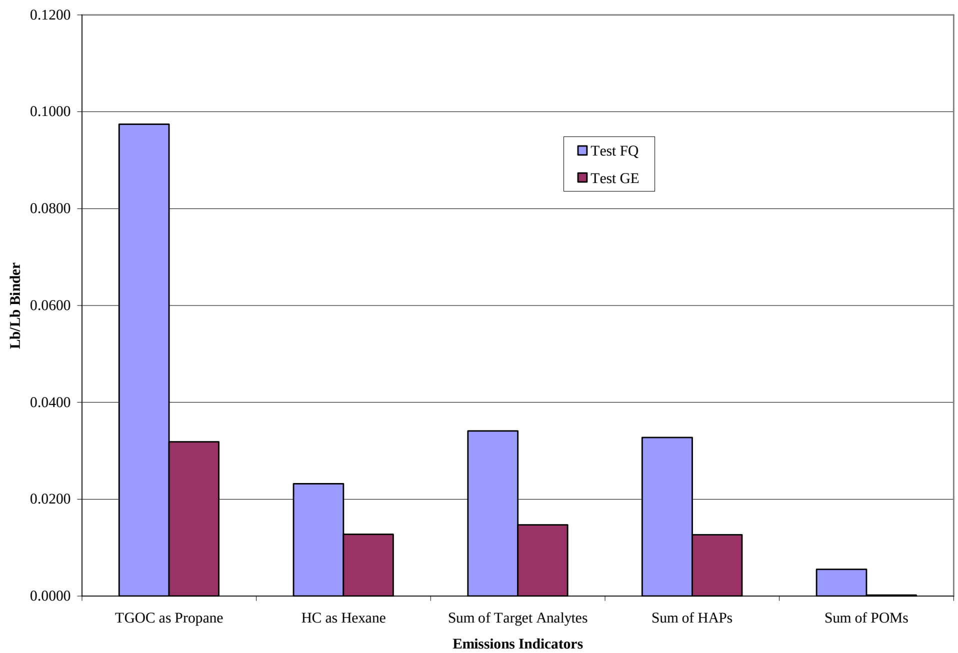
ND: Not Determined

## Table 3-4 Casting Quality Data for Test Plan FQ and Test Plan GE

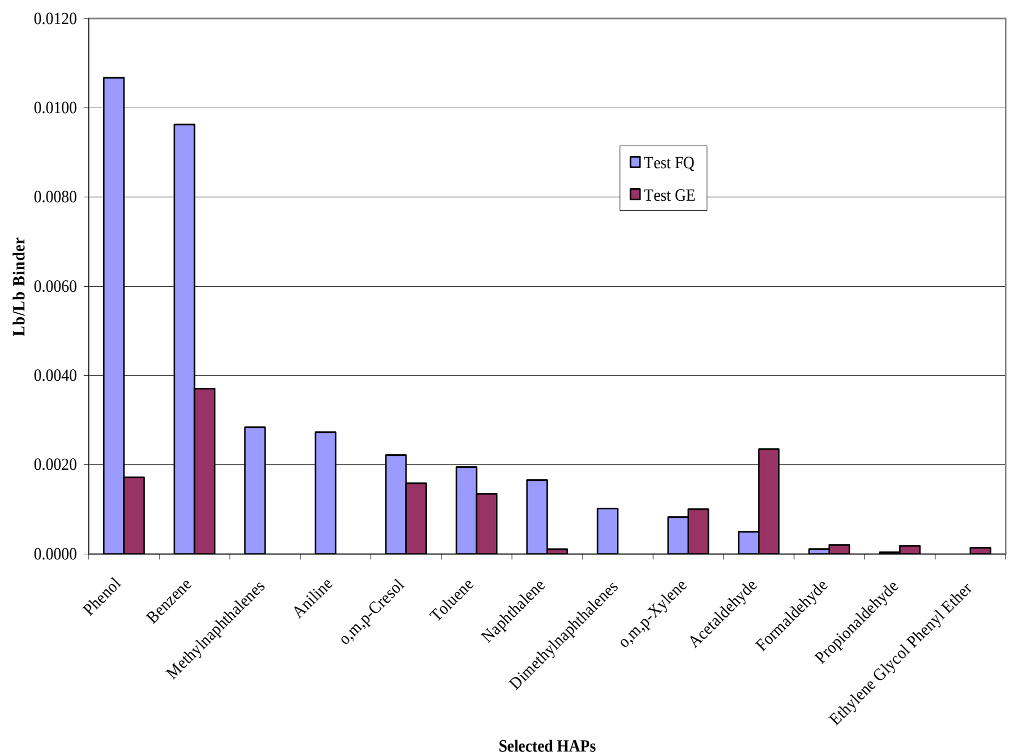
| Overall Casting Appearance | Emission Mold Number | |
|---|---|---|
| **Best** 1 | FQ007 | |
| 2 | FQ003 | |
| 3 | FQ008 | |
| 4 | FQ001 | |
| 5 | FQ005 | |
| 6 | FQ002 | |
| 7 | FQ006 | |
| 8 | FQ009 | |
| 9 | FQ004 | |
| 10 | | GE003 |
| 11 | | GE004 |
| 12 | | GE002 |
| 13 | | GE005 |
| 14 | | GE009 |
| 15 | | GE006 |
| 16 | | GE001 |
| 17 | | GE007 |
| **Worst** 18 | | GE008 |

**Note:** The comparative photos in Appendix C do not demonstrate that all of the GE castings appeared to have an oxidized surface that was covered with small pits. The pits do not appear to be a metallurgical slag. They appear to be of gaseous origin or ash particulates.

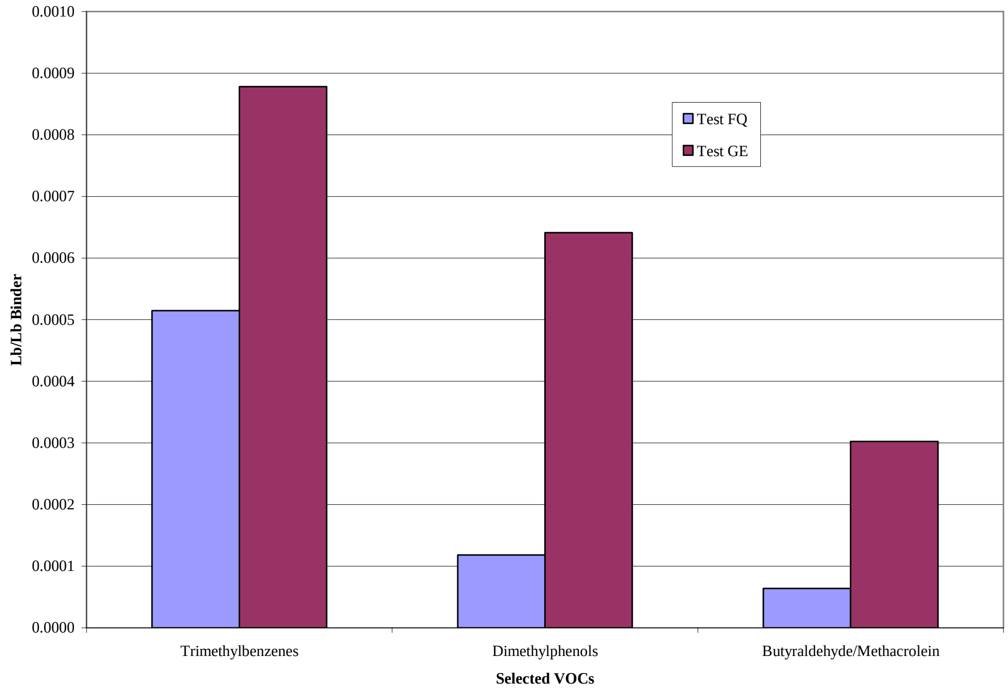
## Figure 3-1 Emission Indicators from Test Series FQ and GE – Lb/Lb Binder



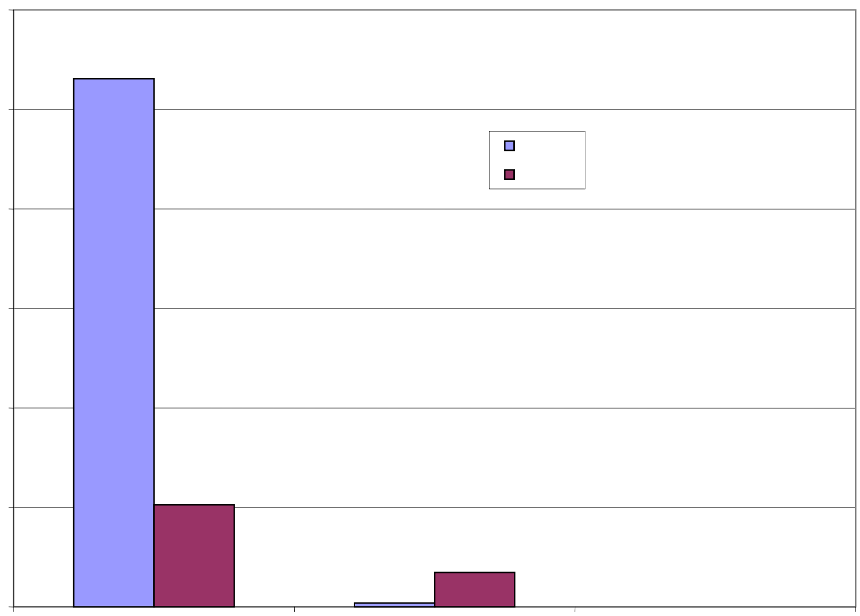

## Figure 3-2 Selected HAP Emissions from Test Series FQ and GE – Lb/Lb Binder



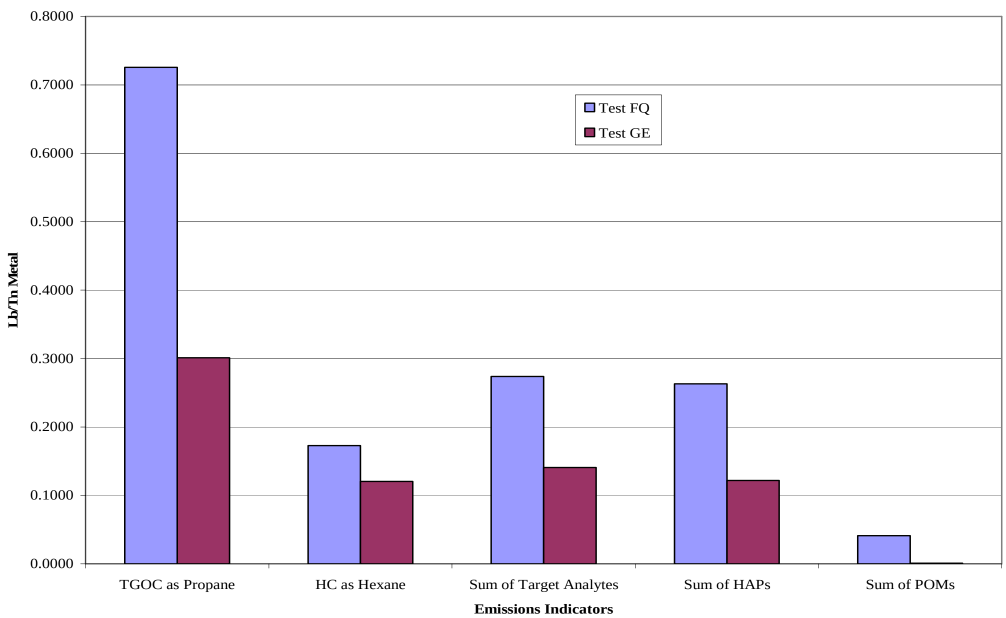
## Figure 3-3 Selected VOC Emissions from Test Series FQ and GE – Lb/Lb Binder




## Figure 3-4 Selected Criteria Pollutants Lb/Lb Binder



## Figure 3-5 Emissions Indicators from Test Series FQ and GE – Lb/Tn Metal




## Figure 3-6 Selected HAPs Emissions from Test Series FQ and GE – Lb/Tn Metal

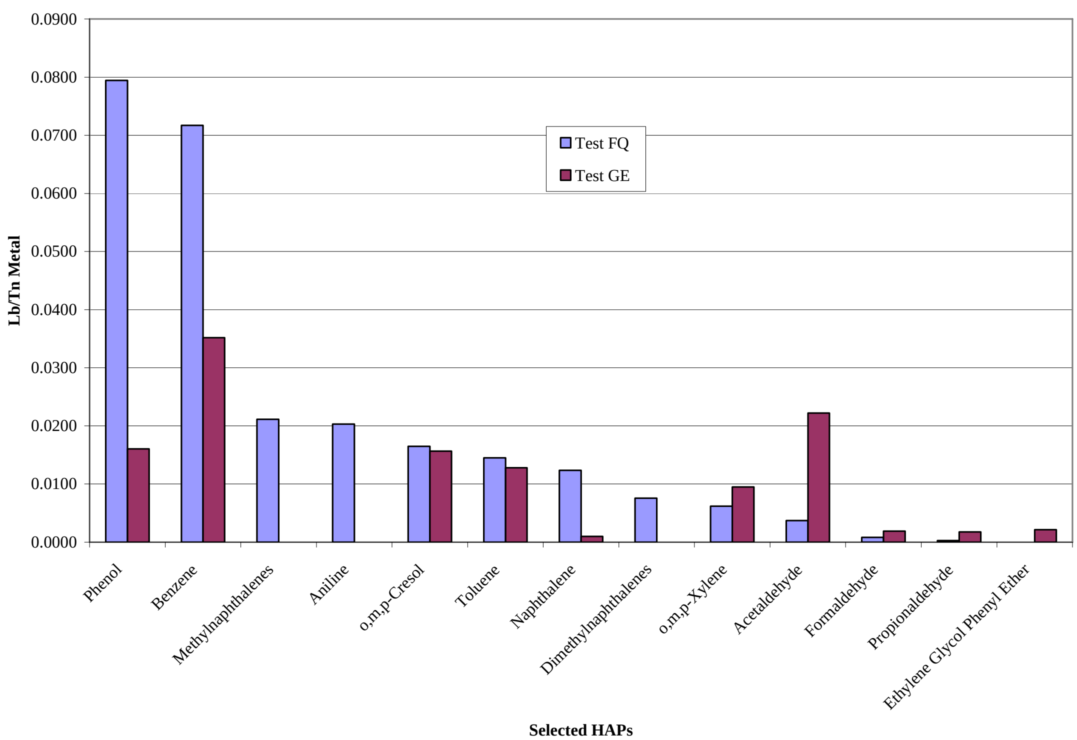


**Figure 3-7 Selected VOC Emissions from Test Series FQ and GE – Lb/Tn Metal**

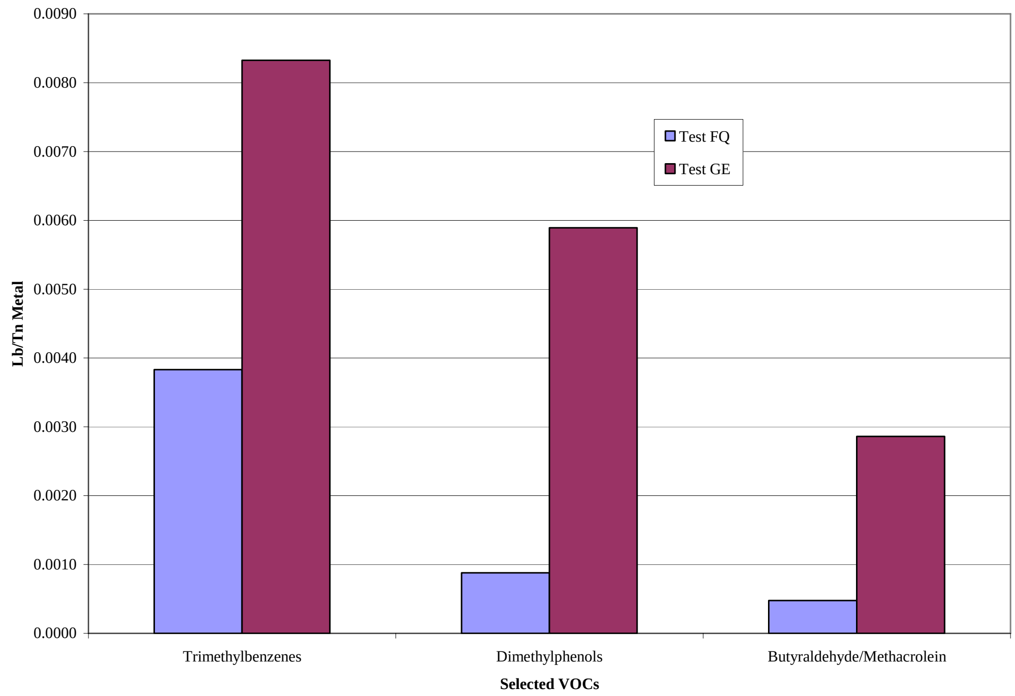
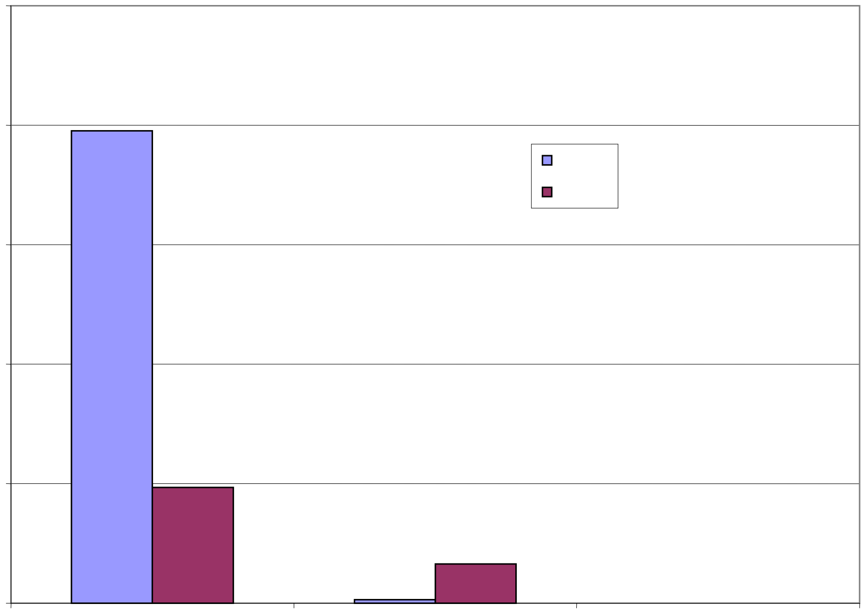



**Figure 3-8 Selected Criteria Pollutants Lb/Tn Metal**



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# 4.0 Discussion of Results

The sampling and analytical methodologies were the same for Test Plans FQ and GE except for the determination of carbon monoxide, carbon dioxide, and nitrogen oxides. Carbon monoxide and carbon dioxide were collected in a Tedlar bag for offsite analysis on Test FQ and were determined on-line with NIST traceable monitors for Test GE. The on-line monitors provide significantly more accurate data than the bag samples. Similarly, the nitrogen oxides were not tested for under Test FQ, but were determined on-line for Test GE. See Appendix B for the detailed results.

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

The results of the tests performed for the comparison of Test FQ to Test GE show a **67%** reduction in TGOC (THC) as propane, a **45%** reduction in HC as hexane, a **57%** reduction in Sum of target analytes, a **61%** reduction in Sum of HAPs, and a **96%** reduction in Sum of POMs when expressed in pounds per ton of metal.

Sixteen (16) of the measured compounds comprised greater than 95% of the mass of all target analytes detected by the coated ECOLOTEC® core in Greensand with seacoal test series and the baseline test series combined. Both phenol and benzene comprised approximately 30% each of the total HAPs and VOCs for the baseline Test FQ when expressed in pounds per ton of metal. For Test GE, benzene was found to be the largest contributor to the total HAPs and target analytes followed by acetaldehyde and phenol at approximately 27%, 17%, and 12% respectively. See Table 3-2.

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

The HC as hexane emission indicator was found to be lower than the total Sum of target analytes for both Tests FQ and GE. This is probably due, in part, to the relatively high amounts of phenol, cresols, and acetaldehyde in the emissions that would not be completely recovered by the HC as hexane method.

Carbon dioxide and methane were detected in the ambient sample for Test FQ. No samples were background corrected. Carbon dioxide and carbon monoxide (a criteria pollutant) were detected in the ambient samples for test GE and all samples were background corrected. The carbon dioxide and carbon monoxide results were generated via the collection of bag samples for Test FQ. These results do not have the accuracy of the continuous monitoring results in Test GE.

Additional analyses were performed for o-toluidine (Test FQ), butyl carbitol, and ethylene glycol phenyl ether (Test GE) which are included as HAPs on the Clean Air Amendment Act 1990 analyte list. Detailed data are found in Appendix B of this report.

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

The general textures of the cored surfaces were only slightly inferior to the reference castings FQ. Most notable was the total absence of core fins that would be beneficial in casting geometries that aggravate such defects. These castings were judged categorically inferior to the reference castings only because of the pervasive presence of surface gas holes particularly in the lighter casting sections. Frequently core veining can be removed at some cost by mechanical means when accessible but holes in a casting as from gas holes are usually fatal for a casting for a variety of reasons.

# APPENDIX A APPROVED TEST PLANS AND SAMPLE PLANS FOR TEST SERIES FQ AND GE

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# Technikon Test Plan

- > **CONTRACT NUMBER:** 1410 **TASK NUMBER:** 1.2.4 **Series:** FQ
- > **SITE:** Pre-production
- > **TEST TYPE:** Baseline: Coated Core Greensand, pouring, cooling, shakeout
- > **METAL TYPE:** Class-30 gray iron
- > **MOLD TYPE:** 4-on coated step-cored greensand with no seacoal**.**
- > **NUMBER OF MOLDS:** 1-3 engineering +3 conditioning + 9 Sampling
- > **CORE TYPE:** Step: 1.4 % Ashland Isocure ® Phenolic Urethane LF305 part I (55%), 904GR Part II (45%), amine cured. 50-120 hrs old.
- > **CORE COATING:** Ashland Velvaplast® CGW 9022 SL
- > **SAMPLE EVENTS:** 9
- > **TEST DATE:** **START:** 15 Dec 2003
  **FINISHED:** 9 Jan 2004

**TEST OBJECTIVES:**

Establish an Emission baseline (pouring, cooling, & shakeout) for the standard coated-core mechanically-produced clay, water, coal-less greensand mold.

