American Petroleum Institute

Comparison of API and EPA Toxic Air Pollutant Emission Factors for Combustion Sources

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PREPARED UNDER CONTRACT BY:

Edward Sabo
PES, a MACTEC Company
560 Herndon Parkway, Suite 200
Herndon, Virginia 20170

American Petroleum Institute

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ABSTRACT

Both the U.S. Environmental Protection Agency (EPA) and the American Petroleum Institute (API) have published toxic air pollutant emission factors for combustion sources. This study compared the published emission factors, identified and explained differences in the factors, and recommended priorities for gathering additional information to improve the quality and reliability of published factors.

This study revealed the following major gaps and inconsistencies in air toxic emission factors for combustion sources:

- There is the lack of data for metals emissions for reciprocating internal combustion engines and gas-fired gas turbines. While it is likely that metal emissions from these sources are small, there are no published emission factors to confirm this assumption.
- There is no consistent list of target compounds in the emission factor databases and not all hazardous air pollutants were targeted in all tests. This results in isolated gaps for specific organics and metals throughout the databases.
- There are several inconsistencies in the emission factors reported by EPA and API. The primary reasons for these inconsistencies are: (1) differences in source populations and operating conditions, (2) differences in sampling and analytical methods, and (3) differences in the treatment of detection limits.
- For most source categories, there are no factors for dioxin/furan emissions.

A literature search revealed several potential sources of new information that could be used to update the EPA or API emission factor databases. These sources include EPA-sponsored testing of reciprocating engines, the Industrial Combustion Coordinated Rulemaking databases, the Petroleum Environmental Research Forum study, and a study by the Gas Technology Institute. A preliminary review of these sources showed that they did not contain the data needed to fill the gaps for dioxins and furans, but could be used to address other gaps and inconsistencies.

Several areas of additional research are recommended:

- Determine the extent to which information available in recent literature is sufficient to verify EPA/API emission factors or fill in existing data gaps.
- Collect additional data for gas-fired boilers/heaters to develop emission factors for polycyclic compounds, metals, and organic hazardous air pollutants.
- Collect additional data for fuel oil-fired boilers and IC engines to develop emission factors for polycyclic compounds, metals, and organic hazardous air pollutants.
- Initiate the process with EPA for the updating of the AP-42 fuel oil and natural gas external combustion sections.
- Where possible, consider adding sampling and analysis for hazardous air pollutants to existing field data collection efforts.

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API STAFF CONTACT

Karin Ritter, Regulatory Analysis and Scientific Affairs Department

MEMBERS OF THE STATIONARY SOURCE EMISSIONS TASK FORCE PROJECT WORKGROUP

Jeff Siegell, ExxonMobil Research and Engineering, Chairperson

Karl Loos, Equilon Enterprises LLC

Lee Gilmer, Equilon Enterprises LLC

Lyman Young, Chevron Texaco

Gary Kizior, BP

PREPARED UNDER CONTRACT BY:

Edward Sabo

PES, a MACTEC Company

560 Herndon Parkway, Suite 200

Herndon, Virginia 20170

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1 INTRODUCTION

Both the U.S. Environmental Protection Agency[1] (EPA) and the American Petroleum Institute[2] (API) have published toxic air pollutant emission factors for combustion sources. These emission factors are frequently used by industry to prepare emission inventories to satisfy regulatory reporting requirements. State and federal agencies also use them to identify emission reduction priorities. While there is some agreement between the two data sets, there are many inconsistencies between the two. In addition, many of the factors are based on very limited data sets or are missing altogether. This study compares and explains differences in published toxic air pollutant emission factors for combustion sources and recommends priorities for gathering additional emission factor information.

The specific objectives of this project were:

- To compare the emission factors published by EPA and API to identify gaps and inconsistencies.
- To identify available emission test data that can potentially be used to verify published factors and fill in existing gaps.
- To recommend additional field-testing or other efforts needed to fill in gaps or resolve inconsistencies.

This report describes the efforts completed to meet these objectives.

2 COMPARISON OF PUBLISHED EMISSION FACTORS

The two primary sources of published emission factors for air toxics from combustion processes are the EPA's AP-42 document and the API's Petroleum Air Toxics Emission Factors (PATEF) database. The EPA periodically updates emission factors to incorporate new available test data. The AP-42 emission factors for boilers and heaters were updated in 1998 to include information from the electric utility hazardous air pollutant study. In the summer of 2000, the EPA updated emission factors for gas turbines and gas-fired reciprocating engines based upon information compiled during the Industrial Combustion Coordinated Rulemaking (ICCR) efforts. The API's PATEF database is based upon tests conducted on petroleum industry sources in California in response to the Air Toxics Hot Spots Information and Assessment Act of 1988.

The following combustion sources found in the petroleum industry were the subject of this study:

- External Combustion, No. 6 Fuel Oil-fired Boilers
- External Combustion, Refinery/Natural Gas-fired Boilers, Heaters, or Steam Generators
- External Combustion, Crude/Pipeline Oil-fired Heaters and Steam Generators
- Internal Combustion, Reciprocating Engines, Diesel-fired, Oxygen < 13%
- Internal Combustion, Reciprocating Engines, Diesel-fired, Oxygen > 13%
- Internal Combustion, Reciprocating Engines, Gas-fired, 2-Stroke, Lean-burn
- Internal Combustion, Reciprocating Engines, Gas-fired, 4-Stroke, Lean-burn
- Internal Combustion, Reciprocating Engines, Gas-fired, 4-Stroke, Rich-burn
- Internal Combustion, Gas Turbines, Refinery/Natural Gas-fired, Duct Burners
- Internal Combustion, Gas Turbines, Refinery/NaturalGas-fired, No Duct Burners
- Direct Combustion, Asphalt Blowing, Blow Cycle
- Direct Combustion, Asphalt Blowing, No Blow Cycle
- Direct Combustion, Coke Calcining

For each of these 13 source categories, PES prepared a table that compares the API and EPA emission factors. These tables are contained in Appendix A. Each table identifies the chemicals for which emission factors are available, EPA emission factor information, and API emission factor information. Each table is accompanied by a narrative discussion of the gaps and inconsistencies that were found for each source category.

