Casting Emission Reduction Program

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Core Room Comparison of Emissions from a Standard Binder and a Naphthalene Depleted Solvent Binder System

Technikon Test #1409-118 FD

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Core Room Comparison of Emissions from a Standard Binder and a Naphthalene Depleted Solvent Binder System

Technikon Test #1409-118 FD

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

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

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Executive Summary

This report contains the results of Volatile Organic Compound (VOC) and Hazardous Air Pollutant (HAP) emission testing during phenolic urethane Cold Box core making. These data are compared to Test EQ, the phenolic urethane Cold Box core-making baseline. All testing was conducted in the Technikon, LLC Production foundry core making facility. The results show that the use of "naphthalene depleted" solvent does not reduce the total HAP emissions.

The test was divided into two segments, core blowing, and core storage. During the core-blowing portion of the test, the gassing and purge emissions and the "fugitive" emissions were measured together. The storage emissions represent the VOCs and HAPs released to the environment from the time of core removal from the core box until the core is used to produce a casting. For this study, a five (5) hour storage time was established. All components of mold making were conducted within enclosures meeting the criteria for a temporary total enclosure (TTE) as specified in US EPA Method 204.

For Test FD, each test segment consisted of six (6) replicate runs at 1.75% binder (BOS). The baseline Test EQ consisted of nine (9) replicate runs at 1.75% binder (BOS). Samples for selected VOCs and HAPs were collected on sorbent tubes during each run for subsequent laboratory analysis in accordance with US-EPA Method 18. All sampling locations were consistent with US EPA Method 1 except for core storage. The storage segment of the test used a laminar flow-through enclosure to sweep all of the emissions to the Method 18 sampling manifold. US EPA Method 25A, Total Gaseous Organic Concentration (TGOC), was used to monitor all segments of the test, but was not reported due to the predominance of the triethylamine catalyst.

The tables below summarize the results for each of the test segments in lbs/lb of binder and lbs/ton sand respectively.

Tests FD and EQ Average Emissions Results Comparison – Lb/Lb Binder

Analyte	Making		Storage		Total	
	FD	EQ	FD	EQ	FD	EQ
HC as Hexane	0.1349	0.0752	0.0369	0.0171	0.1718	0.0923
Sum of VOCs	0.0018	0.0014	0.0007	0.0008	0.0025	0.0022
Sum of HAPs	0.0018	0.0014	0.0007	0.0008	0.0025	0.0022
Sum of POMs	0.0009	0.0010	0.0006	0.0007	0.0015	0.0018

NA = Not Applicable **ND** = Not Detected. TGOC measures all carbon-containing organic compounds.

Tests FD and EQ Average Emissions Results Comparison – Lb/Tn Sand

Analyte	Making		Storage		Total	
	FD	EQ	FD	EQ	FD	EQ
HC as Hexane	4.628	2.719	1.260	0.6006	5.889	3.3197
Sum of VOCs	0.0605	0.0501	0.0236	0.0264	0.0841	0.0765
Sum of HAPs	0.0605	0.0501	0.0236	0.0264	0.0841	0.0765
Sum of POMs	0.0310	0.0365	0.0213	0.0258	0.0524	0.0623

NA = Not Applicable ND = Not Detected. TGOC measures all carbon-containing organic compounds.

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 (USEPA); and the California Air Resources Board (CARB).

1.2 Technikon Objectives

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

The Production Foundry provides simultaneous detailed individual emission measurements using methods based on USEPA protocols for the melting, pouring, sand preparation, mold making, and core making processes. The core making area of the Production foundry contains three core blowers, a Georg Fischer for the preparation of automotive block cores, a Redford/Carver that is used for the production of step cores, and a second smaller Redford/Carver to produce dogbone tensile test specimens.

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

1.3 Report Organization

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

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

1.4 Specific Test Plan and Objectives

This report contains the results of testing performed to provide data on selected VOC emissions from the core making process of two different binder systems. Table 1-1 provides a summary of the test plans for the mixing, core making, and storage phase. The details of the approved test plans are included in Appendix A.

Table 1-1 Test Plan Summary

	Test FD	Test EQ
Type of Process Tested	Core Making Emissions Study	Core Making Emissions Baseline
Test Plan Number	1409-118	1409-123
Binder System	Phenolic Urethane Cold Box Ashland ISOCURE® LF305/52-905GR (naphthalene depleted solvent system)	Phenolic Urethane Cold Box Ashland ISOCURE® LF305/52-904GR (standard solvent system)
Number of test runs	6 each at core blowing and core * storage at 1.75% binder level	9 each at core blowing and core storage at 1.75% binder level
Test Date	6/4/03 > 6/6/03	8/19/02 > 9/13/02
Emissions Measured	TGOC as Propane, HC as Hexane, Naphthalene, O-Cresols, Phenol, Formaldehyde	TGOC as Propane, HC as Hexane, Naphthalene, O-Cresol, Phenol, Formaldehyde
Process Parameters Measured	Sand and Binder Weights; Incoming Sand Temperature; Sand Mixing Time; Core Machine Cycle Time; Temperature & Pressure; Storage Time & Temperature	Sand and Binder Weights; Incoming Sand Temperature; Sand Mixing Time; Core Machine Cycle Time; Temperature & Pressure; Storage Time & Temperature
Source Parameters Measured	Exhaust Duct Temperature, Pressure, and Volumetric Flow Rate	Exhaust Duct Temperature, Pressure, and Volumetric Flow Rate

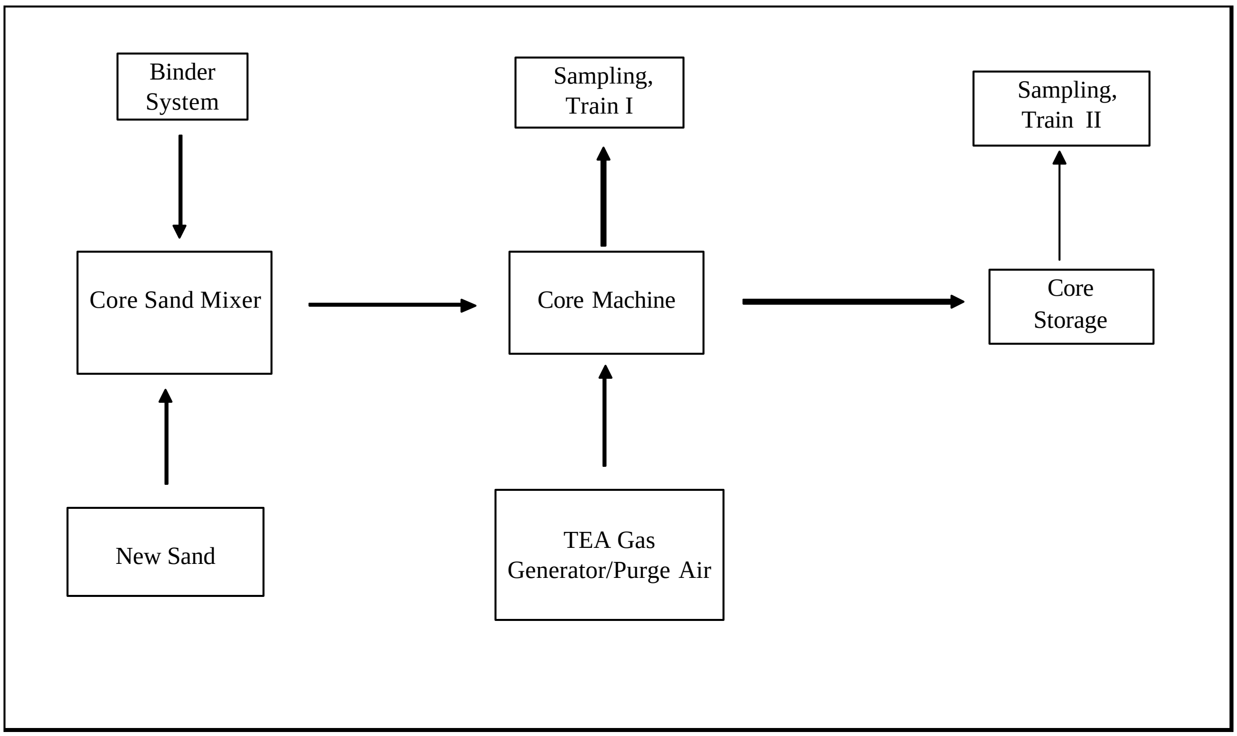
* This test was limited to six (6) test runs due to insufficient binder material.

2.0 Test Methodology

2.1 Description of Process and Testing Equipment

Figure 2-1 is a diagram of the core making process and testing equipment.

Figure 2-1 Core Making and Testing Process



2.2 Description of Testing Program

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

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

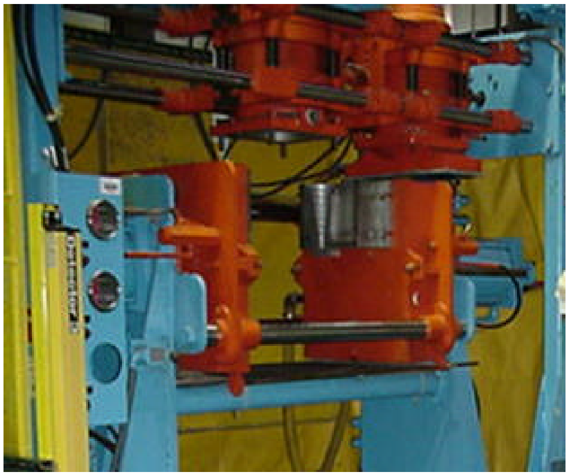
2. **Sand Preparation:** Sands are mixed with quantities of designated binders in a covered 50-pound capacity paddle type cylindrical mixer qualifying as a temporary total enclosure, meeting US EPA Method 204. The sand is preheated or cooled as required to a standard temperature range. The mixer is continuously bathed in temperature-controlled air to maintain the process temperature. Weighted sand and binder components are introduced via an openable window in the cover and mixed for a designated period of time,

then discharged. The cycle time is determined to maintain continuous mixing activity while providing a balanced supply of sand to the core making operation.


Sand Mixing

3. **Core Preparation:** Step cores were prepared for this test in the Production foundry core room area. The sand and binder were mixed and then introduced (blown) into the core tooling of the Redford-Carver core machine. The core-making machine was contained in a permanent total enclosure meeting US EPA Method 204 criteria. An aliquot of the catalyst triethylamine (TEA) gas was heated to 84 ^{o}F and allowed to expand into the piping leading to the core box. Finally, purge air, heated to 80 ^{o}F, pushed the catalyst into the sand in the core box to cure the core, then flushed the catalyst from the core. All these gases were exhausted to a wet gas scrubber charged with sulfuric acid at pH 2 or less. Step cores were fabricated in a single cavity core box. One blow produces a single step core.

4. **Individual Sampling Events:** Sampling to determine the core making emissions consisted of two (2) segments. During the production of step cores, air samples were collected to determine the amount of solvent vented off of the core process. The samples were collected after the background had stabilized during each of the thirty (30) core runs that comprised this portion of the test.


Core Making


Core Storage

The storage segment of the test consisted of placing four (4) cores in the individual storage flow-through sampling enclosures as soon as they were removed from the core machine. Replacement air was allowed to enter under the lower edge of the enclosure through a regulated annular gap to replace the sample air extracted from the top. A five (5) hour integrated sample was collected. All of the enclosures used during this test meet or exceed US-EPA Method 204 criteria for Temporary Total Enclosures.

5. Where new core materials are being evaluated, initial core emissions baseline data are gathered by placing five step-block cores under an**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
Binder Weight (mixing)	Mettler PJ8000 Digital Scale (Gravimetric)
Core Sand Weight (mixing)	Simpson IQ-800-3A Digital Scale
Sand Temperature (mixing)	Stem type dial thermometer & thermocouple
Cycle Time	Digital elapsed time clocks
Purge & Blow Air Temperature	Thermocouple
Purge & Blow Air Pressure	Digital & analog pressure gauges
Enclosure Air Temperature	Thermocouple
TEA Weight	Mettler PB302 Scale (310 gm)
Step Core Weight	OHAUS 110# digital platform scale

6. **Air Emissions Analysis:** The specific sampling and analytical methods used in the core sand mixing, making, and core storage 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, if any, are included in the Technikon Standard Operating Procedures.

Table 2-2 Sampling and Analytical Methods

Measurement Parameter	Test Method*
Port location	EPA Method 1
Number of traverse points	EPA Method 1
Gas velocity and temperature	EPA Method 2
HC as Hexane, Naphthalene, Phenol, Formaldehyde, o,m,p-Cresol, 1 and 2-Methylnaphthalene	EPA Method 18, NIOSH 1500, NIOSH 2002, TO-11
TGOC (THC) as Propane	EPA Method 25A
Volatile Matter content	EPA Method 24

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

7. **<u>Data Reduction, Tabulation and Preliminary Report Preparation</u>:** The analytical results of the emissions tests provide the mass of each analyte in the sample. For the core-blowing segment of the test, the total mass of the analyte emitted is calculated by multiplying the mass of analyte in the sample times the ratio of the sample volume to the total stack gas volume during the test. The total stack gas volume is calculated from the measured stack gas velocity and duct diameter. The total mass of analyte is then divided by the weight of the binder and/or the total weight of the coated sand used to provide emissions data in pounds of analyte per pound of binder and pounds of analyte per ton of sand (coated).

   In the case of the core storage segment of this test, the stack parameters are replaced by the total volume of gas flowing through the storage enclosure during each sampling period. The total flow rate through the enclosure was controlled with critical orifices. The total mass of the analyte emitted is then calculated by multiplying the measured mass of analyte in the sample times the ratio of sample volume to total gas volume over the same time period.

8. **<u>Report Preparation and Review</u>:** The Preliminary Draft Report is reviewed by the Manager, Process Engineering, and the 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. Comments are incorporated into a Final Report prior to final signature approval and distribution.

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

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

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

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

3.0 Test Results

The average emission results for Test FD in lbspounds. per pound of binder used are presented in Table 3-1.

The amount of available VOCs for the binder systems was determined using a method based on US EPA Method 24 and found to be 0.34 pounds per pound of binder or 34% of the binder weight. The average emissions results as a percentage of available VOCs is presented in Table 3-2.

Table 3-3 includes the average emissions results along with the percentage differences between the baseline EQ and the test system FD expressed in pounds per pound of binder.

Table 3-4 represents the average emissions results in pounds per ton of sand for Test FD.

Table 3-5 includes the average emissions results along with the percentage differences between the baseline EQ and the test FD expressed in pounds per ton of sand.

Table 3-6 contains average test process and source data. The total binder weight and the total core weight were calculated from the total amount of sand and the percent binder used in each section of the test.

Appendix B contains the detailed emissions results and process data.

Figures 3-1 and 3-4 represent the results from Tables 3-1 and 3-4 in graphical form.

Figures 3-2, 3-3, 3-5 and 3-6 show the results of the five emissions indicators and selected HAP and VOC emissions data from Tables 3-3 and 3-5 graphically.

Method 25A charts are shown in Appendix C of this document.