**VARIABLES**:

The pattern will be the 4-on step core. The mold will be made with Wexford W450 sand, western and southern bentonite in a 5:2 ratio to yield 7.0 +/- 0.5% MB Clay, no seacoal, and tempered to 40-45% compactability, mechanically compacted. The molds will be maintained at 80-90$^{o}$F prior to pouring. The sand heap will be maintained at 900 pounds. Molds will be poured with iron at 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, followed by 15 minutes additional sampling for a total of 75 minutes. The core coating material, and weight or thickness, and application method will be developed by Ashland Chemical. They will instruct Technikon personnel as to the procedure. This core coating procedure shall become the standard for future product testing.

**BRIEF OVERVIEW:**

This is the first test to include coated cores as the standard. It underscores the increased awareness that along with emission reduction must go maintenance of casting quality and cost. These greensand molds will be produced on mechanically assisted Osborne molding machines. (Ref. CERP test FH). The new 4-on step-core standard mold is a 24 x 24 x 10/10 inch 4-on array of AFS standard drag only step core castings to make a new baseline against which future coated core products can be compared.

**SPECIAL CONDITIONS**:

The process will include rigorous maintenance of the size of sand heap and maintenance of the material and environmental testing temperatures to reduce seasonal and daily temperature dependent influence on the emissions. Initially a 1300 pound greensand heap will be created from a single muller batch. Nine hundred pounds will become the re-circulating heap. The balance will be used to makeup for attrition. Cores will be produced with Wexford W450 sand at 85-90$^{o}$F. The core coating shall be dried with a surface temperature of 250-300$^{o}$F and immediately cooled to and maintained at 80-90$^{o}$F awaiting insertion in the mold. The cores shall be coated and dried within 1 hour of manufacture and be 50-120 hours old when tested.

# Series FQ

## *PCS Greensand Core Baseline with Ashland 305/904 core binder & Mechanized Molding*

## Process Instructions

**A.** Experiment:

1. Create a coated organic core-in-greensand baseline. Measure emissions from a greensand mold made with all virgin Wexford W450 sand, bonded with Western & Southern Bentonite in the ratio of 5:2 to yield 7.0 +/- 0.5% MB Clay, & no seacoal. The molds shall be tempered with potable water to 40-45% compactability, poured at constant weight, temperature, surface area, & shape factor. This test will recycle the same mold material, replacing burned clay with new materials after each casting cycle and providing clay for the retained core sand.

**B.** Materials:

1. Mold sand: Virgin mix of Wexford W450 lake sand, western and southern bentonites in ratio of 5:2, and potable water per recipe.
2. Core: Coated step core made with virgin Wexford W450 sand and 1.4% Ashland Isocure® LF305/52-904GR regular phenolic urethane binder in a 55/45 ratio, TEA catalyzed.
3. Core coating: Ashland Velvaplast® CGW 9022 SL
4. Metal: Class-30 gray cast iron poured at 2630 +/- 10$^{o}$F.
5. Pattern Spray: Black Diamond, hand wiped.

**C.** Briefing:

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

**Caution:** Observe all safety precautions attendant to these operations as delineated in the Preproduction operating and safety instruction manual.

**D.** ISOCURE® Regular Step Cores:

1. Klein vibratory core sand mixer.
   - **a.** Attach the day tanks with the intended part I and part II binder components via respective binder shut-off valves so that they gravity feed to the respective pumps. The binder components should be 80-85$^{o}$F.
   - **b.** On the main control panel turn the AUTO/MAN switch to MANUAL, turn on main disconnects and MASTER START push button.
   - **c.** Fill the Part I and Part II pumps and de-air the lines.

**d.** Turn on the Kloster heater-cooler and set the set-point at 90$^{o}$F.

**(1)** Wait until the sand temperature reaches the set-point to mix sand.

**e.** Conduct a capability study on material fill rates.

**(1)** Remove the mixing bowl skirt to gain access to the binder injection tubes and the bottom side of the batch hopper outlet gate.

**(2)** Calibrate sand.

**(a)** Turn the AUTO/MAN switch to MANUAL on main control panel.
**(b)** Place one bucket of sand, of at least fifty-two (52) pounds net weight, into the sand hopper and manually fill batch hopper using max. and min. proximity switches.
**(c)** Discharge the sand from the batch hopper using the single cycle push button. Catch the sand as it leaves the batch hopper and record the net weight and the dispensing time.
**(d)** Repeat 10 times to determine the weight variation. The sand should be 80-85$^{o}$F.

**(3)** Calibrate the binder pumps.

**(a)** Adjust the part I dispensing rate by adjusting the part I pump stroke to be 55% of 1.4 % (0.77 % BOS) of the average sand batch weight dispensed in D.1.e.2.d.
**(b)** Adjust the machine's inlet air pressure to dispense the binder in about the same time as the sand is dispensed, about 10-15 seconds.
**(c)** Record the pressure and dispensing time, and net weight.
**(d)** Repeat 10 times to determine the variation in dispensing rate.
**(e)** Adjust the part II dispensing rate by adjusting the part II pump stroke to be 45 % of 1.4 % (.63% BOS) of the average sand rate dispensed in D.1.e.2.d.
**(f)** Repeat D.1.e.3.c, & d for Part II pump.

**(4)** Turn off the mixer and replace the mixing bowl skirt.

**f.** Turn on the mixer and turn the AUTO/MAN switch to AUTO.
**g.** Press the SINGLE CYCLE push button on the operator's station to make a batch of sand. Make four batches to start the Redford Carver core machine.
**h.** Make a batch of sand for every 7 core machine cycles when using the step core. About two (2) batches will be retained in the core machine sand magazine.

**Caution:** Do not make more sand than sand magazine will hold plus one (1) batch. If too much sand is made the sand will be exposed to captured TEA and significantly shorten the sand bench life

**2.** Redford/Carver core machine

**a.** Mount the Step-Core core box on the Carver/Redford core machine.
**b.** Start the core machine auxiliary equipment per the Production Foundry OSI for that equipment.
**c.** Set up the core machine in the cold box mode with gassing and working pressures and gas and purge time according to the core recipe sheet.
**d.** Core process setup

**(1)** Set the TEA to a nominal 5 grams per blow (gas time 0.75 sec (R/C), flow .019 lbs/sec (Luber).
**(2)** Set the blow pressure to 30+/-2 psi for 3 seconds (R/C).
**(3)** Set the max purge pressure to 45 psi on the Luber gas generator.
**(4)** Purge for 20 seconds(R/C) with a 10 second rise time (Luber).
**(5)** Total cycle time approximately 1 minute.

**e.** Run the core machine for three (3) cycles and discard the cores. When the cores appear good begin test core manufacture. Five (5) good cores are required for each mold. Make nine (9) additional 50 pound sand batches and run the sand out making core. A minimum of 60 cores are required.
**f.** One half hour to 1 hour after manufacture randomly perform a scratch hardness test on the outer edge of the blow surface on 10 % of the cores and record the results on the Core Production Log. Values less than 25 shall be marked with a HOLD TAG until they can be 100 % scratch hardness tested to re-qualify. Contact the Process Engineer for disposition on all cores with values less than 15 after 1 hour. Weigh each core and log the results.
**g.** The sand lab will sample, at the time of manufacture, one (1) core from each row of each shelf (1 of 11) on each core rack. Those cores will be tested for LOI using the standard 1800 oF core LOI test method and reported out associated with the core rack shelf it represents. Qualified cores receiving the green Quality Checked tag must have LOI values between 1.25-1.50 %. Individual rows that qualify may have the Quality Checked tag affixed. Only cores with the green Quality Tag bearing the current test series and dates and signature of the lab technician and core rack/shelf/position on shelf may be taken to the mold assembly area.

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

**h.** The sand lab will sample one (1) core from the core rack for each mold produced just prior to the emission test to represent the four (4) cores placed in that mold. Those cores will be tested for LOI using the standard 1800 oF core LOI test method and reported out associated with the test mold it is to represent.

**3.** Core coating.

a. Ashland Velvaplast® CGW 9022 SL core coating material will be used to dip-coat the cores.
b. Weigh the uncoated core and log the weight.
c. Coat the entire core up to the ½ inch from the invest side.
d. Normalize the core coating temperature to 70 -80$^{o}$F.
e. Dip the core into the core wash and hold for a count of two (2).
f. Shake the core vertically until the coating ceases to drip.
g. Weigh the wet core and log the weight.
h. Place the core invest side down on the OSI oven lear (chain belt).
i. Dry the core at 275$^{o}$F for 1 hour in the OSI core drying oven.
j. Weigh the dried and cooled coated core and log the weight.

**E.** Sand preparation

**1.** Start up batch: make 1, FQCD1.

a. Thoroughly clean the pre-production muller elevator and molding hoppers.
b. Weigh and add 1225 +/-10 pounds of new Wexford W450 Lakesand, per the recipe, to the running pre-production muller to make a 1300 batch.
c. Add 5 pounds of potable to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.
d. Add the clays slowly to the muller to allow them to be distributed throughout the sand mass in proportion to the sand weight per the recipe for this test.
e. Dry mull for about 3 minutes to allow distribution and some grinding of the clays to occur.
f. Temper the sand-clay mixture slowly, with potable water, to allow for distribution.
g. After about 2 gallons of water have been added allow 30 seconds of mixing then start taking compactability test samples.
h. Based on each test add water incrementally to adjust the temper. Allow 1 minute of mixing. Retest. Repeat until the compactability is in the range 40-45%.
i. Discharge the sand into the mold station elevator.
j. Grab sufficient sample after the final compactability test to fill a quart zip-lock bag. Label bag with the test series and sequence number, date, and time of day and deliver it immediately to the sand lab for analysis
k. Record the total sand mixed in the batch, the total of each type of clay added to the batch, the amount of water added, the total mix time, the final compactability and sand temperature at discharge.
l. The sand will be characterized for Methylene Blue Clay, AFS clay, Moisture content, Compactability, Green Compression strength, 1800 oF loss on ignition (LOI), and 900 oF volatiles. Each volatile and LOI test requires a separate 50 gram sample from the collected sand.
m. Empty the extra greensand from the mold hopper into a clean empty dump hopper whose tare weight is known. Set this sand aside to be used to maintain the recycled batch at 900+/-10 pounds

**2.** Re-mulling: FQCD2

**a.** Add to the sand recovered from poured mold FQCD1 sufficient pre-blended sand so that the sand batch weight is 900 +/- 10 pounds. Record the sand weight.
**b.** Return the sand to the muller and dry blend for about one minute.
**c.** Add the clays, as directed by the process engineering staff, slowly to the muller to allow them to be distributed throughout the sand mass.
**d.** Add 5 pounds of water to the muller to suppress dust distributing it across the sand. Allow to mix for 1 minute.
**e.** Follow the above procedure beginning at E.1.f.

**3.** Re-mulling: FQCD3, FQ001-FQ0XX

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

**F.** Molding: Step core pattern.

**1.** Pattern preparation:

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

**2.** Making the green sand mold.
**a.** Mount the drag pattern on one Osborne Whisper Ram molding machine and mount the cope pattern on the other Osborne machine.
**b.** Lightly rub parting oil from a damp oil rag on the pattern particularly in the corners and recesses.

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

**3.** Mount a cope follower board containing a pour cup pattern to the underside of the squeeze head plate.
**4.** Check the alignment of the pour cup by manually raising the table using the squeeze bypass valve at the bottom rear of the machine until the sprue pierces the pour cup pattern. Move the pour cup pattern as necessary.
**5.** Use the overhead crane to place the pre-weighed drag/cope flask on the mold machine table, parting line surface down.

6. Locate a 24 x 24 x4 inch deep wood upset on top of the flask.
7. Make the green sand mold cope or drag on the Osborn Whisper Ram Jolt-Squeeze mold machine

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

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

- **a.** Open the air supply to the mold machine.

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

- **b.** On the operator's panel turn the POWER switch to ON.
- **c.** Turn the RAM-JOLT-SQUEEZE switch to ON.
- **d.** Turn the DRAW UP switch to AUTO
- **e.** Set the PRE-JOLT timer to 4-5 seconds.
- **f.** Set the squeeze timer to 8 seconds.
- **g.** Set the crow-footed gagger on the support bar. Verify that it is at least ½ inch away from any pattern parts.
- **h.** Manually riddle a half to one inch or so of sand on the pattern using a ¼ inch mesh riddle. Source the sand from the overhead mold sand hopper by actuating the CHATTER GATE valve located under the operators panel.
- **i.** Fill the center potion of the flask.
- **j.** Manually move sand from the center portion to the outboard areas and hand tuck the sand.
- **k.** Finish filling the 24 x 24 x 10 inch flask and the upset with greensand from the overhead molding hopper.
- **l.** Manually level the sand in the upset. By experience manually adjust the sand depth so that the resulting compacted mold is fractionally above the flask only height.
- **m.** Initiate the settling of the sand in the flask by pressing the PRE-JOLT push button. Allow this cycle to stop before proceeding.
- **n.** Remove the upset and set it aside.

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

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

- **o.** Using both hands initiate the automatic machine sequence by simultaneously pressing, holding for 2-3 seconds, and releasing the green push buttons on either side of the operators panel. The machine will squeeze and jolt the sand in the flask and then move the squeeze head to the side.

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

- **p.** Screed the bottom of the drag mold flat to the bottom of the flask if required.
- **q.** Press and release the LOWER DRAW/STOP push button to separate the flask and mold from the pattern.
- **r.** Use the overhead crane to lift the mold half and remove it from the machine. If the mold half is a drag, roll it parting line side up, set it on the floor, blow it out.
- **s.** Finally, press and release the DRAW DOWN pushbutton to cause the draw frame to return to the start position.

**8.** Set four (4) step cores that have been weighed and logged into the drag. Verify that the cores are fully set and flush with the parting line.
**9.** Close the cope over the drag being careful not to crush anything.
**10.** Clamp the flask halves together.
**11.** Weigh and record the weight of the closed un-poured mold, the pre-weighed flask, the coated cores, and the sand weight by difference.
**12.** Measure and record the sand temperature.
**13.** Deliver the mold to the previously cleaned shakeout to be poured.
**14.** Cover the mold with the emission hood.

**G.** Pig molds

**1.** Each day make a 900 pound capacity pig mold for the following day's use.

**H.** Emission hood:

**1.** Loading.

- **a.** Hoist the mold onto the shakeout deck within the emission hood.
- **b.** Close, seal, and lock the emission hood
- **c.** Adjust the ambient air heater control so that the measured temperature of the blended air within the hood is 85-90 oF at the start of the test run.

**2.** Shakeout.

- **a.** After the 45 minute cooling time prescribed in the emission sample plan has elapsed turn on the shakeout unit and run for it the 15 minutes prescribed in the emission sample plan or until the sand has all fallen through the grating.
- **b.** Turn off the shakeout.
- **c.** Sample the emissions for 30 minutes after the start of shakeout, a total of 75 minutes.

**3.** When the emission sampling is completed remove the flask with casting, and recover the sand from the hopper and surrounding floor.

- **a.** Weigh and record the metal poured and the total sand weight recovered and rejoined with the left over mold sand from the molding hopper, spilled molding sand, and sand loosely adhered to the casting.
- **b.** Add sufficient unused premixed sand to the recycled sand to return the sand heap to 900 +/- 10 pounds.

**I.** Melting:

**1.** Initial iron charge:

- **a.** Charge the furnace according to the heat recipe.
- **b.** Place part of the steel scrap on the bottom, followed by carbon alloys, and the balance of the steel.
- **c.** Place a pig on top on top.
- **d.** Bring the furnace contents to the point of beginning to melt over a period of 1 hour at reduced power.
- **e.** Add the balance of the metallics under full power until all is melted and the temperature has reached 2600 to 2700$^{o}$F.
- **f.** Slag the furnace and add the balance of the alloys.
- **g.** 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.
- **h.** Hold the furnace at 2500-2550$^{o}$F until near ready to tap.
- **i.** When ready to tap raise the temperature to 2700$^{o}$F and slag the furnace.
- **j.** Record all metallic and alloy additions to the furnace, tap temperature, and pour temperature. Record all furnace activities with an associated time.

**2.** Back charging.

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

**3.** Emptying the furnace.

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

**J.** Pouring:

**1.** Preheat the ladle.

- **a.** Tap 400 pounds more or less of 2700$^{o}$F iron into the cold ladle.

- **b.** Carefully pour the metal back to the furnace.
- **c.** Cover the ladle.
- **d.** Reheat the metal to 2780 +/- 20$^o$F.
- **e.** Tap 450 pounds of iron into the ladle while pouring inoculating alloys onto the metal stream near its base.
- **f.** Cover the ladle to conserve heat.
- **g.** Move the ladle to the pour position and wait until the metal temperature reaches 2630 +/- 10$^o$F.
- **h.** Commence pouring keeping the sprue full.
- **i.** Upon completion return the extra metal to the furnace, and cover the ladle.
- **j.** Record the pour temperature and pour time on the heat log

Steven M. Knight
Mgr. Process Engineering

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/16/2003** | | | | | | | | | | | **FQ CONDITIONING - RUN 1** |
| **FQ CR-1** | | | | | | | | | | | |
| THC | | x | | | | | | | | | |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/16/2003** | | | | | | | | | | | **FQ CONDITIONING - RUN 2** |
| **FQ CR-2** | | | | | | | | | | | |
| THC | | x | | | | | | | | | |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/17/2003** | | | | | | | | | | | **FQ CONDITIONING - RUN 3** |
| **FQ CR-3** | | | | | | | | | | | |
| THC | | x | | | | | | | | | |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/18/2003** | | | | | | | | | | | |
| RUN 1 | | | | | | | | | | | |
| THC | FQ001 | X | | | | | | | | | TOTAL |
| M-18 | FQ00101 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | | | | | | | | | 60 | 2 | Excess |
| | | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00102 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| Gas, CO, CO2 | FQ00103 | | | | 1 | | | | 0 | | Tedlar Bag |
| NIOSH 1500 | FQ00104 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| NIOSH 1500 | FQ00105 | | | | 1 | | | | 0 | | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00106 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| NIOSH 2002 | FQ00107 | | | | 1 | | | | 0 | | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00108 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| TO11 | FQ00109 | | | | 1 | | | | 0 | | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/18/2003** | | | | | | | | | | | |
| RUN 2 | | | | | | | | | | | |
| THC | FQ002 | X | | | | | | | | | TOTAL |
| M-18 | FQ00201 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 | FQ00202 | | | 1 | | | | | 60 | 2 | Carbopak charcoal |
| M-18 | FQ00203 | | | | 1 | | | | 0 | | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00204 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00205 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| NIOSH 1500 | FQ00206 | | | 1 | | | | | 1000 | 6 | 100/50 mg Charcoal (SKC 226-01) |
| NIOSH 2002 | FQ00207 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00208 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| TO11 | FQ00209 | | | 1 | | | | | 1000 | 10 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/19/2003** | | | | | | | | | | | |
| **RUN 3** | | | | | | | | | | | |
| THC | FQ003 | X | | | | | | | | | TOTAL |
| M-18 | FQ00301 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 | FQ00302 | | | | | 1 | | | 60 | 1 | Carbopak charcoal |
| M-18 MS | FQ00303 | | 1 | | | | | | 60 | 2 | Carbopak charcoal |
| M-18 MS | FQ00304 | | | 1 | | | | | 60 | 3 | Carbopak charcoal |
| Gas, CO, CO2 | FQ00305 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00306 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00307 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| NIOSH 2002 | FQ00308 | | | 1 | | | | | 1000 | 8 | 100/50 mg Silica Gel (SKC 226-10) |
| TO11 | FQ00309 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/19/2003** | | | | | | | | | | | |
| RUN 4 | | | | | | | | | | | |
| THC | FQ004 | X | | | | | | | | | TOTAL |
| M-18 | FQ00401 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 | FQ00402 | | | 1 | | | | | 60 | 2 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00403 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00404 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00405 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00406 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/22/2003** | | | | | | | | | | | |
| RUN 5 | | | | | | | | | | | |
| THC | FQ005 | X | | | | | | | | | TOTAL |
| M-18 | FQ00501 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00502 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00503 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00504 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00505 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/22/2003** | | | | | | | | | | | |
| RUN 6 | | | | | | | | | | | |
| THC | FQ006 | X | | | | | | | | | TOTAL |
| M-18 | FQ00601 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00602 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00603 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00604 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00605 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/22/2003 | | | | | | | | | | | |
| RUN 7 | | | | | | | | | | | |
| THC | FQ007 | X | | | | | | | | | TOTAL |
| M-18 | FQ00701 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00702 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00703 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00704 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00705 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/23/2003 | | | | | | | | | | | |
| RUN 8 | | | | | | | | | | | |
| THC | FQ008 | X | | | | | | | | | TOTAL |
| M-18 | FQ00801 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00802 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00803 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00804 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00805 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION FQ - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **12/23/2003** | | | | | | | | | | | |
| RUN 9 | | | | | | | | | | | |
| THC | FQ009 | X | | | | | | | | | TOTAL |
| M-18 | FQ00901 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| Gas, CO, CO2 | FQ00902 | | 1 | | | | | | 60 | 4 | Tedlar Bag |
| NIOSH 1500 | FQ00903 | | 1 | | | | | | 1000 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 1000 | 6 | Excess |
| NIOSH 2002 | FQ00904 | | 1 | | | | | | 1000 | 7 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 1000 | 8 | Excess |
| TO11 | FQ00905 | | 1 | | | | | | 1000 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 1000 | 10 | Excess |
| | Excess | | | | | | | | 1000 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

# Technikon Test Plan

| | | | | | |
|---|---|---|---|---|---|
| > **CONTRACT NUMBER:** | 1411 | **TASK NUMBER** | 111 | **SERIES** | GE |

> **SITE:** Research Foundry

> **TEST TYPE:** Step core Pour, cool, & shakeout in greensand with no coal

> **METAL TYPE:** Class 30 Gray Iron poured at 2630 F

> **MOLD TYPE:** 4-on step core greensand with no coal

> **NUMBER OF MOLDS:** 12 (3 engineering/conditioning + 9 sampling)

> **CORE TYPE:** Step alkaline phenolic, CO2 activated (Foseco ECOLOTEC 750 ® at 2 .0 % binder

> **CORE COATING:** RHEOTEC XL-40 ® hand dipped from coating as received

> **SAMPLE EVENTS:** 9

> **TEST DATE(S):** **START:** 16 Aug 2004

**FINISH:** 27 Aug 2004

**TEST OBJECTIVES:**

Measure selected PCS HAP & VOC emissions, CO, CO2, NOx, & TGOC from Foseco ECOLOTEC 750 core binder activated with CO2 in greensand with no coal.

