Casting Emission Reduction Program

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VOC Emissions from Sand Mix, Core Making and Storage

Core Room Vendor Test HA International 7211/7621
Technikon Test #1409-112 ES

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EPA United States Environmental Protection Agency

CISA

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

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VOC Emissions from Sand Mix, Core Making and Storage

Core Room Vendor Test HA International 7211/7621

1409-112 ES

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 test was divided into three segments, core mixing, core blowing, and core storage. Core mixing was performed using a Redford/Carver 50 pound core sand mixer. 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 ES, each test segment consisted of six (6) replicate runs at both 1.2% binder (BOS) and 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.

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

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

Analyte	Mixing			Making			Storage			Total		
	ES		EQ	ES		EQ	ES		EQ	ES		EQ
	1.20%	1.75%	1.75%	1.20%	1.75%	1.75%	1.20%	1.75%	1.75%	1.20%	1.75%	1.75%
TGOC as Propane	0.0037	0.0031	0.0041	NA	NA	NA	NA	NA	NA	NA	NA	NA
HC as Hexane	0.0015	0.0012	0.0021	0.0912	0.0643	0.0752	0.0274	0.0217	0.0171	0.1201	0.0871	0.0944
Sum of VOCs	0.0001	0.0001	0.0001	0.0028	0.0021	0.0014	0.0016	0.0011	0.0008	0.0045	0.0033	0.0023
Sum of HAPs	0.0001	0.0001	0.0001	0.0028	0.0021	0.0014	0.0016	0.0011	0.0008	0.0045	0.0033	0.0023
Sum of POMs	ND	ND	ND	0.0021	0.0015	0.0010	0.0016	0.0010	0.0007	0.0036	0.0026	0.0018

NA = Not Applicable ND = Not Detected. TGOC measures all carbon-containing organic compounds. The predominant organic in these test segments was the triethylamine catalyst which was not a target analyte.

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

Analyte	Mixing			Making			Storage			Total		
	ES	ES	EQ	ES	ES	EQ	ES	ES	EQ	ES	ES	EQ
	1.20%	1.75%	1.75%	1.20%	1.75%	1.75%	1.20%	1.75%	1.75%	1.20%	1.75%	1.75%
TGOC as Propane	0.0862	0.1058	0.1892	NA	NA	NA	NA	NA	NA	NA	NA	NA
HC as Hexane	0.0359	0.0393	0.0889	2.1429	2.1947	2.7191	0.6796	0.7149	0.6006	2.8585	2.9489	3.4086
Sum of VOCs	0.0023	0.0027	0.0031	0.0662	0.0723	0.0501	0.0395	0.0362	0.0264	0.1080	0.1112	0.0796
Sum of HAPs	0.0023	0.0027	0.0031	0.0662	0.0723	0.0501	0.0395	0.0362	0.0264	0.1080	0.1112	0.0796
Sum of POMs	ND	ND	ND	0.0487	0.0525	0.0365	0.0385	0.0350	0.0258	0.0871	0.0874	0.0623

NA = Not Applicable ND = Not Detected. TGOC measures all carbon-containing organic compounds. The predominant organic in these test segments was the triethylamine catalyst which was not a target analyte.

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 (US CAR). Its purpose is to evaluate alternative casting materials and processes that are designed to reduce air emissions and/or produce more efficient casting processes. Other technical partners directly supporting the project include: the American Foundry Society (AFS); the Casting Industry Suppliers Association (CISA); the US Environmental Protection Agency (US EPA); and the California Air Resources Board (CARB).

1.2 Technikon Objectives

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

The Production Foundry provides simultaneous detailed individual emission measurements using methods based on US EPA protocols for the melting, pouring, sand preparation, mold making, and core making processes. The core making area of the Production foundry contains three core blowers, a Georg Fischer for the preparation of automotive block cores, a Redford that is used for the production of step cores, and a second smaller Redford 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, and Section 5 contains recommendations for further testing.

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

1.4 Specific Test Plan and Objectives

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

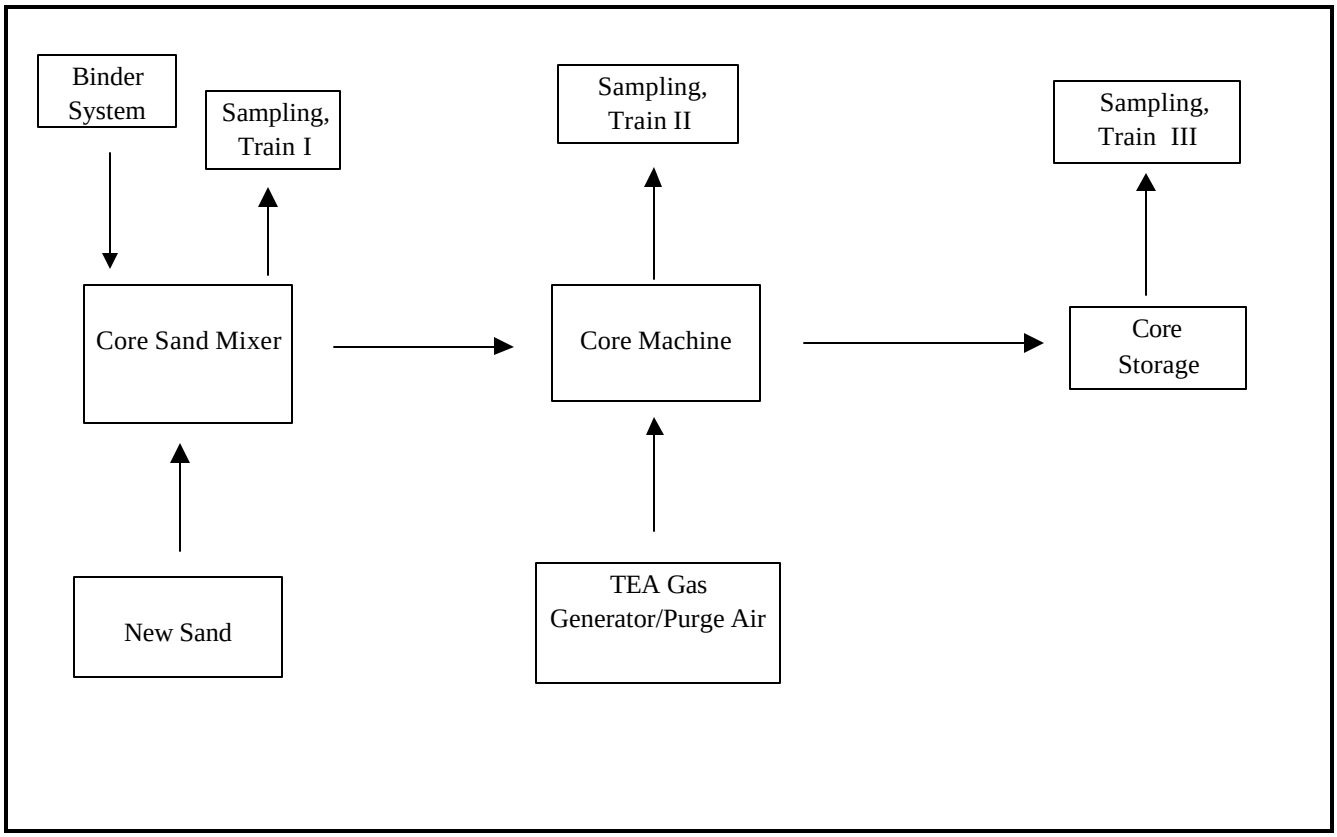
	Test ES	Test EQ
Type of Process Tested	Core Making Emissions Study	Core Making Emissions Baseline
Test Plan Number	1409-112	1409-123
Binder System	Phenolic Urethane Cold Box HA-International Sigmacure® 7211/7621	Phenolic Urethane Cold Box Ashland ISOCURE® LF305/52-904GR
Number of tests	6 each at core blowing, core mixing, and core storage at both 1.2% and 1.75% binder levels	9 each at core blowing, core mixing, and core storage at 1.75% binder level
Test Date	10/2/02 > 10/15/02	8/19/02 > 9/13/02
Emissions Measured	TGOC as Propane, HC as Hexane, Benzene, Naphthalene, o-Cresol, Phenol, Formaldehyde	TGOC as Propane, HC as Hexane, Benzene, 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

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.

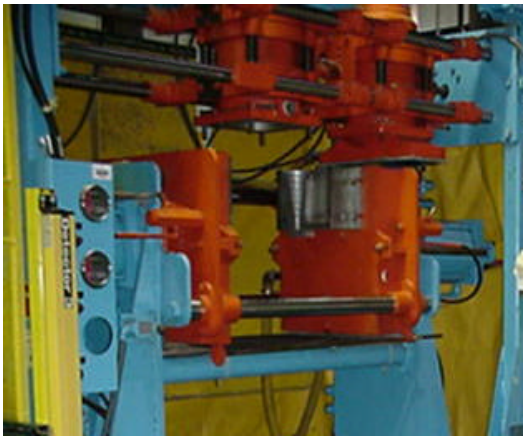
2. **Sand Preparation:** Sands are mixed with quantities of designated binders in a covered 50-pound capacity paddle type cylindrical mixer qualifying as a temporary total enclosure, meeting US EPA Method 204. The sand is preheated or cooled as required to a standard

temperature range. The mixer is continuously bathed in temperature-controlled air to maintain the process and air sampling 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. Emission sampling is accomplished via a heated sample probe located centrally in the headspace of the mixing chamber.

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 in a 50-pound capacity paddle-type sand mixer, 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 three (3) segments. The mixing emissions were collected from a 50-pound capacity core sand mixer for seven (7) minutes after the background level had stabilized. The mixed sand was discharged into the Redford Carver core machine sand storage hopper. Air samples were collected during the seven (7) minute mix cycle including the charging and discharging events.



Core Making

Core Storage

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.

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. **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 USEPA 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. **Data Reduction, Tabulation and Preliminary Report Preparation:** 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 sand mixing and the storage segments 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. **Report Preparation and Review:** 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 Technikon Standard Operating Procedures. In order to ensure the timely review of critical quality control parameters, the following procedures are followed:

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

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

3.0 Test Results

The average emission results for Test ES in pounds 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 0.24 pounds per pound of binder or 24% 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 ES expressed in pounds per pound of binder.

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

Table 3-5 includes the average emissions results along with the percentage differences between the baseline EQ and the test ES 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, 3-2, 3-6, and 3-7 represent the results for each binder level from Tables 3-1 and 3-5 in graphical form.

Figures 3-3 through 3-5 and 3-8 through 3-10 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 ES – Lb/Lb Binder

Analytes	Mixing		Making		Storage	
	1.20%	1.75%	1.20%	1.75%	1.20%	1.75%
TGOC as Propane	0.0037	0.0031	NA	NA	NA	NA
HC as Hexane	0.0015	0.0012	0.0912	0.0643	0.0274	0.0217
Sum of VOCs	0.0001	0.0001	0.0028	0.0021	0.0016	0.0011
Sum of HAPs	0.0001	0.0001	0.0028	0.0021	0.0016	0.0011
Sum of POMs	ND	ND	0.0021	0.0015	0.0016	0.0010
	Individual HAPs and VOCs					
Phenol	0.0001	0.0001	0.0007	0.0005	<0.0001	0.0004
Formaldehyde	<0.0001	<0.0001	0.0001	0.0000	<0.0001	<0.0001
o,m,p-Cresol	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	0.0006	0.0004	0.0004	<0.0001
2-Methylnaphthalene	ND	ND	0.0008	0.0006	0.0006	0.0002
Naphthalene	ND	ND	0.0007	0.0005	0.0006	0.0004

ND: Non Detect; NA: Not Applicable

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

Test ES	Mixing		Making		Storage		Total	
	1.20%	1.75%	1.20%	1.75%	1.20%	1.75%	1.20%	1.75%
HC as Hexane	0.6	0.5	38.0	26.8	11.4	9.0	50.1	36.3

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

Core Mixing	Test EQ	Test ES	% Difference
TGOC as Propane	0.0040	0.0031	-23
HC as Hexane	0.0021	0.0012	-43
Sum of VOCs	0.0001	0.0001	NA
Sum of HAPs	0.0001	0.0001	NA
Sum of POMs	ND	ND	NA
	Individual HAPs and VOCs		
Phenol	0.0001	0.0001	NA
Formaldehyde	<0.0001	<0.0001	NA
o,m,p-Cresol	ND	ND	NA
1-Methylnaphthalene	ND	ND	NA
2-Methylnaphthalene	ND	ND	NA
Naphthalene	ND	ND	NA

Core Making	Test EQ	Test ES	% Difference
TGOC as Propane	NA	NA	NA
HC as Hexane	0.0752	0.0643	-14
Sum of VOCs	0.0014	0.0021	50
Sum of HAPs	0.0014	0.0021	50
Sum of POMs	0.0010	0.0015	50
	Individual HAPs and VOCs		
2-Methylnaphthalene	0.0004	0.0006	50
Phenol	0.0003	0.0005	67
Naphthalene	0.0003	0.0005	67
1-Methylnaphthalene	0.0003	0.0004	33
Formaldehyde	0.0001	<0.0001	-100
o,m,p-Cresol	ND	ND	NA

Core Storage	Test EQ	Test ES	% Difference
TGOC as Propane	NA	NA	NA
HC as Hexane	0.0171	0.0217	27
Sum of VOCs	0.0008	0.0011	38
Sum of HAPs	0.0008	0.0011	38
Sum of POMs	0.0007	0.0010	43
	Individual HAPs and VOCs		
Naphthalene	0.0003	0.0004	33
2-Methylnaphthalene	0.0003	0.0004	33
1-Methylnaphthalene	0.0002	0.0002	NA
Phenol	ND	<0.0001	NA
Formaldehyde	<0.0001	<0.0001	NA
o,m,p-Cresol	ND	ND	NA

ND: Non Detect; NA: Not Applicable

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

Analytes	Mixing		Making		Storage	
	1.20%	1.75%	1.20%	1.75%	1.20%	1.75%
TGOC as Propane	0.0862	0.1058	NA	NA	NA	NA
HC as Hexane	0.0359	0.0393	2.1429	2.1947	0.6796	0.7149
Sum of VOCs	0.0023	0.0027	0.0662	0.0723	0.0395	0.0362
Sum of HAPs	0.0023	0.0027	0.0662	0.0723	0.0395	0.0362
Sum of POMs	0.0000	0.0000	0.0487	0.0525	0.0385	0.0350
	Individual HAPs and VOCs					
Phenol	0.0019	0.0023	0.0161	0.0181	0.0006	0.0007
Formaldehyde	0.0004	0.0004	0.0014	0.0017	0.0004	0.0005
1-Methylnaphthalene	ND	ND	0.0130	0.0139	0.0092	0.0081
2-Methylnaphthalene	ND	ND	0.0196	0.0211	0.0143	0.0126
Naphthalene	ND	ND	0.0160	0.0175	0.0150	0.0142
o,m,p-Cresol	ND	ND	ND	ND	ND	ND

ND: Non Detect; NA: Not Applicable

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

Core Mixing	Test EQ	Test ES	% Difference
TGOC as Propane	0.1394	0.1058	-32
HC as Hexane	0.8889	0.0393	-79
Sum of VOCs	0.0031	0.0027	-15
Sum of HAPs	0.0031	0.0027	-15
Sum of POMs	ND	ND	NA
	Individual HAPs and VOCs		
Phenol	0.0030	0.0023	-30
Formaldehyde	0.0001	0.0004	75
o,m,p-Cresol	ND	ND	NA
1-Methylnaphthalene	ND	ND	NA
2-Methylnaphthalene	ND	ND	NA
Naphthalene	ND	ND	NA

Core Making	Test EQ	Test ES	% Difference
TGOC as Propane	NA	NA	NA
HC as Hexane	2.719	2.195	-20
Sum of VOCs	0.5340	0.0723	31
Sum of HAPs	0.3980	0.0723	31
Sum of POMs	0.0365	0.0525	30
	Individual HAPs and VOCs		
2-Methylnaphthalene	0.0165	0.0211	27
Phenol	0.0108	0.0181	40
Naphthalene	0.0131	0.0175	30
1-Methylnaphthalene	0.0102	0.0139	36
Formaldehyde	0.0028	0.0017	-65
o,m,p-Cresol	ND	ND	NA

Core Storage	Test EQ	Test ES	% Difference
TGOC as Propane	NA	NA	NA
HC as Hexane	0.6006	0.7149	16
Sum of VOCs	0.0264	0.0362	27
Sum of HAPs	0.0264	0.0362	27
Sum of POMs	0.0258	0.0350	26
	Individual HAPs and VOCs		
Naphthalene	0.0090	0.0142	37
2-Methylnaphthalene	0.0093	0.0126	26
1-Methylnaphthalene	0.0075	0.0081	7
Phenol	ND	0.0007	100
Formaldehyde	0.0005	0.0005	NA
o,m,p-Cresol	ND	ND	NA

ND: Non Detect; NA: Not Applicable

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

Core Sand Mix Test	ES Average 1.20 %	ES Average 1.75%	EQ Average 1.75%
Number of tests	6	6	9
Total coated sand weight per test, Lbs.	50.6	50.9	51.0
Binder weight per test, Lbs.	0.597	0.869	0.875
Calculated Average% Binder (BOS)	1.19	1.74	1.74
Calculated Average binder content,%	1.18	1.71	1.71
1800 F LOI, % (note 1)	1.46	1.71	1.61
Ave. Sand temperature, Deg F	87.2	90.2	90
Average mix time doot to door, mm:ss	7:00	7:00	7:00

Core Make Test	ES Average 1.20 %	ES Average 1.75%	EQ Average 1.75%
Number of tests	6	6	9
Average coated sand weight, Lbs.	7.29	7.16	7.00
Total binder coated sand weight, Lbs.	219.9	215.9	209.9
Calculated Total Binder weight per test, Lbs.	2.584	3.688	3.668
Calculated Average% Binder (BOS)	1.19	1.74	1.75
Calculated Average Standard % binder	1.18	1.71	1.72
1800 F LOI after mixing for make, %	1.17	1.59	1.58
Sand temperature, Deg F	91	89	89
Dogbone Core 2 hr. tensile strength	143	207	----
TEA Injection/cycle, gm/cycle (typical)	5	5	3.5
Blow pressure, psi	30	30	30
Max. Purge Pressure, psi	48	48	45
Purge duration, sec	20	20	20
Ave. Machine cycles per test	30	30	30
Ave.Core Machine Cycle time, sec.	62	61	72.7

Core Storage Test	ES Average 1.20 %	ES Average 1.75%	EQ Average 1.75%
Number of tests	6	6	9
Length of test, hours	5.0	5.0	5.0
Average coated sand weigh per test, Lbs.	7.29	7.23	7.24
Calculated Total Binder weight per test, Lbs.	0.087	0.127	0.127
Calculated Average% Binder (BOS)	1.19	1.74	1.75
Calculated Average Standard % binder	1.19	1.71	1.72
1800 F LOI after mixing for storage, %	1.14	1.63	1.56
Sand temperature, Deg F	91	88	88
TEA Injection/cycle, gm/cycle (typical)	5	5	3.7
Blow pressure, psi	30	30	30
Max Purge Pressure, psi	48	48	48
Purge duration, sec	20	20	20
Cores per test	1	1	1
Ave.Core Machine Cycle time, sec.	59	60	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 ES Average Emissions Results – 1.20% Binder – Lb/Lb Binder