Table 3-1 Average Emission Results for Test FD – Lb/Lb Binder

Analytes	Making	Storage
HC as Hexane	0.1349	0.0369
Sum of VOCs	0.0018	0.0007
Sum of HAPs	0.0018	0.0007
Sum of POMs	0.0009	0.0006
Individual HAPs and VOCs		
Naphthalene	0.0009	0.0006
Phenol	0.0007	<0.0001
Formaldehyde	0.0002	0.0001
o,m,p-Cresol	ND	ND
1-Methylnaphthalene	ND	ND
2-Methylnaphthalene	ND	ND

ND: Non Detect

Table 3-2 Average Emission Results for Test FD – % Available Solvent

Test FD	Making	Storage	Total
HC as Hexane	39.7	10.9	50.5

Table 3-3 Test EQ and FD Average Emissions Results – Lb/Lb Binder

Core Making	Test EQ Lb/Lb Binder	Test FD Lb/Lb Binder	% Change from EQ
HC as Hexane	0.0752	0.1349	79
Sum of VOCs	0.0014	0.0018	29
Sum of HAPs	0.0014	0.0018	29
Sum of POMs	0.0010	0.0009	-10
Individual HAPs and VOCs			
2-Methylnaphthalene	0.0004	ND	NA
Naphthalene	0.0003	0.0009	200
Phenol	0.0003	0.0007	133
1-Methylnaphthalene	0.0003	ND	NA
Formaldehyde	0.0001	0.0002	100
o,m,p-Cresol	ND	ND	NA

Core Storage	Test EQ Lb/Lb Binder	Test FD Lb/Lb Binder	% Change from EQ
HC as Hexane	0.0171	0.0369	116
Sum of VOCs	0.0008	0.0007	-13
Sum of HAPs	0.0008	0.0007	-13
Sum of POMs	0.0007	0.0006	-14
Individual HAPs and VOCs			
2-Methylnaphthalene	0.0003	ND	NA
Naphthalene	0.0003	0.0006	100
1-Methylnaphthalene	0.0002	ND	NA
Formaldehyde	<0.0001	0.0001	NA
o,m,p-Cresol	ND	ND	NA
Phenol	ND	<0.0001	NA

ND: Non Detect; NA Not Applicable

Table 3-4 Average Emission Results for Test FD – Lb/Tn Sand

Analytes	Making	Storage
HC as Hexane	4.628	1.260
Sum of VOCs	0.0605	0.0236
Sum of HAPs	0.0605	0.0236
Sum of POMs	0.0310	0.0213
Individual HAPs and VOCs		
Naphthalene	0.0310	0.0213
Phenol	0.0229	0.0002
Formaldehyde	0.0065	0.0021
o,m,p-Cresol	ND	ND
1-Methylnaphthalene	ND	ND
2-Methylnaphthalene	ND	ND

ND: Non Detect

Table 3-5 Tests EQ and FD Average Emissions Results – Lb/Tn Sand

Core Making	Test EQ Lb/Tn Sand	Test FD Lb/Tn Sand	% Change From EQ
HC as Hexane	2.719	4.628	76
Sum of VOCs	0.0534	0.0605	21
Sum of HAPs	0.0534	0.0605	21
Sum of POMs	0.0398	0.0310	-15
Individual HAPs and VOCs			
2-Methylnaphthalene	0.0153	ND	NA
Naphthalene	0.0122	0.0310	154
Phenol	0.0108	0.0229	112
1-Methylnaphthalene	0.0089	ND	NA
Formaldehyde	0.0028	0.0065	132
o,m,p-Cresol	ND	ND	NA

Core Storage	Test EQ Lb/Tn Sand	Test FD Lb/Tn Sand	% Change From EQ
HC as Hexane	0.6006	1.260	110
Sum of VOCs	0.0264	0.0236	-11
Sum of HAPs	0.0264	0.0236	-11
Sum of POMs	0.0258	0.0213	-17
Individual HAPs and VOCs			
2-Methylnaphthalene	0.0093	ND	NA
Naphthalene	0.0090	0.0213	137
1-Methylnaphthalene	0.0075	ND	NA
Formaldehyde	0.0005	0.0021	320
o,m,p-Cresol	ND	ND	NA
Phenol	ND	0.0002	NA

ND: Non Detect; NA: Not Applicable

Table 3-6 Average Process and Source Data for Tests EQ and FD

Core Make Test	FD Average 1.75%	EQ Average 1.75%
Number of tests	6	9
Average coated sand weight, Lbs.	7.21	7.00
Total binder coated sand weight, Lbs.	218.6	209.9
Calculated Total Binder weight per test, Lbs.	3.750	3.668
Calculated Average% Binder (BOS)	1.74	1.75
Calculated Average Standard % binder	1.71	1.72
1800 F LOI after mixing for make, %	ND	1.58
Sand temperature, Deg F	86	89
Dogbone Core 2 hr. tensile strength	164	----
TEA Injection/cycle, gm/cycle (typical)	5	3.5
Blow pressure, psi	40	30
Max. Purge Pressure, psi	45	45
Purge duration, sec	20	20
Ave. Machine cycles per test	30	30
Ave.Core Machine Cycle time, sec.	68	72.7

Core Storage Test	FD Average 1.75%	EQ Average 1.75%
Number of tests	9	9
Length of test, hours	5.0	5.0
Average coated sand weigh per test, Lbs.	7.28	7.24
Calculated Total Binder weight per test, Lbs.	0.125	0.127
Calculated Average% Binder (BOS)	1.74	1.75
Calculated Average Standard % binder	1.71	1.72
1800 F LOI after mixing for storage, %	ND	1.56
Sand temperature, Deg F	86	88
TEA Injection/cycle, gm/cycle (typical)	5	3.7
Blow pressure, psi	40	30
Max Purge Pressure, psi	45	48
Purge duration, sec	20	20
Cores per test	1	1
Ave.Core Machine Cycle time, sec.	66	67.6

Note1: 1800 F LOI is the net weight sample weight difference when combusted at 1800 F for 2 hours and includes decomposition of carbonates that originate in the source sand.

Figure 3-1 Test FD Average Emissions Results – Lb/Lb Binder

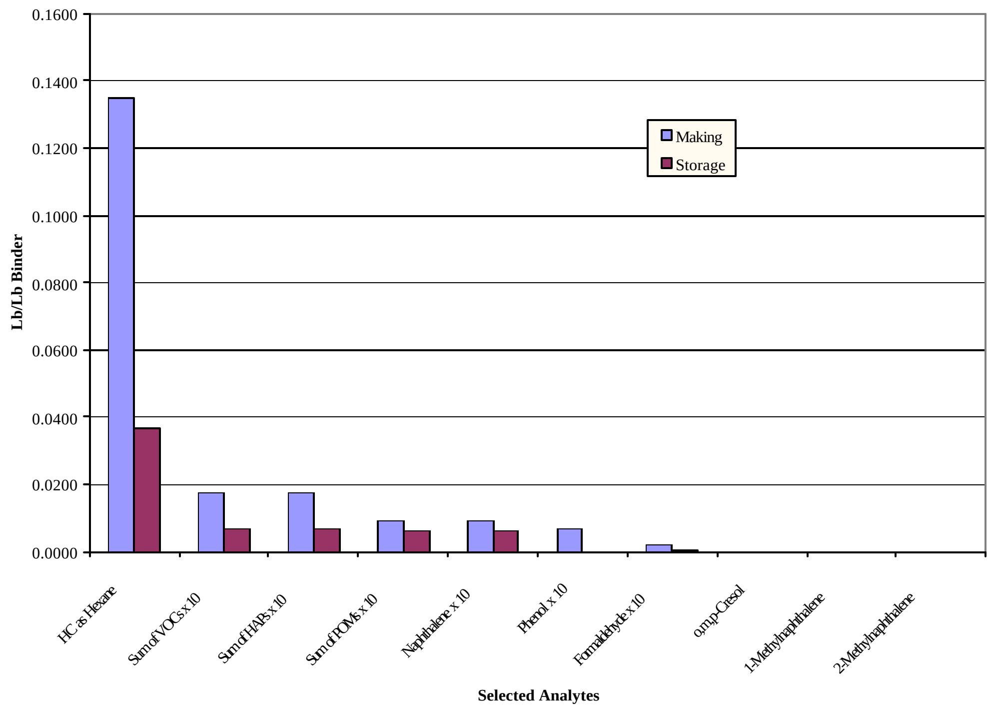


Figure 3-2 Tests EQ and FD Core Making Comparison – Lb/Lb Binder

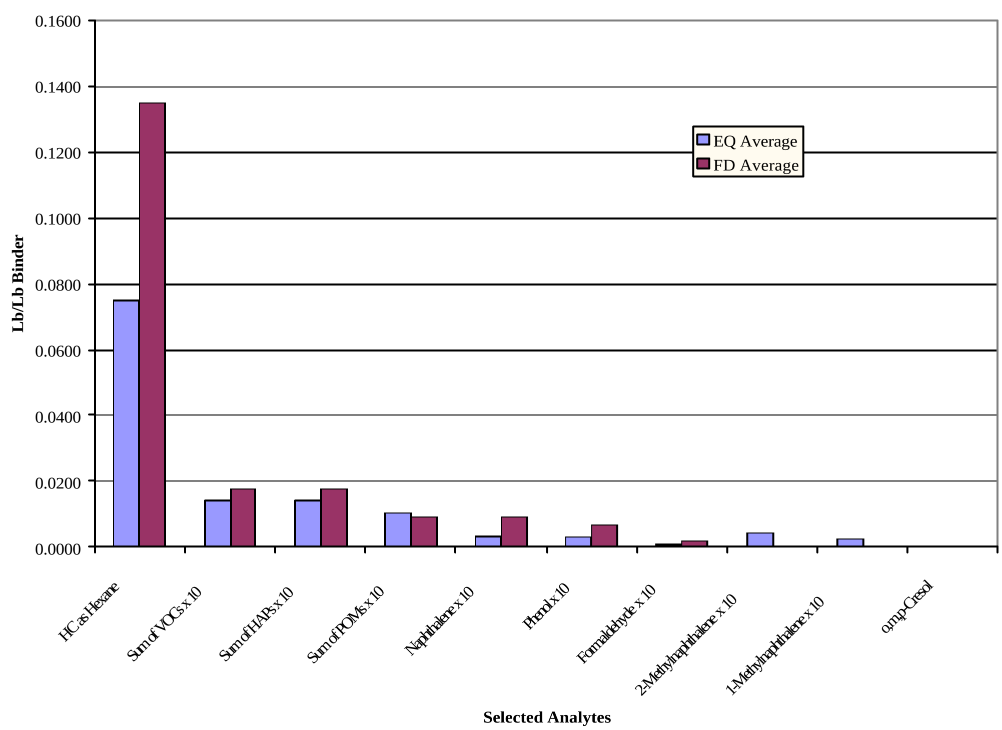


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Figure 3-3 Tests EQ and FD Core Storage Comparison - Lb/Lb Binder

