

Refinery Stream Composition Data— Update to Speciation Data in API 4723

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Executive Summary

The Petroleum Environmental Research Forum (PERF) completed a project in the 1990s to create a compilation of refinery process stream speciation data, which was later published as American Petroleum Institute Publication 4723 (API 4723). The refining industry has routinely used these data for various permitting and reporting purposes, such as estimating hazardous air pollutant (HAP) emissions from equipment fugitives, storage tanks, and loading operations; estimating emissions from miscellaneous process vents; and preparing Toxic Release Inventory (TRI) reports.

Since API 4723 was published, new regulatory requirements (e.g. Mobile Source Air Toxics rule, reformulated gasoline standards, lower fuel sulfur requirements) have resulted in refinery process changes that potentially altered the concentrations of species in process streams. Changing feedstocks, new process additives, and new catalysts may also have affected what species are present in specific process streams.

Therefore, PERF initiated a project to evaluate more recent process stream speciation data from several oil companies' refineries. The project results are provided in this report. Data were compiled for 68 refinery process streams using an expanded list of chemical species. The chemical species selected are those that can be found in refinery process streams and identified in hazardous air pollutant (HAP), persistent bioaccumulative toxic, or TRI lists. For a given process stream, up to 75 chemical species were targeted for inclusion to capture a wider range of volatile, semi-volatile, and metal HAP compounds, compared to the 24 species in the original study. Some concentration data were reported for additional species beyond the targeted list, such that data for a total of 89 different species are reflected in the project results. Most of the new species are metal HAP and heavier semi-volatile compounds.

Updates to laboratory methods have generally improved method accuracy and provide for lower method detection limits (MDLs) than were possible for the original PERF project. The lower detection limits contributed to an increase in the number of chemical species identified in various analytical test methods. The lower limits also allow for lowering the floor that was used in the original study—a default MDL that was set at 0.01 weight percent. By contrast, for the current study, the lowest MDL was for benzo(a)pyrene at 1E-08 weight percent in a coke record.

Based on the more recent data, this report provides updated most likely values (MLVs) associated with 68 refinery process streams. Many process streams had decreases in chemical species MLVs versus the original study. Some process streams had increases, but these results were generally supported by larger datasets. More chemical species may have been identified in a given process stream compared to the original study due to the expanded list of species or due to improved laboratory methods providing lower MDLs.

The material contained in this report will be of use in estimating the emissions of specific chemical species, preparing permit applications, and performing other environmental assessments. API, PERF, and the project participants make no claims as to the suitability or acceptability of the stream composition data reported herein for specific reporting or regulatory purposes.

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Acronyms

API	American Petroleum Institute
CAS #	Chemical Abstracts Service number
CAT	catalytic
H/C	hydrocracker or hydrocrackate
HAP	hazardous air pollutant
LPG	liquefied petroleum gas
Max	maximum
MDL	method detection limit
Min	minimum
MLV	most likely value
ND	non-detectable or non-detect
PAH	polycyclic aromatic hydrocarbons
PERF	Petroleum Environmental Research Forum
TRI	Toxic Release Inventory
US EPA	United States Environmental Protection Agency

Definitions

Dataset: Set of records for a given process stream and chemical species combination

MDL: Each analytical method has a lower concentration limit that can be measured and reported with 99 % confidence that the chemical species is present. This concentration is the method detection limit for determining that the chemical species is present in the mixture.

ND: Non-detect is the result provided in an analytical test for a chemical species that cannot be determined to be present at or above the MDL. If the chemical species is expected to be present in the mixture, the concentration is below the MDL. If the chemical species is not expected to be present, a zero may be substituted for a ND result.

Number of analyses: Number of measurements used to calculate the annual average concentration for a record.

N Data: Number of records; also equal to N_{Obs} .

N_{Obs} : Number of records, also equal to N Data.

N Quantified: Number of records that have quantified values—i.e. values reported at or greater than the method detection levels.

R (R Code): An integrated suite of software facilities for data manipulation, calculation, and graphical display. The software provides a wide variety of statistical (linear and nonlinear modeling, classical statistical tests, time-series analysis, classification, clustering, etc.) and graphical techniques.

Record: A row in the database providing all data associated with a submission of an annual average concentration (number of analyses, number of ND, test method, minimum value, maximum value, MDL, etc.).

Refinery Stream Composition Data—Update to Speciation Data in API 4723

1 Introduction

Passage of the Clean Air Act Amendments of 1990 created a number of new compliance challenges for the United States refining industry. To provide improved approaches to meeting these challenges and allow leveraging of research expenditures, a number of the members of the Petroleum Environmental Research Forum (PERF) formed the Cooperative Air Program (CAP). The CAP consisted of a number of individual research projects, including a project to develop industry-representative concentration profiles for refinery process streams. This effort was undertaken to improve emissions estimates for regulatory applicability determinations, operating permits, risk assessments, and other applications. The results of the CAP work were published as API Publication 4723, *Refinery Stream Speciation* [1].

The refinery stream speciation profiles presented in API 4723 were developed from available stream sampling data from participating PERF companies. Most of these data were collected in the 1980s and 1990s. The speciation profiles were based on analyses from 31 refineries, over 20 different process units, and 65 refinery process streams. One of the most significant observations was the wide range of the reported concentrations for some of the chemical species. Since process units usually monitor and control operations based on physical properties such as temperature or pressure, the range of compositions in a specific process stream may vary widely depending on the product slate, processing severity, and other factors.

Since the publication of API 4723 in 2002, new regulatory requirements have resulted in many changes in refinery processes that may have altered process stream compositions. Changing feedstocks, new process additives, and new catalysts may also have affected the concentrations of chemical species present in specific process streams.

Based on an assessment of the range and depth of more recent stream speciation data, PERF elected to update the stream speciation profiles using more recent composition sampling. The updated profiles are provided in this report. PERF members believe that the newer data are more representative due to improved sampling and analytical techniques and that these newer analyses better reflect changes in refinery operations over recent years.

A large database of records was collated for the current study, representing information from 25 refineries. Each record includes the annual average concentration of a chemical species in a given process stream for a given refinery. For this report, *dataset* refers to a collection of records for a given process stream and chemical species combination.

The original study reported on 24 chemical species and the current study provides data on 89 species. The original study reported on 65 refinery process streams and the current project provides data on 68 process streams.

The process units and streams considered are shown in Table 1.

This report is divided into a number of sections that describe the data collection and analysis procedures, contain tables of stream compositions, and provide a graphical presentation of the data.

Section 2 provides a summary of the data gathering methodology. It contains a list of the process units and streams, and the chemical species included in the study.

Section 3 provides the data analysis methodology, including summaries of data quality and quantity.

Table 1—Process Units and Streams

Alkylation—Alkylate/C4 Olefin Feed	Atmospheric Distillation—Light Atmospheric Gas Oil	Coker—Coke ²	Gasoline Blending—Reformulated Gasoline
Alkylation—Alkylate/NOT C4 Olefin Feed	Atmospheric Distillation—Light Ends	Coker—Coker Gas Oil	Hydrodesulfurization—Diesel
Alkylation—Butane	Atmospheric Distillation—Straight Run Gasoline	Coker—Coker Heavy Naphtha	Hydrodesulfurization—Heating Oil
Alkylation—LPG	Atmospheric Distillation—Straight Run Kerosene	Coker—Coker Light Naphtha	Hydrodesulfurization—Jet/Kerosene
Amine Treating—Fuel Gas ¹	Atmospheric Distillation—Straight Run Naphtha	Coker—Total Naphtha ¹	Hydrodesulfurization—Naphtha
Amine Treating—Sour Gas	Cat Hydrocracker—Heavy H/C Distillate	Coker—Unsaturated Gas	Kerosene Treating—Commercial Jet Fuel
Amine Treating—Treated Olefin	Cat Hydrocracker—Heavy H/C Naphtha	Cracked Gas Plant—Fuel Gas	Lube Unit—Solvent Refined Lubes ²
Aromatics Extract—Benzene	Cat Hydrocracker—Light H/C Distillate	Cracked Gas Plant—Olefins	Naphtha Pretreat—Desulfurized Naphtha
Aromatics Extract—Heavy Aromatics	Cat Hydrocracker—Light H/C Naphtha	Cracked Gas Plant—Sour Gas	Polymerization—Butane
Aromatics Extract—Toluene	Cat Hydrocracker—Saturated Gas	Cracked Gas Plant—Unsaturated Gas	Polymerization—Propane
Aromatics Extract—Xylenes	Cat Hydrotreater—Cat Cracker Feed	Distillate Blending—Diesel Fuel	Supply System—Crude Oil
Asphalt Plant—Asphalt ²	Cat Isomerization—Isobutane	Distillate Blending—Home Heating Oil	Vacuum Distillation—Heavy Vacuum Gas Oil
Asphalt Plant—(Feed) Pitch ²	Cat Isomerization—Isom Naphtha	Fluid Cat Cracker—Cracked Gasoline	Vacuum Distillation—Light Vacuum Gas Oil
Asphalt Plant—Used Solvent	Cat Isomerization—Isopentane ¹	Fluid Cat Cracker—Heavy Cat Gas Oil	Vacuum Distillation—Vacuum Naphtha
Atmospheric Distillation—Atmospheric Residue	Cat Reformer—Reformate	Fluid Cat Cracker—Light Cat Gas Oil	Vacuum Distillation—Vacuum Residue Oil
Atmospheric Distillation—Heavy Atmospheric Gas Oil	Cat Reformer—Reformate Gas	Gasoline Blending—Aviation Gasoline	Various Units—Slop Oil
Atmospheric Distillation—Heavy Naphtha	Caustic Treating—Spent Caustic	Gasoline Blending—Conventional Gasoline	Visbreaker—Cracked Residue ²
¹ New process stream that was not included in original study. ² Process stream that was considered in the original study, but for which no data were provided by participants in that study.			

Section 4 provides the stream composition data in tabular form. First, the number of annual average concentration values used in the current study for the process streams are presented. This is followed by a table listing the number of annual average concentration values by chemical species. The remaining tables provide statistical information for each process unit and associated stream, including the minimum, maximum, and most likely values (MLVs) of the concentration of each compound. These tables (Tables 7 through 74) are the main product of this study.

Section 5 provides a comparison of this updated study to the data in API 4723.

Appendix A contains the process flow diagrams from the original study that were provided as a reference to refineries submitting data.

Appendix B provides graphical presentations of the data by process unit and stream. These graphs show the current study data, current study MLV, and original study MLV for groups of species in each process unit.

Appendix C provides the formulas used within the statistical program (R code) for data conversion to weight percent. See Section 3.1 for further discussion.

The material contained in this report will be of use in estimating the emissions of specific chemical species, preparing permit applications, and performing other environmental assessments. API, PERF, and the project participants make no claims as to the suitability or acceptability of the stream composition data reported herein for specific reporting or regulatory purposes.

2 Data Gathering Methodology

2.1 General

Participating refineries identified the process streams to include in the study, identified the chemical species, used a data collection template, and followed the same instructions for data gathering. Refineries provided available data from the last 10 years, and no new sampling efforts were conducted specifically for this study.

2.2 Identification of Process Streams

The process flow diagrams of refinery units and streams found in Figures 1 through 17 of API 4723 were relied upon in the current study for consistency of identification and classification of process streams by refiners. The flow diagrams are included in Appendix A of this report. No additional process units were added for the current study. However, a Cat Isomerization–Isopentane process stream was added and is reflected in the flow diagram for the Cat Isomerization unit. Additionally, concentration data for Amine Treating–Fuel Gas and for Coker–Total Naphtha were collected in the study. As indicated in Table 1, this study also generated data for the following process streams for which no data were reported in the original study: Asphalt Plant–Asphalt, Asphalt Plant–(Feed) Pitch, Coker–Coke, Lube Unit–Solvent Refined Lubes, and Visbreaker–Cracked Residue. Conversely, process streams that had data reported in the original study, but did not have data reported in this study, were the following: Polymerization–Polymerization Naphtha, Sour Water Stripper–Stripped Sour Water, Saturated Gas Plant–Saturated Gas, and Sulfur Plant–Claus Plant Effluent Gas.

2.3 Identification of Process Species

PERF members reviewed the list of chemical species from the original study, the range of chemical species that are typically reported in the U.S. Environmental Protection Agency (US EPA) TRI reports from refineries, and the full list of hazardous air pollutants (HAPs) to determine the list of chemical species for consideration in this study. The list of chemical species considered is displayed in Table 2 below. The 24 species from the original study are noted in the table with an asterisk. During the data collection for this study, refineries provided data for additional chemical species even though they were not on the target list of species. If such data were provided by more than one source or for multiple years and were not determined to be extraneous as noted in Section 3.3, they were included in the study. There were also some species on the targeted list for which no data were reported. The final list of chemical species included in the study analysis is shown in Table 6.

