CERP

Casting Emission Reduction Program


Prepared by:

TECHNIKON LLC

*5301 Price Avenue ▼ McClellan, CA, 95652 ▼ (916) 929-8001*

www.technikonllc.com


*US Army Task N256*

# Ashland Iron No Bake NBE 1 and 2 Ester Cured Phenolic / Iron

**Technikon # RE 100121 DZ**

**22 June 2001**

*This document was revised for unlimited public distribution.*

United States Environmental Protection Agency

CISA

AMERICAN FOUNDRY SOCIETY, INC.

UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH

USCAR

DaimlerChrysler Ford Motor Company General Motors

THIS PAGE INTENTIONALLY LEFT BLANK

# Pre-Production Air Emission Test Report

## No-Bake Binder Systems

## Ester Cured Phenolic / Iron

## Emissions Test

## RE100121DZ

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

| | | |
|---|---|---|
| Written by: | Carmen Hornsby | 6/20/01 Date |
| Process Engineering Manager: | Steven Knight | 6/20/01 Date |
| VP Measurement Technologies: | Clifford Glowacki, CIH | 6-20-01 Date |
| VP Operations: | George Crandell | 6-20-01 Date |
| President: | William Walden | 6/20/01 Date |

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

THIS PAGE INTENTIONALLY LEFT BLANK

# Table of Contents



# List of Figures



# List of Tables

# Appendices

## Executive Summary

This report contains the results of emission testing to evaluate the pouring, cooling, and shakeout emissions from Test DZ, an Ester Cured Phenolic No-Bake binder system. These data are compared to results from Test DG, a baseline Phenolic Urethane No-Bake binder system. All testing was conducted by Technikon, LLC in its Pre-Production foundry.

The Pre-Production Foundry is a simple general purpose manual foundry that was adapted and instrumented to make detailed organic emission measurements, using methods based on EPA protocols for pouring, casting cooling, and shakeout processes on *discrete* molds. The measurements are conducted under tightly controlled conditions not feasible in a commercial foundry. Evaluating a new product or process in the Technikon Pre-Production Foundry reduces the risk of new material or product introduction for the foundry industry.

The specific objective of Test DG was to establish air emission data against which the air emissions from new materials, equipment and processes, designed to reduce organic Hazardous Air Pollutants (HAPs) and Volatile Organic Compounds (VOCs). This report documents the following test series: A comparison of an Ester Cured Phenolic binder (Test DZ) to the reference Phenolic Urethane binder system (Test DG).

The testing performed involved the collection of continuous air samples over a seventy-five minute period, including the mold pouring, cooling, shakeout, and post shakeout periods. Process and stack parameters were measured and include: the weights of the casting, mold, binder; Loss on Ignition (LOI) values for the mold prior to the test; metallurgical data; and stack temperature, pressure, volumetric flow rate and moisture content. The process parameters were maintained within prescribed ranges in order to ensure the reproducibility of the tests. Samples were collected and analyzed for over seventy (70) target compounds using procedures based on US EPA Method 18. Continuous monitoring of the Total Gaseous Organic Concentration (TGOC), formerly Total Hydrocarbon Content (THC), of the emissions was conducted according to US EPA Method 25A. Finally, the "condensable" organic material in the emissions was determined using a Technikon developed procedure. The "condensables" represent the "back half" catch from US EPA Method 5.

The mass emission rate of each parameter or target compound was calculated, in pounds per ton of metal, using the Method 25A data or the laboratory analytical results, the measured source data, and the weight of each casting. Results for structural isomers have been grouped and reported as a single entity. For example, ortho, meta, and para xylene are the three (3) structural isomers of dimethylbenzene and are reported as o,m,p-xylene though separate results are available in Appendix B of this report. Several "emissions indicators," in addition to the TGOC (THC) as Propane, were also calculated. The HC as Hexane results represent the sum of all organic compounds detected and expressed as hexane. All of the following sums are sub-groups of this measure. The "Sum of VOCs" is based on the sum of the individual target Volatile Organic Compounds (VOCs) measured and includes the Hazardous Air Pollutants (HAPs) and 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 POMs. Finally, the "Sum of POMs" is the sum of all of the polycyclic organic material measured.

Results for the emission indicators for Test DG and DZ are shown in the following table. All results are reported as pounds emitted per ton of metal.

| Emissions Indicators | Test DG | Test DZ | % Change from DG |
|---|---|---|---|
| **TGOC (THC) as Propane** | 12.2 | 3.39 | -72% |
| **HC as Hexane** | 11.1 | 2.37 | -79% |
| **Sum of VOCs** | 4.06 | 0.901 | -78% |
| **Sum of HAPs** | 2.00 | 0.803 | -60% |
| **Sum of POMs** | 0.104 | 0.067 | -36% |

The results from the above table show a decrease in emission indicators for Test DZ (Ester Cured Phenolic binder system) compared to DG (Phenolic Urethane binder system) ranging from 36% to 79% lower emissions.

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

# 1.0 Introduction

## 1.1 Background

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

## 1.2 CERP Objectives

The primary objective of CERP is to evaluate materials, equipment, and processes used in the production of metal castings. Technikon's facility was designed to evaluate alternate materials and production processes designed to achieve significant air emission reductions, especially for the 1990 Clean Air Act Amendment HAPs. 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 data collected during the various testing projects are evaluated to determine both the airborne emissions impact of the materials and/or process changes, and their stability and impact upon the quality and economics of casting and core manufacture. The materials, equipment, and processes may need to be further adapted and defined so that they will integrate into current casting facilities smoothly and with minimum capital expenditure.

Normally, Pre-Production testing is conducted first in order to evaluate the air emissions impact of a proposed alternative material, equipment, or process in the most cost effective manner. The Pre-Production Foundry is a simple general purpose manual foundry that was adapted and instrumented to make detailed emission measurements using methods based on EPA protocols for pouring, casting cooling, and shakeout processes on *discrete* molds under tightly controlled conditions not feasible in a commercial foundry. The Pre-Production Foundry uses a four-cavity, AFS irregular gear mold as its test pattern for No-Bake testing. All No-Bake testing occurs in the Pre-Production Foundry.

The Production Foundry's design as a basic greensand foundry was deliberately chosen so that whatever is tested in this facility will also be convertible to existing mechanized commercial foundries. The type and size of equipment, materials, and processes used emulate an automotive foundry. This facility is used to evaluate materials, equipment, and processes in a *continuous* process that is allowed to vary to the limits of commercial experience in a controlled manner. The Production Foundry provides simultaneous detailed individual emission measurements using methods based on US EPA protocols of the melting, pouring, sand preparation, mold making, and core making processes. It is instrumented so that the data on all activities of the metal casting process can be simultaneously and continuously collected, in order to completely evaluate the economic impact of the prospective emission reducing strategy. The Production Foundry's test casting is a single cavity Ford Motor Company I-4 engine block. Castings are randomly selected to evaluate the impact of the material, equipment, or process on casting quality. Alternative materials, equipment, and processes that demonstrate significant air emission reduction potential, preserve casting quality parameters, and that are economically viable based on the Pre-Production testing, may be further evaluated in the Production Foundry.

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

### 1.3 Report Organization

This report has been designed to document the methodology and results of a specific test plan that was used to evaluate the performance of an alternative material, equipment, or process in the Pre-Production Foundry. 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 Appendices B and C of this report. Section 4 of this report contains a discussion of the results and recommendations for additional testing, if any.

The raw data for this test series are included in a data binder that is maintained at the Technikon facility. There are several support documents that provide details regarding the testing and analytical procedures used. Appendix F contains a listing of these support documents.

### 1.4 Preliminary Testing

The foundation for the specific test protocols and airborne emission measurements has been determined from testing performed to:

- Establish the required number of samples needed to statistically support the evaluation of emission reduction potentials of the alternative materials, equipment, and processes that may be evaluated;

- Provide a series of standardized emissions from standard mold packages.

It has been determined that nine replicate tests will provide a statistically significant sample for the purposes of evaluating the emission reductions from alternative materials, equipment, and processes. The results of the testing conducted in support of this conclusion is included in a report entitled *Evaluation of the Required Number of Replicate Tests to Provide Statistically Significant Air Emission Reduction Comparisons for the CERP Pre-Production Foundry Test Program.*

## 1.5 Specific Test Plan and Objectives

This report contains the results of testing performed to assess the emission reduction potential of two different No-bake binder systems. The test hypothesis is that the test binder system will have lower VOC and HAP emissions than a reference (baseline) No-Bake binder system. Prior to Test DZ, Ester Phenolic binder systems had not been tested at the Technikon facility. Thus, comparison to a Phenolic Urethane system was needed. Table 1-1 provides a summary of the test plans. The details of the approved test plans are included in Appendix A.

**Table 1-1 Test Plan Summary**

| | **Test Plans** | |
|---|---|---|
| **Type of Process tested** | No-Bake Phenolic Urethane | No-Bake Ester Cured Phenolic |
| **Test Plan Number** | RE100102DG | RE100121DZ |
| **Binder System** | Delta HA TECHNISET® 20-665/23-635/17-727 | Ashland Specialty Chemical Company NBE-1/NBE-2 |
| **Metal Poured** | Iron | Iron |
| **Casting Type** | Four-cavity AFS Irregular Gear Mold | |
| **Number of molds poured** | 9 | 11 |
| **Test Dates** | 11-13-00 > 11-15-00 | 1/31/01 > 3/6/01 |
| **Emissions Measured** | 70 organic HAPs and VOCs | |
| **Process Parameters Measured** | Total Casting, Mold and Binder Weights, Metallurgical data, % LOI, Stack Temperature, Stack Moisture Content, Stack Pressure, and Stack Volumetric Flow Rate | |

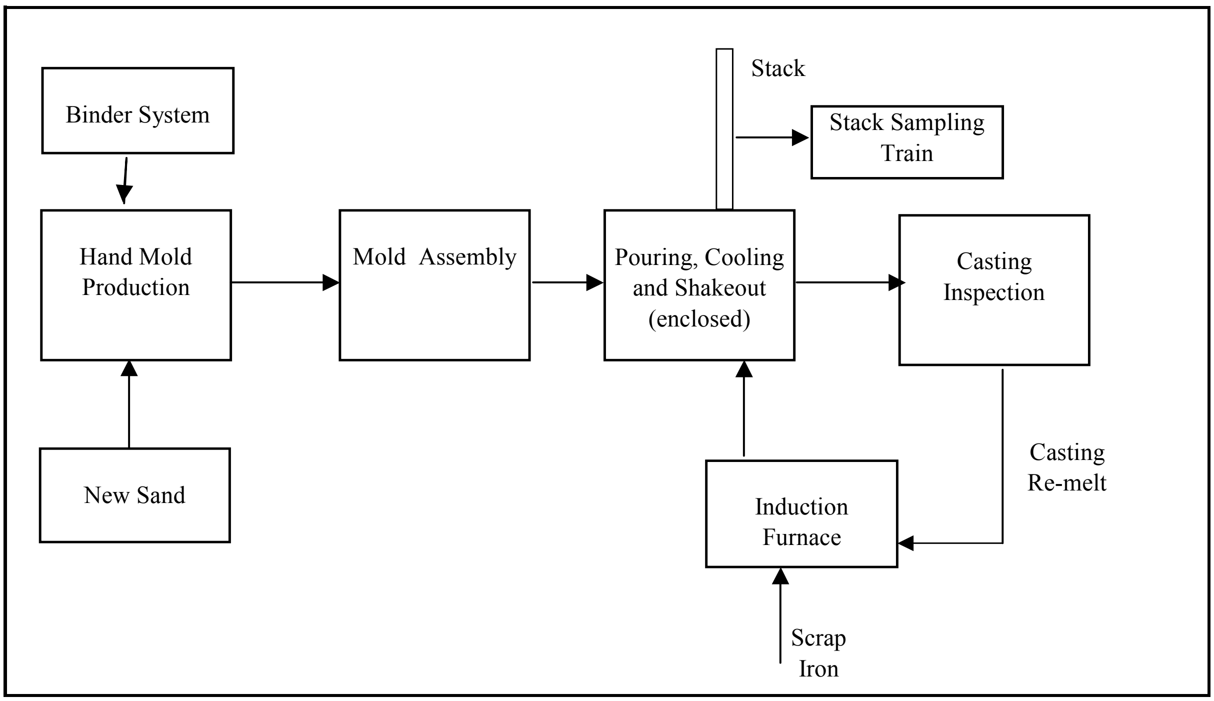
THIS PAGE INTENTIONALLY LEFT BLANK

# 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:

*No-Bake Mold Preparation*

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

2. **Mold and Metal Preparation:** The molds are prepared to a standard composition by the Technikon production team. Relevant process data are collected during mold preparation. Iron is melted in a 1000 lb. Ajax induction furnace (Model MFB-1000). The amount of metal melted is determined from the poured weight of the casting and the number of molds to be poured.

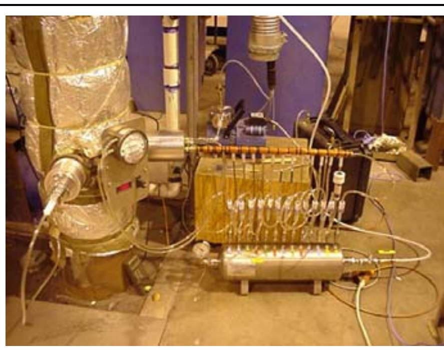
The metal composition is prescribed by a metal composition worksheet. The weight of metal poured into each mold is recorded on the process data summary sheet.

3. **Individual Sampling Events:** Replicate tests are performed on several mold packages. The mold packages are each placed into an enclosed test stand. Iron is poured through an opening in the top of the enclosure. The opening is closed as soon as pouring is completed. Continuous air samples are collected during the forty-five minute pouring and cooling process, during the fifteen minute shakeout of the mold, and for an additional fifteen minute period following shakeout. The total sampling time is seventy-five minutes. The weight of each mold and the weight of binder used to prepare that mold are recorded on the Process Data Summary Sheet. In addition, the pouring temperature, number of cavities poured, the %LOI of the mold before pouring are also recorded on the Process Data Summary Sheet.

*Pouring of Molds Through Opening in Collection Hood*

*Castings after Shake Out*

The unheated emission hood is ventilated at approximately 700 SCFM through a 12-inch diameter heated duct. Emissions samples are drawn from sampling ports located to ensure conformance with EPA Method 1. The tip of the probe is located in the centroid of the duct.



*Volatiles and Condensables Sampling*

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

**Table 2-1 Process Parameters Measured**

| Parameter | Analytical Equipment and Methods |
|---|---|
| Mold Weight | Acme 4260 Crane Scale (Gravimetric) |
| Casting Weight | Westweigh PP2847 Platform Scale (Gravimetric) |
| Binder Weight | Mettler PJ8000 Digital Scale (Gravimetric) |
| Sand Resin Tensile Strength | Dietert 405 Universal Strength Machine |
| Tensile Test Bar Weight | Mettler PJ 4000 Digital Scale (Gravimetric) |
| LOI, % | Denver Instruments XE-100 Analytical Scale (AFS procedure 321-87-S) |
| **Metallurgical Parameters** | |
| Pouring Temperature | Electro-Nite DT 260 (T/C immersion pyrometer) |
| Carbon/Silicon, and Fusion Temperature | Electro-Nite Datacast 2000 (Thermal Arrest) |
| Alloy Weights | OHAUS MP-2 |
| Carbon/Silicon | Baird Foundry Mate Optical Emission Spectrometer |

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 Emissions Testing and Analytical Testing Standard Operating Procedures.

**Table 2-2 Sampling and Analytical Methods**

| Measurement Parameter | Test Method |
|---|---|
| Port location | EPA Method 1 |
| Number of traverse points | EPA Method 1 |
| Gas velocity and temperature | EPA Method 2 |
| Gas density and molecular weight | EPA Method 3a |
| Gas moisture | EPA Method 4, gravimetric |
| HAPs concentration | EPA Method 18, TO11, NIOSH 2002* |
| VOCs concentration | EPA Method 18, 25A, TO11, NIOSH 2002* |
| Condensables | Technikon method ** |

*These methods were specifically modified to meet the testing objectives of the CERP Program.
**The Technikon condensables method is intended to provide a measure of the EPA Method 5 "back-half" determination.

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

   The results of each of the sampling events are included in Appendix B of this report. The results of each test are also averaged and are shown in Table 3.1.

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

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

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

- Immediately following the individual sampling events performed for each test, specific process parameters are reviewed by the Manager - Process Engineering to ensure that the parameters are maintained within the prescribed control ranges. Where data are not within the prescribed ranges, the Manager-Process Engineering and the Vice President of 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 result, in pounds per ton of metal poured, is presented in Table 3-1 for tests reported in this document. This table includes the individual VOC compounds that comprise at least 95% of the total VOCs measured, along with the corresponding sum of VOCs, sum of HAPs, and sum of POMs. The table also includes the TGOC (THC) as Propane, HC as Hexane and the percentage difference between the baseline (DG) and the test system (DZ). Percentage differences in **bold** are the result of emissions differences, not test variability. Figures 3-1, 3-2, and 3-3 represent the comparisons of the five emissions indicators and selected individual HAP and VOC emissions data from Table 3-1 in graphical form. Appendix B contains the detailed data including the results for all analytes measured. Table 3-2 includes the averages of the key process and source parameters and the data target ranges. Detailed process and source data are presented in Appendix C.

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

The laboratory analytical data validation log for this test is maintained in the Technikon offices.

## Table 3-1 Summary of Test Plan DG and DZ Average Results

| Analytes | Test DG (Lb/Tn) | Test DZ (Lb/tn) | % Change From Test DG |
|---|---|---|---|
| TGOC (THC) as Propane | 12.2 | 3.39 | **-72%** |
| HC as Hexane | 11.1 | 2.37 | **-79%** |
| Sum of VOCs | 4.06 | 0.901 | **-78%** |
| Sum of HAPs | 2.00 | 0.803 | **-60%** |
| Sum of POMs | 0.104 | 0.067 | **-36%** |
| **Individual Organic HAPs** | | | |
| Phenol | 0.942 | 0.121 | **-87%** |
| o,m,p-Cresol | 0.500 | 0.047 | **-91%** |
| Benzene | 0.299 | 0.318 | 7% |
| Dimethylnaphthalenes | 0.086 | 0.001 | **-98%** |
| Toluene | 0.056 | 0.054 | -2% |
| Formaldehyde | 0.021 | 0.084 | **310%** |
| Acetaldehyde | 0.004 | 0.069 | **1582%** |
| Methylnaphthalenes | 0.018 | 0.050 | **176%** |
| o,m,p-Xylene | 0.031 | 0.032 | 0% |
| Propionaldehyde | 0.001 | 0.017 | **2167%** |
| Naphthalene | ND | 0.015 | **NA** |
| **Other VOCs** | | | |
| Dimethylphenols | 1.07 | 0.032 | **-97%** |
| Diethylbenzenes | 0.299 | ND | **-100%** |
| Trimethylbenzenes | 0.216 | 0.013 | **-94%** |
| Tetradecane | 0.141 | ND | **-100%** |
| Butylbenzenes | 0.116 | ND | **-100%** |
| Dodecane | 0.060 | ND | **-100%** |
| Indan | 0.057 | ND | **-100%** |
| Undecane | 0.033 | ND | **-100%** |
| Trimethylphenols | ND | 0.021 | **NA** |
| Butyraldehyde/Methacrolein | 0.021 | 0.013 | **-37%** |
| **Other Analytes** | | | |
| Condensables | 0.800 | 0.448 | -44% |
| Carbon Monoxide | 4.18 | 4.32 | 3% |
| Methane | 0.590 | 0.543 | -8% |
| Carbon Dioxide | 59.3 | 52.2 | -12% |

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

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

All **"Other Analytes"** are not included in the sum of HAPs or VOCs.
Percent Change from Test DG" values in bold indicate a 95% probability that the differences in the average values were not from test variability.