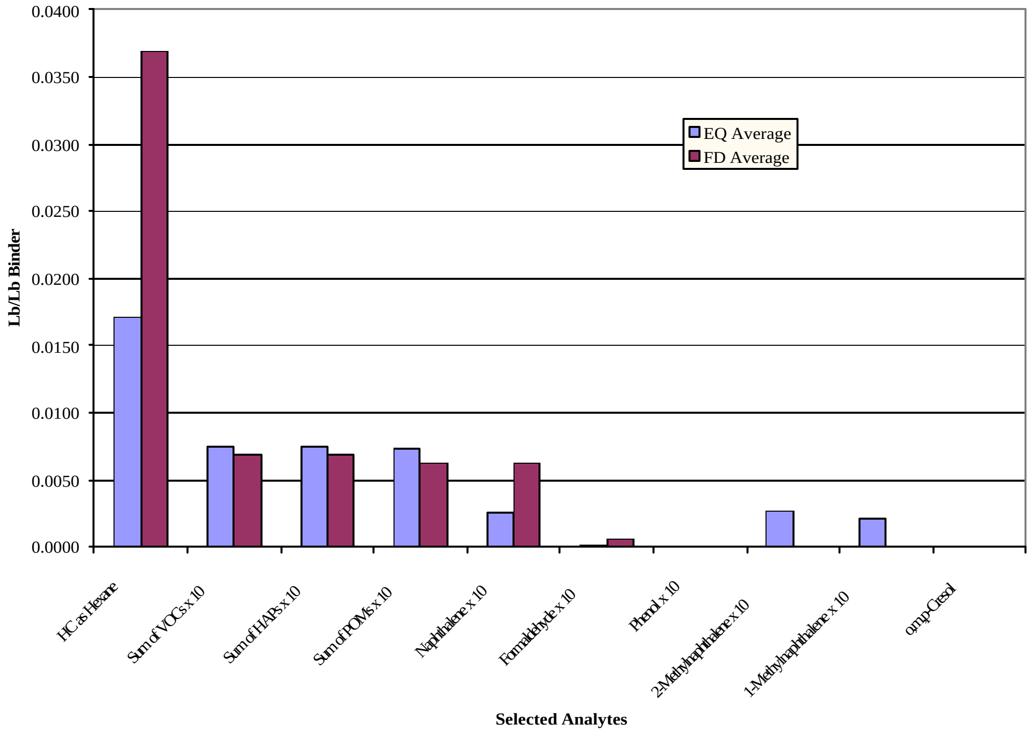


Figure 3-4 Test FD Average Emissions Results - Lb/Tn Sand

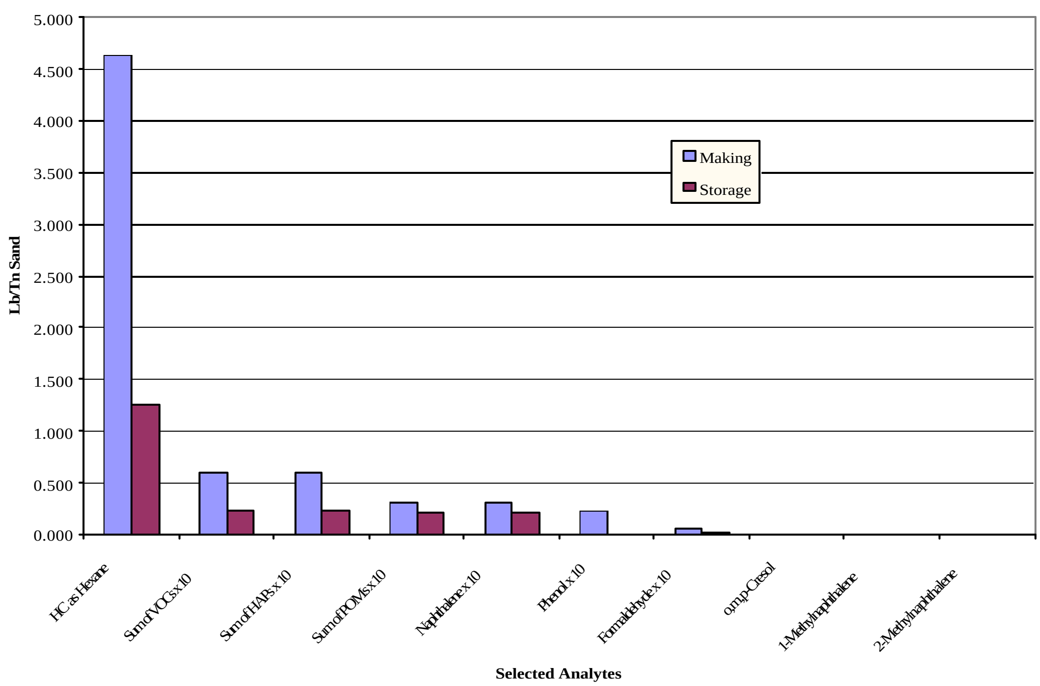


Figure 3-5 Tests EQ and FD Core Making Comparison – Lb/Tn Sand

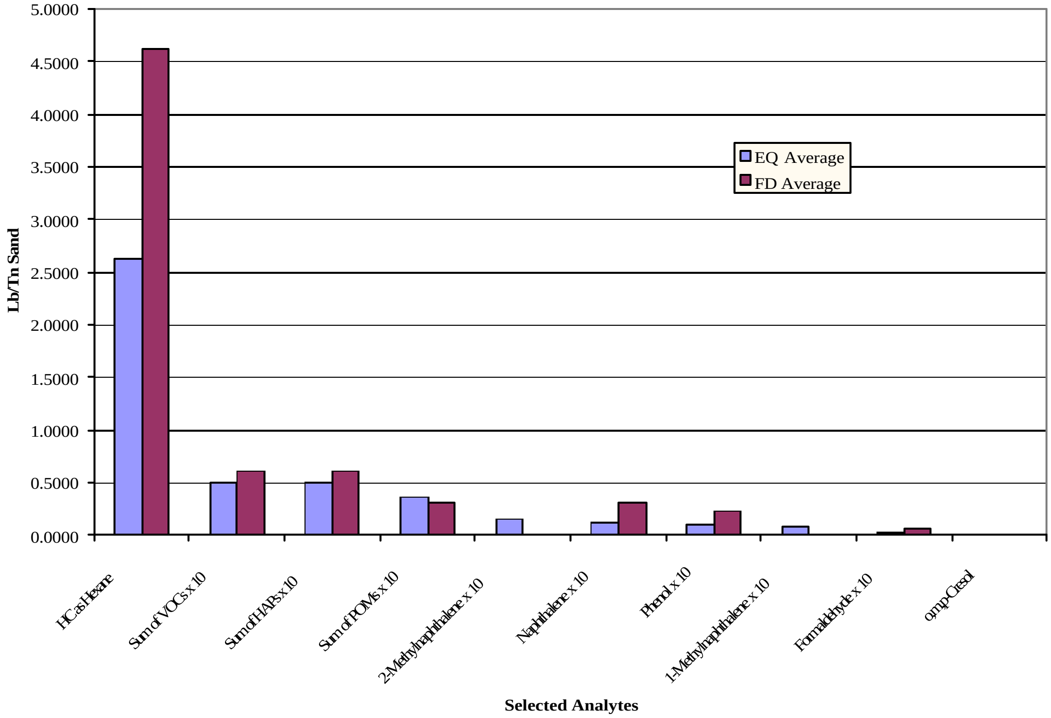
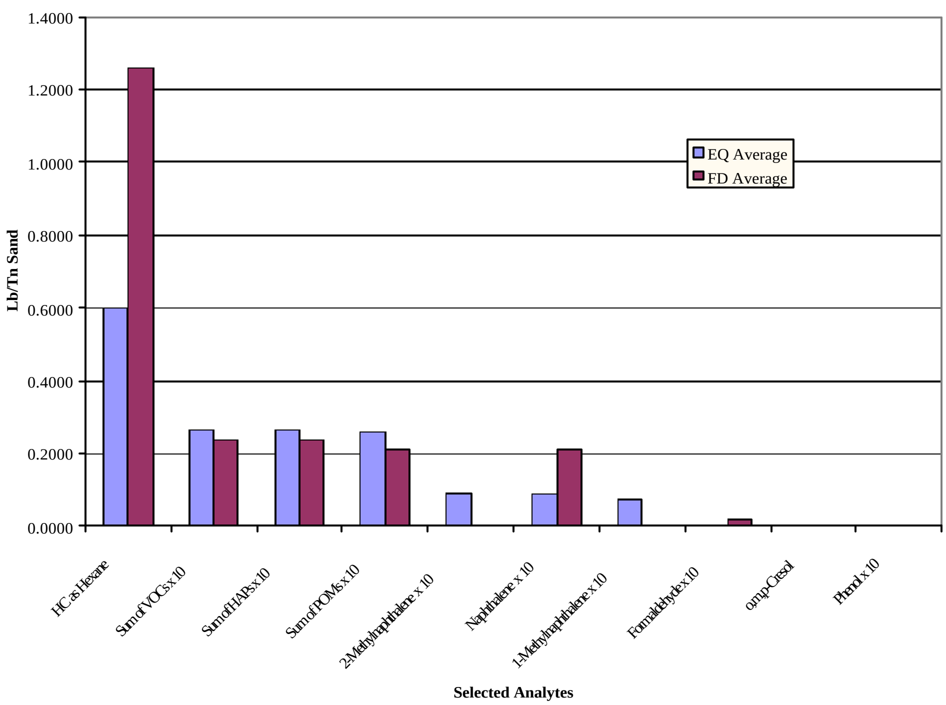


Figure 3-6 Tests EQ and FD Core Storage Comparison – Lb/Tn Sand



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4.0 Discussion of Results

Volatile organic compound (VOC), hazardous air pollutant (HAP), and polycyclic organic material (POM) emissions were measured during core making activities associated with the use of a phenolic urethane binder system in the Technikon research and development core production facility. All of the core-making measurements were conducted within enclosures meeting the criteria for a temporary total enclosure according to US EPA Method 204. Results in this report are expressed in Lb/Lb Binder as well as Lb/Tn Sand.

An independent test for volatile matter content based on EPA Method 24 was performed to determine the amount of available VOCs in the binder system used for this test. The HC as Hexane represents the sum of all compounds that elute from a gas chromatograph between the retention times of hexane and hexadecane. Certain analytes selected for this test may not be represented in the HC as Hexane: formaldehyde, phenol, and cresols, but may be represented in the Method 24 results. Approximately 50% of the available VOCs were recovered from all data streams at the 1.75% binder level for Test FD (Table 3-2). The emission mechanism as VOCs is principally surface evaporation.

Core making contributed the largest proportion of total VOC emissions (59-72%) and core storage (21-41%) for Test FD.

The sample chromatograms for Tests FB and FC were closely reviewed and showed that compounds with boiling points similar to and higher than naphthalene were present in smaller amounts for the "naphthalene depleted" solvent system compared to the standard solvent system. This would have the effect of enriching the more volatile components of the "naphthalene depleted" solvent mixture and result in higher emissions for all species except the POMs.

Gas/Purge and Fugitives

The HC as Hexane results for gas/purge and fugitive emissions contributed approximately 79% of the total found for Test FD during the two test segments. Naphthalene was found in the highest amount followed by phenol and formaldehyde (see Tables 3-3 and 3-5). From Table 3-2, of the percent (%) available solvent measured as HC as Hexane, core making contributed 40%.

Storage

The HC as Hexane for the storage segment contributed 21% of the total found during the two test segments. Naphthalene was found in the highest amount followed by formaldehyde and phenol. From Table 3-2, of the percent (%) available solvent measured as HC as Hexane, core storage contributed 11%.

The distribution of analytes measured varied between the two test segments for Test FD. Naphthalene was found in the highest amounts for both the core making and core storage processes. Phenol was found in relatively higher amounts during core making than core storage.

These differences result from the process changes on the effective surface for evaporation and the air velocity over the effective surface acting on the vapor pressure of each analyte.

Test FD was compared to the baseline Test EQ to look at the effects of a different binder system used in core making processes. From Tables 3-3 and 3-5, the Core Making "% Change from EQ" for HC as Hexane, Sum of VOCs, and Sum of HAPs showed an overall increase for Test FD. The Sum of POMs showed a decrease compared to Test EQ. For the Core Storage segment, only the HC as Hexane increased. In both cases, more naphthalene was found for Test FD than Test EQ.

The two tests were performed under similar conditions except for a single parameter, blow pressure, which was 40 psi for Test FD and 30 psi for Test EQ. Blow pressure alone should not indicate a significant impact on the emissions.

APPENDIX A APPROVED TEST PLAN AND SAMPLE PLAN FOR TEST EQ AND FD

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TECHNIKON TEST PLAN

> **CONTRACT NUMBER:** 1409 **TASK NUMBER:** 1.2.3

> **WORK ORDER NUMBER:** 1165 **Series:** EQ

> **SAMPLE EVENTS:** EQ001-009 MIX, EQ021-029 MAKE, EQ031-039 STORE

> **SITE:** ___**PRE-PRODUCTION (243)** _X__ **FOUNDRY (238)**

> **TEST TYPE:** CAPABILITY, CORE MIXING, CORE MAKING, CORE STORAGE BASELINE 2002

> **METAL TYPE**: NONE

> **MOLD TYPE**: NONE

> **NUMBER OF MOLDS:** NONe

> **CORE TYPE:** AFS STEP CORE, ASHLAND ISOCURE ® LF305/52-904GR PHENOLIC URETHANE BINDER, TEA CATALYZED

> **TEST DATE:** **START:** 19 AUG 2002
> **FINISHED:** 13 SEP 2002

TEST OBJECTIVES:

1. Develop facility and methods to make a core mix, make, and store baseline having significantly reduced process variability and improved independent sample capture methods.

2. Measure selective HAP and VOC emissions fom Core sand mixing, Gas & Purge and Fugitive Core Making, and Core Storage of AFS step cores made with 1.75% Ashland binder to make a 2002 Core baseline.

VARIABLES:

1. Core sand mixing: The uncoated sand shall be Wexford W450 Lakesand. It shall be preheated or cooled to maintain a temperature of 85 +/- 5 degrees Fahrenheit. The binder shall be 1.75 +/- .0175% Ashland 305/52-904 mixed Part I/Part II in the ratio of 55/45. The sand will be coated in the Redford/Carver 50 pound core sand mixer for 7 minutes. One minute shall be used to dispense the sand and the two binder components and one additional minute shall be used strictly for discharging the muller. Each core sand mixing test shall be one seven (7) minute 50-pound cycle within the muller only monitored continuously by TGOC and adsorption tube sampling. Prior to the first test five (5) batches shall be run to the storage hopper to normalize the background. Sampling media will be changed after each one-cycle test, during which time mixing will continue in order to maintain the background concentration. A total of nine (9) mixing tests shall be run.

2. Core Making: The Redford/Carver core machine will operate on a nominal one (1) minute door-to-door cycle. The environmental enclosure shall be supplied with air controlled to 82 +/- 5 degrees Fahrenheit. TEA will be fed to the core machine at a nominal 5 grams per cycle. The purge pressure shall be 20+/-2 psi. The core-make test will begin after the

core machine has run sufficient time, at rate, to have the background emission concentration stabilize. Each core-make test will be 30 core cycles, about one half hour long, with continuous TGOC and adsorption tube sampling. Sample media will be changed after each 30-cycle test. The core machine will run continuously during media change and testing to maintain the background concentration. The gas & purge and fugitive emissions will be collected to a common sampling stack.

3. Core Storage: The store test will consist of weighed cores sampled four (4) at a time, from the core machine and placed in individual sampling domes. The domes are in a temperature-controlled room at 82+/- 5 degrees Fahrenheit and sampled continuously with TGOC and adsorption tubes for 5 hours.

BRIEF OVERVIEW: Core making is not a single process but rather a series of steps, each with its own process collectable and fugitive emissions. This test will look at selected HAP & VOC emissions from combined process collectable and fugitive emission streams during each of the core sand mixing, core making, and core storage steps.

SPECIAL CONDITIONS: The sand mixer will have a removable lid that allows air to infiltrate radially from the perimeter. Materials will be charged though a closeable door in the lid. Samples will be extracted from the center of the headspace below the lid. The core machine with step core tooling shall be housed in a double walled emission enclosure. The area between the walls shall be flushed with temperature-controlled air at 80+/-5 degrees Fahrenheit. This air shall be the ambient make up air for the core process within the enclosure. The core box and core machine shall be tightly plumbed to extract gasses passed through the core box into a common sampling stack with the fugitive gasses. The sampling environment will be maintained at 75-85°F.

Original Signed	____________________
Process Engineering Manager (Technikon)	**Date**
Original Signed	____________________
V.P. Measurement Technology (Technikon)	**Date**
Original Signed	____________________
V.P. Operations (Technikon)	**Date**
Original Signed	____________________
CERP Representative	**Date**

Series EQ (Baseline)

Core Sand Mixing, Curing, and Storage

A. The Experiment:

1. Design and develop improved capability to evaluate the standard emissions from the mixing, making, and storage of gas catalyzed cold reacting core sand mixtures.
2. Evaluate the emissions from Ashland ISOCURE® LF305/52-904 part I and part II binder system to form a mixing, making, storage baseline for Iron-Phenolic Urethane binder systems.

B. Capability Study:

1. Mixing: Design and manufacture a capture hood for the Carver 50 pound capacity core sand mixer consisting of:

   a. An annular air makeup port which allows air to enter the mixer radially in such a way as to not significantly affect the emission evaporation from the sand surface.
   b. The ventilation rate shall be sufficient to prevent escape of the emissions except to the emission-sampling stream.
   c. An emission sampling port centered on the capture hood.
   d. A discharge pipe connected to a sampling train and pump via a heated line to the THC analyzer.

2. Core Making: Design and manufacture a total emission enclosure to capture and sample aggregate emissions from both the core box gas-purge cycles and fugitives from the enclosure.

   a. A gassing head capable of independently delivering a catalyzing gas and purge air from the external Luber gas generator to the common fugitives collection pipe. The flow rate in the sampling pipe at the sampling location must be virtually independent of the whether the gas-purge cycle is active.

3. Storage: Design and manufacture a set of four-storage emission sampling chambers.

   a. Each chamber shall have independent air flow controls.
   b. The sum of the chamber flows shall not exceed 50 liters/minute.
   c. One chamber shall be connected to the THC analyzer.
   d. Three chambers shall be connected to a sampling train via independent sampling media.

4. Conduct a set of preliminary tests to verify that the design criteria are met.

a. Conduct a "mixedness" test to verify that the mixer will create a homogeneous mixture within the prescribed mixing time.
b. Conduct a THC mixing calibration run according to the mixing schedule described below in order to determine the required media flow rates.
c. Conduct a THC core making calibration at 60 core /hour in order to determine the required media flow rates.
d. Conduct a THC core storage calibration run using core made per the core make procedure in order to determine the required media flow rates.
e. Record the ambient air temperature, pressure, and moisture content; scavenging air velocity; all machine parameters; all core weights; and all events.

C. Mixing Test: Nine discrete seven (7) minute batches run contiguously.

1. The test shall be conducted in the 50-pound Carver core sand mixer fitted with the capture hood with make-up air ventilation.

a. The emission sample shall be taken from the air space above the mixing sand.

2. Mixing

a. Turn on the Kloster sand heater/cooler. Adjust the set point so that sand is delivered to the mixer in the temperature range of 80-90°F.
b. Attach the emission sampling equipment to the 50-pound Carver core sand mixer.
c. Pre-measure 1.75% (BOS) Ashland ISOCURE® binder based on a 50 pound batch.

1) Part I (LF305) is 55% of the total resin and is 218.3 grams.
2) Part II (52-904) is 45% of the total resin and is 178.6 grams

Note: pre-wet the dispensing cup and tare the wet cup.

d. Pre-Weigh 50 pounds of Wexford W450 Lake Sand, heated to 80-90°F in the Kloster sand heater/cooler, in the Simpson Technologies weight system.
e. Place the capture hood on top of the mixer. Start the mixer.
f. Start the timer. Start monitoring with the THC only. Monitor with the THC continuously until the end of the test.
g. Make five (5) emission background-generating batches.
h. The procedure for this and the contiguously run test batches shall be as follows: Add the 50 pounds of raw sand, about 20-25 seconds, followed by the binder part I dispensed over 20 seconds, followed by binder part II dispensed over 20 seconds. All materials should be in the mixer within 50-70 seconds from start of the batch. Mix each batch until a total of 6 minutes have elapsed, then discharge the batch until a total of 7 minutes has elapsed from the start of the batch. Be prepared to recharge the mixer for the next batch immediately at the end of each 7-minute period.
i. During this activity the next set of components must be weighed and made ready. Having two or three material sets weighed and protected at all times makes the process go smoothly.

j. At the end of fifth batch (35 minutes)

1) Close the discharge door.
2) Open the sample train to the mixer.
3) The emission sample size will be one (1) batch.
4) During the next batch the media will be changed.
5) The next batch will be an emission sample again.
6) Continue alternating until nine (9) emission tests are complete.

k. Repeat steps C.2.g-h for as many cycles as is necessary to complete the five (5) background batches, the nine (9) emission test batches, and nine (9) media changing periods, a total of 23 batches. Continue batches uninterrupted during media changes between tests.

D. Core Making test: Nine (9) tests each having thirty (30) approximately one (1) minute core cycles.

1. Turn on the core storage room temperature control system 24 hours ahead of expected use time. Set control so that the core machine sees 80^{o}F.
2. Turn on and adjust the Luber TEA gas generator.

a. Make sure there is enough TEA in the Luber TEA storage tank.
b. Set the MAX WORKING PRESSURE to 45 psi.
c. Set the gassing time (T1) to 0.75 seconds
d. Adjust the TEA flow rate to .019 pounds/second.

Note: This will give an amine input of 5.1 grams per cycle.

e. Leave the Timer TR1 at 0.3 seconds, the proportional valve voltage at 7.5 volts and timer at 3 seconds, the low purge pressure at 10 psi and high purge pressure at 45 psi.

Note: This should yield a working pressure of about 7 psi.

f. Connect the TEA weighing container to the Luber supply line.

1) Dispense about 250 grams of TEA into the weigh container. The scale has a 300-gram capacity.
2) Isolate the Luber TEA storage tank.

g. Conduct 5 gassing purge cycles within ½ hour of testing to stabilize the Luber generator.

1) Vent this material to the scrubber.
2) Record the TEA weight dispensed.

h. Record the ambient temperature, the inlet pressure, Max working pressure, working pressure, TEA flow rate, gassing timer value, & purge timer value.