Using the data in these 13 tables, PES prepared a color-coded scheme to visually identify data gaps and inconsistencies using the following indicators:

- A green code indicates that the emission factors are of reasonable quality and there is consistency between the EPA and API databases. The specific criteria are that either the API or EPA emission factor has a data quality rating of A (excellent), B (above average), or C (average), and there is good agreement (within a factor of 5) between the EPA and API factor.

- A yellow code indicates some concern about the quality of the emission factors, either because of inconsistencies between the EPA and API factor or because of a small data set. The specific criteria are: (1) either the API or EPA emission factor had a data quality rating of A, B, or C, but there is disagreement {greater than a factor of 5} between the EPA and API factor; or (2) the emission factor had a data quality rating of D {below average} and there is good agreement {within a factor of 5} between the EPA and API factor.
- A red code indicates the emission factors are of poor quality or based on a single test. The specific criteria are: (1) the emission factor had a data quality rating of D, but there is disagreement {greater than a factor of 5} between the EPA and API factor; or (2) the emission factor had a data quality rating of E {poor}.
- A gray code indicates that there is no emission factor available from either EPA or API.

Detailed graphical summaries of gaps and inconsistencies for each source category and pollutant are presented in Appendix B. Figure 1 summarizes the information in Appendix B by assigning a single color code for each source and pollutant category.

Major gaps in air toxic emission factors for combustion sources include:

- A lack of data for dioxin/furan emissions for most source categories. This gap may be important because EPA's Persistent Bioaccumulative Toxic regulation is focusing attention on these chemicals. The reporting threshold for the dioxin and dioxin-like compounds is 0.1 grams per year. While the relative potential for dioxin emissions from gas-fired heaters is generally considered very low, the industry needs a reasonable and defensible position regarding their potential to emit dioxin.
- A lack of data for metals emissions for reciprocating internal combustion engines (RICE) and gas-fired gas turbines. While it is likely that metal emissions from these sources are small, there are no published emission factors to confirm this assumption.
- No consistent list of target compounds used in the emission testing. Not all HAPs were tested for in all tests. For example, newer testing of reciprocating engines using Fourier Transform Infrared (FTIR) techniques included many more individual organic HAP compounds than older testing, which tended to focus on aldehydes, benzene, toluene, and xylene. Thus, there is a lack of data for certain organic HAP emissions from certain source categories such as gas-fired and fuel oil-fired boilers and heaters. Similarly, not all metals or polycyclic compounds were tested for in all tests. This results in isolated gaps for specific organic HAPs, polycyclic compounds, and metals throughout the database.

There are several inconsistencies in the reported emission factors. For example, several metal EPA emission factors for gas-fired boilers/heaters are 10-50 times lower than the API emission factor. There are many factors that contribute to these inconsistencies, including:

- Differences in source populations and operating conditions. Differences in the design, operation, and maintenance of sources may contribute to emissions factor inconsistencies. For example, the EPA external combustion emission factors based primarily on tests at large electric utility boilers, while the API factors based on petroleum industry boilers and process heaters.
- Differences in sampling and analytical methods. Measurement methods are continually improving. Different measurement methods may contribute to emission factor inconsistencies. For example, formaldehyde may be measured using CARB method 430, EPA method SW-846, or the FTIR method. These different methods can have different biases in the methods, different detection limits, and different data reduction procedures.
- Differences in the treatment of detection limits. Many tests of combustion sources result not in an emission rate but in knowledge that the pollutant was not present at or above the limit of detection of the test method used. How the method detection limits are reported and used to develop composite emission factors may contribute to emission factor inconsistencies. An assigned value of $^1/_2$ of the minimum detection limit is generally used in calculating emission factors. For example, the detection limit for benzo(a)pyrene is a factor of 200 lower if the sample is analyzed using high resolution gas chromatography/high resolution mass spectrometry rather than low resolution gas chromatographe/low resolution mass spectrometry. If two similar sources are tested for benzo(a)pryrene, one using the high resolution technique and one using the low resolution technique, and benzo(a)pyrene is not detected in either sample, the reported emissions will be 200 times higher for the source tested with the low resolution technique[3].

In addition to these factors, other factors such as contamination problems during sampling and variability in quality assurance procedures may be causes of inconsistencies among the emission factors.

	Dioxin/furan	Metals	Polycyclic Compounds	Organic Compounds
No. 6-fired Boilers				
Gas-fired Boilers/Heaters				
Crude/Pipeline Oil-fired Boilers				
RICE, Diesel-fired, > 600 hp				
RICE, Diesel-fired, < 600 hp				
RICE, Gas-fired, 2-stroke lean				
RICE, Gas-fired, 4-stroke lean				
RICE, Gas-fired, 4-stroke rich				
Gas-fired Gas Turbine				
Asphalt Blowing				
Coke Calcining				

Figure 1—Identification of HAP Gaps and Inconsistencies

		EPA or PATEF Quality Rating	EPA/PATEF Ratio	Based on Non-detects?
Generally Good Quality and EPA/PATEF consistent		A,B,C	< 5x	No
Quality is suspect; either EPA/PATEF ratio large or data set is small		A,B,C D	> 5x < 5x	NoNo
Data set is small or of poor quality		D E, NR		
Data Gap – No Factors Available				

Legend

3 PRIORITIZATION OF GAPS AND INCONSISTENCIES

We made a qualitative prioritization of the relative importance of the gaps and inconsistencies identified above. The prioritization considered five factors:

- Emission Factor Quality. We evaluated the relative quality of emission factors based on the data quality rating of the PATEF and EPA factors.
- Toxicity. We evaluated the relative dose that causes adverse health effects of a given pollutant. We considered the risk-based Concentrations (RBCs) that were used as a surrogate for toxicity in EPA's *Ranking and Selection of Hazardous Air Pollutants for Listing Under Section 112(k)*[4].
- Regulatory Importance. We evaluated the relative regulatory importance of each pollutant. We determined whether the chemical is a HAP, an urban air toxic, on the TRI list, and also on the PBT list.
- EPA/API Factor Consistency. We evaluated the consistency between the EPA and API emission factors, identifying factors with a large discrepancy (greater than a factor of 50) and those that were relatively consistent.
- Relative Source Significance. Quantitative data were not available to devise a scoring scheme for this criterion. Instead, the members of the API HAP Gap committee provided a subjective ranking of the importance of each source category. Natural gas-fired heaters and boilers were considered the most important category, followed by gas-fired internal combustion engines, fuel oil-fired heaters and boilers, gas turbines, and small diesel-fired internal combustion engines. Other source categories were not considered to be high priorities for investigation at this time.