**VARIABLES:**

Foseco ECOLOTEC 750 single component binder at 2.0 % (BOS). Binder cure provided by vaporized liquid CO2 at sufficient flow to set the core. The Foseco vaporizing equipment will draw liquid CO2 from a Technikon supplied commercial tank. The client representative will specify the CO2 flow rate and cure time. The R/C core machine will be else wise operated with standard parameters. The Luber TEA generator will be disabled. Wedron 530 sand will be mixed in the Klein mixer with a standard cycle. A total of 60 cores will be made. The cores will be hand dipped in Foseco RHEOTEC XL-40 coating to the core print and dried for 1 hour at 275 F.

The PCS cycle with be the standard 45/15/15 minute cycle but the metal will be poured at 2630 +/- 10$^{o}$F.

**BRIEF OVERVIEW:**

This process is unique in that while the binder is organic the activator, CO2, is not and therefore has the potential for lower net emissions.

**SPECIAL CONDITIONS:**

The sampling environment will be maintained at 85-90$^{o}$F. Foseco is to supply 5 gallons each of ECOLOTEC® 750 core binder, RHEOTEC XL-40® core coating, and CO2 vaporizing equipment. Foseco will provide technical supervision for the core making.

# Series GE

## *PCS: Coated Foseco ECOLOTEC® 750 Core in Greensand with Clay and No Coal, Mechanized Molding*

## Process Instructions

**A.** Experiment:

**1.** Comparative test of coated organic cores in conventional greensand without seacoal. Measure emissions from greensand molds made with all virgin Wexford W450 Lakesand bonded with western & southern bentonite to yield 7.00 +/- 0.5% MB Clay. The molds shall be tempered with potable water to 45-50% compactability, poured at constant weight, temperature, surface area, & shape factor. This test will recycle the same mold material, replacing burned materials after each casting cycle and compensating for core sand dilution.

**B.** Materials:

**1.** Mold sand: Virgin mix of Wexford W450 Lakesand sand, Western & Southern Bentonite in a 5:2 ration for a total of 7% and potable water per recipe. No seacoal will be used.
**2.** Core: Step core made from Wedron 530 sand and 2% (BOS) Foseco ECOLOTEC® 750 single part binder, $CO_2$ gas cured.
**3.** Core Coating: Foseco RHEOTEC® XL-40, hand dipped.
**4.** Metal: Class 30 gray iron poured at 2630 +/- 10$^{o}$F.
**5.** Pattern Spray: Black Diamond, hand wiped.

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

**6.** The following test shall be conducted:
   **a.** Sand batch: Single sand batch to be used for all GE molds.
   **b.** The recycled sand heap shall be maintained at 900+-10 pounds
   **c.** The first three (3) runs will be conditioning runs numbered GECR1-3 and will be monitored by TGOC, CO, $CO_2$, & $NO_x$.
   **d.** Emission sampling will begin on the 4$^{th}$ turn. Nine (9) satisfactory sampling runs numbered GE001-009 will be conducted monitored by both TGOC, CO, $CO_2$, $NO_x$, and sorption tubes. Should a run GE00X need to be repeated the run will be numbered GE00Xa, b, or c etc. The shop supervisor will monitor to assure the numbering consistency of the process data.
   **e.** The shop supervisor and the sampling team technician will coordinate the numbering between the two groups.
   **f.** GECR1: Virgin mix as described above, vented mold.
   **g.** GECR2, GECR3, and GE001-GE0XX: Re-cycled, re-mulled, reconstituted greensand**,** potable water, vented molds.

**C.** Sand preparation

**1.** Start up batch: make 1, GECR1.

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

**b.** Weigh and add 1225 +/-10 pounds of new Wexford W450 sand, per the recipe, to the foundry muller to make a 1300 batch.

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

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

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

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

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

**h.** Based on each test add water incrementally to adjust the temper. Allow 1 minute of mixing. Retest. Repeat until the compactability is in the range 45-50%. Discharge the sand into the mold station elevator.

**i.** Grab sufficient sample from the **mold hopper discharge** to fill a quart zip-lock bag. Label bag with the test series and sequence number, date, and time of day and deliver it immediately to the sand lab for analysis

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

**k.** The sand lab will be immediately characterized for Methylene Blue Clay, Moisture content, Compactability, Green Compression strength, & Green permeability. 1800$^{o}$F loss on ignition (LOI), and 900$^{o}$F volatiles w ill be run at a convenient time. Each volatile and LOI test requires a separate 50 gram sample from the collected sand.

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

**2.** Re-mulling: GECR2

**a.** Add to the sand recovered from poured mold **GECR1** sufficient pre-blended sand so that the sand batch weight is 900 +/- 10 pounds. Record the sand weight.

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

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

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

**e.** Follow the above procedure beginning at B.1.f.

**3.** Re-mulling: GECR3, GE001-GE0XX

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

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

**D.** ECOLOTEC® Step Cores:

- **1.** Klein vibratory core sand mixer.
  - **a.** The binder components should be 75-85$^{o}$F.
  - **b.** Calibrate the Klein mixer sand batch size.
    - **1)** Remove the mixing bowl skirt to gain access to the binder injection tubes and the bottom side of the batch hopper outlet gate.
    - **2)** Calibrate sand.
      - **a)** Turn the AUTO/MAN switch to MANUAL on main control panel.
      - **b)** Place one bucket of preheated raw sand, of at least fifty-two (52) pounds net weight, into the sand hopper and manually fill batch hopper using max. and min. proximity switches.
      - **c)** Discharge the sand from the batch hopper using the single cycle push button. Catch the sand as it leaves the batch hopper and record the net weight and the dispensing time.
      - **d)** Repeat 3 times to determine the weight variation. The sand should be 75-85$^{o}$F.
    - **3)** Turn off the mixer and replace the mixing bowl skirt.
  - **c.** Pre-weigh 2.0% (BOS) of the single part binder into a non-absorbing container for addition to the mixer.
  - **d.** Turn on the mixer and turn the AUTO/MAN switch to AUTO.
  - **e.** Press the SINGLE CYCLE push button on the operator's station to make a batch of sand. As soon as the sand enters the mixer chamber pour the pre-weighed binder through a top opening.
  - **f.** Make three (3) batches to start the Redford Carver core machine.
  - **g.** Make a batch of sand for every 7 core machine cycles when using the step core. About two (2) batches will be retained in the core machine sand magazine.
  - **h.** Clean the mixer bowl when done.

**Caution:** Do not make more sand than sand magazine will hold plus one (1) batch. If too much sand is made the sand will be exposed to captured CO2 and significantly shorten the sand bench life

- **2.** Making cores: Redford/Carver core machine.
  - **a.** Mount the Step-Core core box on the Carver/Redford core machine.
  - **b.** Start the core machine auxiliary equipment per the Production Foundry OSI for that equipment.

- **c.** Set up the core machine in the cold box mode with gassing and working pressures and gas and purge time according to the core recipe sheet.
- **d.** Core process setup
  - **1)** Remove the TEA gas line form the gassing head and install the client supplied CO2 vaporizer equipment to the gas head.
  - **2)** Set the gas timer to 30 seconds.
  - **3)** Set the after gas delay to zero (0) seconds.
  - **4)** Set the purge timer to zero (0) seconds.
  - **5)** Total cycle time approximately 1-2 minutes.

- **e.** Run the core machine for three (3) cycles and discard the cores. When the cores appear good begin test core manufacture. Five (5) good cores are required for each mold. A minimum of 60 cores are required.
- **f.** One half hour to 1 hour after manufacture randomly perform a scratch hardness test on the outer edge of the blow surface on 10 % of the cores and record the results on the Core Production Log. Values less than 25 shall be marked with a HOLD TAG until they can be 100 % scratch hardness tested to re-qualify. Contact the Process Engineer for disposition on all cores with values less than 15 after 1 hour. Weigh each core and log the results.
- **g.** The sand lab will sample, at the time of manufacture, one (1) core from each row of each shelf (1 of 11) on each core rack. Those cores will be tested for LOI using the standard 1800 oF core LOI test method and reported out associated with the core rack shelf it represents. Qualified cores receiving the green **Quality Checked** tag must have **LOI** values between 1.85-2.20 %. Individual rows that qualify may have the **Quality Checked** tag affixed. Only cores with the green Quality Tag bearing the current test series and dates and signature of the lab technician and core rack/shelf/position on shelf may be taken to the mold assembly area.

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

- **h.** The sand lab will sample one (1) core from the core rack for each mold produced just prior to the emission test to represent the four (4) cores placed in that mold. Those cores will be tested for LOI using the standard 1800 oF core LOI test method and reported out associated with the test mold it is to represent.

**3.** Core coating.
- **a.** Foseco RHEOTEC® XL-45 core coating material will be used as received to dip coat the cores. Stir the coating to homogenize.
- **b.** Weigh the uncoated core and log the weight. (Use the SB12001 scale)
- **c.** Within one (1) hour of manufacture coat the entire core up to the ½ inch from the invest side.
- **d.** Normalize the core coating temperature to 70-80$^{o}$F.
- **e.** Dip the core into the core wash and hold for a count of two (2).
- **f.** Shake the core vertically until the coating essentially ceases to drip.
- **g.** Place the core, invest side down, on the OSI oven lear (chain belt).

**h.** Dry the core at 275°F for 1 hour in the OSI core drying oven.
**i.** Weigh the dried and cooled coated core and log the weight. (Use the SB12001 scale)
**j.** Seal the cores in a Zip-lock bag.

**E.** Molding: 4-on step core pattern.
**1.** Pattern preparation:
**a.** Inspect and tighten all loose pattern and gating pieces.
**b.** Repair any damaged pattern or gating parts.
**c.** Affix DYMO tape mold identifier to the number three (3) drag cavity.
**d.** Hand wipe liquid parting on the pattern once each run.

**2.** Mount the drag 4-on step drag pattern into the north mold machine bolster and bolt it down tightly.
**3.** Mount the cope pattern with sprue on the south mold machine.
**4.** Use the overhead crane to place the pre-weighed drag/cope flask on the mold machine table, parting line surface down.
**5.** On the drag pattern hang a "double chicken foot gagger" from the flask bottom support bar and center between the gating and casting cavities.
**6.** Locate a 24 x 24 x4 inch deep wood upset on top of the flask.
**7.** Make the green sand mold on the Osborn Whisper Ram Jolt-Squeeze mold machine

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

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

**a.** Open the air supply to the mold machine.

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

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

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

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

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

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

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

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

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

**F.** Shakeout.

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

4. Add the un-used pre-mixed sand to the recycled sand to return the sand heap to 900 +/- 10 pounds.

**G.** Melting:

1. Initial charge:
   - **a.** Charge the furnace according to the heat recipe.
   - **b.** Place part of the steel scrap on the bottom, followed by alloys, and the balance of the steel.
   - **c.** Bring the furnace contents to the point of beginning to melt over a period of 1 hour at reduced power.
   - **d.** Add the balance of the metallics under full power until all is melted and the temperature has reached 2700 to 2750$^{o}$F.
   - **e.** Slag the furnace and add the balance of the alloys.
   - **f.** Raise the temperature of the melt to 3000$^{o}$F and pour a spectrometer lug in the water chilled mold. Also pour a Data Cast lug to confirm the solidification temperature.
   - **g.** Hold the furnace at 2775-2825$^{o}$F until near ready to tap.
   - **h.** When ready to tap raise the temperature to 3000$^{o}$F and slag the furnace.
   - **i.** Record all metallic and alloy additions to the furnace, tap temperature, and pour temperature. Record all furnace activities with an associated time.

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

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

**H.** Pouring:

1. Preheat the ladle.
   - **a.** Tap 400 pounds more or less of 3000oF metal into the cold ladle.
   - **b.** Casually pour the metal back to the furnace.
   - **c.** Cover the ladle.
   - **d.** Reheat the metal to 3000-3025$^{o}$F.
   - **e.** Tap 450 pounds of iron into the ladle.
   - **f.** Cover the ladle to conserve heat.
   - **g.** Move the ladle to the pour position, and wait until the metal temperature reaches 2630+/- 10$^{o}$F.
   - **h.** Commence pouring keeping the sprue full.
   - **i.** Upon completion return the extra metal to the furnace, and cover the ladle.

**I.** 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.** Sort the castings by the drag DYMO tape mold identifier cast impression.
- **b.** Place the (4) castings from a single mold on one (1) casting basket.
- **c.** Process each rotating basket for eight (8) minutes.
- **d.** Remove castings and remark casting ID on each casting. Refer to drag DYMO tape identifier.
- **e.** Weigh castings for each mold.
- **f.** Separate drag-marked cavity three (3) from each mold for Rank-order evaluation.

**J.** Rank order evaluation.

**1.** The supervisor shall select a group of five persons to make a collective subjective judgment of the casting relative surface appearance.
**2.** Review the general appearance of the castings and select specific casting features to compare.
**3.** For each cavity:

- **a.** Place each casting initially in sequential mold number order.
- **b.** Beginning with casting from mold GE001, compare it to castings from mold GE002.
- **c.** Place the better appearing casting in the first position and the lesser appearing casting in the second position.
- **d.** Repeat this procedure with GE001 to its nearest neighbors until all castings closer to the beginning of the line are better appearing than GE001 and the next casting farther down the line is inferior.
- **e.** Repeat this comparison to next neighbors for each casting number.
- **f.** When all casting numbers have been compared go to the beginning of the line and begin again comparing each casting to its nearest neighbor. Move the castings so that each casting is inferior to the next one closer to the beginning of the line and superior to the one next toward the tail of the line.
- **g.** Repeat this comparison until all concur with the ranking order.

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

Steven Knight
Mgr. Process Engineering

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/24/2004** | | | | | | | | | | | **GE CONDITIONING - RUN 1** |
| **GE CR-1** | | | | | | | | | | | |
| THC | | X | | | | | | | | | |
| CO, CO2 | | X | | | | | | | | | TOTAL |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/24/2004** | | | | | | | | | | | **GE CONDITIONING - RUN 2** |
| **GE CR-2** | | | | | | | | | | | |
| THC | | X | | | | | | | | | |
| CO, CO2 | | X | | | | | | | | | TOTAL |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/24/2004** | | | | | | | | | | | **GE CONDITIONING - RUN 3** |
| **GE CR-3** | | | | | | | | | | | |
| THC | | X | | | | | | | | | |
| CO, CO2 | | X | | | | | | | | | TOTAL |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/25/2004** | | | | | | | | | | | |
| RUN 1 | | | | | | | | | | | |
| THC | GE001 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE001 | X | | | | | | | | | TOTAL |
| M-18 | GE00101 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 | GE00102 | | | | 1 | | | | 0 | | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| NIOSH 2002 | GE00103 | | 1 | | | | | | 800 | 4 | 100/50 mg Silica Gel (SKC 226-10) |
| NIOSH 2002 | GE00104 | | | | 1 | | | | 0 | | 100/50 mg Silica Gel (SKC 226-10) |
| NIOSH 1500 | GE00105 | | 1 | | | | | | 800 | 5 | 100/50 mg Charcoal (SKC 226-01) |
| NIOSH 1500 | GE00106 | | | | 1 | | | | 0 | | 100/50 mg Charcoal (SKC 226-01) |
| TO11 | GE00107 | | 1 | | | | | | 800 | 6 | DNPH Silica Gel (SKC 226-119) |
| TO11 | GE00108 | | | | 1 | | | | 0 | | DNPH Silica Gel (SKC 226-119) |
| Modified NIOSH 1500 | GE00109 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| Modified NIOSH 1500 | GE00110 | | | | 1 | | | | 0 | | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| | Excess | | | | | | | | 800 | 9 | Excess |
| | Excess | | | | | | | | 800 | 10 | Excess |
| | Excess | | | | | | | | 800 | 11 | Excess |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/25/2004** | | | | | | | | | | | |
| RUN 2 | | | | | | | | | | | |
| THC | GE002 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE002 | X | | | | | | | | | TOTAL |
| M-18 | GE00201 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00202 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00203 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00204 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00205 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/25/2004** | | | | | | | | | | | |
| RUN 3 | | | | | | | | | | | |
| THC | GE003 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE003 | X | | | | | | | | | TOTAL |
| M-18 | GE00301 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 | GE00302 | | | 1 | | | | | 60 | 2 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 3 | Excess |
| NIOSH 2002 | GE00303 | | 1 | | | | | | 800 | 4 | 100/50 mg Silica Gel (SKC 226-10) |
| NIOSH 2002 | GE00304 | | | 1 | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| NIOSH 1500 | GE00305 | | 1 | | | | | | 800 | 6 | 100/50 mg Charcoal (SKC 226-01) |
| NIOSH 1500 | GE00306 | | | 1 | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| TO11 | GE00307 | | 1 | | | | | | 800 | 8 | DNPH Silica Gel (SKC 226-119) |
| TO11 | GE00308 | | | 1 | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| Modified NIOSH 1500 | GE00309 | | 1 | | | | | | 800 | 10 | 100/50 mg Charcoal (SKC 226-01) |
| Modified NIOSH 1500 | GE00310 | | | 1 | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/26/2004** | | | | | | | | | | | |
| RUN 4 | | | | | | | | | | | |
| THC | GE004 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE004 | X | | | | | | | | | TOTAL |
| M-18 | GE00401 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 MS | GE00402 | | 1 | | | | | | 60 | 2 | Carbopak charcoal |
| M-18 MS | GE00403 | | | 1 | | | | | 60 | 3 | Carbopak charcoal |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00404 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00405 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00406 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00407 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/26/2004** | | | | | | | | | | | |
| RUN 5 | | | | | | | | | | | |
| THC | GE005 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE005 | X | | | | | | | | | TOTAL |
| M-18 | GE00501 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| M-18 | GE00502 | | | | | 1 | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00503 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00504 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00505 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00506 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |
| | | | | | | | | | | | |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/26/2004** | | | | | | | | | | | |
| RUN 6 | | | | | | | | | | | |
| THC | GE006 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE006 | X | | | | | | | | | TOTAL |
| M-18 | GE00601 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00602 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00603 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00604 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00605 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/27/2004** | | | | | | | | | | | |
| RUN 7 | | | | | | | | | | | |
| THC | GE007 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE007 | X | | | | | | | | | TOTAL |
| M-18 | GE00701 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00702 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00703 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00704 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00705 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |
| | | | | | | | | | | | |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/27/2004** | | | | | | | | | | | |
| RUN 8 | | | | | | | | | | | |
| THC | GE008 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE008 | X | | | | | | | | | TOTAL |
| M-18 | GE00801 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00802 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00803 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00804 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00805 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

## PRE-PRODUCTION GE - SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **8/27/2004** | | | | | | | | | | | |
| RUN 9 | | | | | | | | | | | |
| THC | GE009 | X | | | | | | | | | TOTAL |
| CO, CO2 | GE009 | X | | | | | | | | | TOTAL |
| M-18 | GE00901 | | 1 | | | | | | 60 | 1 | Carbopak charcoal |
| | Excess | | | | | | | | 60 | 2 | Excess |
| | Excess | | | | | | | | 60 | 3 | Excess |
| | Excess | | | | | | | | 800 | 4 | Excess |
| NIOSH 2002 | GE00902 | | 1 | | | | | | 800 | 5 | 100/50 mg Silica Gel (SKC 226-10) |
| | Excess | | | | | | | | 800 | 6 | Excess |
| NIOSH 1500 | GE00903 | | 1 | | | | | | 800 | 7 | 100/50 mg Charcoal (SKC 226-01) |
| | Excess | | | | | | | | 800 | 8 | Excess |
| TO11 | GE00904 | | 1 | | | | | | 800 | 9 | DNPH Silica Gel (SKC 226-119) |
| | Excess | | | | | | | | 800 | 10 | Excess |
| Modified NIOSH 1500 | GE00905 | | 1 | | | | | | 800 | 11 | 100/50 mg Charcoal (SKC 226-01) |
| | Moisture | | 1 | | | | | | 500 | 12 | TOTAL |
| | Excess | | | | | | | | 5000 | 13 | Excess |