3. Attach the emission sample train to the gas-purge-fugitive sample pipe.
4. Begin monitoring with the THC.
5. Prepare the core sand in the Carver mixer according to section C.2.g-h except without the emission sampling equipment attached to the mixer.
6. Prepare the core machine emission enclosure.
7. Verify that the temperature controlled core test room is set to deliver air at 75-85°F to the core enclosure.
8. Set up the Redford/Carver core machine with the step core corebox.
9. Verify that the air temperature in the gas-purge-fugitive exhaust tube is 75-85 degrees Fahrenheit.
10. Set the Redford/Carver core machine to gas for 0.75 seconds with zero (0) second delay after gassing and twenty (20) second purge. Total cycle time to be one (1) minute. Set the cycle counter to zero (0).
11. Start and calibrate the Luber TEA vaporizer to dispense 5.0-5.2 grams of TEA per machine cycle.
12. Mix core sand per section C.2.g-h, as required, in fifty (50) pound batches to assure continuity of production.
13. Cycle the core machine for 10-15 cycles or until fugitives emissions are stable based on the THC and good core manufacture is achieved. Note: if release agent is required brush release agent on to core box do not spray.
14. Make cores continuously as above. Any stoppage will impact the fugitives emission level.
15. Record the number and weight of each core throughout the test.
16. When everybody is ready, start the emission-sampling clock and open the sample train. Sample continuously for 30 core cycles, approximately thirty (30) minute, then close the sample train.
17. Do not stop making core.
18. Set up the sample train again and repeat the test for another thirty-core test. A total of nine (9) half-hour tests are to be performed.
19. Empty and clean the core machine and core sand mixer.

E. Core storage tests.

1. Prepare the 4 individual core storage emission enclosures.
2. Set up a THC to monitor one enclosure and the sample train to monitor the other three enclosures and calibrate them.
3. Mix sand by the method of section C.2.g-h.
4. Make core by the method of Section D.
5. Number, weigh, and record each core.
6. When good core are being made sample four (4) cores whose weight is 7.30, 7.35, or 7.40 pounds for the storage test. Place these cores in the core storage emission enclosures.

7. Close the enclosure bonnet, start the test clock, open to the THC or the sample train.
8. Record the start time for each core as well as the core weight
9. Continue sampling train for 5 hours then close the sample train. Separate longer tests may be conducted by this procedure at the discretion of the emission team.
10. Continue the THC monitoring for 24 hours.
11. Repeat this procedure to obtain nine (9) discrete tests plus the THC monitoring.

Steven Knight
Mgr. Process Engineering

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 1											
THC	EQ-00101	X									TOTAL
NIOSH 1500	EQ-00102		1						20	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	EQ-00103			1					20	2	400/200 mg Charcoal (Orbo 32)
NIOSH 1500	EQ-00104				1						400/200 mg Charcoal (Orbo 32)
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00105		1						1000	8	400/200 mg Silica Gel (Orbo 53)
NIOSH 2002	EQ-00106			1					1000	9	400/200 mg Silica Gel (Orbo 53)
NIOSH 2002	EQ-00107				1						400/200 mg Silica Gel (Orbo 53)
TO11	EQ-00108		1						1000	10	(DNPH cartridge sep-pak)
TO11	EQ-00109				1				1000	11	(DNPH cartridge sep-pak)
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 2											
THC	EQ-00201	X									TOTAL
NIOSH 1500	EQ-00202		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00203		1						1000	8	400/200 mg Silica Gel (Orbo 53)
TO11	EQ-00204		1						1000	9	(DNPH cartridge sep-pak)
TO11	EQ-00205			1					1000	10	(DNPH cartridge sep-pak)
									1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 3											
THC	EQ-00301	X									TOTAL
NIOSH 1500	EQ-00302		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00303		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00304		1						1000	10	(DNPH cartridge sep-pak)
TO11	EQ-00305					1			1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 4											
THC	EQ-00401	X									TOTAL
NIOSH 1500	EQ-00402		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00403		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00404		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthro ugh	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 5											
THC	EQ-00501	X									TOTAL
NIOSH 1500	EQ-00502		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00503		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00504		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 6											
THC	EQ-00601	X									TOTAL
NIOSH 1500	EQ-00602		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00603		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00604		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 7											
THC	EQ-00701	X									TOTAL
NIOSH 1500	EQ-00702		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00703		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00704		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 8											
THC	EQ-00801	X									TOTAL
NIOSH 1500	EQ-00802		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00803		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00804		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 9											
THC	EQ-00901	X									TOTAL
NIOSH 1500	EQ-00902		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-00903		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-00904		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 10											
THC	EQ-01001	X									TOTAL
NIOSH 1500	EQ-01002		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-01003		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-01004		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 11											
THC	EQ-01101	X									TOTAL
NIOSH 1500	EQ-01102		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-01103		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-01104		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 12											
THC	EQ-01201	X									TOTAL
NIOSH 1500	EQ-01202		1						20	1	400/200 mg Charcoal (Orbo 32)
	Excess								20	2	Excess
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-01203		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	EQ-01204		1						1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/9/02											
EVENT 13											
THC	EQ-01301	X									TOTAL
NIOSH 1500	EQ-01302		1						20	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	EQ-01303			1					20	2	400/200 mg Charcoal (Orbo 32)
	Excess								45	3	Excess
	Excess								35	4	Excess
	Excess								60	5	Excess
	Excess								750	6	Excess
	Excess								900	7	Excess
NIOSH 2002	EQ-01305		1						1000	8	400/200 mg Silica Gel (Orbo 53)
NIOSH 2002	EQ-01306			1					1000	9	400/200 mg Silica Gel (Orbo 53)
TO11	EQ-01308		1						1000	10	(DNPH cartridge sep-pak)
TO11	EQ-01309					1			1000	10	(DNPH cartridge sep-pak)
	Excess								1000	11	
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 1											
THC	EQ-02101	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02102		1						500	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	EQ-02103			1					500	6	100/50 mg Charcoal (SKC 226-01)
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02104		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	EQ-02105			1					1000	10	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02106		1						1000	11	(DNPH cartridge sep-pak)
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 2											
THC	EQ-02201	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02202		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02203		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02204		1						1000	10	(DPNH cartridge sep-pak)
	EQ-02205			1					1000	11	(DPNH cartridge sep-pak)
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 3											
THC	EQ-02301	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02302		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02303		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02304		1						1000	10	(DPNH cartridge sep-pak)
TO11	EQ-02305					1			1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 4											
THC	EQ-02401	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02402		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02403		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02404		1						1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 5											
THC	EQ-02501	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02502		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02503		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02504		1						1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 6											
THC	EQ-02601	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02602		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02603		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02604		1						1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 7											
THC	EQ-02701	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02702		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02703		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02704		1						1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT 8											
THC	EQ-02801	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02802		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02803		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02804		1						1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	Excess

CORE MAKING EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**30 Minute Test**
EVENT 9											
THC	EQ-02901	X									TOTAL
	Excess									1	Excess
	Excess									2	Excess
	Excess									3	Excess
	Excess									4	Excess
NIOSH 1500	EQ-02902		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess									7	Excess
	Excess									8	Excess
NIOSH 2002	EQ-02903		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	EQ-02904		1						1000	10	(DPNH cartridge sep-pak)
	Excess								1000	11	Excess
	Excess									12	Excess
	Excess									13	Excess

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/10/02											**5-Hr. Test-Core 1**
EVENT 1											
NIOSH 1500	EQ-03101		1						25	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	EQ-03102			1					25	2	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	EQ-03103		1						60	3	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	EQ-03104			1					30	4	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-03105		1						200	5	(DPNH cartridge sep-pak)
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/10/02											**5 Hour Test-Core 2**
EVENT 2											
NIOSH 1500	EQ-03201		1						30	1	100/50 mg Charcoal (SKC 226-01)
	Excess								20	2	Excess
NIOSH 2002	EQ-3202		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-3203		1						200	4	(DPNH cartridge sep-pak)
TO-11	EQ-3204			1					200	5	(DPNH cartridge sep-pak)
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/10/02											**5 Hour Test-Core 3**
EVENT 3											
NIOSH 1500	EQ-03301		1						30	1	100/50 mg Charcoal (SKC 226-01)
	Excess								30	2	Excess
NIOSH 2002	EQ-03302		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-03303		1						200	4	(DPNH cartridge sep-pak)
TO-11	EQ-03304					1			200	4	(DPNH cartridge sep-pak)
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 4**
EVENT 4											
NIOSH 1500	EQ-03401		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	EQ-03402		1						60	3	150/75 mg Silica Gel (SKC 226-10)
	Excess								30	4	Excess
TO-11	EQ-03403		1						200	5	(DPNH cartridge sep-pak)
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 5**
EVENT 5											
NIOSH 1500	EQ-03501		1						30	1	100/50 mg Charcoal (SKC 226-01)
	Excess								20	2	Excess
NIOSH 2002	EQ-03502		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-03503		1						200	4	(DPNH cartridge sep-pak)
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 6**
EVENT 6											
NIOSH 1500	EQ-03601		1						30	1	100/50 mg Charcoal (SKC 226-01)
	Excess								30	2	Excess
NIOSH 2002	EQ-03602		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-03603		1						200	4	(DPNH cartridge sep-pak)
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 7**
EVENT 7											
NIOSH 1500	EQ-03701		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	EQ-03702		1						60	3	150/75 mg Silica Gel (SKC 226-10)
	Excess								30	4	Excess
TO-11	EQ-03703		1						200	5	(DPNH cartridge sep-pak)
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 8**
EVENT 8											
NIOSH 1500	EQ-03801		1						30	1	100/50 mg Charcoal (SKC 226-01)
	Excess								20	2	Excess
NIOSH 2002	EQ-03802		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-03803		1						200	4	(DPNH cartridge sep-pak)
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orifice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 9**
EVENT 9											
NIOSH 1500	EQ-03901		1						30	1	100/50 mg Charcoal (SKC 226-01)
	Excess								30	2	Excess
NIOSH 2002	EQ-03902		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	EQ-03903		1						200	4	(DPNH cartridge sep-pak)
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orifice

TECHNIKON TEST PLAN

CONTRACT NUMBER: 1409 **TASK NUMBER**: 1.1.8

WORK ORDER NUMBER: 1178 **Series:** FD

SAMPLE EVENTS: FD201-209 make, FD301- 309 store

SITE: ___PRE-PRODUCTION(243) _X__ FOUNDRY(238)

TEST TYPE: Product test: Make and Store core

METAL TYPE: None

MOLD TYPE: None

NUMBER OF MOLDS: None

CORE TYPE: AFS Step Core, using 1.75 % Ashland Isocure ® 305/52-904 "special" Phenolic urethane binder w/o napthalene, TEA catalyzed

TEST DATE: **START**: 20 May 2003

FINISHED: 27 May 2003

TEST OBJECTIVES:

1. Measure selective HAP and VOC emissions from combined Gas & Purge and Fugitive Core Making, and Core Storage of AFS step cores made with 1.75 % Ashland binder.

VARIABLES :

1. Core sand mixing: The uncoated sand shall be Wexford W450 Lakesand. It shall be preheated or cooled to maintain a temperature of 85 +/- 5 degrees Fahrenheit. The binder shall be 1.75 +/- .0175% of napthalene depleted Ashland 305/52-904 mixed Part I/Part II in the ratio of 55/45. The sand will be coated in the Redford/Carver 50 pound core sand mixer for 7 minutes. One minute shall be used to dispense the sand and the two binder components and one additional minute shall be used strictly for discharging the muller. The mixing shall continue until the core making is complete. NO emission testing shall be done on mixing process.

2. Core Making: The Redford/Carver core machine will operate on a nominal one (1) minute door-to-door cycle. The environmental enclosure shall be supplied with air controlled to 82 +/- 5 degrees Fahrenheit. TEA will be fed to the core machine at a nominal 5 grams per cycle. The purge pressure shall be 20+/-2 psi. The core-make test will begin after the core machine has run sufficient time, at rate, to have the background emission concentration stabilize. Each core-make test will be 30 core cycles, about one half hour long, with

continuous TGOC and adsorption tube sampling. Sample media will be changed after each 30 cycle test. The core machine will run continuously during media change and testing to maintain the background concentration. The gas & purge and fugitive emissions will be collected to a common sampling stack. Each core will be individually weighed. A total of nine (9) – 30 core runs shall be made.

3. Core Storage: The store test will consist three (3) sets of four (4) weighed cores sampled from the core machine and placed in individual sampling domes. The domes are in a temperature controlled room at 82+/- 5 degrees Fahrenheit and sampled continuously with TGOC (1) and adsorption tubes (3) for 5 hours. Total nine (9) samples

BRIEF OVERVIEW: Core making is not a single process but rather a series of steps each with its own process collectable and fugitive emissions. This test will look at selected HAP & VOC emissions from combined process collectable and fugitive emission streams during each of the core making and core storage steps.

SPECIAL CONDITIONS: The sand mixer will have a removable lid that allows air to infiltrate radially from the perimeter. Materials will be charged though a closeable door in the lid. The core machine with step core tooling shall be housed in a double walled emission enclosure. The area between the walls shall be flushed with temperature controlled air at 82+/-5 degrees Fahrenheit. This air shall be the ambient make up air for the core process within the enclosure. The core box and core machine shall be tightly plumbed to extract gasses passed through the core box into a common sampling stack with the fugitive gasses. The sampling environment will be maintained at 85 +/-5 ^{o} F.

Series FD

Core Sand Making and Storage

Ashland 305/904 Naphthalene Depleted WO 1178

A. The Experiment:

1. Evaluate the emissions from Ashland Isocure ® 305 part I and 904 part II Phenolic Urethane naphthalene depleted binder system at 1.75 % total binder.

B. Sand Mixing: Discreet seven (7) minute shall be at 1.75 % total binder (BOS).

1. Mixing shall be conducted in the 50 pound Carver core sand mixer.
2. Turn on the Kloster sand heater/cooler. Adjust the set point so that sand is delivered to the mixer in the temperature range of 87-92 oF.
3. Pre-measure 1.75 % (BOS) of the Ashland binder based on a 50 pound batch.
   - **a.** Part I (305) is 55% of the total binder and is 218.5 grams @ 1.75%.
   - **b.** Part II (904) is 45 % of the total binder and is 178.8 grams @ 1.75%.

Note: pre-wet the dispensing cup and tare the wet cup.

4. Pre-Weigh 50 pounds of Wexford W450 Lake Sand, heated to 87-92 oF in the Kloster sand heater/cooler, in the Simpson Technologies weight system.
   - **a.** Start the mixer.
   - **b.** Start the timer.
   - **c.** Add the 50 pounds of raw sand over about 20-25 seconds, followed by the binder part I dispensed over 20 seconds, followed by binder part II dispensed over 20 seconds. All materials should be in the mixer within 50-70 seconds from start of the batch.
   - **d.** Mix each batch until a total of 6 minutes have elapsed, then discharge the batch into the core machine hopper until a total of 7 minutes has elapsed from the start of the batch. Close the trap door to the core machine hopper after each batch. Be prepared to recharge the mixer for the next batch immediately at the end of each 7 minute period.
   - **e.** During the mixing period the next set of components must be weighed and made ready. Having two or three material sets weighed and protected from evaporation at all times makes the process go smoothly.
   - **f.** Repeat steps B.4.a-e for as many cycles as is necessary to complete the core making tests.

C. Core Making Test: Nine (9) discreet tests each having thirty (30) cores cycles, approximately one (1) minute.

1. Turn on the core storage room temperature control system 24 hours ahead of expected use time. Set control so that the core machine sees 80 +/- 3 oF.
2. Turn on the G/F core machine master start.
3. Turn on and adjust the Luber TEA gas generator.

   a. Make sure there is enough TEA in the Luber TEA storage tank.
   b. Set the MAX WORKING PRESSURE to 45 psi.
   c. Set the gassing time (T1) to 0.75 seconds
   d. Adjust the TEA flow rate to .019 pounds/second.

   Note : This will give a amine input of 4-5 grams per cycle.

   e. Leave the Timer TR1 at 0.3 seconds, the proportional valve voltage at 7.5 volts and timer at 3 seconds, the low purge pressure at 10 psi and high purge pressure at 45 psi.

   Note: This should yield a working pressure of about 7 psi.

   f. Connect the TEA weighing container to the Luber supply line.

   (1) Dispense about 250 grams of TEA into the weigh container. The scale has a 300 gram capacity.
   (2) Close valve on Luber TEA storage tank.
   (3) Refill about every 50 blows.
   (4) Measure the TEA consumption during 10 consecutive core cycles. Record the average Tea consumption every 3 sore make cycles.