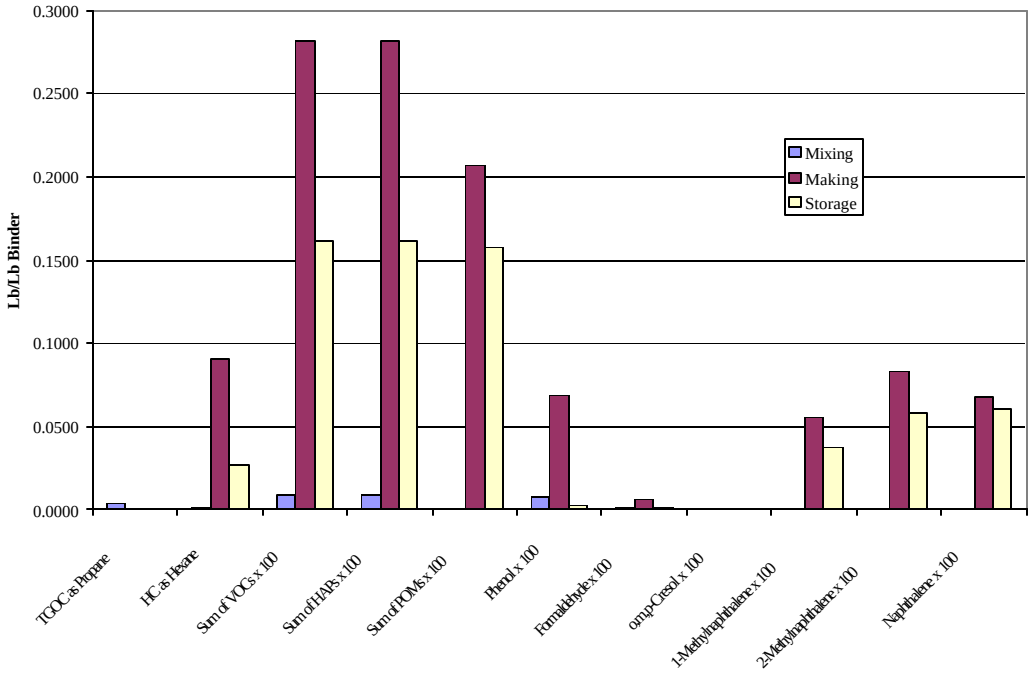


Figure 3-2 Test ES Average Emissions Results – 1.75% Binder – Lb/Lb Binder

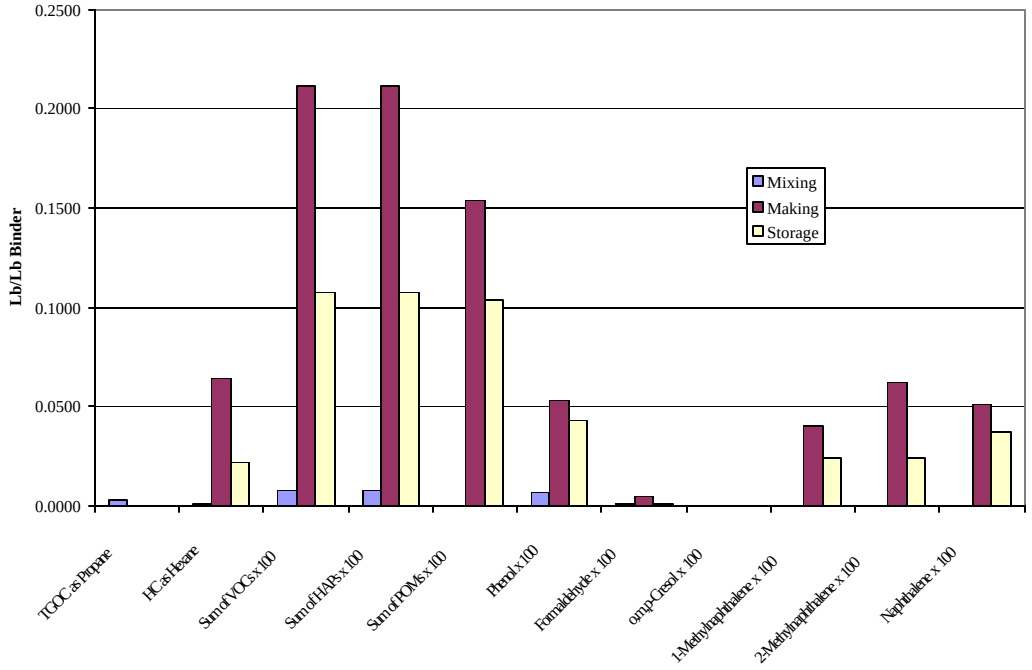


Figure 3-3 Tests EQ and ES Core Sand Mixing Comparison – 1.75% Binder - Lb/Lb Binder

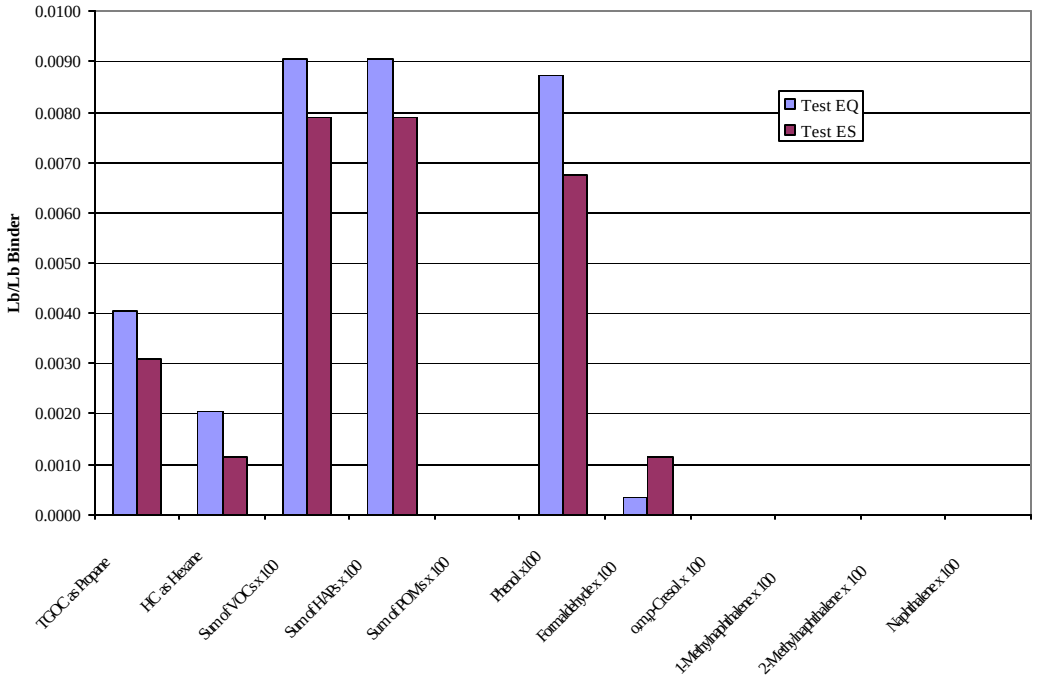


Figure 3-4 Tests EQ and ES Core Making Comparison – 1.75% Binder - Lb/Lb Binder

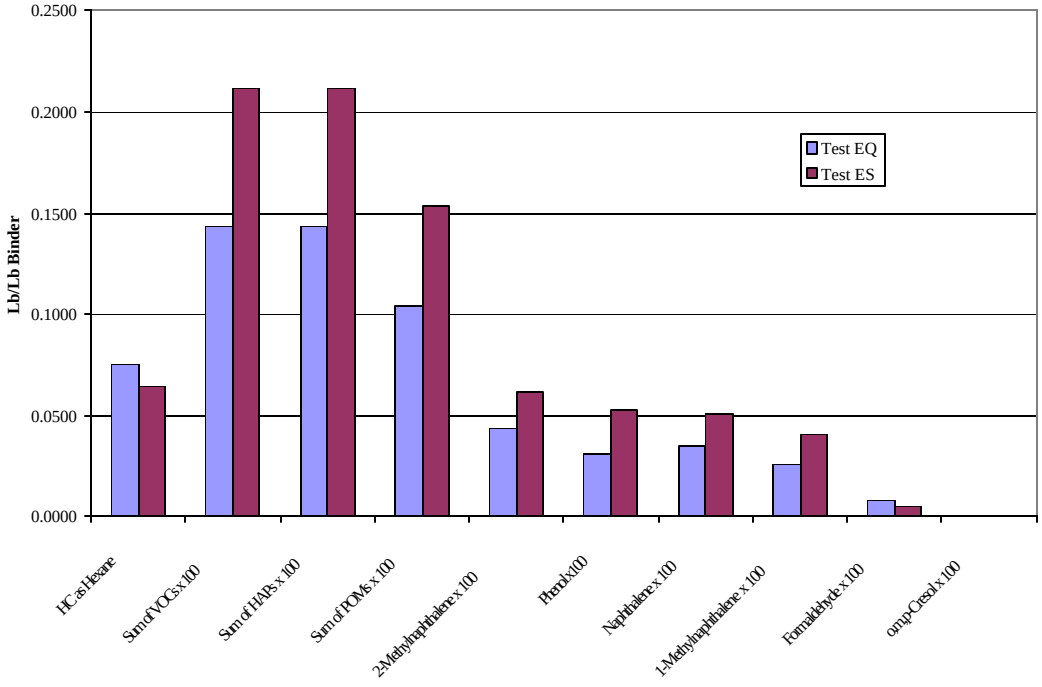


Figure 3-5 Tests EQ and ES Core Storage Comparison – 1.75% Binder – Lb/Lb Binder

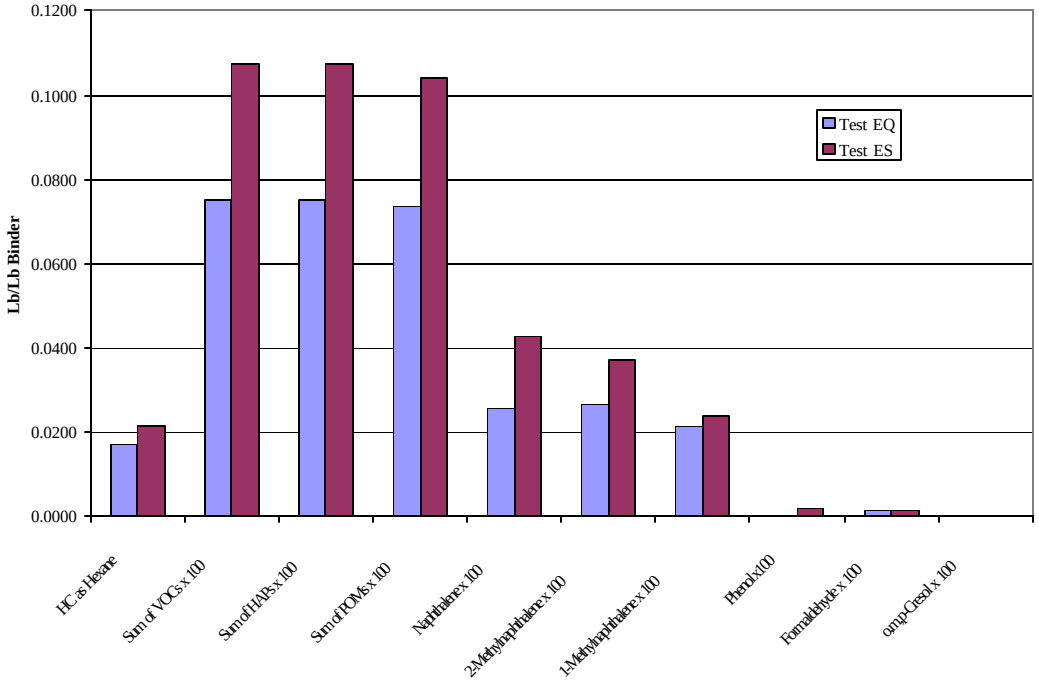


Figure 3-6 Tests ES Average Emissions Results – 1.20% Binder – Lb/Tn Sand

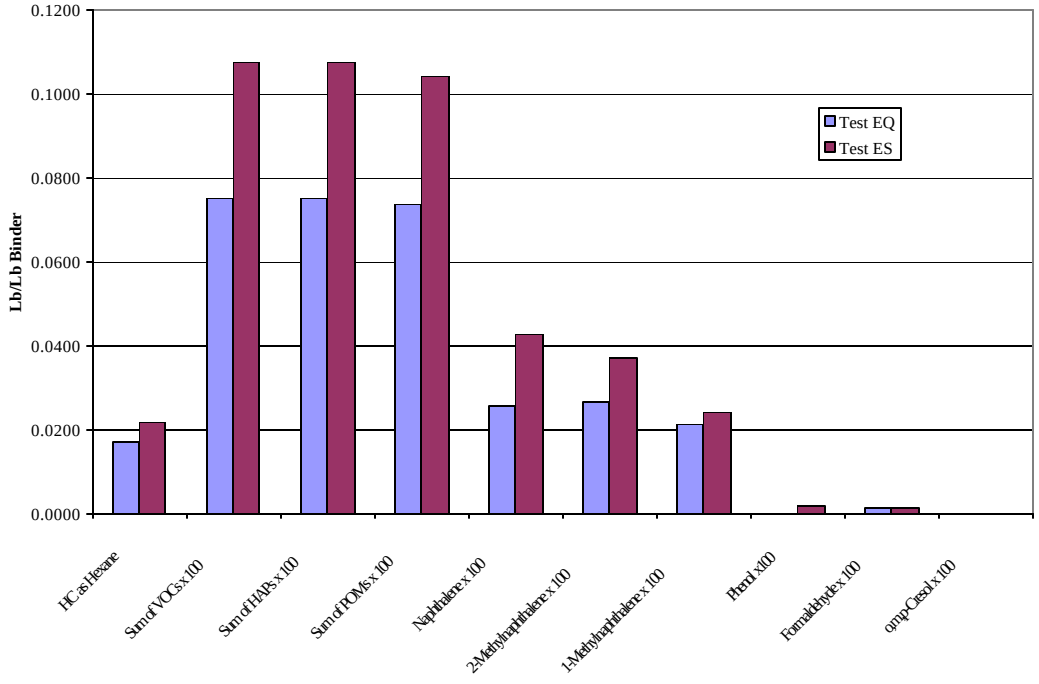


Figure 3-7 Test ES Average Emissions Results – 1.75% Binder – Lb/Tn Sand

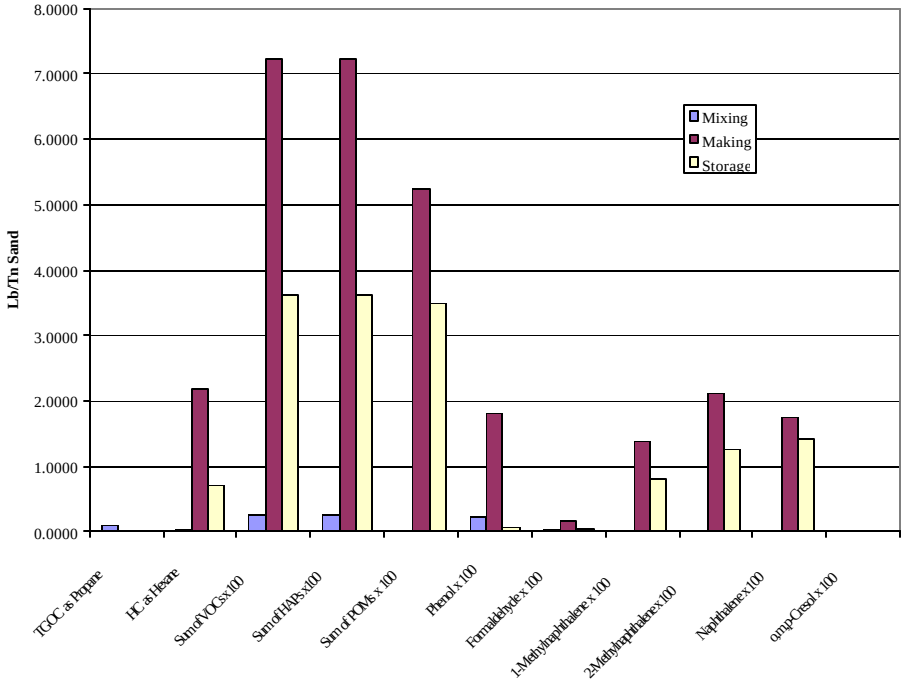


Figure 3-8 Tests EQ and ES Core Mixing Comparison – 1.75% Binder – Lb/Tn Sand

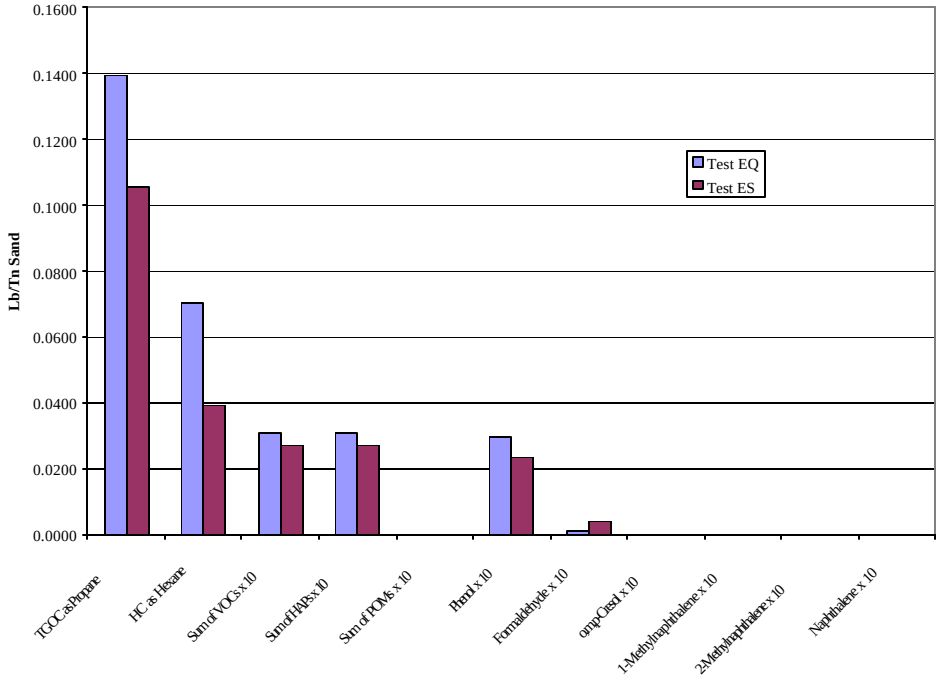


Figure 3-9 Tests EQ and ES Core Making Comparison – 1.75% Binder – Lb/Tn Sand

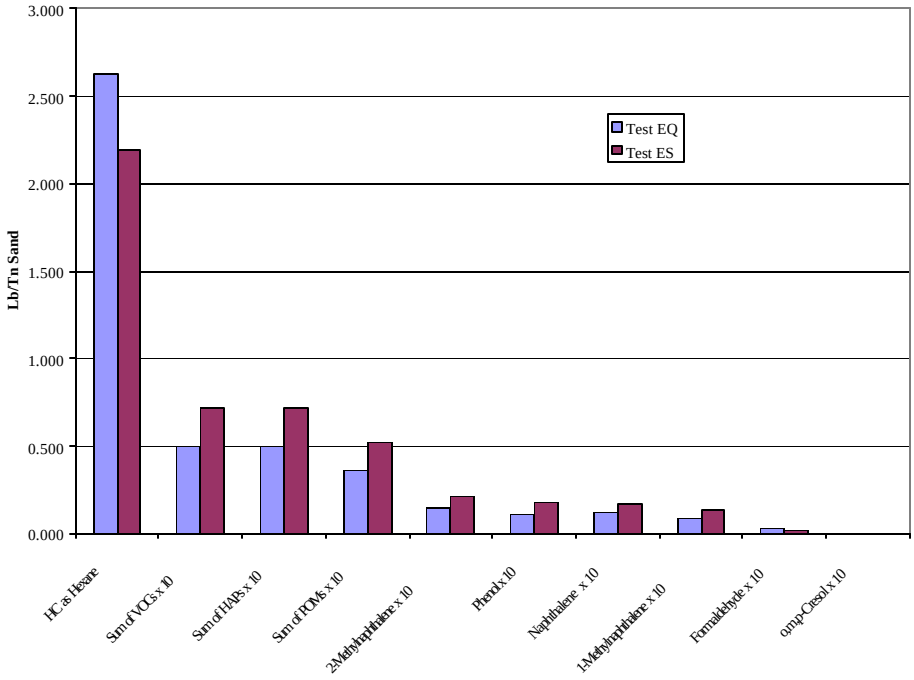
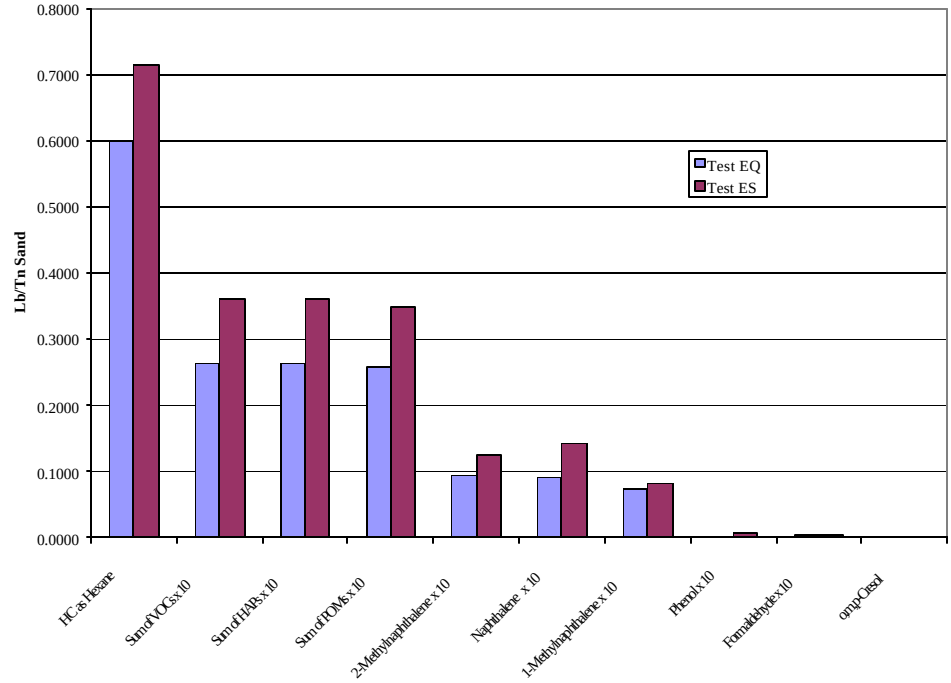


Figure 3-10 Tests EQ and ES Core Storage Comparison – 1.75% Binder – Lb/Tn Sand



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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 1.20% binder level and 36% at the 1.75% binder level for Test ES (Table 3-2). The emission mechanism as VOCs is principally surface evaporation. The increase in binder content adds virtually no new surface. It would be expected that the absolute emissions would be similar at both binder contents. Therefore, a possible explanation for a lowered recovery may be due to the retention of VOCs within the core samples.