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# APPENDIX B TEST SERIES FQ AND GE DETAILED EMISSION RESULTS

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## Test Plan FQ Individual Emission Test Results – Lb/Lb Binder

| HAPs | POMs | Compound/Sample Number | FQ001 | FQ002 | FQ003 | FQ004 | FQ005 | FQ006 | FQ007 | FQ008 | FQ009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | 12/17/03 | 12/18/03 | 12/18/03 | 12/19/03 | 12/22/03 | 12/22/03 | 12/22/03 | 12/23/03 | 12/23/04 | | |
| | | **TGOC as Propane** | I | 9.52E-02 | 9.01E-02 | I | 9.70E-02 | 1.00E-01 | 1.05E-01 | 1.02E-01 | 9.33E-02 | 9.74E-02 | 5.06E-03 |
| | | **HC as Hexane** | I | 2.60E-02 | 2.18E-02 | I | 2.33E-02 | 2.15E-02 | 2.45E-02 | 2.33E-02 | 2.20E-02 | 2.32E-02 | 1.64E-03 |
| | | **Sum of VOCs** | I | 1.81E-02 | 3.45E-02 | I | 3.52E-02 | 3.87E-02 | 3.94E-02 | 3.77E-02 | 3.50E-02 | 3.41E-02 | 7.31E-03 |
| | | **Sum of HAPs** | I | 1.73E-02 | 3.32E-02 | I | 3.37E-02 | 3.71E-02 | 3.80E-02 | 3.63E-02 | 3.37E-02 | 3.27E-02 | 7.08E-03 |
| | | **Sum of POMs** | I | 4.77E-03 | 5.57E-03 | I | 5.31E-03 | 5.36E-03 | 6.11E-03 | 6.05E-03 | 5.43E-03 | 5.52E-03 | 4.61E-04 |
| | | | **Individual Organic HAPs** | | | | | | | | | | |
| x | | **Phenol** | I | 8.05E-03 | 9.72E-03 | I | 9.95E-03 | 1.30E-02 | 1.24E-02 | 1.06E-02 | 1.09E-02 | 1.07E-02 | 1.68E-03 |
| x | | **Benzene** | I | I | 9.64E-03 | I | 9.79E-03 | 8.78E-03 | 9.81E-03 | 1.07E-02 | 9.01E-03 | 9.63E-03 | 6.84E-04 |
| x | | **Aniline** | I | I | 2.23E-03 | I | 2.47E-03 | 3.21E-03 | 3.28E-03 | 2.50E-03 | 2.67E-03 | 2.73E-03 | 4.24E-04 |
| x | | **Toluene** | I | I | 1.95E-03 | I | 1.98E-03 | 1.85E-03 | 1.94E-03 | 2.11E-03 | 1.84E-03 | 1.95E-03 | 9.89E-05 |
| x | z | **2-Methylnaphthalene** | I | 1.60E-03 | 1.81E-03 | I | 1.79E-03 | 2.27E-03 | 2.04E-03 | 1.96E-03 | 1.80E-03 | 1.89E-03 | 2.15E-04 |
| x | | **o-Cresol** | I | 2.02E-03 | 1.52E-03 | I | 1.63E-03 | 2.10E-03 | 1.74E-03 | 1.62E-03 | 1.71E-03 | 1.76E-03 | 2.17E-04 |
| x | z | **Naphthalene** | I | 1.54E-03 | 1.62E-03 | I | 1.60E-03 | 1.86E-03 | 1.67E-03 | 1.76E-03 | 1.56E-03 | 1.66E-03 | 1.16E-04 |
| x | z | **1-Methylnaphthalene** | I | 9.70E-04 | 1.10E-03 | I | 1.07E-03 | I | 1.21E-03 | 1.17E-03 | 1.08E-03 | 1.10E-03 | 8.39E-05 |
| x | | **m,p-Xylene** | I | 7.28E-04 | 6.54E-04 | I | 6.85E-04 | 6.36E-04 | 6.66E-04 | 7.12E-04 | 6.57E-04 | 6.77E-04 | 3.32E-05 |
| x | | **Acetaldehyde** | I | 5.00E-04 | 5.18E-04 | I | 5.00E-04 | 4.94E-04 | 5.17E-04 | 4.73E-04 | I | 5.00E-04 | 1.65E-05 |
| x | | **m,p-Cresol** | I | 3.44E-04 | 3.92E-04 | I | 4.13E-04 | 5.88E-04 | 4.94E-04 | 4.51E-04 | 4.86E-04 | 4.53E-04 | 7.99E-05 |
| x | z | **1,3-Dimethylnaphthalene** | I | 3.22E-04 | 4.06E-04 | I | 4.12E-04 | 5.53E-04 | 4.70E-04 | 4.54E-04 | 4.22E-04 | 4.34E-04 | 7.05E-05 |
| x | | **o-Toluidine** | I | 2.02E-04 | 3.88E-04 | I | 3.71E-04 | 5.17E-04 | 5.22E-04 | 3.84E-04 | 4.12E-04 | 4.00E-04 | 1.07E-04 |
| x | z | **2,6-Dimethylnaphthalene** | I | 2.11E-04 | 2.64E-04 | I | 2.67E-04 | 3.60E-04 | 3.04E-04 | 2.96E-04 | 2.76E-04 | 2.83E-04 | 4.54E-05 |
| x | z | **1,6-Dimethylnaphthalene** | I | 1.29E-04 | 1.64E-04 | I | 1.62E-04 | 2.16E-04 | 1.84E-04 | 1.78E-04 | 1.66E-04 | 1.71E-04 | 2.63E-05 |
| x | | **o-Xylene** | I | 1.66E-04 | 1.49E-04 | I | 1.52E-04 | 1.51E-04 | 1.48E-04 | 1.60E-04 | 1.50E-04 | 1.54E-04 | 6.68E-06 |
| x | | **Formaldehyde** | I | 1.42E-04 | 1.32E-04 | I | 1.09E-04 | 1.04E-04 | 8.67E-05 | 9.65E-05 | 9.22E-05 | 1.09E-04 | 2.08E-05 |
| x | | **Ethylbenzene** | I | 1.01E-04 | 8.75E-05 | I | 9.47E-05 | 9.02E-05 | 9.11E-05 | 9.79E-05 | 9.33E-05 | 9.37E-05 | 4.66E-06 |
| x | | **Hexane** | I | 8.72E-05 | 8.43E-05 | I | 7.88E-05 | 8.47E-05 | I | 8.78E-05 | 8.37E-05 | 8.44E-05 | 3.20E-06 |
| x | z | **2,3-Dimethylnaphthalene** | I | ND | 1.27E-04 | I | ND | ND | 1.43E-04 | 1.48E-04 | 1.36E-04 | 7.91E-05 | 7.43E-05 |
| x | | **Styrene** | I | 7.04E-05 | 6.32E-05 | I | 7.32E-05 | 7.53E-05 | 7.29E-05 | 8.15E-05 | 6.92E-05 | 7.23E-05 | 5.65E-06 |
| x | z | **1,2-Dimethylnaphthalene** | I | ND | 8.27E-05 | I | ND | 1.05E-04 | 8.79E-05 | 8.54E-05 | 0.00E+00 | 5.16E-05 | 4.88E-05 |
| x | | **Propionaldehyde** | I | 4.28E-05 | 4.48E-05 | I | 3.61E-05 | 3.52E-05 | 3.53E-05 | 3.87E-05 | 3.51E-05 | 3.83E-05 | 4.00E-06 |
| x | | **2-Butanone** | I | 2.78E-05 | 3.20E-05 | I | 2.98E-05 | 3.04E-05 | 2.75E-05 | 3.04E-05 | 3.03E-05 | 2.97E-05 | 1.58E-06 |
| x | z | **Acenaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | | **Biphenyl** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,5-Dimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,8-Dimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **2,7-Dimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **2,3,5-Trimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | | **Dimethylaniline** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | | **Acrolein** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |

## Test Plan FQ Individual Emission Test Results – Lb/Lb Binder

| HAPs | POMs | Compound/Sample Number | FQ001 | FQ002 | FQ003 | FQ004 | FQ005 | FQ006 | FQ007 | FQ008 | FQ009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | 12/17/03 | 12/18/03 | 12/18/03 | 12/19/03 | 12/22/03 | 12/22/03 | 12/22/03 | 12/23/03 | 12/23/04 | | |
| | | | **Other VOCs** | | | | | | | | | | |
| | | **1,2,4-Trimethylbenzene** | I | I | 4.10E-04 | I | 4.12E-04 | 4.17E-04 | 4.14E-04 | 4.25E-04 | 4.05E-04 | 4.14E-04 | 6.81E-06 |
| | | **1,2,3-Trimethylbenzene** | I | 1.47E-04 | 1.56E-04 | I | 1.66E-04 | 1.78E-04 | 1.58E-04 | 1.66E-04 | 1.48E-04 | 1.60E-04 | 1.11E-05 |
| | | **3-Ethyltoluene** | I | 1.51E-04 | 1.43E-04 | I | 1.40E-04 | 1.53E-04 | 1.66E-04 | 1.51E-04 | 1.52E-04 | 1.51E-04 | 8.20E-06 |
| | | **Indene** | I | 1.26E-04 | 1.38E-04 | I | 1.52E-04 | 1.64E-04 | 1.46E-04 | 1.52E-04 | 1.34E-04 | 1.45E-04 | 1.29E-05 |
| | | **2,4-Dimethylphenol** | I | 1.54E-04 | 1.00E-04 | I | 1.24E-04 | 1.57E-04 | 9.89E-05 | 9.86E-05 | 9.41E-05 | 1.18E-04 | 2.73E-05 |
| | | **2-Ethyltoluene** | I | 1.08E-04 | 9.56E-05 | I | 8.68E-05 | 1.14E-04 | 1.00E-04 | 1.20E-04 | 9.89E-05 | 1.03E-04 | 1.14E-05 |
| | | **Undecane** | I | I | 8.83E-05 | I | 9.55E-05 | 9.33E-05 | 8.40E-05 | 8.15E-05 | 7.74E-05 | 8.67E-05 | 7.01E-06 |
| | | **Dodecane** | I | ND | 8.99E-05 | I | 1.35E-04 | 8.63E-05 | 8.64E-05 | 7.77E-05 | ND | 6.79E-05 | 5.00E-05 |
| | | **Butyraldehyde/Methacrolein** | I | 5.95E-05 | 6.83E-05 | I | 6.46E-05 | 6.42E-05 | 7.01E-05 | 6.39E-05 | 5.69E-05 | 6.39E-05 | 4.59E-06 |
| | | **1,3-Diethylbenzene** | I | 9.86E-05 | ND | I | 1.41E-04 | 1.40E-04 | ND | ND | ND | 5.43E-05 | 6.91E-05 |
| | | **Crotonaldehyde** | I | ND | ND | I | ND | ND | 1.24E-04 | 8.75E-05 | 8.47E-05 | 4.23E-05 | 5.42E-05 |
| | | **Benzaldehyde** | I | 2.46E-05 | 2.73E-05 | I | 2.61E-05 | 2.59E-05 | 2.54E-05 | 2.49E-05 | 2.36E-05 | 2.54E-05 | 1.18E-06 |
| | | **Cyclohexane** | I | I | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Decane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **2,6-Dimethylphenol** | I | I | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Heptane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Indan** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Nonane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Octane** | I | I | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Propylbenzene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Tetradecane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **1,3,5-Trimethylbenzene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Hexaldehyde** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **o,m,p-Tolualdehyde** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Pentanal** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |

## Test Plan FQ Individual Emission Test Results – Lb/Lb Binder

| HAPs | POMs | Compound/Sample Number | FQ001 | FQ002 | FQ003 | FQ004 | FQ005 | FQ006 | FQ007 | FQ008 | FQ009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **12/17/03** | **12/18/03** | **12/18/03** | **12/19/03** | **12/22/03** | **12/22/03** | **12/22/03** | **12/23/03** | **12/23/04** | | |
| | | | **Other Analytes** | | | | | | | | | | |
| | | **Acetone** | I | 2.40E-04 | 2.46E-04 | I | 2.34E-04 | 2.37E-04 | 2.56E-04 | 2.67E-04 | 2.38E-04 | 2.46E-04 | 1.19E-05 |
| | | **Carbon Dioxide** | I | 2.59E+00 | 3.01E+00 | I | 2.66E+00 | 2.61E+00 | 2.50E+00 | 2.55E+00 | I | 2.65E+00 | 1.84E-01 |
| | | **Carbon Monoxide** | I | ND | 3.76E-02 | I | 4.14E-02 | ND | ND | 3.77E-02 | I | 1.94E-02 | 2.13E-02 |
| | | **Methane** | I | 5.05E-03 | 5.59E-03 | I | 4.94E-03 | 4.85E-03 | 4.44E-03 | 4.96E-03 | I | 4.97E-03 | 3.70E-04 |
| | | **Ethane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |
| | | **Propane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |
| | | **Isobutane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |
| | | **Butane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |
| | | **Neopentane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |
| | | **Isopentane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |
| | | **Pentane** | I | ND | ND | I | ND | ND | ND | ND | I | ND | NA |

**I: Data rejected based on data validation considerations.**

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

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

## Test Plan FQ Individual Emission Test Results – Lb/Tn Metal

| HAPs | POMs | COMPOUND / SAMPLE NUMBER | FQ001 | FQ002 | FQ003 | FQ004 | FQ005 | FQ006 | FQ007 | FQ008 | FQ009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **12/17/03** | **12/18/03** | **12/18/03** | **12/19/03** | **12/22/03** | **12/22/03** | **12/22/03** | **12/23/03** | **12/23/04** | | |
| | | **TGOC as Propane** | I | 7.08E-01 | 6.71E-01 | I | 7.25E-01 | 7.49E-01 | 7.74E-01 | 7.58E-01 | 6.93E-01 | 7.25E-01 | 3.72E-02 |
| | | **HC as Hexane** | I | 1.93E-01 | 1.62E-01 | I | 1.74E-01 | 1.61E-01 | 1.81E-01 | 1.74E-01 | 1.63E-01 | 1.73E-01 | 1.18E-02 |
| | | **Sum of VOCs** | I | I | 2.57E-01 | I | 2.63E-01 | 2.90E-01 | 2.91E-01 | 2.81E-01 | 2.60E-01 | 2.74E-01 | 1.56E-02 |
| | | **Sum of HAPs** | I | I | 2.47E-01 | I | 2.52E-01 | 2.78E-01 | 2.80E-01 | 2.71E-01 | 2.50E-01 | 2.63E-01 | 1.50E-02 |
| | | **Sum of POMs** | I | 3.55E-02 | 4.15E-02 | I | 3.97E-02 | 4.01E-02 | 4.52E-02 | 4.52E-02 | 4.03E-02 | 4.11E-02 | 3.39E-03 |
| | | | **Individual Organic HAPs** | | | | | | | | | | |
| x | | **Phenol** | I | 5.98E-02 | 7.24E-02 | I | 7.44E-02 | 9.74E-02 | 9.17E-02 | 7.94E-02 | 8.11E-02 | 7.94E-02 | 1.25E-02 |
| x | | **Benzene** | I | I | 7.18E-02 | I | 7.32E-02 | 6.57E-02 | 7.25E-02 | 8.00E-02 | 6.69E-02 | 7.17E-02 | 5.11E-03 |
| x | | **Aniline** | I | I | 1.66E-02 | I | 1.85E-02 | 2.40E-02 | 2.43E-02 | 1.87E-02 | 1.99E-02 | 2.03E-02 | 3.12E-03 |
| x | | **Toluene** | I | I | 1.45E-02 | I | 1.48E-02 | 1.38E-02 | 1.43E-02 | 1.58E-02 | 1.37E-02 | 1.45E-02 | 7.55E-04 |
| x | z | **2-Methylnaphthalene** | I | 1.19E-02 | 1.35E-02 | I | 1.34E-02 | 1.69E-02 | 1.51E-02 | 1.46E-02 | 1.34E-02 | 1.41E-02 | 1.62E-03 |
| x | | **o-Cresol** | I | 1.50E-02 | 1.13E-02 | I | 1.22E-02 | 1.57E-02 | 1.29E-02 | 1.21E-02 | 1.27E-02 | 1.31E-02 | 1.62E-03 |
| x | z | **Naphthalene** | I | 1.15E-02 | 1.21E-02 | I | 1.20E-02 | 1.39E-02 | 1.24E-02 | 1.32E-02 | 1.15E-02 | 1.24E-02 | 8.88E-04 |
| x | z | **1-Methylnaphthalene** | I | 7.21E-03 | 8.19E-03 | I | 8.04E-03 | I | 8.93E-03 | 8.75E-03 | 7.99E-03 | 8.19E-03 | 6.15E-04 |
| x | | **m,p-Xylene** | I | 5.41E-03 | 4.87E-03 | I | 5.13E-03 | 4.76E-03 | 4.92E-03 | 5.32E-03 | 4.88E-03 | 5.04E-03 | 2.48E-04 |
| x | | **Acetaldehyde** | I | 3.71E-03 | 3.86E-03 | I | 3.74E-03 | 3.69E-03 | 3.82E-03 | 3.53E-03 | I | 3.73E-03 | 1.15E-04 |
| x | | **m,p-Cresol** | I | 2.56E-03 | 2.92E-03 | I | 3.09E-03 | 4.40E-03 | 3.65E-03 | 3.37E-03 | 3.61E-03 | 3.37E-03 | 5.97E-04 |
| x | z | **1,3-Dimethylnaphthalene** | I | 2.39E-03 | 3.03E-03 | I | 3.08E-03 | 4.13E-03 | 3.48E-03 | 3.39E-03 | 3.13E-03 | 3.23E-03 | 5.29E-04 |
| x | | **o-Toluidine** | I | 1.50E-03 | 2.89E-03 | I | 2.77E-03 | 3.87E-03 | 3.86E-03 | 2.87E-03 | 3.06E-03 | 2.97E-03 | 7.97E-04 |
| x | z | **2,6-Dimethylnaphthalene** | I | 1.57E-03 | 1.97E-03 | I | 1.99E-03 | 2.69E-03 | 2.25E-03 | 2.21E-03 | 2.05E-03 | 2.10E-03 | 3.41E-04 |
| x | z | **1,6-Dimethylnaphthalene** | I | 9.57E-04 | 1.22E-03 | I | 1.21E-03 | 1.61E-03 | 1.36E-03 | 1.33E-03 | 1.23E-03 | 1.27E-03 | 1.98E-04 |
| x | | **o-Xylene** | I | 1.24E-03 | 1.11E-03 | I | 1.14E-03 | 1.13E-03 | 1.10E-03 | 1.19E-03 | 1.11E-03 | 1.15E-03 | 5.06E-05 |
| x | | **Formaldehyde** | I | 1.06E-03 | 9.82E-04 | I | 8.19E-04 | 7.77E-04 | 6.41E-04 | 7.20E-04 | 6.84E-04 | 8.11E-04 | 1.55E-04 |
| x | | **Ethylbenzene** | I | 7.51E-04 | 6.52E-04 | I | 7.08E-04 | 6.74E-04 | 6.73E-04 | 7.30E-04 | 6.93E-04 | 6.97E-04 | 3.49E-05 |
| x | | **Hexane** | I | 6.48E-04 | 6.28E-04 | I | 5.89E-04 | 6.33E-04 | I | 6.55E-04 | 6.22E-04 | 6.29E-04 | 2.32E-05 |
| x | z | **2,3-Dimethylnaphthalene** | I | ND | 9.45E-04 | I | ND | ND | 1.06E-03 | 1.11E-03 | 1.01E-03 | 5.88E-04 | 5.52E-04 |
| x | | **Styrene** | I | 5.23E-04 | 4.71E-04 | I | 5.47E-04 | 5.63E-04 | 5.39E-04 | 6.09E-04 | 5.14E-04 | 5.38E-04 | 4.29E-05 |
| x | z | **1,2-Dimethylnaphthalene** | I | ND | 6.16E-04 | I | ND | 7.86E-04 | 6.50E-04 | 6.38E-04 | 0.00E+00 | 3.84E-04 | 3.63E-04 |
| x | | **Propionaldehyde** | I | 3.18E-04 | 3.34E-04 | I | 2.70E-04 | 2.63E-04 | 2.61E-04 | 2.89E-04 | 2.60E-04 | 2.85E-04 | 2.98E-05 |
| x | | **2-Butanone** | I | 2.06E-04 | 2.38E-04 | I | 2.23E-04 | 2.27E-04 | 2.03E-04 | 2.27E-04 | 2.25E-04 | 2.21E-04 | 1.23E-05 |
| x | | **N,N-Dimethylaniline** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,5-Dimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,8-Dimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **2,3,5-Trimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **2,7-Dimethylnaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | z | **Acenaphthalene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | | **Biphenyl** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| x | | **Acrolein** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |

## Test Plan FQ Individual Emission Test Results – Lb/Tn Metal

| HAPs | POMs | COMPOUND / SAMPLE NUMBER | FQ001 | FQ002 | FQ003 | FQ004 | FQ005 | FQ006 | FQ007 | FQ008 | FQ009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | 12/17/03 | 12/18/03 | 12/18/03 | 12/19/03 | 12/22/03 | 12/22/03 | 12/22/03 | 12/23/03 | 12/23/04 | | |
| | | | **Other VOCs** | | | | | | | | | | |
| | | **1,2,4-Trimethylbenzene** | I | I | 3.05E-03 | I | 3.08E-03 | 3.12E-03 | 3.06E-03 | 3.17E-03 | 3.01E-03 | 3.08E-03 | 5.70E-05 |
| | | **1,2,3-Trimethylbenzene** | I | 1.09E-03 | 1.16E-03 | I | 1.24E-03 | 1.33E-03 | 1.17E-03 | 1.24E-03 | 1.10E-03 | 1.19E-03 | 8.63E-05 |
| | | **3-Ethyltoluene** | I | 1.12E-03 | 1.06E-03 | I | 1.05E-03 | 1.14E-03 | 1.22E-03 | 1.12E-03 | 1.13E-03 | 1.12E-03 | 5.75E-05 |
| | | **Indene** | I | 9.33E-04 | 1.03E-03 | I | 1.14E-03 | 1.23E-03 | 1.08E-03 | 1.14E-03 | 9.95E-04 | 1.08E-03 | 9.92E-05 |
| | | **2,4-Dimethylphenol** | I | 1.15E-03 | 7.47E-04 | I | 9.29E-04 | 1.17E-03 | 7.31E-04 | 7.36E-04 | 6.99E-04 | 8.80E-04 | 2.05E-04 |
| | | **2-Ethyltoluene** | I | 8.00E-04 | 7.12E-04 | I | 6.49E-04 | 8.50E-04 | 7.43E-04 | 8.98E-04 | 7.34E-04 | 7.69E-04 | 8.56E-05 |
| | | **Undecane** | I | I | 6.58E-04 | I | 7.14E-04 | 6.98E-04 | 6.21E-04 | 6.09E-04 | 5.74E-04 | 6.46E-04 | 5.42E-05 |
| | | **Dodecane** | I | ND | 6.70E-04 | I | 1.01E-03 | 6.45E-04 | 6.38E-04 | 5.80E-04 | ND | 5.06E-04 | 3.74E-04 |
| | | **Butyraldehyde/Methacrolein** | I | 4.42E-04 | 5.09E-04 | I | 4.83E-04 | 4.80E-04 | 5.18E-04 | 4.77E-04 | 4.23E-04 | 4.76E-04 | 3.39E-05 |
| | | **1,3-Diethylbenzene** | I | 7.33E-04 | ND | I | 1.05E-03 | 1.05E-03 | ND | ND | ND | 4.05E-04 | 5.16E-04 |
| | | **Crotonaldehyde** | I | ND | ND | I | ND | ND | 9.13E-04 | 6.53E-04 | 6.29E-04 | 3.14E-04 | 4.02E-04 |
| | | **Benzaldehyde** | I | 1.83E-04 | 2.03E-04 | I | 1.95E-04 | 1.94E-04 | 1.88E-04 | 1.86E-04 | 1.75E-04 | 1.89E-04 | 9.12E-06 |
| | | **1,3,5-Trimethylbenzene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **2,6-Dimethylphenol** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Cyclohexane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Decane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Heptane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Indan** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Nonane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **n-Propylbenzene** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Octane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Tetradecane** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Hexaldehyde** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **Pentanal** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |
| | | **o,m,p-Tolualdehyde** | I | ND | ND | I | ND | ND | ND | ND | ND | ND | NA |