Table 2—Targeted Chemical Species

Species Name	CAS #	Species Name	CAS #
1,2 Dichloroethane	107062	Ethane *	74840
1,2,4-Trimethylbenzene *	95636	Ethylbenzene *	100414
1,3 Butadiene *	106990	Ethylene*	107211
2,2,4-Trimethylpentane (isooctane) *	540841	Ethylene glycol *	74851
2,4 Dimethylphenol	105679	Hydrogen sulfide *	7783064
Acetaldehyde	75070	Indeno(1,2,3-cd)pyrene	193395
Acrolein	107028	Isoprene	78795
Anthracene	120127	Lead	N420
Antimony	N010	m,p Cresol	108394
Arsenic	N020	m-Xylene	108383
Barium	N040	Mercury	N458
Benzene *	71432	Methanol *	67561
Benzo(a)anthracene	56553	Methyl ethyl ketone *	78933
Benzo(a)pyrene	50328	Methyl isobutyl ketone	108101
Benzo(b)fluoranthene	205992	Methylcyclo-hexane	108872
Benzo(g,h,i)perylene	191242	Methyl-t-butyl ether *	1634044
Benzo(j,k)fluorine	76774500	n-Hexane*	110543
Benzo(k)fluoranthene	207089	Naphthalene *	91203
Beryllium	N050	Nickel	N495
Biphenyl *	92524	o-Cresol	95487
Butane *	106978	o-Xylene	95476
Cadmium	N078	p-Xylene	106423
Carbon disulfide	75150	PAH Total	30311
Carbon tetrachloride	56235	Phenanthrene	85018
Carbonyl sulfide	463581	Phenol *	108952
Chloroethane (methyl chloride)	75003	Propane *	74986
Chromium	N090	Propylene *	115071
Chromium (hexavalent)	18540299	Propylene oxide	75569
Chrysene	218019	Selenium	N725
Cobalt	N096	Silver	N740
Copper	N100	Styrene *	100425
Cresols (Total) *	1319773	Thallium	N760
Cumene *	98828	Toluene *	108883
Cyanide	N106	Trimethylbenzene	25551137
Cyclohexane	110827	Vanadium	N770
Dibromoethane	106934	Xylenes (Total) *	1330207
Diethanolamine	111422	Zinc	N982
Ethyl t-butyl ether	637923		
* Original study chemical species.			

2.4 Creation of Data Template and Instructions for Data Gathering

A common data submission template was used by PERF member refineries for entering the analytical data and other information needed for processing the data in a statistical program. For accuracy and consistency, step-by-step guidance was included in the template to ensure that the person entering the data would understand how to report the results and method detection limits (MDLs).

The data template included the following information for a given process stream and chemical species for a given year:

- annual average concentration per chemical species;
- analytical test method(s) used;
- average MDL of the analytical test method;
- number of analyses and number of non-detects comprising the annual average concentration;
- minimum and maximum concentrations observed.

If all concentration data for a given process stream and chemical species were below the MDL during a year, refineries were instructed to report the annual average concentration as non-detectable or “ND”.

If the concentration data being averaged were a mixture of non-detects and actual quantified results, refineries were instructed to calculate the annual average using half the MDL for each non-detect result.

2.5 Data Consistency Analysis

A review of the raw data submitted identified some values that appeared anomalous. Through discussions with company representatives, it was determined that some of the original submissions had the following issues:

- Submissions had been consolidated into the wrong stream-species classification.
- Submissions, while from streams within a process unit, were not from one of the limited number of process streams defined in Table 1 that would be considered in the analysis.

Data that were incorrectly classified or appeared illogical (chemical species not normally in a process stream) were reviewed with company representatives, and participants provided corrected data submissions as needed. Extraneous process stream information was not included in the final dataset.

While some of the datasets had a very wide range of reported annual average concentrations for the given chemical species, a large variability in the compositions of refinery process streams was expected and no acceptable criteria for rejecting any of the annual average concentration results were identified. Fortunately, many records were submitted for the process streams and the MLV determined for these streams was not greatly affected by retaining the few potentially questionable individual chemical species' results.

3 Data Analysis

3.1 Data Quality Assurance

The data collection effort yielded 19,145 records with annual average concentration values representing 25 refineries. The concentration values were provided by PERF member companies in a range of units. All data with non-weight-percent unit designations were converted to weight percent for the statistical analysis. About 66 % of the records received were in directly useable formats. These records had unit designations of weight percent, micrograms per kilogram, grams per kilogram, parts per million by weight, parts per billion by weight,

and thousand micrograms per kilogram. Approximately 33 % of the records needed to be converted to weight percent values by obtaining specific gravity, density, or molecular weight for the specific process stream affected. In most cases, this information was provided by the specific refinery or PERF member company. Just over 1 % of the records had to rely on published specific gravity or molecular weight. These conversions were reviewed and approved by the company representatives. A small number of records (0.3 %) did not include unit information or could not be converted to weight percent. These records were removed from the final datasets.

Analytical test methods used were reviewed to confirm that they were recognized standard methods or approved corporate methods. If methods could not be confirmed, associated records were removed from the analyses.

Concentration data were reviewed, and records marked with laboratory “J” quality flag (i.e. laboratory estimated quantity) were removed. All data for chemical species not previously identified for inclusion in the study were individually reviewed to determine if the data should be included. The annual average concentration values were included if multiple refineries submitted records for the same chemical species or if a single refinery submitted the data for multiple years using an acceptable test method.

The data quality indicators applied were as follows:

- A = directly applicable data with unit designations of weight percent, micrograms per kilogram, grams per kilogram, parts per million by weight, parts per billion by weight, or thousand micrograms per kilogram
- B = data that needed to be converted to weight percent values where the process stream specific gravity was provided by the refinery that provided the analytical data
- C = data that needed to be converted to weight percent values utilizing published process stream data
- J = unusable data (laboratory estimated quantity)

These quality codes were later used for weighting in calculating the MLV, consistent with the approach in the original PERF study. The formula reflecting the weighting of data quality is shown in Section 3.4.5.3.

3.2 Data Quantity

The data records used in the final data analysis in this study were 16,336 (out of a total of 19,145 records collected).

Some refineries have continuous mass spectrometers on a small number of process streams. For these situations, the refineries provided an annual average concentration for the chemical species in that process stream, but listed the number of analyses per year in the thousands or as continuous. To prevent undue influence on the calculation of the MLV due to one refinery's data for a continuously monitored stream, the number of analyses for continuous sampler data was truncated to 52. Thus, all data with number of analyses 52 or greater were recoded to 52 (2,941 records).

3.3 Excluded Data and Replaced Values

Records with the following characteristics were excluded from the MLV calculations.

- Data quality was recorded as J.
- The number of analyses was not recorded.
- The number of non-detects was not recorded.

- The record was recorded as quantified (not a non-detect), but the annual average concentration value was reported as 0.
- The number of analyses was equal to the number of non-detects, indicating all values were non-detect, but the record was reported as a quantified value.
- The number of analyses was not equal to the number of non-detects, but the record was reported as a non-detect.

After the above exclusions, 16,336 annual average concentration results were available for MLV calculations. As noted previously, for many of the records, for which measurements were taken continuously, the annual number of analyses and associated number of non-detects were reassigned a value of 52.

In a few cases, annual average concentration values for chemical species that would not be expected to be present in a petroleum refinery or not in the reference stream were reported. Annual average results for these irrelevant species, listed below, were not included in the MLV determinations.

- 1,2,3-Trichloropropane;
- 2,4-Diaminotoluene;
- ethyl t-butyl ether from Supply System—Crude Oil;
- methyl-t-butyl ether from Supply System—Crude Oil.

Of the 16,336 records, 8,504 had an MDL less than 0.01 weight percent, a default value used in the original PERF study. For 2,643 records that had missing MDL values or MDL values reported as zero, the median MDL for the associated stream and chemical species was used in the MLV calculations as described in more detail below.

Figure 1 shows the distribution of annual average concentrations in each data quality class (as described in Section 3.1) following exclusions.

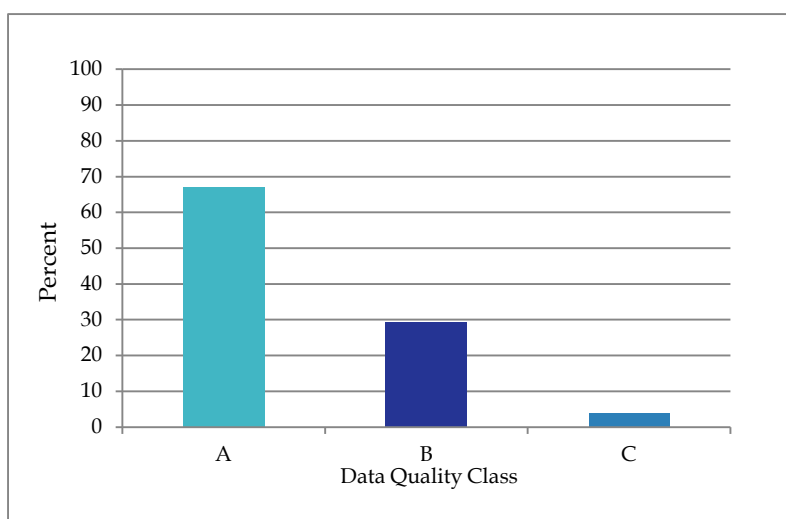


Figure 1—Summary of Data Quality Classes After Exclusions

3.4 Statistical Analysis

3.4.1 General

The objective of this study was to determine the MLV for the concentration of a chemical species in a specific stream from a specific process unit.

MLVs were calculated in accordance with the methodology used in API 4723. As in the original study, a survival regression model was used to obtain unbiased estimates of the MLV from the reported data.

3.4.2 Data Submission and Consolidation

Project participants were asked to submit the annual average measured concentration of each chemical species for each stream (as available) or the fact that the species was not detected (non-detect) if an analysis had been made as discussed in Section 2.4.

The submissions for all the participants were consolidated into the defined process stream and species categories and were reviewed and corrected by the study participants as necessary.

3.4.3 Statistical Analysis to Develop the Most Likely Value

For each refinery process stream and chemical species, the MLV was estimated from the annual average concentrations, in weight percent, contained in the dataset. This section describes the statistical methods used to estimate the MLV. All computations were carried out using the free R software environment for statistical computing and graphics (R Core Team, 2016 [2]).ⁱ

Consistent with the original PERF study, when the number of observations for a process stream and chemical species combination was sufficient (≥ 4 observations and 2 or greater were quantifiable annual average concentrations), the MLV was estimated by the median annual average concentration using survival regression. That is, the median was estimated by fitting a lognormal distribution to the annual average result and accounting for left-censoring (non-detects).

In a lognormal distribution, the natural logs of the measured values can be represented by a normal distribution, an easy distribution for manipulation and presentation. Many studies with hydrocarbon measurements have used the lognormal distribution to establish a conservative estimate of the MLV. While no statistical distribution could perfectly represent all data in this study, experiences of previous studies and validity checks provide ample justification for choosing the lognormal distribution. As shown in the formulas in Section 3.4.5, the determination of the MLV utilized three pieces of information for every record for a specific process stream and species:

- data to represent the annual average concentration—either a reported concentration value or the MDL;
- detection limit indicator to designate whether the annual average concentration was a quantified value or a non-detect at a specified MDL;
- weight based on the number of analyses supporting the reported result and on the quality of the data.

MLV estimates were weighted to reflect the quality (as described in Section 3.1) and number of analyses for each record. The highest weights were given to the highest quality data (A) with the largest number of analyses; the lowest weights were given to low quality data (C). See definition of weighting (wt) in Table 3 below.

ⁱ R is an integrated suite of software facilities for data manipulation, calculation, and graphical display. The software provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, etc.), and graphical techniques.

Due to refinery process changes since the original PERF study, the original study's process stream speciation data were excluded from the establishment of the updated process stream speciation MLV determinations. The summary results tables that the original study provided were used by this project for comparison purposes only. See Table 75 (Comparison of Current Analysis with Original Analysis) in Section 5.

3.4.4 Treatment of Non-detects

Often statistical analyses are carried out on data below MDL using a replacement method. For instance, data reported as below MDL are replaced with half the MDL. The resulting summary statistics tend to be biased (Helsel, 2005 [3]), especially when the MDLs are large and/or differ across the dataset.

