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Casting Emission Reduction Program

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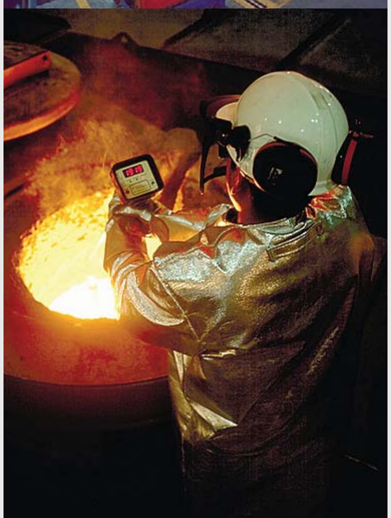

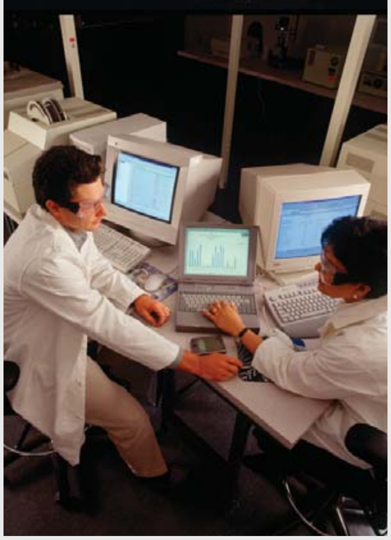

Operated by

TECHNIKON

5301 Price Avenue
McClellan, CA 95652
916-929-8001
www.technikonllc.com

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Emissions from Shell Core Making and Storage

1413-122 HN

September 2007
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Emissions from Shell Core Making and Storage

1413-122 HN

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

Director of Measurement Technologies	*//Original Signed//* Sue Anne Sheya, PhD	Date
Vice President	*//Original Signed//* George Crandell	Date

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

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Executive Summary

A testing protocol was undertaken for Test HN to quantitatively evaluate airborne emissions from a shell core making and storage process. A Beardsley and Piper Cormatic Shell core machine, model SF6CA, with 32 natural gas burners, circa 1963 was used for the test. An insulated vertical draft hood draped on three sides with fire resistant and inert fabric and enclosed on the fourth with a wall of aluminum sheeting functioned as the shell core machine enclosure for capturing emissions. A phenol-formaldehyde resin coated sand (Technisand™ XC30 Shell Sand, Fairmount Minerals) with a stated concentration of 3% based on sand (BOS) weight was the core making material used for all runs. The shell machine was configured with the step-core pattern corebox. Emissions were measured from six replicate runs consisting of the making and concurrent storage of 15 cores, immediately followed by a separate storage period within the enclosure after the blow and cure cycle of the final core, to complete an elapsed run time of 60 minutes. Emission samples were continuously collected for the total core making/storage and separate storage periods.

The emission results were calculated in both pounds of pollutant per pound of binder (lb/lb) and pounds of pollutant per ton of cores (lb/ton). All emissions have been corrected by subtracting background contributions. Subtracting those compounds present from quality control and method background blanks (i.e. ambient background) generates emissions for the complete shell core making process, and including machine, natural gas burners, and material emissions. Material emissions were obtained by subtracting the background contribution produced from a system blank obtained by operating the shell core machine without actual core production.

Emission Indicators are shown in Table 1a for the complete shell core making process, including emissions from the machine and any material emissions obtained by subtracting the ambient background for lb/ton core and lb/lb binder. Table 1b shows material emissions obtained by correcting for the system background for lb/lb binder and lb/ton core.

Table 1a ***Average Emission Indicators Summary Table, Total Process Emissions Core Make/Store and Storage, Test HN***

Analyte Name	lb/ton cores	lb/lb binder
THC as Propane	4.53E+00	7.77E-02
Non-Methane Hydrocarbons	1.61E-01	3.06E-03
Sum of Target Analytes	5.82E-01	1.01E-02
Sum of Target HAPs	1.27E-01	2.22E-03
Sum of Target POMs	3.06E-04	5.30E-06

Natural gas burner emissions are included in process emissions

Table 1b ***Average Emission Indicators Summary Table, Core Make/Store and Storage, Test HN***

Analyte Name	lb/ton cores	lb/lb binder
THC as Propane	5.34E-01	9.16E-03
Non-Methane Hydrocarbons	3.28E-01	5.63E-03
Sum of Target Analytes	5.79E-01	1.00E-02
Sum of Target HAPs	1.25E-01	2.17E-03
Sum of Target POMs	ND	ND

ND=non-detect

Natural gas burner emissions from shell core machine are NOT included

Two analytes comprised approximately 98% of emissions as both lb/lb binder and lb/ton core for both background adjusted data. Ammonia contributed the highest percentage at an average of 78%, followed by phenol at 19%. Formaldehyde accounted for approximately 2% of emissions. The few compounds which supplied the remainder of measurable emissions were all less than 0.5%. HAPs contributed approximately 22% to total measured emissions. Although ammonia is not on the HAP list it is a reportable chemical, and is on the EPA's EPCRA Section 313 chemical list.

The system background contained moderate concentrations of numerous hydrocarbons including benzene, toluene, phenol, and xylenes. The measured criteria pollutants and greenhouse gases concentration were also high in the blank. When comparing the compound concentrations found in the system blank to total emissions from a sample it is evident that a majority of the differentiated hydrocarbons, the total hydrocarbons as measured by TGOC as propane, and the methane originated from the shell core machine, natural gas burners and heated tooling. It is also apparent that most of the total hydrocarbon emissions, as measured by TGOC as propane, are comprised of methane. The emissions for TGOC as propane and methane parallel each other exactly over the entire run.

Emission results from the testing performed and described herein are not suitable for use as emission factors or for purposes other than evaluating the relative emission reductions associated with the use of alternative materials, equipment, or 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.

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1.0 INTRODUCTION

1.1. Background

Technikon LLC is a privately held contract research organization located in McClellan, California, a suburb of Sacramento. Technikon offers emissions research services to industrial and government clients specializing in the metal casting and point source emissions areas. Technikon operates the Casting Emission Reduction Program (CERP). CERP is a cooperative initiative between the Department of Defense (US Army) and the United States Council for Automotive Research (USCAR). The parties to the CERP Cooperative Research and Development Agreement (CRADA) include The Environmental Leadership Council of USCAR, a Michigan partnership of DaimlerChrysler Corporation, Ford Motor Company, and General Motors Corporation; the U.S. Army Research, Development, and Engineering Command (RDECOM-ARDEC); the American Foundry Society (AFS); and the Casting Industry Suppliers Association (CISA). The US Environmental Protection Agency (US EPA) and the California Air Resources Board (CARB) also have been participants in the CERP program and rely on CERP published reports for regulatory compliance data. All published reports are available on the CERP web site at www.cerp-us.org.

1.2. CERP/Technikon Objectives

The primary objective of CERP is to evaluate materials, equipment, and processes used in the production of metal castings. Technikon's facility was designed to evaluate alternative materials and production processes designed to achieve significant air emission reductions. The facility's principal testing arena is designed to measure airborne emissions from individually poured molds. This testing facility enables the repeatable collection and evaluation of airborne emissions and associated process data.

1.3. Report Organization

This report has been written to document the methodology and results of a specific test plan that was used to evaluate shell core making and storage. Cores were made from resin coated sand containing 3% binder BOS.

Section 2.0 of this report includes a summary of the methodologies used for data collection and analysis, procedures for emission calculations, QA/QC procedures, and data management and reduction methods. Specific data collected during this test are summarized in Section 3.0 and detailed data appear in the appendices of this report. Section 4.0 contains a discussion of the results.

The raw data for this test series are archived at the Technikon facility.

1.4. Specific Test Plan and Objectives

Test HN was designed and conducted to evaluate airborne emissions from the making and storage of shell cores. Shell step cores were made with Technisand™ XC30 Shell Sand from Fairmount Minerals containing 3% resin BOS.

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

Table 1-1 Test Plan Summary

Type of Process Tested	Shell Core Making
Test Plan Number	1413-122 HN
Core	3 % (BOS) Fairmount Minerals XC30 Shell Sand
Number of Runs	6 runs with 15 cores made
Test Dates	April 23, 2007 through April 25, 2007
Emissions Measured	81 target analytes and TGOC as propane, CO, CO_2, NOx, SO_2
Process Parameters Measured	Core Weight, Binder weight, Core LOI, Core Box Temperature

2.0 TEST METHODS AND PROCEDURES

2.1. Testing Program

The testing program encompasses the foundry process and emissions testing, both of which are rigorously controlled. Relevant parameters are monitored and recorded prior to and during the emission tests. Process measurements for the shell core test included the weights of the cores, loss on ignition (LOI) values for the core prior to the test, and relevant metallurgical data. Measured source parameters included stack temperature, pressure, volumetric flow rate, and moisture content. All parameters were maintained within prescribed ranges to ensure the reproducibility of the test runs.

2.1.1. Test Plan Review and Approval

The proposed test plan was reviewed and approved by the Technikon staff and by CERP Working Group Chairs as appropriate. The Test Plan for Test HN is included in Appendix A.

2.1.2. Shell Core Making and Storage

Figure 2-1 is a diagram of the shell core making and storage test setup.

Figure 2-1 Shell Core Making/Storage Layout

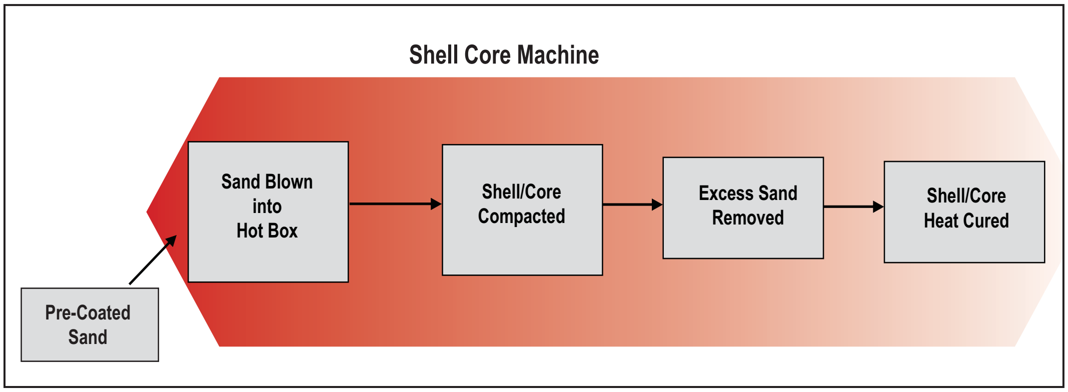


Table 2-1 Beardsley & Piper SF Cormatic Specifications

Sand magazine capacity	60 lbs
Core box: Maximum height	20 in
Maximum length	15.5 in
Maximum width	21 in
BTU per hour natural gas	90000
Voltage	125 VAC
Amps	8

Shell cores were made on a standard vertically parted semi-automated machine. A Beardsley and Piper Cormatic Shell core machine, model SF6CA, with 32 natural gas burners, circa 1963 was used for the test. Table 2-1 summarizes the specifications for the shell core machine. The shell machine was configured with the step core corebox. This pattern was specifically built to evaluate core emissions. An insulated vertical draft hood draped on three sides with fire resistant and chemically neutral fabric and enclosed on the fourth side with a wall of aluminum sheeting functioned as the shell core machine enclosure for capturing emissions. The machine within the enclosure is shown in Figure 2-2.

Figure 2-2 Shell Core Machine Enclosure

Prior to the start of the core making run, the shell corebox was preheated to and maintained at about 450°F. Fifteen cores were yielded for the core making portion of each run. An individual core took less than 2½ min to produce. Finished cores had the color of toast or chestnut with an approximate wall thickness of 1/4 inch. An example of a sectioned finished shell core can be seen in Figure 2-3.

Figure 2-3 Cross Section of Shell Step Core

The start of the core making run commenced when sand was initially blown into the iron corebox. After the investment cycle the core was removed from the corebox, which signaled the end of the 2 min core making time. The core was then immediately placed on a table located inside the enclosed hood for cooling and storage. This period was termed "core making/storage," because cooling cores were constantly present and potentially contributing to emissions during core making. Cores were made continuously until the 15 cores were produced, which averaged just over 30 minutes. All cores were stored on the table under the hood immediately upon removal from the machine. After the 15th core was removed from the shell core machine and placed on the table with the previously made cores, the separate core "storage" period began and continued until the predetermined 60 min run time had elapsed. This separate storage period lasted just under 30 minutes.

2.1.3. Emissions Testing

Emissions testing included several methods for measuring both speciated and undifferentiated hydrocarbons and other chemical classes. The primary test method used for speciation was Method 18, one of the US Environmental Protection Agency's (EPA) reference methods for volatile organic compound (VOC) analysis. Method 18 is an "umbrella" method, and is generally used to identify and/or measure as many compounds as possible in order to calculate actual VOC emissions from other measurements (e.g. EPA Method 25 or 25A). The method is a guideline and a system of quality assurance (QA) checks for VOC analysis rather than a rigorous, explicit manual for sampling or analysis.

As described in the method, sampling was conducted using a Volatile Organic Sampling Train (VOST). A sample gas stream was extracted from the source and then routed using the train through tubes containing adsorbents, which are the collection materials upon which the organic analytes are deposited. The selection of sampling media was based on the compounds expected to be evolved during the test. Adsorption tube samples were collected and analyzed for eighty-one (81) compounds using detailed collection and analysis procedures based on approved federal methods, including those of the EPA.

Two methods were employed to measure undifferentiated hydrocarbon emissions as Emission Indicators: TGOC as Propane, performed in accordance with EPA Method 25A, and non-methane hydrocarbons as determined from methane results obtained in a manner prescribed in EPA CTM-042.

Method 25A is an instrument based method in which the stack gas is introduced directly to a flame ionization detector (FID) without first separating the components. In Method 25A, sampling is accomplished by extracting a gas stream from the stack effluent and transferring it via heated non-reactive tubing to the FID analyzer under very controlled temperature and pressure conditions. The FID measures the quantity of carbon containing molecules, and is calibrated by a gas standard, which in this case is the three carbon alkane, propane (C_3H_8). The FID will give a response relative to the calibration standard and results are expressed in terms of the gas used for calibration. Because the FID responds to all carbon containing compounds, methane (CH_4) and other exempt compounds are included in the total hydrocarbon results.

Methane was analyzed by a separate FID equipped with an oxidizing catalyst (methane cutter) that removes all non-methane hydrocarbons (NMHC). The calibration gas for this FID is methane (CH_4). The two FIDs were run simultaneously, and collected data every second. NMHC results were then determined by subtracting the detected methane from the average total hydrocarbon value.

Continuous on-line monitoring of a subgroup of criteria pollutants and greenhouse gases including carbon dioxide (CO_2), carbon monoxide (CO), and nitrogen oxide (NOx) was conducted according to US EPA Methods 3A, 10, and 7E, respectively.

Figure 2-4 Test Equipment for Emissions Sampling

Figure 2-4 shows the emission sampling equipment set-up for Test HN. The generated emissions were transported through an insulated seven (7) inch stack located above the shell core machine. The flow rate of the emission capture air through the stack was nominally 220 scfm.

Heated sample probes inserted into the stack at relevant locations, determined by EPA Method 1, enabled collection of emissions directly from the stack. One probe provided gases for the sampling manifold to which was attached the VOST and a heated line for the methane analyzer.

Another probe in the stack was used to continuously draw effluent samples and transport them through a second heated sample line to an emissions console that contains a battery of gas analyzers. This console, or emissions bench, consists of a total hydrocarbon analyzer for TGOC analysis, two infrared analyzers (for CO and CO_2) and a chemiluminescence analyzer for NOx. All of the continuous monitors are located in Technikon's laboratory. Figure 2-5 shows details of the VOST and the emissions bench.

Figure 2-5 VOST and On-Line Analyzer

Volatile Organic Sampling Train

E-Bench

The heated sample lines were located approximately 120 feet away from the laboratory. A pressure drop of approximately 2 psi in the FID instruments resulted from the extended distance between the sampling location and the analytical instruments. Sample flows were decreased due to the extended distance, but were still within instrument ranges and sufficient for accurate sampling. Calibrations and calibration checks were performed throughout the test and indicated that the pressure drop could be compensated for, and did not significantly influence measurements.

Mass emission rates for all analytes were calculated using continuous monitoring or laboratory analytical results, measured source data and appropriate process data. Average emission results for individual runs are presented in Appendix B.

Speciated analyte emissions were calculated in addition to five "Emission Indicators:" TGOC as Propane, NMHC, Sum of Target Analytes, Sum of Target Hazardous Air Pollutants (HAPs), and the Sum of Target Polycyclic Organic Matter (POMs). Full descriptions of these indicators can be found in Section 3.0 of this report.