## Test Plan FQ Individual Emission Test Results – Lb/Tn Metal

| HAPs | POMs | COMPOUND / SAMPLE NUMBER | FQ001 | FQ002 | FQ003 | FQ004 | FQ005 | FQ006 | FQ007 | FQ008 | FQ009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **12/17/03** | **12/18/03** | **12/18/03** | **12/19/03** | **12/22/03** | **12/22/03** | **12/22/03** | **12/23/03** | **12/23/04** | | |
| | | | **Other Analytes** | | | | | | | | | | |
| | | **Acetone** | I | 1.78E-03 | 1.83E-03 | I | 1.75E-03 | 1.77E-03 | 1.89E-03 | I | 1.77E-03 | 1.80E-03 | 5.12E-05 |
| | | **Carbon Dioxide** | I | 1.93E+01 | 2.24E+01 | I | 1.99E+01 | 1.95E+01 | 1.85E+01 | 1.90E+01 | NA | 1.98E+01 | 1.39E+00 |
| | | **Carbon Monoxide** | I | ND | 2.80E-01 | I | 3.09E-01 | ND | ND | 2.81E-01 | NA | 2.90E-01 | 1.66E-02 |
| | | **Methane** | I | 5.00E-04 | 5.55E-04 | I | 4.93E-04 | 4.84E-04 | 4.37E-04 | 4.93E-04 | NA | 4.94E-04 | 3.75E-05 |
| | | **Ethane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |
| | | **Propane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |
| | | **Isobutane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |
| | | **Butane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |
| | | **Neopentane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |
| | | **Isopentane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |
| | | **Pentane** | I | ND | ND | I | ND | ND | ND | ND | NA | ND | NA |

**I: Data rejected based on data validation considerations.**

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

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

## Test Plan GE Individual Emission Test Results – Lb/Lb Binder

| HAPS | POMs | Compound/Sample Number | GE001 | GE002 | GE003 | GE004 | GE005 | GE006 | GE007 | GE008 | GE009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **8/25/04** | **8/25/04** | **8/25/04** | **8/26/04** | **8/26/04** | **8/26/04** | **8/27/04** | **8/27/04** | **8/27/04** | | |
| | | **TGOC as Propane** | 2.71E-02 | 3.54E-02 | 3.20E-02 | 3.44E-02 | 3.28E-02 | 2.92E-02 | 3.11E-02 | 3.20E-02 | 3.26E-02 | 3.19E-02 | 2.52E-03 |
| | | **HC as Hexane** | 1.29E-02 | 1.28E-02 | 1.21E-02 | 1.33E-02 | 1.37E-02 | 1.30E-02 | 1.08E-02 | 1.19E-02 | 1.41E-02 | 1.27E-02 | 1.03E-03 |
| | | **Sum of Target Analytes** | 1.38E-02 | 1.51E-02 | 1.62E-02 | 1.47E-02 | 1.50E-02 | 1.48E-02 | 1.30E-02 | 1.50E-02 | I | 1.47E-02 | 9.44E-04 |
| | | **Sum of HAPs** | 1.18E-02 | 1.30E-02 | 1.38E-02 | 1.27E-02 | 1.28E-02 | 1.29E-02 | 1.15E-02 | 1.28E-02 | I | 1.27E-02 | 7.26E-04 |
| | | **Sum of POMs** | 4.93E-05 | 2.76E-04 | 3.31E-04 | 2.59E-04 | 5.76E-05 | 3.26E-04 | 5.08E-05 | 4.90E-05 | 2.71E-04 | 1.86E-04 | 1.29E-04 |
| | | | **Individual Organic HAPs** | | | | | | | | | | |
| x | | **Benzene** | 3.43E-03 | 3.79E-03 | 3.55E-03 | 3.75E-03 | 3.68E-03 | 3.92E-03 | 3.68E-03 | 3.83E-03 | I | 3.70E-03 | 1.56E-04 |
| x | | **Acetaldehyde*** | 2.41E-03 | 2.40E-03 | 2.37E-03 | 2.32E-03 | 2.33E-03 | 2.31E-03 | 2.20E-03 | 2.36E-03 | 2.43E-03 | 2.35E-03 | 7.03E-05 |
| x | | **Phenol** | 1.51E-03 | 1.74E-03 | 2.29E-03 | 1.52E-03 | 1.88E-03 | 1.57E-03 | 1.28E-03 | 1.70E-03 | 1.97E-03 | 1.72E-03 | 2.99E-04 |
| x | | **Toluene** | 1.31E-03 | 1.31E-03 | 1.24E-03 | 1.45E-03 | 1.30E-03 | 1.45E-03 | 1.33E-03 | 1.39E-03 | I | 1.35E-03 | 7.51E-05 |
| x | | **o-Cresol** | 1.04E-03 | 1.16E-03 | 1.56E-03 | 1.04E-03 | 1.29E-03 | 1.06E-03 | 9.16E-04 | 1.23E-03 | 1.47E-03 | 1.20E-03 | 2.13E-04 |
| x | | **m,p-Xylene** | 9.87E-04 | 1.03E-03 | 1.00E-03 | 1.08E-03 | 1.03E-03 | 9.86E-04 | 1.02E-03 | 1.09E-03 | I | 1.03E-03 | 3.83E-05 |
| x | | **m,p-Cresol** | 3.25E-04 | 3.64E-04 | 5.23E-04 | 3.79E-04 | 4.25E-04 | 3.48E-04 | 3.05E-04 | 3.80E-04 | 4.58E-04 | 3.90E-04 | 6.88E-05 |
| x | | **Formaldehyde** | 1.91E-04 | 2.05E-04 | 2.05E-04 | 1.90E-04 | 1.93E-04 | 2.03E-04 | 1.83E-04 | 2.15E-04 | 2.32E-04 | 2.02E-04 | 1.50E-05 |
| x | | **Propionaldehyde** | 1.96E-04 | 1.94E-04 | 1.90E-04 | 1.78E-04 | 1.79E-04 | 1.78E-04 | 1.65E-04 | 1.86E-04 | 2.00E-04 | 1.85E-04 | 1.12E-05 |
| x | | **Ethylene Glycol Phenyl Ether** | ND | 2.29E-04 | 2.80E-04 | 2.59E-04 | ND | 2.69E-04 | ND | ND | 2.17E-04 | 1.39E-04 | 1.34E-04 |
| x | z | **Naphthalene** | 1.04E-04 | 9.64E-05 | 1.12E-04 | 1.14E-04 | 1.16E-04 | 8.56E-05 | 1.01E-04 | 9.47E-05 | 1.16E-04 | 1.05E-04 | 1.09E-05 |
| x | | **Hexane** | I | 7.14E-05 | 6.04E-05 | 6.75E-05 | 8.96E-05 | 1.27E-04 | 6.54E-05 | 7.42E-05 | 7.01E-05 | 7.82E-05 | 2.15E-05 |
| x | | **Butyl Carbitol** | ND | 1.43E-04 | 1.84E-04 | 1.56E-04 | ND | 1.65E-04 | ND | ND | 1.41E-04 | 8.76E-05 | 8.41E-05 |
| x | | **o-Xylene** | 8.33E-05 | 8.13E-05 | 7.95E-05 | 9.73E-05 | 9.20E-05 | 8.80E-05 | 8.13E-05 | 8.44E-05 | 9.42E-05 | 8.68E-05 | 6.39E-06 |
| x | | **2-Butanone** | 6.33E-05 | 6.87E-05 | 6.91E-05 | 6.61E-05 | 7.12E-05 | 6.49E-05 | 7.42E-05 | 7.38E-05 | 8.24E-05 | 7.04E-05 | 5.86E-06 |
| x | | **Ethylbenzene** | 4.93E-05 | 4.64E-05 | 5.05E-05 | I | 5.76E-05 | 5.73E-05 | 5.08E-05 | 4.90E-05 | 5.42E-05 | 5.19E-05 | 4.06E-06 |
| x | | **Styrene** | 5.03E-05 | 5.22E-05 | 5.57E-05 | 5.40E-05 | 5.00E-05 | I | 4.67E-05 | 4.02E-05 | 4.91E-05 | 4.98E-05 | 4.79E-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 | **1,3-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,5-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,6-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,8-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **2,3-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **2,6-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |

## Test Plan GE Individual Emission Test Results – Lb/Lb Binder

| HAPS | POMs | Compound/Sample Number | GE001 | GE002 | GE003 | GE004 | GE005 | GE006 | GE007 | GE008 | GE009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **8/25/04** | **8/25/04** | **8/25/04** | **8/26/04** | **8/26/04** | **8/26/04** | **8/27/04** | **8/27/04** | **8/27/04** | | |
| x | z | **2,7-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-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 | | **Dimethylaniline** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | | **Aniline** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | | **Acrolein** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| | | | **Other VOCs** | | | | | | | | | | |
| | | **1,3,5-Trimethylbenzene** | 6.50E-04 | 6.85E-04 | 6.18E-04 | 6.81E-04 | 6.40E-04 | 6.32E-04 | 6.72E-04 | 7.18E-04 | I | 6.62E-04 | 3.29E-05 |
| | | **2,4-Dimethylphenol** | 2.73E-04 | 3.04E-04 | 4.99E-04 | 3.18E-04 | 3.77E-04 | 2.86E-04 | 2.68E-04 | 3.30E-04 | 3.93E-04 | 3.39E-04 | 7.42E-05 |
| | | **2,6-Dimethylphenol** | 2.74E-04 | 3.02E-04 | 3.86E-04 | 2.18E-04 | 3.19E-04 | 2.72E-04 | 2.30E-04 | 3.43E-04 | 3.77E-04 | 3.03E-04 | 5.96E-05 |
| | | **Butyraldehyde/Methacrolein** | 2.91E-04 | 3.00E-04 | 2.96E-04 | 2.82E-04 | 2.89E-04 | 2.94E-04 | I | 3.15E-04 | 3.51E-04 | 3.02E-04 | 2.19E-05 |
| | | **1,2,4-Trimethylbenzene** | 2.71E-04 | 2.79E-04 | 3.00E-04 | 3.04E-04 | 3.16E-04 | 2.57E-04 | 2.80E-04 | 2.82E-04 | 3.21E-04 | 2.90E-04 | 2.14E-05 |
| | | **Pentanal** | 1.61E-04 | 1.30E-04 | 1.28E-04 | 1.15E-04 | 1.35E-04 | 1.20E-04 | I | 9.61E-05 | 9.29E-05 | 1.22E-04 | 2.20E-05 |
| | | **Benzaldehyde** | 5.90E-05 | 5.74E-05 | 5.91E-05 | 5.45E-05 | 5.99E-05 | 5.50E-05 | I | 5.15E-05 | 5.84E-05 | 5.68E-05 | 2.90E-06 |
| | | **Crotonaldehyde** | 5.02E-05 | 5.81E-05 | 5.56E-05 | 3.85E-05 | 4.21E-05 | 5.54E-05 | 4.26E-05 | 4.62E-05 | 7.00E-05 | 5.10E-05 | 9.90E-06 |
| | | **Hexaldehyde** | ND | ND | 5.83E-06 | ND | ND | ND | ND | ND | I | 7.28E-07 | 2.06E-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 |
| | | **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 |
| | | **Undecane** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| | | **o,m,p-Tolualdehyde** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |

## Test Plan GE Individual Emission Test Results – Lb/Lb Binder

| HAPS | POMs | Compound/Sample Number | GE001 | GE002 | GE003 | GE004 | GE005 | GE006 | GE007 | GE008 | GE009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | 8/25/04 | 8/25/04 | 8/25/04 | 8/26/04 | 8/26/04 | 8/26/04 | 8/27/04 | 8/27/04 | 8/27/04 | | |
| | | | **Other Analytes** | | | | | | | | | | |
| | | **Acetone** | 2.01E-04 | 2.21E-04 | 2.41E-04 | 2.77E-04 | 2.24E-04 | 2.01E-04 | 2.28E-04 | 2.19E-04 | 2.31E-04 | 2.27E-04 | 2.30E-05 |
| | | **Carbon Dioxide** | 4.42E-01 | 5.23E-01 | 4.95E-01 | 5.20E-01 | 5.21E-01 | 5.02E-01 | 5.37E-01 | 5.71E-01 | 5.11E-01 | 5.13E-01 | 3.48E-02 |
| | | **Carbon Monoxide** | 1.57E-01 | 1.68E-01 | 1.65E-01 | 1.71E-01 | 1.78E-01 | 1.70E-01 | 1.69E-01 | 1.90E-01 | 1.90E-01 | 1.73E-01 | 1.09E-02 |
| | | **Nitrogen Oxides** | 2.74E-04 | 2.39E-04 | 3.22E-04 | 1.84E-04 | 2.48E-04 | 2.74E-04 | 2.20E-04 | NA | 2.67E-04 | 2.53E-04 | 4.11E-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 or HAPs.**

*** Results reported as a minimum due to apparent breakthrough for tests GE001 and GE006.**

## Test Plan GE Individual Emissions Test Results – Lb/Tn Metal

| HAPs | POMs | COMPOUND / SAMPLE NUMBER | GE001 | GE002 | GE003 | GE004 | GE005 | GE006 | GE007 | GE008 | GE009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **8/25/04** | **8/25/04** | **8/25/04** | **8/26/04** | **8/26/04** | **8/26/04** | **8/27/04** | **8/27/04** | **8/27/04** | | |
| | | **TGOC as Propane** | 2.67E-01 | 3.46E-01 | 3.18E-01 | 3.24E-01 | 3.11E-01 | 2.76E-01 | 2.89E-01 | 2.84E-01 | 2.94E-01 | 3.01E-01 | 2.56E-02 |
| | | **HC as Hexane** | 1.27E-01 | 1.25E-01 | 1.21E-01 | 1.26E-01 | 1.30E-01 | 1.22E-01 | 9.99E-02 | 1.06E-01 | 1.27E-01 | 1.20E-01 | 1.05E-02 |
| | | **Sum of Target Analytes** | 1.36E-01 | 1.48E-01 | 1.70E-01 | 1.39E-01 | 1.42E-01 | 1.40E-01 | 1.21E-01 | 1.33E-01 | I | 1.41E-01 | 1.40E-02 |
| | | **Sum of HAPs** | 1.16E-01 | 1.27E-01 | 1.48E-01 | 1.20E-01 | 1.21E-01 | 1.21E-01 | 1.07E-01 | 1.14E-01 | I | 1.22E-01 | 1.21E-02 |
| | | **Sum of POMs** | 1.02E-03 | 9.42E-04 | 1.12E-03 | 1.07E-03 | 1.10E-03 | 8.07E-04 | 9.42E-04 | 8.43E-04 | 1.05E-03 | 9.89E-04 | 1.12E-04 |
| | | | **Individual Organic HAPs** | | | | | | | | | | |
| x | | **Benzene** | 3.38E-02 | 3.71E-02 | 3.52E-02 | 3.53E-02 | 3.48E-02 | 3.69E-02 | 3.42E-02 | 3.41E-02 | I | 3.52E-02 | 1.25E-03 |
| x | | **Acetaldehyde*** | 2.38E-02 | 2.35E-02 | 2.36E-02 | 2.18E-02 | 2.21E-02 | 2.17E-02 | 2.04E-02 | 2.10E-02 | 2.19E-02 | 2.22E-02 | 1.16E-03 |
| x | | **Phenol** | 1.49E-02 | 1.70E-02 | 2.07E-02 | 1.43E-02 | 1.79E-02 | 1.48E-02 | 1.19E-02 | 1.51E-02 | 1.78E-02 | 1.60E-02 | 2.58E-03 |
| x | | **Toluene** | 1.29E-02 | 1.28E-02 | 1.23E-02 | 1.37E-02 | 1.23E-02 | 1.36E-02 | 1.24E-02 | 1.24E-02 | I | 1.28E-02 | 5.69E-04 |
| x | | **o-Cresol** | 1.02E-02 | 1.13E-02 | 2.20E-02 | 9.77E-03 | 1.22E-02 | 1.00E-02 | 8.51E-03 | 1.09E-02 | 1.33E-02 | 1.20E-02 | 3.98E-03 |
| x | | **m,p-Xylene** | 9.72E-03 | 1.01E-02 | 9.96E-03 | 1.02E-02 | 9.76E-03 | 9.30E-03 | 9.47E-03 | 9.66E-03 | I | 9.77E-03 | 3.00E-04 |
| x | | **m,p-Cresol** | 3.20E-03 | 3.55E-03 | 4.65E-03 | 3.57E-03 | 4.03E-03 | 3.28E-03 | 2.83E-03 | 3.38E-03 | 4.13E-03 | 3.62E-03 | 5.55E-04 |
| x | | **Formaldehyde** | 1.89E-03 | 2.01E-03 | 2.04E-03 | 1.78E-03 | 1.83E-03 | 1.91E-03 | 1.70E-03 | 1.92E-03 | 2.09E-03 | 1.91E-03 | 1.25E-04 |
| x | | **Propionaldehyde** | 1.93E-03 | 1.90E-03 | 1.89E-03 | 1.67E-03 | 1.70E-03 | 1.67E-03 | 1.53E-03 | 1.65E-03 | 1.81E-03 | 1.75E-03 | 1.35E-04 |
| x | | **Ethylene Glycol Phenyl Ether** | ND | 2.24E-03 | 1.01E-02 | 2.44E-03 | ND | 2.53E-03 | ND | ND | 1.96E-03 | 2.14E-03 | 3.19E-03 |
| x | z | **Naphthalene** | 1.02E-03 | 9.42E-04 | 1.12E-03 | 1.07E-03 | 1.10E-03 | 8.07E-04 | 9.42E-04 | 8.43E-04 | 1.05E-03 | 9.89E-04 | 1.12E-04 |
| x | | **o-Xylene** | 8.20E-04 | 7.95E-04 | 7.89E-04 | 9.16E-04 | 8.72E-04 | 8.30E-04 | 7.55E-04 | 7.51E-04 | 8.49E-04 | 8.20E-04 | 5.41E-05 |
| x | | **Hexane** | I | 6.98E-04 | 6.00E-04 | 6.35E-04 | 8.49E-04 | 1.20E-03 | 6.07E-04 | 6.60E-04 | 6.32E-04 | 7.35E-04 | 2.03E-04 |
| x | | **2-Butanone** | 6.23E-04 | 6.71E-04 | 6.87E-04 | 6.22E-04 | 6.75E-04 | 6.12E-04 | 6.89E-04 | 6.56E-04 | 7.43E-04 | 6.64E-04 | 4.14E-05 |
| x | | **Butyl Carbitol** | ND | 1.40E-03 | 1.10E-03 | 1.47E-03 | ND | 1.56E-03 | ND | ND | 1.27E-03 | 7.54E-04 | 7.27E-04 |
| x | | **Ethylbenzene** | 4.86E-04 | 4.54E-04 | 5.01E-04 | I | 5.46E-04 | 5.40E-04 | 4.71E-04 | 4.36E-04 | 4.89E-04 | 4.90E-04 | 3.84E-05 |
| x | | **Styrene** | 4.95E-04 | 5.10E-04 | 5.54E-04 | 5.08E-04 | 4.74E-04 | I | 4.33E-04 | 3.58E-04 | 4.42E-04 | 4.72E-04 | 6.02E-05 |
| x | z | **1,2-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,3-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,5-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,6-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **1,8-Dimethylnaphthalene** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | z | **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 |

## Test Plan GE Individual Emission Test Results – Lb/Tn Metal

| HAPs | POMs | COMPOUND / SAMPLE NUMBER | GE001 | GE002 | GE003 | GE004 | GE005 | GE006 | GE007 | GE008 | GE009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | 8/25/04 | 8/25/04 | 8/25/04 | 8/26/04 | 8/26/04 | 8/26/04 | 8/27/04 | 8/27/04 | 8/27/04 | | |
| 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 | | **Biphenyl** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |
| x | | **Acrolein** | ND | 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 |
| | | | **Other VOCs** | | | | | | | | | | |
| | | **1,3,5-Trimethylbenzene** | 6.40E-03 | 6.70E-03 | 6.14E-03 | 6.40E-03 | 6.07E-03 | 5.96E-03 | 6.24E-03 | 6.39E-03 | I | 6.29E-03 | 2.35E-04 |
| | | **2,4-Dimethylphenol** | 2.69E-03 | 2.97E-03 | 4.06E-03 | 2.99E-03 | 3.57E-03 | 2.69E-03 | 2.49E-03 | 2.94E-03 | 3.54E-03 | 3.10E-03 | 5.12E-04 |
| | | **Butyraldehyde/Methacrolein** | 2.86E-03 | 2.94E-03 | 2.94E-03 | 2.65E-03 | 2.74E-03 | 2.77E-03 | I | 2.81E-03 | 3.16E-03 | 2.86E-03 | 1.57E-04 |
| | | **2,6-Dimethylphenol** | 2.70E-03 | 2.95E-03 | 3.21E-03 | 2.06E-03 | 3.03E-03 | 2.57E-03 | 2.14E-03 | 3.05E-03 | 3.40E-03 | 2.79E-03 | 4.63E-04 |
| | | **1,2,4-Trimethylbenzene** | 2.66E-03 | 2.73E-03 | 2.98E-03 | 2.86E-03 | 2.99E-03 | 2.42E-03 | 2.60E-03 | 2.51E-03 | 2.89E-03 | 2.74E-03 | 2.07E-04 |
| | | **Pentanal** | 1.59E-03 | 1.27E-03 | 1.27E-03 | 1.09E-03 | 1.28E-03 | 1.13E-03 | I | 8.55E-04 | 8.37E-04 | 1.17E-03 | 2.47E-04 |
| | | **Benzaldehyde** | 5.80E-04 | 5.61E-04 | 5.87E-04 | 5.13E-04 | 5.68E-04 | 5.18E-04 | I | 4.58E-04 | 5.27E-04 | 5.39E-04 | 4.32E-05 |
| | | **Crotonaldehyde** | 4.95E-04 | 5.68E-04 | 5.53E-04 | 3.62E-04 | 3.99E-04 | 5.22E-04 | 3.96E-04 | 4.11E-04 | 6.31E-04 | 4.82E-04 | 9.37E-05 |
| | | **Hexaldehyde** | ND | ND | 5.79E-05 | ND | ND | ND | ND | ND | I | 7.23E-06 | 2.05E-05 |
| | | **1,2,3-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-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 |
| | | **o,m,p-Tolualdehyde** | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NA |