Much of the speciation data submitted by the participants was reported as "less than the MDL" with the value of the MDL specified. However, MDLs varied by the reporting refinery. The original PERF study results included the assumption that 0.01 weight percent was a typical minimum value for a detection limit for hydrocarbon measurement and that value was used for all detection limits that were reported as less than 0.01 weight percent for small datasets (see Table 4—MLV Procedure). The current study did not assign a minimum detection limit value; rather, the actual MDLs were utilized. If MDL values were not provided or were assigned zero, a median MDL was calculated from the records for that process stream-chemical species combination.

The US EPA has used non-detects as valued at one-half the detection limit. For the determination of an MLV, the current study used the procedures described in Table 4. This approach was based on the original procedure and incorporates more sophisticated methods for handling non-detects to reduce bias. The left censored methodsⁱⁱ used are recommended by Helsel [3].

In some cases, the MDL exceeded the largest quantified annual average concentration result for a given process stream and chemical species combination. To avoid skewing the MLV due to a high MDL, the ND result with the high MDL was removed.

3.4.5 MLV Calculation Procedure

3.4.5.1 General

The lognormal distribution can be fit using survival regression methods that explicitly account for left censoring. These methods provide unbiased estimates of the MLV. For this study, models were fit and estimates obtained using the survival regression function ('survreg') in R 3.3.2 (R Core Team, 2016 [2]). Weights, as defined in API 4723, were used to account for the number of analyses used to create each result and the quality of the data as reflected in the definitions and procedures below.

When very few records were available, it was not feasible to use the regression approach and alternative estimation methods were used (see MLV Procedure below).

3.4.5.2 Data Definitions

The definitions in Table 3 describe the data used to calculate MLVs for each process stream and chemical species combination. References to variable names in the database are indicated with quotations (' '). The first set of definitions refers to values submitted for each record. The second set of definitions refers to values calculated across each dataset (all records for a given process stream and chemical species combination).

ⁱⁱ Parametric left censoring methods, such as survival regression, account for the fact that non-detects fall within a range (here, 0 to MDL) rather than assuming they are equal to some arbitrary value, such as half MDL. Thus, they use all the available information without making unrealistic assumptions that can introduce bias.

Table 3—Definitions for MLV Calculations

Records Definitions		
n	=	number of analyses ('NoAnalyses') used to calculate submitted annual average concentration ('Results') for each record
n _{nd}	=	number of analyses ('NoND') below MDL included to calculate submitted annual average concentration for each record
x	=	annual average concentration ('Result') for each record
cens	=	0 if x quantified ('ND.Results'==FALSE) 1 if x not detected ('ND.Results'==TRUE)
Mdl	=	reported method detection limit ('MDL')
wt	=	$\text{sqrt}(n) \cdot (I_A + 0.8 \cdot I_B + 0.6 \cdot I_C)$ where I_A , I_B , and I_C are indicator functions for data quality ('Quality')
Dataset Definitions		
N _{obs}	=	number of records per stream/species; also equal to N Data
N _{cens}	=	number of records per stream/species with all analyses censored ('ND.Results'==TRUE)
N _{quant}	=	$N_{\text{obs}} - N_{\text{cens}}$
X _{min}	=	min (x) if N _{quant} > 0 ND if N _{quant} = 0
X _{max}	=	max (x) if N _{quant} > 0 ND if N _{quant} = 0
mdl _{median}	=	median(mdl)
mlv _{regr}	=	predicted value from a log normal survival regression model
mlv	=	most likely value (MLV)
survreg()	=	R function to fit a parametric survival regression model (R 3.3.2, 2016) to censored data

3.4.5.3 MLV Procedure

Using the data definitions, Table 4 shows how MLVs were calculated in the original study and the current study.

Table 4—MLV Procedure

N _{obs}	N _{quant}	Original Study (API 4723 Data) Procedure	Current Procedure
<4	0	mlv = 0.01	ND
	1 or 2	$\text{mlv} = 0.01 \text{ if } x_{\text{max}} = 0.01$ $= \exp\{ [\log(0.01) + \log(x_{\text{max}})]/2 \}$ $\text{if } x_{\text{min}} = \text{ND}$ $= \exp\{ [\log(x_{\text{min}}) + \log(x_{\text{max}})]/2 \}$ $\text{if } x_{\text{min}} \neq \text{ND}$	$\text{mlv} = \text{ND} \text{ if } x_{\text{max}} = \text{ND}$ $= \exp\{ [\log(\text{mdl}_{\text{median}}/2) + \log(x_{\text{max}})]/2 \}$ $\text{if } x_{\text{min}} = \text{ND}$ $= \exp\{ [\log(x_{\text{min}}) + \log(x_{\text{max}})]/2 \}$ $\text{if } x_{\text{min}} \neq \text{ND}$
<4	3	$\text{mlv} = 0.01 \text{ if } x_{\text{max}} = 0.01$ $= \text{mlv}_{\text{regr}} \text{ if } x_{\text{min}} < x_{\text{max}} \text{ or } 0.01 < x_{\text{max}}$	$\text{mlv} = x_{\text{max}} \quad \text{if } x_{\text{min}} = x_{\text{max}} \text{ or } \text{mdl}_{\text{median}} = x_{\text{max}}$ $= \text{mlv}_{\text{regr}} \quad \text{if } x_{\text{min}} < x_{\text{max}} \text{ or } \text{mdl}_{\text{median}} < x_{\text{max}}$
≥4	0	mlv = 0.01	ND
≥4	1	$\text{mlv} = \exp\{ [(N-1) \cdot \log(0.01) + \log(x_{\text{max}})]/N \}$	$\text{mlv} = \exp\{ [(N_{\text{obs}}-1) \cdot \log(\text{mdl}_{\text{median}}/2) + \log(x_{\text{max}})]/N_{\text{obs}} \}$
≥4	2 or greater	mlv = mlv _{regr}	$\text{mlv} = \text{mlv}_{\text{regr}} \quad \text{if } x_{\text{min}} < x_{\text{max}}$ $= x_{\text{max}} \quad \text{if } x_{\text{min}} = x_{\text{max}}$

4 Summary of Updated Process Stream Composition Data

4.1 General

Many of the study results are as expected. It is noted that this study found that catalytic process product streams generally consisted of the primary product, with smaller concentrations of byproducts. This is assumed to be attributable to improvement in catalyst performance and shifts in refinery operations.

Many process streams had chemical species MLVs decrease versus the original study values. Some process streams had increases, but these results were generally based on larger datasets.

Table 5 lists the unit names and streams associated with that unit and the number of annual average concentration results used in the current study after the exclusions listed in Section 3.3 to determine the MLV. Table 6 lists the chemical species used in the analysis and the number of annual average concentration values associated with each species. Tables 7 through 74 present the details for each process stream.

4.2 Refinery Units and Associated Streams

Table 5—Number of Annual Average Concentration Values for the Refinery Units and Streams

Unit Name—Stream Name	Number of Annual Average Concentration Values
ALKYLATION—Alkylate/C4 Olefin Feed	166
ALKYLATION—Alkylate/NOT C4 Olefin Feed	147
ALKYLATION—Butane	289
ALKYLATION—LPG	116
AMINE TREATING—Fuel Gas	20
AMINE TREATING—Sour Gas	54
AMINE TREATING—Treated Olefinic	113
AROMATICS EXTRACT—Benzene	252
AROMATICS EXTRACT—Heavy Aromatics	61
AROMATICS EXTRACT—Toluene	168
AROMATICS EXTRACT—Xylenes	38
ASPHALT PLANT—(Feed) Pitch	212
ASPHALT PLANT—Asphalt	136
ASPHALT PLANT—Used Solvent	42
ATMOSPHERIC DISTILLATION—Atmospheric Residue	37
ATMOSPHERIC DISTILLATION—Heavy Atmospheric Gas Oil	493
ATMOSPHERIC DISTILLATION—Heavy Naphtha	395
ATMOSPHERIC DISTILLATION—Light Atmospheric Gas Oil	565
ATMOSPHERIC DISTILLATION—Light Ends	283
ATMOSPHERIC DISTILLATION—Straight Run Gasoline	334
ATMOSPHERIC DISTILLATION—Straight Run Kerosene	189
ATMOSPHERIC DISTILLATION—Straight Run Naphtha	742
CATALYTIC HYDROCRACKER—Heavy H/C Distillate	316
CATALYTIC HYDROCRACKER—Heavy H/C Naphtha	269
CATALYTIC HYDROCRACKER—Light H/C Distillate	70
CATALYTIC HYDROCRACKER—Light H/C Naphtha	306
CATALYTIC HYDROCRACKER—Saturated Gas	217
CATALYTIC HYDROTREATER—Cat Cracker Feed	558
CATALYTIC ISOMERIZATION—Isobutane	74
CATALYTIC ISOMERIZATION—Isom Naphtha	168
CATALYTIC ISOMERIZATION—Isopentane	132
CATALYTIC REFORMER—Reformate	899
CATALYTIC REFORMER—Reformate Gas	392
CAUSTIC TREATING—Spent Caustic	321

Unit Name—Stream Name	Number of Annual Average Concentration Values
COKER—Coke	106
COKER—Coker Gas Oil	225
COKER—Coker Heavy Naphtha	370
COKER—Coker Light Naphtha	264
COKER—Coker Total Naphtha	134
COKER—Unsaturated Gas	203
CRACKED GAS PLANT—Fuel Gas	127
CRACKED GAS PLANT—Olefins	218
CRACKED GAS PLANT—Sour Gas	87
CRACKED GAS PLANT—Unsaturated Gas	105
DISTILLATE BLENDING—Diesel Fuel	87
DISTILLATE BLENDING—Home Heating Oil	10
FLUID CATALYTIC CRACKER—Cracked Gasoline	690
FLUID CATALYTIC CRACKER—Heavy Cat Gas Oil	270
FLUID CATALYTIC CRACKER—Light Cat Gas Oil	433
GASOLINE BLENDING—Aviation Gasoline	95
GASOLINE BLENDING—Conventional Gasoline	557
GASOLINE BLENDING—Reformulated Gasoline	200
HYDRODESULFURIZATION—Diesel	424
HYDRODESULFURIZATION—Heating Oil	36
HYDRODESULFURIZATION—Jet/Kerosene	245
HYDRODESULFURIZATION—Naphtha	311
KEROSENE TREATING—Commercial Jet Fuel	57
LUBE UNIT—Solvent Refined Lubes	18
NAPHTHA PRETREAT—Desulfurized Naphtha	355
POLYMERIZATION—Butane	38
POLYMERIZATION—Propane	20
SUPPLY SYSTEM—Crude Oil	738
VACUUM DISTILLATION—Heavy Vacuum Gas Oil	491
VACUUM DISTILLATION—Light Vacuum Gas Oil	199
VACUUM DISTILLATION—Vacuum Naphtha	3
VACUUM DISTILLATION—Vacuum Residue	115
VARIOUS UNITS—Slop Oil	519
VISBREAKER—Cracked Residue	12
Total	16,336

4.3 Species Included in Analysis

Table 6—Number of Annual Average Concentration Values for Each Chemical Species

Species Name	Number of Annual Average Concentration Values
1,2-Dibromoethane *	23
1,2-Dichloroethane	31
1,2,4-Trimethylbenzene	314
1,3-Butadiene	449
2,2,4-Trimethylpentane (isooctane)	235
2,4 Dimethylphenol	2
Acenaphthene *	128
Acenaphthylene *	129
Acetaldehyde	1
Ammonia *	2
Anthracene	220
Antimony	37
Arsenic	87
Barium	42
Benzene	1,017
Benzo(a)anthracene	217
Benzo(a)pyrene	224
Benzo(b)fluoranthene	103
Benzo(b/j)fluoranthene *	24
Benzo(e)pyrene *	110
Benzo(g,h,i)perylene	222
Benzo(k)fluoranthene	222
Beryllium	23
Biphenyl	107
Butane	836
Cadmium	76
Carbon disulfide	74
Carbon tetrachloride	8
Carbonyl sulfide	58
Chromium	101
Chrysene	129
Cobalt	56
Copper	95
Cresols (Total)	12
Cumene	359
Cycloheptane *	52
Cyclohexane	625
Cyclooctane *	49

Species Name	Number of Annual Average Concentration Values
Decane *	89
Dibenz(a,j)acridine *	2
Dibenzo(a,h)anthracene *	86
Diethanolamine	23
Ethyl t-butyl ether	103
Ethane	566
Ethylbenzene	546
Ethylene	203
Fluoranthene *	127
Fluorene *	127
Heptane *	94
Hydrogen sulfide	437
Indeno(1,2,3-c,d)pyrene	221
Isoprene	173
Isopropyl alcohol *	1
Lead	120
m-Xylene	256
m,p-Cresol	8
m,p-Xylene *	34
Manganese *	28
Mercury	46
Methane *	16
Methanol	163
Methyl-t-butyl ether	168
Methyl ethyl ketone	51
Methyl isobutyl ketone	46
Methylcyclohexane	154
n-Hexane	808
Naphthalene	401
Nickel	378
Nonane *	98
o-Cresol	23
o-Xylene	234
Octane *	97
p-Xylene	247
PAH Total	56
Pentane *	142
Perylene *	106
Phenanthrene	236
Phenol	40
Propane	768

Species Name	Number of Annual Average Concentration Values
Propylene	382
Pyrene *	126
Selenium	40
Silver	24
Styrene	90
Toluene	737
Trimethylbenzene	95
Vanadium	367
Xylenes (Total)	373
Zinc	81
Total	16,336
* Additional chemical species that were submitted in addition to the targeted Chemical Species List in Table 2.	