2.1.4. Process Parameter Measurements

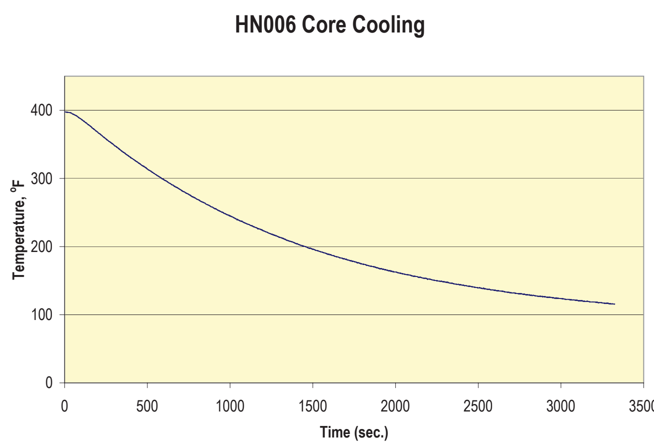
Table 2-2 lists the process parameters that were monitored during each test.

Table 2-2 Process Equipment and Methods

Process Parameters	Equipment and Method(s)
Core Weight	Mettler SB12001 Digital Scale (Gravimetric)
LOI %	Denver Instruments XE-100 Analytical Scale (AFS procedure 5100-00-S)
Core Box Temperature	Omega HH-23 Digital Thermometer

A thermocouple was placed inside of a cooling core during each of the six runs to track cooling rates, in addition to monitoring the core box temperature. Figure 2-6 gives the typical cooling decay rate from the maximum temperature reached by the core (approximately 380 ^{o}F) to the end of the run, as exemplified by run HN006.

Figure 2-6 Cooling Rate of Shell Core



2.1.5. Sampling Methods

The specific sampling and analytical methods used for Test HN are based on federal reference methods shown in Table 2-3. The details of the specific testing procedures and their variance from the reference methods are included in the Technikon Standard Operating Procedures.

Table 2-2 Emission Sampling and Analytical Methods

Measurement Parameter	Test Method(s)
Port Location	US EPA Method 1
Number of Traverse Points	US EPA Method 1
Gas Velocity and Temperature	US EPA Method 2
Gas Density and Molecular Weight	US EPA Method 3a
Gas Moisture	US EPA Method 4 (Gravimetric)
Target Analytes including HAPs and POMs	US EPA Methods TO17, TO11; NIOSH Methods S347; OSHA PV 2003
TGOC	US EPA Method 25A
CO	US EPA Method 10
CO2	US EPA Method 3A
NOx	US EPA Method 7E
SO2	OSHA ID 200
CH4	US EPA CTM 042

Some methods modified to meet specific CERP test objectives.

2.2. Data Reduction, Tabulation and Preliminary Report Preparation

Data calculations for determining emission concentrations resulting from the specific test plan outlined in Appendix A are based on process and emission parameters. The analytical results of the emissions sampling provide the mass of each analyte in the sample. The total mass of the analyte emitted is calculated by multiplying the mass of analyte in the sample by the ratio of total stack gas volume to sample volume. The total stack gas volume is calculated from the measured stack gas velocity and duct diameter and corrected to dry standard conditions using the measured stack pressures, temperatures, gas molecular weight and moisture content. The total mass of analyte is then divided by the weight of the casting poured or weight of binder to provide emissions data in pounds of analyte per ton core or pounds of analyte per pound of binder.

All emissions have been background subtracted. When sample measurements are made, the observed result includes the portion of the analyte in the sample, plus a response due to the background contribution found from either ambient or system blanks. The net analyte sample concentration is therefore the amount of the analyte, if any, found in the blank subtracted from the amount of analyte found in the sample. Background correcting the data allows determination of emissions resulting only from the specific materials or process tested, and not those that may be present in either the ambient air of the research foundry, or from the manufacturing equipment being used during the sampling period.

Subtracting those analytes found in quality control and method blanks (i.e. ambient background) results in emissions for the complete shell core making process, including all emissions from the machine, natural gas burners and any material emissions. Subtracting those analytes found in the system background results in emissions for the materials used in making cores, including the resin. This system background was obtained by operating the shell core machine for a simulated 60 min run, but without core production. Any generated emissions are from operation of the shell core machine system only, including the 32 natural gas burners. Subtracting this system background from the analytical results eliminates the emissions given off by operation of the machine, thereby providing emissions for the tested material only.

Individual speciated emission rates and reporting limit results for each analyte for all sampling runs are included in Appendix B of this report. Average background subtracted emission results for the test are given in Section 3.0, Tables 3-1a to 3-1d.

2.2.1. Report Preparation and Review

The Preliminary Draft Report is created and reviewed by Process Team and Emissions Team members to ensure its completeness, consistency with the test plan, and adherence to QA/QC procedures. Appropriate observations, conclusions and recommendations are added to the report to produce a Draft Report. The Draft Report is then reviewed by senior management and comments are incorporated into a draft Final Report prior to final signature approval and distribution.

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

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

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

- The source (stack) and sampling parameters, analytical results and corresponding laboratory QA/QC data are reviewed by the Emissions Measurement Team to confirm the validity of the data. Senior management of Analytical 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

Average results for the emissions measured during Test HN are presented in Tables 3-1a through 3-1d. Emission rates are given in both lb/lb of binder and lb/ton of cores. In addition, all emission results presented in the tables have been background corrected. Two different background or blank corrections were calculated to provide useful emissions data for core production using a shell core machine. Subtracting the quality control and method blanks (i.e. ambient background) results in emissions for the total shell core process, including emissions from the shell core machine, the natural gas burners and any materials present in the sand or as release agents. Subtracting the system background obtained by operating the shell core machine without core production, results in emissions from the materials used for core making and core storage only.

Tables 3-1a and 3-1b give results for the total process emissions, including the natural gas burners, for the shell core make/store and storage test, as lb/ton cores and lb/lb of binder, respectively. Tables 3-1c and 3-1d give a summary of emissions for the material contributions, including the binder, from core make/store and storage in lb/lb binder and lb/ton of cores, respectively.

The individual chemical compounds targeted for collection and analyses from airborne emissions from the shell core process were chosen based on the chemistry of the binder under investigation, potential emissions from the operation of shell core machine, and analytes historically targeted. These compounds, termed “target analytes” (TA), were chosen for their potential to emit based on chemical and foundry operational parameters.

Included in the tables are the “Sum of Target Analytes,” the “Sum of Target HAPs,” and the “Sum of Target POMs.” These three analyte sums are part of the group termed “Emission Indicators.” The emissions indicator called the “Sum of Target Analytes” is the sum of the individual speciated analytes that were targeted for collection and analysis, and detected at a level above the practical quantitation limit.

The target analyte sum includes targeted compounds that may also be defined as HAPs and

POMs. By definition, HAPs are specific compounds listed in the Clean Air Act Amendments of 1990. The term POM defines a broad class of compounds based on chemical structure and boiling point. POMs as a class are a listed HAP. A subset of organic compounds from the current list of EPA HAPs was targeted for collection and analysis. These individual target HAPs (which may also be POMs by nature of their chemical properties) detected in the samples are summed together and defined as the "Sum of Target HAPs," while the "Sum of Target POMs" only sums those organic HAPs that are also defined as POMs.

Also included in this group and reported in the first section of the tables are "TGOC as Propane" as determined by Method 25A, and NMHC. The second section of the table includes average emission results for select individual target analytes. In addition, average values for a subgroup of criteria and greenhouse gases including CO, CO_2, CH_4, SO_2, and NO_x are given in the third section of the tables. A few individual isomers are reported in the tables, and have not been combined or reported as a group. Isomers which have been targeted and analyzed may be summed as a group using the information located in these tables and in Appendix B.

Table 3-1a Summary of Target Analytes for Total Process Emissions Core Make/Store and Storage, Test HN, lb/lb binder

Analyte Name	Average	Standard Deviation
Emission Indicators		
THC as Propane	7.77E-02	3.41E-03
Non-Methane Hydrocarbons	3.06E-03	2.20E-03
Sum of Target Analytes	1.01E-02	4.23E-04
Sum of Target HAPs	2.22E-03	1.64E-04
Sum of Target POMs	5.30E-06	1.16E-06
Selected Target HAPs and POMs		
Phenol	1.98E-03	1.50E-04
Formaldehyde	1.93E-04	1.31E-05
Toluene	1.26E-05	9.76E-06
Propionaldehyde (Propanal)	7.48E-06	1.09E-06
Acetaldehyde	6.31E-06	9.18E-07
Hexane	4.46E-06	1.29E-06
Benzene	3.09E-06	1.20E-06
Xylene, mp-	2.93E-06	7.20E-07
Methylnaphthalene, 2-	2.72E-06	9.23E-07
Methylnaphthalene, 1-	2.58E-06	4.88E-07
Acrolein	2.03E-06	1.15E-07
Additional Selected Target Analytes		
Ammonia	7.85E-03	2.99E-04
Crotonaldehyde	8.37E-06	9.10E-07
2-Butanone (MEK)	5.82E-06	5.97E-07
Benzaldehyde	4.30E-06	1.56E-06
Butyraldehyde/Methacrolein	4.27E-06	6.19E-07
Pentanal (Valeraldehyde)	1.98E-06	1.18E-07
Criteria Pollutants and Greenhouse Gases		
Carbon Dioxide	8.82E-01	1.01E-02
Methane	7.47E-02	1.66E-03
Carbon Monoxide	5.59E-03	3.94E-04
Nitrogen Oxides	≤PQL	NA
Sulfur Dioxide	≤PQL	NA

NA= Not Applicable

≤PQL=Less than or equal to the Practical Quantitation Limit

Natural gas burner emissions are included in process emissions

Table 3-1b Summary of Target Analytes for Total Process Emissions Core Make/Store and Storage, Test HN, lb/ton core

Analyte Name	Average	Standard Deviation
Emission Indicators		
THC as Propane	4.53E+00	2.00E-01
Non-Methane Hydrocarbons	1.61E-01	1.29E-01
Sum of Target Analytes	5.82E-01	1.94E-02
Sum of Target HAPs	1.27E-01	8.04E-03
Sum of Target POMs	3.06E-04	6.80E-05
Selected Target HAPs and POMs		
Phenol	1.14E-01	7.42E-03
Formaldehyde	1.11E-02	6.88E-04
Toluene	7.24E-04	5.55E-04
Propionaldehyde (Propanal)	4.30E-04	6.44E-05
Acetaldehyde	3.62E-04	5.03E-05
Hexane	2.56E-04	7.31E-05
Benzene	1.78E-04	6.74E-05
Xylene, mp-	1.69E-04	4.03E-05
Methylnaphthalene, 2-	1.58E-04	5.33E-05
Methylnaphthalene, 1-	1.48E-04	2.79E-05
Acrolein	1.17E-04	5.22E-06
Additional Selected Target Analytes		
Ammonia	4.53E-01	1.34E-02
Crotonaldehyde	4.81E-04	5.61E-05
2-Butanone (MEK)	3.35E-04	3.50E-05
Benzaldehyde	2.47E-04	9.04E-05
Butyraldehyde/Methacrolein	2.46E-04	3.81E-05
Pentanal (Valeraldehyde)	1.15E-04	6.71E-06
Criteria Pollutants and Greenhouse Gases		
Carbon Dioxide	5.14E+01	6.20E-01
Methane	4.66E+00	6.89E-01
Carbon Monoxide	3.26E-01	2.31E-02
Nitrogen Oxides	≤PQL	NA
Sulfur Dioxide	≤PQL	NA

NA= Not Applicable

≤PQL=Less than or equal to the Practical Quantitation Limit

Natural gas burner emissions from shell core machine are included

Table 3-1c Summary of Target Analyte Material Emissions for Core Make/Store and Storage, Test HN, lb/lb binder

Analyte Name	Average	Standard Deviation
Emission Indicators		
THC as Propane	9.16E-03	2.92E-03
Non-Methane Hydrocarbons	5.63E-03	2.23E-03
Sum of Target Analytes	1.00E-02	4.22E-04
Sum of Target HAPs	2.17E-03	1.63E-04
Sum of Target POMs	ND	NA
Selected Target HAPs and POMs		
Phenol	1.95E-03	1.51E-04
Formaldehyde	1.93E-04	1.31E-05
Toluene	7.79E-06	8.40E-06
Propionaldehyde (Propanal)	7.48E-06	1.09E-06
Acetaldehyde	6.31E-06	9.18E-07
Acrolein	2.03E-06	1.15E-07
Additional Selected Target Analytes		
Ammonia	7.85E-03	2.99E-04
Crotonaldehyde	8.37E-06	9.10E-07
2-Butanone (MEK)	5.82E-06	5.97E-07
Benzaldehyde	4.30E-06	1.56E-06
Butyraldehyde/Methacrolein	4.27E-06	6.19E-07
Pentanal (Valeraldehyde)	1.98E-06	1.18E-07
Criteria Pollutants and Greenhouse Gases		
Carbon Dioxide	2.73E-01	8.29E-03
Methane	3.54E-03	1.33E-03
Carbon Monoxide	2.16E-03	3.68E-04
Nitrogen Oxides	≤PQL	NA
Sulfur Dioxide	≤PQL	NA

NA= Not Applicable
ND=Not Detected

Table 3-1d Summary of Target Analytes Material Emissions Core Make/Store and Storage, Test HN, lb/ton core

Analyte Name	Average	Standard Deviation
Emission Indicators		
THC as Propane	5.34E-01	1.71E-01
Non-Methane Hydrocarbons	3.28E-01	1.30E-01
Sum of Target Analytes	5.79E-01	1.94E-02
Sum of Target HAPs	1.25E-01	8.05E-03
Sum of Target POMs	ND	NA
Selected Target HAPs and POMs		
Phenol	1.12E-01	7.44E-03
Formaldehyde	1.11E-02	6.88E-04
Toluene	4.46E-04	4.77E-04
Propionaldehyde (Propanal)	4.30E-04	6.44E-05
Acetaldehyde	3.62E-04	5.03E-05
Acrolein	1.17E-04	5.22E-06
Additional Selected Target Analytes		
Ammonia	4.53E-01	1.34E-02
Crotonaldehyde	4.81E-04	5.61E-05
2-Butanone (MEK)	3.35E-04	3.50E-05
Benzaldehyde	2.47E-04	9.04E-05
Butyraldehyde/Methacrolein	2.46E-04	3.81E-05
Pentanal (Valeraldehyde)	1.15E-04	6.71E-06
Criteria Pollutants and Greenhouse Gases		
Carbon Dioxide	1.59E+01	4.89E-01
Methane	2.06E-01	7.74E-02
Carbon Monoxide	1.26E-01	2.15E-02
Nitrogen Oxides	≤PQL	NA
Sulfur Dioxide	≤PQL	NA

ND=Not Detected

NA= Not Applicable

≤PQL=Less than or equal to the Practical Quantitation Limit

A summary of emissions from the continuous gas monitors for Test HN are given in Tables 3-2a as lb/lb of binder and 3-2b as lb/ton of cores. Results reported in these two tables are divided into core make/storage emissions, storage emissions, and total emissions. Every process related event which occurred during the test was timed and recorded, and because the continuous monitors acquire data every second, emission results could be correlated with the recorded events. The average value reported as the total emission average was calculated over the entire run sampling period, and is less than the sum of the core make/store and storage value. This sample run average is reported as the test average for Tables 3-1a through 3-1d and in Appendix B.