The API committee identified gas-fired boilers/heaters as the highest priority source category. Additional test data for polycyclic compounds, metals, and organic HAPs would improve the quality and reliability of the emission factors. Gas-fired IC engines and fuel oil-fired boilers were identified as the second and third highest priority source categories by the API committee. Additional test data for polycyclic compounds, metals, and organic HAPs would improve the quality and reliability of the emission factors.

4 LITERATURE SEARCH

The information available to develop and improve air toxics emission factors is continually expanding. Both EPA and the petroleum industry have gathered new information that is not currently reflected in the emission factors published in AP-42 or PATEF 2.02. PES conducted a literature search to identify data sources that can potentially be used to verify published factors or fill in existing gaps. The following sections describe the results of the literature search.

4.1 AP-42 SECTION UPDATES

The EPA periodically updates AP-42 sections using information collected during regulatory development efforts and information supplied by State agencies and industry. Most of the AP-42 sections related to combustion sources have been updated in the last 2 years. The following table shows the last update for each relevant AP-42 section:

AP-42 Section	Last Update	Sources Covered
1.3	Sept. 1998	Fuel oil-fired boilers
1.4	July 1998	Gas-fired boilers and heaters
3.1	April 2000	Gas-fired gas turbines
3.2	July 2000	Gas-fired reciprocating internal combustion engines
3.3	Oct. 1996	Diesel-fired reciprocating internal combustion engines < 600 hp
3.4	Oct. 1996	Diesel-fired reciprocating internal combustion engines > 600 hp
5.1	Jan. 1995	Asphalt blowing, coke calcining

PES used the most recent updates to AP-42, including the two sections published in April and July 2000, in the analyses described earlier in this report. Sections 1.3 (fuel oil-fired boilers/heaters) and 1.4 (gas-fired boilers/heaters) were last updated in 1998 to include emission test results conducted by EPRI as part of the CAA-mandated electric utility HAP study. Information submitted by industry during the Industrial Combustion Coordinated Rulemaking (ICCR) efforts has been incorporated into the natural gas section but not into the fuel oil section. Section 3.1 (gas turbines) was updated using test reports submitted by industry during the ICCR efforts and test reports gathered by the States of Wisconsin and California. Section 3.2 (gas-fired reciprocating engines) was updated using test reports submitted by industry during the ICCR efforts, EPA-sponsored emission testing conducted at Colorado State University, and from a report recently published by the Gas Technology Institute.

PES contacted EPA's Emission Factor and Inventory Group to determine whether EPA was currently working on updating any of the relevant combustion sections of AP-42. EPA indicated that there is no work currently active on any of the combustion sections of AP-42, but that it is considering reviewing Sections 1.3 and 1.4 in the near future.

4.2 INDUSTRIAL COMBUSTION COORDINATED RULEMAKING (ICCR) DATABASES

As part of the ICCR efforts, EPA compiled emission test databases for gas turbines, reciprocating engines, boilers, and heaters. EPA recently used the ICCR databases to update the emission factors in Sections 3.1 (gas turbines) and 3.2 (gas-fired reciprocating engines). EPA has not used the ICCR databases for boilers and heaters to update Sections 1.3 (fuel oil-fired boilers/heaters) and 1.4 (gas-fired boilers/heaters). Based upon PES' and EER's[5] review of the ICCR databases, it appears that there is information in the databases that can be used to verify published factors or fill in existing gaps. For example, the ICCR database contains 64 test runs for naphthalene from boilers firing fuel oil, whereas the AP-42 emission factor was based on 30 test runs and the API factor was based on only six test runs. For dioxins from boilers firing fuel oil, the ICCR database contains 12 test runs, whereas AP-42 does not have an emission factor and the API factor was based on only three test runs. The ICCR database does not appear to have any information on dioxin emissions from natural gas-fired boilers/heaters.

4.3 PETROLEUM ENVIRONMENTAL RESEARCH FORUM (PERF) STUDY

In 1992, The Petroleum Environmental Research Forum (PERF) initiated Cooperative Research and Development Agreement (CRADA) to study about 60 target compound emissions from full-scale industrial burners. Some of the PERF results have been published[6,7]. However, the first time any of the full-scale data will become publicly available will be the 3rd quarter of the year 2000[8]. The main finding of the PERF research was that organic HAP emissions from gas-fired burners are very low over a wide range of design and operating conditions. The PERF data can potentially be used to verify published factors or fill in existing gaps in organic HAP emission factors.

4.4 GAS TECHNOLOGY INSTITUTE (GTI) STUDY

The GTI (formerly the Gas Research Institute) and API recently published[9] the results of a research program to characterize HAP emissions from petroleum industry combustion sources. The program included testing of eight IC engines, one gas turbine, two boilers, and one heater. The program used FTIR as the primary method for measuring air toxics from each source. The target compound list included organic HAPs, polycyclic compounds, aldehydes, and metals. The emission factors developed under this program can potentially be used to verify published factors or fill in existing gaps in HAP emission factors.