## Table 3-2 Summary of Test Plan DG and DZ Process and Stack Parameters

| Average Process and Stack Parameters | Average of Baseline DG | Target Range for Test DG | Average of Test DZ (Iron) | Target Range for Test DZ |
|---|---|---|---|---|
| Casting Metal Weight, casting & sprue, lbs. | 131 | 128 - 134 | 140 | 132 - 140 |
| Pouring Temperature, °F | 2639 | 2615 - 2645 | 2634 | 2615 - 2645 |
| No Bake Mold Weight, lbs. | 332 | 325 - 335 | 403 | 385 - 405 |
| Resin, % BOS | N/A | N/A | 1.30 | 1.3 |
| Binder, % BOS | 1.14 | 1.1 | N/A | N/A |
| Ratio Resin to co-reactant | 55/45 | 55/45 | N/A | N/A |
| % Co-reactant BO Resin | N/A | N/A | 25.1 | 25 |
| Total Resin, true %(BO(Binder + sand)) | 1.12 | 1.07 - 1.12 | 1.28 | 1.26 - 1.33 |
| Total Binder, true %(BO(Binder + sand)) | 1.17 | 1.14 - 1.18 | 1.60 | 1.57 - 1.62 |
| No Bake Mold LOI, % 1400°F | 1.41 | 1.1-1.9 | 0.99 | 1.5 - 2.5 |
| Dog Bone Tensile Strength 2 hrs, psi | 208 | 100 - 220 | 41 | 60 - 100 |
| Dog Bone Tensile Strength 24 hrs at 90% RH, psi | 87 | 40 - 100 | N/D | 50 - 100 |
| | | | | |
| Average Stack Temperature, °F | 105 | 110 ± 50 | 104 | 110 ±15 |
| Total Moisture Content, % | 0.89 | N/A | 1.35 | N/A |
| Average Stack Velocity, ft./sec. | 16.01 | 15 ± 2 | 16.0 | 15 ± 2 |
| Avg. Stack Pressure, in. Hg | 30.17 | N/A | 29.91 | N/A |
| Stack Flow Rate, scfm | 705 | 700 ± 50 | 695 | 700 ± 50 |

Binder (DG) = Resin = Co-reactant + catalyst

Binder (EB) = Resin + Co-reactant

**Figure 3-1 Comparison of Emission Indicators from Test DG and DZ**

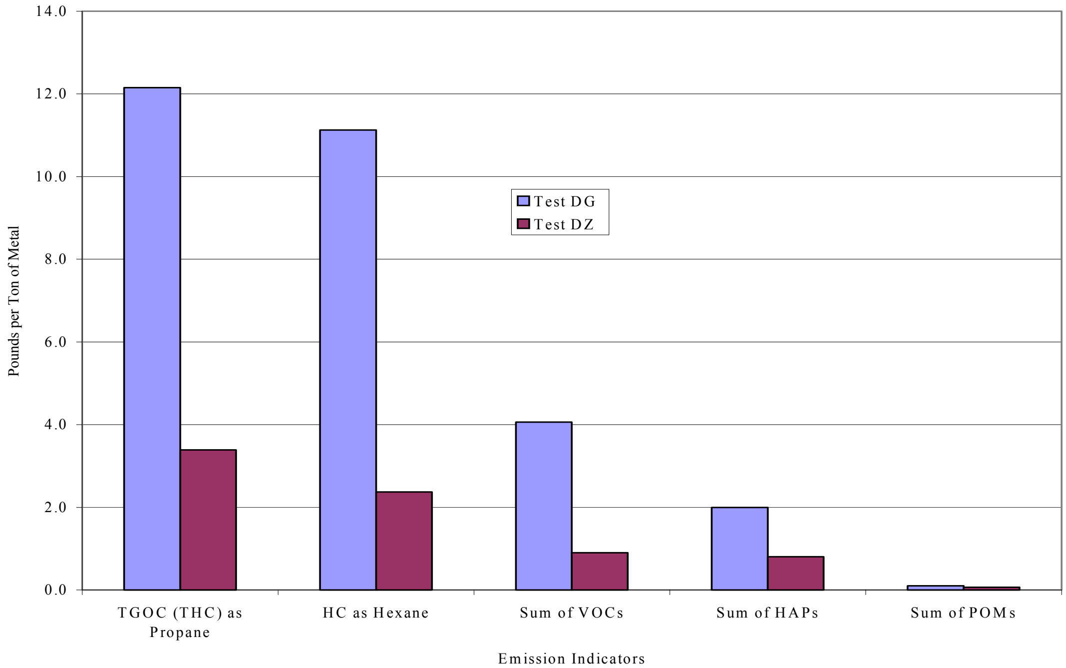
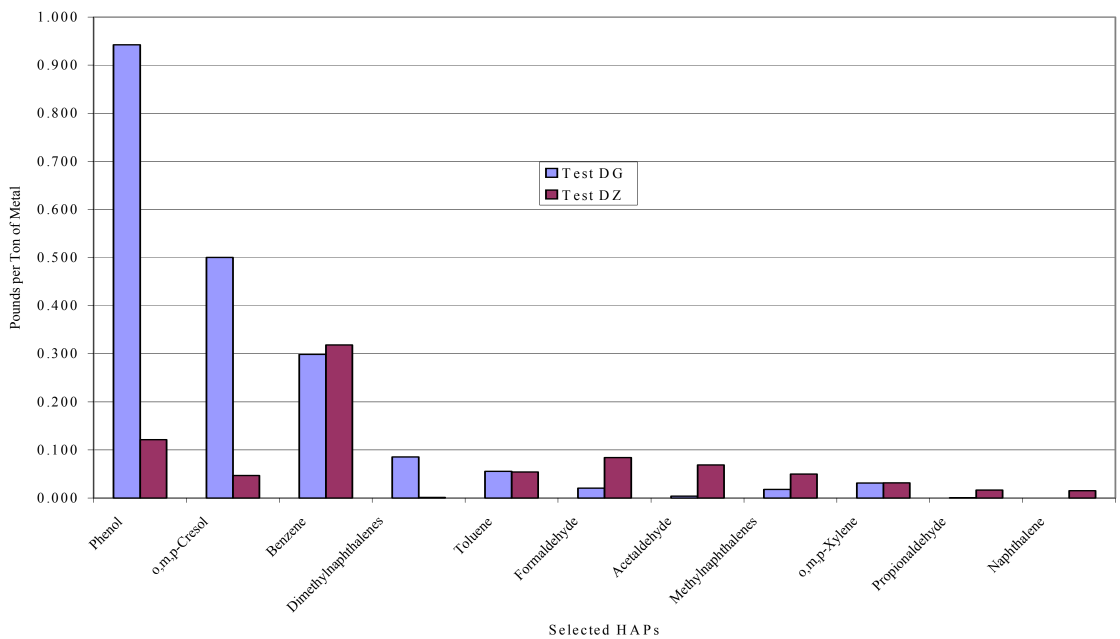
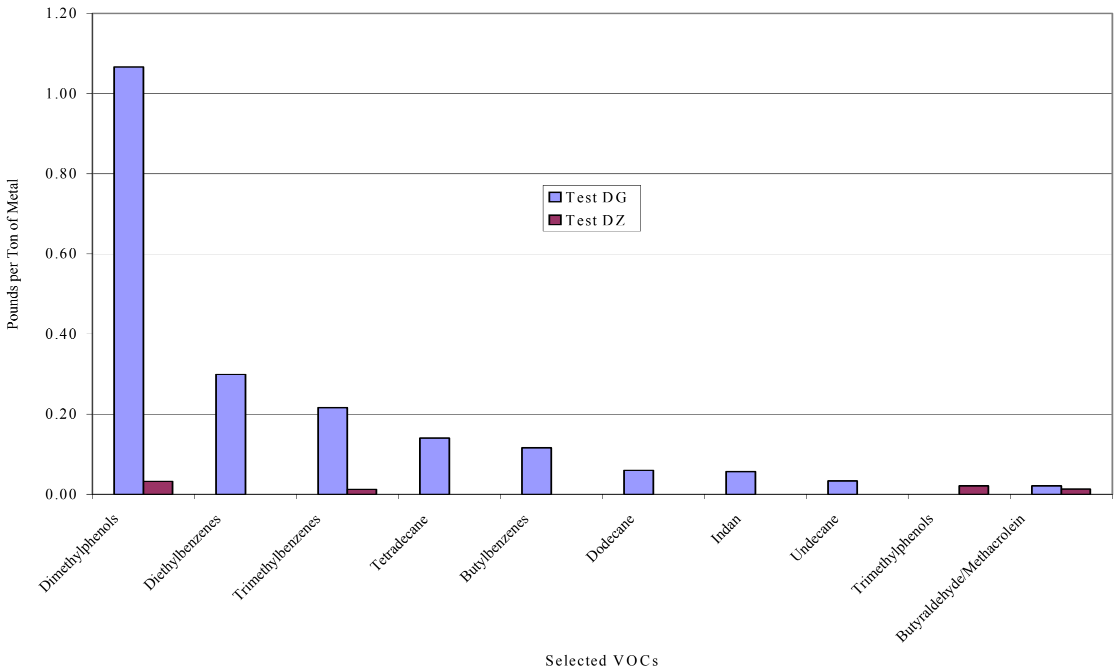



**Figure 3-2 Comparison of Selected HAP Emissions from Test DG and DZ**



## Figure 3-3 Comparison of Selected VOC Emissions from Test DG and DZ



THIS PAGE INTENTIONALLY LEFT BLANK

## 4.0 Discussion of Results

The sampling and analytical methodologies were the same for Test Plans DG and DZ.

Observation of measured process parameters indicates that the validated tests were run within an acceptable range. In Table 3-1, the "% Change from Test DG" emissions values presented in **bold** letters indicate a greater than 95% probability that the differences in the average values were not the result of variability in the test protocol determined from T-Statistic calculations. A table showing the T-Statistics calculated is found in Appendix B.

A total of 11 test pours were performed for the Test Series DZ. Seven of the test pours (Tests 1-7) were invalidated, due to process validation considerations (see Appendix C)*. The results from these test pours were not used during calculations of the reported averages.

The results of the tests performed for the comparison of Test DZ to Test DG show a 72% reduction in TGOC (THC) as propane, a 79% reduction in HC as hexane, a 78% reduction in VOCs, a 60% reduction in HAPs, and a 36% reduction in POMs.

Test DZ showed similar results for total VOCs and total HAPs. From Table 3-1, the VOCs detected that were not HAPs comprised only 8.7% of the Sum of VOCs. Benzene was found in the largest amount with phenol following next. Comparing Test DZ to Test DG, benzene increased by 7% and phenol decreased by 87%.

For the phenolic urethane system (DG), dimethylnaphthalenes comprised 82% of the total POMS and methylnaphthalenes comprised 17.4%. Naphthalene was not detected. For the ester cured phenolic binder system (DZ), dimethylnaphthalenes comprised 2.1% of the total POMs, methylnaphthalenes comprised 75%, and naphthalenes comprised 22.7%.

The chemistry of a phenolic urethane binder system is different than an ester cured phenolic binder system; therefore, different results from the two binders can be expected. The comparison of Test DZ to DG provides only a reference benchmark.

EPA Method 25A, TGOM (THC) 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 detection of relatively less volatile compounds and detects hydrocarbon compounds in the alkane range between C6 and C16, with results calibrated against a six-carbon alkane (hexane).

*This test was conducted at a time when the mold tooling had to be rebuilt. The sand weight from the old tooling was too different to be considered a comparable test. New test binder materials were obtained but yielded dramatically different, although consistent, LOI results from those of the first tests. The LOI quality control test revealed that the LOI content of the binder in the molds was out of range, despite calibration. The results are valid, just not at the planned organic content. This fact needs to be taken into consideration when compared to reference Test DG.

THIS PAGE INTENTIONALLY LEFT BLANK

# APPENDIX A APPROVED TEST PLANS FOR TEST SERIES DG AND DZ

THIS PAGE INTENTIONALLY LEFT BLANK

# TECHNIKON/CERP TEST PLAN

- > **CONTRACT NUMBER:** 1256 **TASK NUMBER:** 120
- > **CONTROL NUMBER:** RE 1 00102
- > **SAMPLE FAMILY:** DG
- > **SAMPLE EVENTS:** 001 thru 021
- > **SITE:** __X__ **PRE-PRODUCTION(243)**____ **CERP FOUNDRY(238)**
- > **TEST TYPE:** Iron: No-Bake Phenolic Urethane Baseline
- > **MOLD TYPE:** No-Bake variable-tooth gear precision mold made with Delta-HA Techniset® No-Bake 20-665 Part I, 23-635 Part II, 17-727 Part III
- > **NUMBER OF MOLDS:** 21
- > **CORE TYPE:** N/A
- > **TEST DATE:** **START:** 13 Nov 00
  **FINISH:** 27 Dec 00

**TEST OBJECTIVES:**

**Primary:** To measure emissions from No-Bake molds, formulated for use with cast iron, and manufactured based on protocols developed in capability study CP and CW to make a No-Bake Iron baseline. The Airsense real-time spectrometer & THC analyzer will be used to monitor the test, and an outside laboratory will collect sample tubes for analysis.

**VARIABLES:**

Three part No-Bake resin at 1.1% resin (BOS) in the ratio of 55% Delta-HA Techniset® 20-665 resin, 45% Delta-HA Techniset® 23-635 co-reactant, and 7% (BOR Part I) Delta-HA Techniset® 17-727 Part III activator.

**BRIEF OVERVIEW:**

The molds will be the standard 4-on variable-tooth gear made from Okie 90 silica sand with the above resin system. The molds will be transferred to the Pouring/cooling/shakeout hooded station used for greensand and core baselines.

**SPECIAL CONDITIONS:**

A shakeout fixture, which will promote disintegration of the No-Bake mold, shall be installed on the shakeout device. This fixture will carry the No-Bake mold and locate the pouring basin in the standard pouring position. Steel hangers will be implanted in each cavity to promote separation of castings from the no bake sand during shakeout.

---

| | |
|---|---|
| Manager Process Engineering (Technikon) | 11/9/00 Date |
| V.P. Measurement Technologies (Technikon) | 11-9-00 Date |
| V.P. Operations (Technikon) | 11-9-00 Date |
| Emissions Team (USCAR) | 12/5/00 Date |
| Process and Facilities Team (USCAR) | 12/5/00 Date |
| Project Manager (CTC) | 12/12/00 Date |

# TECHNIKON TEST PLAN

- > **CONTRACT NUMBER:** 1256 **TASK NUMBER:** 110
- > **CONTROL NUMBER:** RE 1 00121
- > **SAMPLE FAMILY:** DZ
- > **SAMPLE EVENTS:** 001 thru 011
- > **SITE:** X **PRE-PRODUCTION (243)**____**PRODUCTION(238)**
- > **TEST TYPE:** Ashland Phenol – Ester Phenolic, Fe, No-Bake (NBE-1 Resin, NBE-2 Catalyst) Vendor Study
- > **MOLD TYPE:** Ester Phenolic No-Bake Iron System
- > **NUMBER OF MOLDS:** 11
- > **CORE TYPE:** N/A
- > **TEST DATE:** **START:** 31 Jan 01
  **FINISH:** 6 Mar 01

**TEST OBJECTIVES:**

**Primary:**

To measure emissions from No-Bake molds, formulated for use with cast iron, and manufactured based on protocols developed in capability study CP, CW, and DJ to make a Phenolic Urethane No-bake baseline against which other No-Bake tests will be compared. The total hydrocarbon analyzer will be used to monitor the test and sample tubes and bags will be collected and sent to an outside laboratory for analysis.

**VARIABLES:**

No-bake resin at 1.3% resin (BOS) with ester co-reactant.. The amount of co-reactant is to be determined in a pretest evaluation of strip time on 70-80$^{o}$F sand. Recommended co-reactant concentration is 25%.

Protocols were developed in CW and CP for making Phenolic Urethane no-bake molds. The alkaline Phenolic is a different chemical system whose physical, mechanical, and emission characteristics may not fall within the Parameters of the Phenolic Urethane test criteria.

**SPECIAL CONDITIONS**:

The THC will be used to validate whether mold has cracked before shakeout.

---

| | |
|---|---|
| **Process Engineering Manager (Technikon)** | 1-31-01 **Date** |
| **V.P. Measurement Technology (Technikon)** | 1-29-01 **Date** |
| **V.P. Operations (Technikon)** | 1/29/01 **Date** |
| **Emissions Team (USCAR)** | 02/22/01 **Date** |
| **Process and Facilities Team (USCAR)** | 02/22/01 **Date** |
| **Project Manager (CTC)** | 4/25/01 **Date** |

---

## Series DG

# Pre-Production Phenolic Urethane / Iron

## No-Bake Process Instructions

**A. EXPERIMENT**

1. Establish a Phenolic Urethane Iron No-Bake baseline that other No-Bake vendor materials will be compared.

**B. Materials**

1. No-Bake molds: Okie 90 Silica Sand and 1.1% Delta-HA Techniset ® No-Bake Phenolic-Urethane core resin composed of 20-665 part I resin, 23-635 Part II co-reactant, & 17-727 Part III activator. This resins are designed for iron applications.
2. Metal: Class 30 Gray cast iron.

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

**C. MOLD REQUIREMENTS**

1. Make nine (9) Phenolic No-Bake molds according standards determined in CW & CP capability studies.

**D. PHENOLIC URETHANE NO-BAKE CORE SAND PREPARATION**

1. The phenolic urethane No-Bake sand shall be 1.1% total resin (BOS), Part I/Part II ratio 55/45, Part III at 7% of Part I.
2. Calibrate the Kloster No-Bake sand mixer to dispense 240 pounds/min more or less.
3. Calibrate the resin pumps:

   a) Part I: Based on the actual measured sand dispensing rate calibrate the Part I resin to be 55% of 1.1% total resin or 0.605% +/- .01% (BOS).
   b) Part II: Based on the actual measured sand dispensing rate calibrate the Part II co-reactant to be 45 % of 1.1 % total resin or 0.495% +/- 0.01% (BOS).
   c) Calibrate the Part III activator to be 7% +/- 0.1% of Part I.

**E. DOG BONES**

1. Make 24 dogbones according to the protocol establish in capability study CW. (Two (2) 12-piece sets of test dogbones using 12-on core box)

2. Sample the raw uncoated sand from the hopper feeding the core sand mixer, bag, label with date, time, and mold number. Send to sand lab for LOI comparison.
3. Place the core box on the vibrating compaction table.
4. Start the Kloster mixer and waste a few pounds of sand.
5. Flood the core box with sand then stop the mixer.
6. Strike off the core box to ½ inch deep
7. Turn on the vibrating compaction table for 15 seconds.
8. Screed off most of the excess sand.
9. Screed the core box a second time moving very slowly in a back and forth manner to remove **all** excess sand.

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

10. Set aside for about 6-7 minutes or until hard to the touch.
11. Carefully remove the cores from the core box by separating the corebox components.
12. Place 6 bones in the 90% Rh cabinet.
13. Perform tensile tests on 6 bones at each of the following times after dogbone manufacture: 30 minutes, 2 hours, 24 hours, and 24 hours@ 90% Rh. Report the average and standard deviation for each set of six (6) at each time for each mold.
14. Weigh each dogbone and record the weight to the nearest 0.1 grams using the PJ 4000 electronic scale at the time it is tensile tested.

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

15. Run a 1400°F core LOI on three (3) of the 30- minute tensile test dogbones. Report the average value for each mold.
16. Run a 1400°F core LOI on the raw uncoated sand sampled at the same time as the dogbones are made. Calculate a Core Resin LOI as the difference between the average Core LOI and raw sand core LOI. Report this value for each mold.

## F. NO-BAKE MOLD MAKING: 4 ON GEAR CORE BOX

1. Inspect the box for cracks and other damage. Repair before use.
2. Prepare the core box halves with a light coating of Ashland Zipslip® IP 78. Allow to fully dry.
3. Place the drag core box on the vibrating compaction table.
4. Begin filling the box.
5. Immediately start the table vibration.
6. Manually spread the sand around the box as it is filling.
7. Strike off the box until it is full.
8. Allow the vibrator to run an additional 10 seconds after the box is full.
9. Strike off the core box so that the core mold is 5-1/2 inches thick.

**10.** Set the core box aside for 5 to 6 minutes or until it is hard to the touch.
**11.** Invert the box and place on a transport pallet.
**12.** Remove the pivot hole pins.
**13.** Remove the core mold half by tapping lightly on the box with a soft hammer.
**14.** Set the drag core box aside.
**15.** Place the cope core box on the vibrating compaction table.
**16.** Follow steps F3-F13 except that the cope mold is 5 inches thick.
**17.** Rotate the unboxed core to set it on edge.
**18.** Drill vent holes as per template.
**19.** Hand trim the pour basin to promote minimum splash and minimum cup volume.
**20.** Close cope onto drag. Visually check for closure.
**21.** Install two (2) steel straps, one on either side of the pouring cup, with 4 metal corner protectors each to hold the mold tightly closed.
**22.** Weigh and record the weight of the closed mold.