Table 3-2a Comparison Summary of Process, Core Making and Storage Continuous Monitoring Emissions for Test HN, lb/lb binder

		HN001	HN002	HN003	HN004	HN005	HN006	Avg	Stdev	RSD
Total Emissions= Core Make/Store + Store	**System Blank Corrected Data, ppm (background with machine running, gives binder and material emissions only)**									
	TGOC as Propane	8.88E-03	6.14E-02	6.34E-03	7.86E-03	8.66E-03	1.41E-02	1.79E-02	2.15E-02	*120.3%*
	CO	1.99E-03	2.16E-03	2.72E-03	1.79E-03	1.85E-03	2.47E-03	2.16E-03	3.68E-04	*17.0%*
	CO2	2.71E-01	2.63E-01	2.83E-01	2.82E-01	2.75E-01	2.65E-01	2.73E-01	8.29E-03	*3.0%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	2.98E-02	1.85E-03	3.34E-03	3.92E-03	5.04E-03	8.78E-03	1.18E-02	*134.2%*
	Ambient Corrected Data, ppm (background without machine emissions, gives total process emissions)									
	TGOC as Propane	7.89E-02	1.30E-01	7.52E-02	7.53E-02	7.61E-02	8.32E-02	8.64E-02	2.14E-02	*24.8%*
	CO	5.49E-03	5.57E-03	6.17E-03	5.16E-03	5.23E-03	5.93E-03	5.59E-03	3.94E-04	*7.0%*
	CO2	8.93E-01	8.69E-01	8.94E-01	8.80E-01	8.74E-01	8.79E-01	8.82E-01	1.01E-02	*1.2%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	1.01E-01	7.37E-02	7.37E-02	7.42E-02	7.71E-02	7.99E-02	1.19E-02	*14.8%*
Core Make/Store	**System Blank Corrected Data, ppm (background with machine running, gives binder and material emissions only)**									
	TGOC as Propane	1.66E-02	6.75E-02	1.37E-02	1.56E-02	1.42E-02	2.72E-02	2.58E-02	2.10E-02	*81.6%*
	CO	2.10E-03	2.39E-03	2.84E-03	2.05E-03	2.33E-03	3.16E-03	2.48E-03	4.35E-04	*17.5%*
	CO2	2.88E-01	2.72E-01	2.89E-01	2.95E-01	2.86E-01	2.60E-01	2.82E-01	1.32E-02	*4.7%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	3.54E-02	8.09E-03	9.25E-03	7.99E-03	1.66E-02	1.55E-02	1.17E-02	*75.7%*
	Ambient Corrected Data, ppm (background without machine emissions, gives total process emissions)									
	TGOC as Propane	8.66E-02	1.36E-01	8.26E-02	8.30E-02	8.16E-02	9.63E-02	9.43E-02	2.10E-02	*22.3%*
	CO	5.61E-03	5.81E-03	6.28E-03	5.42E-03	5.71E-03	6.62E-03	5.91E-03	4.52E-04	*7.6%*
	CO2	9.10E-01	8.78E-01	9.01E-01	8.94E-01	8.85E-01	8.74E-01	8.90E-01	1.38E-02	*1.5%*
	NOx	4.67E-04	4.41E-04	ND	ND	ND	ND	4.54E-04	1.87E-05	*4.1%*
	CH4	I	1.07E-01	7.99E-02	7.96E-02	7.83E-02	8.87E-02	8.66E-02	1.19E-02	*13.8%*
Store	**System Blank Corrected Data, ppm (background with machine running, gives binder and material emissions only)**									
	TGOC as Propane	ND	5.36E-02	ND	ND	2.04E-03	ND	2.78E-02	3.65E-02	*131.1%*
	CO	1.82E-03	1.86E-03	2.57E-03	1.48E-03	1.27E-03	1.64E-03	1.77E-03	4.48E-04	*25.3%*
	CO2	2.48E-01	2.52E-01	2.74E-01	2.65E-01	2.62E-01	2.71E-01	2.62E-01	1.03E-02	*3.9%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	2.26E-02	ND	ND	ND	ND	2.26E-02	NA	*NA*
	Ambient Corrected Data, ppm (background without machine emissions, gives total process emissions)									
	TGOC as Propane	6.83E-02	1.22E-01	6.55E-02	6.60E-02	6.95E-02	6.74E-02	7.64E-02	2.23E-02	*29.2%*
	CO	5.33E-03	5.28E-03	6.02E-03	4.85E-03	4.64E-03	5.10E-03	5.20E-03	4.76E-04	*9.1%*
	CO2	8.70E-01	8.58E-01	8.86E-01	8.64E-01	8.60E-01	8.84E-01	8.70E-01	1.21E-02	*1.4%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	9.38E-02	6.55E-02	6.66E-02	6.93E-02	6.32E-02	7.17E-02	1.26E-02	*17.5%*

Table 3-2b Comparison Summary of Process, Core Making and Storage Continuous Monitoring Emissions for Test HN, lb/ton core

		HN001	HN002	HN003	HN004	HN005	HN006	Avg	Stdev	RSD
Total Emissions= Core Make/Store + Store	**System Blank Corrected Data, ppm (background with machine running, gives binder and material emissions only)**									
	TGOC as Propane	0.5174	3.5776	0.3702	0.4589	0.5043	0.8215	1.04	1.25	*120.2%*
	CO	0.1158	0.1256	0.1588	0.1044	0.1078	0.1443	0.13	0.02	*17.1%*
	CO2	15.8197	15.3143	16.4971	16.4389	16.0163	15.4669	15.93	0.49	*3.1%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	1.7343	0.1080	0.1947	0.2282	0.2940	0.51	0.69	*134.2%*
	Ambient Corrected Data, ppm (background without machine emissions, gives total process emissions)									
	TGOC as Propane	4.5993	7.5553	4.3876	4.3933	4.4289	4.8569	5.04	1.25	*24.8%*
	CO	0.3201	0.3247	0.3599	0.3013	0.3042	0.3462	0.33	0.02	*7.1%*
	CO2	52.0575	50.6274	52.1634	51.3671	50.8574	51.2920	51.39	0.62	*1.2%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	5.8832	4.2984	4.2984	4.3216	4.5030	4.66	0.69	*14.8%*
Core Make/Store	**System Blank Corrected Data, ppm (background with machine running, gives binder and material emissions only)**									
	TGOC as Propane	0.9667	3.9335	0.8014	0.9094	0.8241	1.5859	1.50	1.23	*81.5%*
	CO	0.1227	0.1390	0.1655	0.1196	0.1359	0.1844	0.14	0.03	*17.6%*
	CO2	16.8055	15.8326	16.8783	17.2426	16.6711	15.1974	16.44	0.77	*4.7%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	2.0634	0.4720	0.5396	0.4651	0.9682	0.90	0.68	*75.6%*
	Ambient Corrected Data, ppm (background without machine emissions, gives total process emissions)									
	TGOC as Propane	5.0485	7.9111	4.8189	4.8438	4.7486	5.6213	5.50	1.22	*22.3%*
	CO	0.3270	0.3381	0.3666	0.3165	0.3323	0.3863	0.34	0.03	*7.7%*
	CO2	53.0432	51.1457	52.5447	52.1708	51.5122	51.0225	51.91	0.81	*1.6%*
	NOx	0.0272	0.0257	ND	ND	ND	ND	0.03	0.00	*4.2%*
	CH4	I	6.2123	4.6624	4.6433	4.5586	5.1773	5.05	0.69	*13.7%*
Store	**System Blank Corrected Data, ppm (background with machine running, gives binder and material emissions only)**									
	TGOC as Propane	ND	3.1242	ND	ND	0.1188	ND	1.62	2.13	*131.1%*
	CO	0.1063	0.1084	0.1500	0.0862	0.0739	0.0958	0.10	0.03	*25.3%*
	CO2	14.4662	14.6539	15.9968	15.4751	15.2267	15.7926	15.27	0.61	*4.0%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	1.3150	ND	ND	ND	ND	1.31	NA	*NA*
	Ambient Corrected Data, ppm (background without machine emissions, gives total process emissions)									
	TGOC as Propane	3.9823	7.1019	3.8217	3.8531	4.0433	3.9330	4.46	1.30	*29.1%*
	CO	0.3106	0.3075	0.3511	0.2831	0.2704	0.2978	0.30	0.03	*9.2%*
	CO2	50.7040	49.9670	51.6631	50.4033	50.0679	51.6178	50.74	0.75	*1.5%*
	NOx	ND	ND	ND	ND	ND	ND	ND	NA	*NA*
	CH4	I	5.4639	3.8206	3.8849	4.0359	3.6881	4.18	0.73	*17.5%*

Emissions data that have been determined to be below the practical quantitation limit (PQL) after data validation and verification are substituted with the numerical value used for the PQL, rather than with the value of zero. If an analyte has calculated concentrations above the PQL for some runs, but values for other runs fall below the PQL, the PQL value is included when calculating analyte averages and sums. However, if an analyte has a concentration that is below the PQL for all runs in a test, the test average is indicated by ≤PQL (less than or equal to the PQL) in the Tables and Figures of this report, and no runs are included in any summations or averages. Omitting these less-than-reporting-limit analytes in calculations ensures that only those targeted compounds which contribute to emissions are included in emission sums.

Examination of measured process parameters indicated that Test HN was run within acceptable ranges and limits. The primary causes and secondary influences on emissions were controlled for each individual run, so that for shell core making and storage, resultant air emissions reflect only the difference in the process and materials being tested.

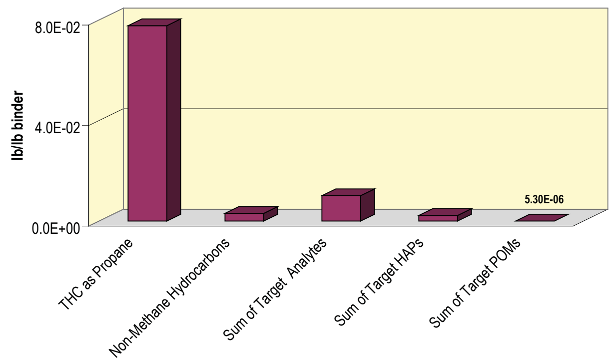
3.1. Discussion of Results

Figures 3-1a to 3-4d graphically present the data from Tables 3-1a through 3-1d for Test HN for the five emissions indicators, selected individual HAP and other chemical class target analytes, and the subgroup of criteria pollutant and greenhouse gases as both lb/lb of binder and lb/ton of cores.

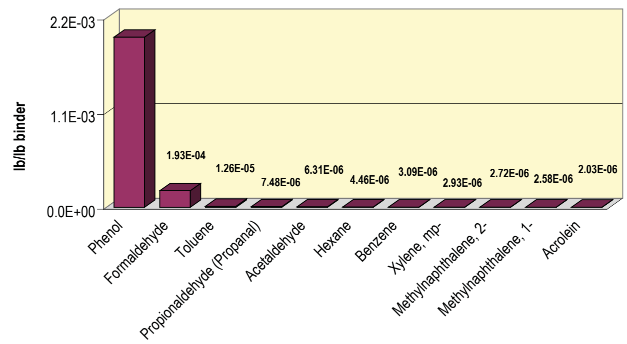
Two analytes comprised approximately 98% of emissions for both lb/lb binder and lb/ton core results. Ammonia contributed the highest percentage at an average of 78%, followed by phenol at 19%. Formaldehyde was the third highest emitter, but contributed only 2% to emissions. The few compounds which supplied the remainder of measurable emissions were all less than 0.5%. Phenol and formaldehyde are HAPs, and although ammonia is not on the HAP list it is a reportable chemical, and is in the EPA's EPCRA Section 313 chemical list.

Figure 3-1a Total Process Emissions Core Make/Store and Storage, Test HN, lb/lb binder

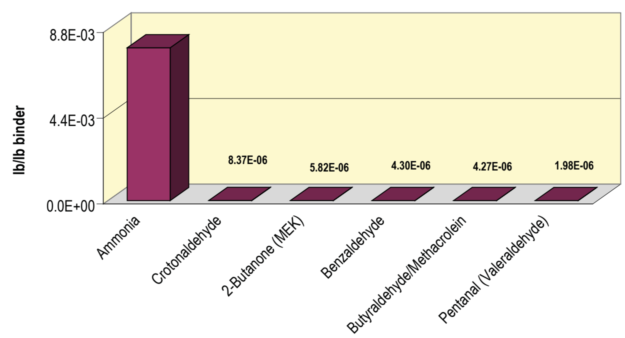
i Emissions Indicators



ii Selected HAP and POM Emissions



iii Selected Target Analyte



Iv Criteria Pollutants and Greenhouse Gases

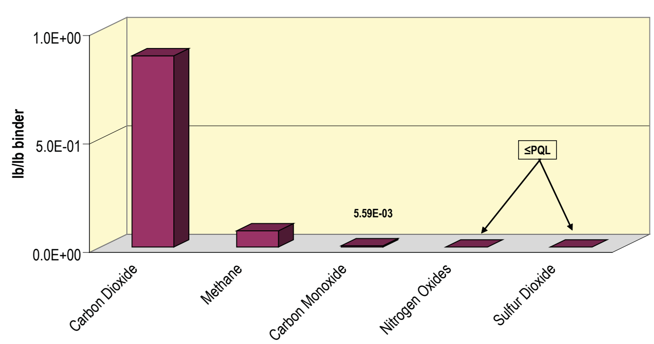
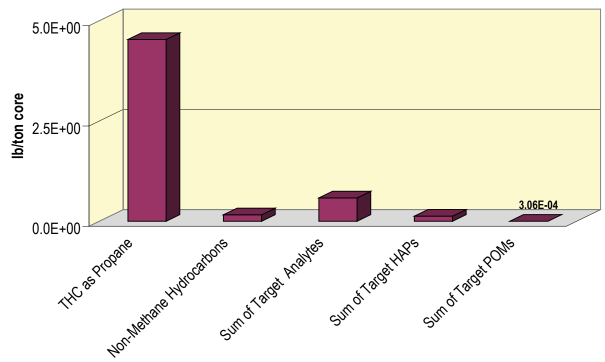
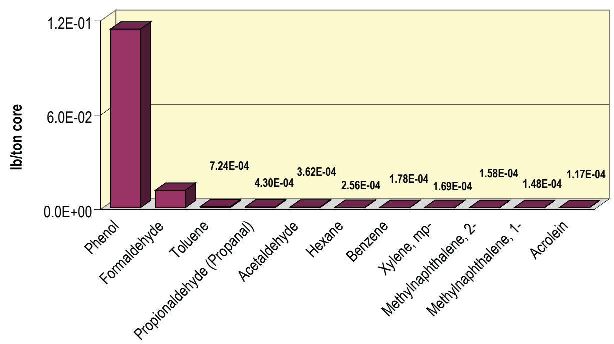


Figure 3-1bTotal Process Emissions Core Make/Store and Storage, Test HN, lb/ton core

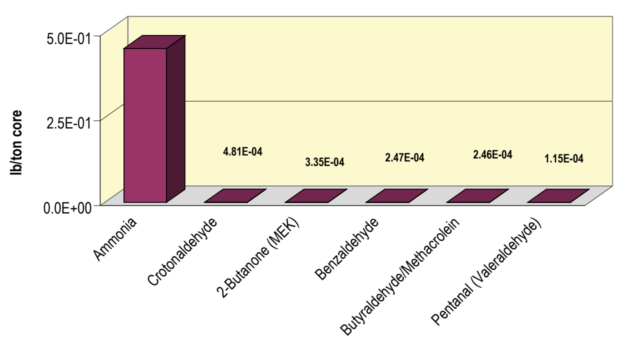
i Emissions Indicators



ii Selected HAP and POM Emissions



iii Selected Target Analyte



Iv Criteria Pollutants and Greenhouse Gases

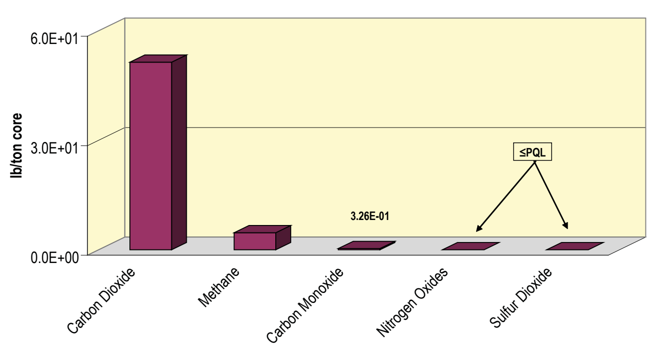
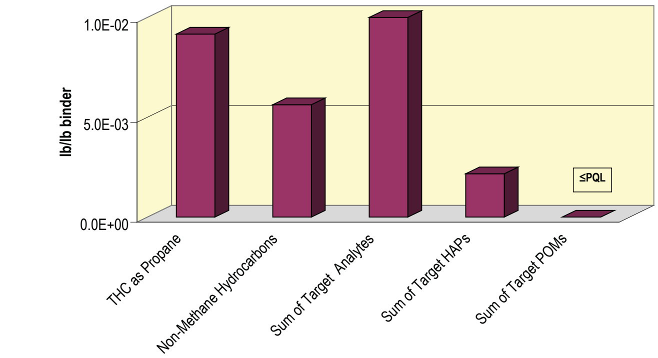
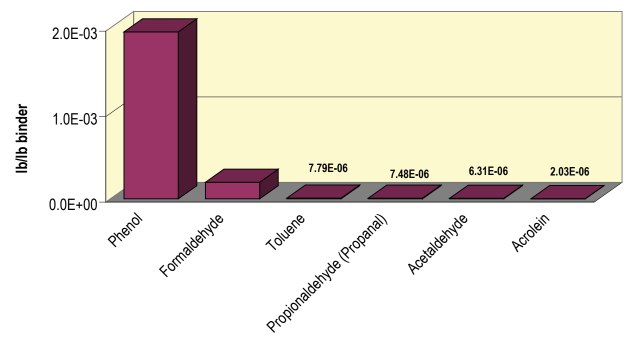


Figure 3-1c Material Emissions for Core Make/Store and Storage, Test HN, lb/lb binder