Caution: Verify that the TEA weigh container is secure on the weigh scale. If the bottle falls to the floor a TEA spill can occur.

   g. Conduct 5 gassing purge cycles within ½ hour of testing to stabilize the Luber generator.

   (1) Vent this material to the scrubber.

   h. Record the ambient temperature, the inlet pressure, Max working pressure, working pressure, TEA flow rate, gassing timer value, & purge timer value.

4. Attach the emission sample train to the gas-purge-fugitive sample pipe.
5. Begin monitoring with the TGOC.
6. Prepare the core sand in the Carver mixer according to section B except without the emission sampling equipment attached to the mixer.
7. Prepare the core machine emission enclosure.
8. Verify that the temperature controlled core test room is set to deliver air at 80-85^{o}F to the core enclosure.
9. Set up the Redford/Carver core machine with the step core corebox.

10. Verify that the air temperature in the gas-purge-fugitive exhaust tube are 80-85 degrees Fahrenheit.
11. Set the Redford/Carver core machine to gas for 0.75 seconds with zero (0) second delay after gassing and twenty (20) second , thirty (30) psi purge. Total cycle time to be about one (1) minute.
12. Set the cycle counter to zero (0).
13. Start and calibrate the Luber TEA vaporizer to dispense about 4 grams of TEA per machine cycle.
14. Mix core sand per section “B” as required in fifty (50) pound batches to assure continuity of production.
15. Cycle the core machine for 10-15 cycles or until fugitives emissions are stable based on the TGOC and good core manufacture is achieved. Note: if release agent is required wipe release agent on to core box do not spray.
16. Make cores continuously as above. Any stoppage will impact the fugitives emission level.
17. Record the number and weight of each core throughout the test.
18. When everybody is ready, start the emission sampling clock and open the sample train. Sample continuously for 30 core cycles, approximately thirty (30) minutes then close the sample train at the start of the 31st core cycle.
19. Do not stop making core.
20. Set up the sample train again and repeat the test for another thirty-core test. A total of nine (9) 30-core tests are to be performed.
21. Empty and clean the core machine and core sand mixer.

D. Core Storage Tests.

1. Prepare the 4 individual core storage emission enclosures.
2. Set up a TGOC to monitor one enclosure and the sample train to monitor the other three enclosures and calibrate them.
3. Mix sand by the method of section “B”.
4. Make core by the method of Section “C”.
5. Number and weigh each core and record same.
6. When good core are being made sample four (4) cores whose weight is at least 7.10 pounds, and differ by no more than 0.05 pounds for the storage test. Place these cores in the core storage emission enclosures.
7. Close the enclosure bonnet, start the test clock, open to the TGOC or the sample train.
8. Record the date, start time for each core as well as the core weight and core number as it appears on the Core Make Log.
9. Continue sampling train and TGOC for 5 hours then close the sample train. Separate longer tests may be conducted by this procedure at the discretion of the emission team.
10. Repeat this procedure to obtain nine (9) discrete tests in groups of three (3) plus the TGOC monitoring.

E. Dog Bone Test Cores

1. Make 12 Dogbone test cores from a single batch of sand each day of testing.
2. Two hours after making the dogbones tensile test them in the Universal 405 Test machine. Perform a scratch hardness test on each dogbone on the flat side of one of the broken ends.
3. Record, for each dogbone the date & time of the sand batch and dogbone manufacture, the total binder content, the time of testing, the core weight, scratch hardness, and tensile strength.
4. Run 1800 oF LOI tests on three (3) dogbones from each set created and report the results.

Steven Knight
Mgr. Process Engineering

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/4/2003											**LF 305 ND/52-904GR ND**
RUN 1											
THC	FD-20101	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20102		1						500	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FD-20103			1					500	6	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FD-20104				1				0		100/50 mg Charcoal (SKC 226-01)
TO11	FD-20105		1						500	7	DNPH SKC 226-119
TO11	FD-20106			1					500	8	DNPH SKC 226-119
TO11	FD-20107				1				0		DNPH SKC 226-119
NIOSH 2002	FD-20108		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FD-20109			1					1000	10	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FD-20110				1				0		150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**LF 305 ND/52-904GR ND**
RUN 2											
THC	FD-20201	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20202		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
TO11	FD-20203		1						500	7	DPNH SKC 226-119
	Excess								500	8	Excess
NIOSH 2002	FD-20204		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**LF 305 ND/52-904GR ND**
RUN3											
THC	FD-20301	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20302		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
TO11	FD-20303		1						500	7	DPNH SKC 226-119
	Excess								500	8	Excess
NIOSH 2002	FD-20304		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**LF 305 ND/52-904GR ND**
RUN 4											
THC	FD-20401	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20402		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
TO11	FD-20403		1						500	7	DPNH SKC 226-119
	Excess								500	8	Excess
NIOSH 2002	FD-20404		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**LF 305 ND/52-904GR ND**
RUN 5											
THC	FD-20501	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20502		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
TO11	FD-20503		1						500	7	DPNH SKC 226-119
	Excess								500	8	Excess
NIOSH 2002	FD-20504		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/6/2003											**LF 305 ND/52-904GR ND**
RUN 6											
THC	FD-20601	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20602		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
TO11	FD-20603		1						500	7	DPNH SKC 226-119
	Excess								500	8	Excess
NIOSH 2002	FD-20604		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/7/2003											**LF 305 ND/52-904GR ND**
RUN 7											
THC	FD-20701	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								60	4	Excess
NIOSH 1500	FD-20702		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
TO11	FD-20703		1						500	7	DPNH SKC 226-119
	Excess								500	8	Excess
NIOSH 2002	FD-20704		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
	Excess								1000	10	Excess
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/4/2003											**5-Hr. Test-Core 1 (D1)**
RUN 1											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30101		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	FD-30102			1					80	2	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30103		1						80	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	FD-30104		1						80	4	DPNH SKC 226-119
	Excess								80	5	Excess
									Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/4/2003											**5 Hour Test-Core 2 (D2)**
RUN 2											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30201		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30202		1						80	2	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	FD-30203			1					80	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	FD-30204		1						80	4	DPNH SKC 226-119
	Excess								80	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/4/2003											**5 Hour Test-Core 3 (D3)**
RUN 3											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30301		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30302		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30303		1						80	4	DPNH SKC 226-119
TO-11	FD-30304			1					90	5	DPNH SKC 226-119
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**5 Hour Test-Core 4 (D1)**
RUN 4											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30401		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30402		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30403		1						80	4	DPNH SKC 226-119
	Excess								80	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**5 Hour Test-Core 5 (D2)**
RUN 5											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30501		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30502		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30503		1						80	4	DPNH SKC 226-119
	Excess								80	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/5/2003											**5 Hour Test-Core 6 (D3)**
RUN 6											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30601		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30602		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30603		1						80	4	DPNH SKC 226-119
	Excess								90	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/6/2003											**5 Hour Test-Core 7 (D1)**
RUN 7											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30701		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30702		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30703		1						80	4	DPNH SKC 226-119
	Excess								90	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/6/2003											**5 Hour Test-Core 8 (D2)**
RUN 8											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30801		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30802		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30803		1						80	4	DPNH SKC 226-119
	Excess								90	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE FD - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
6/6/2003											**5 Hour Test-Core 9 (D3)**
RUN 9											**LF 305 ND/52-904GR ND**
NIOSH 1500	FD-30901		1						60	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	FD-30902		1						80	2	150/75 mg Silica Gel (SKC 226-10)
	Excess								80	3	Excess
TO-11	FD-30903		1						80	4	DPNH SKC 226-119
	Excess								90	5	Excess
	Excess								Variable	6	No Critical Orfice

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APPENDIX B DETAILED TEST AND PROCESS DATA FOR TESTS EQ AND FD

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Individual Core Making Results for Test FD– Lb/Lb Binder

Core Making

HAPs	VOCs	Compound/Sample Number	FD201	FD202	FD203	FD204	FD205	FD206	Average	STDEV
		Test Dates	**6/4/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/6/2003**	**6/6/2003**		
		HC as Hexane	1.42E-01	1.33E-01	1.37E-01	1.27E-01	I	I	1.35E-01	6.50E-03
		Sum of VOCs	1.78E-03	1.66E-03	1.93E-03	1.68E-03	I	I	1.76E-03	1.23E-04
		Sum of HAPs	1.78E-03	1.66E-03	1.93E-03	1.68E-03	I	I	1.76E-03	1.23E-04
		Sum of POMs	9.00E-04	8.38E-04	9.66E-04	9.15E-04	I	I	9.05E-04	5.31E-05
		Individual HAPs and VOCs								
x	z	**Naphthalene**	9.00E-04	8.38E-04	9.66E-04	9.15E-04	I	I	9.05E-04	5.31E-05
x		**Phenol**	6.73E-04	6.08E-04	7.58E-04	6.31E-04	I	I	6.67E-04	6.61E-05
x		**Formaldehyde**	2.11E-04	2.14E-04	2.04E-04	1.34E-04	I	I	1.91E-04	3.79E-05
x		**o,m,p-Cresol**	ND	ND	ND	ND	I	I	ND	NA
x	z	**1-Methylnaphthalene**	ND	ND	ND	ND	I	I	ND	NA
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	I	I	ND	NA

ND : Non Detect; NA: Not Applicable

I: Data rejected based on data validation considerations.

Individual Core Storage Results for Test FD– Lb/Lb Binder

Core Storage

HAPs	VOCs	Compound/Sample Number	FD301	FD302	FD303	FD304	FD305	FD306	FD307	FD308	FD309	Average	STDI
		Test Dates	**6/4/2003**	**6/4/2003**	**6/4/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/6/2003**	**6/6/2003**	**6/6/2003**		
		HC as Hexane	I	2.91E-02	3.46E-02	4.23E-02	3.67E-02	4.14E-02	3.68E-02	3.68E-02	3.78E-02	3.69E-02	4.07E
		Sum of VOCs	I	6.22E-04	8.13E-04	7.45E-04	6.12E-04	7.98E-04	6.16E-04	5.83E-04	7.43E-04	6.92E-04	9.30E
		Sum of HAPs	I	6.22E-04	8.13E-04	7.45E-04	6.12E-04	7.98E-04	6.16E-04	5.83E-04	7.43E-04	6.92E-04	9.30E
		Sum of POMs	I	5.55E-04	7.45E-04	6.61E-04	5.49E-04	7.33E-04	5.51E-04	5.22E-04	6.80E-04	6.24E-04	9.02E
		Individual HAPs and VOCs											
x	z	**Naphthalene**	I	5.55E-04	7.45E-04	6.61E-04	5.49E-04	7.33E-04	5.51E-04	5.22E-04	6.80E-04	6.24E-04	9.02E
x		**Formaldehyde**	I	5.12E-05	5.36E-05	7.10E-05	6.28E-05	6.53E-05	6.44E-05	6.06E-05	6.30E-05	6.15E-05	6.41E
x		**Phenol**	1.47E-05	1.64E-05	1.52E-05	1.32E-05	ND	ND	ND	ND	ND	6.61E-06	7.88E
x		**o,m,p-Cresol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1-Methylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2-Methylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

ND : Non Detect; NA: Not Applicable

I: Data rejected based on data validation considerations.

Individual Core Making Results for Test FD – Lb/Tn Sand

Core Making

HAPs	VOCs	Compound/Sample Number	FD201	FD202	FD203	FD204	FD205	FD206	Average	STDEV
		Test Dates	**6/4/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/6/2003**	**6/6/2003**		
		HC as Hexane	4.88E+00	4.56E+00	4.71E+00	4.36E+00	I	I	4.63E+00	2.21E-01
		Sum of VOCs	6.12E-02	5.69E-02	6.62E-02	5.77E-02	I	I	6.05E-02	4.23E-03
		Sum of HAPs	6.12E-02	5.69E-02	6.62E-02	5.77E-02	I	I	6.05E-02	4.23E-03
		Sum of POMs	3.09E-02	2.87E-02	3.32E-02	3.14E-02	I	I	3.10E-02	1.83E-03
		Individual HAPs and VOCs								
x	z	**Naphthalene**	3.09E-02	2.87E-02	3.32E-02	3.14E-02	I	I	3.10E-02	1.83E-03
x		**Phenol**	2.31E-02	2.09E-02	2.60E-02	2.17E-02	I	I	2.29E-02	2.27E-03
x		**Formaldehyde**	7.23E-03	7.33E-03	7.01E-03	4.61E-03	I	I	6.55E-03	1.30E-03
x		**o,m,p-Cresol**	ND	ND	ND	ND	I	I	ND	NA
x	z	**1-Methylnaphthalene**	ND	ND	ND	ND	I	I	ND	NA
x	z	**2-Methylnaphthalene**	ND	ND	ND	ND	I	I	ND	NA

ND : Non Detect; NA: Not Applicable

I: Data rejected based on data validation considerations.

Individual Core Storage Results for Test FD – Lb/Tn Sand

Core Storage

HAPs	VOCs	Compound/Sample Number	FD301	FD302	FD303	FD304	FD305	FD306	FD307	FD308	FD309	Average	STDE
		Test Dates	**6/4/2003**	**6/4/2003**	**6/4/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/6/2003**	**6/6/2003**	**6/6/2003**		
		HC as Hexane	I	9.97E-01	1.18E+00	1.45E+00	1.26E+00	1.42E+00	1.25E+00	1.25E+00	1.28E+00	1.26E+00	1.39E-
		Sum of VOCs	I	2.13E-02	2.78E-02	2.55E-02	2.09E-02	2.73E-02	2.09E-02	1.98E-02	2.52E-02	2.36E-02	3.20E-
		Sum of HAPs	I	2.13E-02	2.78E-02	2.55E-02	2.09E-02	2.73E-02	2.09E-02	1.98E-02	2.52E-02	2.36E-02	3.20E-
		Sum of POMs	I	1.90E-02	2.55E-02	2.26E-02	1.88E-02	2.51E-02	1.88E-02	1.77E-02	2.31E-02	2.13E-02	3.11E-
		Individual HAPs and VOCs											
x	z	**Naphthalene**	I	1.90E-02	2.55E-02	2.26E-02	1.88E-02	2.51E-02	1.88E-02	1.77E-02	2.31E-02	2.13E-02	3.11E-
x		**Formaldehyde**	I	1.75E-03	1.83E-03	2.43E-03	2.15E-03	2.23E-03	2.19E-03	2.06E-03	2.14E-03	2.10E-03	2.18E-
x		**Phenol**	5.03E-04	5.63E-04	5.18E-04	4.50E-04	ND	ND	ND	ND	ND	2.26E-04	2.70E-
x		**o,m,p-Cresol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**1-Methylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
x	z	**2-Methylnaphthalene**	I	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

ND : Non Detect; NA: Not Applicable

I: Data rejected based on data validation considerations.