4.4 Compositions Listed by Refinery Units and Stream

Tables 7 through 74 provide additional statistical information from the analysis for each process unit and associated stream, including the minimum, maximum, and most likely values (MLVs) of the concentration of each compound and the median MDL in weight percent. N Data represents the total number of records for that chemical species in that specific process stream, N Quantified represents the number of records that had quantified annual average concentrations, and ND represents a non-detect value. For chemical species where all records had annual average concentration results below the MDL (N Quantified equal to zero), ND was used to represent Min, Max, and MLV values.

As described in Section 3.4.4, some of the quantified data did not include the associated MDL for the analytical test, but other non-detect results provided an MDL. This combination of data conditions occasionally results in a median MDL that is greater than the Max value for that process stream-chemical species combination. There are also process stream-chemical species combinations that did not provide any MDL information, only quantified results. This is displayed by a blank in the MDL column.

API, PERF, and the project participants make no claims as to the suitability or acceptability of the stream composition data reported herein for specific reporting or regulatory purposes. Refinery-specific process unit information and other relevant factors should be carefully considered when evaluating whether or how to use chemical species data.

Table 7—ALKYLATION—Alkylate/C4 Olefin Feed

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2-Dibromoethane	1	0	ND	ND	ND	0.002
1,2-Dichloroethane	1	0	ND	ND	ND	0.001
1,2,4-Trimethylbenzene	1	1	0.089	0.089	0.089	0.01
1,3-Butadiene	7	5	ND	0.098	0.0288	0.0131
2,2,4-Trimethylpentane (isooctane)	1	0	ND	ND	ND	0.002
Benzene	17	6	ND	0.291	0.00557	0.0123
Biphenyl	1	0	ND	ND	ND	2
Butane	15	15	0.599	11.8	3.88	0.00847
Carbon disulfide	2	2	8.41E-07	1.5E-06	1.12E-06	5.7E-06
Carbonyl sulfide	3	3	2.39E-05	8.88E-05	4.61E-05	6.8E-06
Cumene	4	1	ND	0.159	0.0119	0.0111
Cyclohexane	12	6	ND	0.0937	0.00818	0.011
Diethanolamine	1	0	ND	ND	ND	0.052
Ethane	12	3	ND	0.009	0.00563	0.00766
Ethylbenzene	5	3	ND	0.015	0.00861	0.01
Ethylene	3	1	ND	0.00778	0.0055	0.00778
Hydrogen sulfide	3	3	1.8E-06	1.21E-05	4.61E-06	1.37E-05
Isoprene	9	8	ND	0.236	0.0224	0.00958
m-Xylene	2	0	ND	ND	ND	0.0122
m,p-Xylene	1	1	0.002	0.002	0.002	0.001
Methanol	1	0	ND	ND	ND	0.0021
Methyl-t-butyl ether	1	0	ND	ND	ND	0.001
Methyl ethyl ketone	1	0	ND	ND	ND	0.001
Methyl isobutyl ketone	1	0	ND	ND	ND	0.001
n-Hexane	17	13	ND	1.21	0.0143	0.00928
Naphthalene	4	3	ND	0.141	0.0363	0.0132
o-Cresol	1	0	ND	ND	ND	5E-04
o-Xylene	3	1	ND	0.0124	0.00877	0.0124
p-Xylene	3	1	ND	0.02	0.011	0.0121
Phenanthrene	1	0	ND	ND	ND	1E-04
Phenol	2	0	ND	ND	ND	1
Propane	7	3	ND	4.64	0.876	0.139
Propylene	3	3	3.71	5.96	5	0.251
Styrene	1	0	ND	ND	ND	0.01
Toluene	10	8	ND	13.8	0.108	0.0122
Xylenes (Total)	4	4	0.0027	0.0747	0.0218	0.0125

Table 8—ALKYLATION—Alkylate/NOT C4 Olefin Feed

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	10	10	0.03	0.19	0.0768	0.01
1,3-Butadiene	2	0	ND	ND	ND	0.01
2,2,4-Trimethylpentane (isooctane)	10	10	23.8	31.5	27.6	0.01
Benzene	18	17	ND	0.73	0.242	0.0702
Biphenyl	1	1	0.01	0.01	0.01	0.01
Butane	6	6	2.14	4.53	2.82	0.01
Cumene	2	2	0.02	0.03	0.0245	0.01
Cyclohexane	8	4	ND	0.05	0.0104	0.01
Ethyl t-butyl ether	9	0	ND	ND	ND	0.1
Ethylbenzene	9	8	ND	0.117	0.0275	0.01
Isoprene	4	0	ND	ND	ND	0.01
m-Xylene	3	3	0.071	0.286	0.157	0.01
Methanol	9	0	ND	ND	ND	0.1
Methyl-t-butyl ether	9	2	ND	0.11	0.0795	0.1
Methylcyclohexane	2	2	0.03	0.05	0.0387	0.01
n-Hexane	9	8	ND	0.559	0.0834	0.01
Naphthalene	6	6	0.012	0.104	0.0508	0.01
o-Xylene	7	7	0.033	0.22	0.118	0.01
p-Xylene	2	2	0.06	0.124	0.0863	0.01
Propane	4	0	ND	ND	ND	0.01
Toluene	9	7	ND	9.95	0.526	0.01
Xylenes (Total)	8	8	0.033	0.581	0.143	0.01

Table 9—ALKYLATION—Butane

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	1	1	0.029	0.029	0.029	
1,3-Butadiene	41	15	ND	1.24	0.00265	0.0104
Acenaphthylene	1	1	0.029	0.029	0.029	
Benzene	2	2	0.00146	0.00439	0.00253	0.0146
Butane	63	63	29.4	98	69.1	0.01
Carbon disulfide	1	0	ND	ND	ND	1E-05
Carbonyl sulfide	1	0	ND	ND	ND	1E-05
Cyclohexane	5	2	ND	0.51	0.00989	0.013
Ethane	38	7	ND	0.044	0.00556	0.00909
Ethylene	3	0	ND	ND	ND	0.0163
Hydrogen sulfide	3	0	ND	ND	ND	0.0132
Methane	4	4	0.016	0.0435	0.0311	
n-Hexane	8	4	ND	0.033	0.0112	0.011
Pentane	12	12	0.302	1.01	0.438	
Propane	56	40	ND	1.16	0.0204	0.00827
Propylene	46	23	ND	0.298	0.00282	0.00862
Toluene	3	3	1.03	1.14	1.09	0.0145

Table 10—ALKYLATION—LPG

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,3-Butadiene	10	4	ND	0.0108	0.0106	0.0106
Benzene	2	1	ND	0.0172	0.0122	0.0172
Butane	19	13	ND	0.144	0.0278	0.0105
Carbon disulfide	5	0	ND	ND	ND	1E-05
Carbonyl sulfide	5	5	3.45E-05	0.000514	0.000194	1E-05
Cyclohexane	3	0	ND	ND	ND	0.0153
Ethane	19	19	0.00927	0.368	0.0443	0.00947
Ethylene	3	0	ND	ND	ND	0.0191
Hydrogen sulfide	6	1	ND	0.0155	1.91E-05	1E-05
n-Hexane	6	1	ND	0.0129	0.00724	0.0129
Propane	19	19	83.1	96.9	87.1	0.00862
Propylene	8	5	ND	0.137	0.00756	0.0101
Toluene	3	0	ND	ND	ND	0.017

Table 11—AMINE TREATING—Fuel Gas

	N Data	N Quantified	Min	Max	MLV	Median MDL
Benzene	4	4	3.42	10.40	5.08	0.13
Ethane	4	4	4.44	7.03	5.96	0.08
Ethylene	4	4	4.89	9.51	7.53	0.15
Propane	4	4	3.76	4.97	4.27	0.07
Propylene	4	4	0.94	2.38	1.44	0.08

Table 12—AMINE TREATING—Sour Gas

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,3-Butadiene	4	0	ND	ND	ND	0.0258
Benzene	3	0	ND	ND	ND	0.0364
Butane	8	7	ND	3.31	0.136	0.025
Carbonyl sulfide	1	1	0.0119	0.0119	0.0119	8.72E-06
Cobalt	1	1	0.0502	0.0502	0.0502	3.69E-05
Ethane	8	7	ND	6.82	3.61	0.0226
Ethylene	4	2	ND	8.44	0.00219	0.0809
Hydrogen sulfide	8	6	ND	3.34	1.48	0.0328
n-Hexane	3	0	ND	ND	ND	0.0273
Propane	7	7	0.324	4.29	0.558	0.0205
Propylene	7	7	0.7	5.36	1.95	0.0214

Table 13—AMINE TREATING—Treated Olefinic

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,3-Butadiene	11	6	ND	0.0988	0.0372	0.0131
Benzene	11	0	ND	ND	ND	0.051
Butane	11	11	0.042	7.47	0.687	0.035
Carbon disulfide	3	1	ND	5.7E-06	4.03E-06	5.7E-06
Carbonyl sulfide	3	3	0.000144	0.000277	0.000174	6.8E-06
Ethane	11	11	0.00103	10.1	0.392	0.00637
Ethylene	6	0	ND	ND	ND	0.0096
Hydrogen sulfide	24	22	ND	4.86	0.0275	0.046
n-Hexane	3	3	0.0101	0.0136	0.012	0.00772
Propane	11	11	0.375	8.58	1.95	0.0288
Propylene	11	11	1.41	17	5.5	0.03
Toluene	3	0	ND	ND	ND	0.0101

Table 14—AROMATICS EXTRACT—Benzene

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	5	3	ND	0.17	0.00799	0.01
1,3-Butadiene	2	0	ND	ND	ND	0.01
2,2,4-Trimethylpentane (isooctane)	1	0	ND	ND	ND	0.01
Anthracene	5	0	ND	ND	ND	0.00275
Benzene	36	36	5.95	100	94.4	0.001
Benzo(a)anthracene	5	0	ND	ND	ND	0.00275
Benzo(a)pyrene	5	0	ND	ND	ND	0.00275
Benzo(g,h,i)perylene	5	0	ND	ND	ND	0.00275
Benzo(k)fluoranthene	5	0	ND	ND	ND	0.00275
Chrysene	5	0	ND	ND	ND	0.00275
Cumene	1	0	ND	ND	ND	0.01
Cycloheptane	3	3	0.00125	0.203	0.0137	
Cyclohexane	35	29	ND	1.02	0.00335	0.005
Ethylbenzene	8	5	ND	0.16	0.00388	0.01
Indeno(1,2,3-c,d)pyrene	5	0	ND	ND	ND	0.00275
Isoprene	3	0	ND	ND	ND	0.01
m-Xylene	4	4	0.004	0.028	0.00881	0.001
Methylcyclohexane	19	19	0.0026	0.004	0.00302	0.005
n-Hexane	32	26	ND	19	0.00332	0.005
Naphthalene	5	0	ND	ND	ND	0.00275
o-Xylene	4	4	0.0035	5.8	0.0269	0.001
p-Xylene	2	2	0.004	0.012	0.00693	0.0055
Pentane	2	2	0.000375	0.0015	0.00075	
Phenanthrene	5	0	ND	ND	ND	0.00275
Propane	3	0	ND	ND	ND	0.01
Toluene	35	35	0.001	21.4	0.0113	0.001
Xylenes (Total)	9	8	ND	0.8	0.0148	0.01

Table 15—AROMATICS EXTRACT—Heavy Aromatics

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,3-Butadiene	6	2	ND	0.743	0.0634	0.0675
Benzene	6	6	10	20.6	12.7	0.0952
Ethane	6	0	ND	ND	ND	0.0591
Ethylbenzene	6	6	0.103	4.9	0.661	0.0942
Ethylene	6	0	ND	ND	ND	0.106
Hydrogen sulfide	6	0	ND	ND	ND	0.0859
o-Xylene	1	1	0.38	0.38	0.38	5E-04
Propane	6	0	ND	ND	ND	0.0538
Propylene	6	1	ND	0.0561	0.0315	0.0561
Toluene	6	6	1.87	7.85	3.54	0.094
Xylenes (Total)	6	6	0.103	26.9	0.686	0.0946