Core making contributed the largest proportion of total VOC emissions (56-76%), core storage the second largest (23-44%), and core mixing the least (1-2%) for Test ES. From Table 3-1, the results for the 1.20% binder level were found to be slightly higher than the 1.75% binder level for all test segments when expressed in Lb/Lb Binder. From Table 3-4, the overall results for the 1.20% binder level were found to be slightly lower than the 1.75% binder level when expressed in Lb/Tn Sand. This apparent anomaly is a consequence of almost the same emission from the same sand weight and significantly different binder contents.

Tables 3-3 and 3-5 represent the results from Test ES compared to the baseline Test EQ. Test ES was performed using both 1.20% and 1.75% binder, and Test EQ used a 1.75% binder level only. Only the 1.75% binder level results for each test series were compared. The TGOC as Propane data is reported only for the mixing segments for both Tests EQ and ES due to the predominance of triethylamine (TEA) in the core making and core storage portions. TEA was not on the selected analyte list for these tests.

Mixing

The mixing HAP emissions consisted of phenol and formaldehyde. The HC as Hexane results for mixing contributed approximately 1-2% of the total found for the three test segments. Similarly, the mixing results for the baseline Test EQ showed a contribution of 2% of the total. Of the percent (%) available solvent measured as HC as Hexane (Table 3-2), mixing contributed 0.6% (1.20% binder) and 0.5% (1.75% binder). Formaldehyde results are reported as a

minimum for Test ES due to apparent breakthrough of the sample tubes for the mixing segment. See Appendix B for detailed results.

Gas/Purge and Fugitives

The HC as Hexane results for gas/purge and fugitive emissions contributed approximately 75% of the total found during the three test segments. 2-Methylnaphthalene was found in the highest amount followed by phenol and naphthalene. From Table 3-2, of the percent (%) available solvent measured as HC as Hexane, core making contributed 38.0% (1.20% binder) and 26.8% (1.75% binder).

Storage

The storage segment contributed 24% of the total found during the three test segments. Naphthalene was found in the highest amount followed by 2 and 1-methylnaphthalene. From Table 3-2, of the percent (%) available solvent measured as HC as Hexane, core storage contributed 11.4% (1.20% binder) and 9.0% (1.75% binder).

The distribution of analytes measured varied between the three test segments for Test ES. During the core mixing process, the naphthalenes were not detected and phenol was found in the highest amount. During the core making and core storage segments, the relative naphthalene and phenol ratios changed between the two processes. The most significant difference was shown with phenol. 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.

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

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TECHNIKON TEST PLAN

> **CONTRACT NUMBER:** 1409 **TASK NUMBER**: 1.1.2

> **WORK ORDER NUMBER**: 1167 **Series:** ES

> **SAMPLE EVENTS**: 6 MIX, 6 MAKE, 6 STORE @ EACH 1.2% & 1.75

> **SITE: ___PRE-PRODUCTION _X__ FOUNDRY**

> **TEST TYPE:** CORE MIXING, CORE MAKING, CORE STORAGE VENDOR PRODUCT.

> **METAL TYPE:** NONE

> **MOLD TYPE**: NONE

> **NUMBER OF TESTS:** 12 CORE SAND MIXING, 12-CORE MAKING, 12 CORE STORAGE, 2 CORE TEST DOGBONES.

> **CORE TYPE: AFS** STEP CORE, HA-INTERNATIONAL SIGMACURE® 7211/7621 PHENOLIC URETHANE BINDER AT 1.2% AND 1.75% (BOS), 55% PART I, 45% PART II, TEA GAS CATALYZED.

> **TEST DATE:** **START:** 2 OCT 2002

FINISHED: 15 Oct 2002

TEST OBJECTIVES:

1. Measure selective HAP and VOC emissions from Core sand mixing, Gas & Purge and Fugitive Core Making, and Core Storage of AFS step cores made with 1.20% & 1.75% binder.
2. Measure 2-hour core dogbone strength at 1.2% and 1.75% 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 89 +/- 2 degrees Fahrenheit. The binder shall be 1.75 +/-0.0175% and 1.2 +/- 0.012% HA-International 7211/7621M 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 and monitored continuously by TGOC and adsorption tube sampling. Prior to the first mixing test five (5) batches shall be run to normalize the background within the muller. 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 six (6) mixing tests shall be run at each of 2 resin levels.
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 sequentially sampled, four (4) in a group, 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 head space 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^{o}F. Core storage will be individual cores tested under individual glass domes in groups of four (4) cores for a period of five hours. The environment will be totally captured. One dome will be monitored by TGOC.

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 ES

Core Sand Mixing, Curing, and Storage HA International 7211/7621

Process Instructions

A. The Experiment

1. Evaluate the emissions from HA International 7211 part I and 7621 part II Phenolic Urethane binder system at 1.2% and 1.75% total binder.

B. Mixing Test

1. Twelve discreet seven (7) minute batches run as 4 sets of three (3) runs per day. Runs 1 thru 6 shall be at 1.2% total binder and runs 7 thru 12 shall be at 1.75%.
2. 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.

3. 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 87-92^{o}F.
b. Attach the emission sampling equipment to the 50-pound Carver core sand mixer.
c. Pre-measure 1.2% or 1.75% (BOS) of the HA International binder based on a 50 pound batch.

1) Part I (7211) is 55% of the total binder and is 149.8 grams @ 1.2% or 218.5 grams @ 1.75%.
2) Part II (7621) is 45% of the total binder and is 122.6 grams @ 1.2% or 178.8 grams @ 1.75%.

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

d. Pre-Weigh 50 pounds of Wexford W450 Lake Sand, heated to 87-92 ^{o}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 TGOC only. Monitor with the TGOC continuously until the end of the test.
g. Use the TGOC data during the background-stabilizing period to confirm the required media flow rates. If a change is required restart the test.
h. Make five (5) emission background-generating batches.

i. 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 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.

j. 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.

k. 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. Collect the air sample until the door is closed at the end of the batch cycle.
4) During the next batch the media will be changed.
5) The next batch will be an emission sample again.
6) Continue alternating until three (3) emission tests for mixing are complete.

l. Repeat steps B.2.i-j for as many cycles as is necessary to complete the five (5) background batches, the three (3) emission test batches, and two (2) media changing periods, a total of 10 batches. Continue batches uninterrupted during media changes between tests.

m. Repeat steps B.2.i-j for as many cycles as is necessary to support the Core Making test.

n. Repeat the above for each day the Mixing test is run.

4. Switch the TGOC over to the Core Making apparatus at the conclusion of the daily Mix test.

C. Core Making Test

1. Twelve (12) discreet tests in four daily sets of three (3) tests, each have thirty (30), approximately one (1) minute, core cycles. Runs 1 thru 6 shall be at 1.2% total binder and runs 7 thru 12 shall be at 1.75%.

a. 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^{o}F.

b. Turn on the G/F core machine master start.

c. Turn on and adjust the Luber TEA gas generator.

1) Make sure there is enough TEA in the Luber TEA storage tank.
2) Set the MAX WORKING PRESSURE to 45 psi.
3) Set the gassing time (T1) to 0.75 seconds

4) Adjust the TEA flow rate to .019 pounds/second.

Note: This will give an amine input of 4 grams per cycle.

5) 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.

6) Connect the TEA weighing container to the Luber supply line.

(a) Dispense about 250 grams of TEA into the weigh container. The scale has a 300-gram capacity.
(b) Close valve on Luber TEA storage tank.
(c) Refill about every 50 blows.

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.

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

(a) Vent this material to the scrubber.
(b) Record the TEA weight dispensed.

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

d. Attach the emission sample train to the gas-purge-fugitive sample pipe.
e. Begin monitoring with the TGOC.
f. Prepare the core sand in the Carver mixer according to section B.2.i-j except without the emission sampling equipment attached to the mixer.
g. Prepare the core machine emission enclosure.
h. Verify that the temperature controlled core test room is set to deliver air at 80-85 ^{o}F to the core enclosure.
i. Set up the Redford/Carver core machine with the step core corebox.
j. Verify that the air temperature in the gas-purge-fugitive exhaust tube is 80-85 degrees Fahrenheit.
k. 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 about one (1) minute. Set the cycle counter to zero (0).
l. Start and calibrate the Luber TEA vaporizer to dispense about 4 grams of TEA per machine cycle. Mix core sand per section B.2.i-j as required in fifty (50) pound batches to assure continuity of production.

m. 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.
n. Make cores continuously as above. Any stoppage will impact the fugitive's emission level.
o. Record the number and weight of each core throughout the test.
p. 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.
q. Do not stop making core.
r. Set up the sample train again and repeat the test for another thirty-core test. A total of twelve (12) 30-core tests are to be performed in groups of three (3) per day.
s. 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.2.i-j.
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 twelve (12) discrete tests in groups of three (3) plus the TGOC monitoring each day.

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.

Steven Knight
Mgr. Process Engineering

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 RUNS:** NINE (9) CORE SAND MIXING; NINE (9) CORE STORAGE

> **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 from 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.

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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 head space 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^{o}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
Process Instructions

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

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

1) 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.
2) The ventilation rate shall be sufficient to prevent escape of the emissions except to the emission-sampling stream.
3) An emission sampling port centered on the capture hood.
4) A discharge pipe connected to a sampling train and pump via a heated line to the THC analyzer.

2. Core Making

a. 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.

1) 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

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

1) Each chamber shall have independent air flow controls.
2) The sum of the chamber flows shall not exceed 50 liters/minute.
3) One chamber shall be connected to the THC analyzer.

4) 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

1. Nine discrete seven (7) minute batches run contiguously.

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

1) 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 oF.
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 oF 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

1. Nine (9) tests, each having thirty (30) approximately one (1) minute core cycles.

a. 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.

b. Turn on and adjust the Luber TEA gas generator.

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

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

5) 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.

6) Connect the TEA weighing container to the Luber supply line.

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

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

(a) Vent this material to the scrubber.
(b) Record the TEA weight dispensed
.

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

c. Attach the emission sample train to the gas-purge-fugitive sample pipe.
d. Begin monitoring with the THC.
e. 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.
f. Prepare the core machine emission enclosure.
g. Verify that the temperature controlled core test room is set to deliver air at 75-85 oF to the core enclosure.
h. Set up the Redford/Carver core machine with the step core corebox.
i. Verify that the air temperature in the gas-purge-fugitive exhaust tube is 75-85 degrees Fahrenheit.
j. 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).
k. Start and calibrate the Luber TEA vaporizer to dispense 5.0-5.2 grams of TEA per machine cycle.
l. Mix core sand per section C.2.g-h as required in fifty (50) pound batches to assure continuity of production.
m. 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.
n. Make cores continuously as above. Any stoppage will impact the fugitive's emission level.
o. Record the number and weight of each core throughout the test.
p. 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.
q. Do not stop making core.
r. 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.
s. 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 ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 1											
THC	ES-10101	X									TOTAL
NIOSH 1500	ES-10102		1						20	1	400/200 mg Charcoal (Orbo 32)
NIOSH 1500	ES-10103			1					20	2	400/200 mg Charcoal (Orbo 32)
NIOSH 1500	ES-10104				1				0		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	ES-10105		1						1000	8	400/200 mg Silica Gel (Orbo 53)
NIOSH 2002	ES-10106			1					1000	9	400/200 mg Silica Gel (Orbo 53)
NIOSH 2002	ES-10107				1				0		400/200 mg Silica Gel (Orbo 53)
TO11	ES-10108		1						1000	10	DNPH SKC 226-119
TO11	ES-10109				1				0		DNPH SKC 226-119
	Excess								1000	11	
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 2											
THC	ES-10201	X									TOTAL
NIOSH 1500	ES-10202		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	ES-10203		1						1000	8	400/200 mg Silica Gel (Orbo 53)
TO11	ES-10204		1						1000	9	DNPH SKC 226-119
TO11	ES-10205			1					1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 3											
THC	ES-10301	X									TOTAL
NIOSH 1500	ES-10302		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	ES-10303		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-10304		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 4											
THC	ES-10401	X									
NIOSH 1500	ES-10402		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	ES-10403		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-10404		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 5											
THC	ES-10501	X									TOTAL
NIOSH 1500	ES-10502		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	ES-10503		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-10504		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 6											
THC	ES-10601	X									TOTAL
NIOSH 1500	ES-10602		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	ES-10603		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-10604		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 7											
THC	ES-10701	X									TOTAL
NIOSH 1500	ES-10702		1						20	1	400/200 mg Charcoal (Orbo 32)
NIOSH 1500	ES-10703			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	ES-10704		1						1000	8	400/200 mg Silica Gel (Orbo 53)
NIOSH 2002	ES-10705			1					1000	9	400/200 mg Silica Gel (Orbo 53)
TO11	ES-10706		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 8											
THC	ES-10801	X									TOTAL
NIOSH 1500	ES-10802		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	ES-10803		1						1000	8	400/200 mg Silica Gel (Orbo 53)
TO11	ES-10804		1						1000	9	DNPH SKC 226-119
TO11	ES-10805			1					1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 9											
THC	ES-10901	X									TOTAL
NIOSH 1500	ES-10902		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	ES-10903		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-10904		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 10											
THC	ES-11001	X									TOTAL
NIOSH 1500	ES-11002		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	ES-11003		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-11004		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 11											
THC	ES-11101	X									
NIOSH 1500	ES-11102		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	ES-11103		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-11104		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MIXING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 12											
THC	ES-11201	X									TOTAL
NIOSH 1500	ES-11202		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	ES-11203		1						1000	8	400/200 mg Silica Gel (Orbo 53)
	Excess								1000	9	Excess
TO11	ES-11204		1						1000	10	DNPH SKC 226-119
	Excess								1000	11	Excess
	Excess								200	12	Excess
	Excess								22000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 1											
THC	ES-20101	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20102		1						500	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	ES-20103			1					500	6	100/50 mg Charcoal (SKC 226-01)
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20104		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	ES-20105			1					1000	10	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20106		1						1000	11	DNPH SKC 226-119
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 2											
THC	ES-20201	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20202		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20203		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20204		1						1000	10	DPNH SKC 226-119
TO11	ES-20205			1					1000	11	DPNH SKC 226-119
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT3											
THC	ES-20301	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20302		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20303		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20304		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											
EVENT 4											**1.2% Binder**
THC	ES-20401	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20402		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20403		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20404		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											
EVENT 5											**1.2% Binder**
THC	ES-20501	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20502		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20503		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20504		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**1.2% Binder**
EVENT 6											
THC	ES-20601	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20602		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20603		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20604		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 7											
THC	ES-20701	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20702		1						500	5	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	ES-20703			1					500	6	100/50 mg Charcoal (SKC 226-01)
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20704		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	ES-20705			1					1000	10	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20706		1						1000	11	DNPH SKC 226-119
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 8											
THC	ES-20801	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20802		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20803		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20804		1						1000	10	DPNH SKC 226-119
TO11	ES-20805			1					1000	11	DPNH SKC 226-119
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 9											
THC	ES-20901	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-20902		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-20903		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-20904		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 10											
THC	ES-21001	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-21002		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-21003		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-21004		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 11											
THC	ES-21101	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-21102		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-21103		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-21104		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE MAKING ES - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**1.75% Binder**
EVENT 12											
THC	ES-21201	X									TOTAL
	Excess								20	1	Excess
	Excess								20	2	Excess
	Excess								20	3	Excess
	Excess								80	4	Excess
NIOSH 1500	ES-21202		1						500	5	100/50 mg Charcoal (SKC 226-01)
	Excess								500	6	Excess
	Excess								900	7	Excess
	Excess								900	8	Excess
NIOSH 2002	ES-21203		1						1000	9	150/75 mg Silica Gel (SKC 226-10)
TO11	ES-21204		1						1000	10	DPNH SKC 226-119
	Excess								1000	11	Excess
	Excess								500	12	Excess
	Excess								5000	13	Excess

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**5-Hr. Test-Core 1 (D1)**
EVENT 1											**1.2% Binder**
NIOSH 1500	ES-30101		1						25	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	ES-30102			1					25	2	100/50 mg Charcoal (SKC 226-01)
NIOSH 2002	ES-30103		1						60	3	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	ES-30104			1					30	4	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-30105		1						200	5	DPNH SKC 226-119
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**5 Hour Test-Core 2 (D2)**
EVENT 2											**1.2% Binder**
NIOSH 1500	ES-30201		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-3202		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-3203		1						200	4	DPNH SKC 226-119
TO-11	ES-3204			1					200	5	DPNH SKC 226-119
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**5 Hour Test-Core 3 (D3)**
EVENT 3											**1.2% Binder**
NIOSH 1500	ES-30301		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-30302		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-30303		1						200	4	DPNH SKC 226-119
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**5 Hour Test-Core 4 (D1)**
EVENT 4											**1.2% Binder**
NIOSH 1500	ES-30401		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-30402		1						60	3	150/75 mg Silica Gel (SKC 226-10)
	Excess								30	4	Excess
TO-11	ES-30403		1						200	5	DPNH SKC 226-119
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**5 Hour Test-Core 5 (D2)**
EVENT 5											**1.2% Binder**
NIOSH 1500	ES-30501		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-30502		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-30503		1						200	4	DPNH SKC 226-119
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/8/02											**5 Hour Test-Core 6 (D3)**
EVENT 6											**1.2% Binder**
NIOSH 1500	ES-30601		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-30602		1						60	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-30603		1						200	4	DPNH SKC 226-119
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**5 Hour Test-Core 7 (D1)**
EVENT 7											**1.75% Binder**
NIOSH 1500	ES-30701		1						25	1	100/50 mg Charcoal (SKC 226-01)
NIOSH 1500	ES-30702			1					25	2	Excess
NIOSH 2002	ES-30703		1						60	3	150/75 mg Silica Gel (SKC 226-10)
NIOSH 2002	ES-30704			1					30	4	Excess
TO-11	ES-30705		1						200	5	DPNH SKC 226-119
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**5 Hour Test-Core 8 (D2)**
EVENT 8											**1.75% Binder**
NIOSH 1500	ES-30801		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-30802		1						45	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-30803		1						200	4	DPNH SKC 226-119
TO-11	ES-30804			1					200	5	DPNH SKC 226-119
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**5 Hour Test-Core 9 (D3)**
EVENT 9											**1.75% Binder**
NIOSH 1500	ES-30901		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-30902		1						45	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-30903		1						200	4	DPNH SKC 226-119
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**5 Hour Test-Core 10 (D1)**
EVENT 10											**1.75% Binder**
NIOSH 1500	ES-31001		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-31002		1						60	3	150/75 mg Silica Gel (SKC 226-10)
	Excess								30	4	DPNH SKC 226-119
TO-11	ES-31003		1						200	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**5 Hour Test-Core 11 (D2)**
EVENT 11											**1.75% Binder**
NIOSH 1500	ES-31101		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-31102		1						45	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-31103		1						200	4	DPNH SKC 226-119
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orfice

CORE STORAGE ES - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
10/9/02											**5 Hour Test-Core 12 (D3)**
EVENT 12											**1.75% Binder**
NIOSH 1500	ES-31201		1						25	1	100/50 mg Charcoal (SKC 226-01)
	Excess								25	2	Excess
NIOSH 2002	ES-31202		1						45	3	150/75 mg Silica Gel (SKC 226-10)
TO-11	ES-31203		1						200	4	DPNH SKC 226-119
	Excess								200	5	Excess
	Excess								Variable	6	No Critical Orfice

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	Breakthrough	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											
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 #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT											
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 #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											
EVENT											
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											
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											
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											
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											
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											
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											
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 #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/10/02											**5-Hr. Test-Core 1**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/10/02											**5 Hour Test-Core 2**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/10/02											**5 Hour Test-Core 3**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 4**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 5**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 6**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 7**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 8**
EVENT											
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 Orfice

CORE STORAGE EQ - SERIES SAMPLE PLAN

Method	Sample #	Date	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments
9/11/02											**5 Hour Test-Core 9**
EVENT											
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 Orfice

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

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Individual Core Mixing Results for Test ES– Lb/Lb Binder

Core Mixing 1.2% Binder

Compound/Sample Number	ES101	ES102	ES103	ES104	ES105	ES106	Average	STDEV
Test Dates	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02		
TGOC as Propane	3.52E-03	3.62E-03	3.78E-03	3.68E-03	3.66E-03	3.67E-03	3.66E-03	8.37E-05
HC as Hexane	1.68E-03	1.33E-03	1.17E-03	1.92E-03	1.15E-03	1.88E-03	1.52E-03	3.50E-04
Sum of VOCs	9.27E-05	9.13E-05	1.02E-04	9.67E-05	9.58E-05	9.80E-05	9.62E-05	3.97E-06
Sum of HAPs	9.27E-05	9.13E-05	1.02E-04	9.67E-05	9.58E-05	9.80E-05	9.62E-05	3.97E-06
Sum of POMs	ND	ND	ND	ND	ND	ND	NA	NA
	Individual HAPs and VOCs							
Phenol	7.74E-05	7.58E-05	8.60E-05	8.02E-05	8.16E-05	8.05E-05	8.02E-05	3.53E-06
Formaldehyde	1.53E-05	1.55E-05	1.65E-05	1.64E-05	1.42E-05	1.75E-05	1.59E-05	1.14E-06
o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
Naphthalene	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable
Note: Formaldehyde results are reported as a minimum due to apparent breakthrough.