An earlier GTI study[10] sponsored emissions testing at five facilities, including two sweet gas plants, two sour gas plants, and one natural gas storage facility. A total of seven reciprocating engines, three incinerators, six heaters, three boilers, and three gas turbines were tested. A list of target compounds was developed based on EPA's list of 188 hazardous air pollutants (HAPs) and selected state air toxics regulations. Continuous measurements based on Fourier transform infrared (FTIR) spectroscopy and manual methods were used for measurement of volatile organic compounds and aldehydes. Manual methods were used to measure emissions of semi-volatile organic compounds, particulate matter, and metals.

5 RECOMMENDATIONS

To begin the process of verifying published factors or filling in existing gaps, several areas of additional research are recommended:

- Determine whether information available in recent literature is sufficient to verify EPA/API emission factors or fill in existing data gaps. Data collected through the ICCR, PERF, and GTI efforts appear to contain data that can be used to develop more reliable emission factors that are representative of petroleum industry boilers and heaters. A closer examination of these data is needed.
- Collect additional field data for gas-fired boilers to develop emission factors for polycyclic compounds, metals, and organic HAPs. The API committee identified gas-fired boilers/heaters as the highest priority source category. Additional test data for polycyclic compounds, metals, and organic HAPs would improve the quality and reliability of the emission factors.
- Collect additional field data for fuel oil-fired boilers and IC engines to develop emission factors for polycyclic compounds, metals, and organic HAPs. Gas-fired IC engines and fuel oil-fired boilers were identified as the second and third highest priority source categories by the API committee. Additional test data for polycyclic compounds, metals, and organic HAPs would improve the quality and reliability of the emission factors.
- Prepare documentation to demonstrate that the relative potential for dioxin emissions from gas-fired heaters is very low.
- Initiate the process with EPA for updating of AP-42 fuel oil and natural gas external combustion sections. The air toxic emission factors in these sections are based almost entirely on testing of electric utility boilers. Existing data collected through the ICCR, PERF, and GRI efforts described above can be used to develop more reliable emission factors that are representative of petroleum industry boilers and heaters.
- Where possible, consider adding HAP sampling and analysis to existing field data collection efforts. API is executing a related effort to characterize PM2.5 emissions from stationary petroleum industry combustion devices. Adding HAP measurements to the existing test plan may be a cost-effective way to collect additional HAP data to resolve inconsistencies and fill in gaps.

6 REFERENCES

1. *Compilation of Air Pollutant Emission Factors Volume I: Stationary Point and Area Sources*, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 2000.

2. *Air Toxic Emission Factors for Combustion Sources Using Petroleum-Base Fuels, Graphical-User-Interface Database and User's Manual Version 2.02*, API Publication Number 349, American Petroleum Institute, Washington, DC, October 1998.

3. *Technical Support for API ICCR Strategies Task 9: Discussion of Sources of Variability in ICCR Emissions Data*, Energy and Environmental Research Corporation, Irvine, California, July 17, 1998.

4. *Ranking and Selection of Hazardous Air Pollutants for Listing Under Section 112(k) of the Clean Air Act Amendments of 1990 – Technical Support Document*, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 28, 1999.

5. *Technical Support for ICCR Strategies Task 4: ICCR Emissions Database Review*, Energy and Environmental Research Corporation, Irvine, California, June 12, 1998.
6. *The Origin and Fate of Toxic Combustion Byproducts in Refinery Heaters: Research to Enable Efficient Compliance with the Clean Air Act*, James G. Seebold, Chevron Research and Technology Company, Richmond, California, August 5, 1997.
7. *Organic Hazardous Air Pollutant Emissions from Gas-fired Boilers and Process Heaters*, Energy and Environmental Research Corporation, Irvine, California, July 16, 1997.
8. *PERF Project 92-19 Status Report*, at http://www.perf.org/projects/1992/92-19.htm
9. *Characterization of Emissions from Oil and Gas Production Field Combustion Units*, API Publication Number 4696, American Petroleum Institute, Washington, DC, December 1999.
10. *Measurement of Air Toxic Emissions from Combustion Equipment at Natural Gas Processing Plants: Volume I*, Document Number GRI-96/0010.1, Gas Research Institute, Chicago, Illinois, 1997.

APPENDIX A—COMPARISON OF AP-42 AND PATEF 2.02 EMISSION FACTORS

Field Name	Description
Substance	Substance name, such as benzene, toluene, etc.
CAS No.	Chemical Abstract Service number
AP-42 Factor (lb/MMBtu)	Emission factor published in the most current version of EPA's AP-42 emission factor document. Factors were converted from units of lb/gallon or lb/MMcf using typical heating values for each fuel
AP-42 Rating	Rating used by EPA to provide an overall assessment of how good a factor is, based on both the quality of the test(s) and on how well the factor represents the emission source. Specifically, A = Excellent. Factor is developed from tests (using EPA reference or other sound methods) taken from many randomly chosen facilities in the industry population B = Above Average. Factor is developed from tests (using EPA reference or other sound methods) taken from a moderate number of facilities. However, it is not clear if the facilities tested represent a random sample of the industry C = Average. Factor is developed from tests (using EPA reference, other sound methods, or a new or unproven methodology) taken from a reasonable of facilities. It is not clear if the facilities tested represent a random sample of the industry D = Below Average. Factor is developed from tests (using EPA reference, other sound methods, or a new or unproven methodology) taken from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There may also be evidence of variability with the source category population. E = Poor. Factor is developed from tests (using new, unproven, or unacceptable methods) taken from a very few number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There may also be evidence of variability with the source category population.
AP-42 # of Tests	Number of sources or sources tests used to develop the emission factor. Typically, there are three test runs per source test.
AP-42 Non-Detect?	Certain AP-42 sections flag emission factors that were generated entirely from method detection limits and not on measured values. A "Yes" in this column means that AP-42 acknowledges that the emission factor is based on the method detection limit.
PATEF Factor (lb/MMBtu)	Mean emission factor published in PATEF 2.02.
PATEF EPA Rating	Same as AP-42 Rating listed above
PATEF # of Tests	Number of sources or sources tests used to develop the emission factor. Typically, there are three test runs per source test.
PATEF Detect Ratio	Ratio of the sum of detected values to the sum of detected and non-detected values. A ratio of one indicates all of the data were detected. A ratio of zero indicates all the data were not detected.
Factor Ratio	Ratio of the AP-42 emission factor to the PATEF emission factor. A ratio of one indicates agreement between the EPA and PATEF emission factors. A ratio greater than one indicates that the AP-42 factor is higher than the PATEF factor. A ratio less than one indicates that the AP-42 factor is less than the PATEF factor.
Quality Flag	The higher of the AP-42 Rating and the PATEF EPA Rating.

