CERP

Casting Emission Reduction Program

Baseline Testing Emission Results
Production Foundry

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Executive Summary

This report contains the results of baseline emission testing conducted at the Casting Emission Reduction Program (CERP) Production Foundry. The baseline testing was conducted by CERP, which is a cooperative initiative between the Department of Defense (McClellan Air Force Base) and the United States Council for Automotive Research (USCAR). CERP's purpose is to evaluate alternative casting materials and processes that are designed to reduce air emissions from foundries and/or improve the efficiency of casting processes. Other technical partners directly supporting the CERP project include: the American Foundrymen's Society (AFS); the Casting Industry Suppliers Association (CISA); the US Environmental Protection Agency (USEPA); and the California Air Resources Board (CARB).

The specific objective of the baseline testing was to establish air emission baseline data against which the air emissions from new materials, equipment and processes, designed to reduce organic Hazardous Air Pollutants (HAPs) and Volatile Organic Compounds (VOCs) could be compared.

The CERP Production Foundry is a basic green sand foundry similar to existing mechanized commercial foundries and emulates an automotive foundry in the type and size of equipment, materials, and processes used. The Production Foundry uses a single cavity automotive I-4 engine block as its test mold pattern. The Production Foundry is used to evaluate materials, equipment, and processes in a continuous real-world production-like environment. The Production Foundry is instrumented to provide emission measurements, according to methods based on USEPA air testing protocols, of the sand system, pouring, cooling and shakeout processes. The Production Foundry is instrumented so that process data on all activities of the metal casting process can be simultaneously and continuously collected in order to complete an economic impact evaluation of the prospective emission reducing strategy.

The baseline testing performed at the Production Foundry involved the collection of continuous air samples over a 60-minute period (a sampling event) at five different sampling points. The sampling points included the sand system, pouring, cooling, shakeout and pouring/cooling/ shakeout combined. Process and stack parameters measured included: the weight of the casting, mold, seacoal additions, and core; % Loss on Ignition (LOI) values for the mold; % LOI for the core; % clay content of the mold; % compactability of the mold; pouring temperatures; metallurgical data; and stack temperature, pressure, volumetric flow rate and moisture content. The process parameters and the stack flow rates were maintained within prescribed ranges in order to ensure the reproducibility of the tests.

Nine individual sampling events were conducted for the baseline test series. Sampling for the baseline test series used procedures based on standard USEPA stack test methods. Test and duplicate air samples were collected for each of the sampling events. The samples were analyzed for individual organic HAPs and VOCs using methods based on USEPA Method 18 and Method TO11 by an independent laboratory. The laboratory data were validated and reduced to a useable data set, according to CERP's validation process. The mass emission rate, in pounds of analyte per ton of metal processed, was calculated for each analyte using the

validated laboratory analytical results, measured stack parameters and sample volumes, the average weight of the casting, and the number of mold/core packages processed at each emission point during the sampling event. Total organic HAP emissions were determined from the sum of the individual HAPs measured. Total VOCs were determined based on the sum of the individual VOCs measured. Table 1 and Figure 1 present a summary of the results of the baseline test.

The variation of the measured process parameters and of the analytical test results indicates that the baseline test presented in this report were run within acceptable control ranges, and therefore provide a suitable basis for future comparative evaluations.

The results of the testing conducted at both the Production and Pre-production Foundries are not suitable for use as general emission factors. The specific materials used (grey iron from an electric melt furnace, greensand with seacoal, a relatively heavy core weight, and a cold box core with a relatively old resin binding system); the specific casting produced (an I-4 automotive block); the specific production processes employed (an impact mold line); and the specific testing conditions (relatively low stack velocity, long sampling times, high capture rates and combined emissions from pouring, cooling and shakeout processes at the Production Foundry) produce emission results unique to the materials, castings, casting processes and measurement conditions used. The data produced are intended to demonstrate the relative emission reductions from the use of alternative materials, equipment and processes, and not the absolute emission levels that would be experienced in commercial foundries. A number of process parameters such as casting surface area, sand to metal ratios, pouring temperatures, stack flow rates, LOI levels, seacoal and resin contents, and the type of foundry (Cope & Drag versus Disa for example) can have a significant impact on actual emission levels. CERP does plan to evaluate, and if possible, quantify the impacts of several of these parameters to assist the foundry industry as well as regulatory agencies in their understanding of the importance of these parameters on air emission levels.

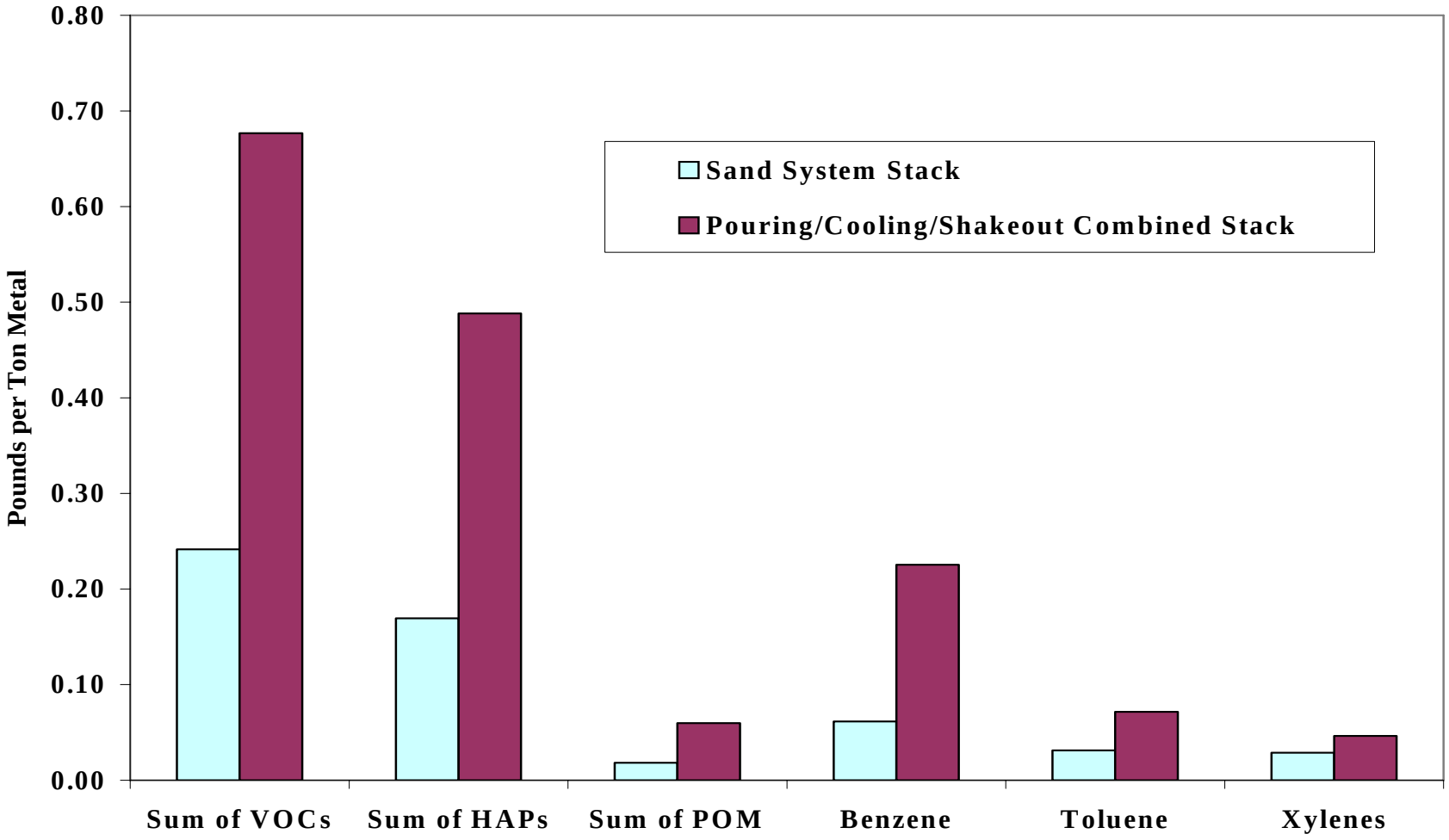
Table 1 - Average Baseline Test Results, lbs/ton metal

Analyte	Sand System	Pouring/Cooling/Shakeout Emissions
Sum of VOCs[a]	0.2414	0.6768
Sum of HAPs[b]	0.1693	0.4882
Sum of POM[c]	0.0183	0.0596
Benzene	0.0615	0.2255
Toluene	0.0312	0.0715
Phenol/3-Ethyltoluene	0.0071	0.0554
Naphthalene	0.0161	0.0365
m,p-Xylene	0.0176	0.0325
o-Xylene	0.0112	0.0138
Hexane	0.0032	0.0120
o-Cresol/Indan	ND	0.0114
Ethyl Benzene	0.0084	0.0097
Styrene	0.0066	0.0079
Acetaldehyde	0.0032	0.0051
2-Methylnaphthalene	0.0101	0.0253
1-Methylnaphthalene	0.0082	0.0161

[a] Sum of all VOCs detected.
[b] Sum of all HAPs detected.
[c] POM: Polycyclic Organic Matter which includes Naphthalene and other compounds, which contain more than one benzene ring and which have a boiling point greater than or equal to 100 ^{o}C.

Note: The results presented are not suitable for use as general emission factors.

Figure 1 – Average Production Foundry Baseline Test Results



Note: The results presented are not suitable for use as general emission factors.

1.0 Introduction

1.1 Background

The Casting Emission Reduction Program (CERP) is a cooperative initiative between the Department of Defense (McClellan Air Force Base) and the United States Council for Automotive Research (USCAR). Its purpose is to evaluate alternative casting materials and processes, which are designed to reduce air emissions from foundries and/or improve the efficiency of casting processes. Other technical partners directly supporting the project include: the American Foundrymen's Society (AFS); the Casting Industry Suppliers Association (CISA); the US Environmental Protection Agency (USEPA); and the California Air Resources Board (CARB). Each of these partners is represented on a Steering Committee that has oversight for the testing conducted at the CERP facility.

1.2 CERP Objectives

The primary objective of CERP is to evaluate the impact on air emissions of materials, equipment, and processes to be used in the production of metal castings. Specifically, the CERP facility has been created to evaluate alternate materials and production processes designed to achieve significant air emission reductions, especially for organic Hazardous Air Pollutants (HAPs). The HAP emission reduction goal for the alternative materials, equipment and production processes is 50 percent as compared to the emissions from a comparable baseline test. The facility has two principal testing arenas: a Pre-production Foundry designed to measure airborne emissions from individually poured molds, and a Production Foundry designed to measure air emissions in a continuous, full-scale production process. Each of these testing arenas has been specifically designed to facilitate the collection and evaluation of airborne emissions, and associated process data. Candidate materials and/or processes are screened for emission reductions in the Pre-production Foundry and then further validated in the Production Foundry. The data collected during the various testing projects are evaluated to determine the impact of the alternate materials and/or processes on air emissions as well as on the quality and economics of casting and core manufacture. These alternate materials, equipment, and processes may need to be further adapted and defined so that they will integrate into current commercial green sand casting facilities smoothly and with minimum capital expenditure.

Pre-production testing is conducted in order to evaluate the impact on air emissions from a proposed alternative material, equipment or process. The CERP Pre-production Foundry is a simple, general purpose manual foundry, which was adapted and instrumented to allow the collection of detailed emission measurements, using methods based on USEPA air testing protocols. Measurements are taken during pouring, casting cooling, and shakeout processes performed on discreet mold and core packages under tightly controlled conditions not feasible in a commercial foundry. The Pre-production foundry uses an eight-on, bottom-feed AFS step block as its test mold pattern. A report entitled "Baseline Testing Emission Results – Pre-production Foundry", provides details of the baseline testing done in the Pre-production Foundry. This report can be obtained from the CERP web-site at www.cerp-aiger.org.

Alternative materials, equipment and processes that, during their testing in the Pre-production Foundry, demonstrate significant air emission reduction potential, preserve casting quality parameters, and are economically viable are further evaluated in the Production Foundry. The Production Foundry's design as a basic green sand foundry was deliberately chosen so that whatever is tested in the Production Foundry could be easily converted for use in existing mechanized commercial foundries. The Production Foundry emulates an automotive foundry in the type and size of equipment, materials, and processes used. The Production Foundry uses a single cavity automotive I-4 engine block as its test mold pattern. The Production Foundry is used to further evaluate materials, equipment, and processes in a continuous real-world production-like environment. The Production Foundry provides simultaneous, detailed, individual emission measurements, according to methods based on USEPA air testing protocols, of the melting, pouring, sand preparation, mold making, and core making processes. The Production Foundry is instrumented so that process data on all activities of the metal casting process can be simultaneously and continuously collected in order to complete an economic impact evaluation of the prospective emission reducing strategy. Castings are randomly selected to evaluate the impact of the alternate material, equipment, or process on the quality of the casting.

The results of the testing conducted at both the Production and Pre-production Foundries are not suitable for use as general emission factors. The specific materials used (grey iron from an electric melt furnace, greensand with seacoal, a relatively heavy core weight, and a cold box core with a relatively old resin binding system); the specific castings produced (an eight-on step block in the Pre-production Foundry and an I-4 automotive block in the Production Foundry); the specific production processes employed (a stationary hand poured mold in the Pre-production Foundry and an impact mold line in the Production Foundry); and the specific testing conditions (relatively low stack velocity, long sampling times, high capture rates, and combined emissions from pouring, cooling and shakeout processes at the Production Foundry) produce emission results unique to the materials, castings, casting processes and measurement conditions used. The data produced are intended to demonstrate the relative emission reductions from the use of alternative materials, equipment and processes, and not the absolute emission levels that would be experienced in commercial foundries. A number of process parameters such as casting surface area, sand to metal ratios, pouring temperatures, stack flow rates, LOI levels, seacoal and resin contents, and the type of foundry (Cope & Drag versus Disa for example) can have a significant impact on actual emission levels. CERP does plan to evaluate and if possible quantify the impacts of several of these parameters to assist the foundry industry as well as regulatory agencies in their understanding of the importance of these parameters on air emission levels.

1.3 Report Organization

This report has been designed to document the methodology used and results obtained during baseline testing in the Production Foundry. Section 1 presents a general overview of baseline testing, while Section 2 of this report includes a summary of the methodologies used for data collection and analysis, emission calculations, quality assurance, quality control (QA/QC) procedures, and data management and reduction methods. Process data and baseline emissions measurement results are presented in Section 3 of this report, with detailed emissions data

included in Appendix A. Section 4 of the report contains a discussion of the results of the baseline test including conclusions drawn from the interpretation of the results.

The raw data, as well as the data validation and reduction steps used, for the baseline test presented in this report are included in the test series data binders, which are maintained at the CERP facility. There are also several support documents, which provide details regarding the testing and analytical procedures used. Appendix B contains a listing of these documents.

1.4 Preliminary Testing

The baseline testing presented in this report was performed according to the "CERP Production Testing Protocols". These protocols were established by CERP, following the performance of a series of preliminary tests. It has been determined by CERP that six to nine replicate tests will provide a statistically significant sample for the purpose of evaluating the emission reductions from alternative materials, equipment and processes. The number of replicate tests may vary, based on the confidence interval necessary to ensure that the test protocols can indeed detect a 50% reduction in emissions. The results of the testing conducted in support of this conclusion are included in the document "CERP Production Testing Protocols."

Two other Production Foundry baseline tests were conducted in August and December 1998 respectively. These baseline tests were conducted to support the development of testing protocols and to evaluate the adequacy of process, sampling and analytical procedures. Physical changes to the configuration of the foundry were made following the first baseline test conducted in August, 1998, and therefore the results of that test are not suitable for use in future comparisons with testing on alternative materials, equipment or processes at the Production Foundry. The results of the second baseline test on the Production Foundry, conducted in December 1998 were also not fully suitable for use as baseline data, although the results are, for the most part, consistent with the results of the baseline test documented in this report.