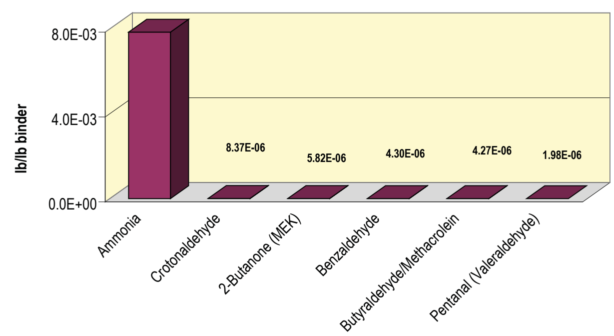
i Emissions Indicators



ii Selected HAP and POM Emissions



iii Selected Target Analyte



Iv Criteria Pollutants and Greenhouse Gases

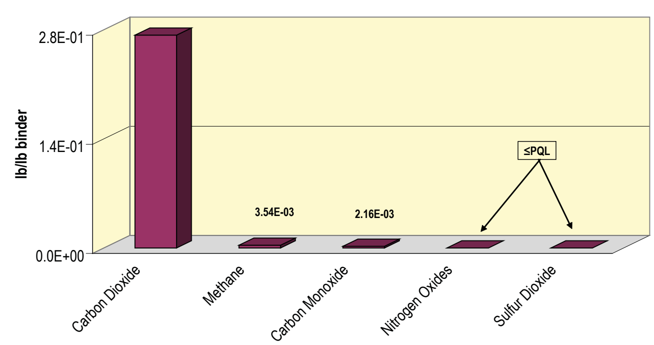
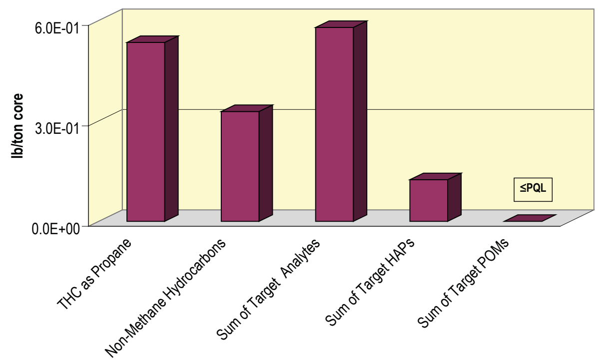
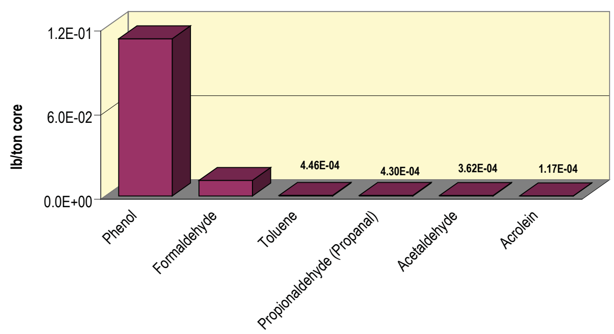


Figure 3-1d Material Emissions for Core Make/Store and Storage, Test HN, lb/tn core

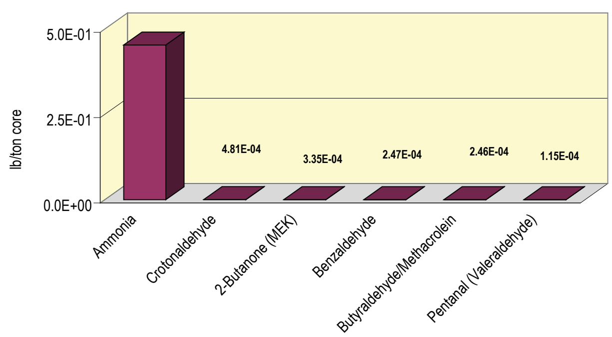
i Emissions Indicators



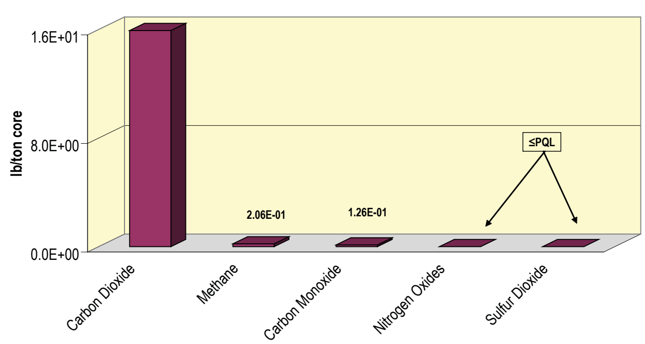
ii Selected HAP and POM Emissions



iii Selected Target Analyte



Iv Criteria Pollutants and Greenhouse Gases



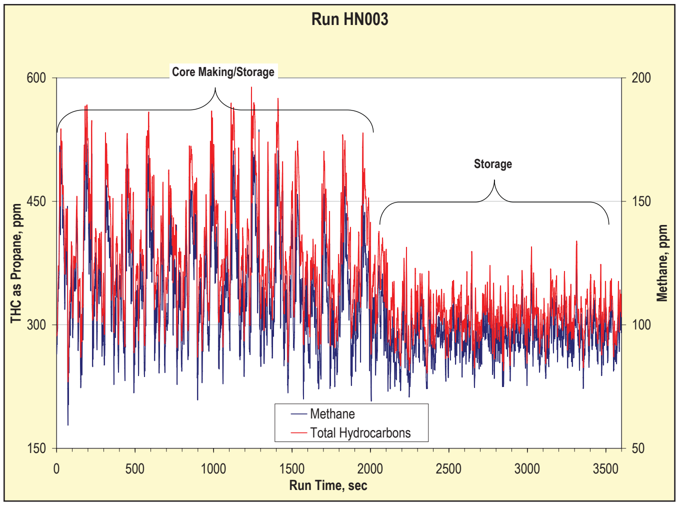
The target analyte sum would theoretically closely match the results for total hydrocarbons obtained by Method 25A, excluding exempt compounds such as methane, and including compounds such as formaldehyde and ammonia, which are less responsive in the FID. For the results reported here, the Sum of Target Analytes is greater than the adjusted TGOC as Propane results. This is because ammonia is included in the sum of targeted analytes, but is not carbon containing and so will not be detected by the FID analyzer.

Total process emissions for core making/storage and storage, including those discharged from the shell core machine, the natural gas burners and all materials used for core making, were obtained by background correcting the data for compounds present in quality control and method blanks (i.e. ambient background). The only analyte found in these blanks was a small concentration of hexane. Of the 81 individual Target Analytes (including criteria pollutants and greenhouse gases), 20 contributed to emissions detectable above the PQL. Eleven of the measurable chemicals are considered HAPs, and together they provided 22% of emissions. Details of the data can be found in Tables 3-1a and 3-1b, and Appendix B.

Material emissions for core making/storage and storage were attained by subtracting a background sample obtained by operating the shell core machine without core production. For this case, 15 analytes of the 81 targeted were responsible for all emissions, including 6 HAPs. As was found for total process emissions, the HAPs contributed approximately 22% to total emissions. Details of the data can be found in Tables 3-1c and 3-1d, and Appendix B.

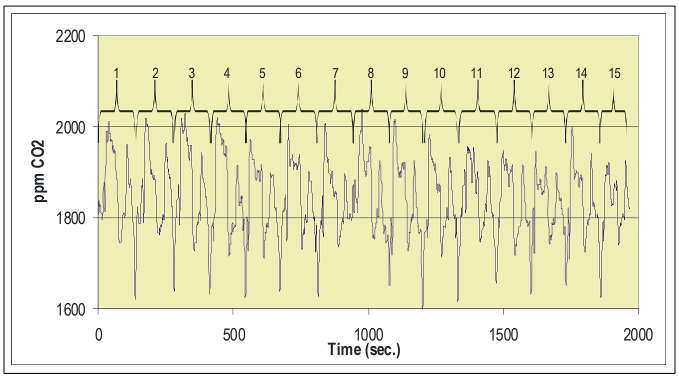
The system background contained moderate concentrations of numerous hydrocarbons including benzene, toluene, phenol, and xylenes. The measured criteria pollutants and greenhouse gases concentration were also high in the system blank. When concentrations found in the system blank are compared to the total emissions from a run, it is evident that a majority of the differentiated hydrocarbons, the total hydrocarbons as measured by TGOC as propane, and the CH_4 originated from the shell core machine, including the natural gas burners. It is also apparent that most of the total hydrocarbon emissions as measured by TGOC as propane is comprised of CH_4. The emissions for total hydrocarbons and methane parallel each other exactly over the entire core making/storage and storage run, as shown by example for run HN003 in Figure 3-5.

Figure 3-5 Comparison of Methane and TGOC results for Shell Core Making



For the continuous monitors, data were acquired every second, and the average value calculated over the entire sampling period is reported as the run average. For Test HN, this average value includes data acquired during the actual core making as well as the short interval between cores (after a finished core was removed from the machine until another was made), and the final 30 minute core storage period (where the cooling cores were stored under the hood after the core making/storage period). The separate storage and cooling period that began after the removal of the fifteenth core shows low emissions. The average for each run is therefore an underestimation of emissions. An example of the cyclical nature of the core making and storage is shown in Figure 3-6 for CO_2.

Figure 3-6 Cyclical Pattern of Emissions from Shell Core Making



Stack samples were also continuously drawn through the media on the VOST during the entire cyclical core making/storage and separate storage periods. The sampling media is minimally affected by those intervals between cores and the separate storage period when there were few to no emissions. This is due to the sample being one single sample that is consolidated over the entire run, rather than a calculated average of numerous samples.

The cooling curve for the cores was anticipated to mimic the decrease in emissions on core storage. However, in comparing Figure 2-6 with the storage period shown in Figure 3-5, emissions decreased much faster than the cooling curve. Immediately upon removal from the machine, emissions dropped almost to background levels.

Average core parameters for Test HN are summarized in Table 3-3, and detailed information regarding testing, sampling, data collection and results for each sampling event are contained in the four appendices. Appendix A contains test plans, instructions and the sampling plans for Test HN. Appendix B contains detailed emissions data and average results for all targeted analytes. Target analyte practical quantitation limits expressed in both lb/lb binder and lb/ton metal are also shown in Appendix B. Appendix C contains detailed process data. Appendix D contains continuous monitor charts. The charts are presented to show TGOC, carbon monoxide, carbon dioxide, methane, and oxides of nitrogen time-dependent emissions profiles for each individual emissions run. Charts have not been background corrected. Appendix E contains acronyms and abbreviations.

Table 3-3 ***Summary of Core Making Process Parameters***

Test HN - Fairmount Minerals XC30	Average of Runs 1-6
Average cooled core weight, g	2515.6
Average core box temperature	456
% stated core binder (BOS)	3
% calculated actual binder	2.9
Number of cores made in run	15
Total core weight in from run, Lbs.	83.2
Total binder weight in run, Lbs.	2.4
Core LOI, %	3.21

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APPENDIX A TEST & SAMPLE PLANS AND PROCESS INSTRUCTIONS

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Technikon Test Plan

page 1 o

Fill-in and check all that apply

♦ **CONTRACT NUMBER:** 1413 **TASK NUMBER** 122 **DOUBLE ALPHA** HN

♦ **SITE:** ☒ On Site at Research Foundry ☐ Off Site at _____

♦ **DATE RANGE:** From Apr. 23, 2007 to APR. 25, 2007

♦ **TEST TYPE:** ☒ Emissions Testing ☐ Mechanical Properties ☐ Casting Quality
☒ Baseline ☐ Comparison to _____ ☐ Other _____

♦ **PROCESSES:** ☒ Core ☐ Mold
☐ Pouring ☐ Cooling ☐ Shakeout ☐ Mixing ☒ Making ☐ Storage
☐ Other _____

♦ **METAL:** ☐ Iron ☐ Aluminum ☐ Steel ☐ Other _____ Pour Temp: _____°F **NA**
Alloy _____

♦ **PATTERN:** ☒ Step ☐ Star ☐ Irregular Gear ☐ Other _____

♦ **MOLD:** Number Molds _____ Number Cavities _____ **NA**
Flask Dimensions _____ Storage Temp: _____°F

♦ **CORE TYPE:** ☐ Cold box ☐ Warm box ☐ Hot box ☐ No-bake ☒ Shell ☐ Oil
☐ Phenolic Urethane ☐ Furan ☐ Inorganic (inc. Sodium Silicate) ☐ Epoxy-Acrylic
☐ Alkaline Phenolic Ester
☐ Coated ☐ Core Wash ☐ Naphthalene Depleted
☐ CO_2 Cured ☐ SO_2 Cured ☐ Acid Cured ☐ TEA Cured ☐ Methyl Formate Cured
☐ Hot Air Cured
☐ Other _____
Product Name(s) Technisand XC30

♦ **CORE COATING:** ☒ None ☐ All Runs ☐ Conditioning Runs Only ☐ Test Runs Only ☐ Baumé _____
Application Method _____ Drying Method _____
Product Name(s) _____

♦ **CORE SAND:** ☐ Greensand ☐ Seacoal ☐ No-Bake ☒ Other Shell
Additives _____
Product Name(s) Technisand XC 30

♦ **CORE BINDER:** Type Phenol-Formaldehyde Concentration 3% (BOS) Ratio ($\frac{P1}{P2}$) _____

Technikon Test Plan

page 2 o

Fill-in and check all that apply

- **CONTRACT NUMBER:** 1413 **TASK NUMBER** 122 **DOUBLE ALPHA** HN
- **RELEASE AGENT:** Type _____ Concentration _____ (BOS)
  Product Name(s) Ashland Zip-Slip 109 W
- **RUNS:** Number for Conditioning _____ Duration _____ Description _____
  Number for Sampling 7 Cores per run 15 (1 with 30) Description 3 minutes making per core for a total 1 hour sampling time per test
- **WASTE MATERIAL TO BE SAMPLED:** ☒ All ☐ None ☐ Core Butts ☐ Loose Sand ☐ Dog bones
  For: *Contaminates listed in EPA CRF section 40 part 261.24*
- **TEST OBJECTIVES:** *To measure emissions from shell core making of Fairmount minerals Technisand XC30 3% BOS shell sand.*
- **RESULTS TO BE REPORTED:** *CO, CO2, NOx,CH4, NH3, SO2 and Select Target Analytes and POMs to be reported in pounds of emissions per pound of binder and pounds per ton of cores made.*
- **ADDITIONAL COMMENTS:** *Technikon will use the shell core machine to perform this test. There will not be total enclosure of the machine in order to allow the operator to operate the machine..*

This test plan is routed to and/or reviewed by the following:

Senior Process Engineer
Production Engineer
Measurement Technology Manager
V.P. Operations
Steering Committee Emissions Team Chair