Table 1—Key to Fields Contained in Tables A-1 to A-13

EXTERNAL COMBUSTION, NO. 6 FUEL OIL

Table A-1 compares the EPA and the API emission factor data for No. 6 fuel oil combustion by boilers. The EPA factors were obtained from AP-42 Section 1.3 – Fuel Oil Combustion (dated 9/98). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The EPA factors were calculated from test data at several EPRI sites, a Southern California Edison site, and a Pacific Gas and Electric site. A total of 46 test runs were conducted at 15 different sites. The boilers were primarily large utility boilers with capacities in excess of 500 million Btu/hour. The API factors were based on emission tests at two refineries conducted in response to California Assembly Bill 2588.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. The PATEF database presents emission factors for 17 different dioxins/furans, one of which is a HAP and six are on the PBT list. These factors are based on a single test. For seven of the compounds, the detect ratio was zero, meaning that all of the data were below the detection limit. EPA has no emission factor data for dioxins/furans, so no comparison to the API emission factors could be made.
- Metals. The PATEF database lists emission factors for only eight compounds based on a single source test. AP-42 presents factors for 20 metals based on tests at as many as 12 utility boilers. For most metals, measured values were above the detection limits. For other metals (beryllium, mercury. selenium), measured values were often below the detection limit. For example, mercury was not detected in any of the three sampling runs during 9 of the 12 source tests. In total, mercury was detected in only 6 of the 27 sampling runs. In these cases, the emission factor is based on half of the detection limit value.
- Polycyclic Compounds. The PATEF emission factors are based on tests at two refinery boilers, while the API factors are based on tests of as many as 11 utility boilers. For three individuals polycyclic compounds (acenaphthene, benzo(a)anthracene, and napthalene), the EPA factors are about 20 times higher than the PATEF factor. There is no obvious reason for these discrepancies. For other polycyclic compounds reported in both data sets, there are no large discrepancies.
- SVOC and VOC. With the exception of benzene and formaldehyde, SVOC and VOC emission factors in both AP-42 and PATEF are based on only one or two tests.

EXTERNAL COMBUSTION, REFINERY GAS/NATURAL GAS

Table A-2 compares the EPA and the API emission factor data for refinery gas/natural gas combustion by boilers, heaters, and steam generators. The EPA factors were obtained from AP-42 Section 1.4 – Natural Gas Combustion (dated 7/98). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated as a pooled emission factor based on the following tests:

- 5 tests of refinery gas-fired industrial boilers
- 16 tests of for refinery gas-fired process heaters
- 1 test of a natural gas/refinery gas-fired process heater
- 1 test of a natural gas-fired process heater
- 2 tests of natural gas-fired steam generators
- 5 tests of natural gas/CVR gas steam generators

The EPA factors were based primarily on emission testing of 15 natural gas-fired utility boilers with ratings in excess of 500 million Btu/hour, and as large as 6,650 million Btu/hour.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. The PATEF emission factors are based on 1 or 2 tests, while the EPA emission factors are based on 1 to 5 tests. Both the EPA and PATEF emission factors generally have below average quality ratings. Both sets of data show that metal emissions are very low, on the order of 10-5 to 10-6 lb/MMBtu. For four metals (beryllium, copper, man-

ganese, and zinc), the EPA factors are at least 5 times lower than the PATEF factor. There is no obvious reason for these discrepancies.

- Polycyclic Compounds. The PATEF emission factors are based on 9-14 tests and have an excellent data quality rating. The EPA factors are based on a single test during which most polycyclic compounds were below the detection limit.
- SVOC and VOC. Both PATEF and EPA have a significant amount of test data for benzene, toluene, formaldehyde, and xylene. There are large discrepancies between the PATEF and EPA emission factors for benzene (PATEF 29 times higher than EPA) and toluene (PATEF 45 times higher). There is reasonably good agreement for the formaldehyde factor. It is interesting to note that EPA reports a very high emission factor for hexane. Applying the EPA hexane factor to a typical refinery (firing rate of 6,000 MMBtu/hr) yields an emission rate of 46 tons per year.

EXTERNAL COMBUSTION, CRUDE OIL/PIPELINE OIL

Table A-3 compares the EPA and the API emission factor data for crude oil/pipeline oil combustion by boilers, process heaters, and steam generators. The API factors were obtained from PATEF 2.02. There are no EPA emission factors in AP-42 for combustion of this type of fuel.

Description of Sources Tested

The PATEF factors were calculated from tests of a single pipeline oil-fired process heater and three crude oil-fired steam generators.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. The PATEF emission factors are based on only one dioxin/furan test. Measured values in most cases were below or near the detection limit.
- Metals. The PATEF emission factors are based on 2-4 tests of unknown quality.
- Polycyclic Compounds. The PATEF emission factors are based on 1-4 tests. polycyclic compound emissions are very low, on the order of 10-6 to 10-8 lb/MMBtu.

INTERNAL COMBUSTION, LARGE DIESEL-FIRED ENGINES

Table A-4 compares the EPA and the API emission factor data for large (> 600 hp) reciprocating internal combustion engines. The EPA factors were obtained from AP-42 Section 3.4 – Large Stationary Diesel and All Stationary Dual-fuel Engines (dated 10/96). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF emission factors were calculated from a single test of a > 650 hp engine with stack oxygen level less than 13%. The EPA emission factors appear to be based on this same test data.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. There are no emission factors for metals in either the EPA or the API databases.
- Polycyclic Compounds. The PATEF and AP-42 emission factors are identical and based on the test of a single engine.
- SVOC and VOC. The PATEF and AP-42 emission factors are identical and based on the test of a single engine.