1.5 Specific Baseline Test Plan and Objectives

This report contains the results of testing performed to assess HAP and VOC the emissions from baseline test at the Production Foundry. The specific objective of the baseline test was to establish emissions and operational baseline information for use in comparisons with alternative materials, equipment and processes designed to reduce HAP and VOC air emissions. Table 1-2 provides a summary of the Test Plan for the baseline test series. The details of the approved test plan are included in Appendix C.

Table 1-1 Production Baseline Test Plan Summary

Test Series	AX
Test Dates	February 16-18, 1999
Number of Test Runs	9 one-hour tests
Sampling Points	Five separate sampling points including the sand system, pouring, cooling, shakeout and pouring/cooling/shakeout combined.
Mold Type	CERP System Sand (H&G Bentonite with seacoal)
Core Type	Phenolic Urethane Cold Box Cores
Casting Type	Single cavity automotive I-4 engine block
Emissions Measured	70 organic HAPs and VOCs
Process and Stack Parameters Measured	Casting, Mold and Core Weights, Molds processed, Metallurgical data, Mold and Core Component Weights, % LOI (mold and core) , % Clay, Stack Temperature, Stack Moisture Content, Stack Pressure, and Stack Volumetric Flow Rate

2.0 Test Methodology

2.1 Description of Process and Testing Equipment

Figure 2-1 is a flow diagram of the Production foundry process.

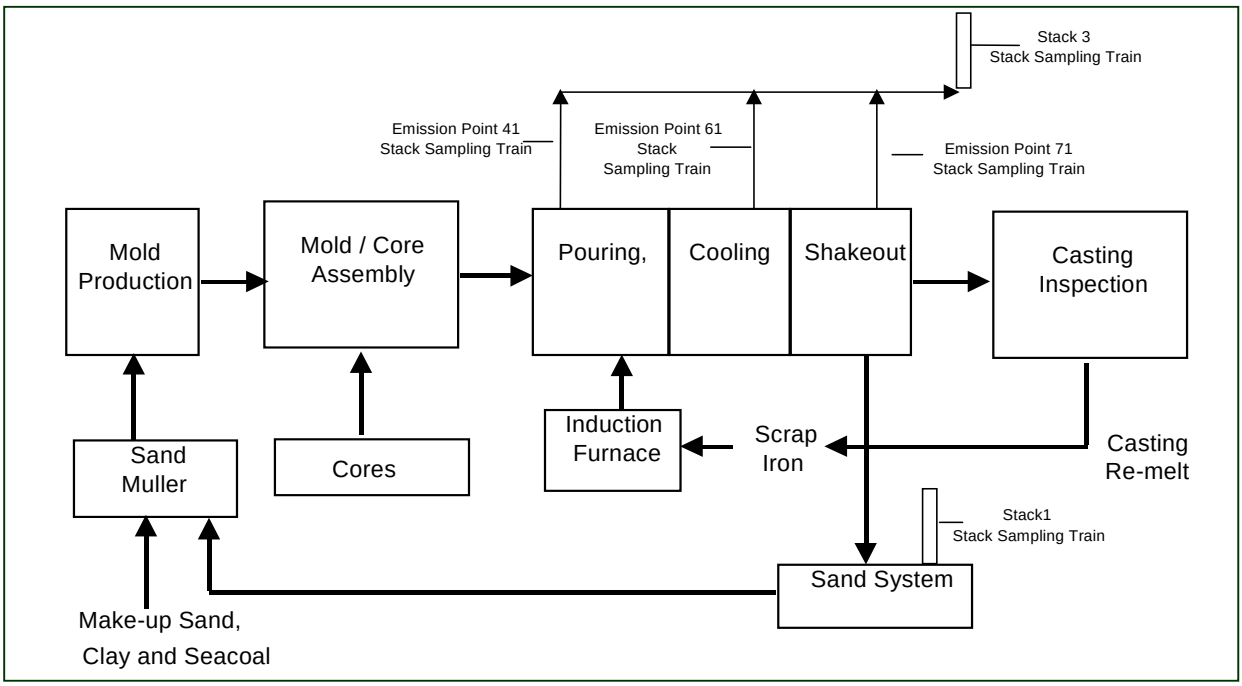


Figure 2-1 Production Foundry Process Flowchart

2.2 Description of Testing Program

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

1. **Mold, Core and Metal Preparation:** Molds were produced on an impact mold line. Cores were prepared to a standard composition by the CERP testing team using a cold box core machine. Iron was melted in two Inductotherm electric induction melt furnaces with a total capacity of 5 tons/hour. The amount of metal melted was determined from the poured weight of the casting and the number of molds to be poured. The metal composition was provided on a metal composition worksheet.

2. **Individual Sampling Events:** Sampling of each of the five sampling points (sand system, pouring, cooling, shakeout and pouring/cooling/shakeout combined) was conducted over nine individual one-hour test runs. Each mold/core package was placed in a flask that was assigned a number and tracked by time and position throughout the process. The number of poured mold/core packages entering each process step (sand system, pouring, cooling and shakeout) for each test hour was determined from the tracking data for each mold/core package. Continuous air samples were collected during each one-hour test run at each of the five sampling points. The average casting weight and mold/core package counts were used to determine the total metal weight processed at each point during each test hour in order to correlate the emissions measurements with the metal weight processed.

   Emissions samples were drawn from sampling ports located in conformance with USEPA Method 1 at each of the five sampling points. The tip of the probe was located at a sampling point where the flow meets the average velocity criterion required by USEPA Method 18. The samples were collected at a constant rate in adsorption tubes (test sample and duplicate sample) and the flow rate through each of the sample tubes was recorded every 10 minutes in order to determine the total sample volume for each sample.

3. **Process Parameter Measurements:** The finished castings were cleaned and quality checks of the castings were performed. Average mold and core weights were determined from weights of the various materials required to assemble the prescribed test mold configuration. The % LOI, % clays and % compactability of the mold were determined from periodic samples of the mold sand. The % LOI of the cores was determined from representative testing of the cores. Pouring temperatures were also recorded periodically during the testing to determine the average pour temperature. Table 2-1 lists the process parameters that were monitored during each test. The analytical equipment and methods used are also listed.

Table 2-1 Process Parameters Measured

Parameter	Analytical Equipment and Methods
Core Weight	Mettler PJ8000 Digital Scale (Gravimetric)
Mold Weight	Acme 4260 Crane Scale (Gravimetric)
Casting Weight	Westweigh PP2847 Platform Scale (Gravimetric)
Seacoal Weight	Toledo PAC-DPC-606050 balance (Gravimetric)
Resin Weight	Mettler PJ8000 Digital Scale (Gravimetric)
LOI% at mold	Mettler Pb302 Scale (AFS procedure 212-87-S)
Core LOI%	Denver Instruments XE-100 Analytical Scale (AFS procedure 321-87-S)
Clay, % at mold	Dietert 535A MB Clay Tester (AFS Procedure 210-87-S)
Metallurgical Parameters	
Pouring temperature	Electro-Nite DT 260 (T/C immersion pyrometer)
Carbon/Silica	Electro-Nite Datacast 2000 (Thermal Arrest)
Alloy Weights	Mettler PJ8000 (Gravimetric)
Mold Compactability	Dietert 319A Sand Squeezer (AFS procedure 221-87-S)

4. **Air Emissions Analysis:** The specific sampling and analytical methods used in the Production Foundry tests were based on the USEPA reference methods shown in Table 2-2. The details of the specific testing procedures and their variance from the reference methods are included in the "CERP Testing, Quality Control and Quality Assurance, and Data Validation Procedures Manual". Appendix D contains a list of all of the analytes tested for along with their respective detection limits.

Table 2-2 Sampling and Analytical Methods

Measurement Parameter	Test Method
Port location	USEPA Method 1
Number of traverse points	USEPA Method 1
Gas velocity and temperature	USEPA Method 2
Gas density and molecular weight	USEPA Method 3
Gas moisture	USEPA Method 4 (wet bulb/dry bulb version)
HAPs analysis	USEPA Method 18 and TO11*
VOCs analysis	USEPA Method 18 and TO11*

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

5. **Data Reduction, Tabulation and Preliminary Report Preparation:** The analytical results of the emissions tests provide the mass of each analyte in the sample. The total mass of the analyte emitted is calculated by multiplying the mass of analyte in the sample times the ratio of total stack gas volume to sample volume. The total stack gas volume is calculated from the measured stack gas velocity and duct diameter and corrected to dry standard conditions using the measured stack pressure, temperature, gas molecular weight and moisture content. The total mass of analyte is then divided by the weight of metal determined from the average casting weight and the count of mold/core packages processed for the specific emission point and test hour. The results are calculated as pounds of analyte per ton of metal processed. The specific calculation formulas are included in the, "CERP Testing, Quality Control and Quality Assurance, and Data Validation Procedures Manual."

   The results of validated duplicate samples for individual sampling events (one-hour test runs) were averaged to provide the result for each analyte for each of the sampling events. The results for each analyte from the nine sampling events were then averaged to provide the analyte's average emission rate for the entire series. The averaged results of each of the sampling events and the corresponding series averages are included in Section 3 of this report.

6. **Report Preparation and Review:** A Preliminary Draft Report was reviewed by the Emissions Supervisor and the Process Supervisor to ensure its completeness, consistency with the test plans, and adherence to the prescribed QA/QC procedures. Appropriate observations, conclusions and recommendations were added to the report to produce a Draft Report. The Draft Report was reviewed by the Process Supervisor, Research Manager, Operations Manager, Program Manager, Facilities and Process Team Chair, and Emission Team Chair. Comments were incorporated into this Final Report.

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

Detailed QA/QC and data validation procedures for the process parameters and stack measurements, and for the laboratory analytical procedures and data are included in the "CERP Testing, Quality Control and Quality Assurance, and Data Validation Procedures Manual". In order to ensure that timely review of critical quality control parameters were achieved, the following procedures were followed:

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

- The analytical results and corresponding laboratory QA/QC data were reviewed by the Emissions Measurement Team to confirm the validity of the data. The Research Manager and Operations Manager determined whether individual sample data should be invalidated, and any invalidated data were rejected from the database.

3.0 Test Results

The air emission results from the baseline test series, in pounds of analyte per ton of metal poured, are presented in Table 3-1. The results include organic HAP compounds and non-HAP VOCs, which together comprise at least 95% of the mass of the VOCs measured during the baseline test. Table 3-1 presents the results from each of the five sampling points including sand system, pouring, cooling, shakeout, and combined pouring/cooling/shakeout. Appendix A contains tables presenting the results for all analytes measured during each test.

Table 3-2 presents the measured process data. Table 3-3 presents the stack data and calculated flow rates. Table 3-4 presents the average test results including the sum of the HAPs and the sum of the VOCs detected, along with the 95% confidence interval as a percentage of the mean.

Figure 3-1 presents the individual test data for the top six HAPs measured. Figure 3-2 presents the individual HAP average emission data shown in Table 3-4 in graphic form. Figure 3-3 shows the average sum of VOCs, HAPs and POMs from Table 3-4 in graphic form. Figure 3-4 presents individual VOC emission data in graphic form for compounds that have the highest overall presence in the emissions of the baseline test. Figure 3-5 shows the relative percent contribution of VOCs and individual HAPs for each of the sampling points. Figure 3-6 presents a comparison of the combined pouring/cooling/shakeout sampling point with the sum of the individual results from the pouring, cooling and shakeout processes.

Table 3-1a – Production Foundry Individual Test Results –Sand System (lbs/ton metal)

Test Number	AX001	AX002	AX003	AX004	AX005	AX006	AX007	AX008	AX009	Average
Individual Organic HAPs										
Benzene	0.0721	0.0525	0.0583	0.0505	0.0563	0.0694	0.0609	0.0703	0.0631	0.0615
Toluene	0.0358	0.0260	0.0264	0.0239	0.0250	0.0292	0.0345	0.0437	0.0362	0.0312
m,p-Xylene	0.0181	0.0146	0.0178	0.0160	0.0156	0.0188	0.0172	NT	0.0229	0.0176
Naphthalene	0.0188	0.0131	0.0146	0.0148	0.0119	0.0165	0.0160	0.0186	0.0210	0.0161
o-Xylene	0.0084	0.0080	0.0112	0.0100	0.0094	0.0110	0.0071	NT	0.0128	0.0097
Ethyl Benzene	0.0047	0.0058	0.0092	0.0083	0.0075	0.0084	0.0040	NT	0.0098	0.0072
Phenol/3-Ethyltoluene	0.0153	0.0050	ND	ND	ND	0.0105	0.0197	0.0137	ND	0.0071
Styrene	0.0039	0.0056	0.0102	0.0089	0.0083	0.0092	0.0028	0.0033	0.0072	0.0066
Acetaldehyde	0.0041	0.0030	0.0034	0.0028	0.0013	0.0032	0.0035	0.0036	0.0040	0.0032
Hexane	ND	0.0032	0.0033	0.0062	0.0056	0.0064	0.0000	0.0000	0.0043	0.0032
Methyl Ethyl Ketone/Butyraldehyde	0.0017	0.0014	0.0015	0.0012	0.0006	0.0017	0.0014	0.0015	0.0014	0.0014
Formaldehyde	0.0007	0.0004	0.0004	0.0007	0.0002	0.0011	0.0013	0.0007	0.0011	0.0007
Individual Volatile Organic Compounds (non-HAPs)										
2-Methylnaphthalene	0.0162	0.0111	0.0000	0.0127	0.0000	0.0128	0.0102	0.0132	0.0145	0.0101
1-Methylnaphthalene	0.0156	0.0000	0.0000	0.0118	0.0000	0.0120	0.0094	0.0127	0.0126	0.0082
1,2,4-Trimethylbenzene	0.0150	0.0117	0.0135	0.0133	0.0121	0.0156	0.0147	0.0154	0.0154	0.0141
1,3,5-Trimethylbenzene	0.0195	0.0108	0.0099	0.0089	0.0083	0.0101	0.0127	0.0154	0.0127	0.0120
Undecane	0.0085	0.0091	0.0141	0.0135	0.0119	0.0136	0.0063	0.0082	0.0117	0.0108
1,2,3-Trimethylbenzene	0.0095	0.0080	0.0102	0.0095	0.0083	0.0101	0.0076	0.0089	0.0098	0.0091
2-Ethyltoluene	0.0057	0.0060	0.0096	0.0083	0.0078	0.0092	0.0044	0.0048	0.0074	0.0070

Note: The results presented are not suitable for use as general emission factors.
Individual compounds shown in the table constitute >95% of mass of all detected compounds.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
ND: Not detected

Table 3-1b – Production Foundry Individual Test Results – Pouring (lbs/ton metal)