Table 16—AROMATICS EXTRACT—Toluene

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	2	2	0.0045	0.005	0.00474	
2,2,4-Trimethylpentane (isooctane)	1	1	0.0259	0.0259	0.0259	0.00961
Benzene	34	31	ND	16.9	0.0696	0.101
Cyclohexane	1	1	0.0552	0.0552	0.0552	0.0108
Ethylbenzene	25	25	0.002	0.812	0.186	0.1
m-Xylene	22	22	0.0552	0.123	0.0872	0.1
Methylcyclohexane	1	1	0.123	0.123	0.123	0.0107
n-Hexane	3	3	0.009	4.25	0.0378	0.00915
o-Xylene	23	17	ND	5.8	0.0534	0.102
Octane	1	1	0.004	0.004	0.004	
p-Xylene	22	22	0.0497	0.0875	0.0668	0.0994
Pentane	1	1	0.01	0.01	0.01	
Toluene	30	30	21.4	100	97.3	0.0999
Xylenes (Total)	2	2	0.0025	0.0095	0.00487	

Table 17—AROMATICS EXTRACT—Xylenes

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	3	3	0.0015	0.004	0.00247	
Benzene	3	3	0.01	5.95	0.38	0.0005
Cyclooctane	1	1	0.004	0.004	0.004	
Ethylbenzene	5	5	14.50	18.40	16.20	
n-Hexane	2	2	0.003	0.006	0.00424	
Nonane	3	3	0.002	0.016	0.00737	
o-Xylene	2	2	5.80	5.80	5.80	0.0005
Pentane	2	2	0.001	0.0015	0.00122	
Toluene	7	7	0.10	21.40	0.62	0.0005
Trimethylbenzene	5	5	0.05	0.18	0.10	
Xylenes (Total)	5	5	80.70	85.10	82.80	

Table 18—ASPHALT PLANT—(Feed) Pitch

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	5	5	0.12	0.15	0.132	0.1
1,3-Butadiene	5	0	ND	ND	ND	0.1
2,2,4-Trimethylpentane (isooctane)	5	1	ND	0.1	0.0574	0.1
Anthracene	6	1	ND	0.005	0.00281	0.005
Arsenic	3	0	ND	ND	ND	1E-04
Barium	3	1	ND	0.0191	0.000535	5E-05
Benzene	5	5	0.14	0.21	0.18	0.1
Benzo(a)anthracene	6	0	ND	ND	ND	0.005
Benzo(a)pyrene	6	0	ND	ND	ND	0.005
Benzo(g,h,i)perylene	6	1	ND	0.005	0.00281	0.005
Benzo(k)fluoranthene	6	0	ND	ND	ND	0.005
Beryllium	3	0	ND	ND	ND	5E-05
Butane	5	5	0.814	1.05	0.957	0.1
Cadmium	5	0	ND	ND	ND	1E-05
Chromium	4	0	ND	ND	ND	3E-05
Chrysene	6	1	ND	0.005	0.00281	0.005
Cobalt	2	0	ND	ND	ND	5E-05
Copper	4	1	ND	1E-04	1.06E-05	3E-05
Cumene	3	3	0.01	0.02	0.0126	0.01
Cyclohexane	5	5	0.38	0.55	0.477	0.1
Ethylbenzene	5	5	0.11	0.15	0.131	0.1
Ethylene	5	0	ND	ND	ND	0.1
Indeno(1,2,3-c,d)pyrene	6	0	ND	ND	ND	0.005
Isoprene	5	0	ND	ND	ND	0.1
Lead	5	1	ND	5E-04	1.26E-05	1E-05
m-Xylene	5	5	0.23	0.4	0.302	0.01

	N Data	N Quantified	Min	Max	MLV	Median MDL
n-Hexane	5	5	1.12	1.22	1.14	0.1
Naphthalene	6	6	0.0013	0.031	0.0119	0.004
Nickel	16	16	0.00179	0.00633	0.00463	5E-05
p-Xylene	5	5	0.02	0.07	0.0517	0.01
Phenanthrene	6	6	9E-04	0.013	0.00634	0.004
Propane	5	5	0.08	0.13	0.106	0.1
Propylene	5	0	ND	ND	ND	0.1
Silver	1	0	ND	ND	ND	1E-05
Styrene	5	0	ND	ND	ND	0.1
Toluene	5	5	0.32	0.46	0.394	0.1
Vanadium	17	16	ND	0.00983	0.00192	5E-05
Xylenes (Total)	5	5	0.29	0.43	0.362	0.01
Zinc	3	2	ND	3E-05	1.22E-05	1E-05

Table 19—ASPHALT PLANT—Asphalt

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2-Dibromoethane	1	0	ND	ND	ND	2E-04
1,2-Dichloroethane	1	0	ND	ND	ND	1E-04
1,3-Butadiene	1	0	ND	ND	ND	5E-04
2,2,4-Trimethylpentane (isooctane)	2	0	ND	ND	ND	0.0051
Anthracene	6	0	ND	ND	ND	0.005
Antimony	1	1	0.00021	0.00021	0.00021	1E-05
Arsenic	5	0	ND	ND	ND	1E-04
Barium	5	1	ND	5E-05	2.87E-05	5E-05
Benzene	1	1	0.00025	0.00025	0.00025	1E-04
Benzo(a)anthracene	6	0	ND	ND	ND	0.005
Benzo(a)pyrene	6	0	ND	ND	ND	0.005
Benzo(g,h,i)perylene	6	1	ND	0.005	0.00281	0.005
Benzo(k)fluoranthene	6	0	ND	ND	ND	0.005
Beryllium	4	0	ND	ND	ND	5E-05
Biphenyl	1	0	ND	ND	ND	4
Cadmium	5	2	ND	1E-04	3.95E-05	5E-05
Carbon disulfide	1	0	ND	ND	ND	2E-04
Carbonyl sulfide	1	0	ND	ND	ND	4
Chromium	2	2	2E-05	3E-05	2.45E-05	1E-05
Chrysene	6	0	ND	ND	ND	0.005
Cobalt	2	2	2E-05	4E-05	2.83E-05	1E-05
Copper	3	0	ND	ND	ND	5E-05
Cumene	1	0	ND	ND	ND	1E-04
Diethanolamine	1	0	ND	ND	ND	0.048
Ethylbenzene	1	1	0.00029	0.00029	0.00029	1E-04



	N Data	N Quantified	Min	Max	MLV	Median MDL
Indeno(1,2,3-c,d)pyrene	6	0	ND	ND	ND	0.005
Lead	3	2	ND	0.00015	6.12E-05	1E-05
m-Xylene	1	1	0.015	0.015	0.015	0.01
m,p-Xylene	1	1	0.00079	0.00079	0.00079	1E-04
Methanol	1	0	ND	ND	ND	0.0019
Methyl-t-butyl ether	1	0	ND	ND	ND	1E-04
Methyl ethyl ketone	1	0	ND	ND	ND	1E-04
Methyl isobutyl ketone	1	0	ND	ND	ND	1E-04
n-Hexane	2	1	ND	0.01	0.00707	0.0051
Naphthalene	7	0	ND	ND	ND	0.005
Nickel	6	6	0.00284	0.0882	0.00972	3E-05
o-Xylene	1	1	3E-04	3E-04	3E-04	1E-04
Phenanthrene	6	0	ND	ND	ND	0.005
Phenol	1	0	ND	ND	ND	4
Selenium	1	0	ND	ND	ND	1E-05
Toluene	1	1	0.00093	0.00093	0.00093	1E-04
Vanadium	6	6	2E-05	0.0244	0.00623	3E-05
Xylenes (Total)	1	1	0.0011	0.0011	0.0011	1E-04
Zinc	6	5	ND	0.00758	0.000157	3E-05

Table 20—ASPHALT PLANT—Used Solvents

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,3-Butadiene	2	1	ND	0.0722	0.0511	0.0722
Butane	12	12	56	62.4	59.2	0.0699
Ethane	2	2	0.278	0.31	0.294	0.0632
Ethylene	2	1	ND	0.204	0.107	0.113
Propane	12	12	0.161	0.535	0.272	0.0576
Propylene	12	12	0.06	0.204	0.104	0.06

Table 21—ATMOSPHERIC DISTILLATION—Atmospheric Residue

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2-Dibromoethane	1	0	ND	ND	ND	2E-04
1,2-Dichloroethane	1	0	ND	ND	ND	1E-04
1,3-Butadiene	1	0	ND	ND	ND	5E-04
2,2,4-Trimethylpentane (isooctane)	1	0	ND	ND	ND	2E-04
Benzene	1	1	0.00018	0.00018	0.00018	1E-04
Biphenyl	1	0	ND	ND	ND	4
Carbon disulfide	1	0	ND	ND	ND	2E-04
Carbonyl sulfide	1	0	ND	ND	ND	4
Cumene	1	0	ND	ND	ND	1E-04
Diethanolamine	1	0	ND	ND	ND	0.052
Ethylbenzene	1	1	9.3E-05	9.3E-05	9.3E-05	1E-04
m,p-Xylene	1	1	0.00024	0.00024	0.00024	1E-04
Methanol	1	0	ND	ND	ND	0.0021
Methyl-t-butyl ether	1	0	ND	ND	ND	1E-04
Methyl ethyl ketone	1	0	ND	ND	ND	1E-04
Methyl isobutyl ketone	1	0	ND	ND	ND	1E-04
n-Hexane	1	1	0.00049	0.00049	0.00049	2E-04
Naphthalene	1	0	ND	ND	ND	4
Nickel	8	8	0.000646	0.0024	0.00109	3E-04
o-Xylene	1	1	7.8E-05	7.8E-05	7.8E-05	1E-04
Phenol	1	0	ND	ND	ND	4
Toluene	1	1	0.00035	0.00035	0.00035	1E-04
Vanadium	7	7	0.00021	0.00246	0.00145	3E-04
Xylenes (Total)	1	1	0.00032	0.00032	0.00032	1E-04

Table 22—ATMOSPHERIC DISTILLATION—Heavy Atmospheric Gas Oil

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	3	3	0.01	0.03	0.0174	0.01
1,3-Butadiene	5	1	ND	0.1	0.0574	0.1
2,2,4-Trimethylpentane (isooctane)	6	1	ND	0.1	0.0561	0.1
Acenaphthene	12	7	ND	0.0127	0.00231	0.005
Acenaphthylene	12	1	ND	0.005	0.00265	0.005
Anthracene	17	6	ND	0.0295	0.00166	0.005
Arsenic	1	1	3.42E-06	3.42E-06	3.42E-06	
Barium	2	0	ND	ND	ND	3.25E-05
Benzene	5	1	ND	0.1	0.0574	0.1
Benzo(a)anthracene	17	1	ND	0.005	0.0026	0.005
Benzo(a)pyrene	17	0	ND	ND	ND	0.005
Benzo(b/j)fluoranthene	12	0	ND	ND	ND	0.005
Benzo(e)pyrene	11	0	ND	ND	ND	0.005

	N Data	N Quantified	Min	Max	MLV	Median MDL
Benzo(g,h,i)perylene	17	0	ND	ND	ND	0.005
Benzo(k)fluoranthene	17	0	ND	ND	ND	0.005
Biphenyl	12	12	0.077	0.077	0.077	
Butane	5	0	ND	ND	ND	0.1
Chromium	3	0	ND	ND	ND	1E-05
Chrysene	5	3	ND	0.0025	0.000536	5E-04
Cobalt	1	1	0.04	0.04	0.04	
Copper	3	0	ND	ND	ND	1E-05
Cumene	5	0	ND	ND	ND	0.1
Cyclohexane	2	2	0.01	0.01	0.01	0.01
Dibenzo(a,h)anthracene	8	0	ND	ND	ND	5E-04
Ethylbenzene	3	3	0.01	0.03	0.015	0.01
Ethylene	5	0	ND	ND	ND	0.1
Fluoranthene	12	6	ND	0.00775	0.00204	0.005
Fluorene	12	11	ND	0.04	0.0112	0.01
Hydrogen sulfide	7	3	ND	0.00015	8.52E-05	0.00015
Indeno(1,2,3-c,d)pyrene	17	0	ND	ND	ND	0.005
Isoprene	5	1	ND	0.1	0.0574	0.1
Lead	3	1	ND	0.000138	2.63E-05	1E-05
m-Xylene	5	5	0.01	0.03	0.0184	0.01
n-Hexane	3	2	ND	0.01	0.00707	0.01
Naphthalene	17	15	ND	0.0125	0.00637	0.005
Nickel	58	25	ND	0.00121	0.000218	3E-04
p-Xylene	5	1	ND	0.1	0.0574	0.1
Perylene	11	0	ND	ND	ND	0.005
Phenanthrene	17	17	0.0158	0.22	0.0397	0.005
Propane	5	0	ND	ND	ND	0.1
Propylene	5	0	ND	ND	ND	0.1
Pyrene	12	12	0.00405	0.0175	0.00628	0.005
Selenium	1	1	5E-05	5E-05	5E-05	5E-06
Silver	4	2	ND	5.9E-05	1.22E-05	1E-05
Styrene	5	0	ND	ND	ND	0.1
Toluene	3	3	0.01	0.03	0.015	0.01
Vanadium	56	30	ND	0.0057	0.000195	3E-04
Xylenes (Total)	4	4	0.01	0.0315	0.0183	0.01
Zinc	2	0	ND	ND	ND	3.25E-05