INTERNAL COMBUSTION, SMALL DIESEL-FIRED ENGINES

Table A-5 compares the EPA and the API emission factor data for small (< 600 hp) reciprocating internal combustion engines. The EPA factors were obtained from AP-42 Section 3.3 – Gasoline and Diesel Industrial Engines (dated 10/96). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF emission factors were calculated from tests of two small (> 650 hp) engines with stack oxygen level greater than 13%. The EPA emission factors appear to be based on this same test data.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. There are no emission factors for metals in either the EPA or the API databases.
- Polycyclic Compounds. The PATEF and AP-42 emission factors are identical and based on the tests of the two engines.
- SVOC and VOC. The PATEF and AP-42 emission factors are identical and based on the tests of the two engines.

INTERNAL COMBUSTION, GAS-FIRED 2-STROKE LEAN-BURN ENGINES

Table A-6 compares the EPA and the API emission factor data for gas-fired, 2-stroke, lean-burn, reciprocating internal combustion engines. The EPA factors were obtained from AP-42 Section 3.2 – Natural Gas-fired Reciprocating Engines (dated 7/00). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated using data from two test data sets. The EPA factors are based on 18 test reports containing 120 emission tests. These test data were gathered over the past 5 years under the ICCR program, EPA-sponsored testing at Colorado State University, and GRI-sponsored testing.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. There are no emission factors for metals in either the EPA or the API databases.
- Polycyclic Compounds. The PATEF emission factors are based on a single test, while the EPA factors are based on from 1 to 7 tests. For the most part, there is reasonably good agreement between the two data sets.
- SVOC and VOC. The PATEF emission factors are based on one or two tests, while the EPA factors are based on as many as 58 tests. The EPA database contains emission factors for many more compounds than are in the PATEF database.

INTERNAL COMBUSTION, GAS-FIRED 4-STROKE LEAN-BURN ENGINES

Table A-7 compares the EPA and the API emission factor data for gas-fired, 4-stroke, lean-burn, reciprocating internal combustion engines. The EPA factors were obtained from AP-42 Section 3.2 – Natural Gas-fired Reciprocating Engines (dated 7/00). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated using data from two test data sets. The EPA factors are based on 18 test reports containing 93 emission tests. These test data were gathered over the past five years under the ICCR program, EPA-sponsored testing at Colorado State University, and GRI-sponsored testing.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. There are no emission factors for metals in either the EPA or the API databases.
- Polycyclic Compounds. The PATEF emission factors are based on a single test, while the EPA factors are based on from 1 to 6 tests. For the most part, the EPA emission factors are higher than the PATEF emission factors.
- SVOC and VOC. The PATEF emission factors are based on one or two tests, while the EPA factors are based on as many as 32 tests. The EPA database contains emission factors for many more compounds than are in the PATEF database.

INTERNAL COMBUSTION, GAS-FIRED 4-STROKE RICH-BURN ENGINES

Table A-8 compares the EPA and the API emission factor data for gas-fired, 4-stroke, rich-burn, reciprocating internal combustion engines. The EPA factors were obtained from AP-42 Section 3.2 – Natural Gas-fired Reciprocating Engines (dated 7/00). The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated using data from two test data sets. The EPA factors are based on 25 test reports containing 111 emission tests. These test data were gathered over the past 5 years under the ICCR program, EPA-sponsored testing at Colorado State University, and GRI-sponsored testing.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. There are no emission factors for metals in either the EPA or the API databases.
- Polycyclic Compounds. There are no emission factors for polycyclic compounds in the API database. The EPA database has emission factors for only naphthalene and total polycyclic compounds. The naphthalene factor was based on one-half of the method detection limit.
- SVOC and VOC. The PATEF emission factors are based on one or two tests, while the EPA factors are based on as many as 18 tests. The EPA database contains emission factors for many more compounds than are in the PATEF database. Ten of the VOC emission factors in AP-42 were based on one-half of the method detection limit.

INTERNAL COMBUSTION, GAS-FIRED GAS-TURBINES

Tables A-9 and A-10 compare the EPA and the API emission factor data for gas-fired gas turbines with and without duct burners. The EPA factors were obtained from AP-42 Section 3.1 – Stationary Gas Turbines (dated 4/00). AP-42 does not distinguish between turbines with and without duct burners. Duct burners are used to provide supplemental heat for the waste heat boiler in the cogeneration cycle. The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated using data from three test data sets. The EPA HAP factors are based on over 60 source tests.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.
- Metals. The PATEF emission factors are based on one or two tests. There are no metal emission factors for gas-fired turbines in AP-42.
- Polycyclic Compounds. The PATEF emission factors are based on one or two tests. AP-42 reports emission factors only for naphthalene and total polycyclic compounds.
- SVOC and VOC. The PATEF emission factors are based on one or two tests, while the EPA factors are based on as many as 33 tests.

DIRECT COMBUSTION, ASPHALT BLOWING

Tables A-11 and A-12 present the emission factors for asphalt blowing, with and without a blow cycle. AP-42 does not have any emission factors for these processes. The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated using data from two tests – one of an asphalt blowing operation with a blow cycle and one of an asphalt blowing operation without a blow cycle. EPA has no test data for these types of sources.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. There are no emission factors for dioxins/furans in either the EPA or the API databases.

- Metals. The PATEF emission factors are based on one test. Only six individual metals were analyzed. There are no metal emission factors for gas-fired turbines in AP-42.
- Polycyclic Compounds. There are no emission factors for polycyclic compounds in either the EPA or the API databases.
- SVOC and VOC. The PATEF emission factors are based on one test. Only six individual compounds were assessed.