Test Number	AX021	AX022	AX023	AX024	AX025	AX026	AX027	AX028	AX029	Average
Individual Organic HAPs										
Benzene	0.0120	0.0156	0.0117	0.0113	0.0093	0.0129	0.0212	0.0194	0.0195	0.0148
Toluene	0.0012	0.0021	0.0014	0.0014	0.0010	0.0017	NT	0.0021	0.0026	0.0017
Hexane	0.0011	0.0012	0.0010	0.0014	0.0013	0.0011	0.0023	0.0017	0.0019	0.0014
Formaldehyde	0.0004	0.0006	0.0006	0.0004	0.0006	0.0007	NT	0.0007	0.0004	0.0006
m,p-Xylene	0.0002	0.0004	0.0003	0.0003	0.0002	0.0002	0.0011	0.0007	0.0009	0.0005
Naphthalene	ND	ND	ND	ND	ND	ND	0.0013	0.0010	0.0010	0.0004
Acetaldehyde	0.0003	0.0002	0.0002	0.0002	0.0003	0.0002	NT	0.0002	0.0003	0.0002
Ethyl Benzene	ND	0.0001	0.0001	0.0001	ND	0.0001	0.0008	0.0006	0.0007	0.0003
o-Xylene	ND	0.0001	0.0001	0.0001	ND	0.0001	NT	0.0006	0.0007	0.0002
Methyl Ethyl Ketone/Butyraldehydes	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Individual Volatile Organic Compounds (non-HAPs)										
Heptane	0.0011	0.0014	0.0010	0.0012	0.0009	0.0013	0.0022	0.0017	0.0021	0.0014
Octane	ND	ND	ND	0.0006	ND	0.0008	0.0013	0.0009	0.0011	0.0005
1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	0.0001	0.0009	0.0006	0.0007	0.0003
Decane	ND	ND	ND	ND	ND	ND	0.0011	0.0007	0.0009	0.0003
2-Ethyltoluene	0.0001	0.0001	0.0001	ND	ND	ND	0.0009	0.0006	0.0007	0.0003
1,2,3-Trimethylbenzene	ND	ND	ND	ND	ND	0.0001	0.0009	0.0006	0.0007	0.0003
Undecane	ND	ND	ND	ND	ND	ND	NT	0.0009	0.0010	0.0002
1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	0.0008	0.0006	0.0007	0.0002

Note: The results presented are not suitable for use as general emission factors.
Individual compounds shown in the table constitute >95% of mass of all detected compounds.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
ND: Not detected

Table 3-1c – Production Foundry Individual Test Results – Cooling (lbs/ton metal)

Test Number	AX031	AX032	AX033	AX034	AX035	AX036	AX037	AX038	AX039	Average
Individual Organic HAPs										
Benzene	0.0488	0.0343	NT	NT	0.0531	0.0532	0.0544	0.0522	0.0537	0.0500
Toluene	0.0133	0.0086	NT	NT	0.0156	0.0141	0.0119	0.0113	0.0118	0.0124
Hexane	0.0038	0.0028	NT	NT	0.0049	0.0047	0.0055	0.0054	0.0058	0.0047
m,p-Xylene	0.0046	0.0028	NT	NT	0.0055	0.0058	0.0049	0.0041	0.0049	0.0047
Phenol/3-Ethyltoluene	0.0014	0.0015	NT	NT	0.0025	0.0027	0.0020	0.0017	0.0027	0.0021
o-Xylene	0.0014	0.0008	NT	NT	0.0017	0.0017	0.0021	0.0020	0.0023	0.0017
Naphthalene	0.0007	0.0004	NT	NT	0.0007	0.0010	0.0023	0.0024	0.0027	0.0015
Ethyl Benzene	0.0010	0.0006	NT	NT	0.0015	0.0012	0.0018	0.0017	0.0018	0.0014
Styrene	0.0004	0.0003	NT	NT	0.0008	0.0009	0.0019	0.0018	0.0018	0.0011
Formaldehyde	ND	ND	0.0002	0.0001	0.0010	0.0011	0.0011	0.0007	0.0008	0.0006
Acetaldehyde	0.0001	ND	0.0001	0.0002	0.0005	0.0006	0.0007	0.0004	0.0004	0.0003
Methyl Ethyl Ketone/Butyraldehydes	ND	ND	0.0001	0.0001	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002
Individual Volatile Organic Compounds (non-HAPs)										
2-Methylnaphthalene	0.0004	0.0002	NT	NT	0.0004	0.0005	0.0018	0.0021	0.0021	0.0011
1-Methylnaphthalene	ND	ND	NT	NT	0.0002	0.0002	0.0017	0.0020	0.0020	0.0009
Heptane	0.0051	0.0036	NT	NT	0.0067	0.0066	0.0069	0.0054	0.0074	0.0060
Octane	0.0045	0.0032	NT	NT	0.0048	0.0061	0.0044	0.0034	0.0046	0.0044
1,2,4-Trimethylbenzene	0.0014	0.0011	NT	NT	0.0020	0.0024	0.0023	0.0021	0.0024	0.0019
Cyclohexane	0.0012	0.0008	NT	NT	0.0013	0.0013	0.0012	0.0006	0.0012	0.0011
2-Ethyltoluene	0.0003	0.0002	NT	NT	0.0004	0.0004	0.0013	0.0014	0.0017	0.0008
Nonane	0.0014	0.0011	NT	NT	0.0017	0.0021	ND	ND	ND	0.0009
1,2,3-Trimethylbenzene	0.0005	0.0004	NT	NT	0.0006	0.0009	0.0015	0.0020	0.0016	0.0011
Undecane	ND	0.0002	NT	NT	0.0005	0.0006	0.0019	0.0022	0.0021	0.0011
1,3,5-Trimethylbenzene	0.0007	0.0004	NT	NT	0.0007	0.0009	0.0016	0.0016	0.0017	0.0011
Decane	ND	0.0008	NT	NT	0.0011	0.0014	0.0016	0.0019	0.0016	0.0012

Note: The results presented are not suitable for use as general emission factors.
Individual compounds shown in the table constitute >95% of mass of all detected compounds.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
ND: Not detected

Table 3-1d – Production Foundry Individual Test Results – Shakeout (lbs/ton metal)

Test Number	AX041	AX042	AX043	AX044	AX045	AX046	AX047	AX048	AX049	Average
Individual Organic HAPs										
Benzene	0.1129	0.1088	0.1087	0.1397	0.1775	0.1863	0.1670	0.1551	0.1400	0.1440
Toluene	0.0405	0.0438	0.0425	0.0573	0.0726	0.0791	0.0570	0.0486	0.0457	0.0541
Phenol/3-Ethyltoluene	0.0367	0.0535	0.0567	0.0867	0.0812	0.1149	0.0874	0.0446	0.0507	0.0680
m,p-Xylene	0.0205	0.0203	0.0201	0.0268	0.0303	0.0359	0.0267	0.0191	0.0205	0.0245
Naphthalene	0.0178	0.0199	0.0278	0.0372	0.0331	0.0442	0.0367	0.0245	0.0314	0.0303
o-Xylene	0.0073	0.0075	0.0074	0.0099	0.0103	0.0122	0.0105	0.0091	0.0095	0.0093
o-Cresol/Indan	0.0085	0.0115	0.0154	0.0201	0.0168	0.0228	0.0173	0.0080	0.0064	0.0141
Ethyl Benzene	0.0041	0.0043	0.0040	0.0056	0.0062	0.0073	0.0078	0.0070	0.0072	0.0059
Hexane	0.0038	0.0045	0.0100	0.0045	0.0051	0.0052	0.0056	0.0056	0.0103	0.0061
Acetaldehyde	NT	0.0042	0.0041	0.0049	0.0051	0.0048	0.0052	0.0039	0.0044	0.0046
Styrene	0.0022	0.0022	0.0023	0.0034	0.0035	0.0038	0.0065	0.0061	0.0067	0.0041
m,p-Cresol/Butylbenzene	ND	0.0021	0.0032	0.0046	0.0111	0.0147	0.0021	ND	ND	0.0042
Methyl Ethyl Ketone/Butyraldehydes	0.0002	0.0024	0.0021	0.0024	0.0024	0.0024	0.0025	0.0025	0.0026	0.0022
Formaldehyde	0.0001	0.0009	0.0013	0.0017	0.0010	0.0015	0.0019	0.0007	0.0008	0.0011
Individual Volatile Organic Compounds (non-HAPs)										
2-Methylnaphthalene	0.0114	0.0133	0.0190	0.0257	0.0273	0.0343	0.0222	0.0167	0.0202	0.0211
1-Methylnaphthalene	0.0059	0.0065	0.0095	0.0127	0.0116	0.0142	0.0141	0.0115	0.0138	0.0111
1,2,4-Trimethylbenzene	0.0126	0.0128	0.0140	0.0187	0.0230	0.0250	0.0163	0.0115	0.0128	0.0163
Octane	0.0074	0.0082	0.0075	0.0098	0.0127	0.0138	0.0087	0.0072	0.0078	0.0092
Undecane	0.0066	0.0075	0.0085	0.0108	0.0081	0.0095	0.0131	0.0126	0.0138	0.0101
Heptane	0.0057	0.0065	0.0060	0.0077	0.0085	0.0091	0.0085	0.0078	0.0077	0.0075
Decane	0.0060	0.0071	0.0075	0.0080	0.0079	0.0085	0.0078	0.0093	0.0091	0.0079
1,2,3-Trimethylbenzene	0.0047	0.0050	0.0054	0.0071	0.0092	0.0109	0.0083	0.0068	0.0078	0.0073
1,3,5-Trimethylbenzene	0.0041	0.0041	0.0043	0.0059	0.0068	0.0069	0.0079	0.0068	0.0072	0.0060
Dodecane	ND	0.0042	0.0054	0.0069	0.0084	0.0100	0.0072	0.0065	0.0076	0.0063
Nonane	ND	0.0041	0.0040	0.0052	0.0074	0.0079	0.0036	0.0027	0.0000	0.0039
2-Ethyltoluene	0.0035	0.0035	0.0036	0.0051	0.0045	0.0059	0.0063	0.0059	0.0063	0.0050

Note: The results presented are not suitable for use as general emission factors.
Individual compounds shown in the table constitute >95% of mass of all detected compounds.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
ND: Not detected

Table 3-1e – Production Foundry Individual Test Results – Pouring, Cooling, Shakeout Combined Stack (lbs/ton metal)

Test Number	AX011	AX012	AX013	AX014	AX015	AX016	AX017	AX018	AX019	Average
Individual Organic HAPs										
Benzene	0.2298	0.3143	0.1683	0.1936	0.1758	0.2300	0.2425	0.2300	0.2454	0.2255
Toluene	0.0698	0.0972	0.0585	0.0667	0.0619	0.0664	0.0679	0.0767	0.0783	0.0715
Naphthalene	0.0316	0.0436	0.0348	0.0222	0.0238	0.0391	0.0417	0.0397	0.0519	0.0365
Phenol/3-Ethyltoluene	0.0234	0.0697	0.0708	0.0430	0.0574	0.0745	0.0569	0.0214	0.0818	0.0554
m,p-Xylene	0.0349	0.0457	0.0265	0.0307	0.0263	0.0266	0.0289	0.0369	0.0363	0.0325
o-Xylene	0.0186	0.0162	0.0097	0.0106	0.0090	0.0097	0.0141	0.0183	0.0178	0.0138
o-Cresol/Indan	ND	0.0150	0.0163	0.0067	0.0113	0.0156	0.0081	0.0129	0.0169	0.0114
Hexane	0.0190	0.0107	0.0073	0.0084	0.0089	0.0066	0.0123	0.0172	0.0174	0.0120
Ethyl Benzene	0.0150	0.0097	0.0055	0.0062	0.0054	0.0057	0.0120	0.0142	0.0135	0.0097
Styrene	0.0146	0.0057	0.0033	0.0018	0.0036	0.0042	0.0117	0.0131	0.0132	0.0079
Acetaldehyde	0.0045	0.0051	0.0049	0.0048	0.0049	0.0065	0.0062	0.0044	0.0044	0.0051
Formaldehyde	0.0009	0.0011	0.0015	0.0021	0.0011	0.0025	0.0024	0.0026	0.0017	0.0018
Methyl Ethyl Ketone/Butyraldehydes	0.0027	0.0032	0.0025	0.0025	0.0026	0.0038	0.0029	0.0028	0.0025	0.0028
Individual Volatile Organic Compounds (non-HAPs)										
2-Methylnaphthalene	0.0240	0.0348	0.0240	0.0079	0.0150	0.0268	0.0294	0.0287	0.0366	0.0253
1-Methylnaphthalene	0.0202	0.0213	0.0116	0.0045	0.0074	0.0131	0.0206	0.0214	0.0249	0.0161
1,2,4-Trimethylbenzene	0.0234	0.0305	0.0168	0.0187	0.0161	0.0198	0.0197	0.0234	0.0242	0.0214
Octane	0.0164	0.0227	0.0128	0.0153	0.0289	0.0150	0.0127	0.0172	0.0173	0.0176
Heptane	0.0190	0.0181	0.0127	0.0139	0.0122	0.0131	0.0149	0.0193	0.0193	0.0158
Undecane	0.0215	0.0120	0.0100	0.0094	0.0085	0.0136	0.0198	0.0209	0.0224	0.0153
Decane	0.0128	0.0087	0.0104	0.0122	0.0099	0.0172	0.0141	0.0125	0.0122	0.0122
1,3,5-Trimethylbenzene	0.0155	0.0204	0.0052	0.0062	0.0053	0.0063	0.0120	0.0146	0.0146	0.0111
1,2,3-Trimethylbenzene	0.0159	0.0136	0.0061	0.0063	0.0054	0.0067	0.0120	0.0135	0.0142	0.0104
2-Ethyltoluene	0.0141	0.0087	0.0052	0.0069	0.0047	0.0064	0.0120	0.0135	0.0135	0.0095
Dodecane	ND	ND	ND	ND	ND	0.0108	0.0114	0.0125	0.0132	0.0053
Tridecane	ND	ND	ND	ND	ND	ND	0.0097	0.0103	0.0116	0.0035

Note: The results presented are not suitable for use as general emission factors.
Individual compounds shown in the table constitute >95% of mass of all detected compounds.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
ND: Not detected

Table 3-2 Production Foundry Baseline Test Process Data

Average Casting Weight, lbs./mold	**151.74**
Average Mold Sand Weight lbs./mold	**1261**
Average Core Sand Weight, lbs./mold	**55.21**
Average Resin Weight, lbs./mold	**0.947**

Process Parameter	# of Samples	Minimum	Maximum	Average	Std Dev.
Compactability, %	38	24	50	**36.8**	4.9
LOI, % (at mold)	38	4.63	6.07	**5.3**	0.28
Clays, % (at mold)	38	5.72	6.91	**6.22**	0.30
Core LOI, %	4	1.55	1.60	**1.57**	0.02
Pouring Temperature, ^{o}F	27	2566	2662	**2622**	23.4

Mold Count

Test Number	AX001	AX002	AX003	AX004	AX005	AX006	AX007	AX008	AX009	Series
Pour Date	2/16/99	2/16/99	2/16/99	2/16/99	2/17/99	2/17/99	2/17/99	2/18/99	2/18/99	Average
Number of Molds at Sand System	23	37	35	39	38	35	40	29	30	34.0
Number of Molds at Pouring	25	25	36	35	38	42	26	38	31	32.9
Number of Molds at Cooling	24	36	37	31	39	39	38	32	32	34.2
Number of Molds at Shakeout	23	37	36	37	38	40	40	34	31	35.1
Number of Molds at Combined Pouring/Cooling/Shakeout	26	35	35	22	39	28	37	31	32	31.7