Table 23—ATMOSPHERIC DISTILLATION—Heavy Naphtha

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	8	8	0.136	2.44	0.731	0.01
1,3-Butadiene	3	1	ND	0.01	0.00707	0.01
2,2,4-Trimethylpentane (isooctane)	6	6	0.0115	0.0145	0.0123	0.01
Acenaphthene	1	0	ND	ND	ND	5E-04
Acenaphthylene	1	0	ND	ND	ND	5E-04
Anthracene	2	0	ND	ND	ND	5E-04
Arsenic	1	1	9E-07	9E-07	9E-07	5E-07
Benzene	34	33	ND	1.57	0.364	0.0118
Benzo(a)anthracene	2	0	ND	ND	ND	5E-04
Benzo(a)pyrene	2	0	ND	ND	ND	5E-04
Benzo(b/j)fluoranthene	1	0	ND	ND	ND	5E-04
Benzo(e)pyrene	1	0	ND	ND	ND	5E-04
Benzo(g,h,i)perylene	2	0	ND	ND	ND	5E-04
Benzo(k)fluoranthene	2	0	ND	ND	ND	5E-04
Biphenyl	6	6	0.716	0.716	0.716	
Butane	28	18	ND	1.25	0.0862	0.01
Carbon disulfide	5	5	8.44E-05	0.00349	0.000304	1E-06
Carbonyl sulfide	2	0	ND	ND	ND	1E-05
Chrysene	1	0	ND	ND	ND	5E-04
Cumene	2	2	0.158	0.168	0.163	0.0116
Cycloheptane	6	6	0.36	0.526	0.421	
Cyclohexane	33	32	ND	4.54	1.43	0.0105
Cyclooctane	6	6	0.881	1.23	1.07	
Decane	6	6	14.5	22.4	18.4	
Dibenzo(a,h)anthracene	1	0	ND	ND	ND	5E-04
Ethyl t-butyl ether	1	0	ND	ND	ND	5E-05
Ethane	10	7	ND	0.0176	0.00604	0.00735
Ethylbenzene	14	14	0.2	1.02	0.5	0.01
Ethylene	2	0	ND	ND	ND	0.132
Fluoranthene	1	0	ND	ND	ND	5E-04
Fluorene	1	0	ND	ND	ND	5E-04
Heptane	6	6	0.225	0.312	0.245	
Hydrogen sulfide	8	7	ND	0.00239	5.25E-05	1E-06
Indeno(1,2,3-c,d)pyrene	2	0	ND	ND	ND	5E-04
Isoprene	13	7	ND	0.243	0.0292	0.00919
m-Xylene	8	8	1.42	2.84	2.22	0.01
Mercury	2	2	5E-08	5E-08	5E-08	
Methyl-t-butyl ether	1	0	ND	ND	ND	5E-05
n-Hexane	40	39	ND	6.48	0.811	0.01
Naphthalene	9	9	0.0018	0.47	0.0467	0.0157
Nonane	6	6	4.06	5.71	4.69	

	N Data	N Quantified	Min	Max	MLV	Median MDL
o-Xylene	8	6	ND	1.15	0.00893	0.01
Octane	6	6	0.958	1.26	1.07	
p-Xylene	8	8	0.44	0.909	0.698	0.01
Pentane	7	7	0.007	0.0385	0.0149	
Perylene	1	0	ND	ND	ND	5E-04
Phenanthrene	2	0	ND	ND	ND	5E-04
Propane	22	8	ND	0.17	0.0259	0.0669
Propylene	3	0	ND	ND	ND	0.0697
Pyrene	1	0	ND	ND	ND	5E-04
Selenium	1	1	5.6E-06	5.6E-06	5.6E-06	5E-07
Toluene	20	20	0.146	7.35	1.4	0.0117
Trimethylbenzene	6	6	3.3	5.07	4.05	
Xylenes (Total)	12	12	0.674	3.9	1.66	0.01

Table 24—ATMOSPHERIC DISTILLATION—Light Atmospheric Gas Oil

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	17	16	ND	0.19	0.0971	0.01
1,3-Butadiene	12	1	ND	0.1	0.053	0.1
2,2,4-Trimethylpentane (isooctane)	2	2	0.02	0.02	0.02	0.01
Acenaphthene	6	5	ND	0.015	0.00525	5E-04
Acenaphthylene	6	1	ND	0.005	0.00281	0.005
Anthracene	17	6	ND	0.077	0.000761	0.005
Benzene	18	16	ND	0.6	0.0171	0.01
Benzo(a)anthracene	17	0	ND	ND	ND	0.005
Benzo(a)pyrene	17	0	ND	ND	ND	0.005
Benzo(b)fluoranthene	6	0	ND	ND	ND	0.00275
Benzo(e)pyrene	5	0	ND	ND	ND	0.005
Benzo(g,h,i)perylene	17	0	ND	ND	ND	0.005
Benzo(k)fluoranthene	17	0	ND	ND	ND	0.005
Biphenyl	7	7	0.057	1.38	0.0829	0.116
Butane	16	16	0.005	1.06	0.0284	0.01
Chrysene	13	0	ND	ND	ND	0.005
Cumene	14	14	0.005	0.03	0.0119	0.0325
Cycloheptane	1	1	0.046	0.046	0.046	
Cyclohexane	17	17	0.00916	0.09	0.0522	0.01
Cyclooctane	1	1	0.033	0.033	0.033	
Decane	6	6	0.265	7.16	0.614	
Dibenzo(a,h)anthracene	4	0	ND	ND	ND	5E-04
Ethyl t-butyl ether	1	0	ND	ND	ND	0.00879
Ethylbenzene	25	25	0.01	0.106	0.0433	0.01
Ethylene	10	0	ND	ND	ND	0.1
Fluoranthene	6	0	ND	ND	ND	0.00275



	N Data	N Quantified	Min	Max	MLV	Median MDL
Fluorene	6	6	0.008	0.027	0.0172	0.02
Heptane	6	6	0.015	0.07	0.029	
Hydrogen sulfide	7	2	ND	0.00037	4.72E-05	2E-04
Indeno(1,2,3-c,d)pyrene	17	0	ND	ND	ND	0.005
Isoprene	11	1	ND	0.1	0.0533	0.1
m-Xylene	11	11	0.07	0.13	0.0967	0.01
Methanol	2	0	ND	ND	ND	0.00517
Methyl-t-butyl ether	1	0	ND	ND	ND	0.00872
n-Hexane	24	24	0.001	0.115	0.0296	0.01
Naphthalene	18	18	0.013	0.26	0.0361	0.005
Nickel	10	0	ND	ND	ND	5E-04
Nonane	6	6	0.105	0.212	0.156	
Octane	6	6	0.035	0.115	0.0626	
p-Xylene	11	11	0.01	0.0336	0.0221	0.01
PAH Total	6	6	1.31	3.66	2.13	0.15
Pentane	5	5	0.005	0.03	0.0151	
Perylene	5	0	ND	ND	ND	0.005
Phenanthrene	17	17	0.0018	0.075	0.0312	0.005
Propane	6	6	0.00565	0.03	0.0133	0.01
Propylene	10	0	ND	ND	ND	0.1
Pyrene	6	0	ND	ND	ND	0.00275
Selenium	1	1	3E-05	3E-05	3E-05	5E-06
Styrene	11	1	ND	0.1	0.0533	0.1
Toluene	25	25	0.0132	0.25	0.0574	0.01
Trimethylbenzene	6	6	0.0934	0.255	0.174	
Vanadium	2	2	5.12E-05	5.14E-05	5.13E-05	1E-04
Xylenes (Total)	25	25	0.055	0.785	0.141	0.01

Table 25—ATM DISTILLATION—Light Ends

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,3-Butadiene	43	25	ND	0.114	0.028	0.0383
Benzene	2	2	1.8	2.06	1.93	0.0128
Butane	45	45	0.4	60.8	15.9	0.0371
Carbon disulfide	3	2	ND	6.45E-05	1.8E-05	1E-05
Carbonyl sulfide	3	3	0.0068	0.0192	0.0134	1E-05
Cyclohexane	8	4	ND	1.68	0.0101	0.014
Ethane	49	48	ND	12	5.54	0.0335
Ethylbenzene	1	1	0.0619	0.0619	0.0619	0.0155
Ethylene	8	6	ND	4.93	2.03	0.0088
Hydrogen sulfide	34	30	ND	1.13	0.214	0.0709
m-Xylene	1	1	0.186	0.186	0.186	0.0155
Methylcyclohexane	1	1	0.124	0.124	0.124	0.0137
n-Hexane	13	8	ND	4.94	0.0203	0.0118
o-Xylene	1	1	0.0786	0.0786	0.0786	0.0157
p-Xylene	1	1	0.0769	0.0769	0.0769	0.0154
Propane	51	51	0.814	72.1	15.9	0.0305
Propylene	17	15	ND	4.96	1.53	0.00926
Toluene	2	2	0.025	0.788	0.14	0.0127

Table 26—ATMOSPHERIC DISTILLATION—Straight Run Gasoline

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	12	12	0.0538	0.588	0.288	0.122
1,3-Butadiene	2	2	0.0431	0.0508	0.0468	0.0861
2,2,4-Trimethylpentane (isooctane)	11	11	0.008	0.0662	0.0496	0.096
Arsenic	3	0	ND	ND	ND	1E-07
Benzene	29	29	0.429	4.64	1.33	0.0121
Butane	26	24	ND	6.54	0.249	0.0834
Carbon disulfide	5	5	5.76E-05	0.00417	0.000386	1E-06
Chromium	3	3	4E-07	8E-07	6.48E-07	1E-07
Copper	3	0	ND	ND	ND	1E-07
Cumene	3	3	0.0236	0.0622	0.057	0.12
Cyclohexane	25	24	ND	5.89	1.75	0.0108
Ethane	17	9	ND	0.0407	0.0217	0.01
Ethylbenzene	12	12	0.074	1.05	0.322	0.12
Hydrogen sulfide	6	2	ND	0.000155	3.46E-06	1E-06
Isoprene	9	6	ND	2.56	0.231	0.00943
Lead	3	0	ND	ND	ND	1E-07
m-Xylene	12	12	0.176	1.67	1.1	0.12
Mercury	3	3	7E-07	1.2E-06	8.46E-07	1E-07
Methylcyclohexane	12	12	2.92	9.91	7.07	0.107
n-Hexane	25	25	1.58	13.6	8.3	0.01
Naphthalene	11	0	ND	ND	ND	0.161
Nickel	3	0	ND	ND	ND	1E-07
o-Xylene	12	12	0.0849	0.94	0.452	0.122
p-Xylene	12	12	0.0683	0.767	0.365	0.119
Propane	24	16	ND	1.65	0.0503	0.0687
Propylene	2	1	ND	0.0424	0.0146	0.00853
Toluene	21	15	ND	4.25	1.66	0.12
Vanadium	3	0	ND	ND	ND	1E-07