Core Mixing 1.75% Binder

Compound/Sample Number	ES107	ES108	ES109	ES110	ES111	ES112	Average	STDEV
Test Dates	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02		
TGOC as Propane	2.89E-03	2.96E-03	3.08E-03	3.17E-03	3.24E-03	3.25E-03	3.10E-03	1.48E-04
HC as Hexane	1.33E-03	8.83E-04	1.30E-03	1.31E-03	9.36E-04	1.14E-03	1.15E-03	1.99E-04
Sum of VOCs	6.94E-05	7.45E-05	7.96E-05	8.10E-05	8.30E-05	8.65E-05	7.90E-05	6.16E-06
Sum of HAPs	6.94E-05	7.45E-05	7.96E-05	8.10E-05	8.30E-05	8.65E-05	7.90E-05	6.16E-06
Sum of POMs	ND	ND	ND	ND	ND	ND	NA	NA
	Individual HAPs and VOCs							
Phenol	5.80E-05	6.30E-05	6.82E-05	6.97E-05	7.16E-05	7.47E-05	6.75E-05	6.08E-06
Formaldehyde	1.14E-05	1.15E-05	1.14E-05	1.14E-05	1.14E-05	1.18E-05	1.15E-05	1.62E-07
o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
Naphthalene	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable
Note: Formaldehyde results are reported as a minimum due to apparent breakthrough.

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

Core Making 1.2% Binder

Compound/Sample Number	ES201	ES202	ES203	ES204	ES205	ES206	Average	STDEV
Test Dates	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02		
TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
HC as Hexane	9.08E-02	8.24E-02	9.31E-02	9.31E-02	9.33E-02	9.44E-02	9.12E-02	4.44E-03
Sum of VOCs	2.33E-03	2.00E-03	3.13E-03	3.19E-03	3.16E-03	3.10E-03	2.82E-03	5.16E-04
Sum of HAPs	2.33E-03	2.00E-03	3.13E-03	3.19E-03	3.16E-03	3.10E-03	2.82E-03	5.16E-04
Sum of POMs	1.66E-03	1.32E-03	2.39E-03	2.38E-03	2.37E-03	2.30E-03	2.07E-03	4.63E-04
	Individual HAPs and VOCs							
2-Methylnaphthalene	6.57E-04	5.18E-04	9.60E-04	9.62E-04	9.57E-04	9.44E-04	8.33E-04	1.95E-04
Phenol	6.14E-04	6.28E-04	6.86E-04	7.44E-04	7.18E-04	7.32E-04	6.87E-04	5.49E-05
Naphthalene	5.75E-04	4.54E-04	7.90E-04	7.73E-04	7.66E-04	7.39E-04	6.83E-04	1.37E-04
1-Methylnaphthalene	4.30E-04	3.48E-04	6.36E-04	6.48E-04	6.49E-04	6.19E-04	5.55E-04	1.32E-04
Formaldehyde	5.71E-05	5.39E-05	5.77E-05	6.42E-05	6.73E-05	6.41E-05	6.07E-05	5.21E-06
o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Core Making 1.75% Binder

Compound/Sample Number	ES207	ES208	ES209	ES210	ES211	ES212	Average	STDEV
Test Dates	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02		
TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
HC as Hexane	6.11E-02	6.21E-02	6.27E-02	6.65E-02	6.61E-02	6.70E-02	6.43E-02	2.55E-03
Sum of VOCs	2.03E-03	2.01E-03	1.89E-03	2.25E-03	2.21E-03	2.32E-03	2.12E-03	1.68E-04
Sum of HAPs	2.03E-03	2.01E-03	1.89E-03	2.25E-03	2.21E-03	2.32E-03	2.12E-03	1.68E-04
Sum of POMs	1.42E-03	1.43E-03	1.30E-03	1.67E-03	1.65E-03	1.74E-03	1.54E-03	1.76E-04
	Individual HAPs and VOCs							
2-Methylnaphthalene	5.66E-04	5.67E-04	5.24E-04	6.75E-04	6.68E-04	7.14E-04	6.19E-04	7.63E-05
Phenol	5.48E-04	5.24E-04	5.40E-04	5.24E-04	5.15E-04	5.32E-04	5.31E-04	1.22E-05
Naphthalene	4.83E-04	4.88E-04	4.43E-04	5.47E-04	5.45E-04	5.61E-04	5.11E-04	4.65E-05
1-Methylnaphthalene	3.74E-04	3.79E-04	3.28E-04	4.52E-04	4.38E-04	4.66E-04	4.06E-04	5.40E-05
Formaldehyde	5.58E-05	4.98E-05	5.05E-05	4.87E-05	4.58E-05	4.77E-05	4.97E-05	3.41E-06
o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

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

Core Storage 1.2% Binder

Compound/Sample Number	ES301	ES302	ES303	ES304	ES305	ES306	Average	STDEV
Test Dates	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02		
TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
HC as Hexane	2.71E-02	2.93E-02	3.06E-02	2.84E-02	2.87E-02	2.04E-02	2.74E-02	3.62E-03
Sum of VOCs	1.45E-03	1.75E-03	1.91E-03	1.91E-03	1.56E-03	1.14E-03	1.62E-03	2.99E-04
Sum of HAPs	1.45E-03	1.75E-03	1.91E-03	1.91E-03	1.56E-03	1.14E-03	1.62E-03	2.99E-04
Sum of POMs	1.43E-03	1.71E-03	1.86E-03	1.86E-03	1.51E-03	1.09E-03	1.58E-03	3.00E-04
	Individual HAPs and VOCs							
Naphthalene	5.50E-04	6.55E-04	7.18E-04	7.22E-04	6.06E-04	4.21E-04	6.12E-04	1.14E-04
2-Methylnaphthalene	5.34E-04	6.40E-04	7.00E-04	6.96E-04	5.54E-04	4.05E-04	5.88E-04	1.14E-04
1-Methylnaphthalene	3.41E-04	4.16E-04	4.47E-04	4.47E-04	3.54E-04	2.62E-04	3.78E-04	7.26E-05
Phenol	1.13E-05	2.44E-05	2.56E-05	3.13E-05	2.61E-05	3.24E-05	2.52E-05	7.54E-06
Formaldehyde	1.70E-05	1.62E-05	1.59E-05	1.75E-05	1.77E-05	1.82E-05	1.71E-05	8.88E-07
o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Core Storage 1.75% Binder

Compound/Sample Number	ES307	ES308	ES309	ES310	ES311	ES312	Average	STDEV
Test Dates	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02		
TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
HC as Hexane	1.91E-02	1.98E-02	2.10E-02	2.22E-02	2.07E-02	2.71E-02	2.17E-02	2.86E-03
Sum of VOCs	9.19E-04	1.08E-03	1.03E-03	1.27E-03	8.08E-04	1.34E-03	1.07E-03	2.04E-04
Sum of HAPs	9.19E-04	1.08E-03	1.03E-03	1.27E-03	8.08E-04	1.34E-03	1.07E-03	2.04E-04
Sum of POMs	8.94E-04	1.04E-03	9.97E-04	1.24E-03	7.70E-04	1.31E-03	1.04E-03	2.03E-04
	Individual HAPs and VOCs							
Naphthalene	3.65E-04	4.27E-04	4.09E-04	4.91E-04	3.43E-04	5.31E-04	4.28E-04	7.21E-05
2-Methylnaphthalene	3.22E-04	3.76E-04	3.57E-04	4.55E-04	2.57E-04	4.71E-04	3.73E-04	8.06E-05
1-Methylnaphthalene	2.07E-04	2.41E-04	2.31E-04	2.91E-04	1.70E-04	3.04E-04	2.41E-04	5.07E-05
Phenol	1.06E-05	2.09E-05	1.77E-05	2.18E-05	2.37E-05	2.25E-05	1.95E-05	4.81E-06
Formaldehyde	1.44E-05	1.42E-05	1.57E-05	1.34E-05	1.41E-05	1.37E-05	1.42E-05	8.16E-07
o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Individual Core Mixing Results for Test ES – Lb/Tn Sand

Core Mixing 1.2% Binder

HAPs	POMs	Compound/Sample Number	ES101	ES102	ES103	ES104	ES105	ES106	Average	STDEV
		Test Dates	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02		
		TGOC as Propane	8.31E-02	8.53E-02	8.90E-02	8.69E-02	8.64E-02	8.65E-02	8.62E-02	1.94E-03
		HC as Hexane	3.97E-02	3.14E-02	2.75E-02	4.53E-02	2.72E-02	4.44E-02	3.59E-02	8.27E-03
		Sum of VOCs	2.19E-03	2.15E-03	2.41E-03	2.28E-03	2.26E-03	2.31E-03	2.27E-03	9.32E-05
		Sum of HAPs	2.19E-03	2.15E-03	2.41E-03	2.28E-03	2.26E-03	2.31E-03	2.27E-03	9.32E-05
		Sum of POMs	ND	ND	ND	ND	ND	ND	NA	NA
			Individual HAPs and VOCs							
x		Phenol	1.83E-03	1.79E-03	2.02E-03	1.89E-03	1.93E-03	1.90E-03	1.89E-03	8.30E-05
x		Formaldehyde	3.62E-04	3.64E-04	3.88E-04	3.88E-04	3.36E-04	4.14E-04	3.75E-04	2.69E-05
x	z	1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
x	z	2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
x	z	Naphthalene	ND	ND	ND	ND	ND	ND	NA	NA
x		o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Note: Formaldehyde results reported as a minimum due to apparent breatkthrough.

Core Mixing 1.75% Binder

HAPs	POMs	Compound/Sample Number	ES107	ES108	ES109	ES110	ES111	ES112	Average	STDEV
		Test Dates	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02		
		TGOC as Propane	9.89E-02	1.01E-01	1.05E-01	1.08E-01	1.11E-01	1.11E-01	1.06E-01	5.02E-03
		HC as Hexane	4.56E-02	3.01E-02	4.43E-02	4.46E-02	3.20E-02	3.90E-02	3.93E-02	6.80E-03
		Sum of VOCs	2.37E-03	2.54E-03	2.71E-03	2.76E-03	2.83E-03	2.95E-03	2.70E-03	2.10E-04
		Sum of HAPs	2.37E-03	2.54E-03	2.71E-03	2.76E-03	2.83E-03	2.95E-03	2.70E-03	2.10E-04
		Sum of POMs	ND	ND	ND	ND	ND	ND	NA	NA
			Individual HAPs and VOCs							
x		Phenol	1.98E-03	2.15E-03	2.33E-03	2.38E-03	2.45E-03	2.55E-03	2.30E-03	2.07E-04
x		Formaldehyde	3.88E-04	3.92E-04	3.88E-04	3.88E-04	3.88E-04	4.02E-04	3.91E-04	5.56E-06
x		o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA
x	z	1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
x	z	2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	NA	NA
x	z	Naphthalene	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Note: Formaldehyde results reported as a minimum due to apparent breatkthrough.

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

Core Making 1.2% Binder

HAPs	POMs	Compound/Sample Number	ES201	ES202	ES203	ES204	ES205	ES206	Average	STDEV
		Test Dates	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	2.14E+00	1.93E+00	2.18E+00	2.19E+00	2.18E+00	2.23E+00	2.14E+00	1.09E-01
		Sum of VOCs	5.51E-02	4.68E-02	7.33E-02	7.52E-02	7.38E-02	7.32E-02	6.62E-02	1.21E-02
		Sum of HAPs	5.51E-02	4.68E-02	7.33E-02	7.52E-02	7.38E-02	7.32E-02	6.62E-02	1.21E-02
		Sum of POMs	3.92E-02	3.09E-02	5.59E-02	5.62E-02	5.54E-02	5.44E-02	4.87E-02	1.09E-02
			Individual HAPs and VOCs							
x	z	2-Methylnaphthalene	1.55E-02	1.21E-02	2.25E-02	2.27E-02	2.24E-02	2.23E-02	1.96E-02	4.59E-03
x		Phenol	1.45E-02	1.47E-02	1.61E-02	1.75E-02	1.68E-02	1.73E-02	1.61E-02	1.31E-03
x	z	Naphthalene	1.36E-02	1.06E-02	1.85E-02	1.82E-02	1.79E-02	1.75E-02	1.60E-02	3.22E-03
x	z	1-Methylnaphthalene	1.02E-02	8.13E-03	1.49E-02	1.53E-02	1.52E-02	1.46E-02	1.30E-02	3.09E-03
x		Formaldehyde	1.35E-03	1.26E-03	1.35E-03	1.51E-03	1.57E-03	1.51E-03	1.43E-03	1.23E-04
x		o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect: NA: Not Applicable

Core Making 1.75% Binder

HAPs	POMs	Compound/Sample Number	ES207	ES208	ES209	ES210	ES211	ES212	Average	STDEV
		Test Dates	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	2.08E+00	2.12E+00	2.15E+00	2.27E+00	2.26E+00	2.29E+00	2.19E+00	8.94E-02
		Sum of VOCs	6.90E-02	6.86E-02	6.45E-02	7.68E-02	7.56E-02	7.93E-02	7.23E-02	5.75E-03
		Sum of HAPs	6.90E-02	6.86E-02	6.45E-02	7.68E-02	7.56E-02	7.93E-02	7.23E-02	5.75E-03
		Sum of POMs	4.85E-02	4.90E-02	4.43E-02	5.72E-02	5.64E-02	5.95E-02	5.25E-02	6.04E-03
			Individual HAPs and VOCs							
x	z	2-Methylnaphthalene	1.93E-02	1.94E-02	1.79E-02	2.31E-02	2.28E-02	2.44E-02	2.11E-02	2.62E-03
x		Phenol	1.86E-02	1.79E-02	1.85E-02	1.79E-02	1.76E-02	1.82E-02	1.81E-02	3.97E-04
x	z	Naphthalene	1.64E-02	1.67E-02	1.52E-02	1.87E-02	1.86E-02	1.92E-02	1.75E-02	1.60E-03
x	z	1-Methylnaphthalene	1.27E-02	1.30E-02	1.12E-02	1.55E-02	1.50E-02	1.59E-02	1.39E-02	1.85E-03
x		Formaldehyde	1.90E-03	1.70E-03	1.73E-03	1.66E-03	1.57E-03	1.63E-03	1.70E-03	1.13E-04
		o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

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

Core Storage 1.2% Binder

HAPs	POMs	Compound/Sample Number	ES301	ES302	ES303	ES304	ES305	ES306	Average	STDEV
		Test Dates	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02	10/08/02		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	6.38E-01	6.94E-01	6.41E-01	7.34E-01	6.80E-01	6.90E-01	6.80E-01	3.60E-02
		Sum of VOCs	3.45E-02	4.15E-02	3.19E-02	4.59E-02	4.57E-02	3.76E-02	3.95E-02	5.82E-03
		Sum of HAPs	3.45E-02	4.15E-02	3.19E-02	4.59E-02	4.57E-02	3.76E-02	3.95E-02	5.82E-03
		Sum of POMs	3.36E-02	4.05E-02	3.09E-02	4.48E-02	4.46E-02	3.64E-02	3.85E-02	5.78E-03
			Individual HAPs and VOCs							
x	z	Naphthalene	1.30E-02	1.55E-02	1.26E-02	1.72E-02	1.73E-02	1.46E-02	1.50E-02	2.03E-03
x	z	2-Methylnaphthalene	1.26E-02	1.52E-02	1.11E-02	1.68E-02	1.67E-02	1.33E-02	1.43E-02	2.30E-03
x	z	1-Methylnaphthalene	8.04E-03	9.84E-03	7.21E-03	1.07E-02	1.07E-02	8.51E-03	9.17E-03	1.47E-03
x		Phenol	5.32E-04	5.77E-04	6.05E-04	7.51E-04	6.25E-04	7.80E-04	6.45E-04	9.86E-05
x		Formaldehyde	4.00E-04	3.85E-04	3.77E-04	4.21E-04	4.23E-04	4.39E-04	4.07E-04	2.41E-05
x		o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Core Storage 1.75% Binder

HAPs	POMs	Compound/Sample Number	ES307	ES308	ES309	ES310	ES311	ES312	Average	STDEV
		Test Dates	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02	10/09/02		
		TGOC as Propane	NA	NA	NA	NA	NA	NA	NA	NA
		HC as Hexane	7.10E-01	6.64E-01	6.89E-01	7.33E-01	7.70E-01	7.24E-01	7.15E-01	3.68E-02
		Sum of VOCs	3.91E-02	3.23E-02	3.75E-02	3.60E-02	4.42E-02	2.82E-02	3.62E-02	5.55E-03
		Sum of HAPs	3.91E-02	3.23E-02	3.75E-02	3.60E-02	4.42E-02	2.82E-02	3.62E-02	5.55E-03
		Sum of POMs	3.79E-02	3.11E-02	3.63E-02	3.47E-02	4.29E-02	2.69E-02	3.50E-02	5.53E-03
			Individual HAPs and VOCs							
x	z	Naphthalene	1.46E-02	1.27E-02	1.49E-02	1.42E-02	1.70E-02	1.20E-02	1.42E-02	1.77E-03
x	z	2-Methylnaphthalene	1.41E-02	1.12E-02	1.31E-02	1.24E-02	1.58E-02	8.99E-03	1.26E-02	2.35E-03
x	z	1-Methylnaphthalene	9.12E-03	7.18E-03	8.37E-03	8.05E-03	1.01E-02	5.92E-03	8.12E-03	1.46E-03
x		Phenol	7.39E-04	7.25E-04	6.17E-04	7.59E-04	8.22E-04	7.86E-04	7.41E-04	7.01E-05
x		Formaldehyde	4.99E-04	4.93E-04	5.47E-04	4.65E-04	4.90E-04	4.79E-04	4.95E-04	2.79E-05
x		o,m,p-Cresol	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Test ES Process and Source Data – Mixing and Core Making

Core Sand Mix Test	1	2	3	4	5	6	7	8	9	10	11	12	Average 1.20 % (1-6)	Average 1.75% (7-12)
Date	10/8/02	10/8/02	10/8/02	10/8/02	10/8/02	10/8/02	10/9/02	10/9/02	10/9/02	10/9/02	10/9/02	10/9/02		
Emission test No	ES101	ES102	ES103	ES104	ES105	ES106	ES107	ES108	ES109	ES110	ES111	ES112		
Total coated sand weight, Lbs.	50.6	50.6	50.6	50.6	50.6	50.6	50.9	50.9	50.9	50.9	50.9	50.9	**50.6**	**50.9**
Binder weight, Lbs.	0.597	0.596	0.596	0.597	0.597	0.597	0.870	0.868	0.868	0.868	0.869	0.869	**0.597**	**0.869**
Calculated % Binder (BOS)	1.19	1.19	1.19	1.19	1.19	1.19	1.74	1.74	1.74	1.74	1.74	1.74	**1.19**	**1.74**
Calculated binder content,%	1.18	1.18	1.18	1.18	1.18	1.18	1.71	1.71	1.71	1.71	1.71	1.71	**1.18**	**1.71**
1800 F LOI, % (note 1)	1.12	1.19	1.20	1.14	1.15	1.14	1.73	1.73	1.64	1.64	1.79	1.71	**1.46**	**1.71**
Sand temperature, Deg F	87	88	87	87	87	87	87	89	90	92	91	92	**87**	**90**
Average mix time door to door, mm:xx	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	0:07:00	**0:07:00**	**0:07:00**