Table 3-3 - Production Foundry Baseline Stack Data and Calculated Flow Rates

	Test Run Number	1	2	3	4	5	6	7	8	9	Average
Sand System	Average Stack Temperature, ºF	70.2	70.0	74.8	76.6	75.0	80.0	81.0	76.1	76.0	75.5
	Total Moisture Content, %	1.20%	1.10%	1.00%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
	Avg. Stack Pressure, in. Hg Abs.	29.77	29.85	29.77	29.70	29.73	29.73	29.75	29.73	29.75	29.75
	Average Stack Velocity, ft./sec.	49.0	50.3	53.9	54.0	50.8	51.1	51.1	49.3	49.3	51.0
	Stack Flow Rate, scfm	36157	37260	39503	39358	37180	37008	36983	35965	35975	37265
Pouring	Average Stack Temperature, ºF	73.0	73.0	73.0	77.5	77.5	82.0	84.0	85.0	79.5	78.3
	Total Moisture Content, %	1.20%	1.10%	1.00%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
	Avg. Stack Pressure, in. Hg Abs.	29.92	29.92	29.92	29.82	29.81	29.81	29.82	29.82	29.76	29.84
	Average Stack Velocity, ft./sec.	71.3	72.6	72.6	72.0	72.0	71.4	71.6	71.3	70.9	71.7
	Stack Flow Rate, scfm	3290	3354	3357	3283	3283	3228	3230	3210	3215	3272
Cooling	Average Stack Temperature, ºF	65.0	67.0	70.0	73.0	73.3	76.5	77.0	73.6	75.0	72.3
	Total Moisture Content, %	1.20%	1.10%	1.00%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
	Avg. Stack Pressure, in. Hg Abs.	29.63	29.63	29.64	29.64	29.57	29.57	29.57	29.54	29.54	29.59
	Average Stack Velocity, ft./sec.	49.7	50.2	49.1	53.2	59.7	58.5	57.1	54.0	54.1	54.0
	Stack Flow Rate, scfm	5181	5217	5083	5470	6124	5965	5819	5534	5528	5547
Shakeout	Average Stack Temperature, ºF	80.0	84.7	87.0	89.0	84.8	94.1	88.2	79.9	87.0	86.1
	Total Moisture Content, %	1.20%	1.10%	1.00%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
	Avg. Stack Pressure, in. Hg Abs.	29.55	29.55	29.55	29.49	29.48	29.48	29.54	29.40	29.40	29.49
	Average Stack Velocity, ft./sec.	48.8	51.1	53.1	62.7	61.5	62.3	62.6	62.9	63.6	58.7
	Stack Flow Rate, scfm	14638	15203	15774	18477	18266	18193	18507	18802	18757	17402
PCS Combine	Average Stack Temperature, ºF	72.0	76.0	76.1	76.2	78.5	83.0	84.0	77.2	78.0	77.9
	Total Moisture Content, %	1.20%	1.10%	1.00%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
	Avg. Stack Pressure, in. Hg Abs.	29.48	29.48	29.48	29.48	29.41	29.41	29.41	29.41	29.41	29.44

	Average Stack Velocity, ft./sec.	56.9	57.1	59.9	59.9	57.3	57.6	57.6	57.3	57.3	57.9
	Stack Flow Rate, scfm	41474	41353	43403	43363	41208	41036	40999	41257	41227	41702

Table 3-4 –Production Foundry Baseline Test - Average Emission Results, Pounds per Ton of Metal

	Sand System		Pouring		Cooling		Shakeout		Pouring/Cooling/Shakeout Combined	
Analytes	Average	(95% C. I./Mean) [a]	Average	(95% C. I./Mean) [a]	Average	(95% C. I./Mean) [a]	Average	(95% C. I./Mean) [a]	Average	(95% C. I./Mean) [a]
Sum of VOCs[b]	0.2388	8.7%	0.0239	25.2%	0.1021	30.6%	0.5187	16.5%	0.6768	13.48%
Sum of HAPs[c]	0.1850	10.0%	0.0204	20.1%	0.0825	30.4%	0.4133	16.4%	0.5477	13.35%
Sum of POM[d]	0.0344	27.1%	0.0004	99.7%	0.0034	55.4%	0.0705	20.1%	0.0960	27.77%
Individual HAP Compounds										
Benzene	0.0615	8.3%	0.0148	19.0%	0.0500	10.6%	0.1440	13.5%	0.2255	12.7%
Toluene	0.0312	14.0%	0.0017	21.5%	0.0124	13.4%	0.0541	16.6%	0.0715	10.5%
Phenol/3-Ethyltoluene	0.0071	71.4%	ND		0.0021	20.7%	0.0680	24.6%	0.0554	25.8%
Naphthalene	0.0161	11.8%	0.0004	99.7%	0.0015	49.2%	0.0303	18.6%	0.0365	17.0%
m,p-Xylene	0.0176	10.1%	0.0005	47.5%	0.0047	15.7%	0.0245	15.6%	0.0325	13.1%
o-Xylene	0.0097	13.4%	0.0002	96.2%	0.0017	21.6%	0.0093	11.7%	0.0138	19.2%
Hexane	0.0032	54.1%	0.0014	19.5%	0.0047	16.8%	0.0061	25.8%	0.0120	25.9%
o-Cresol/Indan	ND		ND		ND		0.0141	26.8%	0.0114	32.0%
Ethyl Benzene	0.0072	20.7%	0.0003	79.0%	0.0014	24.3%	0.0059	16.3%	0.0097	27.6%
Styrene	0.0066	27.5%	0.0002	129.0%	0.0011	44.0%	0.0041	29.5%	0.0079	42.2%
Acetaldehyde	0.0032	17.0%	0.0002	8.4%	0.0003	45.3%	0.0046	7.4%	0.0051	9.9%
2-Methylnaphthalene	0.0101	38.8%	0.0000		0.0011	62.9%	0.0211	22.2%	0.0253	23.5%
1-Methylnaphthalene	0.0082	50.5%	0.0000		0.0009	83.0%	0.0111	18.7%	0.0161	29.1%
Individual VOC Compounds										
1,2,4-Trimethylbenzene	0.0141	6.8%	0.0003	92.4%	0.0019	20.5%	0.0163	19.6%	0.0214	13.7%
Octane	ND		0.0005	66.5%	0.0044	16.1%	0.0092	17.1%	0.0176	19.2%
Heptane	ND		0.0014	21.9%	0.0060	16.4%	0.0075	10.4%	0.0158	12.6%
Undecane	0.0108	17.0%	0.0002	128.8%	0.0011	65.9%	0.0101	17.2%	0.0153	24.4%
Decane	ND		0.0003	100.8%	0.0012	39.0%	0.0079	8.5%	0.0122	13.3%
1,3,5-Trimethylbenzene	0.0120	19.3%	0.0002	99.7%	0.0011	35.6%	0.0060	15.8%	0.0111	32.6%
1,2,3-Trimethylbenzene	0.0091	6.8%	0.0003	95.9%	0.0011	43.4%	0.0073	18.5%	0.0104	26.4%
2-Ethyltoluene	0.0070	17.5%	0.0003	84.0%	0.0008	57.4%	0.0050	16.0%	0.0095	26.6%
Dodecane	ND		ND		ND		0.0063	30.0%	0.0053	77.9%
Tridecane	ND		ND		ND		0.0027	55.6%	0.0035	98.4%

Note: The results presented are not suitable for use as general emission factors.

[a] The 95% Confidence Interval divided by the mean, expressed as a percentage.

[b] Sum of all VOCs detected.

[c] Sum of all HAPs detected.

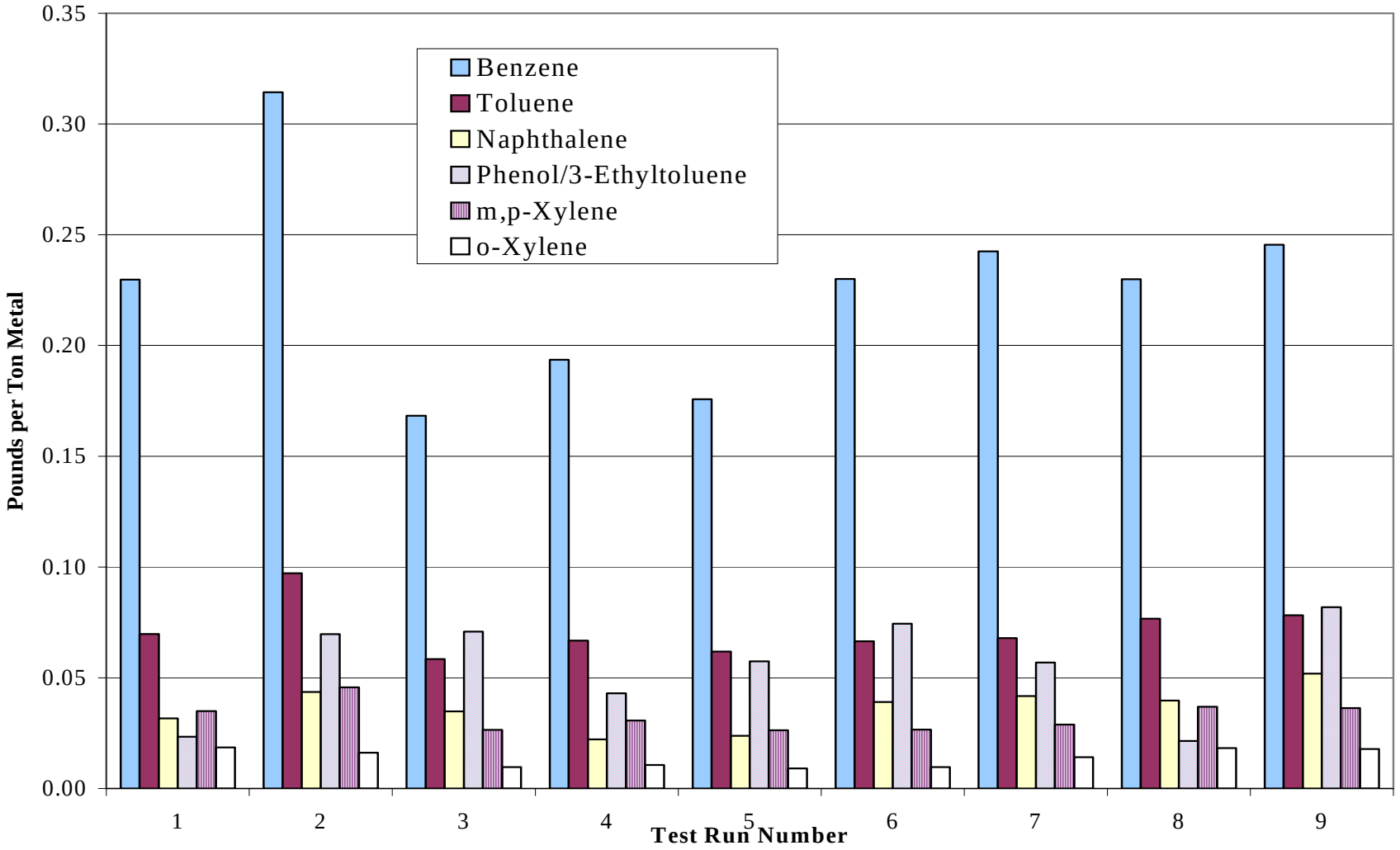
[d] POM: Polycyclic Organic Matter which includes Naphthalene and other compounds, which contain more than one benzene ring and which have a boiling point greater than or equal to 100 ^{o}C.

NT: Analyte was either not tested or the result was rejected based on data validation considerations.

ND: Non detected.

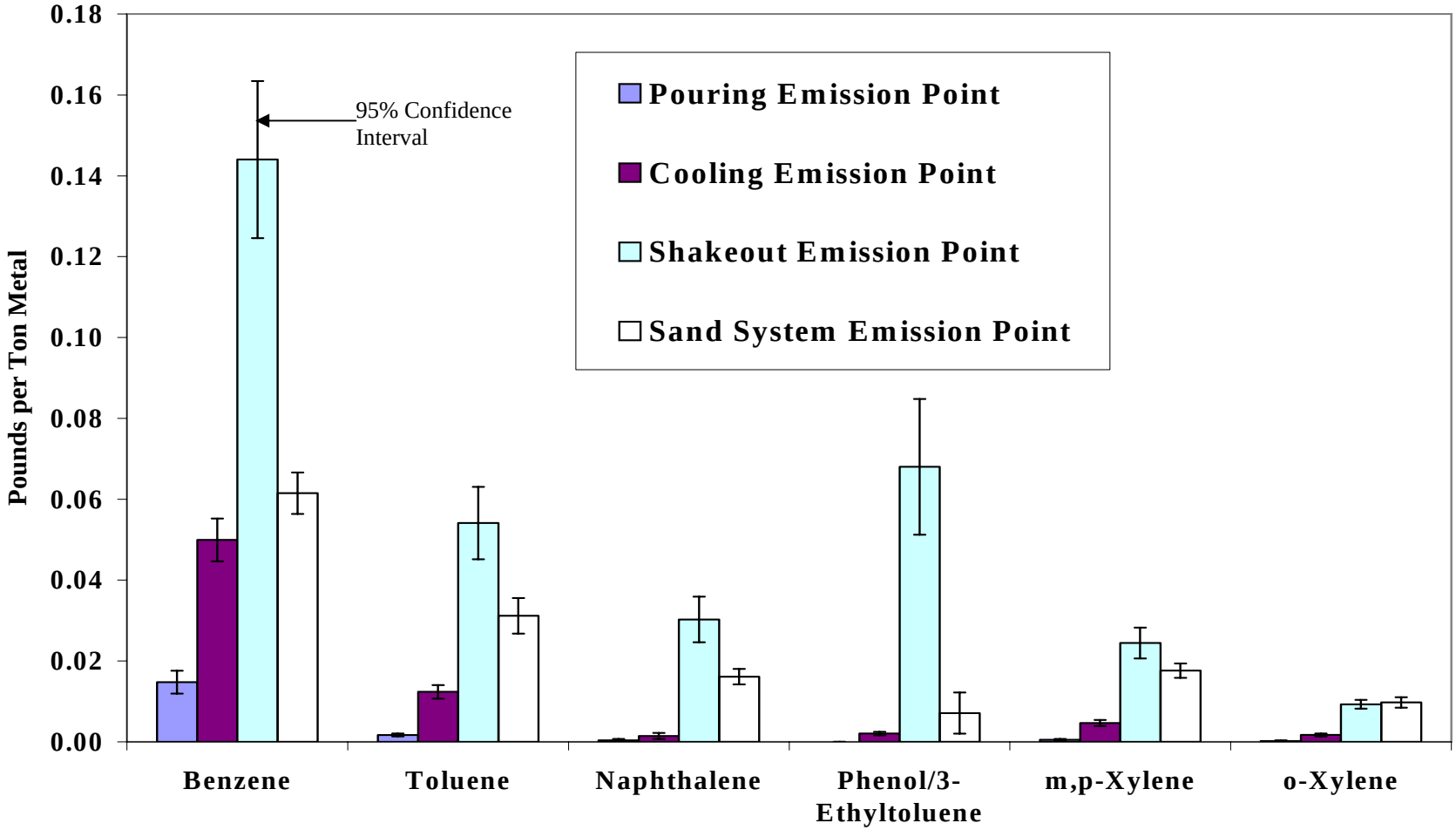
Individual compounds shown in table constitute >95% of mass of all detected compounds.