Test FD Process and Source Data – Core Making

Core Make Test	1	2	3	4	5	6**	7**	Average 1.75% (1-7)
Date	**6/4/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/6/2003**	**6/6/2003**	
Emission test no.	**FD201**	**FD202**	**FD203**	**FD204**	**FD205**	**FD206**	**FD207**	
Average core weight, Lbs.	7.14	7.23	7.07	7.32	Aborted*	7.27	7.21	7.21
Total coated sand weight, Lbs.	214.05	216.85	212.05	234.10	Aborted*	218.12	216.15	218.55
Calculated Total Binder weight, Lbs.	3.67	3.72	3.64	4.02	Aborted*	3.73	3.70	3.75
Calculated % Binder (BOS)	1.75	1.75	1.75	1.75	Aborted*	1.74	1.74	1.74
Calculated standard % binder	1.715	1.716	1.715	1.716	Aborted*	1.712	1.711	1.714
1800 F LOI, % (note 1)	ND	ND	ND	ND	Aborted*	ND	ND	NA
Sand temperature, Deg F	95	84	85	85	Aborted*	87	85	86
Dogbone Core 2 hr. tensile strength	ND	ND	204	204	Aborted*	164	164	164
TEA Injection/cycle, gm/cycle (typical)	5	5	5	5	Aborted*	5	5	5
Blow pressure, psi	40	40	40	40	Aborted*	40	40	40
Max. purge pressure, psi	45	45	45	45	Aborted*	45	45	45
Purge duration, sec	20	20	20	20	Aborted*	20	20	20
Machine cycles per test	30	30	30	32	Aborted*	30	30	30
Ave.core machine cycle time, sec.	60	67	73	68	Aborted*	69	69	68

* Aborted test due to sand chuncks blocking blow head holes

Emission records FD205 & FD206 correspond ro Process records FD206 & FD207 respectively

Test FD Process and Source Data – Core Storage

Core Storage Test	1	1	1	2	2	2	3	3	3	Average 1.75% (7-12)
Date	**6/4/2003**	**6/4/2003**	**6/4/2003**	**6/5/2003**	**6/5/2003**	**6/5/2003**	**6/6/2003**	**6/6/2003**	**6/6/2003**	
Emission test no.	**FD301**	**FD302**	**FD303**	**FD304**	**FD305**	**FD306**	**FD307**	**FD308**	**FD309**	
Total coated sand weight, Lbs.	7.30	7.25	7.25	7.25	7.25	7.25	7.35	7.30	7.30	**7.28**
Calculated total binder weight, Lbs.	0.125	0.124	0.124	0.124	0.124	0.124	0.125	0.124	0.124	**0.125**
Calculated standard % binder	1.75	1.75	1.75	1.75	1.75	1.75	1.73	1.73	1.73	**1.74**
Calculated % binder (BOS)	1.72	1.72	1.72	1.72	1.72	1.72	1.70	1.70	1.70	**1.71**
Sand temperature, Deg F	98	98	98	84	84	84	83	83	83	**86**
1800 F LOI, % (note 1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	**NA**
TEA Injection/cycle, gm/cycle (typical)	5	5	5	5	5	5	5	5	5	**5**
Blow pressure, psi	40	40	40	40	40	40	40	40	40	**40**
Max Purge Pressure, psi	45	45	45	45	45	45	45	45	45	**45**
Purge duration, sec	20	20	20	20	20	20	20	20	20	**20**
Machine cycles per test	1	1	1	1	1	1	1	1	1	**1**
Ave.core machine cycle time, sec.	54	55	57	61	59	57	120	67	63	**66**

Machine cycle time for FD307 includes core box clean time

Individual Core Making and Core Storage Results for Test EQ– Lb/Lb Binder

Core Making

HAPs	POMs	Compound/Sample Number	EQ021	EQ022	EQ023	EQ024	EQ025	EQ026	EQ027	EQ028	EQ029	Average	STDEV
		Test Dates	**9/11/02**	**9/11/02**	**9/11/02**	**9/11/02**	**9/11/02**	**9/12/02**	**9/12/02**	**9/12/02**	**9/12/02**		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	7.29E-02	7.70E-02	7.83E-02	8.51E-02	7.96E-02	6.93E-02	7.29E-02	7.04E-02	7.15E-02	7.52E-02	5.14E-03
		Sum of VOCs	1.14E-03	1.70E-03	1.58E-03	1.68E-03	1.40E-03	1.22E-03	1.32E-03	1.38E-03	1.49E-03	1.43E-03	1.96E-04
		Sum of HAPs	1.14E-03	1.70E-03	1.58E-03	1.68E-03	1.40E-03	1.22E-03	1.32E-03	1.38E-03	1.49E-03	1.43E-03	1.96E-04
		Sum of POMs	7.58E-04	1.27E-03	1.21E-03	1.27E-03	1.07E-03	8.32E-04	9.07E-04	9.73E-04	1.10E-03	1.04E-03	1.88E-04
			Individual Organic HAPs and VOCs										
x	z	**2-Methylnaphthalene**	3.04E-04	5.49E-04	5.08E-04	5.47E-04	4.52E-04	3.47E-04	3.69E-04	4.08E-04	4.58E-04	4.38E-04	8.77E-05
x	z	**Naphthalene**	2.77E-04	4.47E-04	3.96E-04	4.00E-04	3.44E-04	2.80E-04	3.16E-04	3.21E-04	3.66E-04	3.50E-04	5.77E-05
x		**Phenol**	2.98E-04	3.41E-04	2.92E-04	3.30E-04	2.98E-04	3.07E-04	3.15E-04	3.15E-04	2.97E-04	3.10E-04	1.67E-05
x	z	**1-Methylnaphthalene**	1.77E-04	2.77E-04	3.04E-04	3.23E-04	2.70E-04	2.06E-04	2.22E-04	2.45E-04	2.77E-04	2.55E-04	4.73E-05
x		**Formaldehyde**	8.02E-05	9.05E-05	8.03E-05	7.81E-05	3.39E-05	8.35E-05	9.37E-05	8.95E-05	9.15E-05	8.01E-05	1.83E-05
x		**o-Cresol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA

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

Core Storage

HAPs	POMs	Compound/Sample Number	EQ031	EQ032	EQ033	EQ034	EQ035	EQ036	EQ037	EQ038	EQ039	Average	STDEV
		Test Dates	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	1.71E-02	1.47E-02	1.80E-02	I	1.74E-02	2.09E-02	1.54E-02	1.59E-02	1.74E-02	1.71E-02	1.91E-03
		Sum of VOCs	8.64E-04	6.08E-04	8.66E-04	I	7.18E-04	8.92E-04	5.80E-04	6.78E-04	8.04E-04	7.51E-04	1.22E-04
		Sum of HAPs	8.64E-04	6.08E-04	8.66E-04	I	7.18E-04	8.92E-04	5.80E-04	6.78E-04	8.04E-04	7.51E-04	1.22E-04
		Sum of POMs	8.46E-04	5.92E-04	8.48E-04	I	7.11E-04	8.84E-04	5.64E-04	6.61E-04	7.85E-04	7.36E-04	1.23E-04
			Individual Organic HAPs and VOCs										
x	z	**2-Methylnaphthalene**	3.16E-04	2.13E-04	2.96E-04	I	2.53E-04	3.09E-04	2.11E-04	2.34E-04	2.96E-04	2.66E-04	4.34E-05
x	z	**Naphthalene**	2.90E-04	1.99E-04	2.86E-04	I	2.48E-04	3.08E-04	2.05E-04	2.43E-04	2.78E-04	2.57E-04	4.01E-05
x	z	**1-Methylnaphthalene**	2.41E-04	1.79E-04	2.66E-04	I	2.10E-04	2.67E-04	1.48E-04	1.84E-04	2.10E-04	2.13E-04	4.27E-05
x		**Formaldehyde**	1.75E-05	1.69E-05	1.84E-05	I	7.16E-06	8.16E-06	1.63E-05	1.68E-05	1.83E-05	1.49E-05	4.56E-06
x		**o-Cresol**	ND	ND	ND	I	ND	ND	ND	ND	ND	NA	NA
x		**Phenol**	ND	ND	ND	I	ND	ND	ND	ND	ND	NA	NA

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

Individual Core Making and Core Storage Results for Test EQ– Lb/Tn and

Core Making

HAPs	POMs	Compound/Sample Number	EQ021	EQ022	EQ023	EQ024	EQ025	EQ026	EQ027	EQ028	EQ029	Average	STDEV
		Test Dates	**9/11/2002**	**9/11/2002**	**9/11/2002**	**9/11/2002**	**9/11/2002**	**9/12/2002**	**9/12/2002**	**9/12/2002**	**9/12/2002**		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	2.54E+00	2.69E+00	2.74E+00	2.98E+00	2.79E+00	2.41E+00	2.53E+00	2.47E+00	2.51E+00	2.63E+00	1.84E-01
		Sum of VOCs	3.96E-02	5.95E-02	5.54E-02	5.87E-02	4.90E-02	4.25E-02	4.58E-02	4.82E-02	5.21E-02	5.01E-02	6.94E-03
		Sum of HAPs	3.96E-02	5.95E-02	5.54E-02	5.87E-02	4.90E-02	4.25E-02	4.58E-02	4.82E-02	5.21E-02	5.01E-02	6.94E-03
		Sum of POMs	2.64E-02	4.44E-02	4.24E-02	4.44E-02	3.74E-02	2.89E-02	3.15E-02	3.41E-02	3.85E-02	3.65E-02	6.65E-03
			Individual Organic HAPs and VOCs										
x	z	**2-Methylnaphthalene**	1.06E-02	1.92E-02	1.78E-02	1.91E-02	1.59E-02	1.21E-02	1.28E-02	1.43E-02	1.60E-02	1.53E-02	3.09E-03
x	z	**Naphthalene**	9.66E-03	1.56E-02	1.39E-02	1.40E-02	1.20E-02	9.73E-03	1.10E-02	1.12E-02	1.28E-02	1.22E-02	2.03E-03
x		**Phenol**	1.04E-02	1.19E-02	1.03E-02	1.16E-02	1.04E-02	1.07E-02	1.10E-02	1.10E-02	1.04E-02	1.08E-02	5.73E-04
x	z	**1-Methylnaphthalene**	6.17E-03	9.65E-03	1.07E-02	1.13E-02	9.46E-03	7.15E-03	7.72E-03	8.56E-03	9.70E-03	8.93E-03	1.67E-03
x		**Formaldehyde**	2.80E-03	3.16E-03	2.82E-03	2.73E-03	1.19E-03	2.90E-03	3.26E-03	3.13E-03	3.21E-03	2.80E-03	6.36E-04
x		**o-cresol**	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA; Not Applicable

Core Storage

HAPs	POMs	Compound/Sample Number	EQ031	EQ032	EQ033	EQ034	EQ035	EQ036	EQ037	EQ038	EQ039	Average	STDEV
		Test Dates	**9/9/2002**	**9/9/2002**	**9/9/2002**	**9/9/2002**	**9/9/2002**	**9/9/2002**	**9/9/2002**	**9/9/2002**	**9/9/2002**		
		TGOC as Propane	NA	NA	NA	I	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	5.97E-01	5.16E-01	6.31E-01	I	6.14E-01	7.39E-01	5.42E-01	5.58E-01	6.09E-01	6.01E-01	6.85E-02
		Sum of VOCs	3.02E-02	2.13E-02	3.03E-02	I	2.54E-02	3.15E-02	2.03E-02	2.38E-02	2.82E-02	2.64E-02	4.30E-03
		Sum of HAPs	3.02E-02	2.13E-02	3.03E-02	I	2.54E-02	3.15E-02	2.03E-02	2.38E-02	2.82E-02	2.64E-02	4.30E-03
		Sum of POMs	2.96E-02	2.07E-02	2.97E-02	I	2.51E-02	3.12E-02	1.98E-02	2.32E-02	2.75E-02	2.58E-02	4.33E-03
			Individual Organic HAPs and VOCs										
x	z	**2-Methylnaphthalene**	1.10E-02	7.47E-03	1.04E-02	I	8.94E-03	1.09E-02	7.38E-03	8.21E-03	1.04E-02	9.34E-03	1.52E-03
x	z	**Naphthalene**	1.01E-02	6.97E-03	1.00E-02	I	8.75E-03	1.09E-02	7.20E-03	8.50E-03	9.75E-03	9.02E-03	1.41E-03
x	z	**1-Methylnaphthalene**	8.43E-03	6.26E-03	9.30E-03	I	7.42E-03	9.42E-03	5.19E-03	6.45E-03	7.37E-03	7.48E-03	1.50E-03
x		**Formaldehyde**	6.12E-04	5.92E-04	6.45E-04	I	2.53E-04	2.88E-04	5.70E-04	5.87E-04	6.42E-04	5.24E-04	1.59E-04
x		**o-cresol**	ND	ND	ND	I	ND	ND	ND	ND	ND	NA	NA
x		**Phenol**	ND	ND	ND	I	ND	ND	ND	ND	ND	NA	NA

I: Data rejected based on data validation considerations.

ND: Non Detect; NA; Not Applicable

Test EQ Process and Source Data – Core Making and Core Storage

Core Make Test	1	2	3	4	5	6	7	8	9	Average All	Report Average
Date	**9/11/02**	**9/11/02**	**9/11/02**	**9/11/02**	**9/11/02**	**9/12/02**	**9/12/02**	**9/12/02**	**9/12/02**		
Emission test No.	**EQ021**	**EQ022**	**EQ023**	**EQ024**	**EQ025**	**EQ026**	**EQ027**	**EQ028**	**EQ029**		
Total coated sand weight, Lbs.	212.8	210.9	213.3	200.6	197.4	212.2	212.8	213.7	215.8	209.9	**209.9**
Calculated Total Binder weight, Lbs.	3.71	3.68	3.74	3.51	3.46	3.69	3.70	3.74	3.78	3.7	**3.67**
Calculated % Binder (BOS)	1.745	1.747	1.754	1.750	1.754	1.741	1.738	1.750	1.750	1.748	**1.748**
1800 F LOI, %	1.62	1.60	1.60	1.58	1.56	1.58	1.53	1.56	1.55	1.58	**1.58**
Sand temperature, Deg F	87.4	86.8	87	89	87	87.2	89.2	90.8	89.2	88.5	**88.5**
TEA Injection/cycle, gm/cycle	3.90	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.50	**3.50**
Blow pressure, psi	30	30	30	30	30	30	30	30	30	30.0	**30.0**
Max. Purge Pressure, psi	45	45	45	45	45	45	45	45	45	45.0	**45.0**
Purge duration, sec	20	20	20	20	20	20	20	20	20	20.0	**20.0**
Machine cycles per test	30	30	30	31	29	30	30	30	30	30.0	**30.0**
Ave.core machine cycle time, sec.	65.3	75.7	71.0	95.6	82.6	69.8	66.9	64.6	63.2	72.7	**72.7**
										Note 1	Note 1

Core Storage Test	1	1	1	1	2	2	2	2	3	3	3	3	Average All	Report Average
Date	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**	**9/9/02**		
Emission test No.	**THC1**	**EQ031**	**EQ032**	**EQ033**	**THC2**	**EQ034**	**EQ035**	**EQ036**	**THC-3**	**EQ037**	**EQ038**	**EQ039**		
Total coated sand weight, Lbs	7.25	**7.20**	**7.20**	**7.15**	7.25	**7.25**	**7.25**	**7.20**	7.30	**7.30**	**7.25**	**7.25**	7.2	**7.2**
Calculated total binder weight, Lbs.	0.127	**0.126**	**0.126**	**0.125**	0.128	**0.128**	**0.128**	**0.127**	0.128	**0.128**	**0.127**	**0.127**	0.127	**0.127**
Calculated % binder (BOS)	1.748	**1.748**	**1.748**	**1.748**	1.766	**1.766**	**1.766**	**1.766**	1.748	**1.748**	**1.748**	**1.748**	1.754	**1.754**
1800 F LOI, %	ND	**ND**	**ND**	**ND**	1.54	**1.54**	**1.54**	**1.54**	1.57	**1.57**	**1.57**	**1.57**	1.56	**1.56**
Average core weight, Lbs.	7.25	**7.20**	**7.20**	**7.15**	7.25	**7.25**	**7.25**	**7.20**	7.30	**7.30**	**7.25**	**7.25**	7.24	**7.24**
Sand temperature, Deg F	88	**88**	**88**	**88**	85	**85**	**85**	**85**	90	**90**	**90**	**90**	87.6	**87.6**
TEA Injection/cycle, gm/cycle	3.9	**3.9**	**3.9**	**3.9**	3.45	**3.45**	**3.45**	**3.45**	--	**–**	--	--	3.7	**3.7**
Blow pressure, psi	30	**30**	**30**	**30**	30	**30**	**30**	**30**	30	**30**	**30**	**30**	30	**30**
Max purge pressure, psi	45	**45**	**45**	**45**	45	**45**	**45**	**45**	45	**45**	**45**	**45**	45.0	**45.0**
Purge duration, sec	20	**20**	**20**	**20**	20	**20**	**20**	**20**	20	**20**	**20**	**20**	20.0	**20.0**
Ave.core machine cycle time, sec.	81.0	**61.0**	**61.0**	**58.0**	--	**61.0**	**59.0**	**64.0**	--	**62.0**	**85.0**	**84.0**	67.6	**67.6**
													Note 1	Note 1

Note 1: Report Averages included only validated test for which emission data are used in reporting a result Average All included all tests even thought they may have been invalidated for a process or emission data reason.

Note2: Mix test 13 was stopped prematurely. It will not be used.