Table 27—ATMOSPHERIC DISTILLATION—Straight Run Kerosene

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	7	7	0.206	1.57	0.634	0.1
1,3-Butadiene	6	0	ND	ND	ND	0.1
2,2,4-Trimethylpentane (isooctane)	5	1	ND	0.1	0.0574	0.1
Anthracene	6	0	ND	ND	ND	0.005
Benzene	8	7	ND	0.59	0.0196	0.01
Benzo(a)anthracene	6	0	ND	ND	ND	0.005
Benzo(a)pyrene	6	0	ND	ND	ND	0.005
Benzo(g,h,i)perylene	6	0	ND	ND	ND	0.005
Benzo(k)fluoranthene	6	0	ND	ND	ND	0.005
Biphenyl	1	1	0.002	0.002	0.002	0.001
Butane	7	3	ND	0.772	0.00227	0.1
Chrysene	5	0	ND	ND	ND	0.005
Copper	1	0	ND	ND	ND	0.00035
Cumene	7	7	0.008	0.0805	0.0339	0.01
Cyclohexane	6	6	0.0359	0.08	0.0552	0.01
Ethyl t-butyl ether	1	0	ND	ND	ND	0.0092
Ethylbenzene	7	7	0.0708	0.224	0.142	0.1
Ethylene	5	0	ND	ND	ND	0.1
Hydrogen sulfide	3	0	ND	ND	ND	3E-04
Indeno(1,2,3-c,d)pyrene	6	0	ND	ND	ND	0.005
Isoprene	5	0	ND	ND	ND	0.1
m-Xylene	7	7	0.018	0.414	0.183	0.01
Mercury	2	0	ND	ND	ND	5E-09
Methanol	2	0	ND	ND	ND	0.00538
Methyl-t-butyl ether	1	0	ND	ND	ND	0.00913
n-Hexane	6	6	0.0251	0.08	0.0475	0.01
Naphthalene	19	19	0.0829	3.83	2.54	
p-Xylene	6	6	0.055	0.39	0.0875	0.01
Phenanthrene	6	0	ND	ND	ND	0.005
Propane	6	0	ND	ND	ND	0.1
Propylene	5	0	ND	ND	ND	0.1
Styrene	5	0	ND	ND	ND	0.1
Toluene	7	7	0.0571	0.19	0.107	0.01
Xylenes (Total)	7	7	0.233	0.54	0.362	0.01

Table 28—ATMOSPHERIC DISTILLATION—Straight Run Naphtha

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	23	23	0.05	1.59	0.823	0.119
1,3-Butadiene	3	0	ND	ND	ND	0.01
2,2,4-Trimethylpentane (isooctane)	22	17	ND	0.72	0.0452	0.0519
Acenaphthene	1	0	ND	ND	ND	5E-04
Acenaphthylene	1	0	ND	ND	ND	5E-04
Anthracene	2	0	ND	ND	ND	5E-04
Benzene	68	67	ND	5.23	1.2	0.118
Benzo(a)anthracene	2	0	ND	ND	ND	5E-04
Benzo(a)pyrene	2	0	ND	ND	ND	5E-04
Benzo(b)fluoranthene	1	0	ND	ND	ND	5E-04
Benzo(e)pyrene	1	0	ND	ND	ND	5E-04
Benzo(g,h,i)perylene	2	0	ND	ND	ND	5E-04
Benzo(k)fluoranthene	2	0	ND	ND	ND	5E-04
Biphenyl	6	6	0.016	0.016	0.016	
Butane	50	49	ND	14.1	0.604	0.082
Carbon disulfide	5	5	0.000404	0.00488	0.00127	1E-06
Chrysene	1	0	ND	ND	ND	5E-04
Cumene	29	28	ND	0.311	0.131	0.012
Cycloheptane	6	6	9.14	9.76	9.55	
Cyclohexane	61	61	0.012	4.43	2.53	0.0108
Cyclooctane	6	6	6.35	7.41	6.93	
Decane	6	6	0.473	2.2	1	
Dibenzo(a,h)anthracene	1	0	ND	ND	ND	5E-04
Ethyl t-butyl ether	10	0	ND	ND	ND	0.1
Ethane	33	13	ND	0.882	0.0117	0.0738
Ethylbenzene	39	37	ND	1.87	0.586	0.012
Ethylene	2	2	0.002	0.003	0.00245	0.134
Fluoranthene	1	0	ND	ND	ND	5E-04
Fluorene	1	0	ND	ND	ND	5E-04
Heptane	6	6	6.87	9.58	7.55	
Hydrogen sulfide	8	7	ND	0.04	0.000167	1E-06
Indeno(1,2,3-c,d)pyrene	2	0	ND	ND	ND	5E-04
Isoprene	12	6	ND	0.782	0.00991	0.00932
m-Xylene	18	18	0.127	3.58	2.14	0.118
Mercury	2	2	4E-08	4E-08	4E-08	
Methane	2	2	0.0025	0.006	0.00387	
Methanol	10	3	ND	0.14	0.0555	0.1
Methyl-t-butyl ether	11	6	ND	0.29	0.0875	0.1
Methylcyclohexane	14	14	3.96	9.38	7.29	0.104
n-Hexane	66	66	0.031	12.1	5.72	0.01
Naphthalene	6	3	ND	0.0159	0.00518	0.013

	N Data	N Quantified	Min	Max	MLV	Median MDL
Nickel	1	0	ND	ND	ND	1E-04
Nonane	6	6	5.43	7.57	6.02	
o-Xylene	18	16	ND	1.7	0.706	0.119
Octane	6	6	8.07	9.09	8.55	
p-Xylene	18	18	0.043	1.65	0.716	0.117
Pentane	12	12	0.029	14.3	0.964	
Perylene	1	0	ND	ND	ND	5E-04
Phenanthrene	2	0	ND	ND	ND	5E-04
Propane	40	22	ND	4.65	0.115	0.0678
Propylene	6	6	0.0045	0.008	0.00599	
Pyrene	1	0	ND	ND	ND	5E-04
Toluene	46	46	0.476	13.2	3.02	0.0118
Trimethylbenzene	6	6	0.166	0.645	0.312	
Vanadium	1	0	ND	ND	ND	1E-04
Xylenes (Total)	23	21	ND	11.6	1.51	0.01

Table 29—CATALYTIC HYDROCRACKER—Heavy H/C Distillate

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2-Dibromoethane	1	0	ND	ND	ND	0.002
1,2-Dichloroethane	1	0	ND	ND	ND	0.001
1,2,4-Trimethylbenzene	14	14	0.07	1.38	0.4	0.01
1,3-Butadiene	1	0	ND	ND	ND	0.005
2,2,4-Trimethylpentane (isooctane)	10	9	ND	1.35	0.114	0.01
Acenaphthene	6	6	0.001	0.0105	0.00371	0.002
Acenaphthylene	5	0	ND	ND	ND	0.005
Anthracene	3	2	ND	0.00135	0.000581	5E-04
Benzene	16	16	1E-06	0.62	0.0534	0.01
Benzo(a)anthracene	6	0	ND	ND	ND	0.00275
Benzo(a)pyrene	6	0	ND	ND	ND	0.00275
Benzo(b)fluoranthene	6	0	ND	ND	ND	0.00275
Benzo(e)pyrene	5	0	ND	ND	ND	0.005
Benzo(g,h,i)perylene	6	0	ND	ND	ND	0.00275
Benzo(k)fluoranthene	6	0	ND	ND	ND	0.00275
Biphenyl	1	0	ND	ND	ND	2
Butane	6	6	0.005	0.01	0.00794	
Carbon disulfide	1	0	ND	ND	ND	0.002
Carbonyl sulfide	1	0	ND	ND	ND	2
Chrysene	2	0	ND	ND	ND	5E-04
Cumene	15	15	0.0015	0.15	0.0536	0.01
Cycloheptane	1	1	0.018	0.018	0.018	
Cyclohexane	16	16	0.013	1.69	0.363	0.01
Cyclooctane	1	1	0.0255	0.0255	0.0255	

	N Data	N Quantified	Min	Max	MLV	Median MDL
Decane	6	6	0.035	0.777	0.0776	
Dibenzo(a,h)anthracene	4	0	ND	ND	ND	5E-04
Diethanolamine	1	0	ND	ND	ND	0.051
Ethylbenzene	16	16	0.0075	1.37	0.32	0.01
Fluoranthene	5	2	ND	0.01	0.000334	5E-04
Fluorene	5	4	ND	0.0105	0.00149	0.004
Heptane	6	6	0.02	0.0645	0.0284	
Hydrogen sulfide	2	0	ND	ND	ND	2E-04
Indeno(1,2,3-c,d)pyrene	6	0	ND	ND	ND	0.00275
m-Xylene	4	4	2.02	2.16	2.1	0.01
m,p-Xylene	1	1	0.027	0.027	0.027	0.001
Methanol	1	0	ND	ND	ND	0.0021
Methyl-t-butyl ether	1	0	ND	ND	ND	0.001
Methyl ethyl ketone	1	0	ND	ND	ND	0.001
Methyl isobutyl ketone	1	0	ND	ND	ND	0.001
Methylcyclohexane	6	6	7.16	8.36	8.01	0.01
n-Hexane	22	21	ND	2.01	0.115	0.01
Naphthalene	3	3	0.00395	0.0165	0.00946	0.008
Nonane	6	6	0.02	0.0392	0.0279	
o-Xylene	5	5	0.013	1.33	0.854	0.01
Octane	6	6	0.0135	0.0278	0.0209	
p-Xylene	4	4	0.76	1.23	0.834	0.01
PAH Total	1	1	2.8	2.8	2.8	
Pentane	7	7	0.003	0.165	0.0562	
Perylene	4	0	ND	ND	ND	0.005
Phenanthrene	6	6	0.0015	0.0165	0.00394	0.001
Phenol	1	0	ND	ND	ND	2
Pyrene	6	6	0.013	0.0655	0.0312	
Toluene	16	16	0.013	4.94	0.592	0.01
Trimethylbenzene	6	6	0.0372	0.1	0.0637	
Xylenes (Total)	12	12	0.04	5.04	0.419	0.01

Table 30—CATALYTIC HYDROCRACKER—Heavy H/C Naphtha

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2-Dibromoethane	1	0	ND	ND	ND	0.002
1,2-Dichloroethane	1	0	ND	ND	ND	0.001
1,2,4-Trimethylbenzene	5	5	1.02	1.74	1.39	
1,3-Butadiene	3	0	ND	ND	ND	0.005
2,2,4-Trimethylpentane (isooctane)	2	1	ND	0.0394	0.00628	0.00558
Acenaphthene	1	0	ND	ND	ND	5E-04
Acenaphthylene	1	0	ND	ND	ND	5E-04
Anthracene	1	0	ND	ND	ND	5E-04
Benzene	29	28	ND	1.09	0.228	0.112
Benzo(a)anthracene	1	0	ND	ND	ND	5E-04
Benzo(a)pyrene	1	0	ND	ND	ND	5E-04
Benzo(b)fluoranthene	1	0	ND	ND	ND	5E-04
Benzo(e)pyrene	1	0	ND	ND	ND	5E-04
Benzo(g,h,i)perylene	1	0	ND	ND	ND	5E-04
Benzo(k)fluoranthene	1	0	ND	ND	ND	5E-04
Biphenyl	1	0	ND	ND	ND	2
Butane	14	11	ND	0.108	0.0299	0.154
Carbon disulfide	2	0	ND	ND	ND	0.002
Carbonyl sulfide	4	0	ND	ND	ND	0.000219
Chrysene	1	0	ND	ND	ND	5E-04
Cumene	9	8	ND	0.34	0.134	0.0111
Cycloheptane	1	1	0.526	0.526	0.526	
Cyclohexane	18	18	0.0799	7.02	0.375	0.0499
Cyclooctane	1	1	0.662	0.662	0.662	
Decane	6	6	0.66	1.23	0.92	
Dibenzo(a,h)anthracene	1	0	ND	ND	ND	5E-04
Diethanolamine	1	0	ND	ND	ND	0.051
Ethyl t-butyl ether	9	0	ND	ND	ND	0.1
Ethane	5	0	ND	ND	ND	0.00697
Ethylbenzene	10	10	0.0038	1.7	0.743	0.0113
Fluoranthene	1	0	ND	ND	ND	5E-04
Fluorene	1	0	ND	ND	ND	5E-04
Heptane	6	6	0.62	4.62	1.08	
Hydrogen sulfide	5	0	ND	ND	ND	2E-04
Indeno(1,2,3-c,d)pyrene	1	0	ND	ND	ND	5E-04
Isoprene	4	0	ND	ND	ND	0.00872
m-Xylene	2	2	1.05	1.91	1.42	0.0113
m,p-Xylene	3	2	ND	1.71	0.131	2.53
Methanol	10	1	ND	0.1	0.0536	0.1
Methyl-t-butyl ether	10	4	ND	0.23	0.0546	0.1
Methyl ethyl ketone	1	0	ND	ND	ND	0.001