Figure 3-1
Production Foundry Baseline Test - Individual HAP Emissions Results for Pouring/Cooling/Shakeout Combined Stack



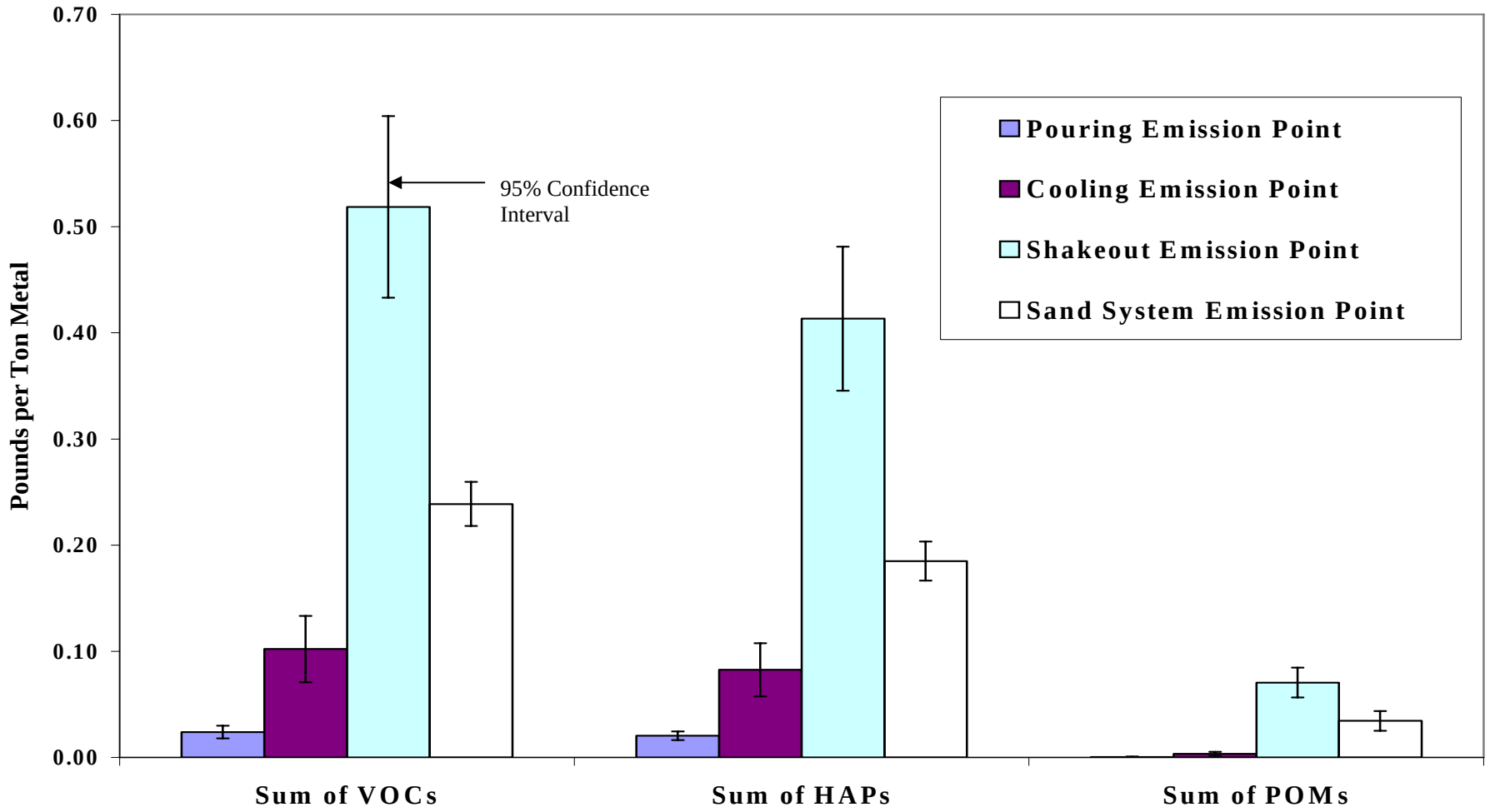
Note: The results presented are not suitable for use as general emission factors.

Figure 3-2
Production Foundry Baseline Test Average Individual HAP Results



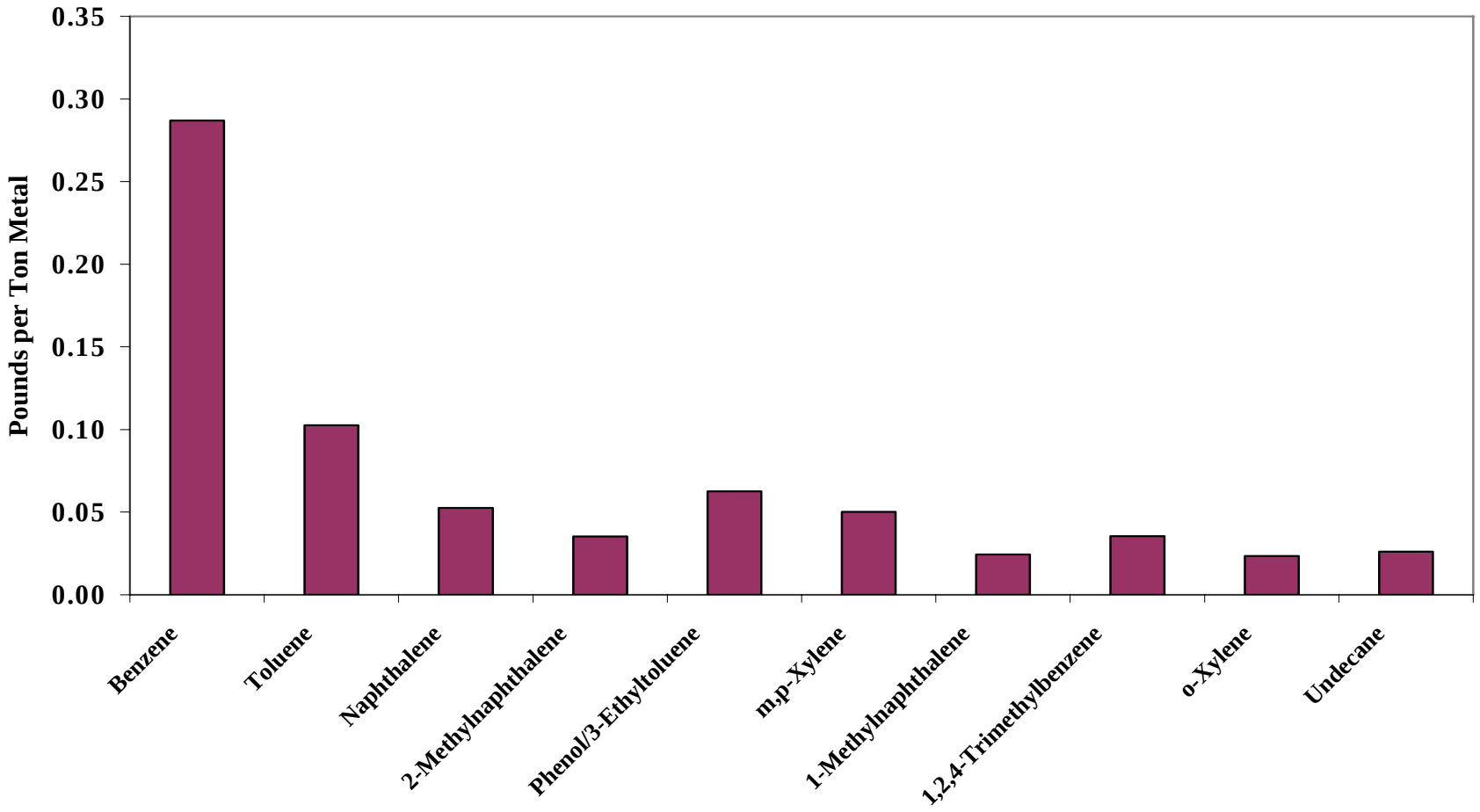
Note: The results presented are not suitable for use as general emission factors. The distribution shown is only appropriate for the CERP Cope and Drag Line with the Push-up Push-off style shakeout.

Figure 3-3
Production Foundry Baseline Test Average Total VOC, HAP and POM Emission Results



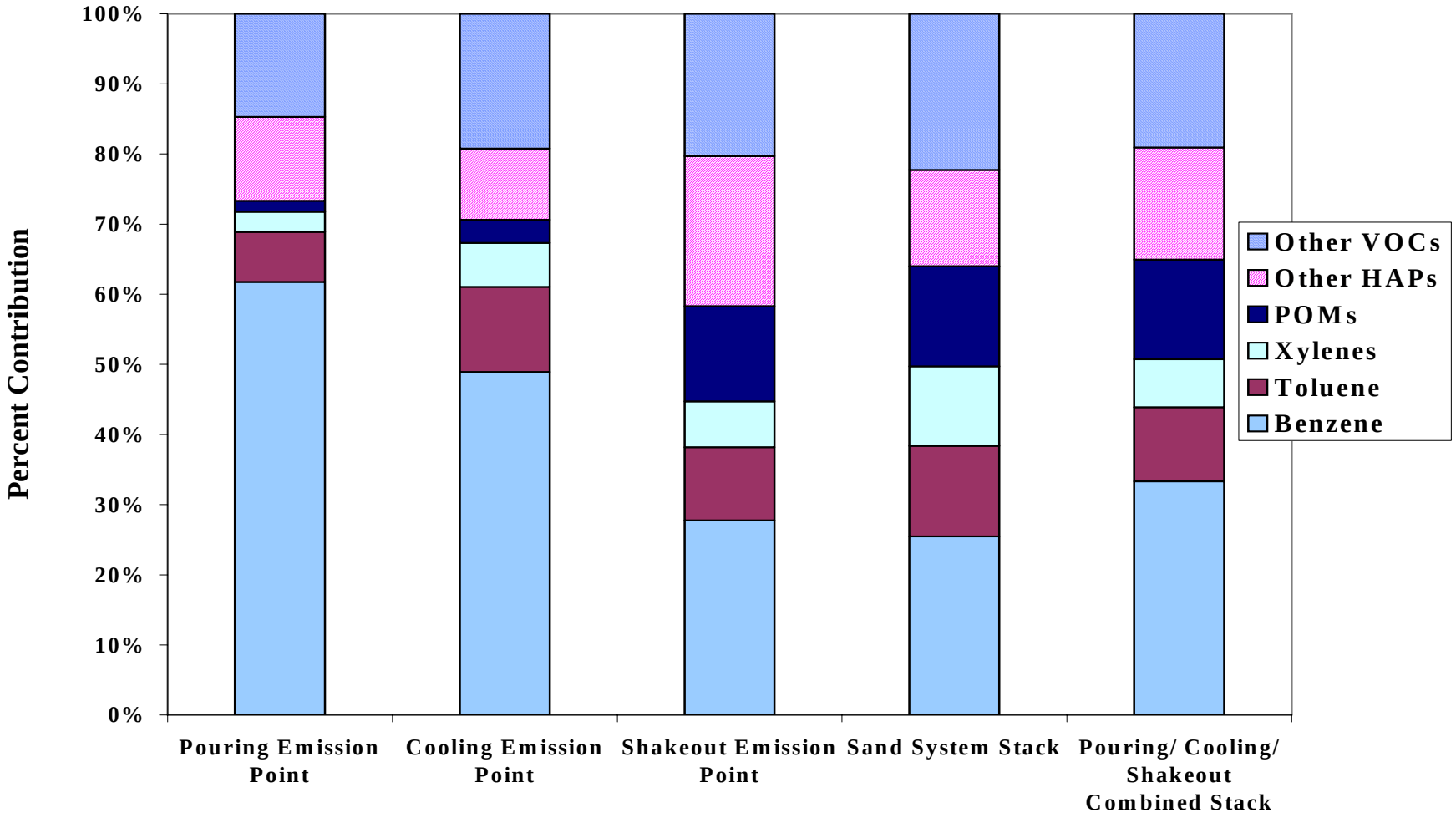
Note: The results presented are not suitable for use as general emission factors. The distribution shown is only appropriate for the CERP Cope and Drag Line with the Push-up Push-off style shakeout.

Figure 3-4
Production Foundry Baseline - Average VOC Results for Pouring/Cooling/Shakeout Combined Stack Plus Sand System Stack



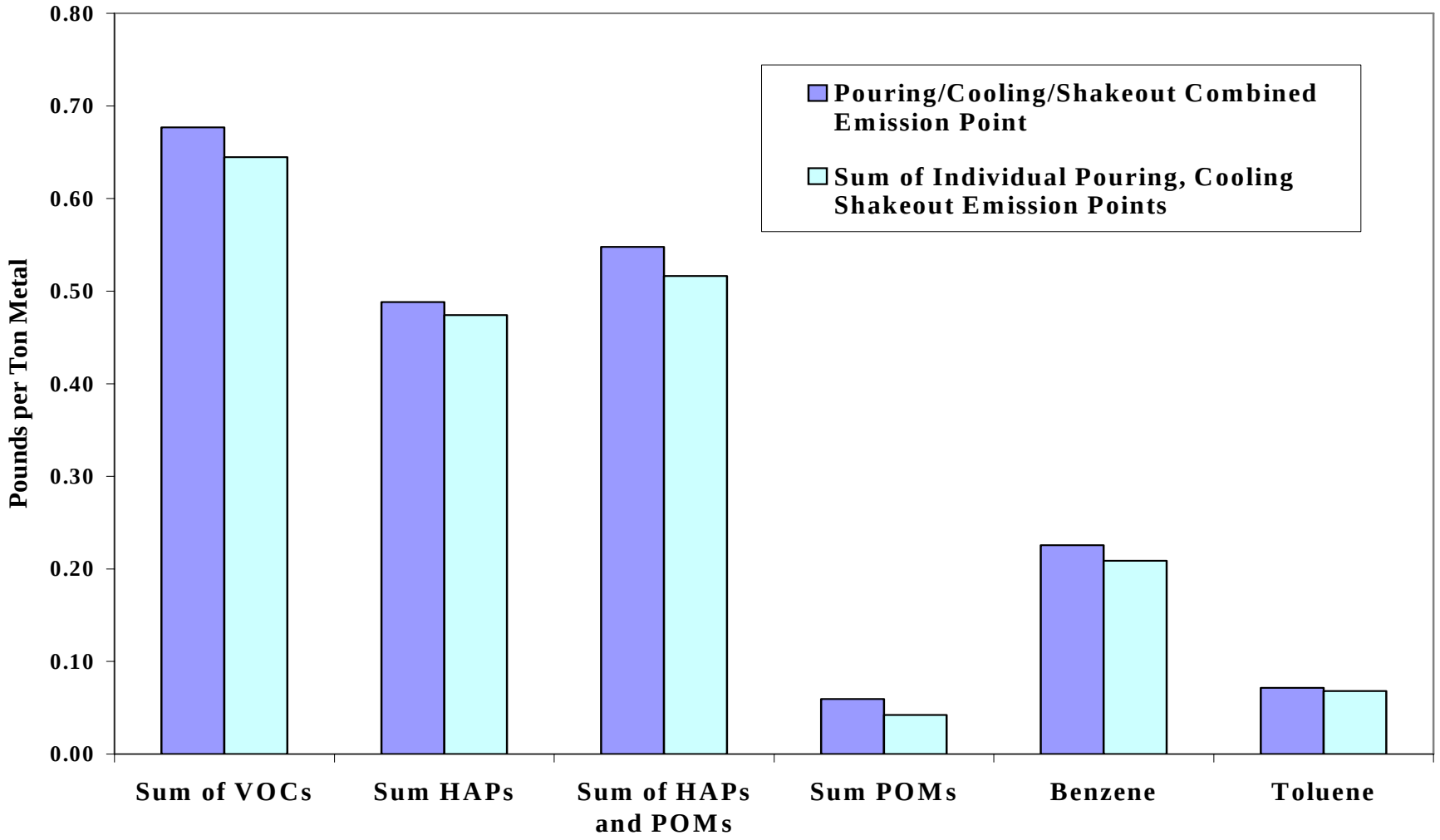
Note: The results presented are not suitable for use as general emission factors.

Figure 3-5
Production Foundry Baseline - Relative Percent Contribution of HAPs and VOCs



Note: The results presented are not suitable for use as general emission factors.

Figure 3-6 – Comparison of the Combined Pouring/Cooling/Skakeout Emission Point with the Sum of Individual Pouring, Cooling and Shakeout Emission Points



Note: The results presented are not suitable for use as general emission factors.

4.0 Discussion of Results and Conclusions

Ten of the measured HAP compounds (Benzene, Toluene, Naphthalene, Phenol/3- Ethyltoluene, m,p-Xylene, o-Xylene, Hexane, 2-Methylnaphthalene, 1-Methylnaphthalene and o-Cresol/Indan) comprise 90% of the mass of all HAPs measured at the Pouring/Cooling/Shakeout combined stack. As it can be seen in Figure 3-1, the relative magnitude of the individual HAP compounds was generally consistent between each of the individual nine tests with benzene being the largest single HAP and VOC measured. Figure 3-2 shows that the single largest contribution of HAPs comes from the shakeout process (59%) followed by the sand system (26%), pouring (3%) and cooling (12%) processes. This distribution of emissions is only appropriate for the specific type of system tested (i.e. a cope and drag line with a push-off push-up style shakeout).