Core Make Test	1	2	3	4	5	6	7	8	9	10	11	12	Average 1.20 % (1-6)	Average 1.75% (7-12)
Date	10/8/02	10/8/02	10/8/02	10/8/02	10/8/02	10/8/02	10/9/02	10/9/02	10/9/02	10/9/02	10/9/02	10/9/02		
Emission test no.	ES201	ES202	ES203	ES204	ES205	ES206	ES207	ES208	ES209	ES210	ES211	ES212		
Average core weight, Lbs.	7.29	7.28	7.29	7.30	7.3	7.28	7.27	7.18	7.13	7.18	7.12	7.06	**7.29**	**7.16**
Total coated sand weight, Lbs.	218.7	225.7	218.7	219.0	219.0	218.4	218.1	215.4	221.0	215.4	213.6	211.8	**219.9**	**215.9**
Calculated Total Binder weight, Lbs	2.58	2.64	2.56	2.58	2.56	2.58	3.71	3.68	3.78	3.68	3.65	3.62	**2.58**	**3.69**
Calculated % Binder (BOS)	1.20	1.19	1.18	1.19	1	1.19	1.73	1.74	1.74	1.74	1.74	1.74	**1.19**	**1.74**
Calculated standard % binder	1.18	1.17	1.17	1.18	1.17	1.18	1.70	1.71	1.71	1.71	1.71	1.71	**1.18**	**1.71**
1800 F LOI, % (note 1)	1.14	1.19	1.18	1.18	1.15	1.17	1.61	1.58	1.59	1.59	1.6	1.59	**1.17**	**1.59**
Sand temperature, Deg F	89	91	91	89	90	92	88	87	87	90	90	89	**91**	**89**
Dogbone Core 2 hr. tensile strength	143 psi average of 12 bones, St dev: 15.8 psi						207 psi average of 12 bones, St dev: 16.3						**143.0**	**207.0**
TEA Injection/cycle, gm/cycle (typical)	5	5	5	5	5	5	5	5	5	5	5	5	**5**	**5**
Blow pressure, psi	30	30	30	30	30	30	30	30	30	30	30	30	**30**	**30**
Max. purge pressure, psi	48	48	48	48	48	48	48	48	48	48	48	48	**48**	**48**
Purge duration, sec	20	20	20	20	20	20	20	20	20	20	20	20	**20**	**20**
Machine cycles per test	30	31	30	30	30	30	30	30	31	30	30	30	**30**	**30**
Ave.core machine cycle time, sec.	67	60	61	61	61	59	65	61	60	61	59	60	**62**	**61**

Test ES Process and Source Data- Core Storage

Core Storage Test	1	1	1	2	2	2	3	3	3	4	4	4	Average 1.20 % (1-6)	Average 1.75% (7-12)
Date	**10/8/02**	**10/8/02**	**10/8/02**	**10/8/02**	**10/8/02**	**10/8/02**	**10/9/02**	**10/9/02**	**10/9/02**	**10/9/02**	**10/9/02**	**10/9/02**		
Emission test no.	**ES301**	**ES302**	**ES303**	**ES304**	**ES305**	**ES306**	**ES307**	**ES308**	**ES309**	**ES310**	**ES311**	**ES312**		
Total coated sand weight, Lbs.	7.30	7.35	7.35	7.25	7.35	7.15	7.30	7.25	7.25	7.35	7.15	7.10	**7.29**	**7.23**
Calculated total binder weight, Lbs.	0.086	0.087	0.087	0.087	0.088	0.086	0.127	0.126	0.126	0.128	0.124	0.124	**0.087**	**0.126**
Calculated standard % binder	1.18	1.18	1.18	1.20	1.20	1.20	1.74	1.74	1.74	1.74	1.74	1.74	**1.19**	**1.74**
Calculated % binder (BOS)	1.20	1.20	1.20	1.18	1.18	1.18	1.71	1.71	1.71	1.71	1.71	1.71	**1.19**	**1.71**
Sand temperature, Deg F	89	89	89	91	91	91	88	88	88	88	88	88	**91**	**88**
1800 F LOI, % (note 1)	1.14	1.14	1.14	1.14	1.14	1.14	1.63	1.63	1.63	1.63	1.63	1.63	**1.14**	**1.63**
TEA Injection/cycle, gm/cycle (typical)	5	5	5	5	5	5	5	5	5	5	5	5	**5**	**5**
Blow pressure, psi	30	30	30	30	30	30	30	30	30	30	30	30	**30**	**30**
Max Purge Pressure, psi	48	48	48	48	48	48	48	48	48	48	48	48	**48**	**48**
Purge duration, sec	20	20	20	20	20	20	20	20	20	20	20	20	**20**	**20**
Machine cycles per test	1	1	1	1	1	1	1	1	1	1	1	1	**1**	**1**
Ave.core machine cycle time, sec.	60	65	54	59	59	59	60	58	61	60	60	60	**59**	**60**

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.

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

Core Mixing 1.75% Binder

HAPs	POMs	Compound/Sample Number	EQ004	EQ005	EQ006	EQ007	EQ008	EQ009	EQ010	EQ011	EQ012	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	4.20E-03	4.00E-03	4.00E-03	4.00E-03	4.10E-03	4.00E-03	4.00E-03	4.00E-03	4.10E-03	4.04E-03	7.26E-05
		HC as Hexane	2.23E-03	1.43E-03	1.79E-03	2.05E-03	2.10E-03	2.17E-03	1.99E-03	2.43E-03	2.31E-03	2.06E-03	2.98E-04
		Sum of VOCs	9.33E-05	8.88E-05	9.15E-05	8.97E-05	8.52E-05	8.97E-05	8.90E-05	8.88E-05	9.95E-05	9.06E-05	3.97E-06
		Sum of HAPs	9.33E-05	8.88E-05	9.15E-05	8.97E-05	8.52E-05	8.97E-05	8.90E-05	8.88E-05	9.95E-05	9.06E-05	3.97E-06
		Sum of POMs	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
			Individual Organic HAPs and VOCs										
x		Phenol	8.98E-05	8.54E-05	8.81E-05	8.63E-05	8.18E-05	8.63E-05	8.55E-05	8.53E-05	9.61E-05	8.72E-05	3.98E-06
x		Formaldehyde	3.50E-06	3.42E-06	3.37E-06	3.41E-06	3.42E-06	3.48E-06	3.49E-06	3.53E-06	3.42E-06	3.45E-06	5.47E-08
x		o-Cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
x	z	1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
x	z	2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
x	z	Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA: Not Applicable

Formaldehyde results reported as a mimimum.

Core Making 1.75% Binder

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		
		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

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

Core Storage 1.75% Binder

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		
		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 Mixing and Core Making Results for Test EQ– Lb/Tn Sand

Core Mixing 1.75% Binder

HAPs	POMs	Compound/Sample Number	EQ004	EQ005	EQ006	EQ007	EQ008	EQ009	EQ010	EQ011	EQ012	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	1.44E-01	1.37E-01	1.38E-01	1.38E-01	1.41E-01	1.39E-01	1.39E-01	1.39E-01	1.41E-01	1.39E-01	2.18E-03
		HC as Hexane	7.59E-02	4.88E-02	6.10E-02	7.06E-02	7.22E-02	7.47E-02	6.84E-02	8.36E-02	7.95E-02	7.05E-02	1.04E-02
		Sum of VOCs	3.18E-03	3.02E-03	3.12E-03	3.08E-03	2.93E-03	3.09E-03	3.06E-03	3.05E-03	3.42E-03	3.11E-03	1.36E-04
		Sum of HAPs	3.18E-03	3.02E-03	3.12E-03	3.08E-03	2.93E-03	3.09E-03	3.06E-03	3.05E-03	3.42E-03	3.11E-03	1.36E-04
		Sum of POMs	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
		Individual Organic HAPs and VOCs											
x		Phenol	3.06E-03	2.91E-03	3.00E-03	2.97E-03	2.81E-03	2.97E-03	2.94E-03	2.93E-03	3.30E-03	2.99E-03	1.36E-04
x		Formaldehyde	1.19E-04	1.16E-04	1.15E-04	1.17E-04	1.17E-04	1.20E-04	1.20E-04	1.21E-04	1.17E-04	1.18E-04	2.07E-06
x		o-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
x	z	1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
x	z	2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
x	z	Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA

ND: Non Detect; NA; Not Applicable

Formaldehyde results reported as a minimum due to apparent breakthrough.

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	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

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

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	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 – Mixing

Core Sand Mixing Test	1	2	3	4	5	6	7	8	9	10	11	12	13	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	9/9/02		
Emission test No.	EQ001	EQ002	EQ003	EQ004	EQ005	EQ006	EQ007	EQ008	EQ009	EQ010	EQ011	EQ012	EQ013		
Total coated sand weight, Lbs.	51.4	50.9	50.9	**51.4**	**51.4**	**51.4**	**50.9**	**50.9**	**50.9**	**50.9**	**50.9**	**50.9**	50.9	51.0	**51.0**
Binder weight, Lbs.	0.876	0.875	0.874	**0.876**	**0.875**	**0.876**	**0.875**	**0.875**	**0.876**	**0.874**	**0.875**	**0.875**	0.874	0.875	**0.875**
Calculated % binder (BOS)	1.73	1.75	1.75	1.73	1.73	1.73	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.74	**1.74**
Calculated binder content,%	1.71	1.72	1.72	**1.71**	**1.70**	**1.71**	**1.72**	**1.72**	**1.72**	**1.72**	**1.72**	**1.72**	1.72	1.71	**1.71**
1800 F LOI, %	1.58	1.71	1.72	**1.62**	**1.54**	**1.65**	**1.58**	**1.56**	**1.64**	**1.64**	**ND**	**1.62**	1.60	1.62	**1.61**
Sand temperature, Deg F	84	83	84	**95**	**90**	**90**	**90**	**89**	**88**	**88**	**88**	**89**	90	88	**89.7**
													Note 2	Note 1	Note 1

Test EQ Process and Source Data – Core Making

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

Test EQ Process and Source Data - Storage

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 ES Quantitation Limits - Lb/Lb Binder

Core Mixing		
Analytes	1.20%	1.75%
HC as hexane	9.04E-05	6.21E-05
1-methylnaphthalene	9.04E-05	6.21E-05
2-methylnaphthalene	9.04E-05	6.21E-05
formaldehyde	3.76E-08	3.76E-08
naphthalene	9.04E-05	6.21E-05
o,m,p-cresol	1.11E-06	7.62E-07
phenol	5.55E-07	3.81E-07

Core Making		
Analytes	1.20%	1.75%
HC as hexane	1.56E-04	1.09E-04
1-methylnaphthalene	1.56E-04	1.09E-04
2-methylnaphthalene	1.56E-04	1.09E-04
formaldehyde	3.73E-06	2.61E-06
naphthalene	1.56E-04	1.09E-04
o,m,p-cresol	4.64E-05	3.25E-05
phenol	3.87E-05	2.71E-05

Core Storage		
Analytes	1.20%	1.75%
HC as hexane	9.88E-05	6.82E-05
1-methylnaphthalene	9.88E-05	6.82E-05
2-methylnaphthalene	9.88E-05	6.82E-05
formaldehyde	6.49E-07	4.48E-07
naphthalene	9.88E-05	6.82E-05
o,m,p-cresol	2.42E-05	1.67E-05
phenol	2.02E-05	1.39E-05

Test ES Quantitation Limits - Lb/Tn Sand

Core Mixing		
Analytes	1.20%	1.75%
HC as hexane	2.13E-03	2.12E-03
1-methylnaphthalene	2.13E-03	2.12E-03
2-methylnaphthalene	2.13E-03	2.12E-03
formaldehyde	1.29E-06	1.28E-06
naphthalene	2.13E-03	4.24E-03
o,m,p-cresol	2.62E-05	2.60E-05
phenol	1.31E-05	1.30E-05

Core Making		
Analytes	1.20%	1.75%
HC as hexane	3.65E-03	3.72E-03
1-methylnaphthalene	3.65E-03	3.72E-03
2-methylnaphthalene	3.65E-03	3.72E-03
formaldehyde	8.75E-05	8.91E-05
naphthalene	3.65E-03	3.72E-03
o,m,p-cresol	1.09E-03	1.11E-03
phenol	9.08E-04	9.25E-04

Core Storage		
Analytes	1.20%	1.75%
HC as hexane	2.36E-03	2.38E-03
1-methylnaphthalene	2.36E-03	2.38E-03
2-methylnaphthalene	2.36E-03	2.38E-03
formaldehyde	1.55E-05	1.56E-05
naphthalene	2.36E-03	2.38E-03
o,m,p-cresol	5.79E-04	5.83E-04
phenol	4.82E-04	4.86E-04

Test EQ Quantitation Limits - Lb/Lb Binder

Core Mixing	
1.75%	
HC as hexane	6.69E-05
1-methylnaphthalene	6.69E-05
2-methylnaphthalene	6.69E-05
naphthalene	6.69E-05
o,m,p-cresol	8.73E-07
formaldehyde	3.62E-08
phenol	4.37E-07

Core Making	
1.75%	
HC as hexane	1.09E-04
1-methylnaphthalene	1.09E-04
2-methylnaphthalene	1.09E-04
naphthalene	1.09E-04
o,m,p-cresol	3.19E-05
formaldehyde	1.85E-06
phenol	2.66E-05

Core Storage	
1.75%	
HC as hexane	6.57E-05
1-methylnaphthalene	6.57E-05
2-methylnaphthalene	6.57E-05
naphthalene	6.57E-05
o,m,p-cresol	1.61E-05
formaldehyde	2.64E-07
phenol	1.34E-05

Test EQ Quantitation Limits - Lb/Tn Sand

Core Mixing	
1.75%	
HC as hexane	2.30E-03
1-methylnaphthalene	2.30E-03
2-methylnaphthalene	2.30E-03
naphthalene	2.30E-03
o,m,p-cresol	3.00E-05
formaldehyde	1.24E-06
phenol	1.50E-05

Core Making	
1.75%	
HC as hexane	3.81E-03
1-methylnaphthalene	3.81E-03
2-methylnaphthalene	3.81E-03
naphthalene	3.81E-03
o,m,p-cresol	1.12E-03
formaldehyde	6.46E-05
phenol	9.30E-04

Core Storage	
1.75%	
HC as hexane	2.32E-03
1-methylnaphthalene	2.32E-03
2-methylnaphthalene	2.32E-03
naphthalene	2.32E-03
o,m,p-cresol	5.69E-04
formaldehyde	9.32E-06
phenol	4.74E-04

APPENDIX C METHOD 25A CHARTS

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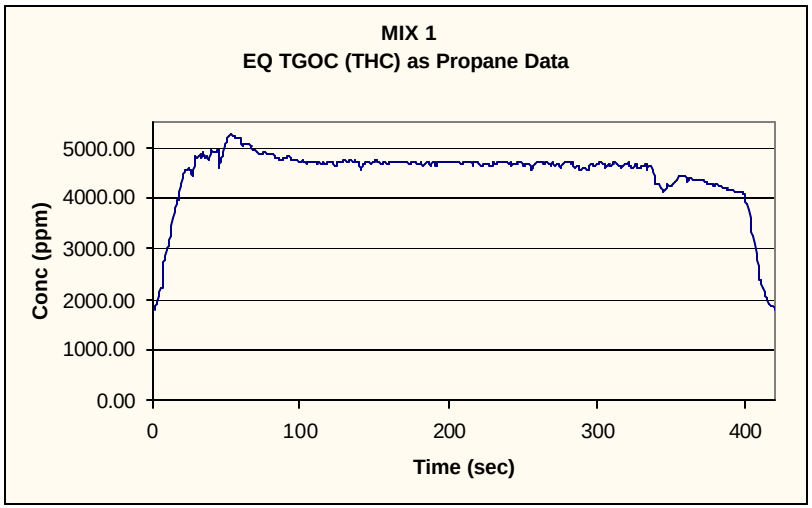
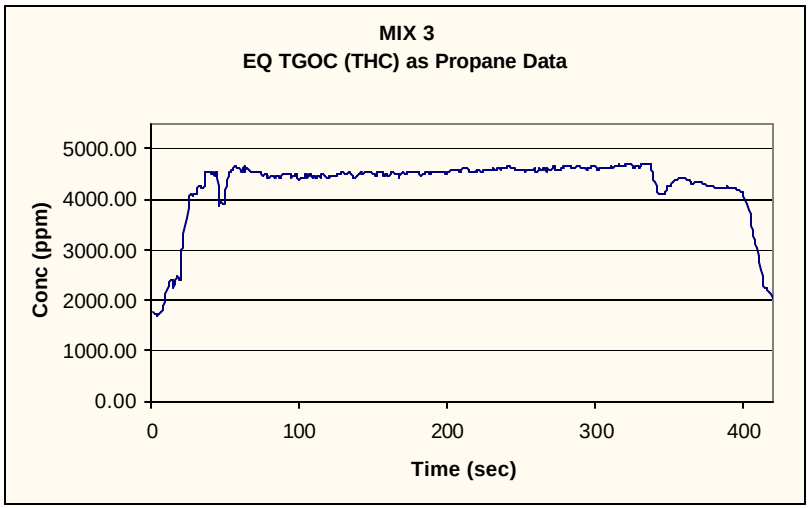
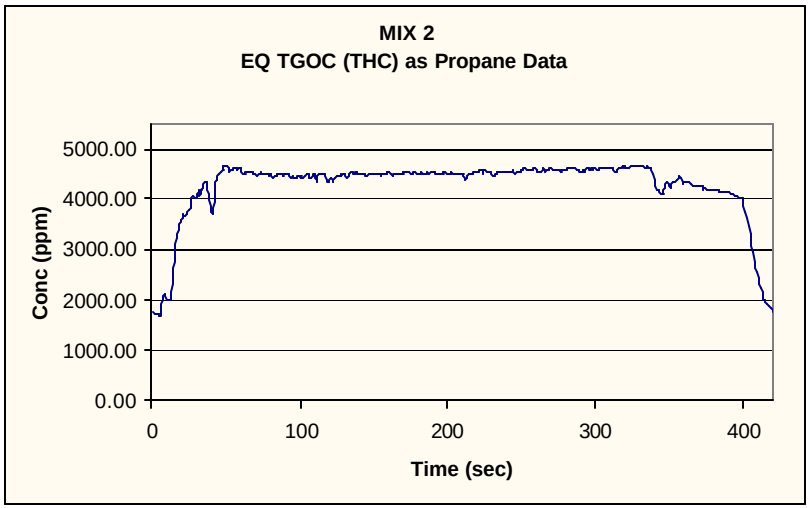
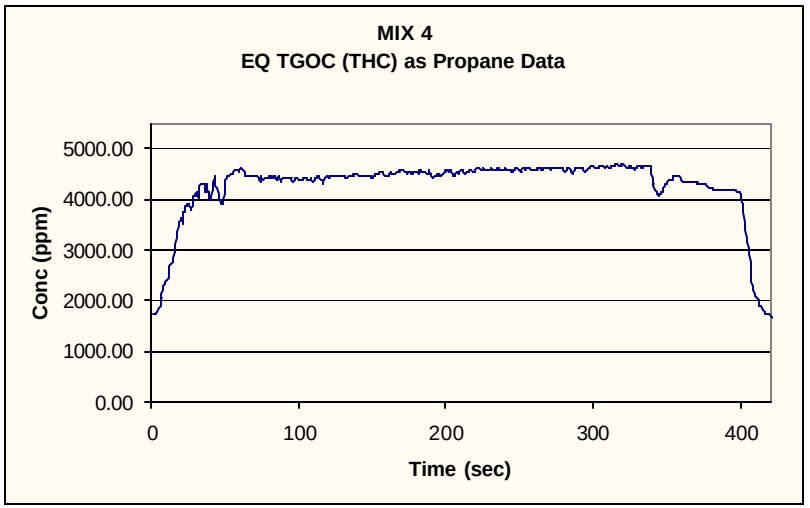
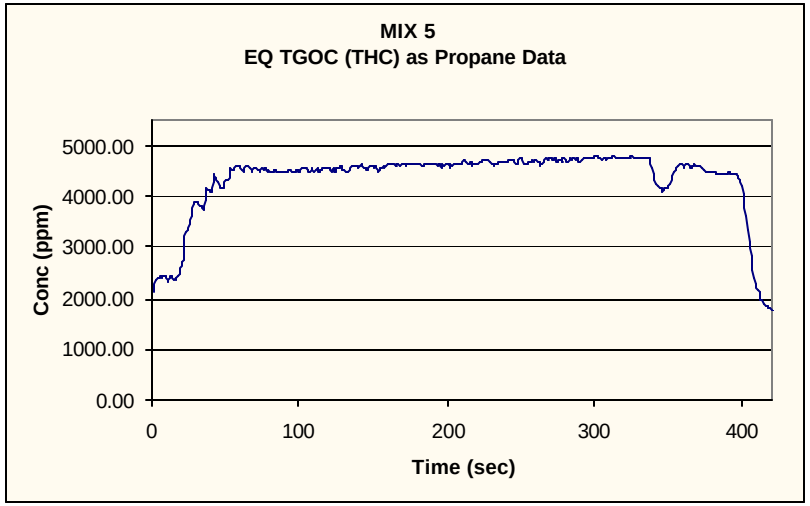
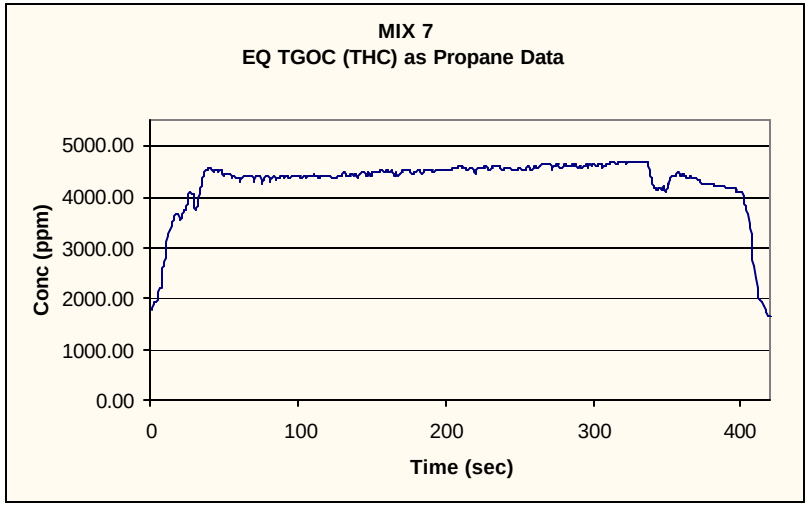