## G. EMISSION HOOD

**1.** Loading

- **a)** Hoist the mold onto the shakeout deck fixture within the emission hood with the pouring cup side toward the furnace.
- **b)** Install the cope weighting device.
- **c)** Install a half inch re-rod casting hangers through the cope into each of the four riser cavities and suspend them over the horizontal mold retaining bars.
- **d)** Close, seal, and lock the emission hood

**2.** Shakeout

- **a)** After 45 minutes of cooling time has elapsed turn on the shakeout unit and run for 15 minutes as prescribed in the emission test plan from pouring.
- **b)** Turn off the shakeout. The emission sampling will continue for an additional 15 minutes or a total of 75 minutes
- **c)** Wait for the emission team to signal that they are finished sampling.
- **d)** Open the hood, remove the castings
- **e)** Clean core sand out of the pit and off the shakeout.
- **f)** Weigh and record cast metal weight.

## H. MELTING

**1.** Initial charge

- **a)** Charge the furnace according to the *Generic Start Up Charge for Pre-Production* heat recipe bearing effectivity date 18 Mar 1999.

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

**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.

## I. Pouring

**1.** Preheat the ladle.

**a)** Tap 400 pounds more or less of 2700$^o$F metal into the cold ladle.
**b)** Casually pour the metal back to the furnace.
**c)** Cover the ladle.
**d)** Reheat the metal to 2780 +/- 20$^o$F.
**e)** Tap 450 pounds more or less 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, open the emission hood pour door and wait until the metal temperature reaches 2630 +/- 10$^o$F.
**h)** Commence pouring keeping the sprue full.

**i)** Upon completion close the hood door, return the extra metal to the furnace, and cover the ladle.

William Snider
For:
Steven Knight
Process Engineering Manager

## Series DZ

# Pre-Production Iron Alkaline Phenolic Cured
## No-Bake Process Instructions

**A. Experiment**:

1. A study to compare emissions from Phenol-Formaldehyde No-Bake molds to which other No-bake vender materials will be compared.

**B. Materials**:

1. No-bake molds: Wexford W450 Lakesand and 1.3% Ashland No-bake Phenol - Formaldehyde core resin composed of NBE-1 Part I resin, and NBE-2 catalyst (co-reactant). These resins are designed for iron applications.
2. Metal: Class 30 Gray cast iron.

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

**C. CATALYST REQUIREMENTS**

1. The catalyst requirement for this system is not insignificant and must be recognized as one of the source material for emissions.
2. Before the scheduled test date conduct a strip time determination in the sand lab at the required resin content and operating temperature. Use the minimum catalyst so determined.

**D. MOLD REQUIREMENTS**

1. Make nine (9) Phenol - Formaldehyde no-bake molds according standards determined in CW, CP, DJ capability studies.
2. Make the molds with a 7 inch high drag and 7 inch high cope.
3. Monitor the pour with the THC to detect mold cracking before shakeout.

**E. Phenol - Formaldehyde No-bake Core Sand preparation**:

1. The Phenol – Formaldehyde no-bake sand shall be 1.3% total resin (BOS). The amount of catalyst shall be pre-determined in a strip time evaluation.
2. Use pump 1 for the resin and pump 2 for the catalyst.
3. Flush the Part 1 and Part 2 pumps and lines with the Furan resin and acid catalysts respectively until only these materials come out. The part 3 pump is not used.
4. Calibrate the Kloster no-bake sand mixer to dispense 180 pounds/min more or less.
5. Calibrate the resin pumps:

**a)** Furan resin Part I: Based on the actual measured sand dispensing rate calibrate the furan resin to be 1.3% resin +/- .01% (BOS).

**b)** Acid catalyst Part II: Calibrate the acid catalyst pump per the strip time evaluation +/- .25% of the Phenol - Formaldehyde resin (Part I).

**F. Dog bones:**

1. Make 24 dogbones according to the protocol established in capability study CW.(Two (2) 12-piece sets of test dogbones using 12-on core box)
2. Sample the raw uncoated sand from the hopper feeding the core sand mixer, bag, label with date, time, and mold number. Send to sand lab for LOI comparison.
3. Place the core box on the vibrating compaction table.
4. Start the Kloster mixer and waste a few pounds of sand.
5. Flood the core box with sand then stop the mixer.
6. Strike off the core box to ½ inch deep
7. Turn on the vibrating compaction table for 15 seconds.
8. Screed off most of the excess sand.
9. Screed the core box a second time moving very slowly in a back and forth manner to remove **all** excess sand.

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

10. Set aside for a time equivalent to the pre-determined strip time or until hard to the touch.
11. Carefully remove the cores from the core box by separating the corebox components.
12. Place 6 bones in the 90% Rh cabinet.
13. Perform tensile tests on 6 bones at each of the following times after dogbone manufacture: 30 minutes, 2 hours, 24 hours, and 24 hours@ 90% Rh. Report the average and standard deviation for each set of six (6) at each time for each mold.
14. Weigh each dogbone and record the weight to the nearest 0.1 grams using the PJ 4000 electronic scale at the time it is tensile tested.

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

15. Run a 1400$^{o}$F core LOI on three (3) of the 30- minute tensile test dogbones. Report the average value for each mold.
16. Run a 1400$^{o}$F core LOI on the raw uncoated sand sampled at the same time as the dogbones are made. Calculate a Core Resin LOI as the difference between the average Core LOI and raw sand core LOI. Report this value for each mold.

**G. No-bake mold making: 4 on gear core box.**

1. Inspect the box for cracks and other damage. Repair before use.

2. Prepare the core box halves with a light coating of Ashland Zipslip ® IP 78. Allow to fully dry.
3. Place the drag core box on the vibrating compaction table.
4. Begin filling the box.
5. Immediately start the table vibration.
6. Manually spread the sand around the box as it is filling.
7. Strike off the box until it is full.
8. Allow the vibrator to run an additional 10 seconds after the box is full.
9. Strike off the core box so that the core mold is 7 inches thick.
10. Set the core box aside for 5 to 6 minutes or until it is hard to the touch.
11. Invert the box and place on a transport pallet.
12. Remove the pivot hole pins.
13. Remove the core mold half by tapping lightly on the box with a soft hammer.
14. Set the drag core box aside.
15. Place the cope core box on the vibrating compaction table.
16. Follow steps G3-G13 except that the cope mold is 7 inches thick.
17. Rotate the unboxed core to set it on edge.
18. Drill vent holes as per template.
19. Hand trim the pour basin to promote minimum splash and minimum cup volume.
20. Close cope onto drag. Visually check for closure.
21. Install two (2) steel straps, one on either side of the pouring cup, with 4 metal corner protectors each to hold the mold tightly closed.
22. Weigh and record the weight of the closed mold.

## H. EMISSION HOOD:

1. Loading.

   a) Hoist the mold onto the shakeout deck fixture within the emission hood with the pouring cup side toward the furnace.
   b) Install the cope weighting device.
   c) Install a half inch re-rod casting hangers through the cope into each of the four riser cavities and suspend them over the horizontal mold retaining bars.
   d) Close, seal, and lock the emission hood

2. Shakeout.

   a) After 45 minutes of cooling time has elapsed turn on the shakeout unit and run for 15 minutes as prescribed in the emission test plan. from pouring.
   b) Turn off the shakeout. The emission sampling will continue for an additional 15 minutes or a total of 75 minutes
   c) Wait for the emission team to signal that they are finished sampling.
   d) Open the hood, remove the castings
   e) Clean core sand out of the pit and off the shakeout.

**f)** Weigh and record cast metal weight.

## I. MELTING:

**1.** Initial charge:

**a)** Charge the furnace according to the **Generic Start Up Charge for Pre-Production** heat recipe bearing effectivity date 18 Mar 1999.
**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.
**h)** The temperature of the primary liquidus (TPL) must be in the range of 2200-2350$^{o}$F.
**i)** Hold the furnace at 2500-2550$^{o}$F until near ready to tap.
**j)** When ready to tap raise the temperature to 2700$^{o}$F and slag the furnace.
**k)** Record all metallic and alloy additions to the furnace, tap temperature, and pour temperature. Record all furnace activities with an associated time.

**2.** Back charging.

**a)** If additional iron is desired back charge according to the **Generic Pre-production Last Melt** heat recipe bearing effectivity date 18 Mar 1999.
**b)** Charge a few pieces of steel first to make a splash barrier, followed by the carbon alloys.
**c)** Follow the above steps beginning with I.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 metal into the cold ladle.
**b)** Casually pour the metal back to the furnace.
**c)** Cover the ladle.

**d)** Reheat the metal to 2780 +/- 20°F.
**e)** Tap 450 pounds more or less 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, open the emission hood pour door and wait until the metal temperature reaches 2630 +/- 10°F.
**h)** Commence pouring keeping the sprue full.
**i)** Upon completion close the hood door, return the extra metal to the furnace, and cover the ladle.

William Snider
For:
Steven Knight
Process Engineering Manager

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/13/00 | | | | | | | | | | | No-Bake Iron, 1.1% Resin |
| EVENT 1 | | | | | | | | | | | |
| AIRSENSE | DG00101 | | | | | | | | | | TOTAL |
| THC | DG00102 | | | | | | | | | | TOTAL |
| PUF | DG00118 | | | | | | | | 35L | | Port B |
| | | | | | | | | | | | |
| 11/13/00 | | | | | | | | | | | No-Bake Iron, 1.1% Resin |
| EVENT 2 | | | | | | | | | | | |
| AIRSENSE | DG00201 | | | | | | | | | | TOTAL |
| THC | DG00202 | | | | | | | | | | TOTAL |
| PUF | DG00210 | | | | | | | | 35L | | Port B |
| | | | | | | | | | | | |
| 11/13/00 | | | | | | | | | | | No-Bake Iron, 1.1% Resin |
| EVENT 3 | | | | | | | | | | | |
| AIRSENSE | DG00301 | | | | | | | | | | TOTAL |
| THC | DG00302 | | | | | | | | | | TOTAL |
| PUF | DG00310 | | | | | | | | 35L | | Port B |
| | | | | | | | | | | | |
| 11/14/00 | | | | | | | | | | | |
| EVENT 4 | | | | | | | | | | | |
| PUF | DG004 | | | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/14/00 | | | | | | | | | | | |
| EVENT 5 | | | | | | | | | | | |
| AIRSENSE | DG00501 | X | | | | | | | | | TOTAL |
| THC | DG00502 | X | | | | | | | | | TOTAL |
| M-18 | DG00503 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG00504 | | | | | 1 | | | 25 | 1 | TOTAL |
| M-18 | DG00505 | | 1 | | | | | | 25 | 2 | TOTAL |
| M-18 | DG00506 | | | | | 1 | | | 25 | 2 | TOTAL |
| M-18 by MS | DG00507 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG00508 | | | | | 1 | | | 25 | 3 | TOTAL |
| M-18 by MS | DG00509 | | 1 | | | | | | 25 | 4 | TOTAL |
| M-18 by MS | DG00510 | | | | | 1 | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG00511 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG00512 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG00513 | | 1 | | | | | | 1000 | 10 | TOTAL |
| TO11 | DG00514 | | | | | 1 | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG00515 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/14/00 | | | | | | | | | | | |
| EVENT 7 | | | | | | | | | | | |
| AIRSENSE | DG00701 | X | | | | | | | | | TOTAL |
| THC | DG00702 | X | | | | | | | | | TOTAL |
| M-18 | DG00703 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG00704 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG00705 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG00706 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG00707 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG00708 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG00709 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG00710 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/15/00 | | | | | | | | | | | |
| EVENT 8 | | | | | | | | | | | |
| AIRSENSE | DG00801 | X | | | | | | | | | TOTAL |
| THC | DG00802 | X | | | | | | | | | TOTAL |
| M-18 | DG00803 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG00804 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG00805 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG00806 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG00807 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG00808 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG00809 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG00810 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/15/00 | | | | | | | | | | | |
| EVENT 9 | | | | | | | | | | | |
| AIRSENSE | DG00901 | X | | | | | | | | | TOTAL |
| THC | DG00902 | X | | | | | | | | | TOTAL |
| M-18 | DG00903 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG00904 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG00905 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG00906 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG00907 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG00908 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG00909 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG00910 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/15/00 | | | | | | | | | | | |
| EVENT 10 | | | | | | | | | | | |
| AIRSENSE | DG01001 | X | | | | | | | | | TOTAL |
| THC | DG01002 | X | | | | | | | | | TOTAL |
| M-18 | DG01003 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG01004 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG01005 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG01006 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG01007 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG01008 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG01009 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01010 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/15/00 | | | | | | | | | | | |
| EVENT 11 | | | | | | | | | | | |
| AIRSENSE | DG01101 | X | | | | | | | | | TOTAL |
| THC | DG01102 | X | | | | | | | | | TOTAL |
| M-18 | DG01103 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG01104 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG01105 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG01106 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG01107 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG01108 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG01109 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01110 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/16/00 | | | | | | | | | | | |
| EVENT 12 | | | | | | | | | | | |
| AIRSENSE | DG01201 | X | | | | | | | | | TOTAL |
| THC | DG01202 | X | | | | | | | | | TOTAL |
| M-18 | DG01203 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG01204 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG01205 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG01206 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG01207 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG01208 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG01209 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01210 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/16/00 | | | | | | | | | | | |
| EVENT 13 | | | | | | | | | | | |
| AIRSENSE | DG01301 | X | | | | | | | | | TOTAL |
| THC | DG01302 | X | | | | | | | | | TOTAL |
| M-18 | DG01303 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DG01304 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 by MS | DG01305 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 by MS | DG01306 | | | 1 | | | | | 25 | 4 | TOTAL |
| EXCESS | | | | | | | | | 25 | 5 | Excess |
| NIOSH 1500 | DG01307 | | 1 | | | | | | 500 | 6 | TOTAL Orbo 32L |
| EXCESS | | | | | | | | | 500 | 7 | Excess |
| NIOSH 2002 | DG01308 | | 1 | | | | | | 500 | 8 | TOTAL (SKC 226-15) |
| EXCESS | | | | | | | | | 500 | 9 | Excess |
| TO11 | DG01309 | | 1 | | | | | | 1000 | 10 | TOTAL |
| EXCESS | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01310 | | 1 | | | | | | 35L | | Port B |
| M-18 | DG01311 | | | | | | X | | 25 | | BOTTLE - Mix 1A |
| M-18 | DG01312 | | | | | | X | | 25 | | BOTTLE - Mix 1A |
| M-18 | DG01313 | | | | | | X | | 25 | | TRAIN - Mix 1A |
| M-18 | DG01314 | | | | | | X | | 25 | | TRAIN - Mix 1A |
| TO11 | DG01315 | | | | | | X | | 500 | | BOTTLE - Mix 2 |
| TO11 | DG01316 | | | | | | X | | 500 | | BOTTLE - Mix 2 |
| TO11 | DG01317 | | | | | | X | | 500 | | TRAIN - Mix 2 |
| TO11 | DG01318 | | | | | | X | | 500 | | TRAIN - Mix 2 |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/26/00 | | | | | | | | | | | |
| EVENT 14 | | | | | | | | | | | |
| AIRSENSE | DG01401 | | | | | | | | | | TOTAL |
| THC | DG01402 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG01403 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01404 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01405 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01406 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG01407 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG01408 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01409 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01410 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01411 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01412 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01413 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01414 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/26/00 | | | | | | | | | | | |
| EVENT 15 | | | | | | | | | | | |
| AIRSENSE | DG01501 | | | | | | | | | | TOTAL |
| THC | DG01502 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG01503 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01504 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01505 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01506 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG01507 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG01508 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01509 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01510 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01511 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01512 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01513 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01514 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/26/00 | | | | | | | | | | | |
| EVENT 16 | | | | | | | | | | | |
| AIRSENSE | DG01601 | | | | | | | | | | TOTAL |
| THC | DG01602 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG01603 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01604 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01605 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01606 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG01607 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG01608 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01609 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01610 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01611 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01612 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01613 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01614 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/26/00 | | | | | | | | | | | |
| EVENT 17 | | | | | | | | | | | |
| AIRSENSE | DG01701 | | | | | | | | | | TOTAL |
| THC | DG01702 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG01703 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01704 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01705 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01706 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG01707 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG01708 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01709 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01710 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01711 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01712 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01713 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01714 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/27/00 | | | | | | | | | | | |
| EVENT 18 | | | | | | | | | | | |
| AIRSENSE | DG01801 | | | | | | | | | | TOTAL |
| THC | DG01802 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG01803 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01804 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01805 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01806 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG01807 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG01808 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01809 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01810 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01811 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01812 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01813 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01814 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/27/00 | | | | | | | | | | | |
| EVENT 19 | | | | | | | | | | | |
| AIRSENSE | DG01901 | | | | | | | | | | TOTAL |
| THC | DG01902 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG01903 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01904 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01905 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01906 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG01907 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG01908 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01909 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01910 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01911 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01912 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG01913 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG01914 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/27/00 | | | | | | | | | | | |
| EVENT 20 | | | | | | | | | | | |
| AIRSENSE | DG02001 | | | | | | | | | | TOTAL |
| THC | DG02002 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG02003 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02004 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02005 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02006 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG02007 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG02008 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02009 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02010 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02011 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02012 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02013 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG02014 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/27/00 | | | | | | | | | | | |
| EVENT 21 | | | | | | | | | | | |
| AIRSENSE | DG02101 | | | | | | | | | | TOTAL |
| THC | DG02102 | X | | | | | | | | | TOTAL |
| NIOSH 1500 | DG02103 | | 1 | | | | | | 200 | 1 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02104 | | 1 | | | | | | 200 | 2 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02105 | | 1 | | | | | | 200 | 3 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02106 | | 1 | | | | | | 200 | 4 | TOTAL - Orbo 32small |
| GAS,CO + CO2 | DG02107 | | 1 | | | | | | 60 | 5 | Bag sample to Airtoxics |
| NIOSH 1500 | DG02108 | | 1 | | | | | | 200 | 6 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02109 | | 1 | | | | | | 200 | 7 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02110 | | 1 | | | | | | 200 | 8 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02111 | | 1 | | | | | | 200 | 9 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02112 | | 1 | | | | | | 200 | 10 | TOTAL - Orbo 32small |
| NIOSH 1500 | DG02113 | | 1 | | | | | | 200 | 11 | TOTAL - Orbo 32small |
| Moisture | | | 1 | | | | | | 500 | 12 | |
| Excess | | | | | | | | | 5000 | 13 | Excess |
| PUF | DG02114 | | 1 | | | | | | 35L | | Port B |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/31/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 1 | | | | | | | | | | | unless noted. |
| THC | DZ00101 | X | | | | | | | | | TOTAL |
| M-18 | DZ00102 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00103 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 | DZ00104 | | | | 1 | | | | 0 | 2 | QC-Manifold Blank |
| M-18 MS (Quant) | DZ00105 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00106 | | | 1 | | | | | 25 | 4 | TOTAL |
| M-18 MS (Quant) | DZ00107 | | | | 1 | | | | 0 | 4 | QC-Manifold Blank |
| GAS,CO + CO2 | DZ00108 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| Excess | | | | | | | | | 1000 | 6 | Excess |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| TO11 | DZ00109 | | 1 | | | | | | 750 | 8 | Total |
| TO11 | DZ00110 | | | | 1 | | | | 0 | 8 | QC - Manifold Blank |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | |
| PUF | DZ001 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/31/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 2 | | | | | | | | | | | unless noted. |
| THC | DZ00202 | X | | | | | | | | | TOTAL |
| M-18 | DZ00203 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00204 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 MS (Quant) | DZ00205 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00206 | | | 1 | | | | | 25 | 4 | TOTAL |
| GAS,CO + CO2 | DZ00207 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| Excess | | | | | | | | | 1000 | 6 | Excess |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| TO11 | DZ00208 | | 1 | | | | | | 750 | 8 | Total |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | |
| PUF | DZ002 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/31/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 3 | | | | | | | | | | | unless noted. |
| THC | DZ00301 | X | | | | | | | | | TOTAL |
| M-18 | DZ00302 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00303 | | | | | 1 | | | 25 | 1 | TOTAL |
| M-18 | DZ00304 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 | DZ00305 | | | | | 1 | | | 25 | 2 | TOTAL |
| M-18 MS (Quant) | DZ00306 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00307 | | | | | 1 | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00308 | | | 1 | | | | | 25 | 4 | TOTAL |
| M-18 MS (Quant) | DZ00309 | | | | | 1 | | | 25 | 4 | TOTAL |
| GAS,CO + CO2 | DZ00310 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| Excess | | | | | | | | | 1000 | 6 | Excess |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| TO11 | DZ00311 | | 1 | | | | | | 750 | 8 | Total |
| TO11 | DZ00312 | | | | | 1 | | | 750 | 8 | Total |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | |
| PUF | DZ003 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DG SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/31/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 4 | | | | | | | | | | | unless noted. |
| THC | DZ00402 | X | | | | | | | | | TOTAL |
| M-18 | DZ00403 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00404 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 MS (Quant) | DZ00405 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00406 | | | 1 | | | | | 25 | 4 | TOTAL |
| GAS,CO + CO2 | DZ00407 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| Excess | | | | | | | | | 1000 | 6 | Excess |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| TO11 | DZ00408 | | 1 | | | | | | 750 | 8 | Total |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | |
| PUF | DZ004 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/1/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 5 | | | | | | | | | | | unless noted. |
| AIRSENSE | DZ00501 | | | | | | | | | | TOTAL |
| THC | DZ00502 | X | | | | | | | | | TOTAL |
| M-18 | DZ00503 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00504 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 MS (Quant) | DZ00505 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00506 | | | 1 | | | | | 25 | 4 | TOTAL |
| GAS,CO + CO2 | DZ00507 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| Excess | | | | | | | | | 1000 | 6 | TOTAL (SKC 226-115) |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| TO11 | DZ00508 | | 1 | | | | | | 750 | 8 | Total |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | |
| PUF | DZ005 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/1/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 6 | | | | | | | | | | | unless noted. |
| AIRSENSE | DZ00601 | | | | | | | | | | TOTAL |
| THC | DZ00602 | X | | | | | | | | | TOTAL |
| M-18 | DZ00603 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00604 | | | 1 | | | | | 25 | 2 | TOTAL |
| M-18 MS (Quant) | DZ00605 | | 1 | | | | | | 25 | 3 | TOTAL |
| M-18 MS (Quant) | DZ00606 | | | 1 | | | | | 25 | 4 | TOTAL |
| GAS,CO + CO2 | DZ00607 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| Excess | | | | | | | | | 1000 | 6 | Excess |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| TO11 | DZ00608 | | 1 | | | | | | 750 | 8 | Total |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | |
| PUF | DZ006 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/1/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 7 | | | | | | | | | | | unless noted. |
| THC | DZ00702 | X | | | | | | | | | TOTAL |
| M-18 | DZ00703 | | 1 | | | | | | 25 | 1 | TOTAL |
| M-18 | DZ00704 | | | 1 | | | | | 25 | 2 | TOTAL |
| Excess | | | | | | | | | 25 | 3 | Excess |
| Excess | | | | | | | | | 25 | 4 | Excess |
| Excess | | | | | | | | | 60 | 5 | Excess |
| Excess | | | | | | | | | 1000 | 6 | Excess |
| Excess | | | | | | | | | 1000 | 7 | Excess |
| Excess | | | | | | | | | 750 | 8 | Excess |
| Excess | | | | | | | | | 500 | 9 | Excess |
| Excess | | | | | | | | | 250 | 10 | Excess |
| Excess | | | | | | | | | 1700 | 11 | Excess |
| Excess | | | | | | | | | 500 | 12 | Excess |
| Excess | | | | | | | | | 2500 | 13 | Excess |
| PUF | DZ007 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/6/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 8 | | | | | | | | | | | unless noted. |
| THC | DZ00801 | X | | | | | | | | | TOTAL |
| M-18 | DZ00802 | | 1 | | | | | | 25 | 1 | TOTAL M-18 (FID) |
| M-18 | DZ00803 | | | 1 | | | | | 25 | 2 | DUP M-18 (FID) |
| M-18 | DZ00804 | | | | 1 | | | | 0 | 2 | Manifold Blank |
| M-18 MS (Quant) | DZ00805 | | 1 | | | | | | 25 | 3 | TOTAL M-18 MS |
| Excess | | | | | | | | | 25 | 4 | Excess |
| GAS,CO + CO2 | DZ00806 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| NIOSH1500 | DZ00807 | | 1 | | | | | | 500 | 6 | TOTAL (SKC 226-01) |
| NIOSH1500 | DZ00808 | | | 1 | | | | | 500 | 7 | DUP (SKC 226-01) |
| NIOSH1500 | DZ00809 | | | | 1 | | | | 0 | 7 | Manifold Blank |
| TO11 | DZ00810 | | 1 | | | | | | 250 | 8 | TOTAL (DNPH) |
| TO11 | DZ00811 | | | 1 | | | | | 250 | 9 | DUP (DNPH) |
| TO11 | DZ00812 | | | | 1 | | | | 0 | 9 | Manifold Blank |
| Excess | | | | | | | | | 1000 | 10 | Excess |
| Excess | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | Excess |
| PUF | DZ008 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/6/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 9 | | | | | | | | | | | unless noted. |
| THC | DZ00901 | X | | | | | | | | | TOTAL |
| M-18 | DZ00902 | | 1 | | | | | | 25 | 1 | TOTAL M-18 (FID) |
| M-18 | DZ00903 | | | | | 1 | | | 25 | 1 | Breakthrough M-18 (FID) |
| Excess | | | | | | | | | 25 | 2 | Excess |
| M-18 MS (Quant) | DZ00904 | | 1 | | | | | | 25 | 3 | TOTAL M-18 MS |
| Excess | | | | | | | | | 25 | 4 | Excess |
| GAS,CO + CO2 | DZ00905 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| NIOSH1500 | DZ00906 | | 1 | | | | | | 500 | 6 | TOTAL (SKC 226-01) |
| Excess | | | | | | | | | 500 | 7 | Excess |
| TO11 | DZ00907 | | 1 | | | | | | 250 | 8 | TOTAL (DNPH) |
| TO11 | DZ00908 | | | | | 1 | | | 250 | 8 | Breakthrough (DNPH) |
| Excess | | | | | | | | | 250 | 9 | Excess |
| Excess | | | | | | | | | 1000 | 10 | Excess |
| Excess | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | Excess |
| PUF | DZ009 | | 1 | | | | | | 15L | | Sample using opposite port |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/6/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 10 | | | | | | | | | | | unless noted. |
| THC | DZ01001 | X | | | | | | | | | TOTAL |
| M-18 | DZ01002 | | 1 | | | | | | 25 | 1 | TOTAL M-18 (FID) |
| Excess | | | | | | | | | 25 | 2 | Excess |
| M-18 MS (Quant) | DZ01003 | | 1 | | | | | | 25 | 3 | TOTAL M-18 MS |
| Excess | | | | | | | | | 25 | 4 | Excess |
| GAS,CO + CO2 | DZ01004 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| NIOSH1500 | DZ01005 | | 1 | | | | | | 500 | 6 | TOTAL (SKC 226-01) |
| Excess | | | | | | | | | 500 | 7 | Excess |
| TO11 | DZ01006 | | 1 | | | | | | 250 | 8 | TOTAL (DNPH) |
| Excess | | | | | | | | | 250 | 9 | Excess |
| Excess | | | | | | | | | 1000 | 10 | Excess |
| Excess | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | Excess |