One of the test design objectives was to have the 90% confidence interval for the test series within 20% of the mean of the test series, such that the comparative evaluations against tests of alternative materials, equipment or processes would allow for a determination of whether the alternative material, equipment or process resulted in a 50% reduction in HAP emissions. The statistical evaluation of the data shown in Table 3-4 shows that the 95% confidence interval is within 20% of the mean for the sum of HAPs and VOCs, and for the principle individual HAP compounds at the sand system, shakeout and combined pouring/cooling/shakeout emission points. This result exceeds the original design goal. Higher relative variability was seen at the pouring and cooling emission points, which is expected due to the relatively lower measured emissions. Several of the individual analytes did show higher variability, and this is also reflected in the degree of variability for the sum of HAPs and VOCs. It will be important to conduct statistical evaluations of the comparison of the baseline test with alternative materials, equipment or processes to ensure that differences in measured values are statistically significant. In particular, test results for the POMs showed greater variability than the other individual HAPs measured.

Several observations can be made regarding the measured operating parameters and the emissions results of the Production Foundry baseline test. The measured test parameters showed that the tests were run within prescribed ranges and maintained constant throughout the test series. The sum of the individual flows for pouring, cooling and shakeout do not total the measured flow at the combined stack. This is due to additional dilution airflow from the casting cooling area, which was an empty cooling lane. This dilution air could include small amounts of pollutants and could account for small differences when comparing the sum of the emissions from the individual stacks with the combined stack as seen in Figure 3-6.

This baseline test demonstrated good consistency of the process variables, good consistency of emissions results at individual sampling points, and good agreement between the sum of the results for the individual pouring, cooling and shakeout emission point and the combined pouring/cooling/ shakeout sampling point (see Figure 3-6). The results of this baseline are, therefore, suitable for use in future comparisons with alternative materials, equipment and processes designed to reduce HAP emissions.

Appendix A

Emission Test Results

Production Foundry Baseline Test
February 16-18, 1999

(AX Test Series)

PRODUCTION FOUNDRY BASELINE TEST SERIES– SAND SYSTEM, EMISSION POINT 1
INDIVIDUAL TEST TESULTS, LBS/TON METAL

Analyte	AX001	AX002	AX003	AX004	AX005	AX006	AX007	AX008	AX009	Average
Hexane	0.00E+00	3.19E-03	3.28E-03	6.20E-03	5.63E-03	6.36E-03	0.00E+00	0.00E+00	4.33E-03	3.22E-03
Benzene	7.21E-02	5.25E-02	5.83E-02	5.05E-02	5.63E-02	6.94E-02	6.09E-02	7.03E-02	6.31E-02	6.15E-02
Toluene	3.58E-02	2.60E-02	2.64E-02	2.39E-02	2.50E-02	2.92E-02	3.45E-02	4.37E-02	3.62E-02	3.12E-02
Ethyl Benzene	4.67E-03	5.83E-03	9.22E-03	8.27E-03	7.51E-03	8.38E-03	3.96E-03	1.77E-02	9.81E-03	8.37E-03
m,p-Xylene	1.81E-02	1.46E-02	1.78E-02	1.60E-02	1.56E-02	1.88E-02	1.72E-02	NT	2.29E-02	1.76E-02
Styrene	3.86E-03	5.64E-03	1.02E-02	8.86E-03	8.32E-03	9.25E-03	2.79E-03	3.34E-03	7.21E-03	6.61E-03
o-Xylene	8.39E-03	8.03E-03	1.12E-02	1.00E-02	9.39E-03	1.10E-02	7.10E-03	2.31E-02	1.28E-02	1.12E-02
1,3,5-Trimethylbenzene	1.95E-02	1.08E-02	9.88E-03	8.86E-03	8.32E-03	1.01E-02	1.27E-02	1.54E-02	1.27E-02	1.20E-02
2-Ethyltoluene	5.67E-03	6.03E-03	9.55E-03	8.27E-03	7.78E-03	9.25E-03	4.36E-03	4.85E-03	7.37E-03	7.01E-03
1,2,4-Trimethylbenzene	1.50E-02	1.17E-02	1.35E-02	1.33E-02	1.21E-02	1.56E-02	1.47E-02	1.54E-02	1.54E-02	1.41E-02
1,2,3-Trimethylbenzene	9.48E-03	8.02E-03	1.02E-02	9.46E-03	8.32E-03	1.01E-02	7.61E-03	8.87E-03	9.81E-03	9.10E-03
Undecane	8.50E-03	9.12E-03	1.41E-02	1.35E-02	1.19E-02	1.36E-02	6.31E-03	8.25E-03	1.17E-02	1.08E-02
Naphthalene	1.88E-02	1.31E-02	1.46E-02	1.48E-02	1.19E-02	1.65E-02	1.60E-02	1.86E-02	2.10E-02	1.61E-02
2-Methylnaphthalene	1.62E-02	1.11E-02	0.00E+00	1.27E-02	0.00E+00	1.28E-02	1.02E-02	1.32E-02	1.45E-02	1.01E-02
1-Methylnaphthalene	1.56E-02	0.00E+00	0.00E+00	1.18E-02	0.00E+00	1.20E-02	9.43E-03	1.27E-02	1.26E-02	8.24E-03
1,3-Dimethylnaphthalene	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	0.00E+00
Cyclohexane	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	0.00E+00
Heptane	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	0.00E+00
Octane	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	0.00E+00
Nonane	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	0.00E+00
Cumene	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	0.00E+00
Phenol/3-Ethyltoluene	1.53E-02	5.01E-03	0.00E+00	0.00E+00	0.00E+00	1.05E-02	1.97E-02	1.37E-02	0.00E+00	7.13E-03
4-Ethyltoluene	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	0.00E+00
Propylbenzene	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	0.00E+00
Isobutylbenzene	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	0.00E+00
Decane	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	0.00E+00
p-Cymene	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	0.00E+00
o-Cresol/Indan	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	0.00E+00
m,p-Cresol/Butylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-03	0.00E+00	0.00E+00	6.85E-04
1,4-Diethylbenzene	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	0.00E+00
1,3-Diethylbenzene	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	0.00E+00
Indene	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	0.00E+00
1,2-Diethylbenzene	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	0.00E+00
2,6-Dimethylphenol	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – SAND SYSTEM, EMISSION POINT 1
INDIVIDUAL TEST TESULTS, LBS/TON METAL (Continued)

Analyte	AX001	AX002	AX003	AX004	AX005	AX006	AX007	AX008	AX009	Average
2,4-Dimethylphenol	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	0.00E+00
3,5-Dimethylphenol	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	0.00E+00
1,3-Diisopropylbenzene	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	0.00E+00
2,3-Dimethylphenol	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	0.00E+00
3,4-Dimethylphenol	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	0.00E+00
2,4,6-Trimethylphenol	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	0.00E+00
Dodecane	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	0.00E+00
2,3,5-Trimethylphenol	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	0.00E+00
Tridecane	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	0.00E+00
Tetradecane	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	0.00E+00
Biphenyl	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	0.00E+00
2,7-Dimethylnaphthalene	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	0.00E+00
2,6-Dimethylnaphthalene	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	0.00E+00
2,3-Dimethylnaphthalene	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	0.00E+00
1,5-Dimethylnaphthalene	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	0.00E+00
1,6-Dimethylnaphthalene	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	0.00E+00
Acenaphthylene	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	0.00E+00
1,2-Dimethylnaphthalene	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	0.00E+00
1,8-Dimethylnaphthalene	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	0.00E+00
2,3,5-Trimethylnaphthalene	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	0.00E+00
THC ref. to Undecane (MW=156)	2.00E-01	1.83E-01	1.88E-01	1.83E-01	1.88E-01	2.51E-01	2.28E-01	2.94E-01	2.68E-01	2.20E-01
Formaldehyde	7.21E-04	3.98E-04	3.55E-04	7.32E-04	2.49E-04	1.06E-03	1.28E-03	7.29E-04	1.07E-03	7.32E-04
Acetaldehyde	4.12E-03	2.98E-03	3.36E-03	2.83E-03	1.28E-03	3.25E-03	3.50E-03	3.64E-03	3.96E-03	3.21E-03
Acrolein	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	0.00E+00
Acetone	4.90E-03	3.81E-03	4.11E-03	3.66E-03	2.00E-03	4.44E-03	3.96E-03	4.45E-03	4.16E-03	3.94E-03
Propanal	3.87E-04	3.65E-04	3.92E-04	3.49E-04	1.60E-04	NT	3.20E-04	3.64E-04	3.76E-04	3.39E-04
Crotonaldehyde	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	0.00E+00
Methacrolein	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methyl Ethyl Ketone/Butyraldehydes	1.67E-03	1.41E-03	1.49E-03	1.20E-03	6.09E-04	1.66E-03	1.36E-03	1.54E-03	1.43E-03	1.37E-03
Benzaldehyde	4.90E-04	0.00E+00	8.22E-04	0.00E+00	3.13E-04	1.09E-03	6.09E-04	5.26E-04	0.00E+00	4.28E-04
Pentanal	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	0.00E+00
m,p-Tolualdehyde	0.00E+00	0.00E+00	5.79E-04	0.00E+00	0.00E+00	6.32E-04	4.26E-04	0.00E+00	0.00E+00	1.82E-04
4-Methyl-2-pentanone	0.00E+00	0.00E+00	5.23E-04	0.00E+00	0.00E+00	4.61E-04	4.64E-04	0.00E+00	0.00E+00	1.61E-04
Hexanal	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – POURING, EMISSION POINT 41
INDIVIDUAL TEST TESULTS, LBS/TON METAL

Analyte	AX021	AX022	AX023	AX024	AX025	AX026	AX027	AX028	AX029	Average
Hexane	1.14E-03	1.19E-03	9.52E-04	1.41E-03	1.33E-03	1.12E-03	2.29E-03	1.66E-03	1.89E-03	1.44E-03
Benzene	1.20E-02	1.56E-02	1.17E-02	1.13E-02	9.28E-03	1.29E-02	2.12E-02	1.94E-02	1.95E-02	1.48E-02
Toluene	1.19E-03	2.08E-03	1.44E-03	1.44E-03	1.05E-03	1.73E-03	NT	2.10E-03	2.61E-03	1.70E-03
Ethyl Benzene	0.00E+00	1.12E-04	7.27E-05	7.79E-05	0.00E+00	8.95E-05	8.40E-04	6.00E-04	6.95E-04	2.76E-04
m,p-Xylene	2.26E-04	4.49E-04	2.55E-04	2.65E-04	1.74E-04	2.48E-04	1.14E-03	7.39E-04	9.45E-04	4.94E-04
Styrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	6.93E-04	8.34E-04	1.91E-04
o-Xylene	0.00E+00	1.21E-04	7.27E-05	6.71E-05	0.00E+00	6.31E-05	NT	6.00E-04	7.23E-04	2.06E-04
1,3,5-Trimethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.07E-04	5.54E-04	6.67E-04	2.25E-04
2-Ethyltoluene	1.23E-04	9.32E-05	7.14E-05	0.00E+00	0.00E+00	0.00E+00	9.08E-04	5.77E-04	7.22E-04	2.77E-04
1,2,4-Trimethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-04	8.74E-04	6.00E-04	6.95E-04	2.55E-04
1,2,3-Trimethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.65E-05	8.74E-04	6.23E-04	7.23E-04	2.53E-04
Undecane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	8.92E-04	1.03E-03	2.41E-04
Naphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E-03	9.58E-04	1.03E-03	3.71E-04
2-Methylnaphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00
1-Methylnaphthalene	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	0.00E+00
1,3-Dimethylnaphthalene	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	0.00E+00
Cyclohexane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptane	1.12E-03	1.40E-03	1.01E-03	1.17E-03	8.72E-04	1.27E-03	2.22E-03	1.72E-03	2.10E-03	1.43E-03
Octane	0.00E+00	0.00E+00	0.00E+00	5.84E-04	0.00E+00	7.56E-04	1.25E-03	8.58E-04	1.07E-03	5.02E-04
Nonane	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	0.00E+00
Cumene	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	0.00E+00
Phenol/3-Ethyltoluene	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	0.00E+00
4-Ethyltoluene	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	0.00E+00
Propylbenzene	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	0.00E+00
Isobutylbenzene	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	0.00E+00
Decane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-03	6.76E-04	9.14E-04	3.00E-04
p-Cymene	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	0.00E+00
o-Cresol/Indan	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	0.00E+00
m,p-Cresol/Butylbenzene	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	0.00E+00
1,4-Diethylbenzene	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	0.00E+00
1,3-Diethylbenzene	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	0.00E+00
Indene	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	0.00E+00
1,2-Diethylbenzene	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	0.00E+00
2,6-Dimethylphenol	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – POURING, EMISSION POINT 41
INDIVIDUAL TEST TESULTS, LBS/TON METAL (Continued)

Analyte	AX021	AX022	AX023	AX024	AX025	AX026	AX027	AX028	AX029	Average
2,4-Dimethylphenol	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	0.00E+00
3,5-Dimethylphenol	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	0.00E+00
1,3-Diisopropylbenzene	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	0.00E+00
2,3-Dimethylphenol	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	0.00E+00
3,4-Dimethylphenol	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	0.00E+00
2,4,6-Trimethylphenol	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	0.00E+00
Dodecane	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	0.00E+00
2,3,5-Trimethylphenol	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	0.00E+00
Tridecane	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	0.00E+00
Tetradecane	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	0.00E+00
Biphenyl	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	0.00E+00
2,7-Dimethylnaphthalene	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	0.00E+00
2,6-Dimethylnaphthalene	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	0.00E+00
2,3-Dimethylnaphthalene	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	0.00E+00
1,5-Dimethylnaphthalene	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	0.00E+00
1,6-Dimethylnaphthalene	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	0.00E+00
Acenaphthylene	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	0.00E+00
1,2-Dimethylnaphthalene	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	0.00E+00
1,8-Dimethylnaphthalene	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	0.00E+00
2,3,5-Trimethylnaphthalene	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	0.00E+00
THC ref. to Undecane (MW=156)	4.07E-02	5.27E-02	4.20E-02	3.81E-02	3.51E-02	3.36E-02	4.91E-02	4.25E-02	5.14E-02	4.28E-02
Formaldehyde	4.29E-04	5.79E-04	6.44E-04	4.01E-04	5.54E-04	7.44E-04	NT	6.65E-04	4.40E-04	5.57E-04
Acetaldehyde	2.57E-04	2.36E-04	1.99E-04	2.16E-04	2.77E-04	2.31E-04	NT	2.47E-04	2.88E-04	2.44E-04
Acrolein	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	0.00E+00
Acetone	1.69E-04	1.70E-04	1.12E-04	1.20E-04	1.52E-04	1.13E-04	NT	1.21E-04	1.54E-04	1.39E-04
Propanal	3.86E-05	4.08E-05	3.38E-05	4.17E-05	5.68E-05	3.98E-05	NT	4.04E-05	1.17E-04	5.11E-05
Crotonaldehyde	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	0.00E+00
Methacrolein	4.29E-05	3.00E-05	1.84E-05	2.47E-05	3.19E-05	2.57E-05	NT	2.40E-05	3.39E-05	2.89E-05
Methyl Ethyl Ketone/Butyraldehydes	1.03E-04	1.20E-04	8.90E-05	1.11E-04	9.28E-05	8.34E-05	1.36E-04	8.29E-05	8.13E-05	1.00E-04
Benzaldehyde	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-05	0.00E+00	3.81E-06
Pentanal	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	0.00E+00
m,p-Tolualdehyde	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	0.00E+00
4-Methyl-2-pentanone	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	0.00E+00
Hexanal	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – COOLING, EMISSION POINT 61
INDIVIDUAL TEST TESULTS, LBS/TON METAL