## Test Plan GE Individual Emission Test Results – Lb/Tn Metal

| HAPs | POMs | COMPOUND / SAMPLE NUMBER | GE001 | GE002 | GE003 | GE004 | GE005 | GE006 | GE007 | GE008 | GE009 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Test Dates** | **8/25/04** | **8/25/04** | **8/25/04** | **8/26/04** | **8/26/04** | **8/26/04** | **8/27/04** | **8/27/04** | **8/27/04** | | |
| | | | **Other Analytes** | | | | | | | | | | |
| | | **Acetone** | 1.98E-03 | 2.16E-03 | 2.39E-03 | 2.61E-03 | 2.12E-03 | 1.90E-03 | 2.11E-03 | 1.95E-03 | 2.08E-03 | 2.14E-03 | 2.27E-04 |
| | | **Carbon Dioxide** | 4.35E+00 | 5.11E+00 | 4.91E+00 | 4.89E+00 | 4.94E+00 | 4.73E+00 | 4.99E+00 | 5.08E+00 | 4.61E+00 | 4.85E+00 | 2.44E-01 |
| | | **Carbon Monoxide** | 1.55E+00 | 1.64E+00 | 1.64E+00 | 1.61E+00 | 1.69E+00 | 1.60E+00 | 1.57E+00 | 1.69E+00 | 1.71E+00 | 1.63E+00 | 5.57E-02 |
| | | **Nitrogen Oxides** | 2.69E-03 | 2.34E-03 | 3.19E-03 | 1.73E-03 | 2.35E-03 | 2.58E-03 | 2.04E-03 | NA | 2.41E-03 | 2.42E-03 | 4.35E-04 |

**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 or HAPs.**

*** Results reported as a minimum due to apparent breakthrough for tests GE001 and GE006.**

## Test FQ Quantitation Limits – Lb/Lb Binder

| Analytes | Lb/Lb Binder |
|---|---|
| 1,2,3-Trimethylbenzene | 1.59E-05 |
| 1,2,4-Trimethylbenzene | 1.59E-05 |
| 1,3,5-Trimethylbenzene | 1.59E-05 |
| 1,3-Dimethylnaphthalene | 1.59E-05 |
| 1-Methylnaphthalene | 1.59E-05 |
| 2-Ethyltoluene | 1.59E-05 |
| 2-Methylnaphthalene | 1.59E-05 |
| Benzene | 1.59E-05 |
| Ethylbenzene | 1.59E-05 |
| Hexane | 1.59E-05 |
| m,p-Xylene | 1.59E-05 |
| Naphthalene | 1.59E-05 |
| o-Xylene | 1.59E-05 |
| Styrene | 1.59E-05 |
| Toluene | 1.59E-05 |
| Undecane | 1.59E-05 |
| 1,2-Dimethylnaphthalene | 7.95E-05 |
| 1,3-Diethylbenzene | 7.95E-05 |
| 1,5-Dimethylnaphthalene | 7.95E-05 |
| 1,6-Dimethylnaphthalene | 7.95E-05 |
| 1,8-Dimethylnaphthalene | 7.95E-05 |
| 2,3,5-Trimethylnaphthalene | 7.95E-05 |
| 2,3-Dimethylnaphthalene | 7.95E-05 |
| 2,4-Dimethylphenol | 7.95E-05 |

| Analytes | Lb/Lb Binder |
|---|---|
| 2,6-Dimethylnaphthalene | 7.95E-05 |
| 2,6-Dimethylphenol | 7.95E-05 |
| 2,7- Dimethylnaphthalene | 7.95E-05 |
| 3-Ethyltoluene | 7.95E-05 |
| Acenaphthalene | 7.95E-05 |
| Biphenyl | 7.95E-05 |
| Cyclohexane | 7.95E-05 |
| Decane | 7.95E-05 |
| Dodecane | 7.95E-05 |
| Heptane | 7.95E-05 |
| Indan | 7.95E-05 |
| Indene | 7.95E-05 |
| m,p-Cresol | 7.95E-05 |
| Nonane | 7.95E-05 |
| o-Cresol | 7.95E-05 |
| Octane | 7.95E-05 |
| Phenol | 7.95E-05 |
| Propylbenzene | 7.95E-05 |
| Tetradecane | 7.95E-05 |
| HC as Hexane | 4.80E-04 |
| 2-Butanone (MEK) | 1.41E-05 |
| Acetaldehyde | 1.41E-05 |
| Acetone | 1.41E-05 |
| Acrolein | 1.41E-05 |

| Analytes | Lb/Lb Binder |
|---|---|
| Benzaldehyde | 1.41E-05 |
| Butyraldehyde | 1.41E-05 |
| Crotonaldehyde | 1.41E-05 |
| Formaldehyde | 1.41E-05 |
| Hexaldehyde | 1.41E-05 |
| Butyraldehyde/Methacrolein | 2.35E-05 |
| o,m,p-Tolualdehyde | 3.76E-05 |
| Pentanal (Valeraldehyde) | 1.41E-05 |
| Propionaldehyde (Propanal) | 1.41E-05 |
| Aniline | 9.58E-05 |
| Dimethylaniline | 9.58E-05 |
| o-Toluidine | 4.79E-05 |
| Carbon  Monoxide | 3.76E-02 |
| Methane | 2.15E-03 |
| Carbon Dioxide | 5.90E-02 |
| Ethane | 4.02E-02 |
| Propane | 5.90E-02 |
| Isobutane | 7.78E-02 |
| Butane | 7.78E-02 |
| Neopentane | 9.66E-02 |
| Isopentane | 9.66E-02 |
| Pentane | 9.66E-02 |

## Test FQ Quantitation Limits – Lb/Tn Metal

| Analytes | Lb/Tn Metal |
|---|---|
| 1,2,3-Trimethylbenzene | 1.18E-04 |
| 1,2,4-Trimethylbenzene | 1.18E-04 |
| 1,3,5-Trimethylbenzene | 1.18E-04 |
| 1,3-Dimethylnaphthalene | 1.18E-04 |
| 1-Methylnaphthalene | 1.18E-04 |
| 2-Ethyltoluene | 1.18E-04 |
| 2-Methylnaphthalene | 1.18E-04 |
| Benzene | 1.18E-04 |
| Ethylbenzene | 1.18E-04 |
| Hexane | 1.18E-04 |
| m,p-Xylene | 1.18E-04 |
| Naphthalene | 1.18E-04 |
| o-Xylene | 1.18E-04 |
| Styrene | 1.18E-04 |
| Toluene | 1.18E-04 |
| Undecane | 1.18E-04 |
| 1,2-Dimethylnaphthalene | 5.92E-04 |
| 1,3-Diethylbenzene | 5.92E-04 |
| 1,5-Dimethylnaphthalene | 5.92E-04 |
| 1,6-Dimethylnaphthalene | 5.92E-04 |
| 1,8-Dimethylnaphthalene | 5.92E-04 |
| 2,3,5-Trimethylnaphthalene | 5.92E-04 |
| 2,3-Dimethylnaphthalene | 5.92E-04 |
| 2,4-Dimethylphenol | 5.92E-04 |

| Analytes | Lb/Tn Metal |
|---|---|
| 2,6-Dimethylnaphthalene | 5.92E-04 |
| 2,6-Dimethylphenol | 5.92E-04 |
| 2,7- Dimethylnaphthalene | 5.92E-04 |
| 3-Ethyltoluene | 5.92E-04 |
| Acenaphthalene | 5.92E-04 |
| Biphenyl | 5.92E-04 |
| Cyclohexane | 5.92E-04 |
| Decane | 5.92E-04 |
| Dodecane | 5.92E-04 |
| Heptane | 5.92E-04 |
| Indan | 5.92E-04 |
| Indene | 5.92E-04 |
| m,p-Cresol | 5.92E-04 |
| Nonane | 5.92E-04 |
| o-Cresol | 5.92E-04 |
| Octane | 5.92E-04 |
| Phenol | 5.92E-04 |
| Propylbenzene | 5.92E-04 |
| Tetradecane | 5.92E-04 |
| HC as Hexane | 5.92E-02 |
| 2-Butanone (MEK) | 1.78E-03 |
| Acetaldehyde | 1.78E-03 |
| Acetone | 1.78E-03 |
| Acrolein | 1.78E-03 |

| Analytes | Lb/Tn Metal |
|---|---|
| Benzaldehyde | 1.78E-03 |
| Butyraldehyde | 1.78E-03 |
| Crotonaldehyde | 1.78E-03 |
| Formaldehyde | 1.78E-03 |
| Hexaldehyde | 1.78E-03 |
| Butyraldehyde/Methacrolein | 2.96E-03 |
| o,m,p-Tolualdehyde | 4.73E-03 |
| Pentanal (Valeraldehyde) | 1.78E-03 |
| Propionaldehyde (Propanal) | 1.78E-03 |
| Aniline | 1.18E-02 |
| Dimethylaniline | 1.18E-02 |
| o-Toluidine | 5.92E-03 |
| Carbon Monoxide | 2.80E-01 |
| Methane | 1.60E-02 |
| Carbon Dioxide | 4.40E-01 |
| Ethane | 3.00E-01 |
| Propane | 4.40E-01 |
| Isobutane | 5.79E-01 |
| Butane | 5.79E-01 |
| Neopentane | 7.19E-01 |
| Isopentane | 7.19E-01 |
| Pentane | 7.19E-01 |

## Test GE Quantitation Limits – Lb/Lb Binder

| Analytes | Lb/Lb Binder |
|---|---|
| 1,2,3-Trimethylbenzene | 1.18E-05 |
| 1,2,4-Trimethylbenzene | 1.18E-05 |
| 1,3,5-Trimethylbenzene | 1.18E-05 |
| 1,3-Dimethylnaphthalene | 1.18E-05 |
| 1-Methylnaphthalene | 1.18E-05 |
| 2-Ethyltoluene | 1.18E-05 |
| 2-Methylnaphthalene | 1.18E-05 |
| Benzene | 1.18E-05 |
| Ethylbenzene | 1.18E-05 |
| Hexane | 1.18E-05 |
| m,p-Xylene | 1.18E-05 |
| Naphthalene | 1.18E-05 |
| o-Xylene | 1.18E-05 |
| Styrene | 1.18E-05 |
| Toluene | 1.18E-05 |
| Undecane | 1.18E-05 |
| 1,2-Dimethylnaphthalene | 5.92E-05 |
| 1,3-Diethylbenzene | 5.92E-05 |
| 1,5-Dimethylnaphthalene | 5.92E-05 |
| 1,6-Dimethylnaphthalene | 5.92E-05 |
| 1,8-Dimethylnaphthalene | 5.92E-05 |

| Analytes | Lb/Lb Binder |
|---|---|
| 2,3,5-Trimethylnaphthalene | 5.92E-05 |
| 2,3-Dimethylnaphthalene | 5.92E-05 |
| 2,4-Dimethylphenol | 5.92E-05 |
| 2,6-Dimethylnaphthalene | 5.92E-05 |
| 2,6-Dimethylphenol | 5.92E-05 |
| 2,7- Dimethylnaphthalene | 5.92E-05 |
| 3-Ethyltoluene | 5.92E-05 |
| Acenaphthalene | 5.92E-05 |
| Biphenyl | 5.92E-05 |
| Cyclohexane | 5.92E-05 |
| Decane | 5.92E-05 |
| Dodecane | 5.92E-05 |
| Heptane | 5.92E-05 |
| Indan | 5.92E-05 |
| Indene | 5.92E-05 |
| m,p-Cresol | 5.92E-05 |
| Nonane | 5.92E-05 |
| o-Cresol | 5.92E-05 |
| Octane | 5.92E-05 |
| Phenol | 5.92E-05 |
| Propylbenzene | 5.92E-05 |

| Analytes | Lb/Lb Binder |
|---|---|
| Tetradecane | 5.92E-05 |
| HC as Hexane | 3.83E-04 |
| 2-Butanone (MEK) | 1.19E-05 |
| Acetaldehyde | 1.19E-05 |
| Acetone | 1.19E-05 |
| Acrolein | 1.19E-05 |
| Benzaldehyde | 1.19E-05 |
| Butyraldehyde | 1.19E-05 |
| Crotonaldehyde | 1.19E-05 |
| Formaldehyde | 1.19E-05 |
| Hexaldehyde | 1.19E-05 |
| Butyraldehyde/Methacrolein | 1.99E-05 |
| o,m,p-Tolualdehyde | 3.18E-05 |
| Pentanal (Valeraldehyde) | 1.19E-05 |
| Propionaldehyde (Propanal) | 1.19E-05 |
| Aniline | 7.66E-05 |
| Dimethylaniline | 1.53E-04 |
| Carbon Monoxide | 2.84E-03 |
| Carbon Dioxide | 4.46E-03 |
| Butyl Carbitol | 1.26E-04 |
| Ethylene Glycol Phenyl Ether | 2.10E-04 |
| Nitrogen Oxides | 3.04E-03 |

## Test GE Quantitation Limits – Lb/Tn Metal

| Analytes | Lb/Tn Metal |
|---|---|
| 1,2,3-Trimethylbenzene | 1.12E-04 |
| 1,2,4-Trimethylbenzene | 1.12E-04 |
| 1,3,5-Trimethylbenzene | 1.12E-04 |
| 1,3-Dimethylnaphthalene | 1.12E-04 |
| 1-Methylnaphthalene | 1.12E-04 |
| 2-Ethyltoluene | 1.12E-04 |
| 2-Methylnaphthalene | 1.12E-04 |
| Benzene | 1.12E-04 |
| Ethylbenzene | 1.12E-04 |
| Hexane | 1.12E-04 |
| m,p-Xylene | 1.12E-04 |
| Naphthalene | 1.12E-04 |
| o-Xylene | 1.12E-04 |
| Styrene | 1.12E-04 |
| Toluene | 1.12E-04 |
| Undecane | 1.12E-04 |
| 1,2-Dimethylnaphthalene | 5.59E-04 |
| 1,3-Diethylbenzene | 5.59E-04 |
| 1,5-Dimethylnaphthalene | 5.59E-04 |
| 1,6-Dimethylnaphthalene | 5.59E-04 |
| 1,8-Dimethylnaphthalene | 5.59E-04 |

| Analytes | Lb/Tn Metal |
|---|---|
| 2,3,5-Trimethylnaphthalene | 5.59E-04 |
| 2,3-Dimethylnaphthalene | 5.59E-04 |
| 2,4-Dimethylphenol | 5.59E-04 |
| 2,6-Dimethylnaphthalene | 5.59E-04 |
| 2,6-Dimethylphenol | 5.59E-04 |
| 2,7- Dimethylnaphthalene | 5.59E-04 |
| 3-Ethyltoluene | 5.59E-04 |
| Acenaphthalene | 5.59E-04 |
| Biphenyl | 5.59E-04 |
| Cyclohexane | 5.59E-04 |
| Decane | 5.59E-04 |
| Dodecane | 5.59E-04 |
| Heptane | 5.59E-04 |
| Indan | 5.59E-04 |
| Indene | 5.59E-04 |
| m,p-Cresol | 5.59E-04 |
| Nonane | 5.59E-04 |
| o-Cresol | 5.59E-04 |
| Octane | 5.59E-04 |
| Phenol | 5.59E-04 |
| Propylbenzene | 5.59E-04 |

| Analytes | Lb/Tn Metal |
|---|---|
| Tetradecane | 5.59E-04 |
| HC as Hexane | 5.59E-02 |
| 2-Butanone (MEK) | 1.68E-03 |
| Acetaldehyde | 1.68E-03 |
| Acetone | 1.68E-03 |
| Acrolein | 1.68E-03 |
| Benzaldehyde | 1.68E-03 |
| Butyraldehyde | 1.68E-03 |
| Crotonaldehyde | 1.68E-03 |
| Formaldehyde | 1.68E-03 |
| Hexaldehyde | 1.68E-03 |
| Butyraldehyde/Methacrolein | 2.79E-03 |
| o,m,p-Tolualdehyde | 4.47E-03 |
| Pentanal (Valeraldehyde) | 1.68E-03 |
| Propionaldehyde (Propanal) | 1.68E-03 |
| Aniline | 1.12E-02 |
| Dimethylaniline | 2.24E-02 |
| Butyl Carbitol | 1.68E-02 |
| Ethylene Glycol Phenyl Ether | 2.79E-02 |
| Carbon Monoxide | 2.68E-02 |
| Carbon Dioxide | 4.21E-02 |
| Nitrogen Oxides | 2.87E-02 |

## Test Plan T-Statistics – Lb/Lb Binder

| Analytes | Test FQ Lb/Lb Binder | Test GE Lb/Lb Binder | T-Statistic |
|---|---|---|---|
| **TGOC as Propane** | 0.0974 | 0.0319 | 31.2 |
| **HC as Hexane** | 0.0232 | 0.0127 | 15.2 |
| **Sum of Target Analytes** | 0.0341 | 0.0147 | 7.0 |
| **Sum of HAPs** | 0.0327 | 0.0127 | 7.4 |
| **Sum of POMs** | 0.0055 | 0.0002 | 27.6 |
| **Individual Organic HAPs** | | | |
| **Phenol** | 0.0107 | 0.0017 | 13.8 |
| **Benzene** | 0.0096 | 0.0037 | 21.6 |
| **Methylnaphthalenes** | 0.0028 | ND | 24.7 |
| **Aniline** | 0.0027 | ND | 17.9 |
| **o,m,p-Cresol** | 0.0022 | 0.0016 | 4.0 |
| **Toluene** | 0.0019 | 0.0013 | 11.9 |
| **Naphthalene** | 0.0017 | 0.0001 | 42.3 |
| **Dimethylnaphthalenes** | 0.0010 | ND | 13.2 |
| **o,m,p-Xylene** | 0.0008 | 0.0010 | -2.0 |
| **Acetaldehyde** | 0.0005 | 0.0023 | -54.0 |
| **Formaldehyde** | 0.0001 | 0.0002 | NA |
| **Propionaldehyde** | <0.0001 | 0.0002 | NA |
| **Ethylene Glycol Phenyl Ether** | NT | 0.0001 | -3.0 |
| **Other VOCs** | | | |
| **Trimethylbenzenes** | 0.0005 | 0.0009 | -4.0 |
| **Dimethylphenols** | 0.0001 | 0.0006 | -15.0 |
| **Butyraldehyde/Methacrolein** | 0.0001 | 0.0003 | NA |
| **Other Analytes** | | | |
| **Carbon Dioxide** | 2.654 | 0.5135 | 30.3 |
| **Carbon Monoxide** | 0.0194 | 0.1731 | -17.4 |
| **Nitrogen Oxides** | NT | 0.0003 | NA |

**Individual results constitute >95% of mass of all detected target analytes.**

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

## Test Plan T-Statistics – Lb/Tn Metal

| Analytes | Test FQ Lb/Tn Metal | Test GE Lb/Tn Metal | T-statistic |
|---|---|---|---|
| **TGOC as Propane** | 0.7255 | 0.3010 | 25.8 |
| **HC as Hexane** | 0.1726 | 0.1204 | 9.2 |
| **Sum of Target Analytes** | 0.2737 | 0.1409 | 17.7 |
| **Sum of HAPs** | 0.2630 | 0.1217 | 20.3 |
| **Sum of POMs** | 0.0411 | 0.0010 | 31.2 |
| **Individual Organic HAPs** | | | |
| **Phenol** | 0.0794 | 0.0160 | 13.2 |
| **Benzene** | 0.0717 | 0.0352 | 18.5 |
| **Methylnaphthalenes** | 0.0211 | ND | 23.3 |
| **Aniline** | 0.0203 | ND | 17.3 |
| **o,m,p-Cresol** | 0.0165 | 0.0156 | 0.5 |
| **Toluene** | 0.0145 | 0.0128 | 4.7 |
| **Naphthalene** | 0.0124 | 0.0010 | 33.4 |
| **Dimethylnaphthalenes** | 0.0076 | ND | 13.4 |
| **o,m,p-Xylene** | 0.0062 | 0.0095 | -3.0 |
| **Acetaldehyde** | 0.0037 | 0.0222 | -46.0 |
| **Formaldehyde** | 0.0008 | 0.0019 | -13.3 |
| **Propionaldehyde** | 0.0003 | 0.0017 | -42.0 |
| **Ethylene Glycol Phenyl Ether** | NT | 0.0021 | -2.0 |
| **Other VOCs** | | | |
| **Trimethylbenzenes** | 0.0038 | 0.0083 | -5.4 |
| **Dimethylphenols** | 0.0009 | 0.0059 | -16.2 |
| **Butyraldehyde/Methacrolein** | 0.0005 | 0.0029 | -36.0 |
| **Other Analytes** | | | |
| **Carbon Dioxide** | 19.77 | 4.845 | 28.0 |
| **Carbon Monoxide** | 0.1451 | 1.633 | -23.6 |