## PRE-PRODUCTION DZ SERIES SAMPLE PLAN

| Method | Sample # | Data | Sample | Duplicate | Blank | Breakthrough | Spike | Spike Duplicate | Flow (ml/min) | Train Channel | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/6/01 | | | | | | | | | | | Samples to Clayton Lab. |
| EVENT 11 | | | | | | | | | | | unless noted. |
| THC | DZ01101 | X | | | | | | | | | TOTAL |
| M-18 | DZ01102 | | 1 | | | | | | 25 | 1 | TOTAL M-18 (FID) |
| Excess | | | | | | | | | 25 | 2 | Excess |
| M-18 MS (Quant) | DZ01103 | | 1 | | | | | | 25 | 3 | TOTAL M-18 MS |
| Excess | | | | | | | | | 25 | 4 | Excess |
| GAS,CO + CO2 | DZ01104 | | 1 | | | | | | 60 | 5 | TEDLAR BAG Sample to Airtoxics Lab. |
| NIOSH1500 | DZ01105 | | 1 | | | | | | 500 | 6 | TOTAL (SKC 226-01) |
| Excess | | | | | | | | | 500 | 7 | Excess |
| TO11 | DZ01106 | | 1 | | | | | | 250 | 8 | TOTAL (DNPH) |
| Excess | | | | | | | | | 250 | 9 | Excess |
| Excess | | | | | | | | | 1000 | 10 | Excess |
| Excess | | | | | | | | | 1000 | 11 | Excess |
| Moisture | | | | | | | | | 500 | 12 | EPA Method 4 |
| Excess | | | | | | | | | 2500 | 13 | Excess |
| PUF | DZ011 | | 1 | | | | | | 15L | | Sample using opposite port |
| M-18 | DZ01107 | | | | | | X | | 25 | | BOTTLE - Mix 1A |
| M-18 | DZ01108 | | | | | | X | | 25 | | BOTTLE - Mix 1A |
| TO11 | DZ01109 | | | | | | X | | 500 | | BOTTLE - Mix 2 |
| TO11 | DZ01110 | | | | | | X | | 500 | | BOTTLE - Mix 2 |

# APPENDIX B TEST SERIES DG AND DZ DETAILED RESULT

THIS PAGE INTENTIONALLY LEFT LANK

## Test Plan DG and DZ Average Test Results with T-Statistics

| Analytes | Test DG (Lb/Tn) | Test DZ (Lb/tn) | T Statistic |
|---|---|---|---|
| TGOC (THC) as Propane | 12.2 | 3.39 | 31.33 |
| HC as Hexane | 11.1 | 2.37 | 29.95 |
| Sum of VOCs | 4.06 | 0.901 | 16.41 |
| Sum of HAPs | 2.00 | 0.803 | 13.74 |
| Sum of POMs | 0.104 | 0.067 | 5.30 |
| **Individual Organic HAPs** | | | |
| Phenol | 0.942 | 0.121 | 16.88 |
| o,m,p-Cresol | 0.500 | 0.047 | 16.10 |
| Benzene | 0.299 | 0.318 | 1.26 |
| Dimethylnaphthalenes | 0.086 | 0.001 | 14.91 |
| Toluene | 0.056 | 0.054 | 0.41 |
| Formaldehyde | 0.021 | 0.084 | 20.38 |
| Acetaldehyde | 0.004 | 0.069 | 25.69 |
| Methylnaphthalenes | 0.018 | 0.050 | 12.72 |
| o,m,p-Xylene | 0.031 | 0.032 | 0.05 |
| Propionaldehyde | 0.001 | 0.017 | 28.19 |
| Naphthalene | ND | 0.015 | 6.56 |
| **Other VOCs** | | | |
| Dimethylphenols | 1.07 | 0.032 | 22.89 |
| Diethylbenzenes | 0.299 | ND | 4.05 |
| Trimethylbenzenes | 0.216 | 0.013 | 11.28 |
| Tetradecane | 0.141 | ND | 11.31 |
| Butylbenzenes | 0.116 | ND | 8.38 |
| Dodecane | 0.060 | ND | 21.05 |
| Indan | 0.057 | ND | 28.89 |
| Undecane | 0.033 | ND | 21.66 |
| Trimethylphenols | ND | 0.021 | 4.90 |
| Butyraldehyde/Methacrolein | 0.021 | 0.013 | 3.65 |
| **Other Analytes** | | | |
| Condensables | 0.800 | 0.448 | 6.77 |
| Carbon  Monoxide | 4.18 | 4.32 | 0.52 |
| Methane | 0.590 | 0.543 | 1.75 |
| Carbon Dioxide | 59.3 | 52.2 | 3.58 |

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

**ND:** Non Detect

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

**Test Plan DG Individual Test Results – Lbs/Tn Metal**

| POMs | HAPS | COMPOUND / SAMPLE NUMBER | DG005 | DG006 | DG007 | DG008 | DG009 | DG010 | DG011 | DG012 | DG013 | AVERAGE | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Date** | **11/14/00** | **11/14/00** | **11/14/00** | **11/15/00** | **11/15/00** | **11/15/00** | **11/15/00** | **11/16/00** | **11/16/00** | | |
| | | THC as Propane | 1.25E+01 | 1.09E+01 | 1.35E+01 | 1.26E+01 | 1.23E+01 | 1.23E+01 | 1.17E+01 | I | 1.15E+01 | 1.22E+01 | 7.85E-01 |
| | | HC as Hexane | 1.06E+01 | 9.92E+00 | 1.27E+01 | 1.16E+01 | 1.10E+01 | 1.14E+01 | 1.10E+01 | I | 1.07E+01 | 1.11E+01 | 8.21E-01 |
| | | Sum of VOCs | 4.08E+00 | 3.95E+00 | 4.83E+00 | 3.33E+00 | 4.40E+00 | 4.62E+00 | 3.49E+00 | I | 3.80E+00 | 4.06E+00 | 5.28E-01 |
| | | Sum of HAPs | 1.80E+00 | 2.01E+00 | 2.28E+00 | 1.72E+00 | 2.28E+00 | 2.10E+00 | 1.93E+00 | I | 1.88E+00 | 2.00E+00 | 2.09E-01 |
| | | Sum of POMs | 1.11E-01 | 9.14E-02 | 1.13E-01 | 8.12E-02 | 1.24E-01 | 1.31E-01 | 8.32E-02 | I | 9.43E-02 | 1.04E-01 | 1.89E-02 |
| | | | **Individual HAPs and VOCs** | | | | | | | | | | |
| | z | Phenol | 7.56E-01 | 1.01E+00 | 1.10E+00 | 8.32E-01 | 1.13E+00 | 9.46E-01 | 9.39E-01 | I | 8.34E-01 | 9.42E-01 | 1.32E-01 |
| | z | m,p-Cresol | 4.53E-01 | 4.10E-01 | 5.25E-01 | 3.47E-01 | 4.97E-01 | 5.10E-01 | 4.17E-01 | I | 4.78E-01 | 4.55E-01 | 6.02E-02 |
| | z | Benzene | 2.85E-01 | 2.86E-01 | 2.71E-01 | 3.10E-01 | 3.10E-01 | 3.18E-01 | 3.14E-01 | I | 2.94E-01 | 2.99E-01 | 1.68E-02 |
| | z | Toluene | 5.12E-02 | 5.02E-02 | 6.53E-02 | 5.33E-02 | 5.65E-02 | 5.78E-02 | 5.84E-02 | I | 5.17E-02 | 5.56E-02 | 5.02E-03 |
| x | z | 1,2-Dimethylnaphthalene | 4.80E-02 | 4.35E-02 | 4.80E-02 | 3.85E-02 | 5.31E-02 | 5.57E-02 | 3.75E-02 | I | 4.23E-02 | 4.58E-02 | 6.55E-03 |
| | z | o-Cresol | 3.56E-02 | 6.83E-02 | 8.54E-02 | 1.31E-02 | 5.46E-02 | 6.11E-02 | 2.74E-02 | I | 2.05E-02 | 4.58E-02 | 2.55E-02 |
| | z | m,p-Xylene | 2.27E-02 | 2.20E-02 | 2.77E-02 | 2.14E-02 | 2.31E-02 | 2.55E-02 | 2.33E-02 | I | 2.13E-02 | 2.34E-02 | 2.20E-03 |
| | z | Formaldehyde | 3.17E-02 | 2.03E-02 | 2.47E-02 | 1.37E-02 | 2.65E-02 | 9.42E-03 | 9.66E-03 | I | 2.83E-02 | 2.05E-02 | 8.67E-03 |
| x | z | 1,5-Dimethylnaphthalene | 1.98E-02 | 1.66E-02 | 2.05E-02 | 1.34E-02 | 2.22E-02 | 2.42E-02 | 1.52E-02 | I | 1.62E-02 | 1.85E-02 | 3.72E-03 |
| | z | Aniline | 1.57E-02 | 1.94E-02 | 2.46E-02 | 1.57E-02 | 1.64E-02 | I | 1.88E-02 | I | 1.89E-02 | 1.85E-02 | 3.13E-03 |
| | z | Styrene | 1.40E-02 | 1.38E-02 | 1.58E-02 | 1.26E-02 | 1.48E-02 | 1.52E-02 | 1.47E-02 | I | 1.32E-02 | 1.43E-02 | 1.05E-03 |
| x | z | 1,3-Dimethylnaphthalene | 1.41E-02 | 1.26E-02 | 1.46E-02 | 1.04E-02 | 1.63E-02 | 1.69E-02 | 1.07E-02 | I | 1.20E-02 | 1.35E-02 | 2.45E-03 |
| x | z | 2-Methylnaphthalene | 1.25E-02 | 1.10E-02 | 1.26E-02 | 9.23E-03 | 1.40E-02 | 1.39E-02 | 9.27E-03 | I | 1.06E-02 | 1.16E-02 | 1.90E-03 |
| | z | o-Xylene | 7.78E-03 | 7.42E-03 | 9.23E-03 | 7.41E-03 | 8.12E-03 | 8.75E-03 | 8.07E-03 | I | 7.42E-03 | 8.03E-03 | 6.71E-04 |
| x | z | 1-Methylnaphthalene | 6.69E-03 | 5.84E-03 | 6.94E-03 | 5.13E-03 | 7.90E-03 | 8.06E-03 | 5.28E-03 | I | 5.85E-03 | 6.46E-03 | 1.12E-03 |
| | z | Ethylbenzene | 5.76E-03 | 5.97E-03 | 5.87E-03 | 5.03E-03 | 6.78E-03 | 7.40E-03 | 6.46E-03 | I | 5.33E-03 | 6.07E-03 | 7.76E-04 |
| x | z | 1,6-Dimethylnaphthalene | 6.37E-03 | ND | 7.00E-03 | 4.48E-03 | 7.12E-03 | 8.10E-03 | 5.20E-03 | I | 5.34E-03 | 5.45E-03 | 2.50E-03 |
| | z | Biphenyl | 4.88E-03 | 4.01E-03 | 4.78E-03 | 3.53E-03 | 5.17E-03 | 5.31E-03 | 3.53E-03 | I | 3.95E-03 | 4.40E-03 | 7.23E-04 |
| | z | Acetaldehyde | I | 3.84E-03 | 3.27E-03 | 3.68E-03 | 6.77E-03 | 2.89E-03 | 2.70E-03 | I | 5.38E-03 | 4.08E-03 | 1.48E-03 |
| x | z | 2,3-Dimethylnaphthalene | 3.22E-03 | 1.80E-03 | 3.63E-03 | ND | 3.82E-03 | 4.28E-03 | ND | I | 1.88E-03 | 2.33E-03 | 1.68E-03 |
| | z | Acrolein | 1.12E-03 | 8.85E-04 | 1.38E-03 | 7.09E-04 | 1.08E-03 | 3.94E-04 | 5.56E-04 | I | 1.28E-03 | 9.25E-04 | 3.51E-04 |
| | z | Propionaldehyde | I | 7.83E-04 | 8.34E-04 | 6.44E-04 | 1.01E-03 | 5.11E-04 | 4.95E-04 | I | 8.80E-04 | 7.37E-04 | 1.93E-04 |
| | z | 2-Butanone | ND | 1.82E-04 | 6.86E-04 | 5.93E-04 | ND | 9.42E-04 | I | I | ND | 3.43E-04 | 3.91E-04 |
| | z | Hexane | 2.35E-03 | ND | ND | ND | ND | ND | ND | I | ND | 2.93E-04 | 8.30E-04 |