Analyte	AX031	AX032	AX033	AX034	AX035	AX036	AX037	AX038	AX039	Average
Hexane	3.80E-03	2.79E-03	NT	NT	4.87E-03	4.69E-03	5.48E-03	5.43E-03	5.79E-03	4.69E-03
Benzene	4.88E-02	3.43E-02	NT	NT	5.31E-02	5.32E-02	5.44E-02	5.22E-02	5.37E-02	5.00E-02
Toluene	1.33E-02	8.63E-03	NT	NT	1.56E-02	1.41E-02	1.19E-02	1.13E-02	1.18E-02	1.24E-02
Ethyl Benzene	9.76E-04	6.29E-04	NT	NT	1.46E-03	1.24E-03	1.81E-03	1.72E-03	1.78E-03	1.37E-03
m,p-Xylene	4.63E-03	2.82E-03	NT	NT	5.52E-03	5.79E-03	4.94E-03	4.10E-03	4.87E-03	4.67E-03
Styrene	4.49E-04	3.23E-04	NT	NT	8.05E-04	8.82E-04	1.85E-03	1.77E-03	1.82E-03	1.13E-03
o-Xylene	1.37E-03	8.47E-04	NT	NT	1.71E-03	1.69E-03	2.14E-03	2.05E-03	2.32E-03	1.73E-03
1,3,5-Trimethylbenzene	6.74E-04	4.16E-04	NT	NT	7.41E-04	8.80E-04	1.56E-03	1.58E-03	1.69E-03	1.08E-03
2-Ethyltoluene	2.57E-04	2.24E-04	NT	NT	3.57E-04	4.43E-04	1.32E-03	1.44E-03	1.69E-03	8.17E-04
1,2,4-Trimethylbenzene	1.37E-03	1.05E-03	NT	NT	1.96E-03	2.40E-03	2.35E-03	2.05E-03	2.41E-03	1.94E-03
1,2,3-Trimethylbenzene	5.34E-04	3.58E-04	NT	NT	6.24E-04	8.89E-04	1.48E-03	2.02E-03	1.59E-03	1.07E-03
Undecane	0.00E+00	2.17E-04	NT	NT	4.60E-04	6.48E-04	1.94E-03	2.20E-03	2.15E-03	1.09E-03
Naphthalene	6.57E-04	4.10E-04	NT	NT	7.34E-04	1.02E-03	2.30E-03	2.40E-03	2.73E-03	1.46E-03
2-Methylnaphthalene	3.64E-04	1.95E-04	NT	NT	3.58E-04	4.86E-04	1.83E-03	2.13E-03	2.15E-03	1.07E-03
1-Methylnaphthalene	0.00E+00	0.00E+00	NT	NT	1.61E-04	2.14E-04	1.71E-03	1.99E-03	1.95E-03	8.61E-04
1,3-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cyclohexane	1.15E-03	8.32E-04	NT	NT	1.26E-03	1.34E-03	1.24E-03	5.51E-04	1.23E-03	1.09E-03
Heptane	5.13E-03	3.62E-03	NT	NT	6.74E-03	6.58E-03	6.89E-03	5.43E-03	7.42E-03	5.97E-03
Octane	4.52E-03	3.20E-03	NT	NT	4.84E-03	6.10E-03	4.36E-03	3.39E-03	4.56E-03	4.42E-03
Nonane	1.39E-03	1.14E-03	NT	NT	1.74E-03	2.06E-03	0.00E+00	0.00E+00	0.00E+00	9.04E-04
Cumene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenol/3-Ethyltoluene	1.40E-03	1.46E-03	NT	NT	2.46E-03	2.71E-03	2.01E-03	1.67E-03	2.73E-03	2.06E-03
4-Ethyltoluene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Propylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Isobutylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Decane	0.00E+00	7.97E-04	NT	NT	1.14E-03	1.45E-03	1.59E-03	1.85E-03	1.63E-03	1.21E-03
p-Cymene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
o-Cresol/Indan	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
m,p-Cresol/Butylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,4-Diethylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3-Diethylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Diethylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-Dimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – COOLING, EMISSION POINT 61
INDIVIDUAL TEST TESULTS, LBS/TON METAL (Continued)

Analyte	AX031	AX032	AX033	AX034	AX035	AX036	AX037	AX038	AX039	Average
2,4-Dimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3,5-Dimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3-Diisopropylbenzene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3-Dimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3,4-Dimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-Trimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dodecane	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,5-Trimethylphenol	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tridecane	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tetradecane	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Biphenyl	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,7-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,5-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,6-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acenaphthylene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,8-Dimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,5-Trimethylnaphthalene	0.00E+00	0.00E+00	NT	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
THC ref. to Undecane (MW=156)	1.65E-01	1.11E-01	NT	NT	1.76E-01	2.00E-01	1.73E-01	1.47E-01	1.78E-01	1.64E-01
Formaldehyde	3.75E-05	3.24E-05	1.58E-04	1.17E-04	9.68E-04	1.07E-03	1.13E-03	7.03E-04	7.69E-04	5.54E-04
Acetaldehyde	1.02E-04	3.24E-05	1.44E-04	1.91E-04	4.84E-04	5.63E-04	7.38E-04	4.39E-04	3.98E-04	3.43E-04
Acrolein	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	0.00E+00
Acetone	9.62E-05	5.99E-05	1.77E-04	1.52E-04	6.63E-04	6.39E-04	6.64E-04	6.15E-04	6.10E-04	4.09E-04
Propanal	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.37E-05	6.65E-05	7.14E-05	4.10E-05	6.36E-05	3.40E-05
Crotonaldehyde	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	0.00E+00
Methacrolein	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.33E-05	4.86E-05	5.41E-05	0.00E+00	5.04E-05	2.18E-05
Methyl Ethyl Ketone/Butyraldehydes	4.53E-05	0.00E+00	7.46E-05	5.97E-05	2.40E-04	2.81E-04	2.71E-04	1.87E-04	2.41E-04	1.56E-04
Benzaldehyde	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.88E-05	8.19E-05	6.40E-05	0.00E+00	7.96E-05	3.27E-05
Pentanal	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	0.00E+00
m,p-Tolualdehyde	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Methyl-2-pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.65E-05	0.00E+00	0.00E+00	0.00E+00	7.39E-06
Hexanal	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – SHAKEOUT, EMISSION POINT 71
INDIVIDUAL TEST TESULTS, LBS/TON METAL

Analyte	AX041	AX042	AX043	AX044	AX045	AX046	AX047	AX048	AX049	Average
Hexane	3.83E-03	4.47E-03	1.00E-02	4.49E-03	5.14E-03	5.20E-03	5.57E-03	5.61E-03	1.03E-02	6.07E-03
Benzene	1.13E-01	1.09E-01	1.09E-01	1.40E-01	1.78E-01	1.86E-01	1.67E-01	1.55E-01	1.40E-01	1.44E-01
Toluene	4.05E-02	4.38E-02	4.25E-02	5.73E-02	7.26E-02	7.91E-02	5.70E-02	4.86E-02	4.57E-02	5.41E-02
Ethyl Benzene	4.15E-03	4.30E-03	3.97E-03	5.65E-03	6.24E-03	7.27E-03	7.77E-03	6.99E-03	7.17E-03	5.94E-03
m,p-Xylene	2.05E-02	2.03E-02	2.01E-02	2.68E-02	3.03E-02	3.59E-02	2.67E-02	1.91E-02	2.05E-02	2.45E-02
Styrene	2.21E-03	2.24E-03	2.32E-03	3.39E-03	3.50E-03	3.84E-03	6.47E-03	6.08E-03	6.66E-03	4.08E-03
o-Xylene	7.30E-03	7.48E-03	7.36E-03	9.94E-03	1.03E-02	1.22E-02	1.05E-02	9.10E-03	9.50E-03	9.29E-03
1,3,5-Trimethylbenzene	4.14E-03	4.12E-03	4.35E-03	5.91E-03	6.82E-03	6.93E-03	7.90E-03	6.83E-03	7.17E-03	6.02E-03
2-Ethyltoluene	3.46E-03	3.50E-03	3.63E-03	5.14E-03	4.54E-03	5.89E-03	6.34E-03	5.92E-03	6.33E-03	4.97E-03
1,2,4-Trimethylbenzene	1.26E-02	1.28E-02	1.40E-02	1.87E-02	2.30E-02	2.50E-02	1.63E-02	1.15E-02	1.28E-02	1.63E-02
1,2,3-Trimethylbenzene	4.70E-03	5.02E-03	5.39E-03	7.09E-03	9.19E-03	1.09E-02	8.29E-03	6.83E-03	7.83E-03	7.25E-03
Undecane	6.55E-03	7.52E-03	8.53E-03	1.08E-02	8.14E-03	9.46E-03	1.31E-02	1.26E-02	1.38E-02	1.01E-02
Naphthalene	1.78E-02	1.99E-02	2.78E-02	3.72E-02	3.31E-02	4.42E-02	3.67E-02	2.45E-02	3.14E-02	3.03E-02
2-Methylnaphthalene	1.14E-02	1.33E-02	1.90E-02	2.57E-02	2.73E-02	3.43E-02	2.22E-02	1.67E-02	2.02E-02	2.11E-02
1-Methylnaphthalene	5.86E-03	6.47E-03	9.55E-03	1.27E-02	1.16E-02	1.42E-02	1.41E-02	1.15E-02	1.38E-02	1.11E-02
1,3-Dimethylnaphthalene	1.97E-03	2.23E-03	3.86E-03	3.88E-03	5.68E-03	7.71E-03	1.22E-02	1.25E-02	1.37E-02	7.07E-03
Cyclohexane	0.00E+00	1.60E-03	0.00E+00	1.81E-03	1.83E-03	2.01E-03	0.00E+00	0.00E+00	0.00E+00	8.06E-04
Heptane	5.67E-03	6.51E-03	5.98E-03	7.71E-03	8.48E-03	9.14E-03	8.52E-03	7.81E-03	7.70E-03	7.50E-03
Octane	7.42E-03	8.22E-03	7.47E-03	9.75E-03	1.27E-02	1.38E-02	8.70E-03	7.17E-03	7.85E-03	9.22E-03
Nonane	0.00E+00	4.13E-03	3.97E-03	5.17E-03	7.43E-03	7.87E-03	3.59E-03	2.68E-03	0.00E+00	3.87E-03
Cumene	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	0.00E+00
Phenol/3-Ethyltoluene	3.67E-02	5.35E-02	5.67E-02	8.67E-02	8.12E-02	1.15E-01	8.74E-02	4.46E-02	5.07E-02	6.80E-02
4-Ethyltoluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-03	4.29E-03	0.00E+00	0.00E+00	0.00E+00	8.86E-04
Propylbenzene	0.00E+00	2.71E-03	2.71E-03	3.86E-03	2.61E-03	3.23E-03	2.62E-03	0.00E+00	0.00E+00	1.97E-03
Isobutylbenzene	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	0.00E+00
Decane	5.98E-03	7.06E-03	7.46E-03	7.96E-03	7.89E-03	8.51E-03	7.78E-03	9.34E-03	9.05E-03	7.89E-03
p-Cymene	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	0.00E+00
o-Cresol/Indan	8.51E-03	1.15E-02	1.54E-02	2.01E-02	1.68E-02	2.28E-02	1.73E-02	7.96E-03	6.37E-03	1.41E-02
m,p-Cresol/Butylbenzene	0.00E+00	2.07E-03	3.23E-03	4.58E-03	1.11E-02	1.47E-02	2.08E-03	0.00E+00	0.00E+00	4.20E-03
1,4-Diethylbenzene	3.51E-03	4.26E-03	4.73E-03	6.49E-03	2.04E-03	2.70E-03	4.92E-03	2.74E-03	3.12E-03	3.83E-03
1,3-Diethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indene	0.00E+00	2.23E-03	2.71E-03	3.51E-03	4.99E-03	5.49E-03	3.88E-03	3.77E-03	4.15E-03	3.41E-03
1,2-Diethylbenzene	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	0.00E+00
2,6-Dimethylphenol	0.00E+00	3.87E-03	5.08E-03	5.75E-03	4.36E-03	5.29E-03	4.58E-03	0.00E+00	0.00E+00	3.21E-03

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – SHAKEOUT, EMISSION POINT 71
INDIVIDUAL TEST TESULTS, LBS/TON METAL (Continued)

Analyte	AX041	AX042	AX043	AX044	AX045	AX046	AX047	AX048	AX049	Average
2,4-Dimethylphenol	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	0.00E+00
3,5-Dimethylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.57E-03	NT	0.00E+00	0.00E+00	0.00E+00	6.96E-04
1,3-Diisopropylbenzene	0.00E+00	2.94E-03	2.95E-03	3.87E-03	0.00E+00	8.11E-03	5.96E-03	3.57E-03	5.00E-03	3.60E-03
2,3-Dimethylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3,4-Dimethylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00
2,4,6-Trimethylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00
Dodecane	0.00E+00	4.20E-03	5.43E-03	6.88E-03	8.41E-03	9.98E-03	7.22E-03	6.53E-03	7.62E-03	6.25E-03
2,3,5-Trimethylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00
Tridecane	0.00E+00	2.07E-03	3.04E-03	3.69E-03	0.00E+00	0.00E+00	5.37E-03	5.01E-03	5.48E-03	2.74E-03
Tetradecane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.54E-03	6.31E-03	0.00E+00	0.00E+00	0.00E+00	1.21E-03
Biphenyl	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	0.00E+00
2,7-Dimethylnaphthalene	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	0.00E+00
2,6-Dimethylnaphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3-Dimethylnaphthalene	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	0.00E+00
1,5-Dimethylnaphthalene	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	0.00E+00
1,6-Dimethylnaphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-03	4.64E-03	0.00E+00	0.00E+00	0.00E+00	9.24E-04
Acenaphthylene	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	0.00E+00
1,2-Dimethylnaphthalene	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	0.00E+00
1,8-Dimethylnaphthalene	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	0.00E+00
2,3,5-Trimethylnaphthalene	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	0.00E+00
THC ref. to Undecane (MW=156)	5.80E-01	6.31E-01	6.77E-01	8.84E-01	8.70E-01	1.01E+00	6.73E-01	5.16E-01	5.59E-01	7.12E-01
Formaldehyde	1.02E-04	9.43E-04	1.34E-03	1.66E-03	1.03E-03	1.51E-03	1.88E-03	7.07E-04	8.22E-04	1.11E-03
Acetaldehyde	NT	4.15E-03	4.11E-03	4.90E-03	5.06E-03	4.76E-03	5.21E-03	3.90E-03	4.40E-03	4.56E-03
Acrolein	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	0.00E+00
Acetone	NT	7.28E-03	6.88E-03	8.31E-03	7.90E-03	7.56E-03	7.96E-03	8.25E-03	8.51E-03	7.83E-03
Propanal	NT	6.53E-04	6.37E-04	7.69E-04	7.51E-04	6.88E-04	6.59E-04	5.62E-04	6.36E-04	6.69E-04
Crotonaldehyde	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	0.00E+00
Methacrolein	NT	4.00E-04	1.84E-04	4.46E-04	3.08E-04	2.19E-04	3.47E-04	3.17E-04	3.91E-04	3.27E-04
Methyl Ethyl Ketone/Butyraldehydes	1.57E-04	2.41E-03	2.10E-03	2.45E-03	2.45E-03	2.42E-03	2.46E-03	2.54E-03	2.64E-03	2.18E-03
Benzaldehyde	NT	1.74E-03	2.35E-03	2.62E-03	2.45E-03	1.81E-03	1.52E-03	1.45E-03	1.66E-03	1.95E-03
Pentanal	0.00E+00	2.38E-04	0.00E+00	2.27E-04	2.53E-04	2.12E-04	2.61E-04	2.63E-04	3.13E-04	1.96E-04
m,p-Tolualdehyde	NT	7.06E-04	5.95E-04	8.65E-04	1.11E-03	8.32E-04	4.41E-04	4.08E-04	8.31E-04	7.23E-04
4-Methyl-2-pentanone	0.00E+00	3.81E-04	3.94E-04	6.29E-04	5.45E-04	3.78E-04	3.84E-04	3.53E-04	4.40E-04	3.89E-04
Hexanal	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – COMBINED POURING/COOLING/SHAKEOUT, EMISSION POINT 3
INDIVIDUAL TEST TESULTS, LBS/TON METAL