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)		Comments: One hour of core making accompanied by an additional half hour of core storage for a total period of 90 minutes
4/25/2007											
THC, CH4, CO, CO_2 & NOx	HN010	X									TOTAL
TO-17	HN01001		1						60	1	Carbopak charcoal
	Excess								60	2	BLOCKED
	Excess								60	3	BLOCKED
Acetophenone	HN01002		1						200	4	15/30 mg Tenax (SKC 226-35-03)
	Excess								200	5	BLOCKED
NIOSH S347	HN01003		1						1000	6	Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN01004		1						1000	7	Acid Silica Gel (SKC 226-10-06)
OSHA ID200	HN01005		1						1000	8	100/50 mg Carbon Bead (SKC 226-80)
	Excess								1000	9	BLOCKED
TO11	HN01006		1						1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	BLOCKED
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)		Comments: System blank with core blower burners on
THC, CH4, CO, CO_2 & NOx	HN011	X									TOTAL
TO-17	HN01101		1						60	1	Carbopak charcoal
	Excess								60	2	BLOCKED
	Excess								60	3	BLOCKED
Acetophenone	HN01102		1						200	4	15/30 mg Tenax (SKC 226-35-03)
	Excess								200	5	BLOCKED
NIOSH S347	HN01103		1						1000	6	Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN01104								1000	7	Acid Silica Gel (SKC 226-10-06)
OSHA ID200	HN01105		1						1000	8	100/50 mg Carbon Bead (SKC 226-80)
	Excess								1000	9	BLOCKED
TO11	HN01106		1						1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	BLOCKED
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments:
4/23/2007											
THC, CH4, CO, CO_2 & NOx	HN001	X									TOTAL
TO-17	HN00101		1						60	1	Carbopak charcoal
TO-17	HN00102				1				0		Carbopak charcoal
	Excess								60	2	BLOCKED
	Excess								60	3	BLOCKED
Acetophenone	HN00103		1						200	4	15/30 mg Tenax (SKC 226-35-03)
Acetophenone	HN00104				1				0		15/30 mg Tenax (SKC 226-35-03)
	Excess								200	5	BLOCKED
NIOSH S347	HN00105		1						1000	6	Acid Silica Gel (SKC 226-10-06)
NIOSH S347	HN00106				1				0		Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN00107		1						1000	7	Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN00108				1				0		Acid Silica Gel (SKC 226-10-06)
OSHA ID200	HN00109		1						1000	8	100/50 mg Carbon Bead (SKC 226-80)
OSHA ID200	HN00110				1				0		100/50 mg Carbon Bead (SKC 226-80)
TO11	HN00111		1						1000	9	DNPH Silica Gel (SKC 226-119)
TO11	HN00112			1					1000	10	DNPH Silica Gel (SKC 226-119)
TO11	HN00113				1				0		DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	BLOCKED
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments:
4/23/2007											
THC, CH4, CO, CO_2 & NOx	HN002	X									TOTAL
TO-17	HN00201		1						60	1	Carbopak charcoal
TO-17	HN00202			1					60	2	Carbopak charcoal
	Excess								60	3	BLOCKED
Acetophenone	HN00203		1						200	4	15/30 mg Tenax (SKC 226-35-03)
Acetophenone	HN00204			1					200	5	15/30 mg Tenax (SKC 226-35-03)
NIOSH S347	HN00205		1						1000	6	Acid Silica Gel (SKC 226-10-06)
NIOSH S347	HN00206			1					1000	7	Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN00207		1						1000	8	Acid Silica Gel (SKC 226-10-06)
OSHA ID200	HN00208		1						1000	9	100/50 mg Carbon Bead (SKC 226-80)
	Excess								1000	10	BLOCKED
TO11	HN00209		1						1000	11	DNPH Silica Gel (SKC 226-119)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments:
4/24/2007											
THC, CH4, CO, CO_2 & NOx	HN003	X									TOTAL
TO-17	HN00301		1						60	1	Carbopak charcoal
TO-17 MS	HN00302		1						60	2	Carbopak charcoal
TO-17 MS	HN00303			1					60	3	Carbopak charcoal
	Excess								200	4	BLOCKED
Acetophenone	HN00304		1						200	5	15/30 mg Tenax (SKC 226-35-03)
NIOSH S347	HN00305		1						1000	6	Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN00306		1						1000	7	Acid Silica Gel (SKC 226-10-06)
NIOSH 6016	HN00307			1					1000	8	Acid Silica Gel (SKC 226-10-06)
OSHA ID200	HN00308		1						1000	9	100/50 mg Carbon Bead (SKC 226-80)
OSHA ID200	HN00309			1					1000	10	100/50 mg Carbon Bead (SKC 226-80)
TO11	HN00310		1						1000	11	DNPH Silica Gel (SKC 226-119)
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments:
4/24/2007											
THC, CH4, CO, CO_2 & NOx	HN004	X									TOTAL
TO-17	HN00401		1						60	1	Carbopak charcoal
TO-17	HN00402					1			60	1	Carbopak charcoal
	Excess								60	2	BLOCKED
	Excess								60	3	BLCOKED
Acetophenone	HN00403		1						200	4	15/30 mg Tenax (SKC 226-35-03)
	Excess								200	5	BLOCKED
NIOSH S347	HN00404		1						1000	6	Acid Silica Gel (SKC 226-10-06)
	Excess								1000	7	BLOCKED
OSHA ID200	HN00405		1						1000	8	100/50 mg Carbon Bead (SKC 226-80)
	Excess								1000	9	BLOCKED
TO11	HN00406		1						1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	BLOCKED
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)	Train Channel	Comments:
4/24/2007											
THC, CH4, CO, CO_2 & NOx	HN005	X									TOTAL
TO-17	HN00501		1						60	1	Carbopak charcoal
	Excess								60	2	BLOCKED
	Excess								60	3	BLOCKED
Acetophenone	HN00502		1						200	4	15/30 mg Tenax (SKC 226-35-03)
	Excess								200	5	BLOCKED
NIOSH S347	HN00503		1						1000	6	Acid Silica Gel (SKC 226-10-06)
	Excess								1000	7	BLOCKED
OSHA ID200	HN00504		1						1000	8	100/50 mg Carbon Bead (SKC 226-80)
	Excess								1000	9	BLOCKED
TO11	HN00505		1						1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	BLOCKED
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

RESEARCH FOUNDRY HN - SERIES SAMPLE PLAN

Method	Sample #	Data	Sample	Duplicate	Blank	Breakthrough	Spike	Spike Duplicate	Flow (ml/min)		Comments:
4/25/2007											
THC, CH4, CO, CO_2 & NOx	HN006	X									TOTAL
TO-17	HN00601		1						60	1	Carbopak charcoal
	Excess								60	2	BLOCKED
	Excess								60	3	BLOCKED
Acetophenone	HN00602		1						200	4	15/30 mg Tenax (SKC 226-35-03)
	Excess								200	5	BLOCKED
NIOSH S347	HN00603		1						1000	6	Acid Silica Gel (SKC 226-10-06)
	Excess								1000	7	BLOCKED
OSHA ID200	HN00604		1						1000	8	100/50 mg Carbon Bead (SKC 226-80)
	Excess								1000	9	BLOCKED
TO11	HN00605		1						1000	10	DNPH Silica Gel (SKC 226-119)
	Excess								1000	11	BLOCKED
	Moisture		1						500	12	TOTAL
	Excess								5000	13	Excess

Series – 1413-122 HN

Core Making and Storage

Fairmount Minerals Technisand XC30 Shell Sand Process Instructions

A. The Experiment:

1. Measure total selected emissions from the making of step cores with Technisand XC30. This will also include a storage time.

B. Materials:

1. Technisand XC30, 3% resin (BOS).
2. Ashland Zipslip 109 W parting spray.
3. Dow Corning #7 release agent.

C. Machine setup.

1. Install and align the upgraded step core box onto the shell core machine.
2. Adjust gas and allow time for the east side of the shell box to reach 450F.

D. Core Making test: Six (6) tests each having fifteen (15) approximately two (2) minute core cycles, with a thirty (30) minute storage cycle.

Note: It may take up to two (2) hours to temperature stabilize all the equipment.

Note: Use a smoke generator to verify that containment is achieved particularly around the shell box during machine use.

1. Prepare the core machine emission enclosure.
2. Cycle the core machine for 2-5 cycles or until background emissions are stable based on the THC and good core manufacture is achieved. Remove these cores from the enclosure.
3. When everybody is ready, start the emission sampling clock and open the sample train. Sample continuously for 15 to 20 core cycles, approximately thirty (30) minutes and while cores are in the hood, sample for another 30 minutes for a total of 60 minutes.
4. Make the first core and place a thermocouple in it.
5. Make cores continuously and place each core on the cart/table in the enclosure after removed from the machine. Any stoppage will impact the fugitive emission level.
6. Record sample number, box temperature, and start time made of each core throughout the test.

Note: Occasionally, an incompletely cured core will occur. This does not necessarily constitute a failed sample emission cycle. Inferior cores should not be used for other purposes. Cores made for storage testing should be complete and no less than 0.1 pounds lighter than the median core weight for the group. Cores made for other testing may have the tip missing (0.05 pounds).

7. Do not stop making cores unless emission background level is allowed to re-stabilize before another test is begun.
8. Set up the sample train again and repeat the test for another fifteen core test. A total of six (6) tests are to be performed.
9. Empty and clean the core machine and core sand mixer.

Tom Fennell
Process Engineer

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APPENDIX B DETAILED EMISSION RESULTS AND QUANTITATION LIMITS

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Total Process Emissions Core Make/Store and Storage, Test HN, lb/ton core

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
Emission Indicators											
			THC as Propane	4.60E+00	I	4.39E+00	4.39E+00	4.43E+00	4.86E+00	4.53E+00	2.00E-01
			Non-Methane Hydrocarbons	I	I	8.93E-02	9.49E-02	1.07E-01	3.54E-01	1.61E-01	1.29E-01
			Sum of Target Analytes	5.63E-01	5.92E-01	5.63E-01	5.89E-01	6.12E-01	5.72E-01	5.82E-01	1.94E-02
			Sum of Target HAPs	1.19E-01	1.34E-01	1.26E-01	1.32E-01	1.36E-01	1.17E-01	1.27E-01	8.04E-03
			Sum of Target POMs	2.46E-04	2.50E-04	3.59E-04	2.62E-04	3.04E-04	4.14E-04	3.06E-04	6.80E-05
Selected Target HAPs and POMs											
TA		H	Phenol	1.06E-01	1.20E-01	1.12E-01	1.17E-01	1.22E-01	1.05E-01	1.14E-01	7.42E-03
TA		H	Formaldehyde	1.06E-02	1.19E-02	1.18E-02	1.06E-02	1.14E-02	1.03E-02	1.11E-02	6.88E-04
TA		H	Toluene	8.20E-04	2.68E-04	2.89E-04	1.72E-03	8.77E-04	3.76E-04	7.24E-04	5.55E-04
TA		H	Propionaldehyde (Propanal)	3.78E-04	4.41E-04	4.23E-04	3.62E-04	4.29E-04	5.45E-04	4.30E-04	6.44E-05
TA		H	Acetaldehyde	3.84E-04	3.51E-04	3.20E-04	3.97E-04	4.29E-04	2.94E-04	3.62E-04	5.03E-05
TA		H	Hexane	3.08E-04	2.53E-04	2.09E-04	3.62E-04	2.50E-04	1.53E-04	2.56E-04	7.31E-05
TA		H	Benzene	1.80E-04	3.06E-04	≤PQL	1.71E-04	≤PQL	1.66E-04	1.78E-04	6.74E-05
TA		H	Xylene, mp-	1.48E-04	≤PQL	2.31E-04	1.86E-04	1.88E-04	1.36E-04	1.69E-04	4.03E-05
TA	P	H	Methylnaphthalene, 2-	≤PQL	≤PQL	2.25E-04	1.24E-04	≤PQL	2.28E-04	1.58E-04	5.33E-05
TA	P	H	Methylnaphthalene, 1-	≤PQL	1.26E-04	1.34E-04	1.38E-04	1.81E-04	1.86E-04	1.48E-04	2.79E-05
TA		H	Acrolein	I	1.23E-04	≤PQL	1.19E-04	1.19E-04	≤PQL	1.17E-04	5.22E-06
TA	P	H	Acenaphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Anthracene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,8-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,7-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Naphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Trimethylnaphthalene, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Biphenyl	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, mp-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Ethylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Styrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Xylene, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Acetophenone	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Additional Selected Trget Analytes											
TA			Ammonia	4.43E-01	4.56E-01	4.36E-01	4.56E-01	4.75E-01	4.54E-01	4.53E-01	1.34E-02
TA			Crotonaldehyde	5.15E-04	4.71E-04	4.38E-04	4.16E-04	4.77E-04	5.72E-04	4.81E-04	5.61E-05
TA			2-Butanone (MEK)	3.82E-04	2.87E-04	3.32E-04	3.23E-04	3.68E-04	3.15E-04	3.35E-04	3.50E-05
TA			Benzaldehyde	≤PQL	2.12E-04	2.89E-04	2.24E-04	2.62E-04	3.84E-04	2.47E-04	9.04E-05
TA			Butyraldehyde/Methacrolein	3.13E-04	2.25E-04	2.36E-04	2.04E-04	2.33E-04	2.62E-04	2.46E-04	3.81E-05
TA			Pentanal (Valeraldehyde)	I	≤PQL	≤PQL	≤PQL	1.14E-04	1.27E-04	1.15E-04	6.71E-06
TA			Cyclohexane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

I=invalidated
NA=not applicable
≤PQL=less than or equal to pratical quantation limit

Total Process Emissions Core Make/Store and Storage, Test HN, lb/ton core

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
TA			Decane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dodecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Heptane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Hexaldehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indan	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Nonane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			o,m,p-Tolualdehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Octane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Propylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tetradecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Undecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			alpha-Methylstyrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, sec-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, tert-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Cymene, p-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diisopropylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isobutylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isopropylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tridecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,4,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Selected Criteria Pollutants and Greenhouse Gases											
			Carbon Dioxide	5.21E+01	5.06E+01	5.22E+01	5.14E+01	5.09E+01	5.13E+01	5.14E+01	6.20E-01
			Methane	I	5.88E+00	4.30E+00	4.30E+00	4.32E+00	4.50E+00	4.66E+00	6.89E-01
			Carbon Monoxide	3.20E-01	3.25E-01	3.60E-01	3.01E-01	3.04E-01	3.46E-01	3.26E-01	2.31E-02
			Nitrogen Oxides	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
			Sulfur Dioxide	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

I=invalidated
NA=not applicable
≤PQL=less than or equal to pratical quantation limit

Detailed Total Process Emissions Core Make/Store and Storage, Test HN, lb/lb binder

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
Emission Indicators											
			THC as Propane	7.89E-02	I	7.52E-02	7.53E-02	7.61E-02	8.32E-02	7.77E-02	3.41E-03
			Non-Methane Hydrocarbons	I	I	1.53E-03	1.63E-03	1.84E-03	6.06E-03	3.06E-03	2.20E-03
			Sum of Target Analytes	9.67E-03	1.01E-02	9.77E-03	1.04E-02	1.08E-02	9.85E-03	1.01E-02	4.23E-04
			Sum of Target HAPs	2.04E-03	2.36E-03	2.18E-03	2.31E-03	2.40E-03	2.01E-03	2.22E-03	1.64E-04
			Sum of Target POMs	4.22E-06	4.33E-06	6.23E-06	4.61E-06	5.30E-06	7.12E-06	5.30E-06	1.16E-06
Selected Target HAPs and POMs											
TA		H	Phenol	1.82E-03	2.11E-03	1.94E-03	2.06E-03	2.15E-03	1.80E-03	1.98E-03	1.50E-04
TA		H	Formaldehyde	1.82E-04	2.09E-04	2.05E-04	1.87E-04	2.00E-04	1.77E-04	1.93E-04	1.31E-05
TA		H	Toluene	1.41E-05	4.69E-06	5.02E-06	3.02E-05	1.54E-05	6.47E-06	1.26E-05	9.76E-06
TA		H	Propionaldehyde (Propanal)	6.48E-06	7.74E-06	7.35E-06	6.37E-06	7.55E-06	9.38E-06	7.48E-06	1.09E-06
TA		H	Acetaldehyde	6.59E-06	6.15E-06	5.55E-06	6.97E-06	7.55E-06	5.06E-06	6.31E-06	9.18E-07
TA		H	Hexane	5.28E-06	4.43E-06	3.63E-06	6.36E-06	4.40E-06	2.64E-06	4.46E-06	1.29E-06
TA		H	Benzene	3.09E-06	5.37E-06	≤PQL	3.00E-06	≤PQL	2.85E-06	3.09E-06	1.20E-06
TA		H	Xylene, mp-	2.54E-06	≤PQL	4.01E-06	3.26E-06	3.31E-06	2.33E-06	2.93E-06	7.20E-07
TA	P	H	Methylnaphthalene, 2-	≤PQL	≤PQL	3.90E-06	2.18E-06	≤PQL	3.93E-06	2.72E-06	9.23E-07
TA	P	H	Methylnaphthalene, 1-	≤PQL	2.22E-06	2.33E-06	2.43E-06	3.19E-06	3.19E-06	2.58E-06	4.88E-07
TA		H	Acrolein	I	2.16E-06	≤PQL	2.08E-06	2.09E-06	≤PQL	2.03E-06	1.15E-07
TA	P	H	Acenaphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Anthracene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,8-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,7-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Naphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Trimethylnaphthalene, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Biphenyl	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, mp-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Ethylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Styrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Xylene, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Acetophenone	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Additional Selected Trget Analytes											
TA			Ammonia	7.60E-03	7.75E-03	7.56E-03	8.02E-03	8.36E-03	7.80E-03	7.85E-03	2.99E-04
TA			Crotonaldehyde	8.83E-06	8.25E-06	7.60E-06	7.30E-06	8.40E-06	9.84E-06	8.37E-06	9.10E-07
TA			2-Butanone (MEK)	6.55E-06	5.03E-06	5.77E-06	5.68E-06	6.49E-06	5.41E-06	5.82E-06	5.97E-07
TA			Benzaldehyde	≤PQL	3.72E-06	5.02E-06	3.94E-06	4.62E-06	6.60E-06	4.30E-06	1.56E-06
TA			Butyraldehyde/Methacrolein	5.38E-06	3.95E-06	4.10E-06	3.58E-06	4.11E-06	4.51E-06	4.27E-06	6.19E-07
TA			Pentanal (Valeraldehyde)	I	≤PQL	≤PQL	≤PQL	2.00E-06	2.18E-06	1.98E-06	1.18E-07
TA			Cyclohexane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

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Detailed Total Process Emissions Core Make/Store and Storage, Test HN, lb/lb binder

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
TA			Decane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dodecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Heptane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Hexaldehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indan	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Nonane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			o,m,p-Tolualdehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Octane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Propylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tetradecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Undecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			alpha-Methylstyrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, sec-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, tert-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Cymene, p-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diisopropylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isobutylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isopropylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tridecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,4,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Selected Criteria Pollutants and Greenhouse Gases											
			Carbon Dioxide	8.93E-01	8.69E-01	8.94E-01	8.80E-01	8.74E-01	8.79E-01	8.82E-01	1.01E-02
			Methane	I	I	7.37E-02	7.37E-02	7.42E-02	7.71E-02	7.47E-02	1.66E-03
			Carbon Monoxide	5.49E-03	5.57E-03	6.17E-03	5.16E-03	5.23E-03	5.93E-03	5.59E-03	3.94E-04
			Nitrogen Oxides	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
			Sulfur Dioxide	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