MIX 1
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

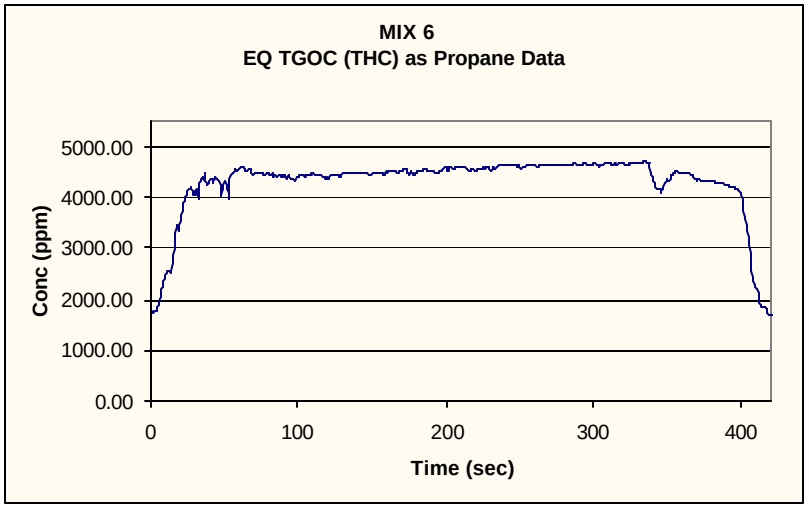

MIX 3
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

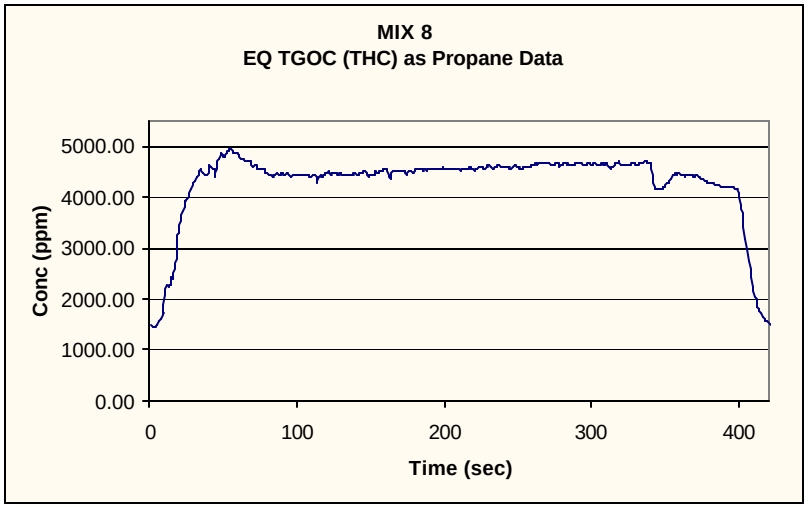

MIX 2
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

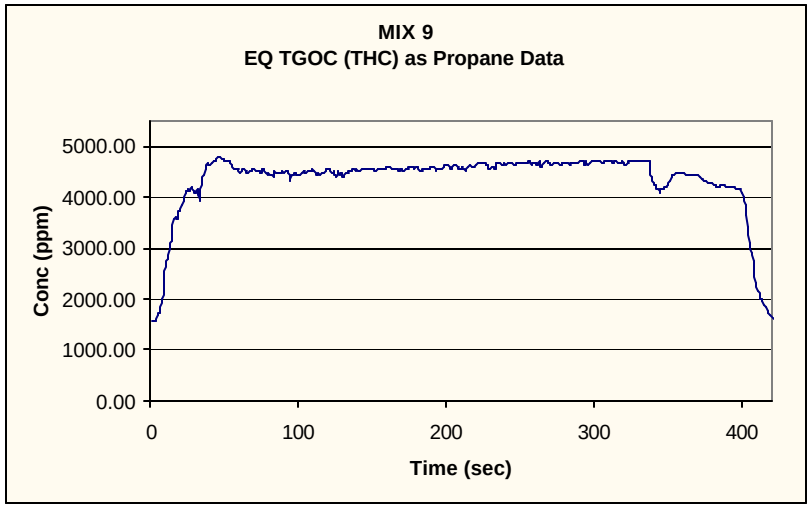

MIX 4
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

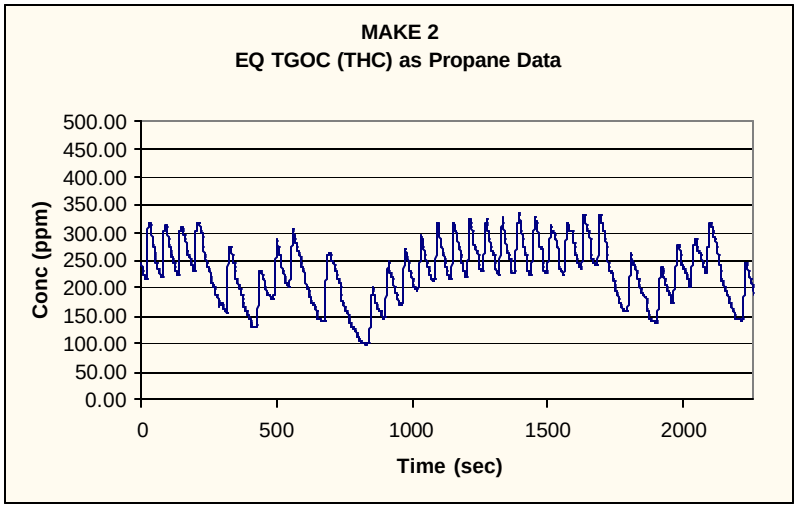

MIX 5
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

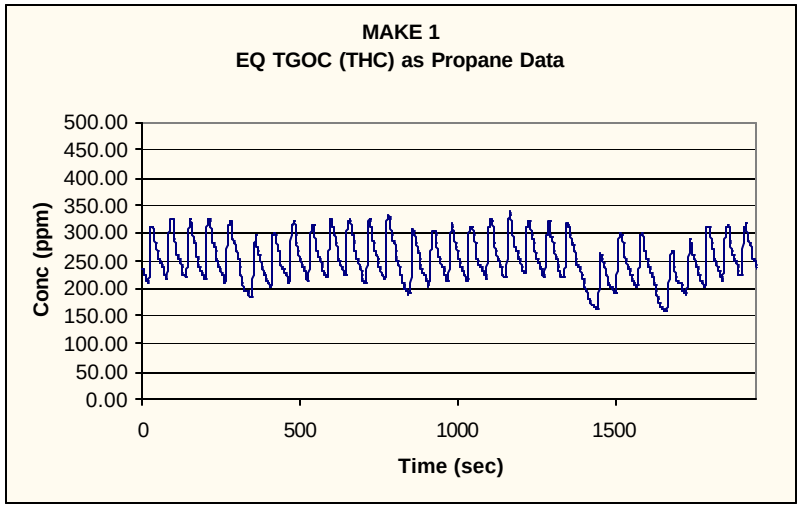

MIX 7
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

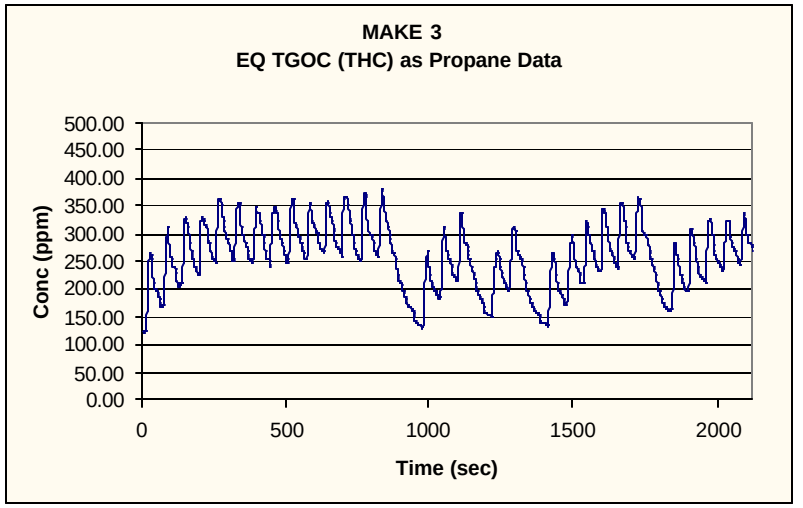

MIX 6
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

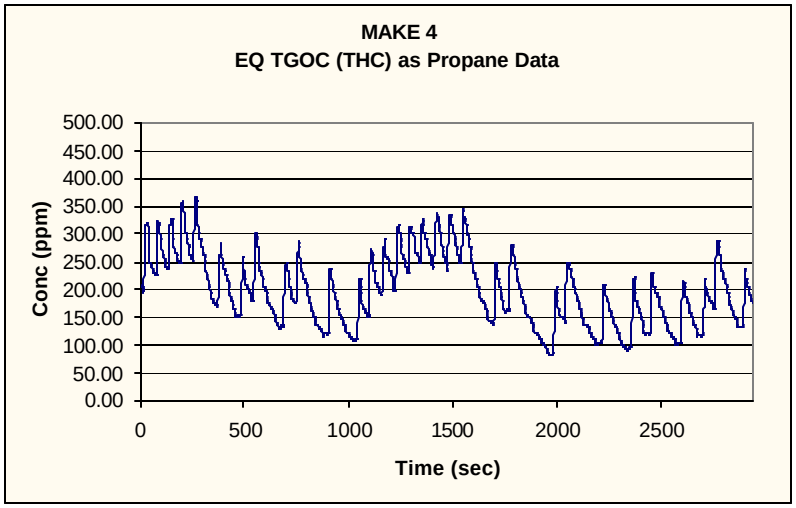

MIX 8
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

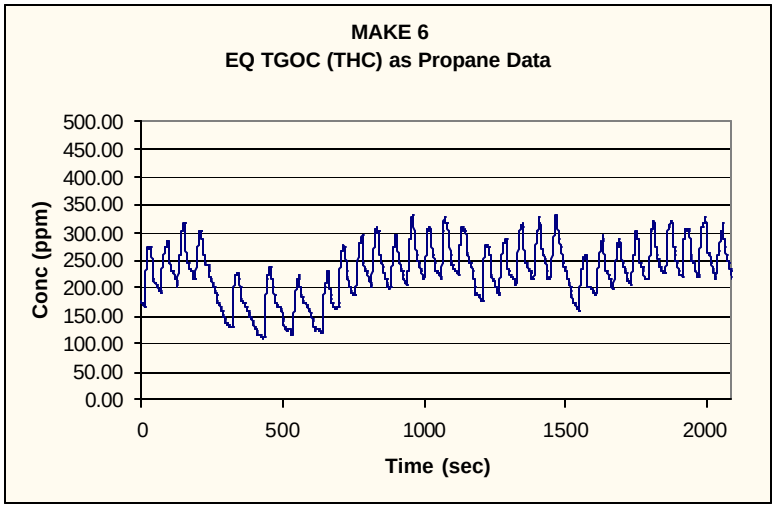

MIX 9
EQ TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

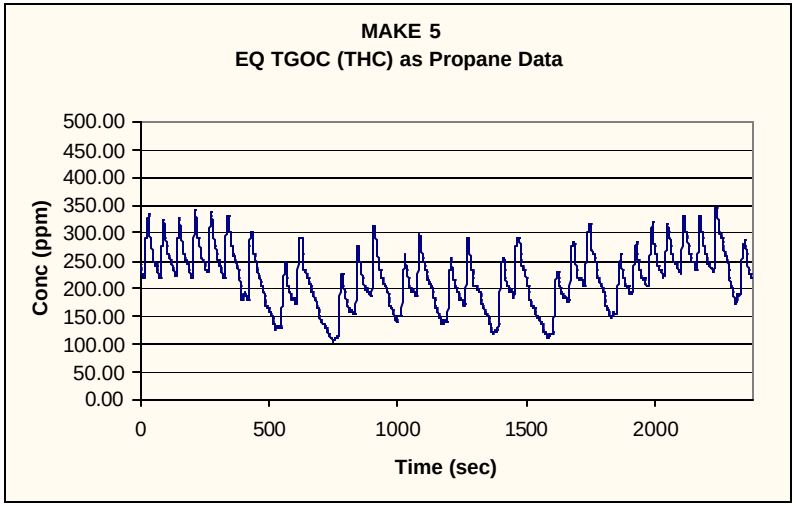

MAKE 2
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

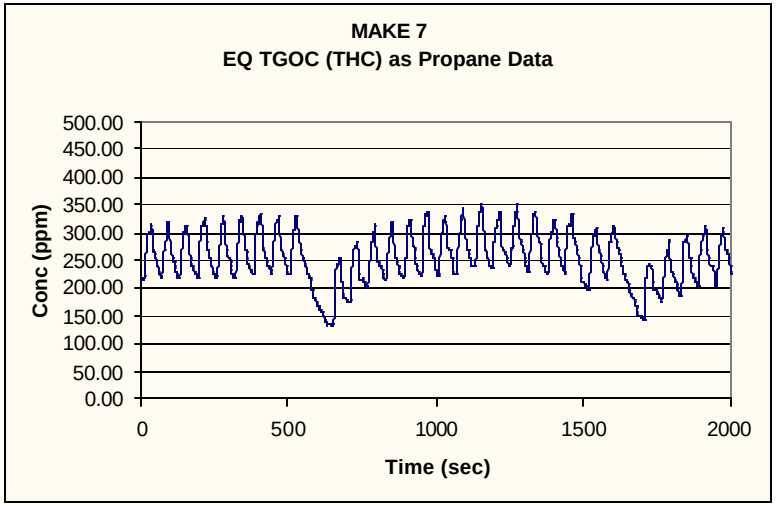

MAKE 1
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
Time (sec)

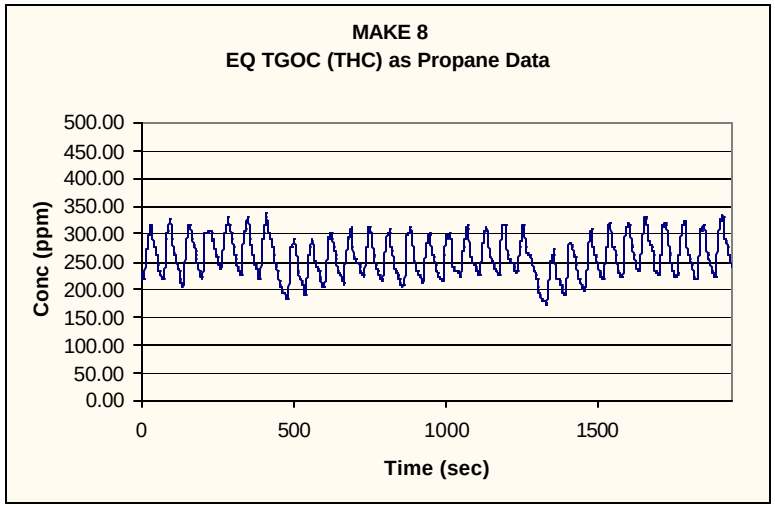

MAKE 3
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

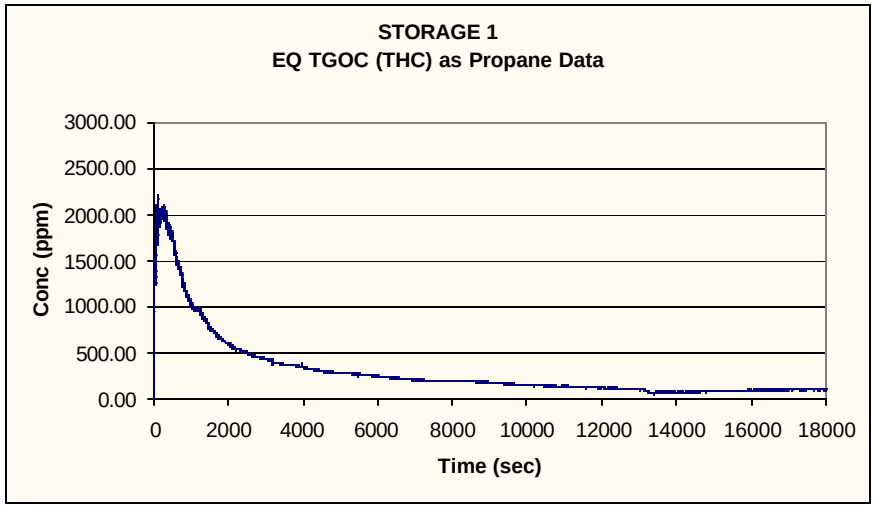

MAKE 4
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
2500
Time (sec)

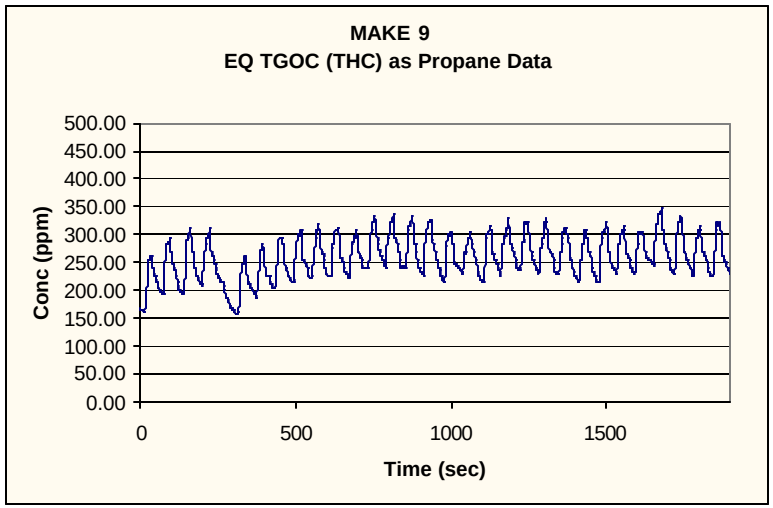

MAKE 6
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

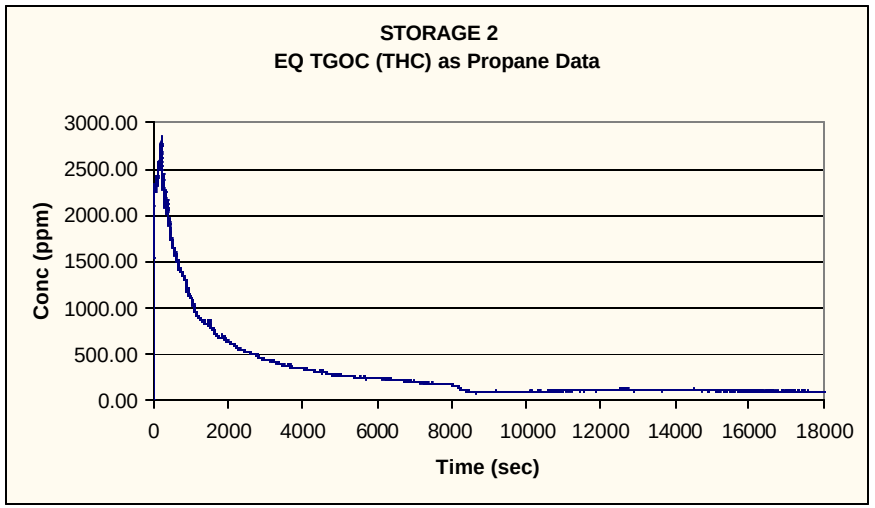

MAKE 5
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

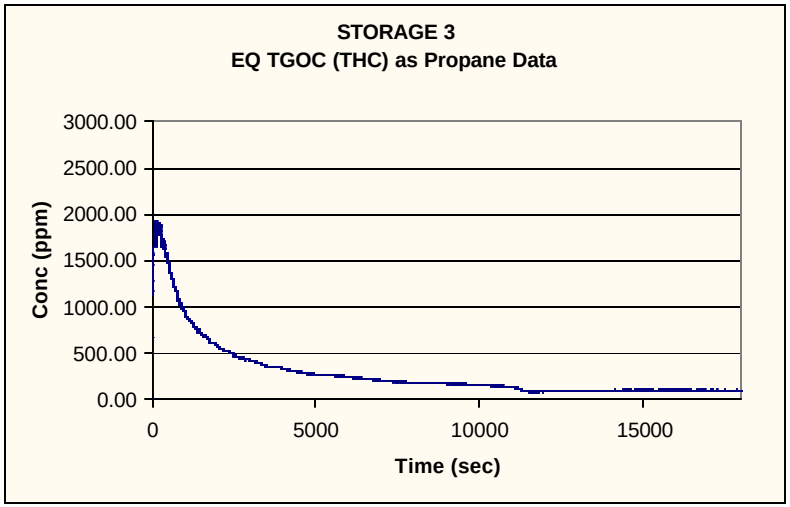

MAKE 7
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
2000
Time (sec)