Analyte	AX011	AX012	AX013	AX014	AX015	AX016	AX017	AX018	AX019	Average
Hexane	1.90E-02	1.07E-02	7.26E-03	8.40E-03	8.92E-03	6.63E-03	1.23E-02	1.72E-02	1.74E-02	1.20E-02
Benzene	2.30E-01	3.14E-01	1.68E-01	1.94E-01	1.76E-01	2.30E-01	2.43E-01	2.30E-01	2.45E-01	2.26E-01
Toluene	6.98E-02	9.72E-02	5.85E-02	6.67E-02	6.19E-02	6.64E-02	6.79E-02	7.67E-02	7.83E-02	7.15E-02
Ethyl Benzene	1.50E-02	9.72E-03	5.48E-03	6.22E-03	5.36E-03	5.68E-03	1.20E-02	1.42E-02	1.35E-02	9.69E-03
m,p-Xylene	3.49E-02	4.57E-02	2.65E-02	3.07E-02	2.63E-02	2.66E-02	2.89E-02	3.69E-02	3.63E-02	3.25E-02
Styrene	1.46E-02	5.70E-03	3.31E-03	1.83E-03	3.63E-03	4.15E-03	1.17E-02	1.31E-02	1.32E-02	7.91E-03
o-Xylene	1.86E-02	1.62E-02	9.70E-03	1.06E-02	9.02E-03	9.69E-03	1.41E-02	1.83E-02	1.78E-02	1.38E-02
1,3,5-Trimethylbenzene	1.55E-02	2.04E-02	5.22E-03	6.20E-03	5.27E-03	6.28E-03	1.20E-02	1.46E-02	1.46E-02	1.11E-02
2-Ethyltoluene	1.41E-02	8.75E-03	5.20E-03	6.92E-03	4.66E-03	6.40E-03	1.20E-02	1.35E-02	1.35E-02	9.45E-03
1,2,4-Trimethylbenzene	2.34E-02	3.05E-02	1.68E-02	1.87E-02	1.61E-02	1.98E-02	1.97E-02	2.34E-02	2.42E-02	2.14E-02
1,2,3-Trimethylbenzene	1.59E-02	1.36E-02	6.06E-03	6.29E-03	5.38E-03	6.74E-03	1.20E-02	1.35E-02	1.42E-02	1.04E-02
Undecane	2.15E-02	1.20E-02	9.95E-03	9.44E-03	8.51E-03	1.36E-02	1.98E-02	2.09E-02	2.24E-02	1.53E-02
Naphthalene	3.16E-02	4.36E-02	3.48E-02	2.22E-02	2.38E-02	3.91E-02	4.17E-02	3.97E-02	5.19E-02	3.65E-02
2-Methylnaphthalene	2.40E-02	3.48E-02	2.40E-02	7.91E-03	1.50E-02	2.68E-02	2.94E-02	2.87E-02	3.66E-02	2.53E-02
1-Methylnaphthalene	2.02E-02	2.13E-02	1.16E-02	4.48E-03	7.35E-03	1.31E-02	2.06E-02	2.14E-02	2.49E-02	1.61E-02
1,3-Dimethylnaphthalene	0.00E+00	1.75E-02	4.80E-03	4.90E-03	2.62E-03	6.59E-03	2.52E-02	2.92E-02	2.99E-02	1.34E-02
Cyclohexane	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	0.00E+00
Heptane	1.90E-02	1.81E-02	1.27E-02	1.39E-02	1.22E-02	1.31E-02	1.49E-02	1.93E-02	1.93E-02	1.58E-02
Octane	1.64E-02	2.27E-02	1.28E-02	1.53E-02	2.89E-02	1.50E-02	1.27E-02	1.72E-02	1.73E-02	1.76E-02
Nonane	0.00E+00	NT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cumene	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	0.00E+00
Phenol/3-Ethyltoluene	2.34E-02	6.97E-02	7.08E-02	4.30E-02	5.74E-02	7.45E-02	5.69E-02	2.14E-02	8.18E-02	5.54E-02
4-Ethyltoluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NT	0.00E+00	0.00E+00
Propylbenzene	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	0.00E+00
Isobutylbenzene	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	0.00E+00
Decane	1.28E-02	8.67E-03	1.04E-02	1.22E-02	9.95E-03	1.72E-02	1.41E-02	1.25E-02	1.22E-02	1.22E-02
p-Cymene	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	0.00E+00
o-Cresol/Indan	0.00E+00	1.50E-02	1.63E-02	6.67E-03	1.13E-02	1.56E-02	8.11E-03	1.29E-02	1.69E-02	1.14E-02
m,p-Cresol/Butylbenzene	0.00E+00	1.38E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.53E-03
1,4-Diethylbenzene	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	0.00E+00
1,3-Diethylbenzene	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	0.00E+00
Indene	8.44E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.73E-03	7.59E-03	8.54E-03	3.48E-03
1,2-Diethylbenzene	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	0.00E+00
2,6-Dimethylphenol	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

PRODUCTION FOUNDRY BASELINE TEST SERIES – COMBINED POURING/COOLING/SHAKEOUT, EMISSION POINT 3
INDIVIDUAL TEST TESULTS, LBS/TON METAL (Continued)

Analyte	AX011	AX012	AX013	AX014	AX015	AX016	AX017	AX018	AX019	Average
2,4-Dimethylphenol	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	0.00E+00
3,5-Dimethylphenol	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	0.00E+00
1,3-Diisopropylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.58E-03	0.00E+00	0.00E+00	0.00E+00	6.20E-04
2,3-Dimethylphenol	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	0.00E+00
3,4-Dimethylphenol	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	0.00E+00
2,4,6-Trimethylphenol	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	0.00E+00
Dodecane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-02	1.14E-02	1.25E-02	1.32E-02	5.33E-03
2,3,5-Trimethylphenol	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	0.00E+00
Tridecane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.66E-03	1.03E-02	1.16E-02	3.51E-03
Tetradecane	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	0.00E+00
Biphenyl	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	0.00E+00
2,7-Dimethylnaphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-02	1.46E-02	1.57E-02	4.79E-03
2,6-Dimethylnaphthalene	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	0.00E+00
2,3-Dimethylnaphthalene	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	0.00E+00
1,5-Dimethylnaphthalene	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	0.00E+00
1,6-Dimethylnaphthalene	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	0.00E+00
Acenaphthylene	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	0.00E+00
1,2-Dimethylnaphthalene	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	0.00E+00
1,8-Dimethylnaphthalene	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	0.00E+00
2,3,5-Trimethylnaphthalene	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	0.00E+00
THC ref. to Undecane (MW=156)	7.55E-01	9.72E-01	9.27E-01	5.21E-01	8.81E-01	1.08E+00	3.06E-01	9.13E-01	9.60E-01	8.13E-01
Formaldehyde	9.03E-04	1.08E-03	1.49E-03	2.09E-03	1.06E-03	2.49E-03	2.38E-03	2.63E-03	1.72E-03	1.76E-03
Acetaldehyde	4.52E-03	5.11E-03	4.89E-03	4.76E-03	4.88E-03	6.48E-03	6.22E-03	4.38E-03	4.41E-03	5.07E-03
Acrolein	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	0.00E+00
Acetone	8.24E-03	8.89E-03	8.15E-03	7.94E-03	7.84E-03	1.03E-02	9.15E-03	8.76E-03	8.19E-03	8.60E-03
Propanal	7.70E-04	7.75E-04	8.15E-04	7.48E-04	NT	9.72E-04	8.42E-04	6.13E-04	6.30E-04	7.71E-04
Crotonaldehyde	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	0.00E+00
Methacrolein	0.00E+00	4.35E-04	3.56E-04	3.63E-04	3.83E-04	3.24E-04	3.11E-04	2.41E-04	0.00E+00	2.68E-04
Methyl Ethyl Ketone/Butyraldehydes	2.66E-03	3.22E-03	2.55E-03	2.49E-03	2.61E-03	3.78E-03	2.93E-03	2.85E-03	2.52E-03	2.84E-03
Benzaldehyde	0.00E+00	1.48E-03	1.55E-03	1.45E-03	2.09E-03	2.32E-03	1.32E-03	1.20E-03	1.34E-03	1.42E-03
Pentanal	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	0.00E+00
m,p-Tolualdehyde	0.00E+00	9.46E-04	9.47E-04	5.90E-04	8.71E-04	1.19E-03	9.70E-04	0.00E+00	5.88E-04	6.78E-04
4-Methyl-2-pentanone	0.00E+00	6.62E-04	7.33E-04	0.00E+00	5.92E-04	8.10E-04	7.87E-04	0.00E+00	0.00E+00	3.98E-04
Hexanal	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	0.00E+00

Note: The results presented are not suitable for use as general emission factors.
NT: Analyte was either not tested or the result was rejected based on data validation considerations.
0.00E+00 indicates that the value was below the detection limit.

Appendix B

Listing of Support Documents

Appendix B: Listing of Support Documents

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

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

2. "CERP Testing, Quality Control and Quality Assurance Procedures and Data Validation Procedures Manual".

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

4. Baseline (AX) data binder.

Appendix C

Approved Test Plan

CERP TEST PLAN

- **CONTROL NUMBER: RE 2 00025**

SAMPLE FAMILY: AX

- **SAMPLING EVENTS: 011 thru 019 Stack 41 (Pouring)**
- **SAMPLING EVENTS: 021 thru 029 Stack 61 (Combined Cooling)**
- **SAMPLING EVENTS: 031 thru 039 Stack 71 (Main Shakeout)**
- **SAMPLING EVENTS: 041 thru 049 Stack 1 (Total Sand System & Re-claimed Sand from Pits)**
- **SAMPLING EVENTS: 051 thru 059 Stack 3 (Combined Pouring, Cooling, & Shakeout)**

- **SITE: ____PRE-PRODUCTION(243)__X__CERP FOUNDRY(238)**

- **TEST TYPE: Production Foundry Baseline**

- **MOLD TYPE: Greensand using existing system sand**

- **NUMBER OF MOLDS POURED: 500**

- **CORE TYPE: CERP Isocure Engine Core**

TEST DATES: START: 2/16/1999
FINISH: 2/18/1999

TEST OBJECTIVES:
Primary: Pilot Foundry Baseline. To determine the baseline emissions from standard I-4 engine molds with seacoal and Isocure cores as the only known organic source in a production setting. The statistical validity will be based on 9-1 hour sampling events at each of 5 separate stacks.

VARIABLES:
All molds will be made using existing sand system materials. The cores are made with Lake Sand and 1.75% Isocure resin in the proportion 57% Part I and 43% Part II.

BRIEF OVERVIEW:

This base line is analogous to the green sand and organic core composite baseline AU that was run in the pre-production foundry. The main difference being that instead of one stack and one mold, we are sampling at five stack locations with the mold rate of approximately 40 molds per hour. The stacks that were selected for the base line are stack 41(pouring) stack 61 (combined cooling from lines 2,3) stack 71 (main shakeout), and stack 1 (total sand system and re-claimed sand from the pits) and stack 3 (combined pouring, cooling, and shakeout). Stacks 1 and 3 make up all emissions leaving the foundry with the exception of melting. The statistical validity will be based on nine sampling events on each stack. Emission tests will be done over several days to gather nine one-hour runs per stack, with change out time for switching sampling tubes. The emissions from this series of tests will be the baseline for those companies testing both mold and core materials.

SPECIAL CONDITIONS:

The Airsense 500 and other online instruments (criteria/diluent gases and total hydrocarbons) will track the foundry process at stack 3 (combined pouring, cooling, and shakeout) for the duration of all testing.

Senior Process Engineer	3-10-99 **Date**
Operations Manager	3 10-99 **Date**
Emissions Team (USCAR)	3/13/99 **Date**
Process and Facilities Team (USCAR)	3/10/99 **Date**
Project Manager	3/10/99 **Date**

C:ez/emission forms/reports/ax/ax-test_plan.doc

Appendix D

List of Analytes

Production Foundry Baseline List of Analytes

Analyte	CAS Number	Reporting Limit (ng)	HAP	POM	VOC
1,2,3-Trimethylbenzene	526-73-8	20			X
1,2,4-Trimethylbenzene	95-63-6	20			X
1,2-Diethylbenzene	135-01-3	100			X
1,2-Dimethylnaphthalene	573-98-8	100	X	X	X
1,3,5-Trimethylbenzene	108-67-8	20			X
1,3-Diethylbenzene		100			X
1,3-Diisopropylbenzene	99-62-7	100			X
1,3-Dimethylnaphthalene	575-41-7	20	X	X	X
1,4-Diethylbenzene	105-05-5	100			
1,5-Dimethylnaphthalene	571-61-9	100	X	X	X
1,6-Dimethylnaphthalene	575-43-9	100	X	X	X
1,8-Dimethylnaphthalene	569-41-5	100	X	X	X
1-Methylnaphthalene	90-12-0	20	X	X	X
2,3,5-Trimethylnaphthalene	2245-38-7	100	X	X	X
2,3,5-Trimethylphenol	697-82-5	100			X
2,3-Dimethylnaphthalene	581-40-8	100	X	X	X
2,3-Dimethylphenol	526-75-0	100			X
2,4,6-Trimethylphenol	527-60-6	100			X
2,4-Dimethylphenol	95-87-4	100			X
2,6-Dimethylnaphthalene	581-42-0	100	X	X	X
2,6-Dimethylphenol	576-26-1	100			X
2,7- Dimethylnaphthalene		100	X	X	X
2-Butanone (MEK)	78-93-3	300	X		X
2-Ethyltoluene	611-14-3	20			X
2-Methylnaphthalene	91-57-6	20	X	X	X
2-Methylphenol (o-cresol)	95-48-7	100	X		X
3,4-Dimethylphenol	95-65-8	100			X
3,5-Dimethylphenol	108-68-9	100			X
3-Ethyltoluene	620-14-4	100			X
4-Ethyltoluene	622-96-8	20			X
Acenaphthalene	209-96-8	100	X	X	X
Acetaldehyde	75-07-0	300	X		X
Acetone	67-64-1	300			
Acrolein	107-02-8	300	X		X
Benzaldehyde		300			X
Benzene	71-43-2	20	X		X
Biphenyl	92-52-4	100	X		X
Butylbenzene	105-05-5	20			X
Crotonaldehyde	123-73-9	300			X

Production Foundry Baseline List of Analytes

Analyte	CAS Number	Reporting Limit (ng)	HAP	POM	VOC
Cumene	98-82-8	100	X		X
Cyclohexane	110-82-7	100			X
Decane	124-18-5	100			X
Dodecane	112-40-3	100			X
Ethylbenzene	100-41-4	20	X		X
Formaldehyde	500-00-0	300	X		X
Heptane	142-82-5	100			X
Hexaldehyde	66-25-1	300	X		X
Hexane	110-54-3	20			X
Indan	496-11-7	100			X
Indene	95-13-6	100			X
Isobutylbenzene	538-93-2	100			X
m,p-cresol	108-39-4	100	X		X
m,p-xylene	108-38-3	20	X		X
Methacrolein	78-85-3	300			X
Naphthalene	91-20-3	20	X	X	X
Nonane	111-84-2	100			X
o-Cresol	95-48-7	100	X		X
o,m,p-Tolualdehyde	620-23-5	300			X
Octane	11-65-9	100			X
o-xylene	95-47-6	20	X		X
p-Cymene	99-87-6	100	X		X
Pentenal (Valeraldehyde)	110-62-3	300			X
Phenol	108-95-2	100	X		X
Propionaldehyde (Propanal)	123-38-6	300	X		X
Propylbenzene	103-65-1	100			X
Styrene	100-42-5	20	X		X
Tetradecane	629-54-4	100			X
Toluene	108-88-3	20	X		X
Tridecane	629-50-5	100			X
Undecane	1120-21-4	20			X