**Test Plan DG Individual Test Results – Lbs/Tn Metal**

| POMs | HAPS | COMPOUND / SAMPLE NUMBER | DG005 | DG006 | DG007 | DG008 | DG009 | DG010 | DG011 | DG012 | DG013 | AVERAGE | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Date** | **11/14/00** | **11/14/00** | **11/14/00** | **11/15/00** | **11/15/00** | **11/15/00** | **11/15/00** | **11/16/00** | **11/16/00** | | |
| x | z | 1,8-Dimethylnaphthalene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| x | z | 2,3,5-Trimethylnaphthalene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| x | z | 2,6-Dimethylnaphthalene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| x | z | 2,7-Dimethylnaphthalene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | z | Cumene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| x | z | Naphthalene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | z | N,N-Dimethylaniline | I | I | I | I | I | I | I | I | I | N/A | N/A |
| | | 2,6-Dimethylphenol | 1.11E+00 | 1.01E+00 | 1.28E+00 | 9.58E-01 | 1.13E+00 | 1.15E+00 | 9.20E-01 | I | 9.66E-01 | 1.07E+00 | 1.24E-01 |
| | | 1,2-Diethylbenzene | 4.40E-01 | 2.36E-01 | 5.65E-01 | 7.77E-03 | 2.60E-01 | 5.24E-01 | 7.68E-03 | I | 2.57E-01 | 2.87E-01 | 2.13E-01 |
| | | 1,2,3-Trimethylbenzene | 1.51E-01 | 1.39E-01 | 1.69E-01 | 1.30E-01 | 1.51E-01 | 1.46E-01 | 1.24E-01 | I | 1.26E-01 | 1.42E-01 | 1.52E-02 |
| | | Tetradecane | 9.51E-02 | 1.72E-01 | 1.86E-01 | 1.53E-01 | 1.03E-01 | 1.05E-01 | 1.44E-01 | I | 1.67E-01 | 1.41E-01 | 3.52E-02 |
| | | Isobutylbenzene | 1.44E-01 | 1.31E-01 | 6.73E-02 | 6.48E-02 | 1.52E-01 | 1.52E-01 | 1.32E-01 | I | 7.68E-02 | 1.15E-01 | 3.85E-02 |
| | | Dodecane | 5.72E-02 | 5.09E-02 | 6.27E-02 | 5.29E-02 | 7.02E-02 | 7.22E-02 | 5.32E-02 | I | 5.78E-02 | 5.96E-02 | 8.01E-03 |
| | | Indan | 5.68E-02 | 5.35E-02 | 6.73E-02 | 5.28E-02 | 5.87E-02 | 6.10E-02 | 5.24E-02 | I | 5.07E-02 | 5.67E-02 | 5.55E-03 |
| | | 1,2,4-Trimethylbenzene | 4.02E-02 | 3.75E-02 | 4.64E-02 | 3.67E-02 | 4.57E-02 | 4.68E-02 | 4.08E-02 | I | 4.04E-02 | 4.18E-02 | 4.00E-03 |
| | | Undecane | 3.38E-02 | 2.82E-02 | 3.83E-02 | 2.95E-02 | 3.46E-02 | 4.04E-02 | 3.00E-02 | I | 3.13E-02 | 3.33E-02 | 4.34E-03 |
| | | 1,3,5-Trimethylbenzene | 5.51E-02 | ND | ND | 2.55E-02 | ND | 1.32E-01 | ND | I | 4.51E-02 | 3.23E-02 | 4.61E-02 |
| | | Indene | 3.84E-02 | 3.60E-02 | 2.07E-02 | 1.24E-02 | 3.89E-02 | 2.17E-02 | 2.76E-02 | I | 2.62E-02 | 2.77E-02 | 9.49E-03 |
| | | Butyraldehyde/Methacrolien | 3.14E-02 | 2.21E-02 | I | 1.82E-02 | 1.93E-02 | 1.74E-02 | 1.38E-02 | I | 2.62E-02 | 2.12E-02 | 5.94E-03 |
| | | 1,3-Diethylbenzene | ND | ND | 1.35E-02 | 4.64E-02 | ND | 1.34E-02 | ND | I | 2.15E-02 | 1.19E-02 | 1.63E-02 |
| | | 1,3-Diisopropylbenzene | 9.80E-03 | 4.29E-03 | 9.29E-03 | 8.11E-03 | 9.21E-03 | 9.49E-03 | 8.42E-03 | I | 8.10E-03 | 8.34E-03 | 1.76E-03 |
| | | Tridecane | 6.87E-03 | 7.66E-03 | 6.97E-03 | 5.53E-03 | 8.30E-03 | 7.95E-03 | 5.37E-03 | I | 6.27E-03 | 6.86E-03 | 1.09E-03 |
| | | 2-Ethyltoluene | 3.61E-03 | 5.13E-03 | 9.52E-03 | 3.12E-03 | 1.07E-02 | 6.65E-03 | 4.01E-03 | I | 5.78E-03 | 6.06E-03 | 2.76E-03 |
| | | Benzaldehyde | 5.63E-03 | 4.09E-03 | 5.84E-03 | 2.99E-03 | 4.62E-03 | 2.66E-03 | 2.52E-03 | I | 5.42E-03 | 4.22E-03 | 1.37E-03 |
| | | o,m,p-Tolualdehyde | 4.16E-03 | 2.96E-03 | 3.42E-03 | 1.96E-03 | 3.46E-03 | 1.71E-03 | 1.62E-03 | I | 3.65E-03 | 2.87E-03 | 9.75E-04 |
| | | Decane | ND | ND | ND | ND | 1.11E-02 | ND | ND | I | ND | 1.38E-03 | 3.91E-03 |
| | | sec-Butylbenzene | ND | ND | ND | ND | 3.02E-03 | 2.93E-03 | ND | I | 1.49E-03 | 9.30E-04 | 1.36E-03 |
| | | Pentanal | ND | ND | 7.92E-04 | ND | 3.28E-03 | 2.75E-04 | ND | I | ND | 5.44E-04 | 1.14E-03 |
| | | 2,4-Dimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 1,4-Diethylbenzene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |

**Test Plan DG Individual Test Results – Lbs/Tn Metal**

| POMs | HAPS | COMPOUND / SAMPLE NUMBER | DG005 | DG006 | DG007 | DG008 | DG009 | DG010 | DG011 | DG012 | DG013 | AVERAGE | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Date** | **11/14/00** | **11/14/00** | **11/14/00** | **11/15/00** | **11/15/00** | **11/15/00** | **11/15/00** | **11/16/00** | **11/16/00** | | |
| | | 2,3,5-Trimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 2,3-Dimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 2,4,6-Trimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 2,5-Dimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 3,4-Dimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 3,5-Dimethylphenol | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 3-Ethyltoluene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | 4-Ethyltoluene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| x | | Acenaphthalene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | a-Methylstyrene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Anthracene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Butylbenzene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Crotonaldehyde | ND | ND | ND | ND | ND | ND | I | I | ND | N/A | N/A |
| | | Cyclohexane | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Heptane | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Hexaldehyde | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Nonane | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | n-Propylbenzene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | Octane | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | p-Cymene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | tert-Butylbenzene | ND | ND | ND | ND | ND | ND | ND | I | ND | N/A | N/A |
| | | | **Other Analytes** | | | | | | | | | | |
| | | Acetone | I | 1.24E-03 | 5.64E-04 | 1.72E-03 | 1.77E-03 | 1.70E-03 | 1.52E-03 | I | 1.45E-03 | 1.42E-03 | 4.21E-04 |
| | | Condensables | NT | 8.85E-01 | I | 7.87E-01 | 8.08E-01 | 9.10E-01 | 6.73E-01 | 7.12E-01 | 8.26E-01 | 8.00E-01 | 8.56E-02 |

## Test Plan DG Individual Test Results – Lb/Tn Metal

| COMPOUND / SAMPLE NUMBER | DG018 | DG019 | DG020 | DG021 | AVERAGE | STDEV |
|---|---|---|---|---|---|---|
| **Pour Date** | **12/27/00** | **12/27/00** | **12/27/00** | **12/27/00** | | |
| | **Other Analytes (continued)** | | | | | |
| Carbon Monoxide | 3.74E+00 | 4.71E+00 | 4.27E+00 | 4.02E+00 | 4.18E+00 | 4.13E-01 |
| Methane | 5.50E-01 | 6.40E-01 | 6.52E-01 | 5.17E-01 | 5.90E-01 | 6.63E-02 |
| Carbon Dioxide | 6.05E+01 | 6.11E+01 | 6.14E+01 | 5.42E+01 | 5.93E+01 | 3.40E+00 |
| Ethane | ND | ND | ND | ND | N/A | N/A |
| Propane | ND | ND | ND | ND | N/A | N/A |
| Isobutane | ND | ND | ND | ND | N/A | N/A |
| Butane | ND | ND | ND | ND | N/A | N/A |
| Neopentane | ND | ND | ND | ND | N/A | N/A |
| Isopentane | ND | ND | ND | ND | N/A | N/A |
| Pentane | ND | ND | ND | ND | N/A | N/A |

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

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

**N/A**: Not Applicable; **NT**: Not Tested

## Test Plan DZ Individual Test Results – Lb/Tn Metal

| POMs | HAPs | COMPOUND / SAMPLE NUMBER | DZ002 | DZ003 | DZ004 | DZ005 | DZ006 | DZ008 | DZ009 | DZ010 | DZ011 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Dates** | **1/31/01** | **1/31/01** | **1/31/01** | **2/1/01** | **2/1/01** | **3/6/01** | **3/6/01** | **3/6/01** | **3/6/01** | | |
| | | TGOC (THC) as Propane | I | I | I | I | I | 3.43E+00 | 3.44E+00 | 3.30E+00 | 3.39E+00 | 3.39E+00 | 6.63E-02 |
| | | HC as Hexane | NT | NT | NT | NT | NT | 2.27E+00 | 2.39E+00 | 2.39E+00 | 2.44E+00 | 2.37E+00 | 7.06E-02 |
| | | Sum of VOCs | I | I | I | I | I | 8.13E-01 | 9.85E-01 | 8.24E-01 | 9.80E-01 | 9.01E-01 | 9.49E-02 |
| | | Sum of HAPs | I | I | I | I | I | 7.34E-01 | 8.61E-01 | 7.15E-01 | 9.01E-01 | 8.03E-01 | 9.23E-02 |
| | | Sum of POMs | I | I | I | I | I | 6.37E-02 | 7.21E-02 | 6.29E-02 | 6.76E-02 | 6.66E-02 | 4.23E-03 |
| | | **Individual HAPs and VOCs** | | | | | | | | | | | |
| | x | Benzene | I | I | I | I | I | 2.92E-01 | 3.40E-01 | 2.95E-01 | 3.46E-01 | 3.18E-01 | 2.87E-02 |
| | x | Phenol | I | I | I | I | I | 8.60E-02 | 1.35E-01 | 1.14E-01 | 1.49E-01 | 1.21E-01 | 2.75E-02 |
| | x | Formaldehyde | I | I | I | I | I | 8.30E-02 | 8.43E-02 | I | 8.55E-02 | 8.43E-02 | 1.25E-03 |
| | x | Acetaldehyde | I | I | I | I | I | 6.33E-02 | 6.56E-02 | 7.35E-02 | 7.19E-02 | 6.85E-02 | 4.91E-03 |
| | x | Toluene | I | I | I | I | I | 5.15E-02 | 5.63E-02 | 4.97E-02 | 5.99E-02 | 5.44E-02 | 4.64E-03 |
| z | x | 1-Methylnaphthalene | I | I | I | I | I | 5.23E-02 | 4.82E-02 | 4.28E-02 | 3.97E-02 | 4.58E-02 | 5.63E-03 |
| | x | o-Cresol | I | I | I | I | I | 2.30E-02 | 4.30E-02 | 3.61E-02 | 5.15E-02 | 3.84E-02 | 1.20E-02 |
| | x | m,p-Xylene | I | I | I | I | I | 2.54E-02 | 3.11E-02 | 2.66E-02 | 3.41E-02 | 2.93E-02 | 4.00E-03 |
| | x | Propionaldehyde | I | I | I | I | I | 1.55E-02 | 1.63E-02 | 1.81E-02 | 1.69E-02 | 1.67E-02 | 1.12E-03 |
| z | x | Naphthalene | I | I | I | I | I | 8.82E-03 | 1.76E-02 | 1.49E-02 | 1.94E-02 | 1.52E-02 | 4.63E-03 |
| | x | m,p-Cresol | I | I | I | I | I | 1.24E-02 | I | 2.06E-02 | ND | 1.10E-02 | 1.04E-02 |
| | x | 2-Butanone | I | I | I | I | I | 8.37E-03 | 7.58E-03 | 8.77E-03 | 7.67E-03 | 8.10E-03 | 5.72E-04 |
| | x | Acrolein | I | I | I | I | I | 4.52E-03 | 5.02E-03 | 5.57E-03 | 5.72E-03 | 5.21E-03 | 5.47E-04 |
| z | x | 2-Methylnaphthalene | I | I | I | I | I | 2.53E-03 | 4.59E-03 | 3.81E-03 | 5.99E-03 | 4.23E-03 | 1.45E-03 |
| | x | o-Xylene | I | I | I | I | I | 1.90E-03 | 2.47E-03 | 2.04E-03 | 2.56E-03 | 2.24E-03 | 3.22E-04 |
| | x | Ethylbenzene | I | I | I | I | I | ND | 2.62E-03 | 2.03E-03 | 2.84E-03 | 1.87E-03 | 1.29E-03 |
| z | x | 1,3-Dimethylnaphthalene | I | I | I | I | I | ND | 1.76E-03 | 1.43E-03 | 2.52E-03 | 1.43E-03 | 1.06E-03 |
| | x | Styrene | I | I | I | I | I | 3.26E-03 | ND | ND | ND | 8.16E-04 | 1.63E-03 |
| | x | Hexane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | 1,2-Dimethylnaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | **x** | **1,5-Dimethylnaphthalene** | I | I | I | I | I | ND | ND | ND | ND | NA | NA |

## Test Plan DZ Individual Test Results – Lb/Tn Metal

| POMs | HAPs | COMPOUND / SAMPLE NUMBER | DZ002 | DZ003 | DZ004 | DZ005 | DZ006 | DZ008 | DZ009 | DZ010 | DZ011 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Dates** | **1/31/01** | **1/31/01** | **1/31/01** | **2/1/01** | **2/1/01** | **3/6/01** | **3/6/01** | **3/6/01** | **3/6/01** | | |
| z | **x** | **1,6-Dimethylnaphthalene** | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | 1,8-Dimethylnaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | 2,3,5-Trimethylnaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | 2,3-Dimethylnaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | 2,6-Dimethylnaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | 2,7-Dimethylnaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| z | x | Acenaphthalene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | x | Biphenyl | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | x | Cumene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 2,4-Dimethylphenol | I | I | I | I | I | 2.24E-02 | 5.17E-02 | 4.28E-02 | I | 3.90E-02 | 1.50E-02 |
| | | 2,4,6-Trimethylphenol | I | I | I | I | I | 9.20E-03 | 2.55E-02 | 2.00E-02 | 2.84E-02 | 2.08E-02 | 8.47E-03 |
| | | Butyraldehyde/Methacrolein | I | I | I | I | I | 1.21E-02 | 1.28E-02 | 1.46E-02 | 1.36E-02 | 1.33E-02 | 1.07E-03 |
| | | 1,2,4-Trimethylbenzene | I | I | I | I | I | 7.39E-03 | 1.08E-02 | 8.81E-03 | 1.28E-02 | 9.94E-03 | 2.34E-03 |
| | | Pentanal | I | I | I | I | I | 9.66E-03 | 9.11E-03 | 9.46E-03 | 8.34E-03 | 9.14E-03 | 5.80E-04 |
| | | Benzaldehyde | I | I | I | I | I | 5.22E-03 | 4.40E-03 | 4.91E-03 | 4.69E-03 | 4.80E-03 | 3.49E-04 |
| | | 2,6-Dimethylphenol | I | I | I | I | I | 1.18E-02 | ND | ND | ND | 2.95E-03 | 5.91E-03 |
| | | Indene | I | I | I | I | I | ND | 3.48E-03 | 3.03E-03 | 4.02E-03 | 2.63E-03 | 1.80E-03 |
| | | 1,3,5-Trimethylbenzene | I | I | I | I | I | ND | 3.80E-03 | 2.28E-03 | 4.25E-03 | 2.58E-03 | 1.92E-03 |
| | | Hexaldehyde | I | I | I | I | I | 1.46E-03 | 1.69E-03 | 2.02E-03 | 1.86E-03 | 1.76E-03 | 2.41E-04 |
| | | Crotonaldehyde | I | I | I | I | I | ND | 8.83E-04 | 9.38E-04 | 9.04E-04 | 6.81E-04 | 4.55E-04 |
| | | 2,5-Dimethylphenol | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | o,m,p-Tolualdehyde | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 1,2,3-Trimethylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 1,2-Diethylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 1,3-Diethylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 1,3-Diisopropylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 1,4-Diethylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |

## Test Plan DZ Individual Test Results – Lb/Tn Metal

| POMs | HAPs | COMPOUND / SAMPLE NUMBER | DZ002 | DZ003 | DZ004 | DZ005 | DZ006 | DZ008 | DZ009 | DZ010 | DZ011 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Dates** | **1/31/01** | **1/31/01** | **1/31/01** | **2/1/01** | **2/1/01** | **3/6/01** | **3/6/01** | **3/6/01** | **3/6/01** | | |
| | | 2,3,5-Trimethylphenol | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 2,3-Dimethylphenol | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 2-Ethyltoluene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 3,4-Dimethylphenol | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 3,5-Dimethylphenol | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 3-Ethyltoluene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | 4-Ethyltoluene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | a-Methylstyrene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Anthracene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Butylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Cyclohexane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Decane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Dodecane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Heptane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Indan | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Isobutylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Nonane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | n-Propylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Octane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | p-Cymene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | sec-Butylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | tert-Butylbenzene | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Tetradecane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Tridecane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | Undecane | I | I | I | I | I | ND | ND | ND | ND | NA | NA |
| | | **Other Analytes** | | | | | | | | | | | |
| | | Condensables | I | I | I | I | I | 5.65E-01 | 4.27E-01 | 4.37E-01 | 3.63E-01 | 4.48E-01 | 8.46E-02 |

## Test Plan DZ Individual Test Results – Lb/Tn Metal

| POMs | HAPs | COMPOUND / SAMPLE NUMBER | DZ002 | DZ003 | DZ004 | DZ005 | DZ006 | DZ008 | DZ009 | DZ010 | DZ011 | Average | STDEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Pour Dates** | **1/31/01** | **1/31/01** | **1/31/01** | **2/1/01** | **2/1/01** | **3/6/01** | **3/6/01** | **3/6/01** | **3/6/01** | | |
| | | Acetone | I | I | I | I | I | 9.98E-03 | 1.01E-02 | 1.13E-02 | 1.06E-02 | 1.05E-02 | 6.11E-04 |
| | | Carbon Monoxide | I | I | I | I | I | 4.84E+00 | 3.99E+00 | 4.14E+00 | I | 4.32E+00 | 4.55E-01 |
| | | Methane | I | I | I | I | I | 5.73E-01 | 5.24E-01 | 5.32E-01 | I | 5.43E-01 | 2.60E-02 |
| | | Carbon Dioxide | I | I | I | I | I | 5.51E+01 | 5.26E+01 | 4.88E+01 | I | 5.22E+01 | 3.20E+00 |
| | | Ethane | I | I | I | I | I | ND | ND | ND | I | NA | NA |
| | | Propane | I | I | I | I | I | ND | ND | ND | I | NA | NA |
| | | Isobutane | I | I | I | I | I | ND | ND | ND | I | NA | NA |
| | | Butane | I | I | I | I | I | ND | ND | ND | I | NA | NA |
| | | Neopentane | I | I | I | I | I | ND | ND | ND | I | NA | NA |
| | | Isopentane | I | I | I | I | I | ND | ND | ND | I | NA | NA |
| | | Pentane | I | I | I | I | I | ND | ND | ND | I | NA | NA |

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

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

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

THIS PAGE INTENTIONALLY LEFT BLANK

# APPENDIX C TEST SERIES DG AND DZ DETAILED PROCESS AND SOURCE DATA

THIS PAGE INTENTIONALLY LEFT BLANK

## Test DG Process and Source Data

| Description | DG001 | DG002 | DG003 | DG004 | **DG005** | **DG006** | **DG007** | **DG008** | **DG009** |
|---|---|---|---|---|---|---|---|---|---|
| | 11/13/00 | 11/13/00 | 11/13/00 | 11/14/00 | **11/14/00** | **11/14/00** | **11/14/00** | **11/15/00** | **11/15/00** |
| Casting Metal Weight, lbs. (Note 1) | 132 | 130 | 111 | 134 | **136** | **138** | **123** | **130** | **129** |
| Total No Bake Mold Weight, lbs. | 332 | 333 | 339 | 326 | **329** | **332** | **334** | **333** | **334** |
| Total Binder Weight including catalyst, lbs | 3.813 | 3.824 | 3.893 | 4.003 | **4.040** | **4.076** | **4.101** | **3.775** | **3.786** |
| No. Cavities Poured (four-on gears) | 4 | 4 | 4 | 4 | **4** | **4** | **4** | **4** | **4** |
| No Bake Mold LOI, % 1400°F | 1.24 | 1.23 | 1.17 | 1.49 | **1.25** | **1.39** | **1.23** | **1.52** | **1.68** |
| Pouring Temperature, °F | 2640 | 2638 | 2635 | 2626 | **2636** | **2640** | **2622** | **2636** | **2638** |
| Dog Bone Tensile Strength 30 min., psi | 115.00 | 109.67 | 86.67 | 102.67 | **123.67** | **103.67** | **87.00** | **129** | **82.83** |
| Dog Bone Tensile Strength 2 hrs, psi | 151.00 | 147.83 | 145.00 | 209.67 | **198.33** | **200.33** | **203.67** | **237.33** | **200.50** |
| Dog Bone Tensile Strength 24 hrs, psi | 181.17 | 182.17 | 196.67 | 274.83 | **239.33** | **221.17** | **239.00** | **200.67** | **179.17** |
| Dog Bone Tensile Strength 24 hrs at 90% RH, psi | 61.50 | 61.00 | 62.00 | 64.83 | **64.17** | **107.17** | **105.50** | **73.00** | **85.17** |
| Sand Flow Rate, lbs / 15 seconds | 58.60 | 58.60 | 58.60 | 55.00 | **55.00** | **55.00** | **55.00** | **59.50** | **59.50** |
| (Resin + co-reactant), % BOS | 1.12 | 1.12 | 1.12 | 1.20 | **1.20** | **1.20** | **1.20** | **1.10** | **1.10** |
| Resin, grams | 160.40 | 160.40 | 160.40 | 161.90 | **161.90** | **161.90** | **161.90** | **163.50** | **163.50** |
| Co-reactant, grams | 137.20 | 137.20 | 137.20 | 137.10 | **137.10** | **137.10** | **137.10** | **134.50** | **134.50** |
| Catalyst, BO Resin, grams | 11.50 | 11.50 | 11.50 | 11.40 | **11.40** | **11.40** | **11.40** | **11.70** | **11.70** |
| Total Binder, true % BO(Binder + Sand) | 1.15 | 1.15 | 1.15 | 1.23 | 1.23 | 1.23 | 1.23 | 1.13 | 1.13 |
| Total (Resin + co-reactant), true % BO(Binder + sand) | 1.11 | 1.11 | 1.11 | 1.18 | 1.18 | 1.18 | 1.18 | 1.09 | 1.09 |
| Average Stack Temperature, ºF | - | - | - | - | **105** | **109** | **111** | **97** | **104** |
| Total Moisture Content, % | - | - | - | - | **0.94** | **0.98** | **0.94** | **0.78** | **0.78** |
| Average Stack Velocity, ft./sec. | - | - | - | - | **15.90** | **15.90** | **15.90** | **16.20** | **15.80** |
| Avg. Stack Pressure, in. Hg | - | - | - | - | **30.14** | **30.10** | **30.09** | **30.24** | **30.23** |
| Stack Flow Rate, scfm | - | - | - | - | **697** | **693** | **693** | **727** | **699** |
| Total Hydrocarbon, (Note 4) ppm | - | - | - | - | **144.5** | **128.9** | **142.1** | **133.6** | **134.2** |
| THC variation100*(DG00x-DG(ave.)) / DG(ave) % | - | - | - | - | **9.82** | **-2.04** | **7.99** | **1.53** | **1.99** |

**BO** = Based On **( )** Binder = Resin + Co-reactant + Catalyst

Binder fraction = binder including catalyst(lbs)/(sand + binder including catalyst(lbs)). Binder fraction x mold weight used in mold = Total Binder Weight including catalyst.