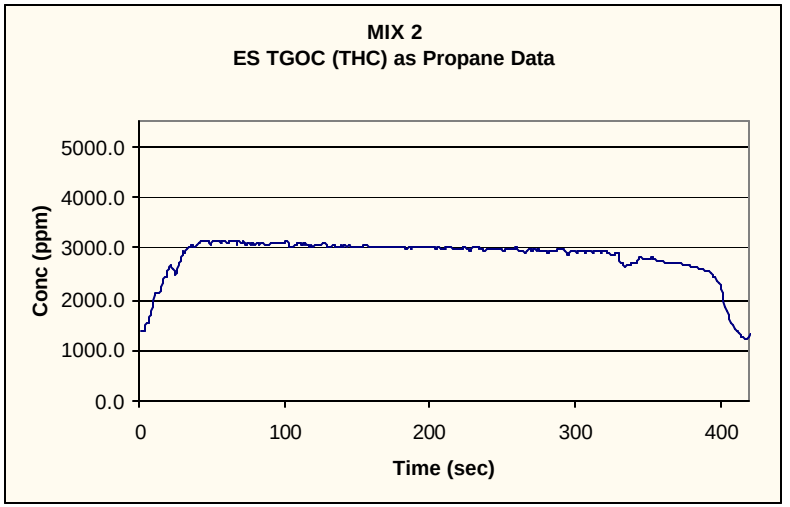

MAKE 8
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
Time (sec)

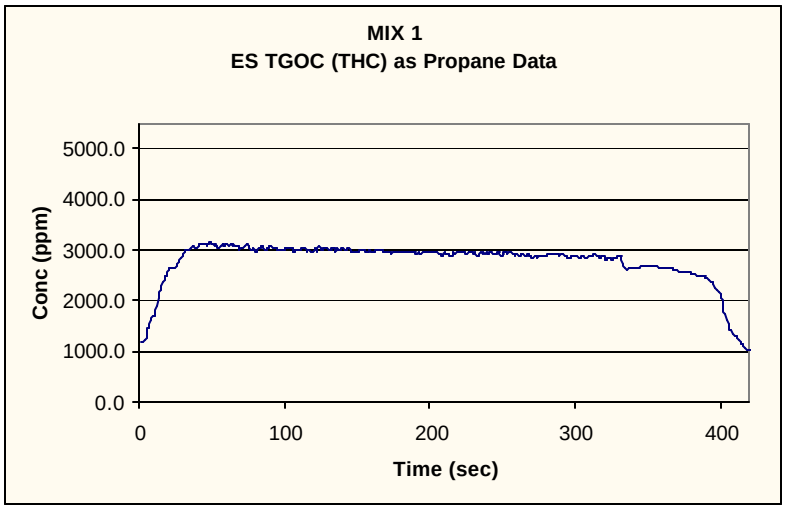

STORAGE 1
EQ TGOC (THC) as Propane Data
Conc (ppm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Time (sec)

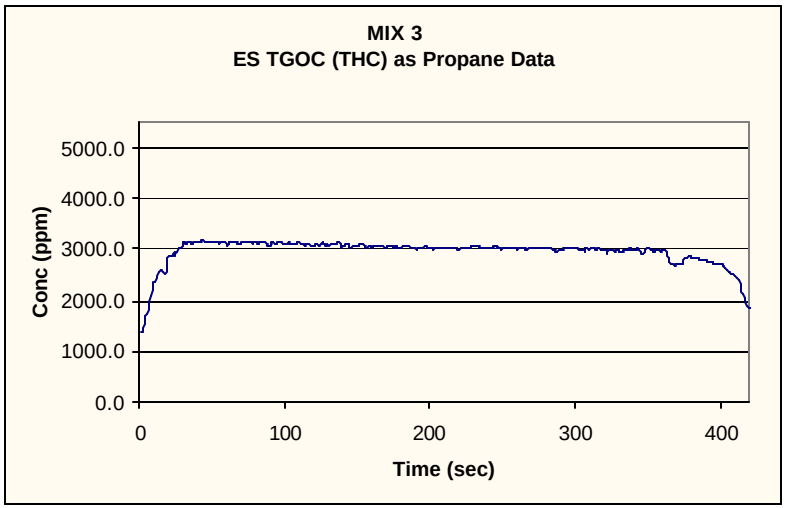

MAKE 9
EQ TGOC (THC) as Propane Data
Conc (ppm)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
500
1000
1500
Time (sec)

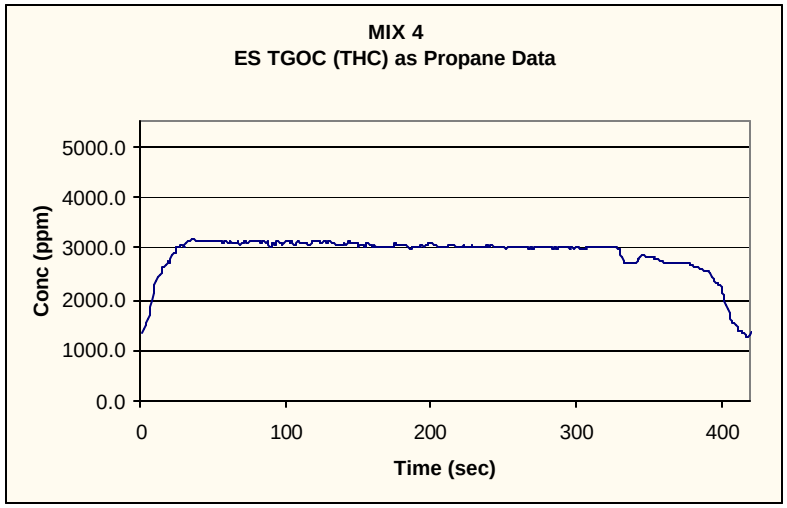

STORAGE 2
EQ TGOC (THC) as Propane Data
Conc (ppm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Time (sec)

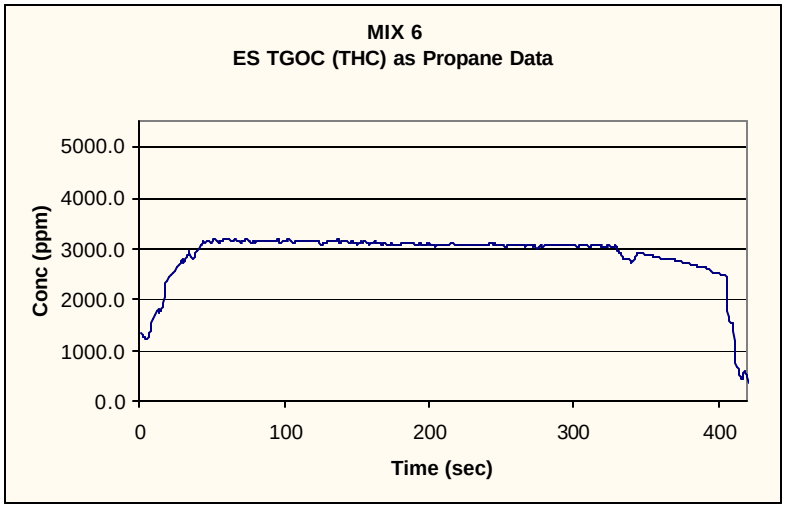

STORAGE 3
EQ TGOC (THC) as Propane Data
Conc (ppm)
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0
5000
10000
15000
Time (sec)

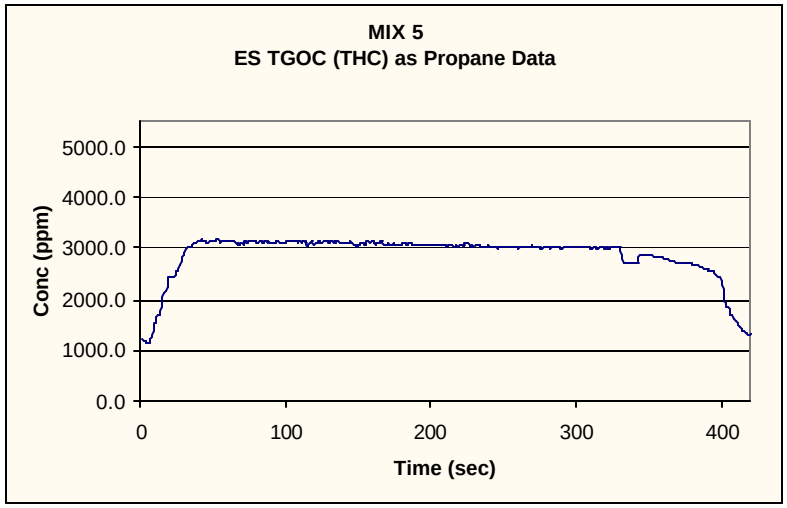

MIX 2
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
0
100
200
300
400
Time (sec)

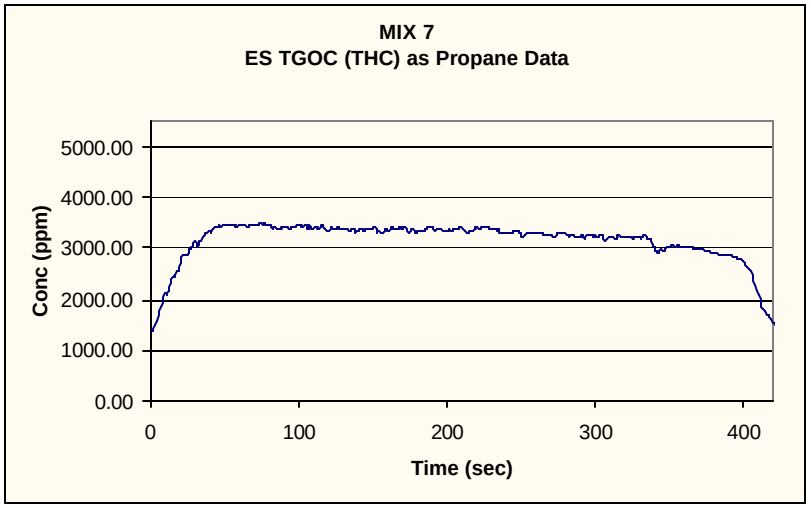

MIX 1
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
0
100
200
300
400
Time (sec)

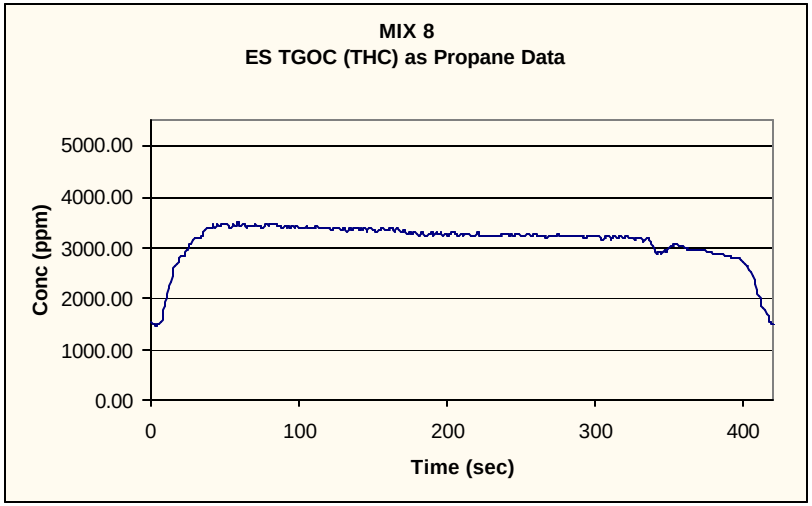

MIX 3
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
0
100
200
300
400
Time (sec)

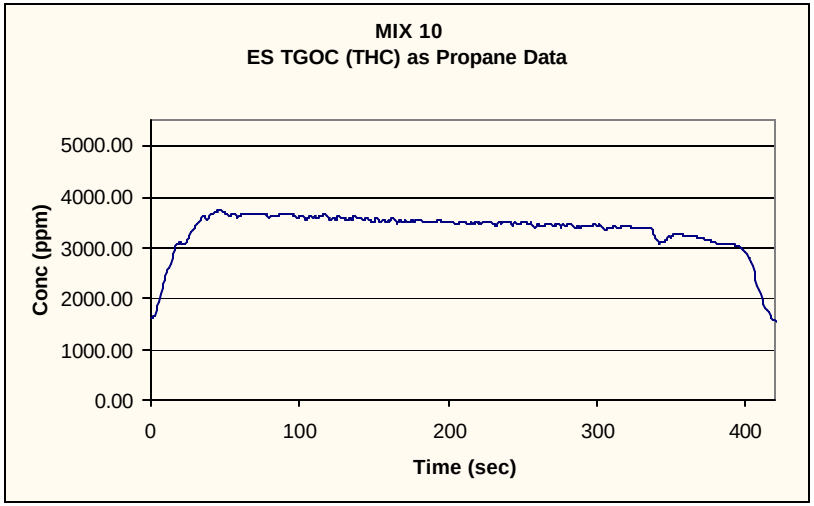

MIX 4
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
0
100
200
300
400
Time (sec)

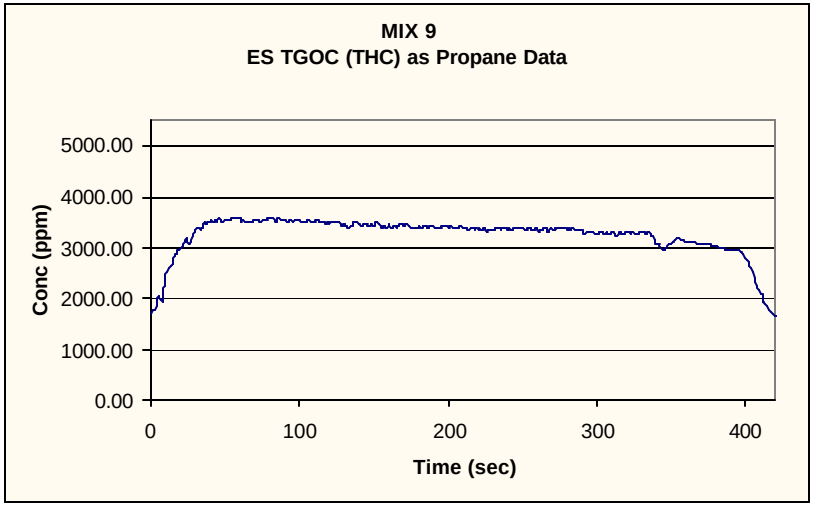

MIX 6
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
0
100
200
300
400
Time (sec)

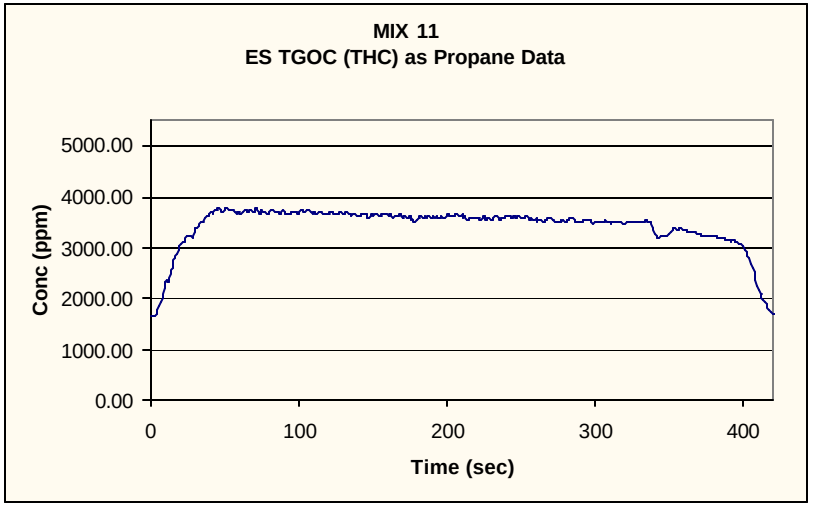

MIX 5
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
0
100
200
300
400
Time (sec)