DIRECT COMBUSTION, COKE CALCINING

Table A-13 presents the emission factors for coke calcining. AP-42 does not have any emission factors for this process. The API factors were obtained from PATEF 2.02.

Description of Sources Tested

The PATEF factors were calculated using data from one test. EPA has no test data for this type of source.

Identification and Explanation of Gaps and Inconsistencies

- Dioxins/Furans. The PATEF emission factors are based on one test. There are no emission factors in AP-42.
- Metals. The PATEF emission factors are based on one test. There are no emission factors in AP-42.
- Polycyclic Compounds. The PATEF emission factors are based on one test. There are no emission factors in AP-42.
- SVOC and VOC. The PATEF emission factors are based on one test. There are no emission factors in AP-42.

TABLE A-1 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion, No. 6 Fuel Oil

Substance	CAS No.	AP-42 Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	PATEF 2.02 Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Factor Ratio (EPA/PATEF)	Quality Flag
Dioxin/Furan											
Dioxin:4D 2378	1746-01-6					4.31E-12	E	1	0.00		Poor
Dioxin:5D 12378	40321-76-4					2.50E-12	E	1	0.00		Poor
Dioxin:6D 123478	39227-28-6					2.50E-12	E	1	0.00		Poor
Dioxin:6D 123678	57653-85-7					2.50E-12	E	1	0.25		Poor
Dioxin:6D 123789	19408-74-3					2.50E-12	E	1	0.25		Poor
Dioxin:7D 1234678	35822-46-9					2.12E-11	E	1	1.00		Poor
Dioxin:8D						5.10E-10	E	1	1.00		Poor
Furan:4F 2378	51207-31-9					5.54E-12	E	1	1.00		Poor
Furan:5F 12378	57117-41-6					3.12E-12	E	1	0.00		Poor
Furan:5F 23478	5711-31-4					3.12E-12	E	1	0.00		Poor
Furan:6F 123478	70648-26-9					2.48E-12	E	1	0.50		Poor
Furan:6F 123678	57117-44-9					1.86E-12	E	1	0.33		Poor
Furan:6F 123789	72918-21-9					2.50E-12	E	1	0.00		Poor
Furan:6F 234678	60851-34-5					3.74E-12	E	1	0.50		Poor
Furan:7F 1234678	67562-39-4					9.79E-12	E	1	1.00		Poor
Furan:7F 1234789	55673-89-7					3.15E-12	E	1	0.00		Poor
Furan:8F						4.86E-11	E	1	1.00		Poor
Metals											
Antimony	7440-36-0	3.50E-05	E	1							Poor
Arsenic	7440-38-2	8.80E-06	C	12							Average
Barium	7440-39-3	1.71E-05	D	3							Below Ave.
Beryllium	7440-41-7	1.85E-07	C	12		4.28E-07	E	1	0.00	0.43	Average
Cadmium	7440-43-9	2.65E-06	C	12							Average
Chloride		2.31E-03	D	2							Below Ave.
Chromium (Hex)	18540-29-9	1.65E-06	C	12							Average
Chromium (Total)	7440-47-3	5.63E-06	C	10		3.28E-05	E	1	1.00	**0.17**	Average
Cobalt	7440-48-4	4.01E-05	D	3							Below Ave.
Copper	7440-50-8	1.17E-05	C	12		2.62E-05	E	1	1.00	0.45	Average
Flouride		2.49E-04	D	2							Below Ave.
Lead	7439-92-1	1.01E-05	C	12							Average
Manganese	7439-96-5	2.00E-05	C	12		3.95E-05	E	1	1.00	0.51	Average
Mercury	7439-97-6	7.53E-07	C	12		7.02E-08	E	1	0.00	**10.7**	Average

TABLE A-1 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion, No. 6 Fuel Oil

		AP-42				PATEF 2.02				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Molybdenum	7439-98-7	5.25E-06	D	3							Below Ave.
Nickel	7440-02-0	5.63E-04	C	12		2.27E-03	E	1	1.00	0.25	Average
Phosphorus	7723-14-0	6.31E-05	D	2							Below Ave.
Selenium	7782-49-2	4.55E-06	C	12		1.96E-05	E	1	0.17	0.23	Average
Vanadium	7440-62-2	2.12E-04	D	3							Below Ave.
Zinc	7440-66-6	1.94E-04	D	3		1.09E-04	E	1	1.00	1.78	Below Ave.
Polycyclic Compounds											
Acenaphthene	83-32-9	1.41E-07	C	10		6.00E-09	D	2	0.88	**23.4**	Average
Acenaphthylene	208-96-8	1.69E-09	D	10		2.09E-09	D	2	0.00	0.81	Below Ave.
Anthracene	120-12-7	8.13E-09	C	10		2.07E-09	D	2	0.93	3.92	Average
Benzo(a)anthracene	56-55-3	2.67E-08	C	10		1.32E-09	D	2	0.00	**20.3**	Average
Benzo(a)pyrene	50-32-8			9	Yes	1.36E-09	D	2	0.00		Below Ave.
Benzo(b)fluoranthene	205-99-2					8.11E-09	D	2	0.40		Below Ave.
Benzo(b+k)fluoranthene		9.87E-09	C	9							Average
Benzo(e)pyrene	192-97-2					5.80E-09	D	1	0.00		Below Ave.
Benzo(g,h,i)perylene	191-24-2	1.51E-08	C	9		6.72E-09	D	2	0.00	2.24	Average
Benzo(k)fluoranthene	207-08-9					4.55E-10	D	1	0.00		Below Ave.
Chrysene	218-01-9	1.59E-08	C	10		2.62E-08	D	2	1.00	0.61	Average
Dibenz(a,h)anthracene	53-70-3	1.11E-08	D	3							Below Ave.
Fluoranthene	206-44-0	3.23E-08	C	10		5.25E-08	D	2	1.00	0.61	Average
Fluorene	86-73-7	2.98E-08	C	11		3.14E-08	D	2	1.00	0.95	Average
Indeno(1,2,3-cd)pyrene	193-39-5	1.43E-08	C	9		3.05E-09	D	2	0.00	4.68	Average
Naphthalene	91-20-3	7.53E-06	C	10		4.04E-07	D	2	1.00	**18.7**	Average
Phenanthrene	85-01-8	7.00E-08	C	11		7.39E-08	D	2	1.00	0.95	Average
Pyrene	129-00-0	2.83E-08	C	10		2.72E-08	D	2	0.97	1.04	Average
Polycyclic Compounds - Total		7.94E-06				6.54E-07	D	2	0.95	**12.1**	Below Ave.
SVOC											
2-Chloronaphthalene	91-58-7					1.54E-10	D	1	0.00		Below Ave.
2-Methylnaphthalene	91-57-6					7.40E-08	D	1	1.00		Below Ave.
Perylene	198-55-0					7.44E-10	D	1	0.00		Below Ave.