Example: (0.6808/(58.6 + 0.6808)) = 0.0114. 0.0114x 332 = 3.785 (lbs binder per mold) 1.1% No Bake resin DG001-013

Example: (0.6637/(58.5 + 0.6637))=0.0112. 0.0112 x 324=3.635 (lbs binder /mold) 1.1% No Bake resin DG018-021

NOTE 1: Casting metal used is Iron. Rebar hangers excluded from casting weight.

NOTE 2: Dog Bone Tensile Strength values are the average of six samples.

NOTE 3: No stack data for tests DG001-004 was recorded, therefore, these tests will not be used for comparisons.

NOTE 4: Test pours DG014 and DG017 were run-outs. DG015, no hangers were installed and DG016 was mfr'd incorrectly.

NOTE 5: Castings DG003, DG007, DG019 and DG020 had shorter than average pour sprues.

NOTE 6: Tests DG018, DG020 and DG021 will not be used in the comparison averages due to LOI, Dogbone tensile strength value, & THC variations.

NOTE 7: Tests in bold type are used for the report comparison.

NOTE 8: DG012 will not be used because there is no LOI data.

## Test DG Process and Source Data

| Description | DG010 | DG011 | DG012 | DG013 | DG014 | DG015 | DG016 | DG017 | DG018 | DG019 | DG020 | DG021 | Average of DG001-021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11/15/00 | 11/15/00 | 11/16/00 | 11/16/00 | 12/26/01 | 12/26/01 | 12/26/01 | 12/26/01 | 12/27/00 | 12/27/00 | 12/27/00 | 12/27/00 | |
| Casting Metal Weight, lbs. (Note 1) | **132** | **134** | 132 | **131** | 124 | - | - | 138 | 133 | **127** | 124 | 136 | 130 |
| Total No Bake Mold Weight, lbs. | **334** | **332** | 330 | **333** | 332 | 327 | - | 327 | 325 | **324** | 314 | 321 | 330 |
| Total Binder Weight including catalyst, lbs | **3.786** | **3.763** | 3.822 | **3.857** | 3.821 | 3.763 | - | 3.763 | 3.646 | **3.634** | 3.522 | 3.601 | 3.814 |
| No. Cavities Poured (four-on gears) | **4** | **4** | 4 | **4** | 4 | 4 | - | 4 | 4 | **4** | 4 | 4 | 4 |
| No Bake Mold LOI, % 1400°F | **1.35** | **1.46** | ND | **1.64** | - | - | - | - | 0.99 | **1.16** | 0.97 | 1.22 | 1.31 |
| Pouring Temperature, °F | **2658** | **2631** | 2628 | **2636** | 2632 | 2636 | - | 2626 | 2622 | **2652** | 2622 | 2640 | 2635 |
| Dog Bone Tensile Strength 30 min., psi | **103.00** | **78.67** | 85.50 | **129.67** | - | - | - | - | 35.83 | **84.67** | 72.50 | 89.83 | 95.29 |
| Dog Bone Tensile Strength 2 hrs, psi | **242.00** | **212.17** | 256.50 | **234.17** | - | - | - | - | 95.17 | **145.33** | 124.83 | 122.83 | 183.92 |
| Dog Bone Tensile Strength 24 hrs, psi | **260.17** | **186.67** | 241.17 | **240.33** | - | - | - | - | 207.50 | **207.00** | 191.67 | 163.83 | 212.50 |
| Dog Bone Tensile Strength 24 hrs at 90% RH, psi | **80.33** | **104.67** | 86.17 | **96.00** | - | - | - | - | 68.83 | **63.67** | 61.83 | 49.00 | 76.17 |
| Sand Flow Rate, lbs / 15 seconds | **59.50** | **59.50** | 59.00 | **59.00** | 58.50 | 58.50 | 58.50 | 58.50 | 58.50 | **58.50** | 58.50 | 58.50 | 58.09 |
| (Resin + co-reactant), % BOS | **1.10** | **1.10** | 1.13 | **1.13** | **1.13** | **1.13** | **1.13** | **1.13** | 1.10 | **1.10** | 1.10 | 1.10 | 1.13 |
| Resin, grams | **163.50** | **163.50** | 161.50 | **161.50** | 162.90 | 162.90 | 162.90 | 162.90 | 156.90 | **156.90** | 156.90 | 156.90 | 161.19 |
| Co-reactant, grams | **134.50** | **134.50** | 140.40 | **140.40** | 136.10 | 136.10 | 136.10 | 136.10 | 134.00 | **134.00** | 134.00 | 134.00 | 136.15 |
| Catalyst, BO Resin, grams | **11.70** | **11.70** | 12.00 | **12.00** | 10.20 | 10.20 | 10.20 | 10.20 | 10.40 | **10.40** | 10.40 | 10.40 | 11.11 |
| Total Binder, true % BO(Binder + Sand) | 1.13 | 1.13 | 1.16 | 1.16 | 1.15 | 1.15 | 1.15 | 1.15 | 1.12 | 1.12 | 1.12 | 1.12 | 1.16 |
| Total (Resin + co-reactant) true% BO(Binder + sand) | 1.09 | 1.09 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.08 | 1.08 | 1.08 | 1.08 | 1.11 |
| Average Stack Temperature, ºF | **107** | **108** | 97 | **101** | 99 | 101 | - | - | 99 | **106** | 111 | 111 | 104 |
| Total Moisture Content, % | **0.89** | **0.97** | 0.74 | **0.79** | 0.92 | 0.97 | - | - | 0.86 | **0.92** | 0.92 | 0.9 | 0.89 |
| Average Stack Velocity, ft./sec. | **16.40** | **16.40** | 15.70 | **15.80** | 15.70 | 15.80 | - | - | 15.70 | **15.80** | 15.90 | 16.40 | 15.95 |
| Avg. Stack Pressure, in. Hg | **30.19** | **30.15** | 30.12 | **30.12** | 30.31 | 30.28 | - | - | 30.35 | **30.30** | 30.31 | 30.26 | 30.21 |
| Stack Flow Rate, scfm | **719** | **718** | 703 | **700** | 702 | 701 | - | - | 703 | **698** | 695 | 718 | 704 |
| Total Hydrocarbon, (Note 4) ppm | **134.3** | **129.4** | - | **127.8** | - | - | - | - | 119.9 | **136.6** | 142.5 | 105.2 | 131.6 |
| THC variation100*(DG00x-DG(ave.))/DG(ave) % | **2.06** | **-1.66** | **-** | **-2.88** | - | - | - | - | **-8.88** | **3.81** | **8.30** | **-20.05** | - |

BO = Based On ( ) Binder = Resin + Co-reactant + Catalyst

Binder fraction = binder including catalyst(lbs)/(sand + binder including catalyst(lbs)). Binder fraction x mold weight used in mold = Total Binder Weight including catalyst.

Example: (0.6808/(58.6 + 0.6808)) = 0.0114. 0.0114x 332 = 3.785 (lbs binder per mold) 1.1% No Bake resin DG001-013

Example: (0..6637/(58.5 + 0.6637)) = 0.0112. 0.0112 x 324 = 3.635 (lbs binder per mold) 1.1% No Bake resin DG018-021

NOTE 1: Casting metal used is Iron. Rebar hangers excluded from casting weight.

NOTE 2: Dog Bone Tensile Strength values are the average of six samples.

NOTE 3: No stack data for tests DG001-004 was recorded, therefore, these tests will not be used for comparisons.

NOTE 4: Test pours DG014 and DG017 were run-outs. DG015, no hangers were installed and DG016 was mfr'd incorrectly.

NOTE 5: Castings DG003, DG007, DG019 and DG020 had shorter than average pour sprues.

NOTE 6: Tests DG018, DG020 and DG021 will not be used in the comparison averages due to LOI, Dogbone tensile strength value, & THC variations.

NOTE 7: Tests in bold type are used for the report comparison.

NOTE 8: DG012 will not be used because there is no LOI data.

## Test DZ Process and Source Data

| Description | DZ001 | DZ002 | DZ003 | DZ004 | DZ005 | DZ006 | DZ007 | DZ008 | DZ009 | DZ010 | DZ011 | Averages | Averages |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/31/01 | 1/31/01 | 1/31/01 | 1/31/01 | 2/1/01 | 2/1/01 | 2/1/01 | 3/6/01 | 3/6/01 | 3/6/01 | 3/6/01 | all | for Report |
| Casting Metal Weight, lbs. (Note 1) | N/D | 148 | 130 | 145 | 140 | 134 | Note 6 | 134 | 140 | 143 | 141 | 139 | 140 |
| Total No Bake Mold Weight, lbs. | 443 | 448 | 449 | 446 | 366 | 371 | 318 | 401 | 409 | 401 | 402 | 405 | 403 |
| Total Binder Weight including catalyst, lbs | 7.078 | 7.158 | 7.173 | 7.126 | 5.831 | 5.910 | 5.066 | 6.415 | 6.543 | 6.415 | 6.431 | 6.47 | 6.45 |
| No. Cavities Poured (four-on gear) | N/D | 4 | 4 | 4 | 4 | 4 | - | 4 | 4 | 4 | 4 | 4 | 4 |
| No Bake Mold LOI, % 1400°F | 1.54 | 1.54 | 1.55 | 1.53 | 1.60 | 1.59 | 1.34 | 1.03 | 1.05 | 1.01 | 0.86 | 1.33 | 0.99 |
| Pouring Temperature, °F | 2640 | 2640 | 2637 | 2620 | 2630 | 2633 | 2635 | 2638 | 2621 | 2641 | 2634 | 2634 | 2634 |
| Dog Bone Tensile Strength 30 min., psi | 26 | 40 | 41 | 38 | 30 | 43 | 37 | 21 | 27 | 28 | 21 | 32 | 24 |
| Dog Bone Tensile Strength 2 hrs, psi | 66 | 73 | 80 | 84 | ND | ND | ND | 35 | 42 | 43 | 44 | 58 | 41 |
| Dog Bone Tensile Strength 24 hrs, psi | 102 | 117 | 110 | 106 | 117 | 118 | 94 | N/D | N/D | N/D | N/D | 109 | N/D |
| Dog Bone Tensile Strength 24 hrs at 90% RH, psi | 87 | 68 | 70 | 82 | 91 | 84 | 64 | N/D | N/D | N/D | N/D | 78 | N/D |
| Sand Flow Rate, lbs / 15 seconds | 48.50 | 48.50 | 48.50 | 48.50 | 47.50 | 47.50 | 47.50 | 47.20 | 47.20 | 47.20 | 47.20 | 47.75 | 47.20 |
| Resin, % BOS | 1.30 | 1.30 | 1.30 | 1.30 | 1.29 | 1.29 | 1.29 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 |
| Resin, grams | 286.00 | 286.00 | 286.00 | 286.00 | 278.70 | 278.70 | 278.70 | 278.50 | 278.50 | 278.50 | 278.50 | 281.28 | 278.50 |
| Co-reactant, grams | 71.50 | 71.50 | 71.50 | 71.50 | 70.40 | 70.40 | 70.40 | 69.90 | 69.90 | 69.90 | 69.90 | 70.62 | 69.90 |
| Catalyst (contained in Co-reactant) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0 |
| Co-reactant, BO Resin, % | 25.0 | 25.0 | 25.0 | 25.0 | 25.3 | 25.3 | 25.3 | 25.1 | 25.1 | 25.1 | 25.1 | 25.11 | 25.10 |
| Total Binder, true %(BO(resin + co-reactant + sand)) | 1.60 | 1.60 | 1.60 | 1.60 | 1.59 | 1.59 | 1.59 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 |
| Total Resin, true %(BO( resin + coreactant + sand)) | 1.28 | 1.28 | 1.28 | 1.28 | 1.27 | 1.27 | 1.27 | 1.28 | 1.28 | 1.28 | 1.28 | 1.28 | 1.28 |
| | | | | | | | | | | | | | |
| Average Stack Temperature, °F | - | 98 | 102 | 100 | 99 | 102 | - | 98 | 103 | 107 | 109 | 102 | 104 |
| Total Moisture Content, % | - | 0.74 | 0.76 | 0.76 | 0.76 | 0.77 | - | 1.27 | 1.32 | 1.38 | 1.44 | 1.02 | 1.35 |
| Average Stack Velocity, ft./sec. | - | 15.7 | 15.8 | 16.0 | 15.7 | 16.0 | - | 15.8 | 16.2 | 16.0 | 16.0 | 15.9 | 16.0 |
| Avg. Stack Pressure, in. Hg | - | 30.33 | 30.33 | 30.26 | 30.35 | 30.39 | - | 29.87 | 29.92 | 29.92 | 29.94 | 30.15 | 29.91 |
| Stack Flow Rate, scfm | - | 705 | 702 | 714 | 704 | 714 | - | 696 | 705 | 690 | 689 | 702 | 695 |

Binder = Resin + Co-reactant BO = Based on ()

Total binder weight including catalyst = Binder weight per lb of sand x Total No Bake mold weight.

Binder weight per lb of sand = (Binder (parts 1&2) (gms) / 454 (gms/lb)) / (binder (parts 1&2) (gms) / 454 (gms/lbs) + sand(lbs)).

Example: (0.7875)(lbs Binder)) / (0.7875 (lbs Binder) + 48.50 (lbs sand)) = 0.0160 (lbs binder / lb of sand). 0.0160 x 443 = 7.078 (lbs binder per mold) 1.3% No Bake resin EB001- 011

NOTE 1: Casting metal used is Iron.

NOTE 2: Dog Bone Tensile Strength values are the average of six samples.

NOTE 3: ND means no data available.

NOTE: 4 DZ001-004 mold height is 14" (7" cope & drag), DZ005-006 mold height is 12" (5" cope and 7" drag) and new tooling pattern was used. All were dis-qualified due to mold weight and height.

NOTE: 5 Test DZ001 was stopped due to run-out.

NOTE: 7 All mold copes had to be pried loose of the castings, using a pry bar, at the conclusion of the test.

NOTE: 8 Tests DZ001-007and DZ010-011 @ 1400°F; DZ008-009 @ 1050°F. Method changed to eliminate carbonate decomposition error factor. Duplicate runs at 1050°F and 1400°F were the same ± 1%.

NOTE 9: Total binder weight variation is caused by mold height variation. See NOTE 4.

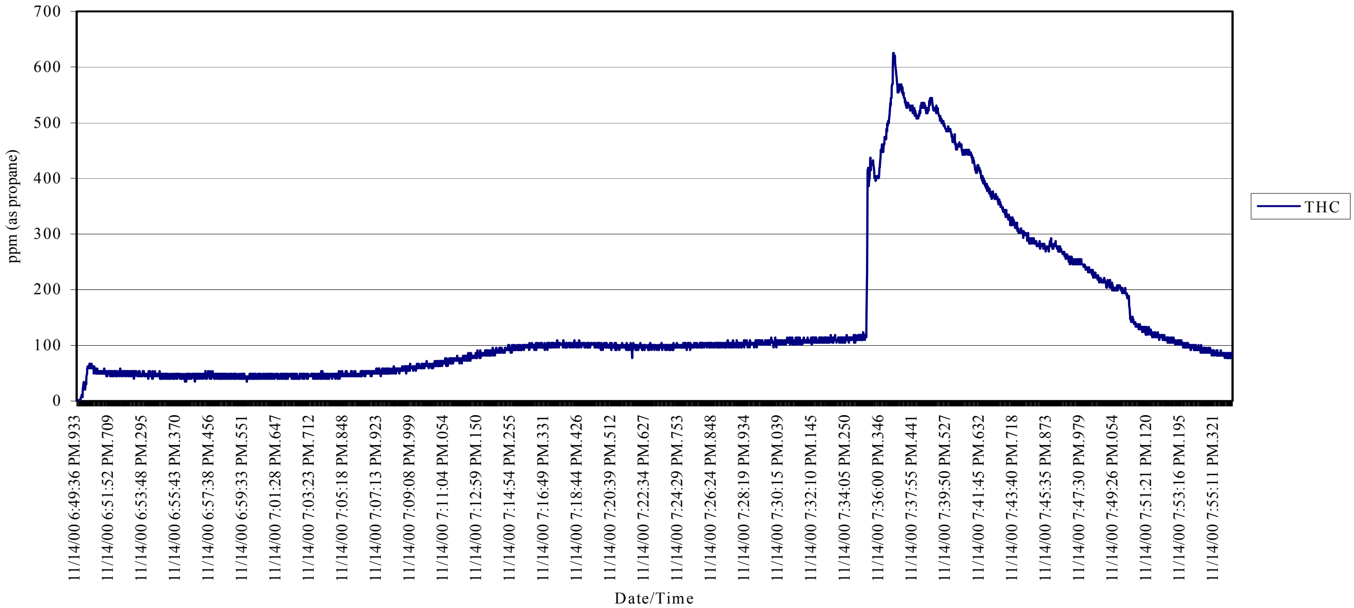
NOTE 10: DZ008-011. Different batch of resin which had less LOI content than as received. Tests are usable but the LOI content is different than the test plan.