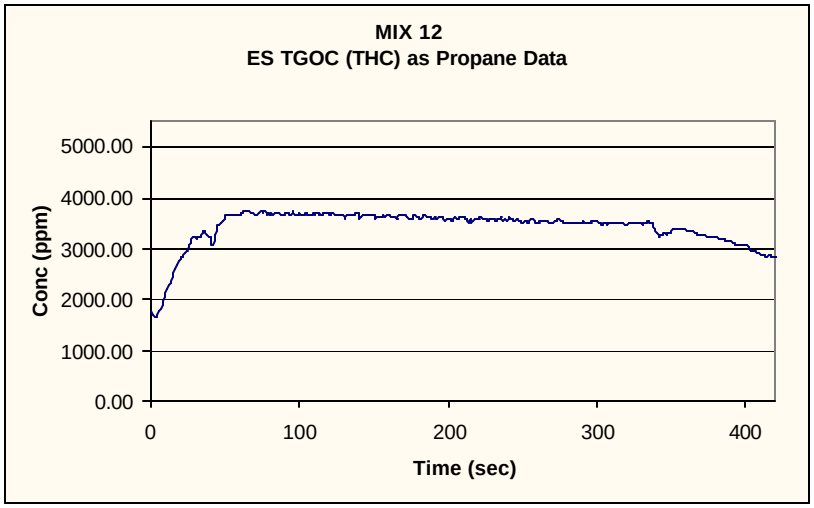

MIX 7
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

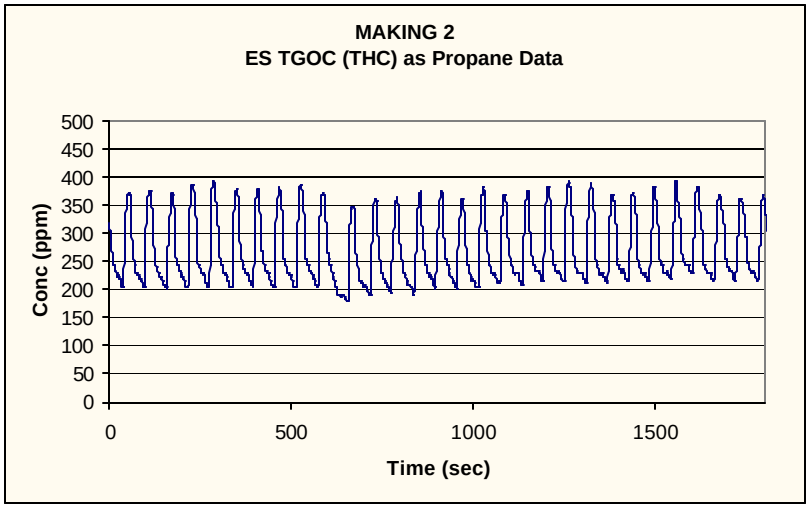

MIX 8
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

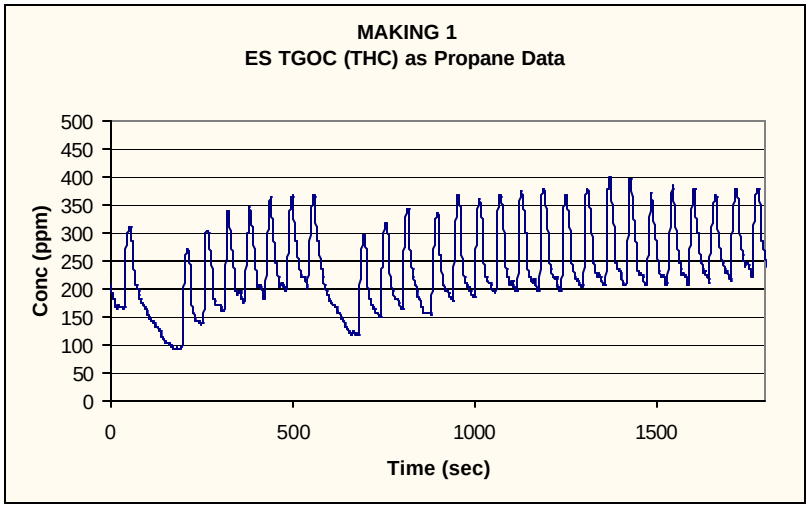

MIX 10
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

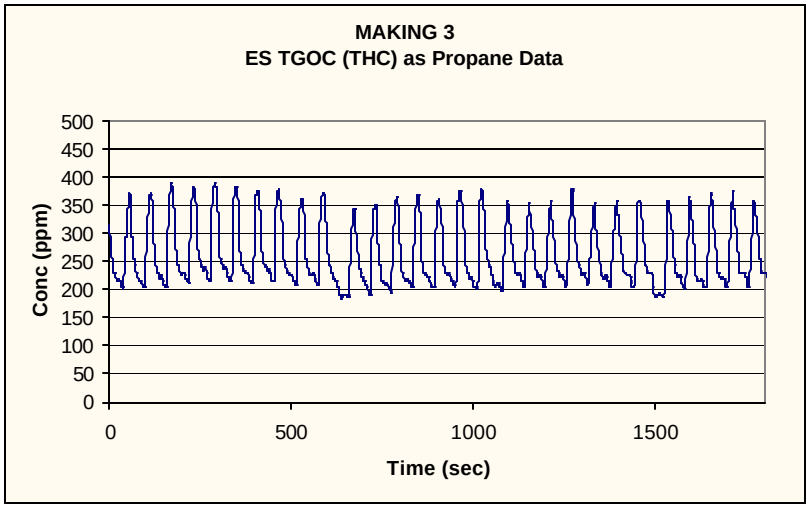

MIX 9
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

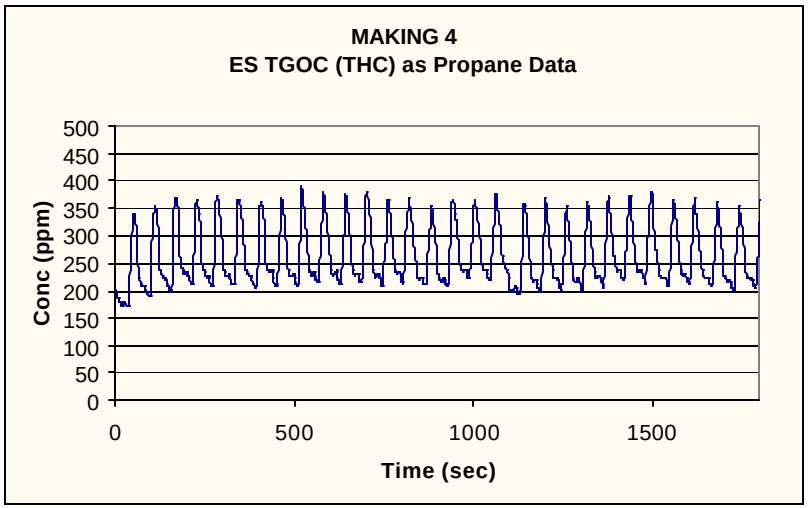

MIX 11
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

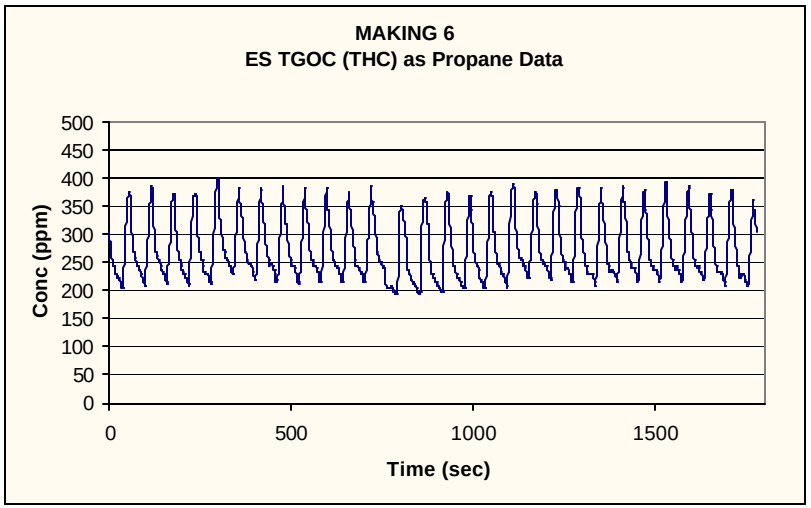

MIX 12
ES TGOC (THC) as Propane Data
Conc (ppm)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
100
200
300
400
Time (sec)

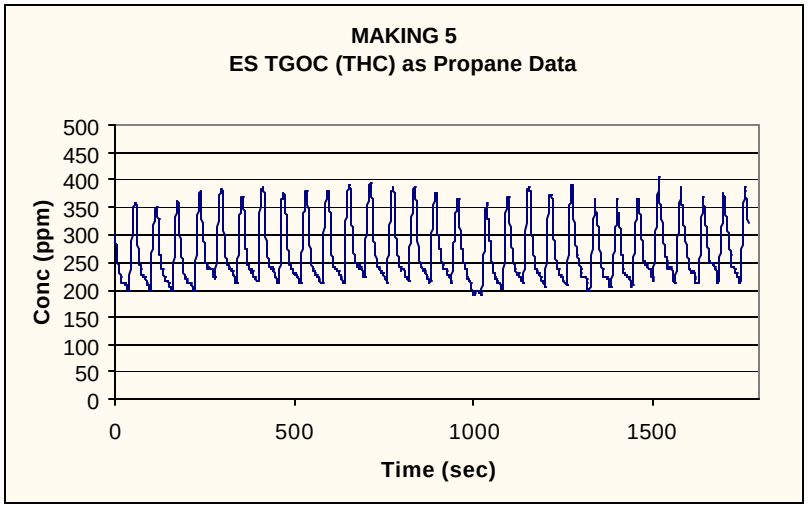

MAKING 2
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

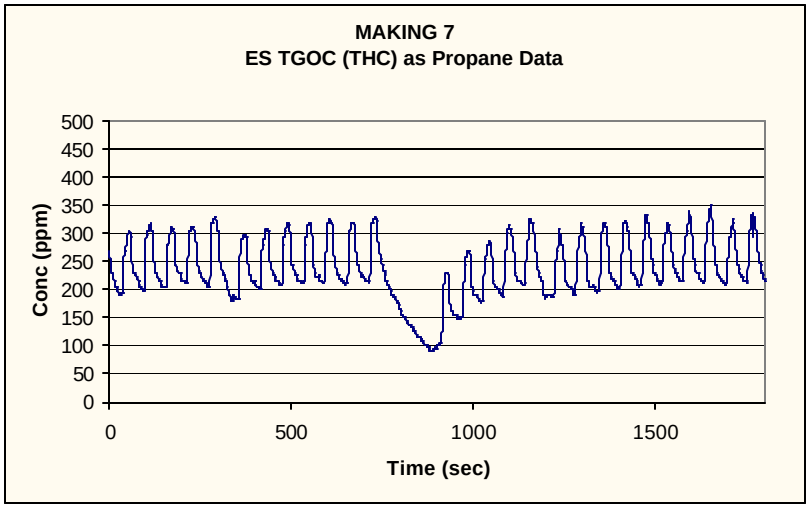

MAKING 1
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

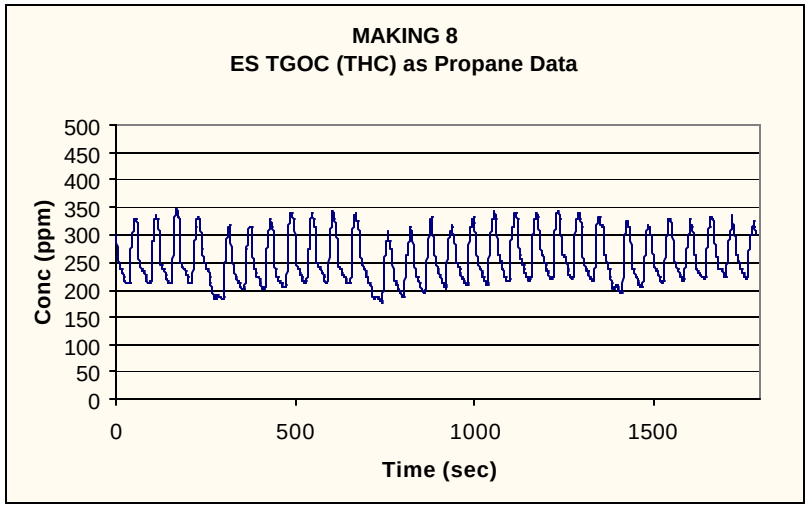

MAKING 3
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

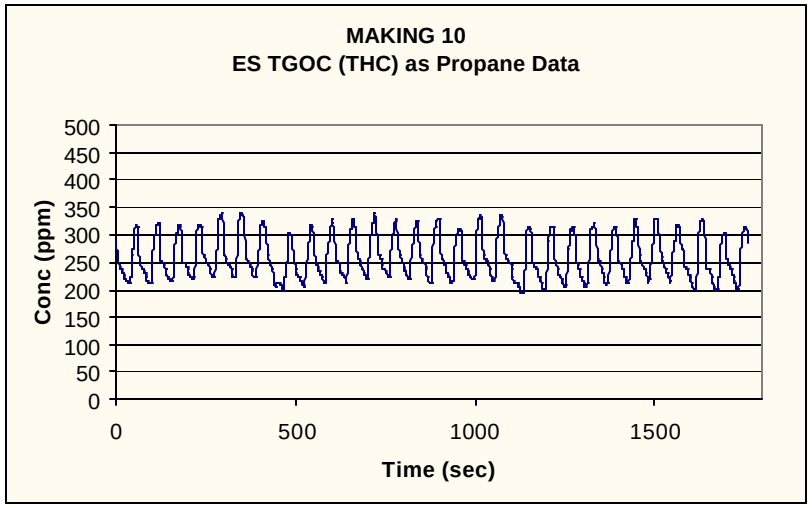

MAKING 4
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

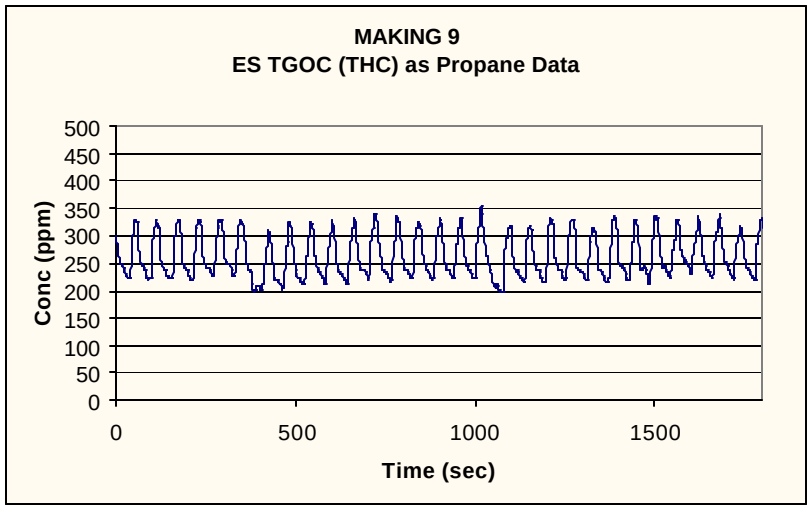

MAKING 6
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

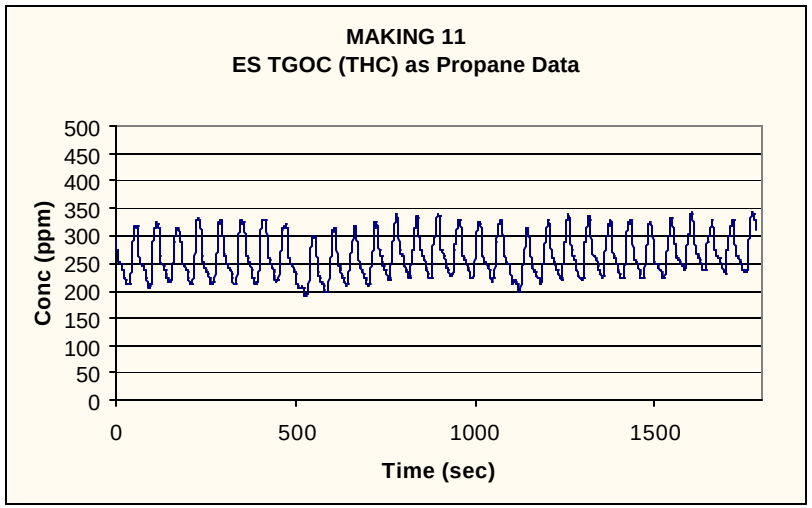

MAKING 5
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

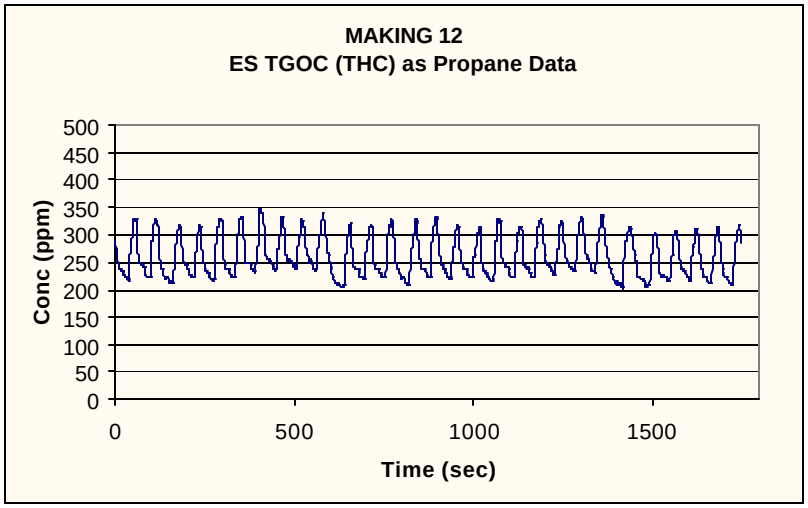

MAKING 7
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

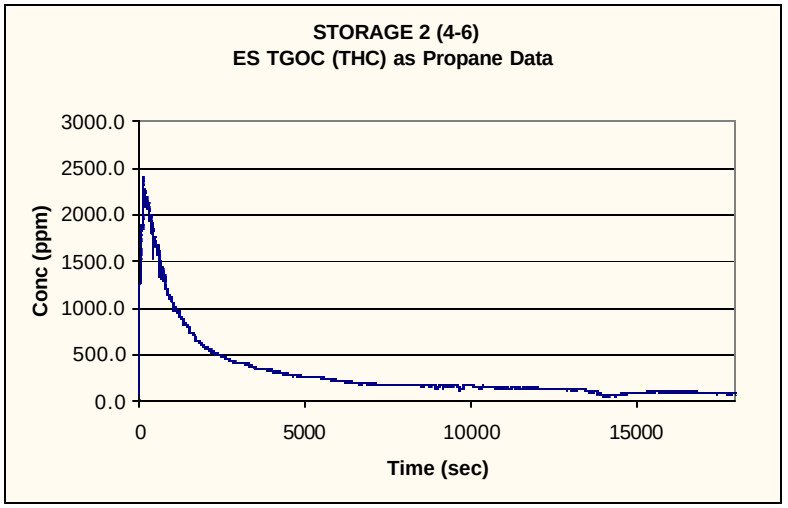

MAKING 8
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

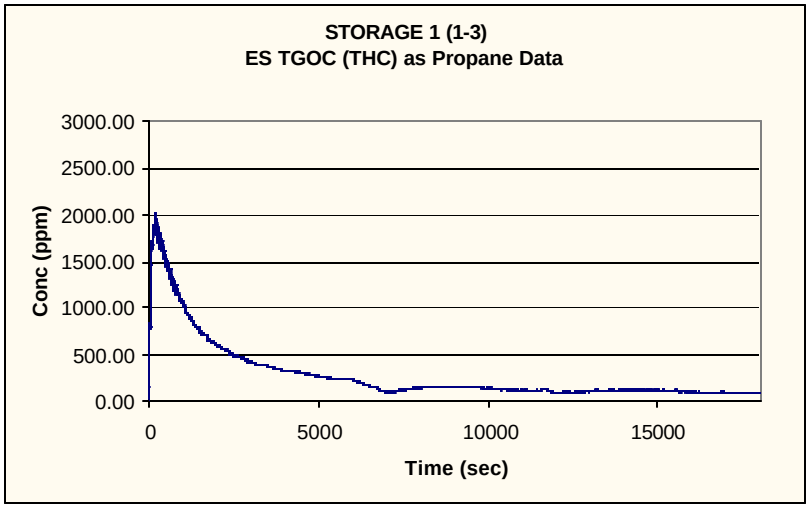

MAKING 10
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

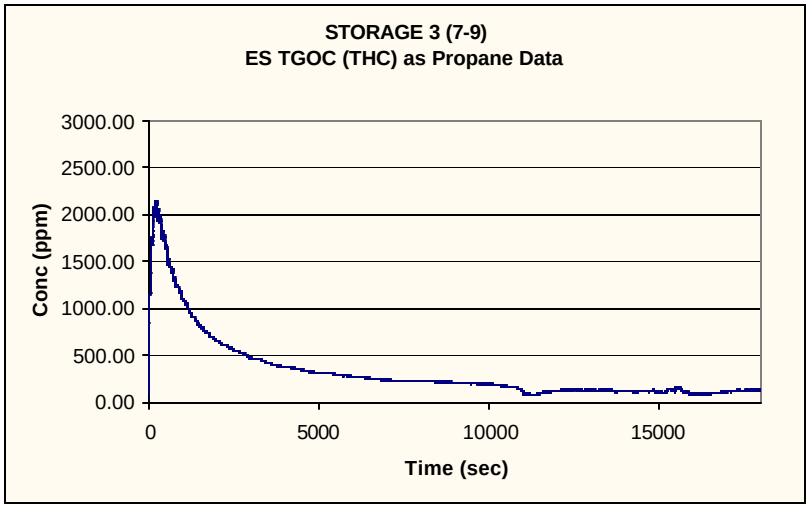

MAKING 9
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)

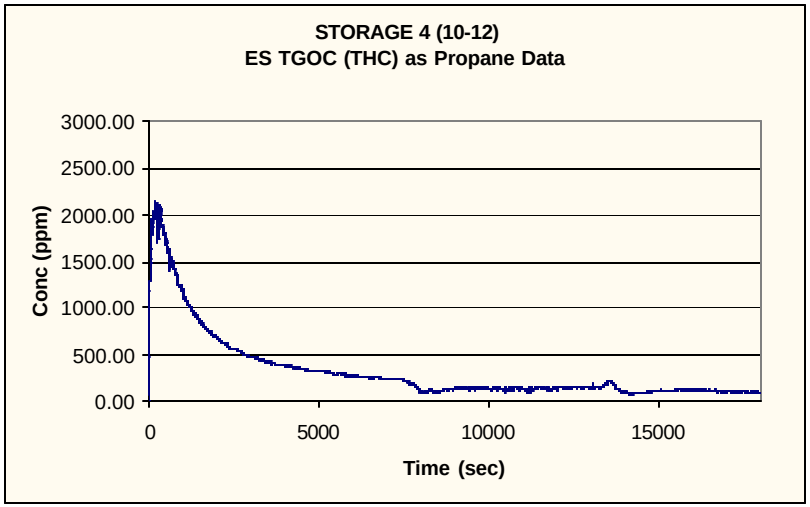

MAKING 11
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)


MAKING 12
ES TGOC (THC) as Propane Data
Conc (ppm)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
Time (sec)


STORAGE 2 (4-6)
ES TGOC (THC) as Propane Data
Conc (ppm)
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
0
5000
10000
15000
Time (sec)


STORAGE 1 (1-3)
ES 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)


STORAGE 3 (7-9)
ES 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)


STORAGE 4 (10-12)
ES TGOC (THC) as Propane Data
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Conc (ppm)
0
5000
10000
15000
Time (sec)

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APPENDIX D GLOSSARY

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Glossary

ND	Non Detect
NA	Not Applicable
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.
BOS	Based on Sand
Binder	Part 1 plus Part II