**Individual results constitute >95% of mass of all detected target analytes.**

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

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# APPENDIX C TEST SERIES FQ AND GE DETAILED PROCESS DATA

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# Test FQ Detailed Process Data

| Greensand PCS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Dates | **12/17/2003** | **12/18/2003** | **12/18/2003** | **12/19/2003** | **12/22/2003** | **12/22/2003** | **12/22/2003** | **12/23/2003** | **12/23/2004** | **Averages** |
| Emissions Sample # / Production Sample # | **FQ001** | **FQ002** | **FQ003** | **FQ004** | **FQ005** | **FQ006** | **FQ007** | **FQ008** | **FQ009** | |
| Cast Weight (all metal inside mold), Lbs. | 108.30 | 106.30 | 107.15 | 106.80 | 106.70 | 106.70 | 107.45 | 105.85 | 106.95 | **106.91** |
| Pouring Time, sec. | 21 | 24 | 27 | 27 | 25 | 23 | 26 | 31 | 24 | **25** |
| Pouring Temp ,°F | 2635 | nd | 2626 | 2640 | 2622 | 2632 | 2626 | 2620 | 2636 | **2630** |
| Pour Hood Process Air Temp at Start of Pour, °F | 86 | 85 | 86 | 87 | 87 | 88 | 87 | 88 | 89 | **87** |
| Mixer auto dispensed batch weight, Lbs | 51.38 | 51.38 | 51.38 | 51.38 | 51.38 | 51.38 | 51.38 | 51.38 | 51.55 | **51.40** |
| Calibrated auto dispensed binder weight, Lbs | 0.728 | 0.728 | 0.728 | 0.728 | 0.728 | 0.728 | 0.728 | 0.728 | 0.719 | **0.727** |
| Core binder calibrated weight, %BOS | 1.42 | 1.42 | 1.42 | 1.42 | 1.42 | 1.42 | 1.42 | 1.42 | 1.40 | **1.41** |
| Core binder calibrated weight, % | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.38 | **1.39** |
| Total uncoated core weight in mold, Lbs. | 28.45 | 28.30 | 28.55 | 28.65 | 28.60 | 28.60 | 28.40 | 28.30 | 28.85 | **28.52** |
| Total binder weight in mold, Lbs. | 0.397 | 0.395 | 0.399 | 0.400 | 0.399 | 0.399 | 0.397 | 0.395 | 0.397 | **0.398** |
| Core LOI, % | 1.33 | 1.32 | 1.41 | 1.32 | 1.31 | 1.32 | 1.38 | 1.46 | 1.49 | **1.37** |
| Total dried core coating weight in mold. Lbs | 0.20 | 0.40 | 0.40 | 0.40 | 0.35 | 0.30 | 0.35 | 0.40 | 0.20 | **0.33** |
| Core age, hrs. | 70 | 72 | 91 | 106 | 164 | 168 | 171 | 188 | 171 | **133** |
| Muller Batch Weight, Lbs. | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | **900** |
| GS Mold Sand Weight, Lbs. | 620 | 617 | 613 | 609 | 610 | 612 | 613 | 610 | 609 | **613** |
| Mold compactability, % | 48 | 51 | 57 | 57 | 56 | 57 | 59 | 58 | 55 | **55** |
| Mold Temperature, °F | 90 | 70 | 88 | 78 | 67 | 72 | 74 | 71 | 76 | **76** |
| Average Green Compression , psi | 11.93 | 13.77 | 12.38 | 13.22 | 12.27 | 12.51 | 12.57 | 16.36 | 15.93 | **13.44** |
| GS Compactability, % | 26 | 40 | 42 | 47 | 52 | 53 | 55 | 44 | 45 | **45** |
| GS Moisture Content, % | 1.34 | 1.68 | 1.78 | 2.06 | 2.28 | 2.04 | 2.26 | 1.92 | 2.06 | **1.94** |
| GS MB Clay Content, % | 6.09 | 6.09 | 5.62 | 5.97 | 6.21 | 6.21 | 6.21 | 6.68 | 6.56 | **6.18** |
| MB Clay reagent, ml | 26.0 | 26.0 | 24.0 | 25.5 | 26.5 | 26.5 | 26.5 | 28.5 | 28.0 | **26.4** |
| 1800°F LOI - Mold Sand, % | 0.76 | 0.75 | 0.93 | 0.88 | 0.83 | 0.74 | 0.90 | 0.85 | 0.79 | **0.83** |
| 900°F Volatiles , % | 0.52 | 0.26 | 0.28 | 0.40 | 0.34 | 0.40 | 0.44 | 0.44 | 0.34 | **0.38** |
| Appearance ranking: 1 = best, 9 = worst | 4 | 6 | 2 | 9 | 5 | 7 | 1 | 3 | 8 | |

# Test GE Detailed Process Data

| Greensand PCS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test Dates | **8/24/04** | **8/24/04** | **8/24/04** | **8/25/04** | **8/25/04** | **8/25/04** | **8/26/04** | **8/26/04** | **8/26/04** | **8/27/04** | **8/27/04** | **8/27/04** | **Averages** |
| Emissions Sample # | **GEER01** | **GEER02** | **GEER03** | **GE001** | **GE002** | **GE003** | **GE004** | **GE005** | **GE006** | **GE007** | **GE008** | **GE009** | |
| Production Sample # | **GE001** | **GE002** | **GE003** | **GE004** | **GE005** | **GE006** | **GE007** | **GE008** | **GE009** | **GE010** | **GE011** | **GE012** | |
| Cast Weight (all metal inside mold), Lbs. | 114.15 | 110.95 | 111.45 | 110.90 | 112.75 | 111.15 | 113.70 | 111.20 | 111.8 | 113.55 | 118.25 | 118.5 | **113.5** |
| Pouring Time, sec. | 15 | 18 | 18 | 21 | 18 | 19 | 18 | 16 | 20 | 17 | 17 | 15 | **17.9** |
| Pouring Temp ,°F | 2623 | 2638 | 2633 | 2636 | 2639 | 2637 | 2633 | 2638 | 2627 | 2636 | 2639 | 2626 | **2634.6** |
| Pour Hood Process Air Temp at Start of Pour, $^{o}$F | 88 | 87 | 89 | 88 | 88 | 90 | 89 | 88 | 87 | 86 | 86 | 90 | **88.0** |
| Mixer auto dispensedsand batch weight, Lbs | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | 50.25 | **50.25** |
| Weighed binder weight, Lbs | 1.022 | 1.005 | 1.011 | 1.001 | 1.010 | 1.009 | 1.006 | 1.006 | 1.005 | 1.005 | 1.006 | 1.006 | **1.006** |
| Core binder calibrated weight, %BOS | 2.03 | 2.00 | 2.01 | 1.99 | 2.01 | 2.01 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | **2.00** |
| Core binder calibrated weight, % | 1.99 | 1.96 | 1.97 | 1.95 | 1.97 | 1.97 | 1.96 | 1.96 | 1.96 | 1.96 | 1.96 | 1.96 | **1.96** |
| Total uncoated core weight in mold, Lbs. | 27.49 | 27.56 | 27.68 | 27.96 | 27.98 | 28.04 | 27.28 | 26.86 | 26.86 | 26.89 | 26.79 | 27.20 | **27.32** |
| Total binder weight in mold, Lbs. | 0.548 | 0.541 | 0.546 | 0.546 | 0.551 | 0.552 | 0.535 | 0.527 | 0.527 | 0.527 | 0.526 | 0.534 | **0.536** |
| Core coating weight, Lbs **Note 2** | 0.21 | 0.36 | 0.35 | 0.28 | 0.35 | 0.36 | 0.32 | 0.39 | 0.40 | 0.39 | 0.43 | 0.32 | **0.36** |
| Core coating sp.gr., deg. Bē | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | **39** |
| Sand temperature. Deg F | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | **72** |
| Core LOI, % **Note 1** | 1.27 | 1.29 | 1.08 | 1.02 | 1.06 | 1.01 | 1.04 | 1.04 | 1.02 | 0.99 | 0.99 | 1.02 | **1.02** |
| Core dogbone tensile, psi | 81 | 81 | 77 | 77 | 72 | 76 | 71 | 79 | 72 | 81 | 80 | 79 | **76** |
| Core age, hrs. | 22 | 25 | 28 | 46 | 49 | 52 | 70 | 72 | 75 | 93 | 96 | 100 | **73** |
| Muller Batch Weight, Lbs. | 1301 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | **900** |
| GS Mold Sand Weight, Lbs. | 648 | 642 | 645 | 646 | 644 | 647 | 648 | 643 | 647 | 649 | 645 | 636 | **645** |
| Mold compactability, % | 59 | 57 | 60 | 59 | 57 | 57 | 54 | 55 | 54 | 50 | 55 | 52 | **55** |
| Mold Temperature, $^{o}$F | 83 | 87 | 87 | 80 | 83 | 87 | 73 | 80 | 87 | 80 | 83 | 85 | **82** |
| Average Green Compression , psi | 16.28 | 16.13 | 15.56 | 16.18 | 47.75 | 18.31 | 20.23 | 19.04 | 19.71 | 21.32 | 20.86 | 22.73 | **22.90** |
| GS Compactability, % | 56 | 52 | 55 | 57 | 54 | 55 | 47 | 46 | 44 | 46 | 54 | 46 | **50** |
| GS Moisture Content, % | 4.36 | 3.12 | 2.46 | 2.46 | 2.80 | 2.20 | 2.76 | 2.30 | 2.38 | 2.46 | 2.44 | 1.96 | **2.42** |
| GS MB Clay Content, % | 7.91 | 8.04 | 8.04 | 8.29 | 8.17 | 8.18 | 8.29 | 8.04 | 8.56 | 8.3 | 8.30 | 8.17 | **8.26** |
| MB Clay reagent, ml | 30.5 | 31.0 | 31.0 | 32.0 | 31.5 | 31.5 | 32.0 | 31.0 | 33.0 | 32.0 | 32.0 | 31.5 | **31.8** |
| 1800°F LOI - Mold Sand, % | 0.93 | 1.06 | 0.93 | 0.97 | 1.03 | 0.91 | 1.02 | 1.13 | 1.00 | 1.04 | 0.98 | 0.92 | **1.00** |
| 900°F Volatiles , % | 0.32 | 0.46 | 0.48 | 0.44 | 0.54 | 0.36 | 0.38 | 0.52 | 0.22 | 0.36 | 0.30 | 0.08 | **0.36** |
| Overall appearance ranking: 1 = best, 9 = worst | 5a | 6b | 6a | 7 | 3 | 1 | 2 | 4 | 6 | 8 | 9 | 5 | |

Note 1: Mold GE001,2 are raw core from core machine, cores GE003-12 are oven dried.

Note 2: The core coating weight includes about 0.06 Lbs per core of volatile binder solvent that evaporated during drying

## FQ Cavity 3 Core Photos

FQ001

FQ002

FQ003

FQ004

FQ005

FQ006

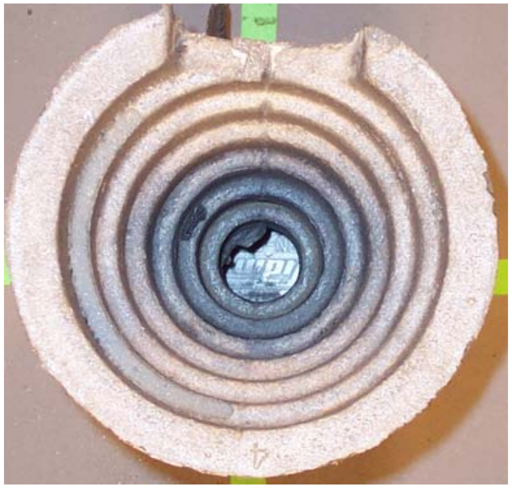
## FQ Cavity 3 Core Photos

FQ007

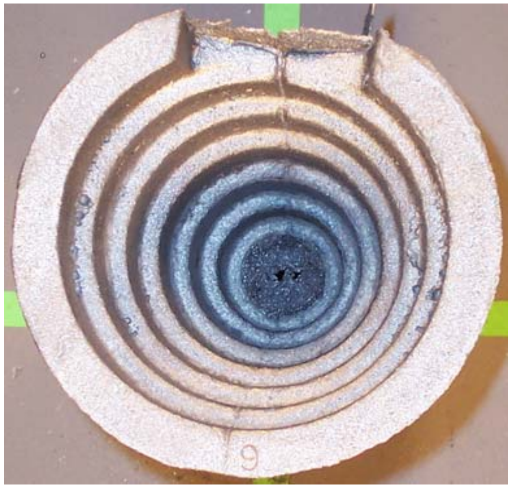
FQ008

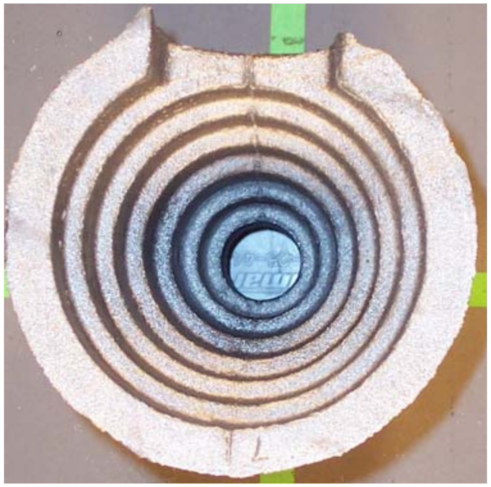
FQ009

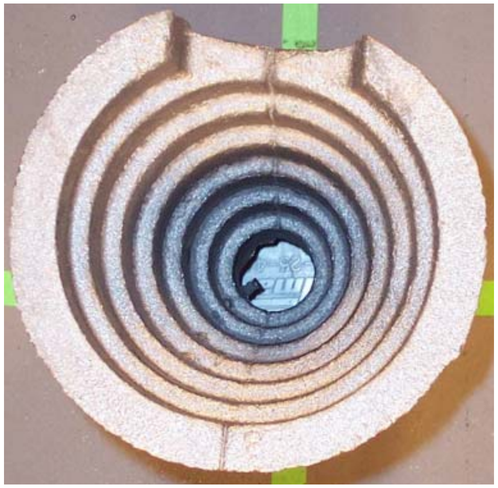
## GE Cavity 3 Core Photos

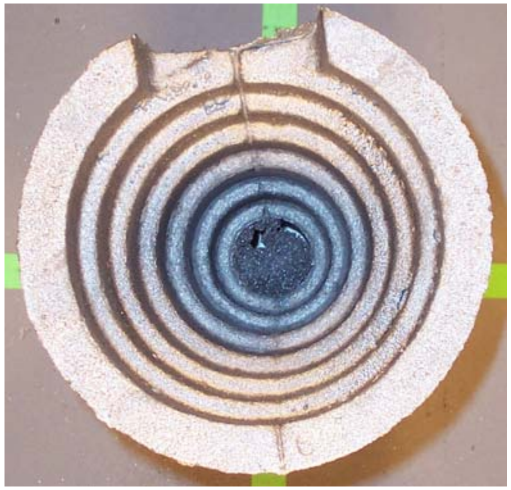

GE001


GE002

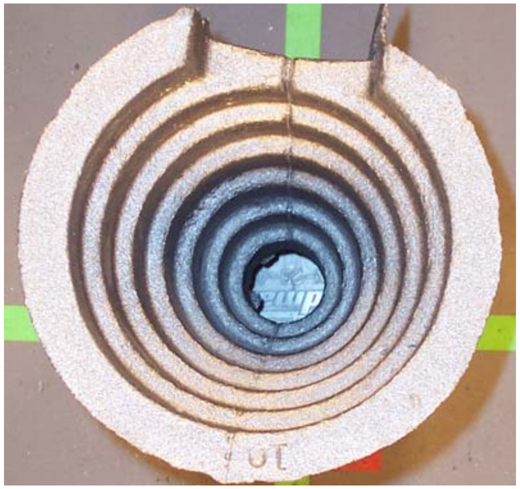

GE003


GE004

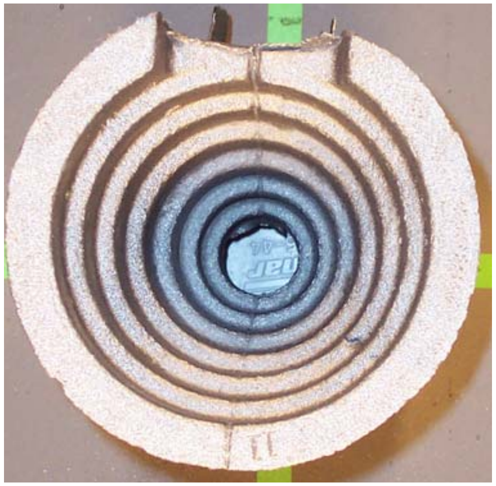

GE005


GE006

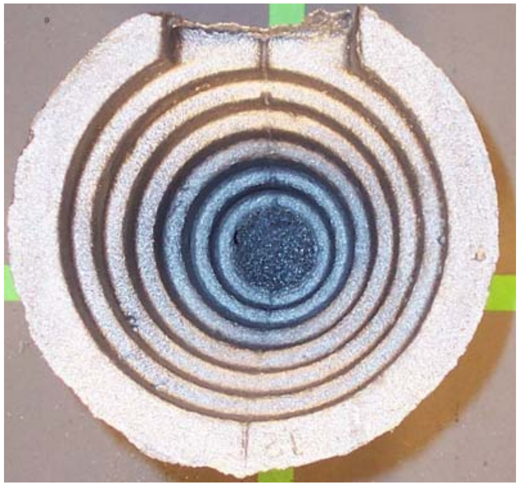
## GE Cavity 3 Core Photos



**GE007**



**GE008**



**GE009**

# APPENDIX D METHOD 25A CHARTS

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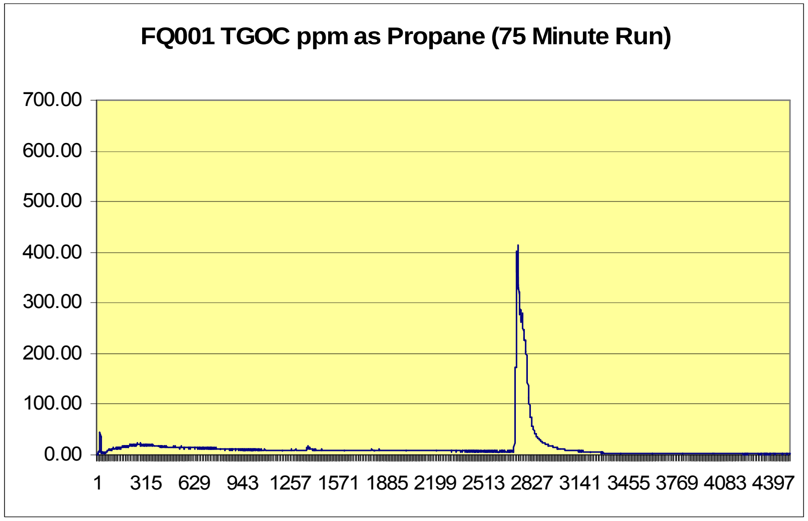
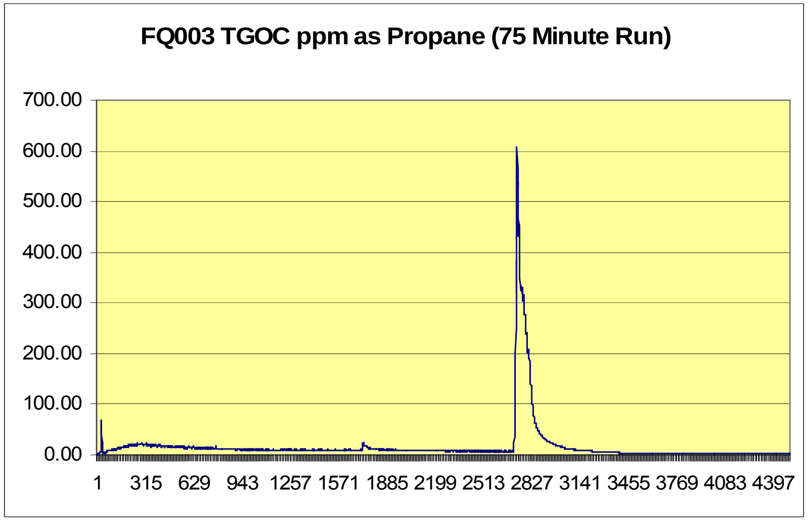
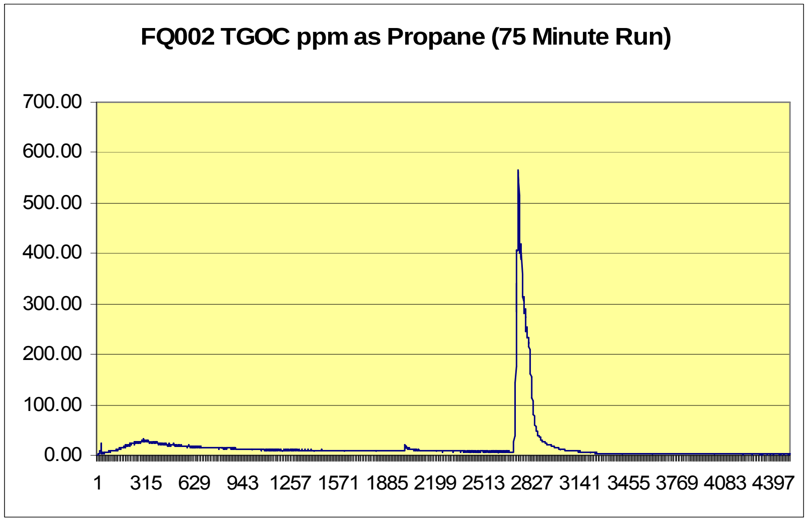
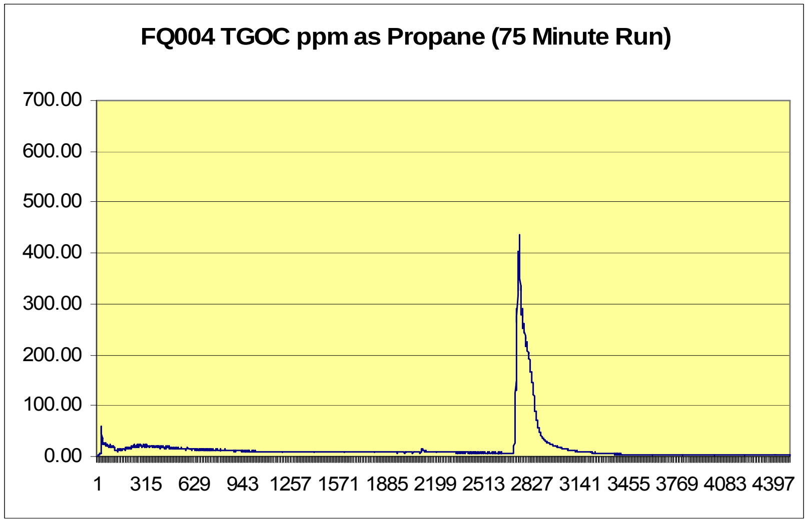
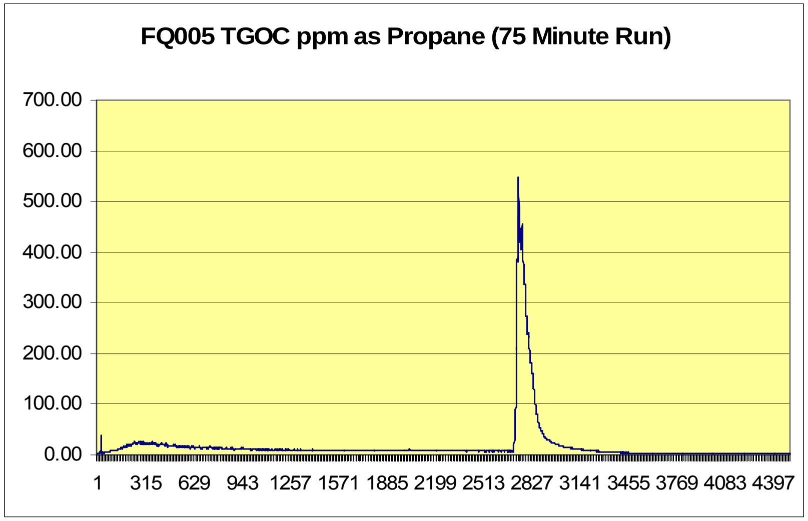
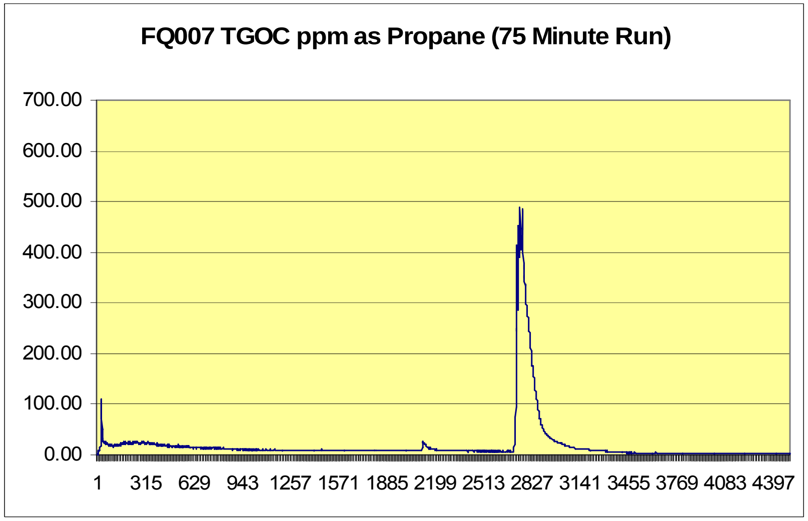