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Emissions Core Make/Store and Storage, Test HN, lb/ton core

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
Emission Indicators											
			THC as Propane	5.17E-01	I	3.70E-01	4.59E-01	5.04E-01	8.22E-01	5.34E-01	1.71E-01
			Non-Methane Hydrocarbons	I	I	2.62E-01	2.64E-01	2.76E-01	5.28E-01	3.28E-01	1.30E-01
			Sum of Target Analytes	5.61E-01	5.90E-01	5.60E-01	5.86E-01	6.10E-01	5.70E-01	5.79E-01	1.94E-02
			Sum of Target HAPs	1.16E-01	1.32E-01	1.23E-01	1.29E-01	1.33E-01	1.14E-01	1.25E-01	8.05E-03
			Sum of Target POMs	ND	ND	ND	ND	ND	ND	ND	NA
Selected Target HAPs and POMs											
TA		H	Phenol	1.04E-01	1.19E-01	1.10E-01	1.16E-01	1.21E-01	1.03E-01	1.12E-01	7.44E-03
TA		H	Formaldehyde	1.06E-02	1.19E-02	1.18E-02	1.06E-02	1.14E-02	1.03E-02	1.11E-02	6.88E-04
TA		H	Toluene	4.43E-04	≤PQL	≤PQL	1.35E-03	5.15E-04	≤PQL	4.46E-04	4.77E-04
TA		H	Propionaldehyde (Propanal)	3.78E-04	4.41E-04	4.23E-04	3.62E-04	4.29E-04	5.45E-04	4.30E-04	6.44E-05
TA		H	Acetaldehyde	3.84E-04	3.51E-04	3.20E-04	3.97E-04	4.29E-04	2.94E-04	3.62E-04	5.03E-05
TA		H	Acrolein	I	1.23E-04	≤PQL	1.19E-04	1.19E-04	≤PQL	1.17E-04	5.22E-06
TA	P	H	Acenaphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Anthracene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,8-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,7-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Methylnaphthalene, 1-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Methylnaphthalene, 2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Naphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Trimethylnaphthalene, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Benzene	≤PQL	I	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Biphenyl	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, mp-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Ethylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Hexane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Styrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Xylene, mp-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Xylene, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Acetophenone	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Additional Selected Target Analytes											
TA			Ammonia	4.43E-01	4.56E-01	4.36E-01	4.56E-01	4.75E-01	4.54E-01	4.53E-01	1.34E-02
TA			Crotonaldehyde	5.15E-04	4.71E-04	4.38E-04	4.16E-04	4.77E-04	5.72E-04	4.81E-04	5.61E-05
TA			2-Butanone (MEK)	3.82E-04	2.87E-04	3.32E-04	3.23E-04	3.68E-04	3.15E-04	3.35E-04	3.50E-05
TA			Benzaldehyde	≤PQL	2.12E-04	2.89E-04	2.24E-04	2.62E-04	3.84E-04	2.47E-04	9.04E-05
TA			Butyraldehyde/Methacrolein	3.13E-04	2.25E-04	2.36E-04	2.04E-04	2.33E-04	2.62E-04	2.46E-04	3.81E-05
TA			Pentanal (Valeraldehyde)	I	≤PQL	≤PQL	≤PQL	1.14E-04	1.27E-04	1.15E-04	6.71E-06
TA			Cyclohexane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

(continued on next page)

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≤PQL=less than or equal to pratical quantation limit

Emissions Core Make/Store and Storage, Test HN, lb/ton core (continued)

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
TA			Decane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dodecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Heptane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Hexaldehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indan	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Nonane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			o,m,p-Tolualdehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Octane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Propylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tetradecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Undecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			alpha-Methylstyrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, sec-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, tert-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Cymene, p-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diisopropylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isobutylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isopropylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tridecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,4,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
0.00E+00											
			Methane	I	I	1.08E-01	1.95E-01	2.28E-01	2.94E-01	2.06E-01	7.74E-02
			Carbon Monoxide	1.16E-01	1.26E-01	1.59E-01	1.04E-01	1.08E-01	1.44E-01	1.26E-01	2.15E-02
			Nitrogen Oxides	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
			Sulfur Dioxide	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

I=invalidated
NA=not applicable
≤PQL=less than or equal to pratical quantation limit

Detailed Emissions Core Make/Store and Storage, Test HN, lb/lb binder

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	23-Apr-07	23-Apr-07	24-Apr-07	24-Apr-07	24-Apr-07	25-Apr-07	–	–
Emission Indicators											
			THC as Propane	8.88E-03	I	6.34E-03	7.86E-03	8.66E-03	1.41E-02	9.16E-03	2.92E-03
			Non-Methane Hydrocarbons	I	I	4.49E-03	4.53E-03	4.74E-03	9.04E-03	5.63E-03	2.23E-03
			Sum of Target Analytes	9.62E-03	1.01E-02	9.72E-03	1.03E-02	1.07E-02	9.80E-03	1.00E-02	4.22E-04
			Sum of Target HAPs	1.99E-03	2.31E-03	2.13E-03	2.26E-03	2.35E-03	1.97E-03	2.17E-03	1.63E-04
			Sum of Target POMs	ND	ND	ND	ND	ND	ND	ND	NA
Selected Target HAPs and POMs											
TA		H	Phenol	1.79E-03	2.08E-03	1.91E-03	2.03E-03	2.12E-03	1.77E-03	1.95E-03	1.51E-04
TA		H	Formaldehyde	1.82E-04	2.09E-04	2.05E-04	1.87E-04	2.00E-04	1.77E-04	1.93E-04	1.31E-05
TA		H	Toluene	7.60E-06	≤PQL	≤PQL	2.37E-05	9.07E-06	≤PQL	7.79E-06	8.40E-06
TA		H	Propionaldehyde (Propanal)	6.48E-06	7.74E-06	7.35E-06	6.37E-06	7.55E-06	9.38E-06	7.48E-06	1.09E-06
TA		H	Acetaldehyde	6.59E-06	6.15E-06	5.55E-06	6.97E-06	7.55E-06	5.06E-06	6.31E-06	9.18E-07
TA		H	Acrolein	I	2.16E-06	≤PQL	2.08E-06	2.09E-06	≤PQL	2.03E-06	1.15E-07
TA	P	H	Acenaphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Anthracene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 1,8-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Dimethylnaphthalene, 2,7-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Methylnaphthalene, 1-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Methylnaphthalene, 2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Naphthalene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA	P	H	Trimethylnaphthalene, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Benzene	≤PQL	I	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Biphenyl	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, mp-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Cresol, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Ethylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Hexane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Styrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Xylene, mp-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Xylene, o-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA		H	Acetophenone	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Additional Selected Target Analytes											
TA			Ammonia	7.60E-03	7.75E-03	7.56E-03	8.02E-03	8.36E-03	7.80E-03	7.85E-03	2.99E-04
TA			Crotonaldehyde	8.83E-06	8.25E-06	7.60E-06	7.30E-06	8.40E-06	9.84E-06	8.37E-06	9.10E-07
TA			2-Butanone (MEK)	6.55E-06	5.03E-06	5.77E-06	5.68E-06	6.49E-06	5.41E-06	5.82E-06	5.97E-07
TA			Benzaldehyde	≤PQL	3.72E-06	5.02E-06	3.94E-06	4.62E-06	6.60E-06	4.30E-06	1.56E-06
TA			Butyraldehyde/Methacrolein	5.38E-06	3.95E-06	4.10E-06	3.58E-06	4.11E-06	4.51E-06	4.27E-06	6.19E-07
TA			Pentanal (Valeraldehyde)	I	≤PQL	≤PQL	≤PQL	2.00E-06	2.18E-06	1.98E-06	1.18E-07
TA			Cyclohexane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

(continued on next page)

I=invalidated
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≤PQL=less than or equal to pratical quantation limit

Detailed Emissions Core Make/Store and Storage, Test HN, lb/lb binder (continued)

TA	POM	HAP		HN001	HN002	HN003	HN004	HN005	HN006	Average	Standard Deviation
			Test Dates	**23-Apr-07**	**23-Apr-07**	**24-Apr-07**	**24-Apr-07**	**24-Apr-07**	**25-Apr-07**	**–**	**–**
TA			Decane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dodecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Heptane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Hexaldehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indan	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Nonane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			o,m,p-Tolualdehyde	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Octane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Propylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tetradecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,2,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylbenzene, 1,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Undecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			alpha-Methylstyrene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, n-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, sec-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Butylbenzene, tert-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Cymene, p-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,2-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diethylbenzene, 1,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Diisopropylbenzene, 1,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,3-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 2,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Dimethylphenol, 3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Ethyltoluene, 4-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Indene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isobutylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Isopropylbenzene	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Tridecane	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,3,5-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
TA			Trimethylphenol, 2,4,6-	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
Selected Criteria Pollutants and Greenhouse Gases											
			Carbon Dioxide	2.71E-01	2.63E-01	2.83E-01	2.82E-01	2.75E-01	2.65E-01	2.73E-01	8.29E-03
			Methane	I	I	1.85E-03	3.34E-03	3.92E-03	5.04E-03	3.54E-03	1.33E-03
			Carbon Monoxide	1.99E-03	2.16E-03	2.72E-03	1.79E-03	1.85E-03	2.47E-03	2.16E-03	3.68E-04
			Nitrogen Oxides	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA
			Sulfur Dioxide	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	≤PQL	NA

I=invalidated
NA=not applicable
≤PQL=less than or equal to pratical quantation limit

Practical Reporting Limits, Total Process Emissions Core Make/Store and Storage, Test HN, lb/tn core

Analyte	lb/tn core	Analyte	lb/tn core
2-Butanone (MEK)	1.11E-04	Dodecane	1.23E-04
Acenaphthalene	1.23E-04	Ethylbenzene	1.23E-04
Acetaldehyde	1.11E-04	Ethyltoluene, 2-	1.23E-04
Acetophenone	1.43E-02	Ethyltoluene, 3-	1.23E-04
Acrolein	1.11E-04	Ethyltoluene, 4-	1.23E-04
alpha-Methylstyrene	1.23E-04	Formaldehyde	1.11E-04
Ammonia	4.32E-03	Heptane	1.23E-04
Anthracene	1.23E-04	Hexaldehyde	1.11E-04
Benzaldehyde	1.11E-04	Hexane	1.23E-04
Benzene	1.23E-04	Indan	1.23E-04
Biphenyl	1.23E-04	Indene	1.23E-04
Butylbenzene, n-	1.23E-04	Isobutylbenzene	1.23E-04
Butylbenzene, sec-	1.23E-04	Isopropylbenzene	1.23E-04
Butylbenzene, tert-	1.23E-04	Methane	1.34E-02
Butyraldehyde/Methacrolein	1.86E-04	Methylnaphthalene, 1-	1.23E-04
Carbon Dioxide	3.68E-02	Methylnaphthalene, 2-	1.23E-04
Carbon Monoxide	2.34E-02	Naphthalene	1.23E-04
Cresol, mp-	1.23E-04	Nitrogen Oxides	2.51E-02
Cresol, o-	1.23E-04	Nonane	1.23E-04
Crotonaldehyde	1.11E-04	o,m,p-Tolualdehyde	2.97E-04
Cyclohexane	1.23E-04	Octane	1.23E-04
Cymene, p-	1.23E-04	Pentanal (Valeraldehyde)	1.11E-04
Decane	1.23E-04	Phenol	1.23E-04
Diethylbenzene, 1,2-	1.23E-04	Propionaldehyde (Propanal)	1.11E-04
Diethylbenzene, 1,3-	1.23E-04	Propylbenzene, n-	1.23E-04
Diethylbenzene, 1,4-	1.23E-04	Styrene	1.23E-04
Diisopropylbenzene, 1,3-	1.23E-04	Sulfur Dioxide	1.48E-03
Dimethylnaphthalene, 1,2-	1.23E-04	Tetradecane	1.23E-04
Dimethylnaphthalene, 1,3-	1.23E-04	THC as Propane	3.68E-02
Dimethylnaphthalene, 1,5-	1.23E-04	Toluene	1.23E-04
Dimethylnaphthalene, 1,6-	1.23E-04	Tridecane	1.23E-04
Dimethylnaphthalene, 1,8-	1.23E-04	Trimethylbenzene, 1,2,3-	1.23E-04
Dimethylnaphthalene, 2,3-	1.23E-04	Trimethylbenzene, 1,2,4-	1.23E-04
Dimethylnaphthalene, 2,6-	1.23E-04	Trimethylbenzene, 1,3,5-	1.23E-04
Dimethylnaphthalene, 2,7-	1.23E-04	Trimethylnaphthalene, 2,3,5-	1.23E-04
Dimethylphenol, 2,3-	1.23E-04	Trimethylphenol, 2,3,5-	1.23E-04
Dimethylphenol, 2,4-	1.23E-04	Trimethylphenol, 2,4,6-	1.23E-04
Dimethylphenol, 2,5-	1.23E-04	Undecane	1.23E-04
Dimethylphenol, 2,6-	1.23E-04	Xylene, mp-	1.23E-04
Dimethylphenol, 3,4-	1.23E-04	Xylene, o-	1.23E-04
Dimethylphenol, 3,5-	1.23E-04		

Practical Reporting Limits, Total Process Emissions Core Make/Store and Storage, Test HN, lb/lb binder

Analyte	lb/lb Binder	Analyte	lb/lb Binder
2-Butanone (MEK)	1.91E-06	Dodecane	2.11E-06
Acenaphthalene	2.11E-06	Ethylbenzene	2.11E-06
Acetaldehyde	1.91E-06	Ethyltoluene, 2-	2.11E-06
Acetophenone	2.45E-04	Ethyltoluene, 3-	2.11E-06
Acrolein	1.91E-06	Ethyltoluene, 4-	2.11E-06
alpha-Methylstyrene	2.11E-06	Formaldehyde	1.91E-06
Ammonia	7.41E-05	Heptane	2.11E-06
Anthracene	2.11E-06	Hexaldehyde	1.91E-06
Benzaldehyde	1.91E-06	Hexane	2.11E-06
Benzene	2.11E-06	Indan	2.11E-06
Biphenyl	2.11E-06	Indene	2.11E-06
Butylbenzene, n-	2.11E-06	Isobutylbenzene	2.11E-06
Butylbenzene, sec-	2.11E-06	Isopropylbenzene	2.11E-06
Butylbenzene, tert-	2.11E-06	Methane	2.30E-04
Butyraldehyde/Methacrolein	3.18E-06	Methylnaphthalene, 1-	2.11E-06
Carbon Dioxide	6.32E-04	Methylnaphthalene, 2-	2.11E-06
Carbon Monoxide	4.02E-04	Naphthalene	2.11E-06
Cresol, mp-	2.11E-06	Nitrogen Oxides	4.31E-04
Cresol, o-	2.11E-06	Nonane	2.11E-06
Crotonaldehyde	1.91E-06	o,m,p-Tolualdehyde	5.09E-06
Cyclohexane	2.11E-06	Octane	2.11E-06
Cymene, p-	2.11E-06	Pentanal (Valeraldehyde)	1.91E-06
Decane	2.11E-06	Phenol	2.11E-06
Diethylbenzene, 1,2-	2.11E-06	Propionaldehyde (Propanal)	1.91E-06
Diethylbenzene, 1,3-	2.11E-06	Propylbenzene, n-	2.11E-06
Diethylbenzene, 1,4-	2.11E-06	Styrene	2.11E-06
Diisopropylbenzene, 1,3-	2.11E-06	Sulfur Dioxide	2.53E-05
Dimethylnaphthalene, 1,2-	2.11E-06	Tetradecane	2.11E-06
Dimethylnaphthalene, 1,3-	2.11E-06	THC as Propane	6.32E-04
Dimethylnaphthalene, 1,5-	2.11E-06	Toluene	2.11E-06
Dimethylnaphthalene, 1,6-	2.11E-06	Tridecane	2.11E-06
Dimethylnaphthalene, 1,8-	2.11E-06	Trimethylbenzene, 1,2,3-	2.11E-06
Dimethylnaphthalene, 2,3-	2.11E-06	Trimethylbenzene, 1,2,4-	2.11E-06
Dimethylnaphthalene, 2,6-	2.11E-06	Trimethylbenzene, 1,3,5-	2.11E-06
Dimethylnaphthalene, 2,7-	2.11E-06	Trimethylnaphthalene, 2,3,5-	2.11E-06
Dimethylphenol, 2,3-	2.11E-06	Trimethylphenol, 2,3,5-	2.11E-06
Dimethylphenol, 2,4-	2.11E-06	Trimethylphenol, 2,4,6-	2.11E-06
Dimethylphenol, 2,5-	2.11E-06	Undecane	2.11E-06
Dimethylphenol, 2,6-	2.11E-06	Xylene, mp-	2.11E-06
Dimethylphenol, 3,4-	2.11E-06	Xylene, o-	2.11E-06
Dimethylphenol, 3,5-	2.11E-06		