	N Data	N Quantified	Min	Max	MLV	Median MDL
Methyl isobutyl ketone	1	0	ND	ND	ND	0.001
Methylcyclohexane	1	1	7.69	7.69	7.69	0.0102
n-Hexane	19	19	0.0022	2.46	0.137	0.00845
Naphthalene	3	0	ND	ND	ND	0.0149
Nonane	6	6	0.672	1.06	0.812	
o-Xylene	4	3	ND	1.38	0.0139	0.0115
Octane	6	6	0.795	1.27	0.967	
p-Xylene	2	2	0.867	1.58	1.17	0.0112
Pentane	6	6	0.008	3.34	0.265	
Perylene	1	0	ND	ND	ND	5E-04
Phenanthrene	1	0	ND	ND	ND	5E-04
Phenol	1	0	ND	ND	ND	2
Propane	5	4	ND	0.0825	0.0576	0.127
Propylene	1	0	ND	ND	ND	0.00016
Pyrene	1	0	ND	ND	ND	5E-04
Toluene	17	17	0.018	7.24	3.52	0.222
Trimethylbenzene	6	6	0.53	1.55	0.887	
Xylenes (Total)	7	7	0.014	4.28	1.59	0.001

Table 31—CATALYTIC HYDROCRACKER—Light H/C Distillate

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	6	5	ND	2.15	0.172	0.01
2,2,4-Trimethylpentane (isooctane)	5	5	0.02	1.39	0.137	0.01
Benzene	6	6	1.4	6.63	2.51	0.01
Butane	1	0	ND	ND	ND	0.143
Carbonyl sulfide	1	0	ND	ND	ND	1E-05
Cumene	5	5	0.02	0.526	0.0403	0.01
Cyclohexane	7	7	0.19	5.43	2.34	0.01
Ethylbenzene	6	6	0.08	1.27	0.31	0.01
Hydrogen sulfide	2	1	ND	1E-05	7.07E-06	1E-05
m-Xylene	3	3	0.64	2.44	1.28	0.01
Methylcyclohexane	4	4	0.03	2.06	0.225	0.01
n-Hexane	6	6	3.06	14.3	8.26	0.01
o-Xylene	3	3	0.32	2.04	0.763	0.01
p-Xylene	3	3	0.28	0.84	0.533	0.01
Propane	1	0	ND	ND	ND	0.118
Toluene	7	7	0.13	2.98	1.21	0.01
Xylenes (Total)	4	4	0.02	1.51	0.456	0.01

Table 32—CATALYTIC HYDROCRACKER—Light H/C Naphtha

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	1	1	0.012	0.012	0.012	0.01
1,3-Butadiene	6	0	ND	ND	ND	0.0409
Acenaphthene	5	0	ND	ND	ND	5E-04
Acenaphthylene	4	0	ND	ND	ND	0.00275
Anthracene	1	0	ND	ND	ND	0.005
Benzene	39	39	0.00976	5.46	0.704	0.115
Benzo(a)anthracene	1	0	ND	ND	ND	0.005
Benzo(a)pyrene	5	0	ND	ND	ND	5E-04
Benzo(b)fluoranthene	5	0	ND	ND	ND	5E-04
Benzo(e)pyrene	4	0	ND	ND	ND	0.00275
Benzo(g,h,i)perylene	5	0	ND	ND	ND	5E-04
Benzo(k)fluoranthene	5	0	ND	ND	ND	5E-04
Butane	8	8	0.262	12.1	1.79	0.0396
Carbonyl sulfide	2	0	ND	ND	ND	1E-05
Chrysene	1	0	ND	ND	ND	5E-04
Cumene	1	0	ND	ND	ND	0.01
Cycloheptane	5	5	5.06	15.9	10.5	
Cyclohexane	13	12	ND	7.23	0.8	0.0512
Cyclooctane	5	5	0.05	2.2	0.337	
Dibenzo(a,h)anthracene	3	0	ND	ND	ND	5E-04
Ethyl t-butyl ether	27	0	ND	ND	ND	0.1
Ethane	6	3	ND	7.32	0.00249	0.0358
Ethylbenzene	1	0	ND	ND	ND	0.01
Ethylene	2	0	ND	ND	ND	0.00118
Fluoranthene	5	0	ND	ND	ND	5E-04
Fluorene	5	0	ND	ND	ND	5E-04
Heptane	5	5	2.45	6.04	3.97	
Hydrogen sulfide	6	5	ND	11.5	0.0399	0.0265
Indeno(1,2,3-c,d)pyrene	5	0	ND	ND	ND	5E-04
Isoprene	1	1	0.0984	0.0984	0.0984	0.00895
Methanol	4	4	0.06	0.09	0.069	0.1
Methyl-t-butyl ether	27	15	ND	0.4	0.0936	0.1
Methylcyclohexane	1	1	0.938	0.938	0.938	0.0114
n-Hexane	14	14	0.025	18	2.56	0.0267
Naphthalene	5	1	ND	0.01	0.0033	0.005
Nonane	2	2	0.006	0.347	0.0456	
o-Cresol	1	0	ND	ND	ND	5E-04
Octane	5	5	0.008	1.46	0.147	
Pentane	8	8	0.0175	29.2	2.25	
Perylene	4	0	ND	ND	ND	0.00275
Phenanthrene	6	0	ND	ND	ND	5E-04
Phenol	1	0	ND	ND	ND	5E-04

	N Data	N Quantified	Min	Max	MLV	Median MDL
Propane	8	7	ND	14.9	0.0027	0.0326
Propylene	5	3	ND	0.0475	6.79E-05	0.0339
Pyrene	5	0	ND	ND	ND	5E-04
Styrene	1	0	ND	ND	ND	0.01
Toluene	3	3	0.283	1.47	0.701	0.0114
Xylenes (Total)	1	0	ND	ND	ND	0.01

Table 33—CATALYTIC HYDROCRACKER—Saturated Gas

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	1	1	0.027	0.027	0.027	
1,3-Butadiene	20	0	ND	ND	ND	0.176
Benzene	8	8	0.058	0.573	0.101	0.0243
Butane	21	20	ND	18.2	0.938	0.0854
Cycloheptane	2	2	0.096	0.13	0.112	
Cyclohexane	4	4	0.0375	0.104	0.0574	
Cyclooctane	1	1	0.014	0.014	0.014	
Ethane	21	20	ND	25.5	13.7	0.154
Ethylbenzene	3	3	0.008	0.208	0.0362	
Ethylene	15	6	ND	18.3	0.0971	0.277
Heptane	3	3	0.12	0.6	0.209	
Hydrogen sulfide	25	11	ND	53.1	0.00774	0.224
Methane	5	5	14.2	41.6	20.2	
n-Hexane	12	12	0.127	2.78	0.324	0.0182
Nonane	1	1	0.066	0.066	0.066	
Octane	1	1	0.0775	0.0775	0.0775	
Pentane	10	10	0.012	6.23	0.465	
Propane	26	25	ND	27.4	12.8	0.141
Propylene	25	8	ND	6.62	0.0108	0.11
Toluene	7	7	0.031	0.213	0.0975	0.0239
Trimethylbenzene	3	3	0.02	0.033	0.0286	
Xylenes (Total)	3	3	0.031	1.04	0.168	

Table 34—CATALYTIC HYDROCRACKER–Cat Cracker Feed

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2-Dibromoethane	1	0	ND	ND	ND	0.002
1,2-Dichloroethane	1	0	ND	ND	ND	0.001
1,2,4-Trimethylbenzene	2	2	0.02	0.17	0.0583	0.002
1,3-Butadiene	1	0	ND	ND	ND	0.005
2,2,4-Trimethylpentane (isooctane)	1	0	ND	ND	ND	0.002
Acenaphthene	6	3	ND	0.00375	0.00062	0.00275
Acenaphthylene	11	0	ND	ND	ND	0.005
Anthracene	24	10	ND	0.022	0.00142	0.00275
Antimony	7	0	ND	ND	ND	1E-05
Arsenic	6	2	ND	3E-05	6.01E-06	1E-05
Barium	10	1	ND	5.2E-05	6.32E-06	1E-05
Benzene	3	2	ND	0.0023	0.00152	0.001
Benzo(a)anthracene	22	8	ND	0.0073	0.00104	0.005
Benzo(a)pyrene	13	5	ND	0.0037	0.000623	0.00275
Benzo(b)fluoranthene	6	0	ND	ND	ND	0.00312
Benzo(b/j)fluoranthene	2	2	0.00135	0.00265	0.00189	0.005
Benzo(e)pyrene	11	7	ND	0.00405	0.00188	0.005
Benzo(g,h,i)perylene	23	11	ND	0.0122	0.00178	0.005
Benzo(k)fluoranthene	12	2	ND	0.0043	0.000136	5E-04
Beryllium	1	0	ND	ND	ND	1E-05
Biphenyl	1	0	ND	ND	ND	2
Cadmium	16	1	ND	1E-04	6.03E-06	1E-05
Carbon disulfide	1	0	ND	ND	ND	0.002
Carbonyl sulfide	1	0	ND	ND	ND	2
Chromium	18	1	ND	1E-04	5.91E-06	1E-05
Chrysene	14	3	ND	0.00715	0.000429	0.00275
Cobalt	8	1	ND	0.17	1.84E-05	1E-05
Copper	17	4	ND	6.6E-05	3.9E-06	1E-05
Cumene	2	1	ND	0.002	0.00141	0.0015
Cyclohexane	1	0	ND	ND	ND	0.002
Dibenz(a,j)acridine	2	2	2E-04	2E-04	2E-04	5E-04
Dibenzo(a,h)anthracene	4	2	ND	6E-04	0.000496	5E-04
Diethanolamine	1	0	ND	ND	ND	0.049
Ethylbenzene	3	3	0.0076	0.023	0.012	0.0015
Fluoranthene	11	6	ND	0.016	0.00159	0.005
Fluorene	11	3	ND	0.00905	0.000384	0.005
Hydrogen sulfide	1	1	2E-06	2E-06	2E-06	
Indeno(1,2,3-c,d)pyrene	22	1	ND	0.01	0.00266	0.005
Lead	16	7	ND	7E-05	1.02E-05	1E-05
m,p-Xylene	1	1	0.024	0.024	0.024	0.001
Manganese	7	0	ND	ND	ND	1E-05

	N Data	N Quantified	Min	Max	MLV	Median MDL
Mercury	4	3	ND	8.7E-07	1.59E-07	5.01E-05
Methanol	1	0	ND	ND	ND	0.002
Methyl-t-butyl ether	1	0	ND	ND	ND	0.001
Methyl ethyl ketone	1	0	ND	ND	ND	0.001
Methyl isobutyl ketone	1	0	ND	ND	ND	0.001
n-Hexane	3	1	ND	0.0025	0.00137	0.002
Naphthalene	25	16	ND	0.19	0.0033	0.005
Nickel	35	25	ND	0.000238	4.44E-05	1E-05
o-Cresol	1	0	ND	ND	ND	5E-04
o-Xylene	1	1	0.01	0.01	0.01	0.001
Perylene	3	2	ND	0.00175	0.000661	0.005
Phenanthrene	24	23	ND	0.85	0.0148	0.00275
Phenol	2	0	ND	ND	ND	1
Pyrene	11	11	0.008	0.102	0.0409	0.005
Selenium	7	1	ND	5E-05	6.95E-06	1E-05
Silver	9	6	ND	5E-04	1.8E-05	1E-05
Styrene	1	0	ND	ND	ND	0.002
Toluene	3	3	0.01	0.035	0.0174	0.0015
Vanadium	35	29	ND	0.00028	3.48E-05	1E-05
Xylenes (Total)	3	3	0.02	0.16	0.0477	0.0015
Zinc	18	6	ND	1E-04	5.56E-06	1E-05

Table 35—CATALYTIC ISOMERIZATION—Isobutane

	N Data	N Quantified	Min	Max	MLV	Median MDL
1,2,4-Trimethylbenzene	2	2	0.11	0.15	0.128	0.01
1,3-Butadiene	3	3	0.0967	0.236	0.119	0.107
Benzene	2	2	0.14	0.48	0.259	0.01
Butane	12	12	0.166	11.4	5.99	0.104
Cumene	2	2	0.02	0.03	0.0245	0.01
Cyclohexane	2	2	0.56	0.74	0.644	0.01
Ethane	5	5	0.05	7.48	3.2	0.00941
Ethylbenzene	2	2	0.79	0.94	0.862	0.01
m-Xylene	2	2	1.03	1.51	1.25	0.01
Methylcyclohexane	2	2	4.53	5.6	5.04	0.01
n-Hexane	2	2	1.67	2.31	1.96	0.01
o-Xylene	2	2	0.57	1.01	0.759	0.01
p-Xylene	2	2	0.49	0.72	0.594	0.01
Propane	18	18	0.462	5.16	1.35	0.0856
Propylene	14	4	ND	0.902	0.0262	0.0893
Toluene	2	2	1.77	2.08	1.92	0.01