THIS PAGE INTENTIONALLY LEFT BLANK

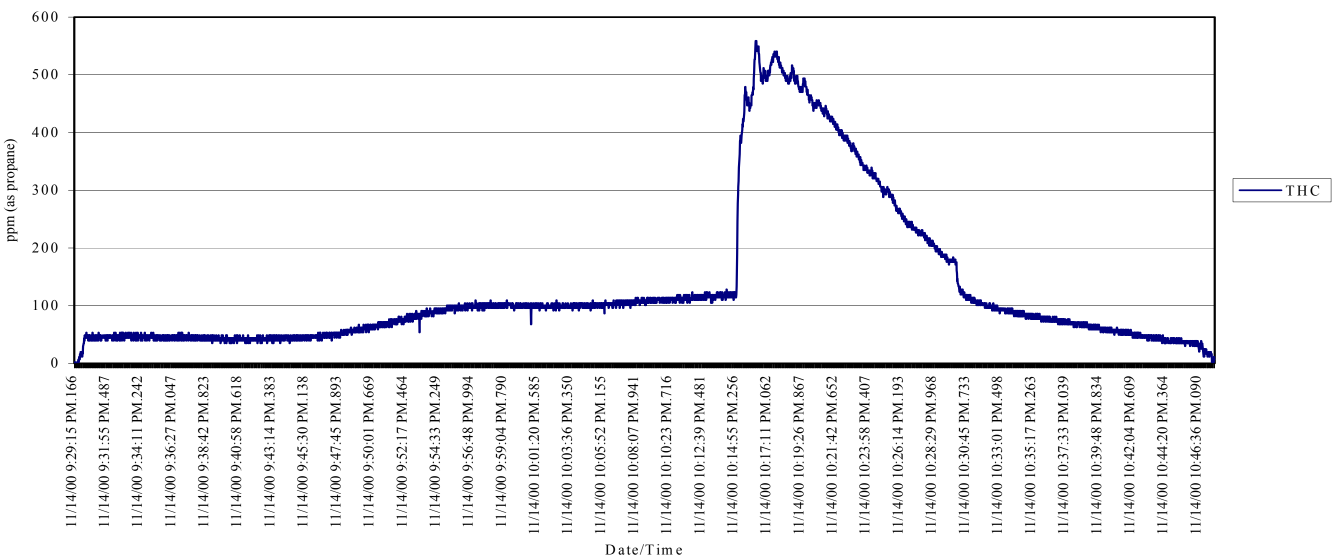
# APPENDIX D METHOD 25A CHARTS

THIS PAGE INTENTIONALLY LEFT BLANK

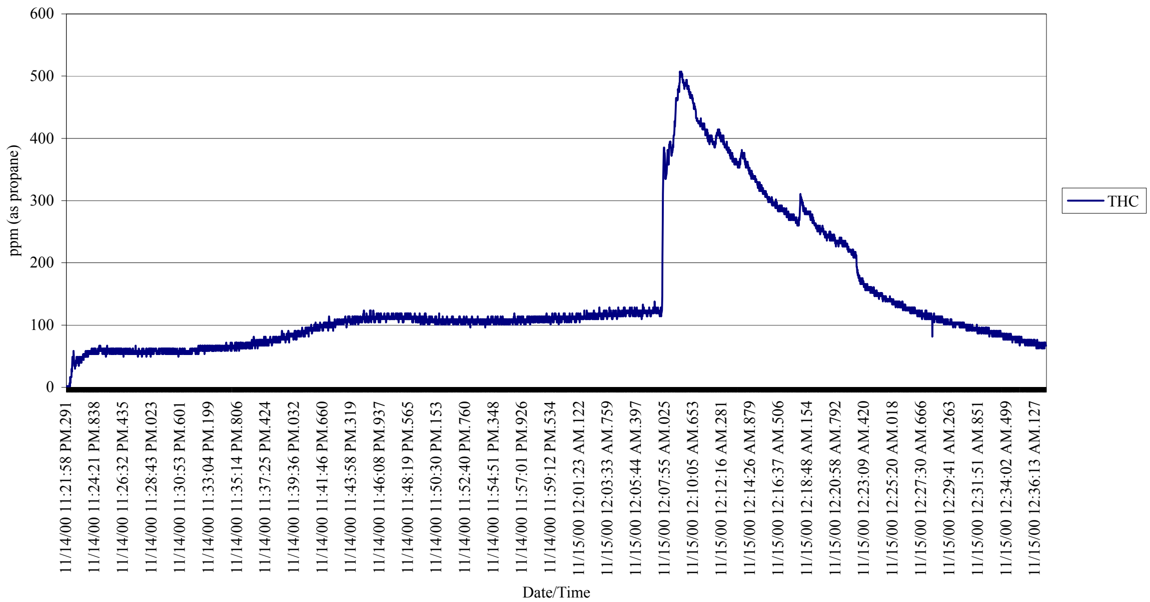
DG005


700
600
500
400
300
200
100
0
ppm (as propane)
THC
Date/Time

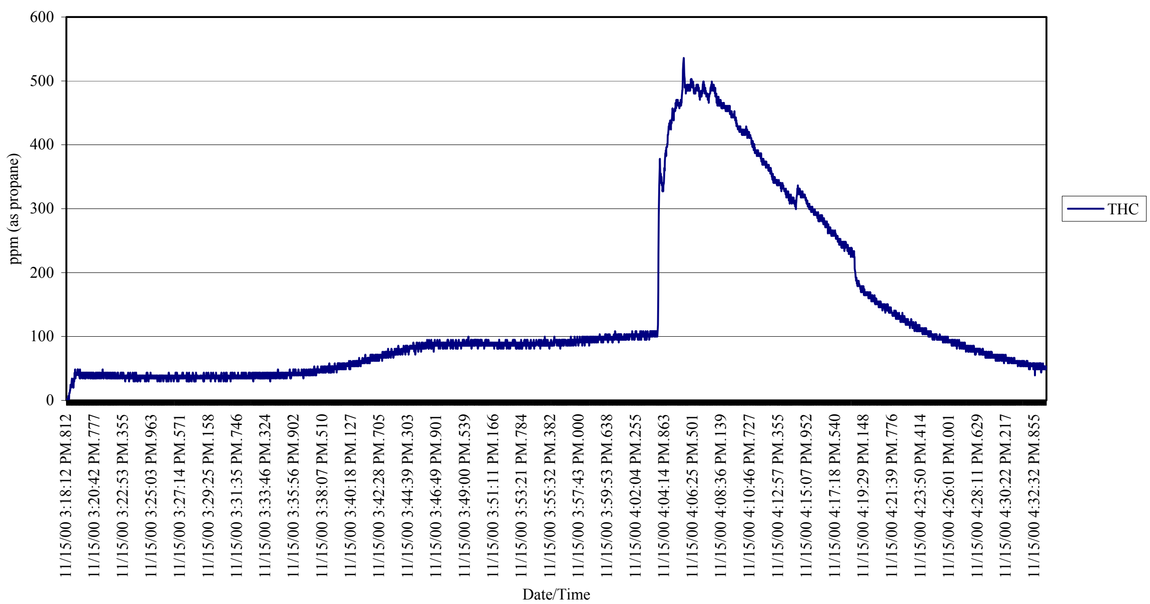
DG006


600
500
400
300
200
100
0
ppm (as propane)
THC
Date/Time

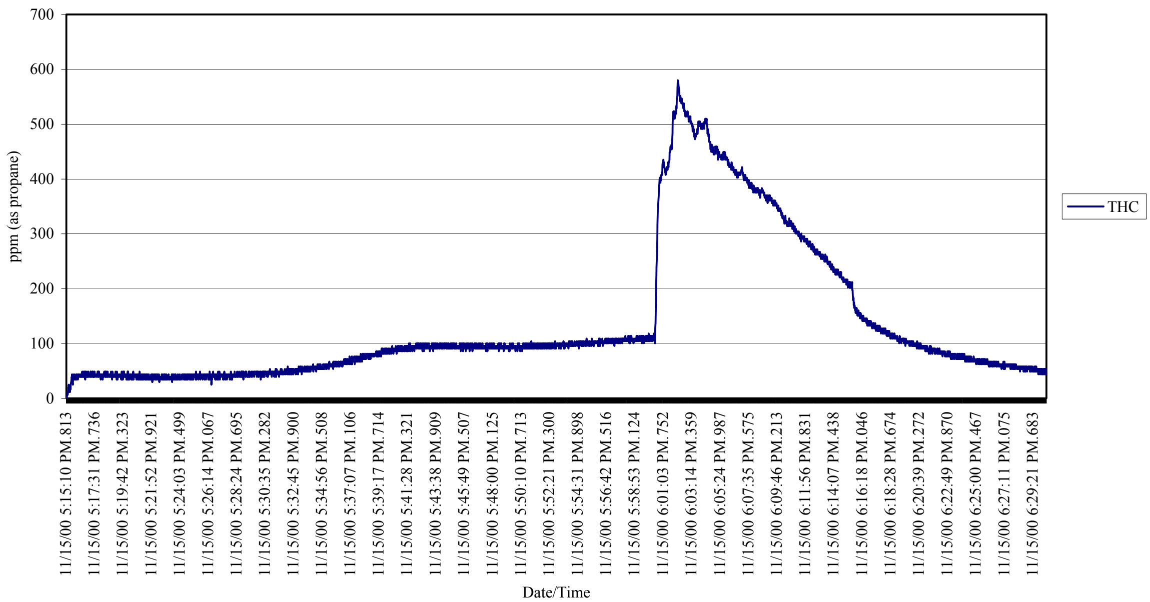
## DG007


600
500
400
300
200
100
0
ppm (as propane)
THC
11/14/00 11:21:58 PM.291
11/14/00 11:24:21 PM.838
11/14/00 11:26:32 PM.435
11/14/00 11:28:43 PM.023
11/14/00 11:30:53 PM.601
11/14/00 11:33:04 PM.199
11/14/00 11:35:14 PM.806
11/14/00 11:37:25 PM.424
11/14/00 11:39:36 PM.032
11/14/00 11:41:46 PM.660
11/14/00 11:43:58 PM.319
11/14/00 11:46:08 PM.937
11/14/00 11:48:19 PM.565
11/14/00 11:50:30 PM.153
11/14/00 11:52:40 PM.760
11/14/00 11:54:51 PM.348
11/14/00 11:57:01 PM.926
11/14/00 11:59:12 PM.534
11/15/00 12:01:23 AM.122
11/15/00 12:03:33 AM.759
11/15/00 12:05:44 AM.397
11/15/00 12:07:55 AM.025
11/15/00 12:10:05 AM.653
11/15/00 12:12:16 AM.281
11/15/00 12:14:26 AM.879
11/15/00 12:16:37 AM.506
11/15/00 12:18:48 AM.154
11/15/00 12:20:58 AM.792
11/15/00 12:23:09 AM.420
11/15/00 12:25:20 AM.018
11/15/00 12:27:30 AM.666
11/15/00 12:29:41 AM.263
11/15/00 12:31:51 AM.851
11/15/00 12:34:02 AM.499
11/15/00 12:36:13 AM.127
Date/Time

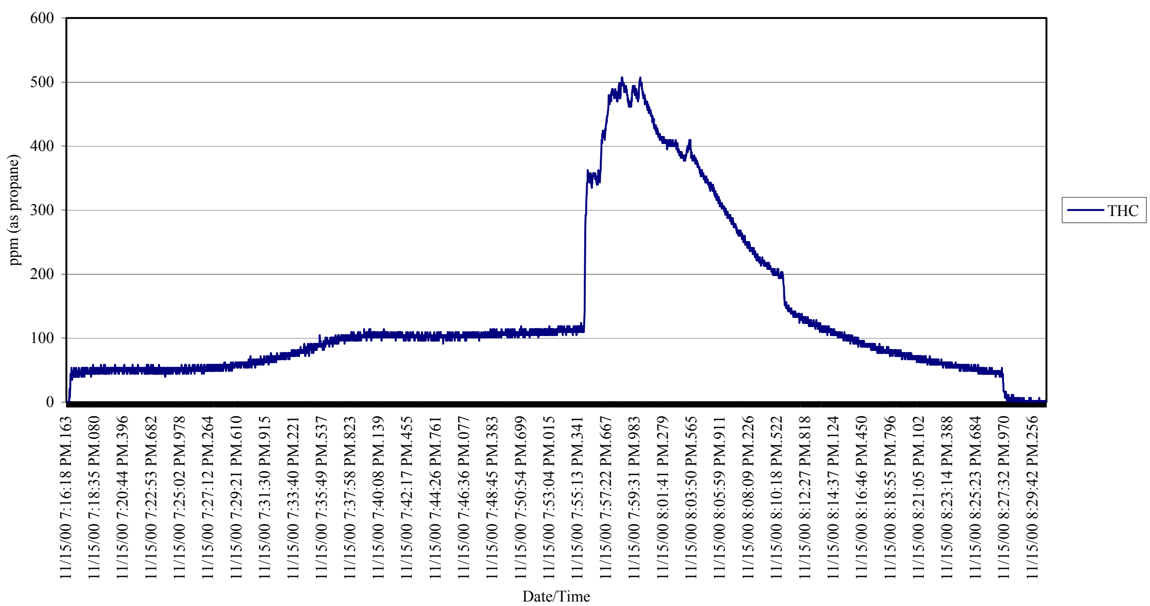
## DG008


600
500
400
300
200
100
0
ppm (as propane)
THC
11/15/00 3:18:12 PM.812
11/15/00 3:20:42 PM.777
11/15/00 3:22:53 PM.355
11/15/00 3:25:03 PM.963
11/15/00 3:27:14 PM.571
11/15/00 3:29:25 PM.158
11/15/00 3:31:35 PM.746
11/15/00 3:33:46 PM.324
11/15/00 3:35:56 PM.902
11/15/00 3:38:07 PM.510
11/15/00 3:40:18 PM.127
11/15/00 3:42:28 PM.705
11/15/00 3:44:39 PM.303
11/15/00 3:46:49 PM.901
11/15/00 3:49:00 PM.539
11/15/00 3:51:11 PM.166
11/15/00 3:53:21 PM.784
11/15/00 3:55:32 PM.382
11/15/00 3:57:43 PM.000
11/15/00 3:59:53 PM.638
11/15/00 4:02:04 PM.255
11/15/00 4:04:14 PM.863
11/15/00 4:06:25 PM.501
11/15/00 4:08:36 PM.139
11/15/00 4:10:46 PM.727
11/15/00 4:12:57 PM.355
11/15/00 4:15:07 PM.952
11/15/00 4:17:18 PM.540
11/15/00 4:19:29 PM.148
11/15/00 4:21:39 PM.776
11/15/00 4:23:50 PM.414
11/15/00 4:26:01 PM.001
11/15/00 4:28:11 PM.629
11/15/00 4:30:22 PM.217
11/15/00 4:32:32 PM.855
Date/Time

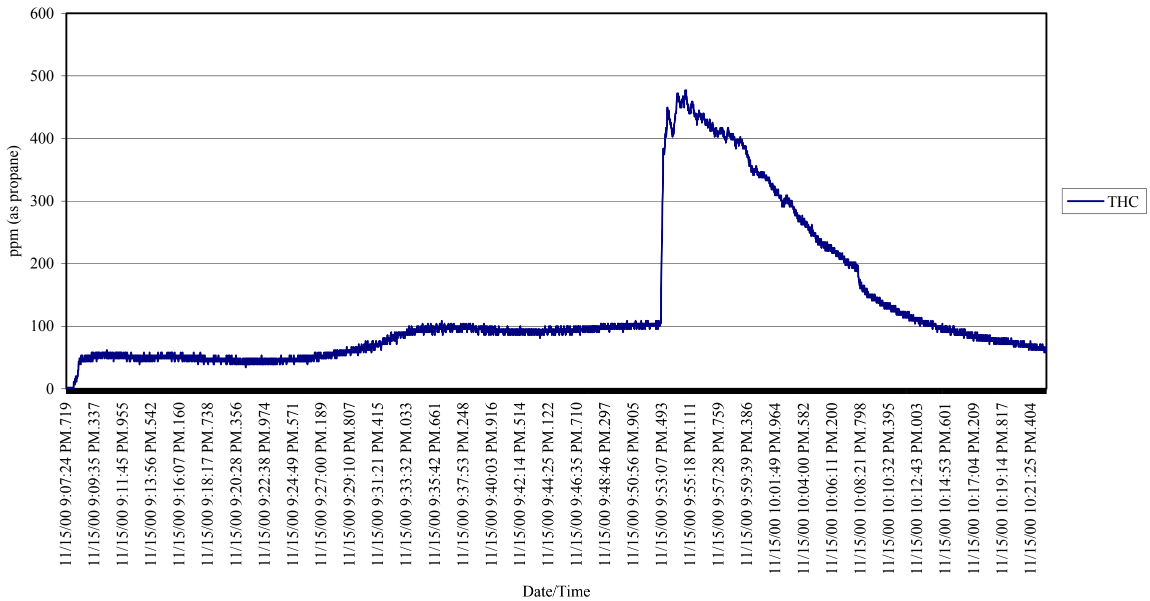
## DG009


700
600
500
400
300
200
100
0
ppm (as propane)
THC
11/15/00 5:15:10 PM.813
11/15/00 5:17:31 PM.736
11/15/00 5:19:42 PM.323
11/15/00 5:21:52 PM.921
11/15/00 5:24:03 PM.499
11/15/00 5:26:14 PM.067
11/15/00 5:28:24 PM.695
11/15/00 5:30:35 PM.282
11/15/00 5:32:45 PM.900
11/15/00 5:34:56 PM.508
11/15/00 5:37:07 PM.106
11/15/00 5:39:17 PM.714
11/15/00 5:41:28 PM.321
11/15/00 5:43:38 PM.909
11/15/00 5:45:49 PM.507
11/15/00 5:48:00 PM.125
11/15/00 5:50:10 PM.713
11/15/00 5:52:21 PM.300
11/15/00 5:54:31 PM.898
11/15/00 5:56:42 PM.516
11/15/00 5:58:53 PM.124
11/15/00 6:01:03 PM.752
11/15/00 6:03:14 PM.359
11/15/00 6:05:24 PM.987
11/15/00 6:07:35 PM.575
11/15/00 6:09:46 PM.213
11/15/00 6:11:56 PM.831
11/15/00 6:14:07 PM.438
11/15/00 6:16:18 PM.046
11/15/00 6:18:28 PM.674
11/15/00 6:20:39 PM.272
11/15/00 6:22:49 PM.870
11/15/00 6:25:00 PM.467
11/15/00 6:27:11 PM.075
11/15/00 6:29:21 PM.683
Date/Time

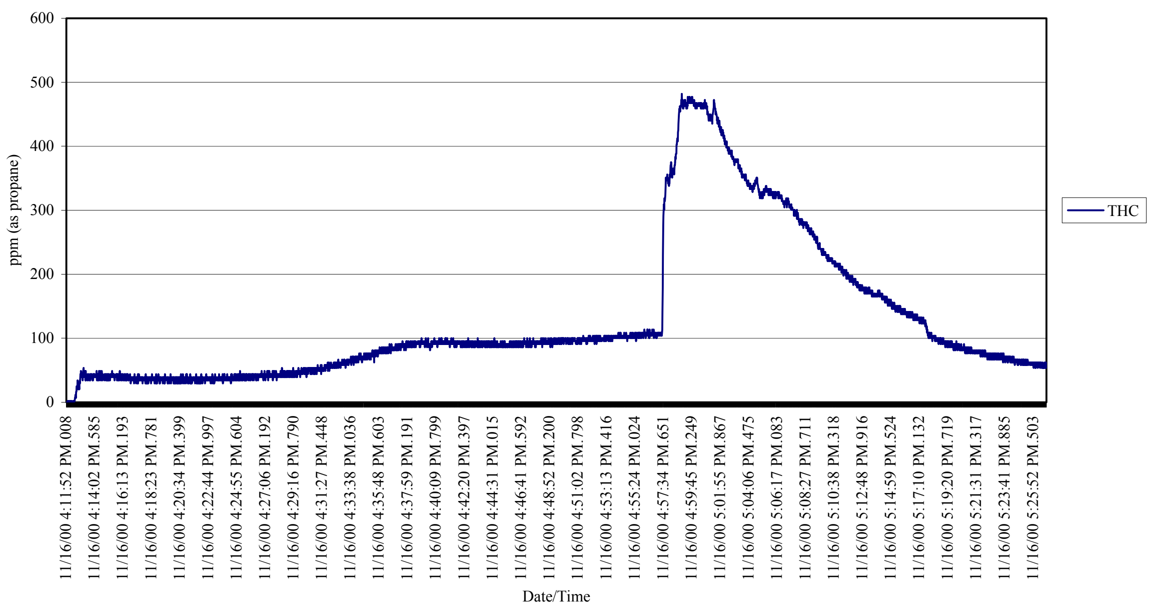
## DG010


600
500
400
300
200
100
0
ppm (as propane)
THC
11/15/00 7:16:18 PM.163
11/15/00 7:18:35 PM.080
11/15/00 7:20:44 PM.396
11/15/00 7:22:53 PM.682
11/15/00 7:25:02 PM.978
11/15/00 7:27:12 PM.264
11/15/00 7:29:21 PM.610
11/15/00 7:31:30 PM.915
11/15/00 7:33:40 PM.221
11/15/00 7:35:49 PM.537
11/15/00 7:37:58 PM.823
11/15/00 7:40:08 PM.139
11/15/00 7:42:17 PM.455
11/15/00 7:44:26 PM.761
11/15/00 7:46:36 PM.077
11/15/00 7:48:45 PM.383
11/15/00 7:50:54 PM.699
11/15/00 7:53:04 PM.015
11/15/00 7:55:13 PM.341
11/15/00 7:57:22 PM.667
11/15/00 7:59:31 PM.983
11/15/00 8:01:41 PM.279
11/15/00 8:03:50 PM.565
11/15/00 8:05:59 PM.911
11/15/00 8:08:09 PM.226
11/15/00 8:10:18 PM.522
11/15/00 8:12:27 PM.818
11/15/00 8:14:37 PM.124
11/15/00 8:16:46 PM.450
11/15/00 8:18:55 PM.796
11/15/00 8:21:05 PM.102
11/15/00 8:23:14 PM.388
11/15/00 8:25:23 PM.684
11/15/00 8:27:32 PM.970
11/15/00 8:29:42 PM.256
Date/Time