Practical Reporting Limits, Core Make/Store and Storage, Test HN, lb/ton core

Analyte	lb/tn core	Analyte	lb/tn core
2-Butanone (MEK)	1.11E-04	Dodecane	1.23E-04
Acenaphthalene	1.23E-04	Ethylbenzene	1.23E-04
Acetaldehyde	1.11E-04	Ethyltoluene, 2-	1.23E-04
Acetophenone	1.43E-02	Ethyltoluene, 3-	1.23E-04
Acrolein	1.11E-04	Ethyltoluene, 4-	1.23E-04
alpha-Methylstyrene	1.23E-04	Formaldehyde	1.11E-04
Ammonia	4.32E-03	Heptane	1.23E-04
Anthracene	1.23E-04	Hexaldehyde	1.11E-04
Benzaldehyde	1.11E-04	Hexane	1.23E-04
Benzene	1.23E-04	Indan	1.23E-04
Biphenyl	1.23E-04	Indene	1.23E-04
Butylbenzene, n-	1.23E-04	Isobutylbenzene	1.23E-04
Butylbenzene, sec-	1.23E-04	Isopropylbenzene	1.23E-04
Butylbenzene, tert-	1.23E-04	Methane	1.34E-02
Butyraldehyde/Methacrolein	1.86E-04	Methylnaphthalene, 1-	1.23E-04
Carbon Dioxide	3.68E-02	Methylnaphthalene, 2-	1.23E-04
Carbon Monoxide	2.34E-02	Naphthalene	1.23E-04
Cresol, mp-	1.23E-04	Nitrogen Oxides	2.51E-02
Cresol, o-	1.23E-04	Nonane	1.23E-04
Crotonaldehyde	1.11E-04	o,m,p-Tolualdehyde	2.97E-04
Cyclohexane	1.23E-04	Octane	1.23E-04
Cymene, p-	1.23E-04	Pentanal (Valeraldehyde)	1.11E-04
Decane	1.23E-04	Phenol	1.23E-04
Diethylbenzene, 1,2-	1.23E-04	Propionaldehyde (Propanal)	1.11E-04
Diethylbenzene, 1,3-	1.23E-04	Propylbenzene, n-	1.23E-04
Diethylbenzene, 1,4-	1.23E-04	Styrene	1.23E-04
Diisopropylbenzene, 1,3-	1.23E-04	Sulfur Dioxide	1.48E-03
Dimethylnaphthalene, 1,2-	1.23E-04	Tetradecane	1.23E-04
Dimethylnaphthalene, 1,3-	1.23E-04	THC as Propane	3.68E-02
Dimethylnaphthalene, 1,5-	1.23E-04	Toluene	1.23E-04
Dimethylnaphthalene, 1,6-	1.23E-04	Tridecane	1.23E-04
Dimethylnaphthalene, 1,8-	1.23E-04	Trimethylbenzene, 1,2,3-	1.23E-04
Dimethylnaphthalene, 2,3-	1.23E-04	Trimethylbenzene, 1,2,4-	1.23E-04
Dimethylnaphthalene, 2,6-	1.23E-04	Trimethylbenzene, 1,3,5-	1.23E-04
Dimethylnaphthalene, 2,7-	1.23E-04	Trimethylnaphthalene, 2,3,5-	1.23E-04
Dimethylphenol, 2,3-	1.23E-04	Trimethylphenol, 2,3,5-	1.23E-04
Dimethylphenol, 2,4-	1.23E-04	Trimethylphenol, 2,4,6-	1.23E-04
Dimethylphenol, 2,5-	1.23E-04	Undecane	1.23E-04
Dimethylphenol, 2,6-	1.23E-04	Xylene, mp-	1.23E-04
Dimethylphenol, 3,4-	1.23E-04	Xylene, o-	1.23E-04
Dimethylphenol, 3,5-	1.23E-04		

Practical Reporting Limits, Core Make/Store and Storage, Test HN, lb/lb binder

Analyte	lb/lb Binder	Analyte	lb/lb Binder
2-Butanone (MEK)	1.91E-06	Dodecane	2.11E-06
Acenaphthalene	2.11E-06	Ethylbenzene	2.11E-06
Acetaldehyde	1.91E-06	Ethyltoluene, 2-	2.11E-06
Acetophenone	2.45E-04	Ethyltoluene, 3-	2.11E-06
Acrolein	1.91E-06	Ethyltoluene, 4-	2.11E-06
alpha-Methylstyrene	2.11E-06	Formaldehyde	1.91E-06
Ammonia	7.41E-05	Heptane	2.11E-06
Anthracene	2.11E-06	Hexaldehyde	1.91E-06
Benzaldehyde	1.91E-06	Hexane	2.11E-06
Benzene	2.11E-06	Indan	2.11E-06
Biphenyl	2.11E-06	Indene	2.11E-06
Butylbenzene, n-	2.11E-06	Isobutylbenzene	2.11E-06
Butylbenzene, sec-	2.11E-06	Isopropylbenzene	2.11E-06
Butylbenzene, tert-	2.11E-06	Methane	2.30E-04
Butyraldehyde/Methacrolein	3.18E-06	Methylnaphthalene, 1-	2.11E-06
Carbon Dioxide	6.32E-04	Methylnaphthalene, 2-	2.11E-06
Carbon Monoxide	4.02E-04	Naphthalene	2.11E-06
Cresol, mp-	2.11E-06	Nitrogen Oxides	4.31E-04
Cresol, o-	2.11E-06	Nonane	2.11E-06
Crotonaldehyde	1.91E-06	o,m,p-Tolualdehyde	5.09E-06
Cyclohexane	2.11E-06	Octane	2.11E-06
Cymene, p-	2.11E-06	Pentanal (Valeraldehyde)	1.91E-06
Decane	2.11E-06	Phenol	2.11E-06
Diethylbenzene, 1,2-	2.11E-06	Propionaldehyde (Propanal)	1.91E-06
Diethylbenzene, 1,3-	2.11E-06	Propylbenzene, n-	2.11E-06
Diethylbenzene, 1,4-	2.11E-06	Styrene	2.11E-06
Diisopropylbenzene, 1,3-	2.11E-06	Sulfur Dioxide	2.53E-05
Dimethylnaphthalene, 1,2-	2.11E-06	Tetradecane	2.11E-06
Dimethylnaphthalene, 1,3-	2.11E-06	THC as Propane	6.32E-04
Dimethylnaphthalene, 1,5-	2.11E-06	Toluene	2.11E-06
Dimethylnaphthalene, 1,6-	2.11E-06	Tridecane	2.11E-06
Dimethylnaphthalene, 1,8-	2.11E-06	Trimethylbenzene, 1,2,3-	2.11E-06
Dimethylnaphthalene, 2,3-	2.11E-06	Trimethylbenzene, 1,2,4-	2.11E-06
Dimethylnaphthalene, 2,6-	2.11E-06	Trimethylbenzene, 1,3,5-	2.11E-06
Dimethylnaphthalene, 2,7-	2.11E-06	Trimethylnaphthalene, 2,3,5-	2.11E-06
Dimethylphenol, 2,3-	2.11E-06	Trimethylphenol, 2,3,5-	2.11E-06
Dimethylphenol, 2,4-	2.11E-06	Trimethylphenol, 2,4,6-	2.11E-06
Dimethylphenol, 2,5-	2.11E-06	Undecane	2.11E-06
Dimethylphenol, 2,6-	2.11E-06	Xylene, mp-	2.11E-06
Dimethylphenol, 3,4-	2.11E-06	Xylene, o-	2.11E-06
Dimethylphenol, 3,5-	2.11E-06		

APPENDIX C DETAILED PROCESS DATA

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Test HN - Detailed Process Data

	Technisand XC30 Coremaking						
Test Dates	04/23/07	04/23/07	04/24/07	04/24/07	04/24/07	04/25/07	Averages
Emissions Sample #	HN001	HN002	HN003	HN004	HN005	HN006	
Production Sample #	HN001	HN002	HN003	HN004	HN005	HN006	
Average cooled core weight, g	2479.8	2533.7	2508.8	2539.2	2545.6	2486.5	2515.6
Average core box temperature	452	452	459	460	458	455	456
% stated core binder (BOS)	3	3	3	3	3	3	3
% calculated actual binder	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Number of cores made in run	15	15	15	15	15	15	15
Total core weight in from run, Lbs.	82.01	83.79	82.96	83.97	84.18	82.23	83.19
Total binder weight in run, Lbs.	2.4	2.4	2.4	2.4	2.5	2.4	2.4
Core LOI, %	3.1627	3.2267	3.2703	3.2101	3.2257	3.1912	3.21

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APPENDIX D CONTINUOUS EMISSION CHARTS

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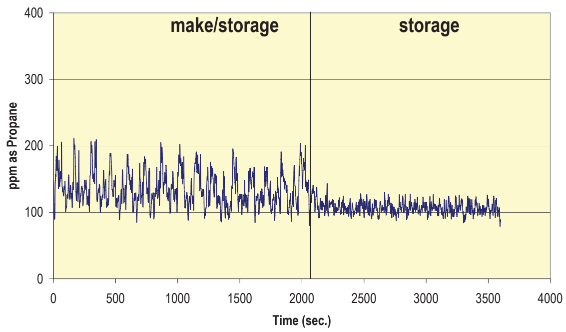
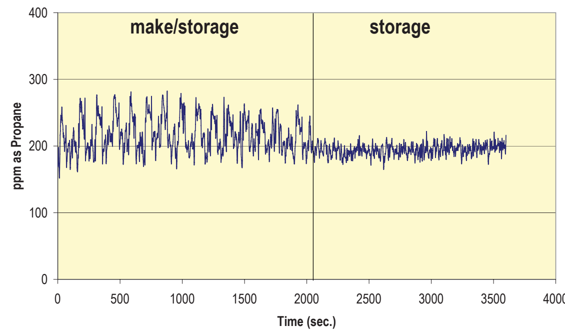
HN001 TGOC



HN002 TGOC



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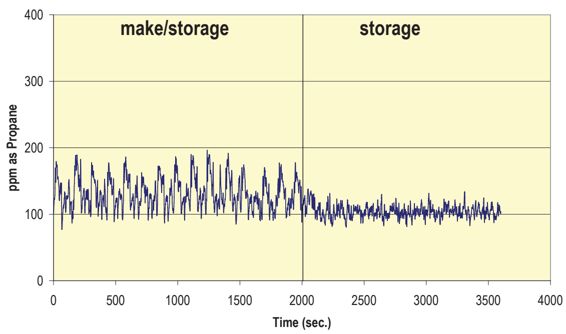

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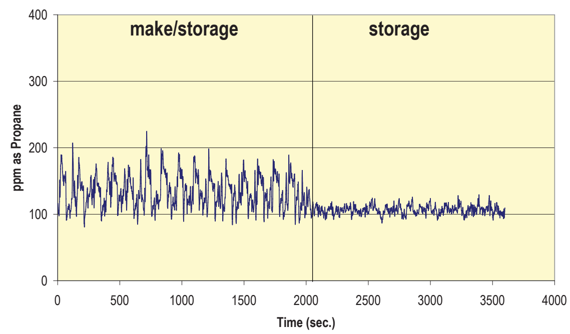

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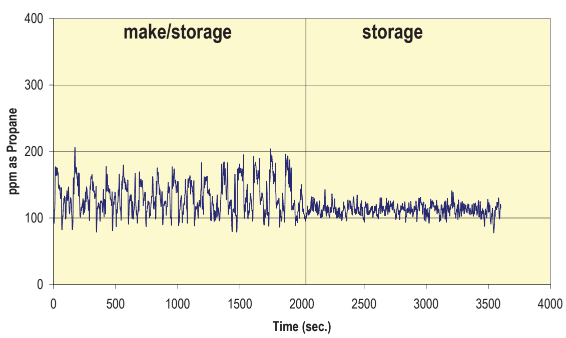

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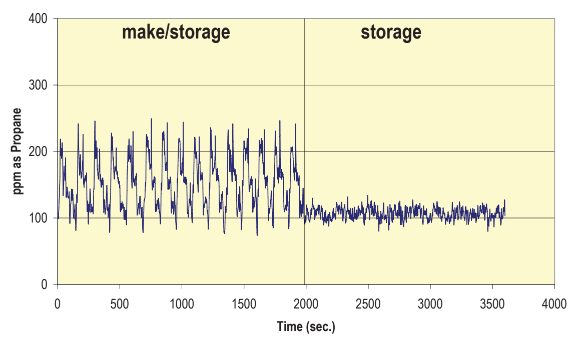
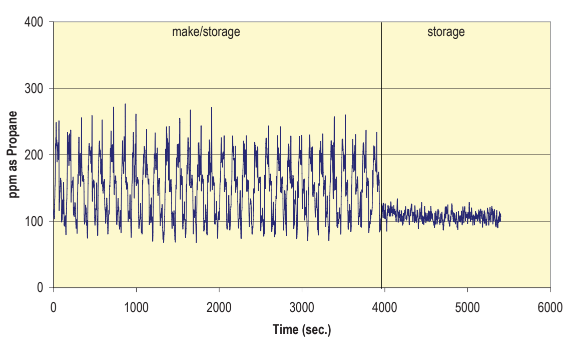
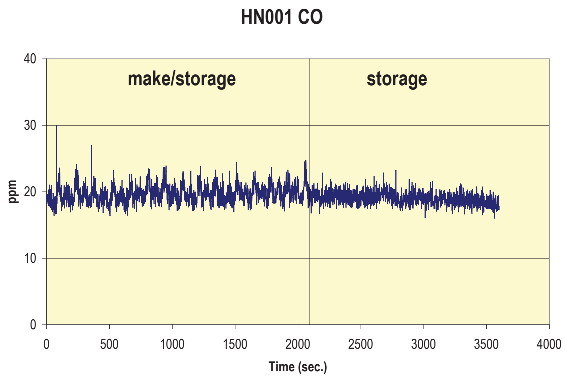
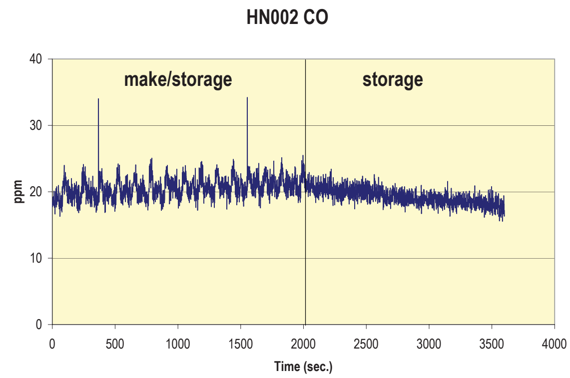


HN010 TGOC




HN001 CO
make/storage
storage
ppm
Time (sec.)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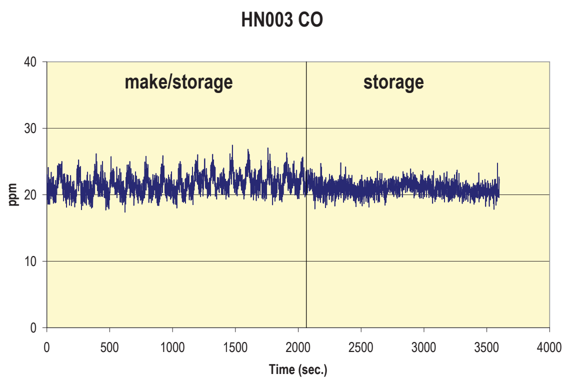
make/storage
storage
ppm
Time (sec.)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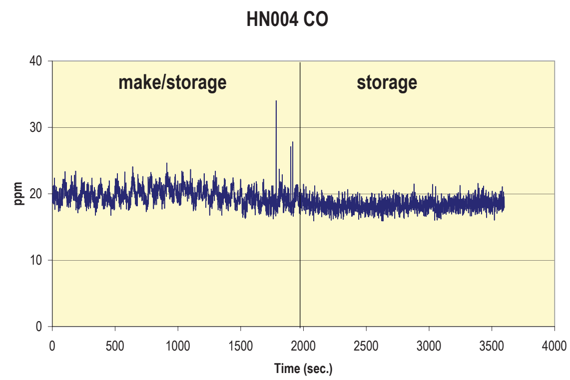
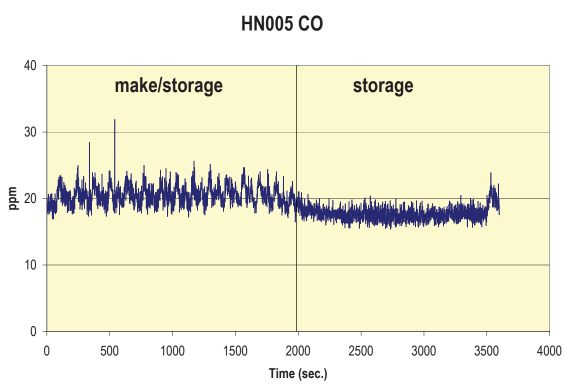
make/storage
storage
ppm
Time (sec.)