FQ001 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

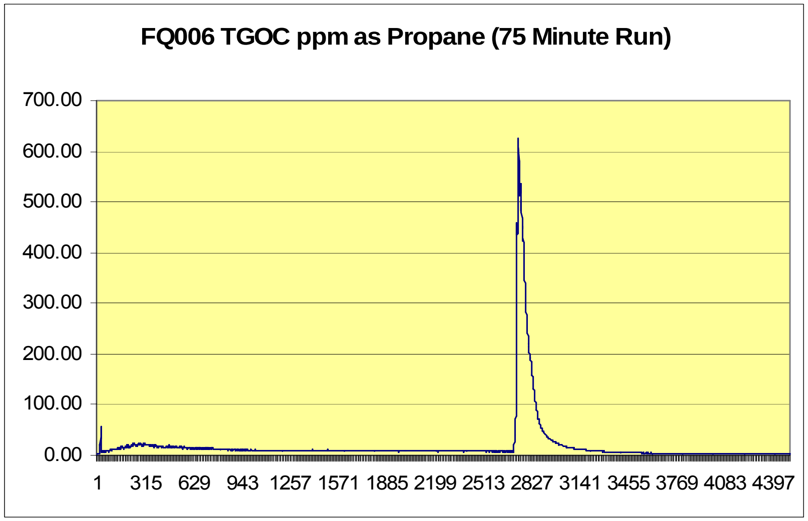

FQ003 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

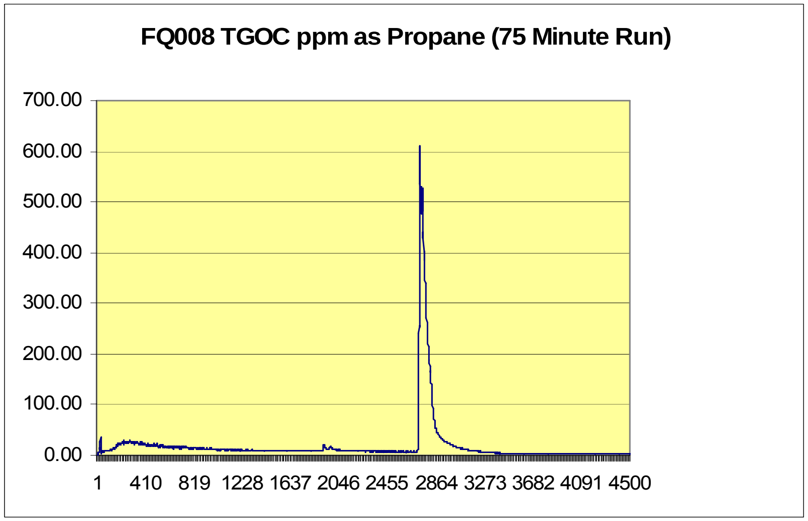

FQ002 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397

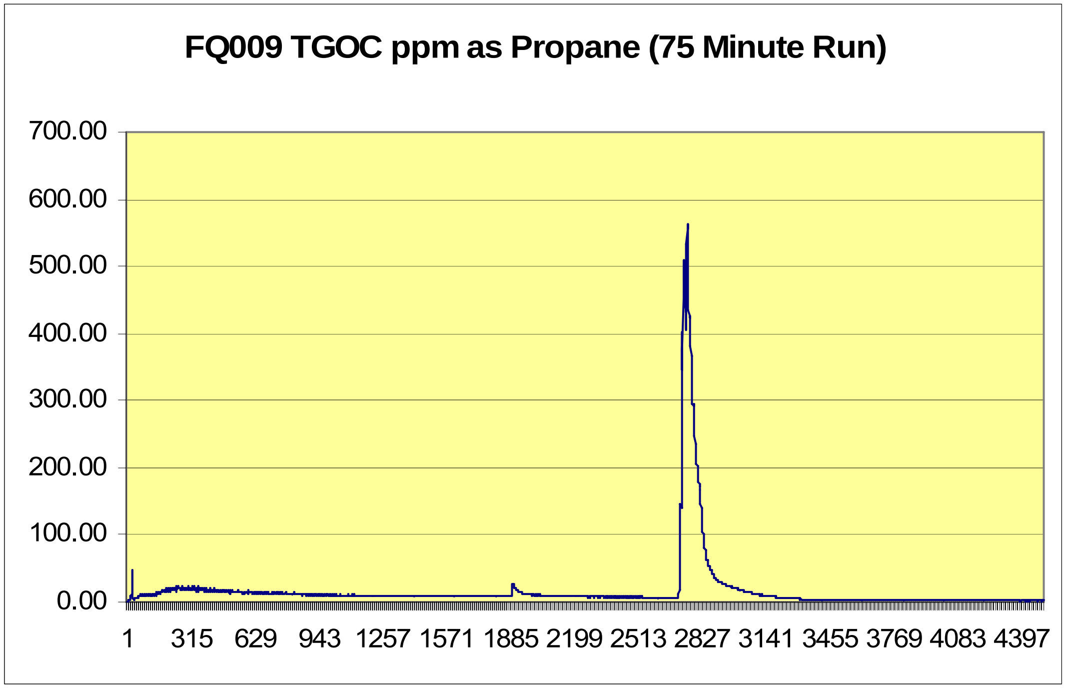

FQ004 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FQ005 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FQ007 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FQ006 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 315 629 943 1257 1571 1885 2199 2513 2827 3141 3455 3769 4083 4397


FQ008 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1 410 819 1228 1637 2046 2455 2864 3273 3682 4091 4500


FQ009 TGOC ppm as Propane (75 Minute Run)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1
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629
943
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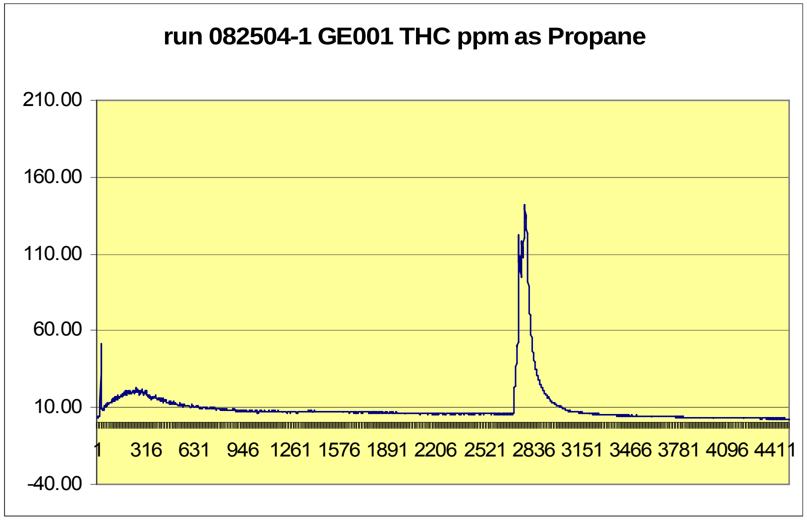
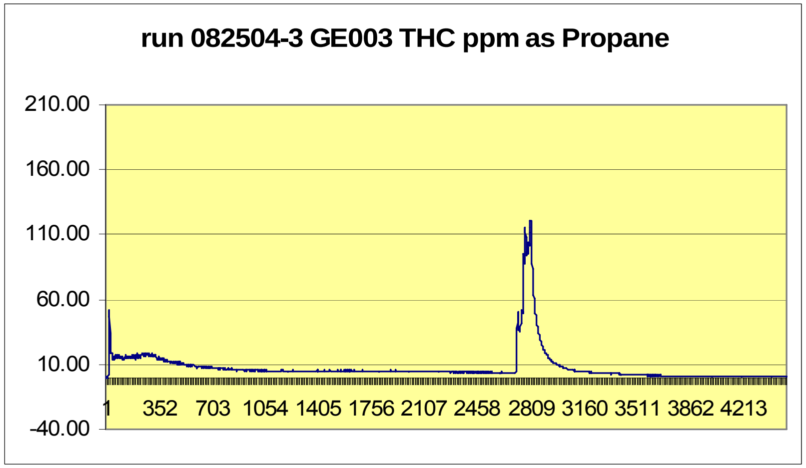
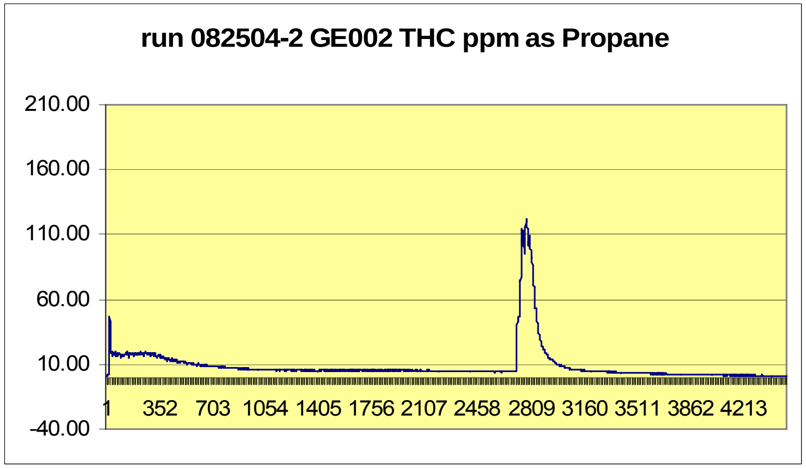
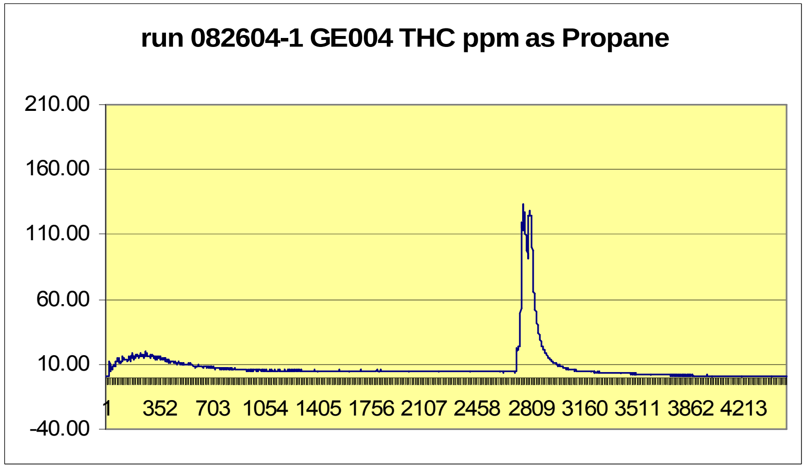
3455
3769
4083
4397


run 082504-1 GE001 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
1 316 631 946 1261 1576 1891 2206 2521 2836 3151 3466 3781 4096 4411


run 082504-3 GE003 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
1 352 703 1054 1405 1756 2107 2458 2809 3160 3511 3862 4213


run 082504-2 GE002 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
1 352 703 1054 1405 1756 2107 2458 2809 3160 3511 3862 4213


run 082604-1 GE004 THC ppm as Propane
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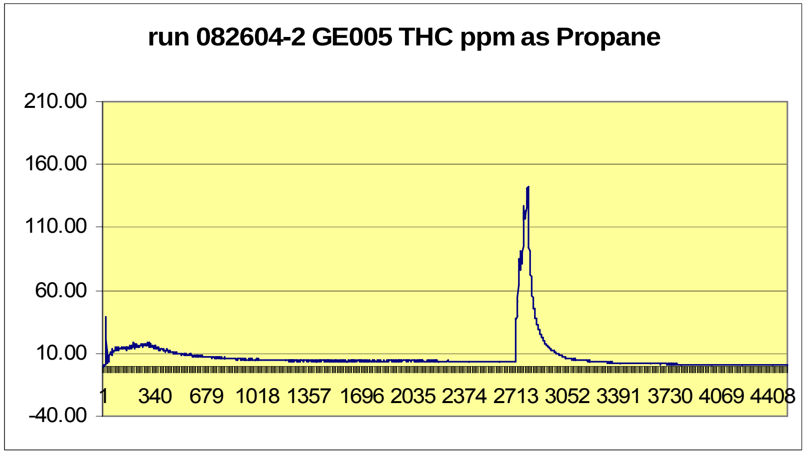
160.00
110.00
60.00
10.00
-40.00
1 352 703 1054 1405 1756 2107 2458 2809 3160 3511 3862 4213


run 082604-2 GE005 THC ppm as Propane
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160.00
110.00
60.00
10.00
-40.00
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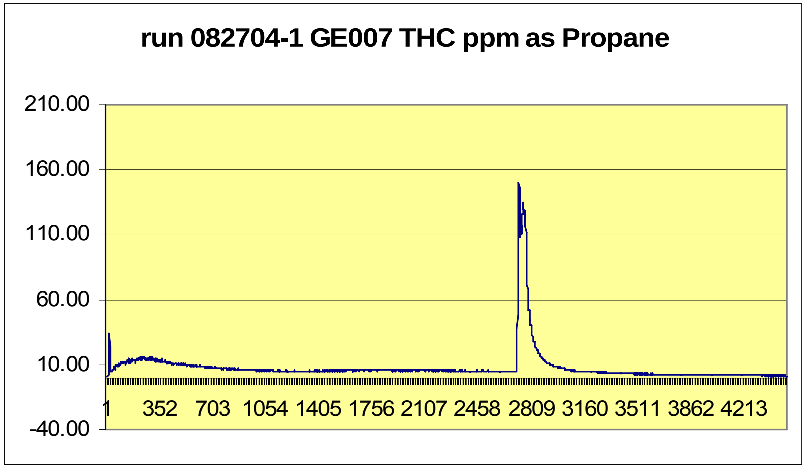
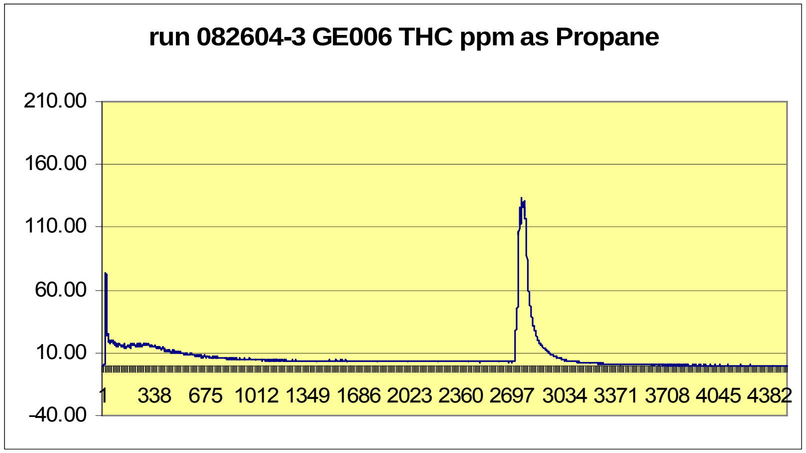

run 082704-1 GE007 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
1 352 703 1054 1405 1756 2107 2458 2809 3160 3511 3862 4213


run 082604-3 GE006 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
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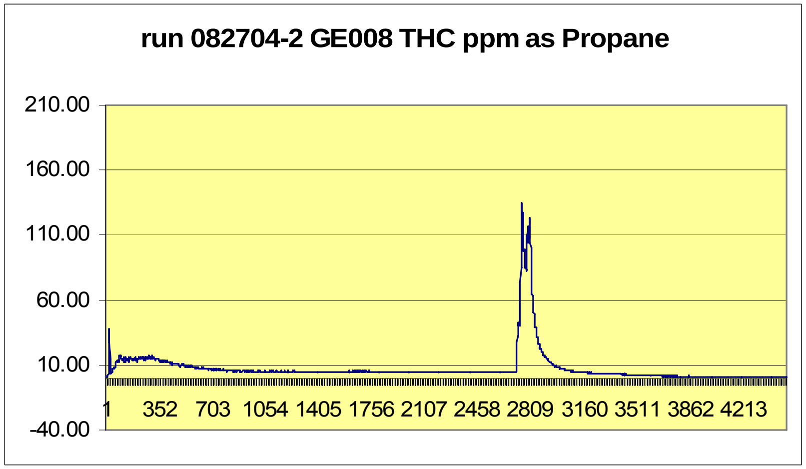
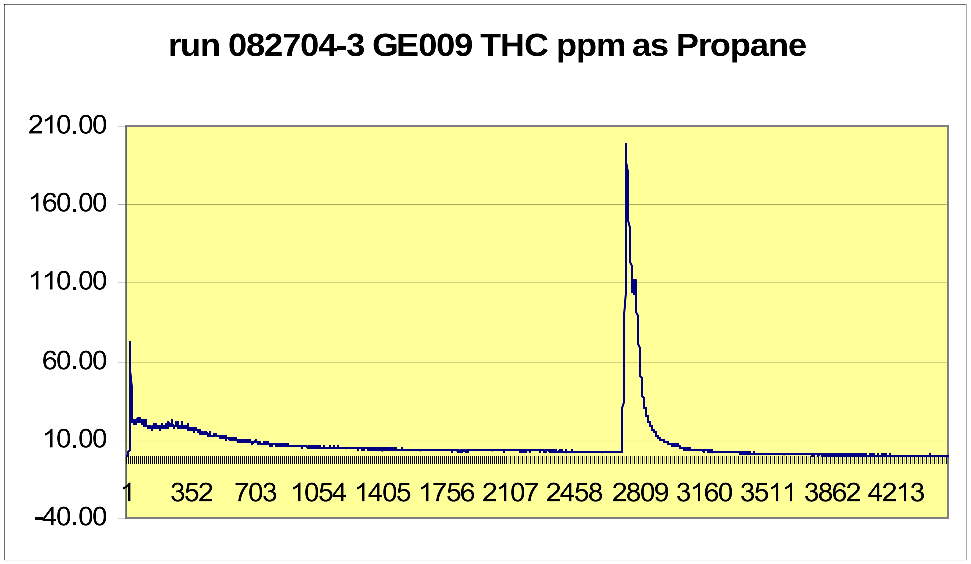

run 082704-2 GE008 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
1 352 703 1054 1405 1756 2107 2458 2809 3160 3511 3862 4213


run 082704-3 GE009 THC ppm as Propane
210.00
160.00
110.00
60.00
10.00
-40.00
1
352
703
1054
1405
1756
2107
2458
2809
3160
3511
3862
4213

# APPENDIX E GLOSSARY

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# Glossary

| | |
|---|---|
| **BO** | Based on ( ). |
| **BOS** | Based on Sand. |
| **Criteria Pollutant** | Pollutants, including; CO, $SO_2$, NOx, VOC, Particulate Matter and Lead, for which the US EPA has established National Ambient Air Quality Standards. |
| **HAP** | Hazardous Air Pollutant defined by the 1990 Clean Air Act Amendment |
| **HC as Hexane** | Calculated by the summation of all area between elution of Hexane through the elution of Hexadecane. The quantity of HC is performed against a five-point calibration curve of Hexane by dividing the total area count from C6 through C16 to the area of Hexane from the initial calibration curve. |
| **I** | Data rejected based on data validation considerations |
| **LOI** | Loss On Ignition |
| **NA** | Not Applicable |
| **ND** | Non-Detect |
| **NT** | Lab testing was not done |
| **POM** | Polycyclic Organic Matter (POM) including Naphthalene and other compounds that contain more than one benzene ring and have a boiling point greater than or equal to 100 degrees Celsius. |
| **TGOC as Propane** | Weighted to the detection of more volatile hydrocarbon species, beginning at C1 (methane), with results calibrated against a three-carbon alkane (propane). |
| **VOC** | Volatile Organic Compound |