Test EQ Quantitation Limits - Lb/Tn Sand

Analytes	Core Making	Core Storage
HC as hexane	3.81E-03	2.32E-03
1-methylnaphthalene	3.81E-03	2.32E-03
2-methylnaphthalene	3.81E-03	2.32E-03
naphthalene	3.81E-03	2.32E-03
o,m,p-cresol	1.12E-03	5.69E-04
formaldehyde	6.46E-05	9.32E-06
phenol	9.30E-04	4.74E-04

Test EQ Quantitation Limits - Lb/Lb Binder

Analytes	Core Making	Core Storage
HC as hexane	1.09E-04	6.57E-05
1-methylnaphthalene	1.09E-04	6.57E-05
2-methylnaphthalene	1.09E-04	6.57E-05
naphthalene	1.09E-04	6.57E-05
o,m,p-cresol	3.19E-05	1.61E-05
formaldehyde	1.85E-06	2.64E-07
phenol	2.66E-05	1.34E-05

Test FD Quantitation Limits - Lb/Tn Sand

Analytes	Core Making	Core Storage
HC as Hexane	3.63E-03	1.15E-03
1-Methylnaphthalene	3.63E-03	1.15E-03
2-Methylnaphthalene	3.63E-03	1.15E-03
Formaldehyde	1.21E-04	2.51E-05
Naphthalene	3.63E-03	1.15E-03
o,m,p-Cresol	1.07E-03	5.02E-04
Phenol	8.94E-04	4.18E-04

Test FD Quantitation Limits - Lb/Lb Binder

Analytes	Core Making	Core Storage
HC as hexane	1.06E-04	3.36E-05
1-Methylnaphthalene	1.06E-04	3.36E-05
2-Methylnaphthalene	1.06E-04	3.36E-05
Formaldehyde	3.54E-06	7.30E-07
Naphthalene	1.06E-04	3.36E-05
o,m,p-Cresol	3.13E-05	1.46E-05
Phenol	2.61E-05	1.22E-05

APPENDIX C METHOD 25A CHARTS

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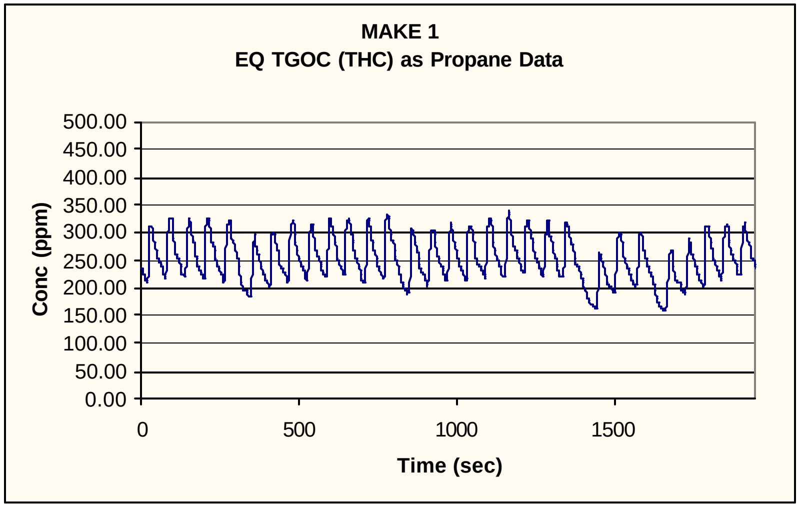
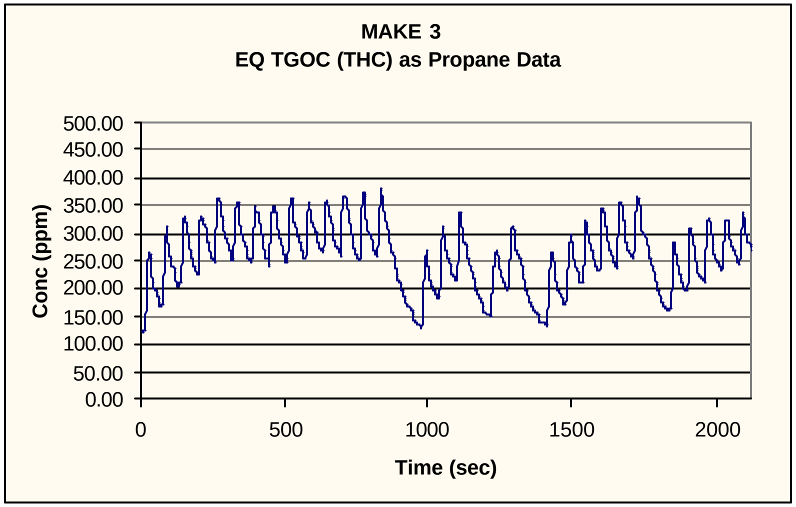
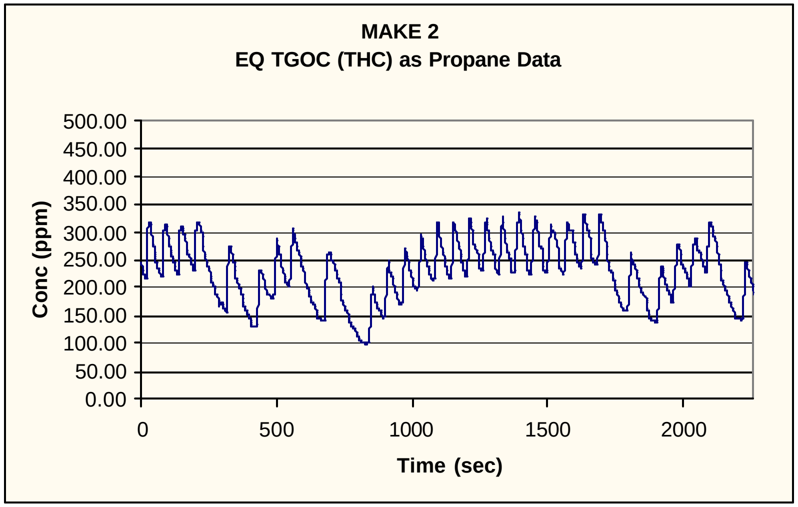
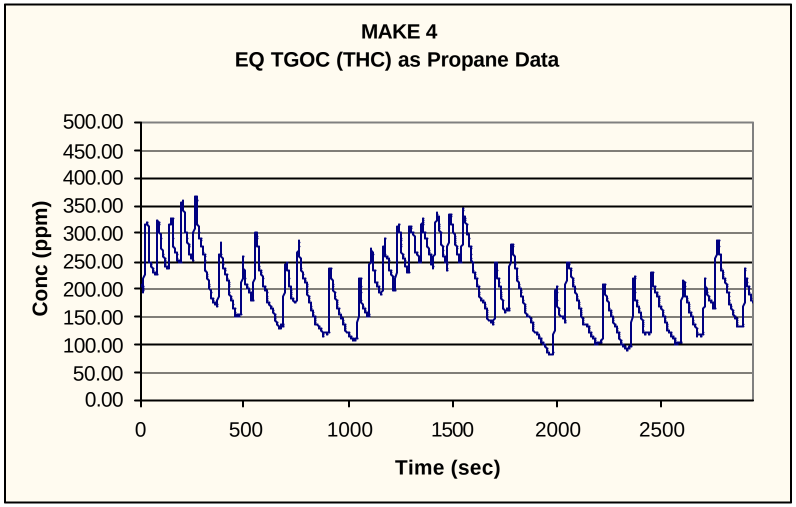
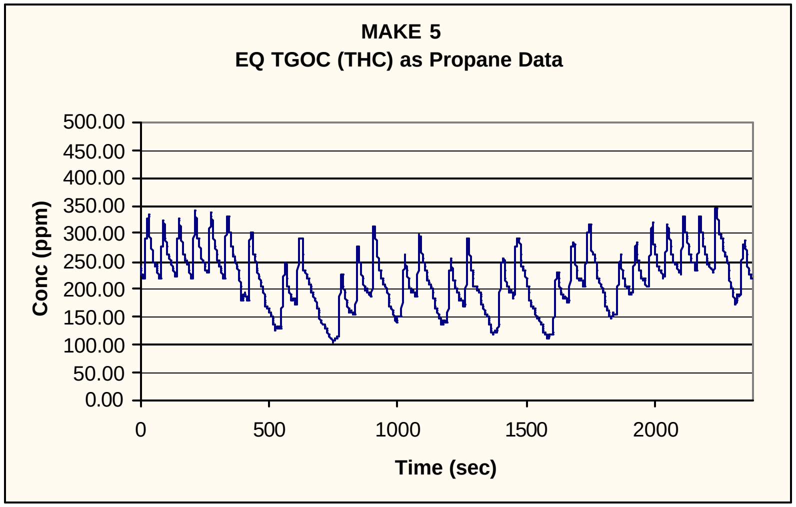
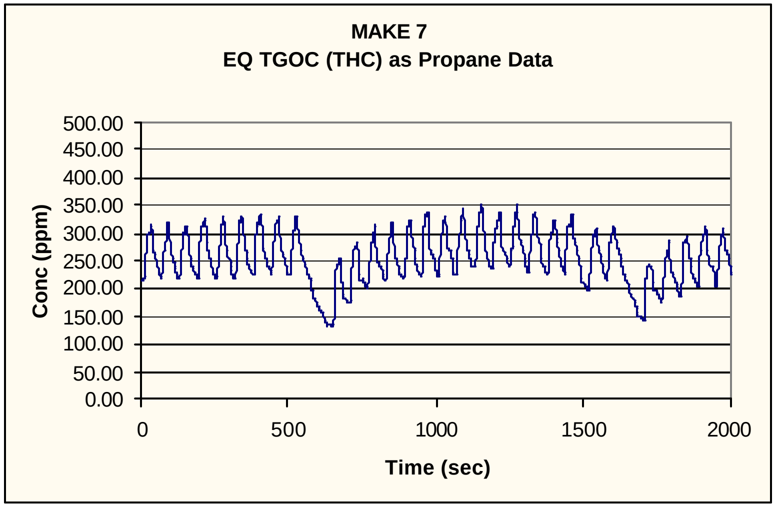

MAKE 1
EQ TGOC (THC) as Propane Data
Conc (ppm)
Time (sec)

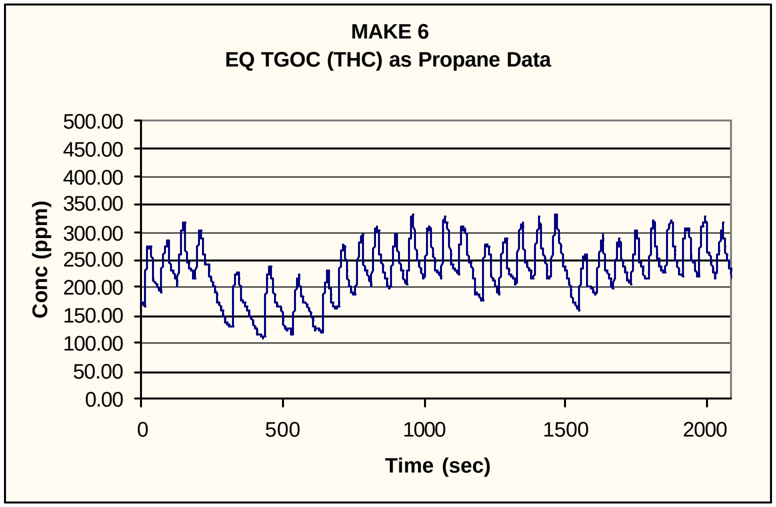

MAKE 3
EQ TGOC (THC) as Propane Data
Conc (ppm)
Time (sec)

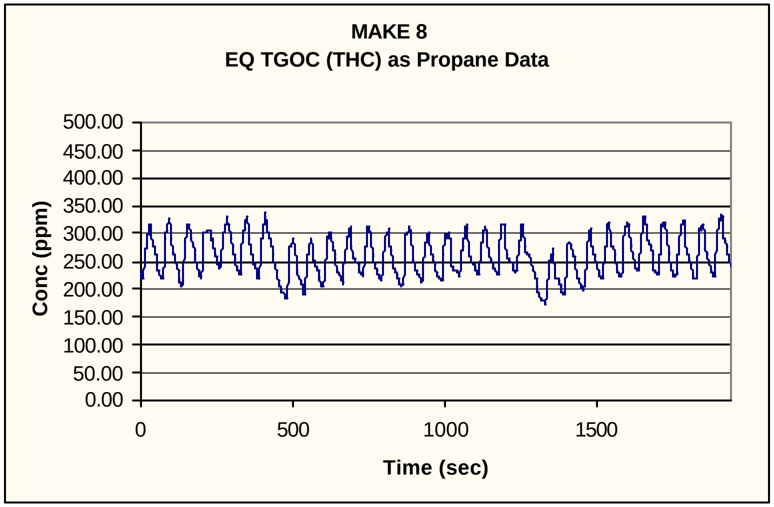

MAKE 2
EQ TGOC (THC) as Propane Data
Conc (ppm)
Time (sec)

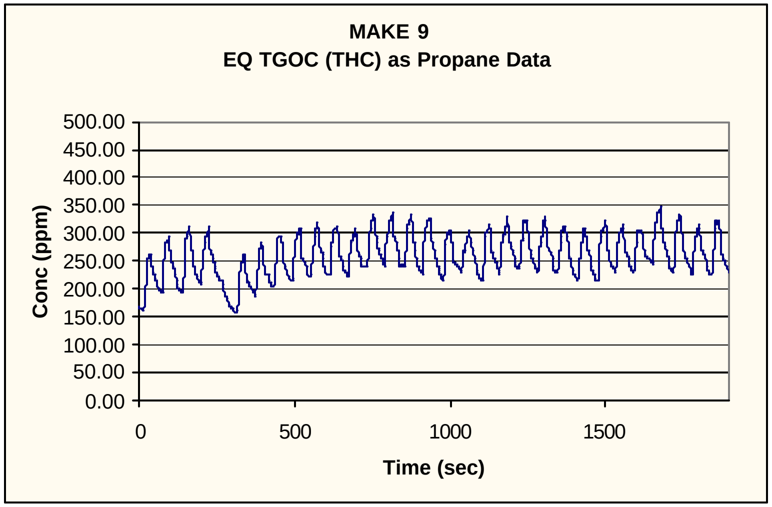

MAKE 4
EQ TGOC (THC) as Propane Data
Conc (ppm)
Time (sec)