HN004 CO
make/storage
storage
ppm
Time (sec.)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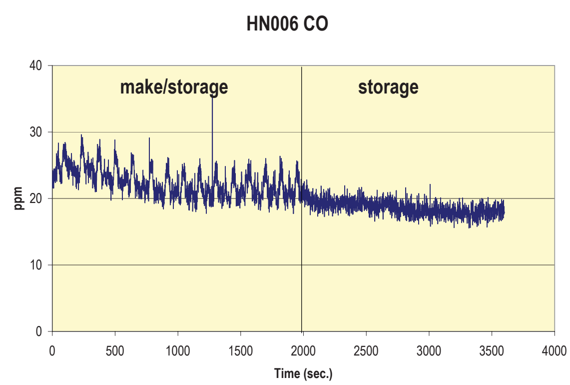
make/storage
storage
ppm
Time (sec.)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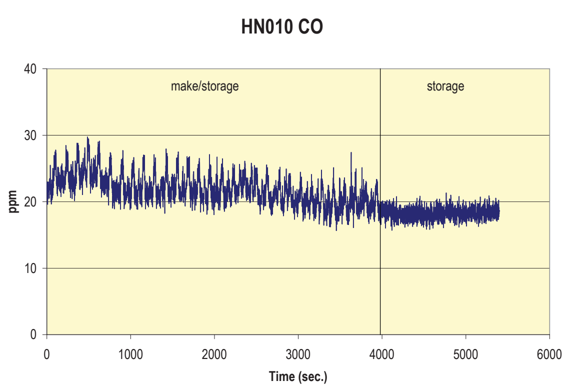
make/storage
storage
ppm
Time (sec.)


HN010 CO
make/storage
storage
ppm
Time (sec.)

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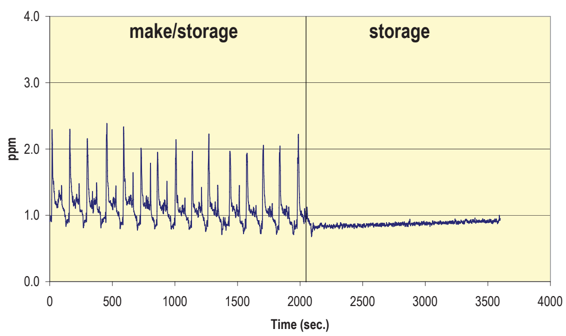

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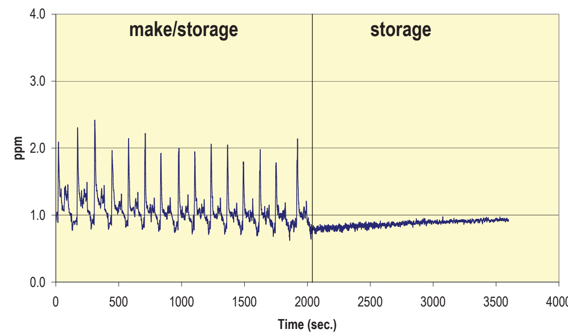

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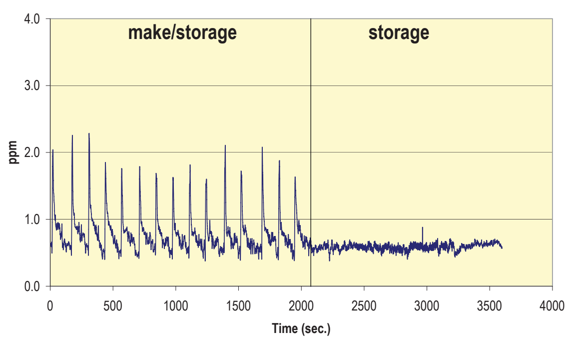

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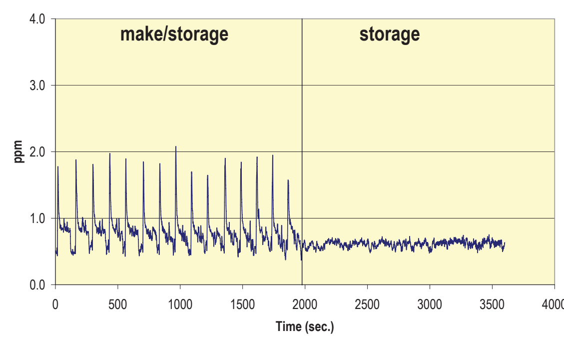

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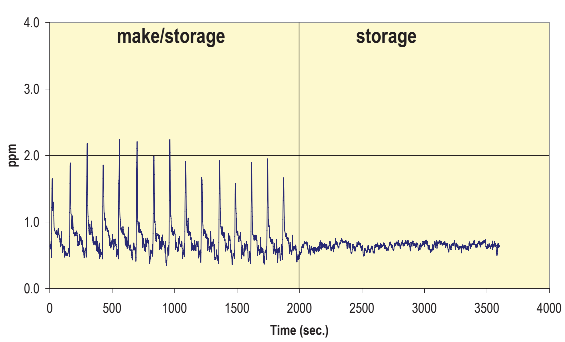

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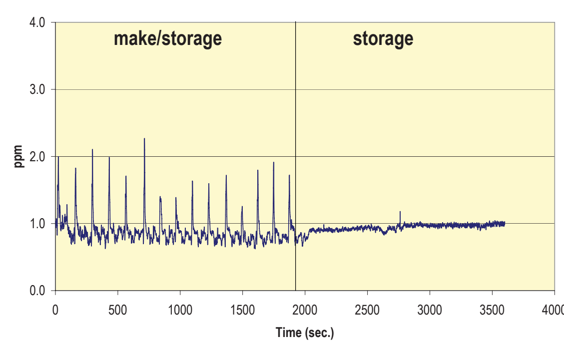

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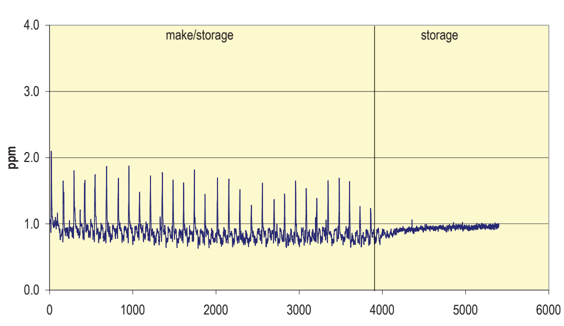

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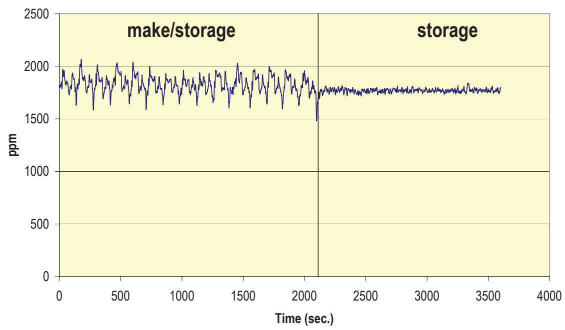

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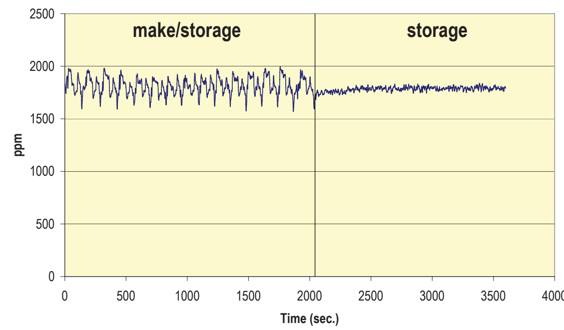

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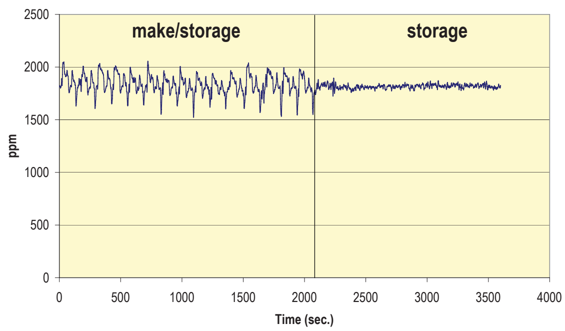

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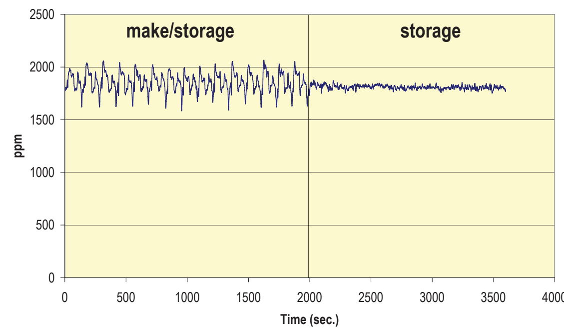

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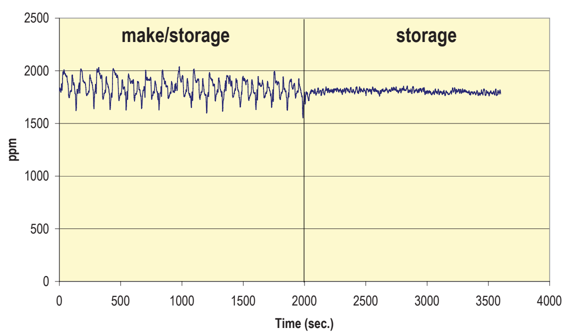

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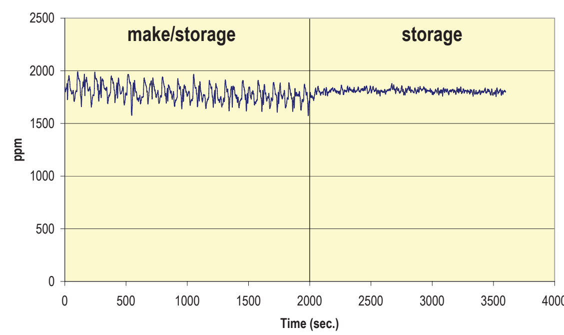

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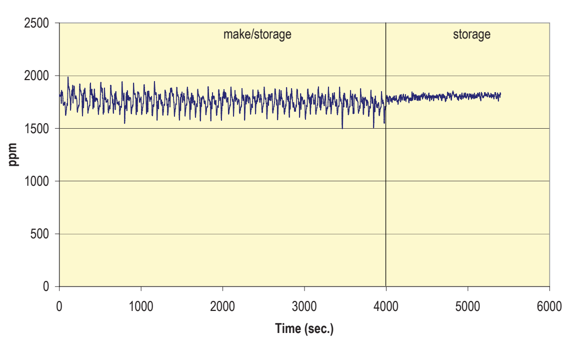
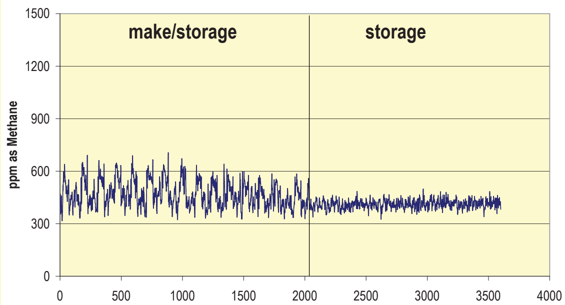


HN001 CH_4

Data Invalidated

HN002 CH_4



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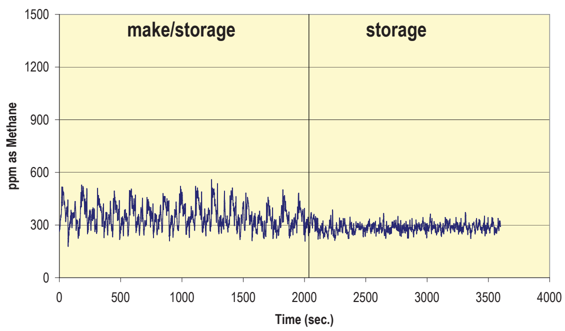

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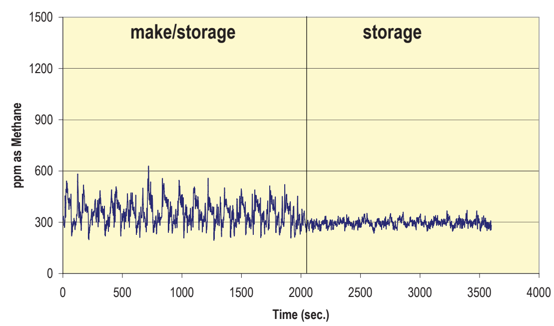

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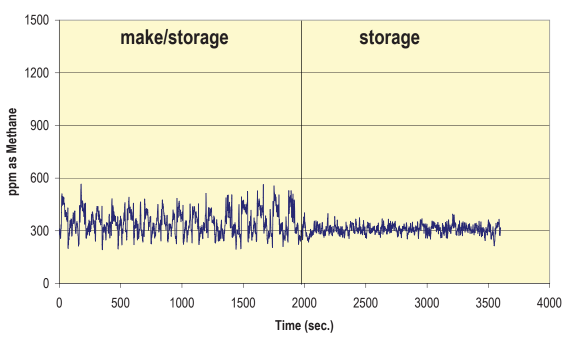

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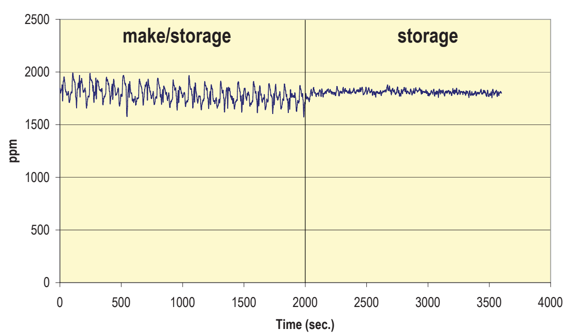

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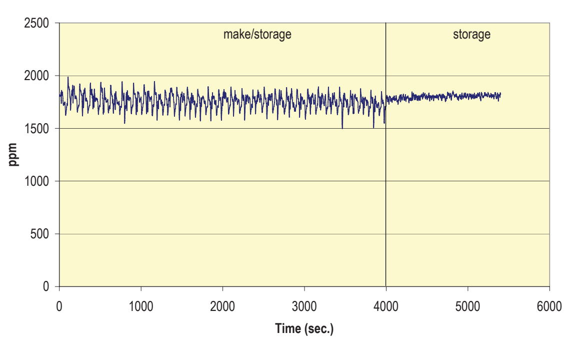

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APPENDIX E ACRONYMS AND ABBREVIATIONS

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Acronyms & Abbreviations

AFS	American Foundry Society
ARDEC	(US) Army Armament Research, Development and Engineering Center
BO	Based on ( ).
BOS	Based on Sand.
CAAA	Clean Air Act Amendments of 1990
CARB	California Air Resources Board
CERP	Casting Emission Reduction Program
CFR	Code of Federal Regulations
CH_4	Methane
CISA	Casting Industry Suppliers Association
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRADA	Cooperative Research and Development Agreement
CTM	Conditional Test Method
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
ERC	Environmental Research Consortium
FID	Flame Ionization Detector
GS	Greensand
HAP	Hazardous Air Pollutant defined by the 1990 Clean Air Act Amendment
HC	Hydrocarbon
I	Invalidated Data
Lb/Lb	Pound per Pound of Binder used
Lb/Tn	Pound per Ton of Metal poured
LOI	Loss on Ignition
MB	Methylene Blue
NA	Not Applicable; Not Available
ND	Non-Detect; Not detected below the practical quantitation limit
NG	Natural Gas
NOx	Oxides of Nitrogen
NMHC	Non-Methane Hydrocarbons

NT	Not Tested - Lab testing was not done
PCS	Pouring, Cooling, Shakeout
POM	Polycyclic Organic Matter
psi	Pounds per Square Inch
QA/QC	Quality Assurance/Quality Control
scfm	Standard Cubic Feel per Minute
SO_2	Sulfur Dioxide
TA	Target Analyte
TEA	Triethylamine
TGOC	Total Gaseous Organic Concentration
THC	Total Hydrocarbon Concentration
US EPA	United States Environmental Protection Agency
USCAR	United States Council for Automotive Research
VOST	Volatile Organic Sampling Train
WBS	Work Breakdown Structure