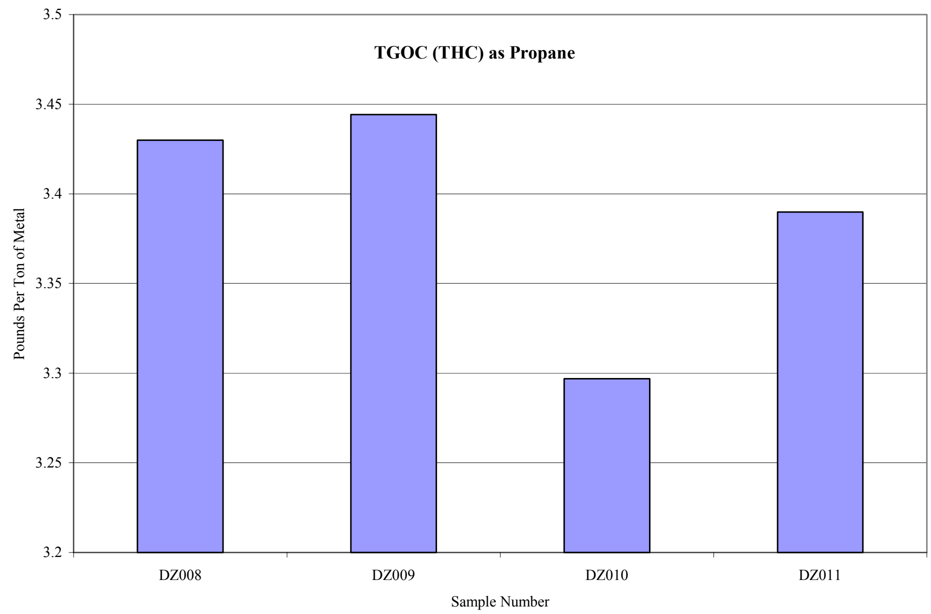
## DG011


600
500
400
300
200
100
0
ppm (as propane)
THC
11/15/00 9:07:24 PM.719
11/15/00 9:09:35 PM.337
11/15/00 9:11:45 PM.955
11/15/00 9:13:56 PM.542
11/15/00 9:16:07 PM.160
11/15/00 9:18:17 PM.738
11/15/00 9:20:28 PM.356
11/15/00 9:22:38 PM.974
11/15/00 9:24:49 PM.571
11/15/00 9:27:00 PM.189
11/15/00 9:29:10 PM.807
11/15/00 9:31:21 PM.415
11/15/00 9:33:32 PM.033
11/15/00 9:35:42 PM.661
11/15/00 9:37:53 PM.248
11/15/00 9:40:03 PM.916
11/15/00 9:42:14 PM.514
11/15/00 9:44:25 PM.122
11/15/00 9:46:35 PM.710
11/15/00 9:48:46 PM.297
11/15/00 9:50:56 PM.905
11/15/00 9:53:07 PM.493
11/15/00 9:55:18 PM.111
11/15/00 9:57:28 PM.759
11/15/00 9:59:39 PM.386
11/15/00 10:01:49 PM.964
11/15/00 10:04:00 PM.582
11/15/00 10:06:11 PM.200
11/15/00 10:08:21 PM.798
11/15/00 10:10:32 PM.395
11/15/00 10:12:43 PM.003
11/15/00 10:14:53 PM.601
11/15/00 10:17:04 PM.209
11/15/00 10:19:14 PM.817
11/15/00 10:21:25 PM.404
Date/Time

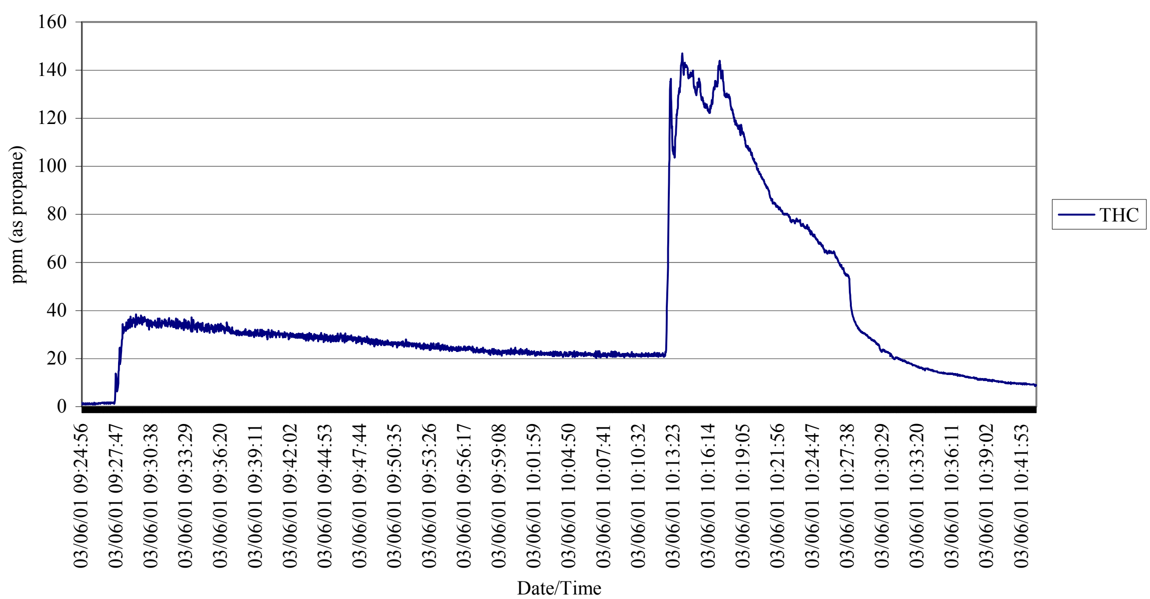
## DG013

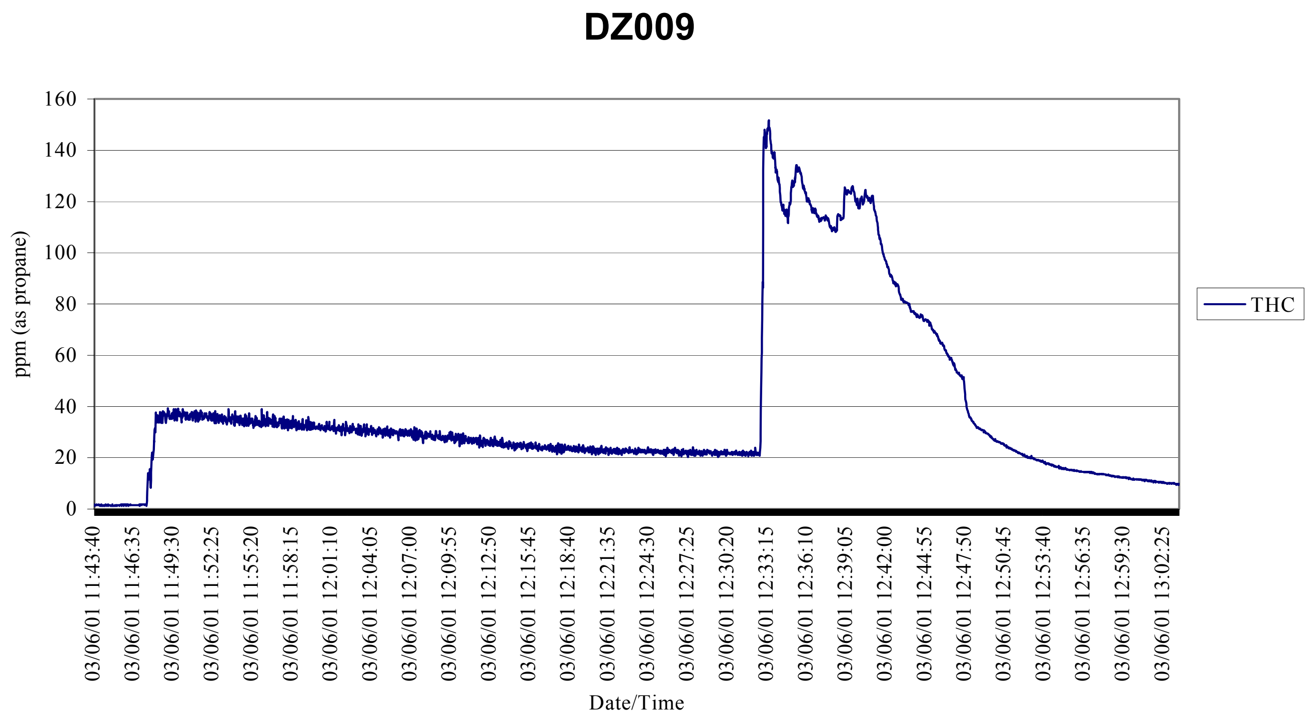

600
500
400
300
200
100
0
ppm (as propane)
THC
11/16/00 4:11:52 PM.008
11/16/00 4:14:02 PM.585
11/16/00 4:16:13 PM.193
11/16/00 4:18:23 PM.781
11/16/00 4:20:34 PM.399
11/16/00 4:22:44 PM.997
11/16/00 4:24:55 PM.604
11/16/00 4:27:06 PM.192
11/16/00 4:29:16 PM.790
11/16/00 4:31:27 PM.448
11/16/00 4:33:38 PM.036
11/16/00 4:35:48 PM.603
11/16/00 4:37:59 PM.191
11/16/00 4:40:09 PM.799
11/16/00 4:42:20 PM.397
11/16/00 4:44:31 PM.015
11/16/00 4:46:41 PM.592
11/16/00 4:48:52 PM.200
11/16/00 4:51:02 PM.798
11/16/00 4:53:13 PM.416
11/16/00 4:55:24 PM.024
11/16/00 4:57:34 PM.651
11/16/00 4:59:45 PM.249
11/16/00 5:01:55 PM.867
11/16/00 5:04:06 PM.475
11/16/00 5:06:17 PM.083
11/16/00 5:08:27 PM.711
11/16/00 5:10:38 PM.318
11/16/00 5:12:48 PM.916
11/16/00 5:14:59 PM.524
11/16/00 5:17:10 PM.132
11/16/00 5:19:20 PM.719
11/16/00 5:21:31 PM.317
11/16/00 5:23:41 PM.885
11/16/00 5:25:52 PM.503
Date/Time

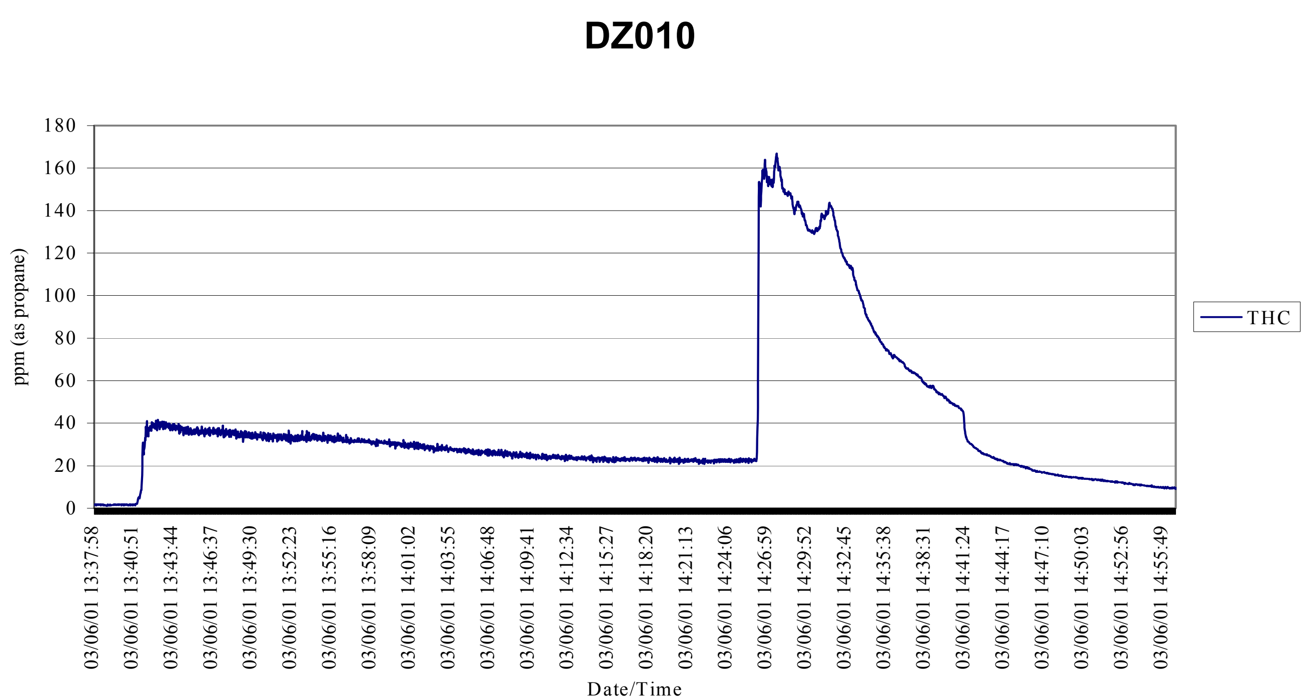
## Test Series DZ - TGOC (THC) as Propane

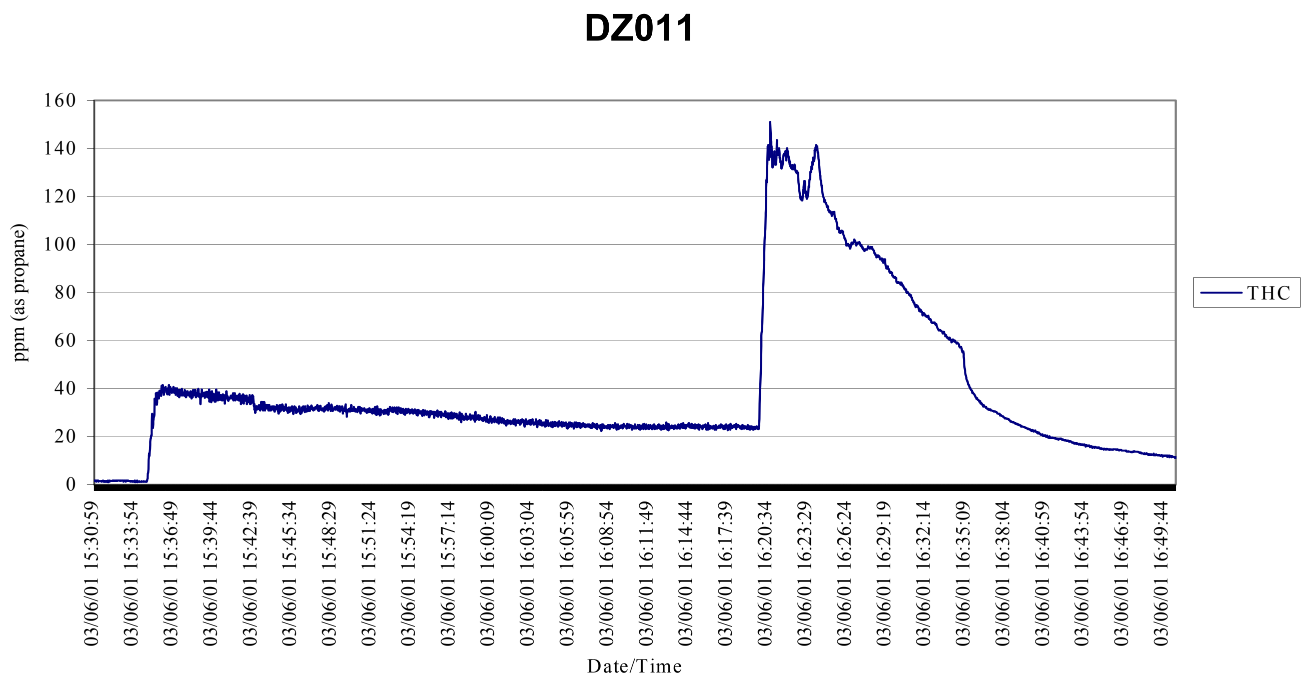



## DZ008




DZ009
160
140
120
100
80
60
40
20
0
ppm (as propane)
THC
03/06/01 11:43:40
03/06/01 11:46:35
03/06/01 11:49:30
03/06/01 11:52:25
03/06/01 11:55:20
03/06/01 11:58:15
03/06/01 12:01:10
03/06/01 12:04:05
03/06/01 12:07:00
03/06/01 12:09:55
03/06/01 12:12:50
03/06/01 12:15:45
03/06/01 12:18:40
03/06/01 12:21:35
03/06/01 12:24:30
03/06/01 12:27:25
03/06/01 12:30:20
03/06/01 12:33:15
03/06/01 12:36:10
03/06/01 12:39:05
03/06/01 12:42:00
03/06/01 12:44:55
03/06/01 12:47:50
03/06/01 12:50:45
03/06/01 12:53:40
03/06/01 12:56:35
03/06/01 12:59:30
03/06/01 13:02:25
Date/Time


DZ010
180
160
140
120
100
80
60
40
20
0
ppm (as propane)
THC
03/06/01 13:37:58
03/06/01 13:40:51
03/06/01 13:43:44
03/06/01 13:46:37
03/06/01 13:49:30
03/06/01 13:52:23
03/06/01 13:55:16
03/06/01 13:58:09
03/06/01 14:01:02
03/06/01 14:03:55
03/06/01 14:06:48
03/06/01 14:09:41
03/06/01 14:12:34
03/06/01 14:15:27
03/06/01 14:18:20
03/06/01 14:21:13
03/06/01 14:24:06
03/06/01 14:26:59
03/06/01 14:29:52
03/06/01 14:32:45
03/06/01 14:35:38
03/06/01 14:38:31
03/06/01 14:41:24
03/06/01 14:44:17
03/06/01 14:47:10
03/06/01 14:50:03
03/06/01 14:52:56
03/06/01 14:55:49
Date/Time


DZ011
ppm (as propane)
160
140
120
100
80
60
40
20
0
THC
03/06/01 15:30:59
03/06/01 15:33:54
03/06/01 15:36:49
03/06/01 15:39:44
03/06/01 15:42:39
03/06/01 15:45:34
03/06/01 15:48:29
03/06/01 15:51:24
03/06/01 15:54:19
03/06/01 15:57:14
03/06/01 16:00:09
03/06/01 16:03:04
03/06/01 16:05:59
03/06/01 16:08:54
03/06/01 16:11:49
03/06/01 16:14:44
03/06/01 16:17:39
03/06/01 16:20:34
03/06/01 16:23:29
03/06/01 16:26:24
03/06/01 16:29:19
03/06/01 16:32:14
03/06/01 16:35:09
03/06/01 16:38:04
03/06/01 16:40:59
03/06/01 16:43:54
03/06/01 16:46:49
03/06/01 16:49:44
Date/Time

THIS PAGE INTENTIONALLY LEFT BLANK

# APPENDIX E LISTING OF SUPPORT DOCUMENTS

THIS PAGE INTENTIONALLY LEFT BLANK

# Listing of Support Documents

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

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

2. Technikon Emissions Testing and Analytical Testing Standard Operating Procedures.

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

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

THIS PAGE INTENTIONALLY LEFT BLANK

# APPENDIX F GLOSSARY

THIS PAGE INTENTIONALLY LEFT BLANK

# Glossary

**t-Test** The calculated T statistic, Ts, is compared against a table value. The table value is a function of the sample size and on the level of confidence desired. For tests with nine sample values each, the T value associated with a confidence level of 95% is 2.12. Calculated values of Ts greater than or equal to this value would indicate that there is 95% or better probability that the differences between the two test series were not the result of test variability.

**ND** Non Detect, No Data

**NT** Lab testing was not done on this analyte.

**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.

**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.

**LOI** Loss of Ignition. LOI represents the change in weight of a sample expressed as % of the original dry weight as a consequence of combustion in air at the test temperature of 1400˚F

**Binder** Part 1 plus Part 2 plus Part 3

**Resin** Part 1

**Co-Reactant** Part 2

**Catalyst** Part 3

**BO** Based On ( )

**BOS** Based On Sand