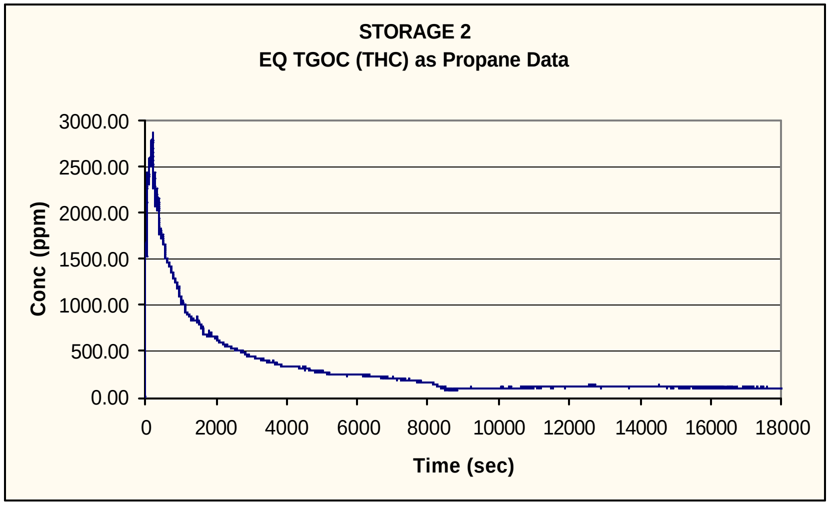

MAKE 5
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

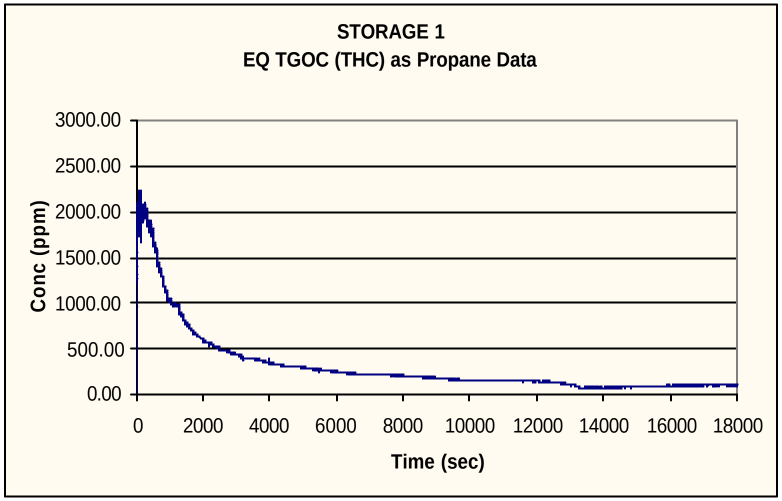

MAKE 7
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

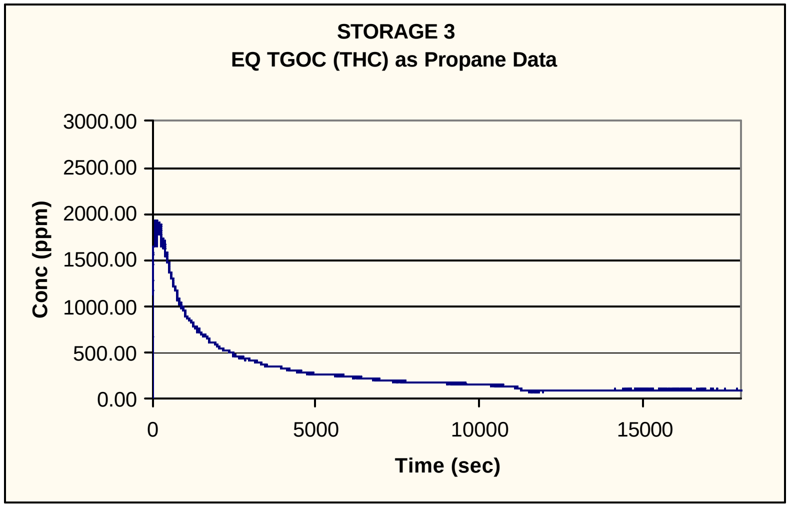

MAKE 6
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

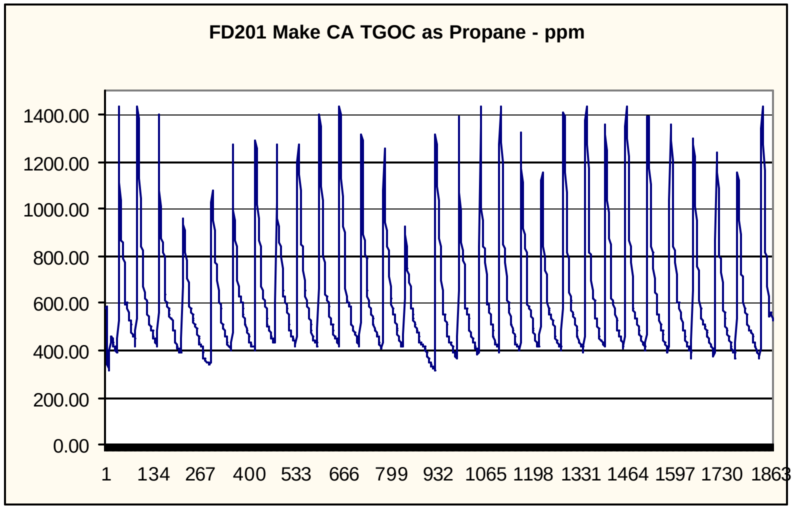

MAKE 8
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
Time (sec)

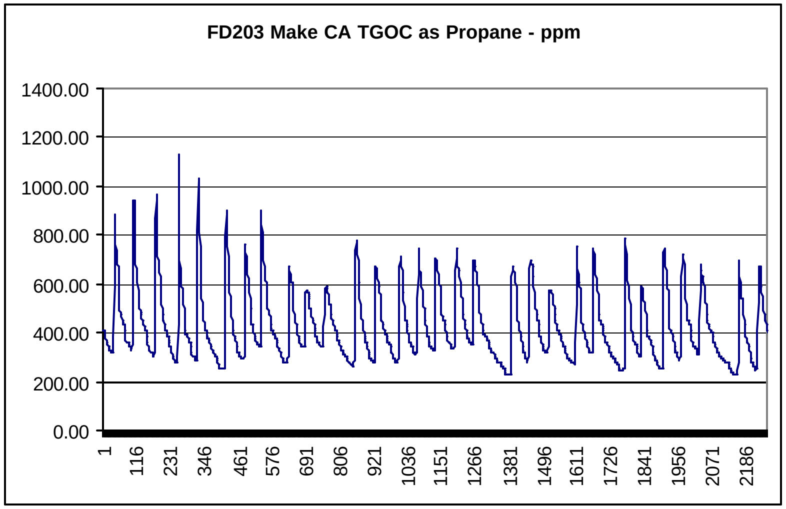

MAKE 9
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
Time (sec)

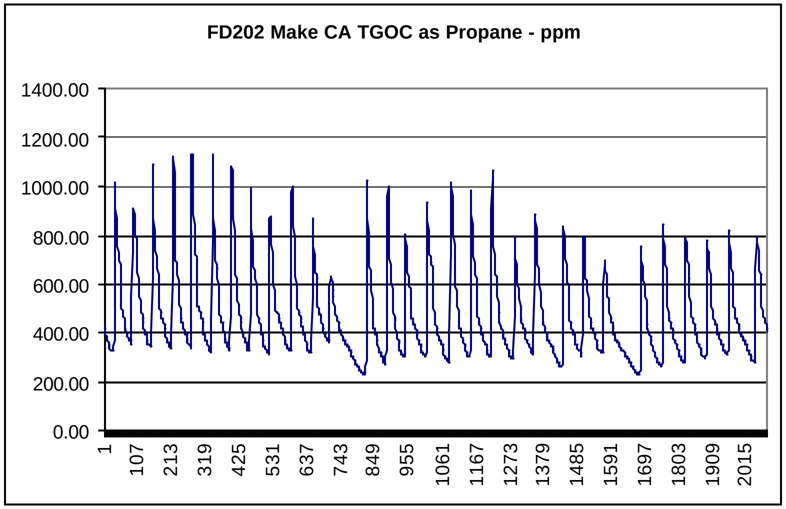

STORAGE 2
EQ TGOC (THC) as Propane Data
Conc (ppm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Time (sec)

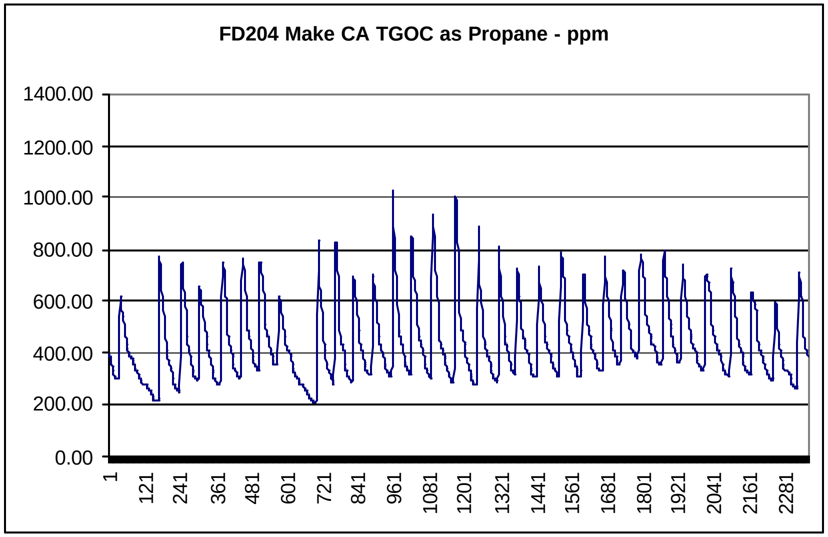

STORAGE 1
EQ TGOC (THC) as Propane Data
Conc (ppm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Time (sec)

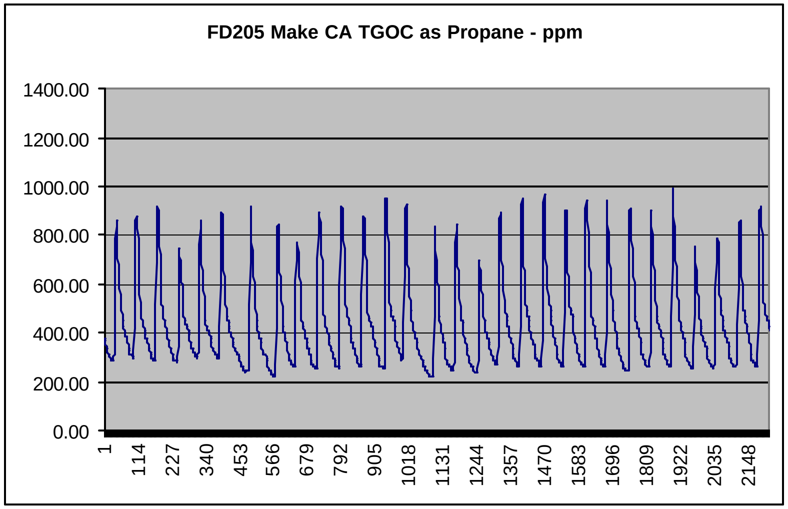

STORAGE 3
EQ TGOC (THC) as Propane Data
Conc (ppm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0
5000
10000
15000
Time (sec)

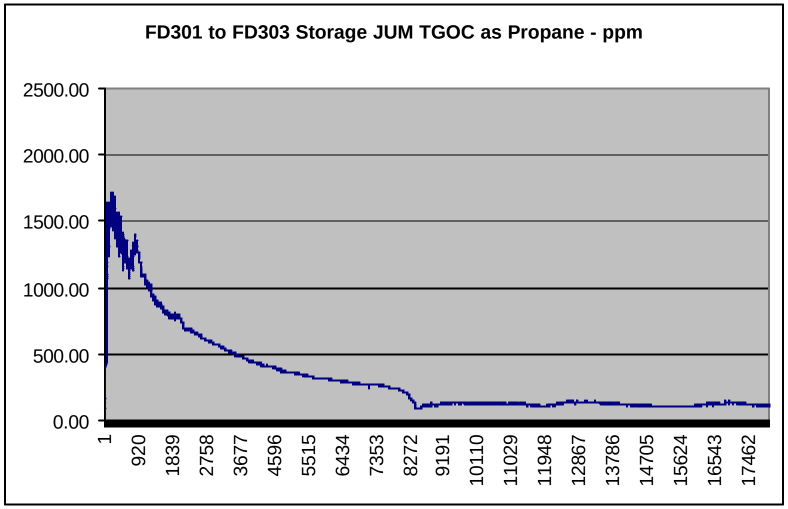

FD201 Make CA TGOC as Propane - ppm
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1 134 267 400 533 666 799 932 1065 1198 1331 1464 1597 1730 1863

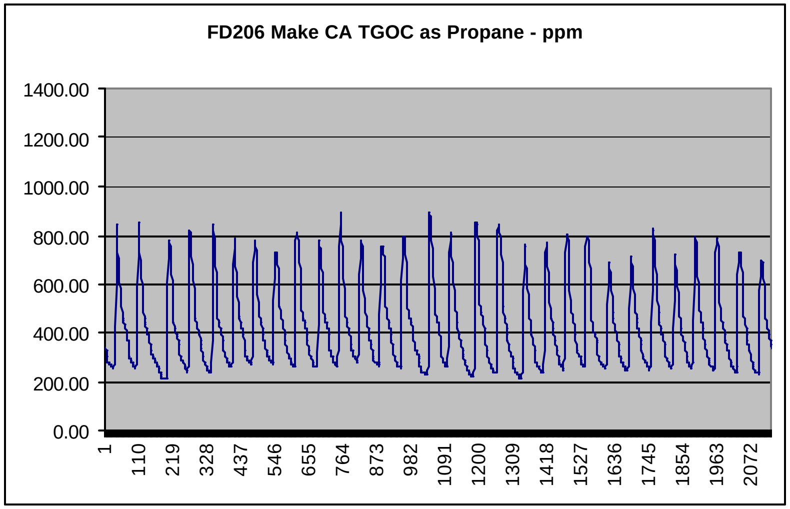

FD203 Make CA TGOC as Propane - ppm
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1 116 231 346 461 576 691 806 921 1036 1151 1266 1381 1496 1611 1726 1841 1956 2071 2186

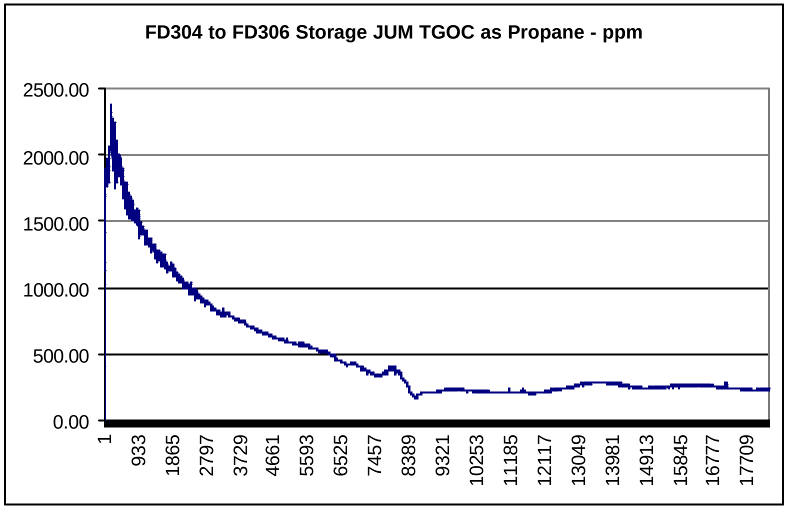

FD202 Make CA TGOC as Propane - ppm
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1 107 213 319 425 531 637 743 849 955 1061 1167 1273 1379 1485 1591 1697 1803 1909 2015

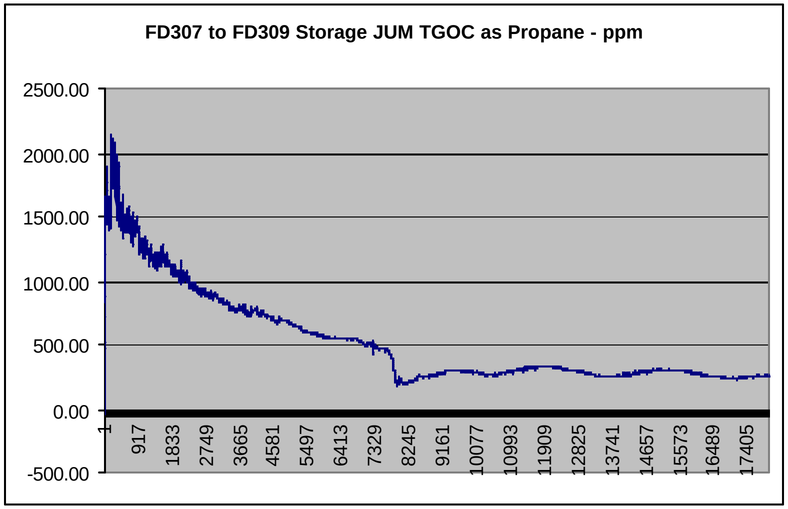

FD204 Make CA TGOC as Propane - ppm
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1 121 241 361 481 601 721 841 961 1081 1201 1321 1441 1561 1681 1801 1921 2041 2161 2281


FD205 Make CA TGOC as Propane - ppm
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1 114 227 340 453 566 679 792 905 1018 1131 1244 1357 1470 1583 1696 1809 1922 2035 2148


FD301 to FD303 Storage JUM TGOC as Propane - ppm
2500.00
2000.00
1500.00
1000.00
500.00
0.00
1 920 1839 2758 3677 4596 5515 6434 7353 8272 9191 10110 11029 11948 12867 13786 14705 15624 16543 17462


FD206 Make CA TGOC as Propane - ppm
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1 110 219 328 437 546 655 764 873 982 1091 1200 1309 1418 1527 1636 1745 1854 1963 2072


FD304 to FD306 Storage JUM TGOC as Propane - ppm
2500.00
2000.00
1500.00
1000.00
500.00
0.00
1 933 1865 2797 3729 4661 5593 6525 7457 8389 9321 10253 11185 12117 13049 13981 14913 15845 16777 17709


FD307 to FD309 Storage JUM TGOC as Propane - ppm
2500.00
2000.00
1500.00
1000.00
500.00
0.00
-500.00
1
917
1833
2749
3665
4581
5497
6413
7329
8245
9161
10077
10993
11909
12825
13741
14657
15573
16489
17405

APPENDIX D GLOSSARY

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Glossary

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