TABLE A-1 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion, No. 6 Fuel Oil

		AP-42				PATEF 2.02				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
VOC											
1,1,1-Trichlorethane		1.57E-06	E	1							Poor
Acetaldehyde	75-07-0					6.99E-06	D	2	0.76		Below Ave.
Aldehyde Total						5.21E-05	D	2	0.25		Below Ave.
Benzene	71-43-2	1.43E-06	C	12							Average
Chloroform	67-66-3					3.37E-05	D	1	0.00		Below Ave.
Ethylbenzene	100-41-4	4.24E-07	E	1							Poor
Formaldehyde	50-00-0	2.20E-04	C	12		1.65E-05	D	1	0.93	**13.3**	Average
Toluene	108-88-3	4.13E-05	D	2		3.91E-05	D	1	0.00	1.06	Below Ave.
Xylene (o)	95-47-6	7.27E-07	E	1							Poor

TABLE A-2 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion - Refinery Gas/Natural Gas
Refinery Gas-fired Boilers, Refinery and Natural Gas-fired Process Heaters, Natural Gas/CVR-fired Steam Generators

		AP-42				PATEF				Factor	
Substance	**CAS No.**	**Factor (lb/MMBtu)**	**AP42 Rating**	**# of Tests**	**Non-Detect?**	**Factor (lb/MMBtu)**	**EPA Rating**	**# of Tests**	**Detect Ratio**	**Ratio (EPA/PATEF)**	**Quality Flag**
Metals											
Antimony	7440-36-0					5.17E-07	D	1	1.00		Below Ave.
Arsenic	7440-38-2	1.96E-07	E	2		7.19E-07	E	2	1.00	0.27	Poor
Barium	7440-39-3	4.31E-06	D	3		5.78E-06	D	1	0.00	0.75	Below Ave.
Beryllium	7440-41-7	1.18E-08	E	1	Yes	1.31E-07	E	1	1.00	**0.090**	Poor
Cadmium	7440-43-9	1.08E-06	D	3		1.49E-06	E	2	1.00	0.72	Below Ave.
Chromium (Total)	7440-47-3	1.37E-06	D	5		5.74E-06	D	2	0.96	0.24	Below Ave.
Cobalt	7440-48-4	8.24E-08	D	2							Below Ave.
Copper	7440-50-8	8.33E-07	C	4		4.65E-06	D	2	1.00	**0.18**	Average
Lead	7439-92-1					3.75E-06	D	2	1.00		Below Ave.
Manganese	7439-96-5	3.73E-07	D	2		4.89E-06	D	2	1.00	**0.076**	Below Ave.
Mercury	7439-97-6	2.55E-07	D	2		1.80E-07	D	1	0.36	1.42	Below Ave.
Molybdenum	7439-98-7	1.08E-06	D	2							Below Ave.
Nickel	7440-02-0	2.06E-06	C	5		7.54E-06	D	2	0.97	0.27	Average
Phosphorus	7723-14-0					6.42E-07	D	1	0.00		Below Ave.
Selenium	7782-49-2	2.35E-08	E	1	Yes	8.75E-07	E	2	0.16	**0.027**	Poor
Silver	7440-22-4					1.61E-06	D	1	0.94		Below Ave.
Thallium	7440-28-0					5.78E-06	D	1	0.00		Below Ave.
Vanadium	7440-62-2	2.25E-06	D	3							Below Ave.
Zinc	7440-66-6	2.84E-05	E	1		1.43E-03	E	2	1.00	**0.020**	Poor
Polycyclic Compounds											
Acenaphthene	83-32-9	1.76E-09	E	1	Yes	2.43E-09	A	9	0.79	0.73	Excellent
Acenaphthylene	208-96-8	1.76E-09	E	1	Yes	6.53E-09	A	9	0.89	0.27	Excellent
Anthracene	120-12-7	2.35E-09	E	1	Yes	4.73E-09	A	9	0.97	0.50	Excellent
Benzo(a)anthracene	56-55-3	1.76E-09	E	1	Yes	2.22E-08	A	14	0.99	**0.080**	Excellent
Benzo(a)pyrene	50-32-8	1.18E-09	E	1	Yes	5.74E-08	A	14	0.98	**0.020**	Excellent
Benzo(b)fluoranthene	205-99-2	1.76E-09	E	1	Yes	2.65E-08	A	14	0.98	**0.067**	Excellent
Benzo(g,h,i)perylene	191-24-2	1.18E-09	E	1	Yes	1.27E-09	A	9	0.39	0.93	Excellent
Benzo(k)fluoranthene	207-08-9	1.76E-09	E	1	Yes	1.67E-08	A	13	0.95	**0.11**	Excellent
Chrysene	218-01-9	1.76E-09	E	1	Yes	1.59E-09	A	9	0.51	1.11	Excellent
Dibenz(a,h)anthracene	53-70-3	1.18E-09	E	1	Yes	1.50E-09	A	9	0.00	0.79	Excellent
Fluoranthene	206-44-0	2.94E-09	E	1		8.71E-09	A	9	1.00	0.34	Excellent

TABLE A-2 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion - Refinery Gas/Natural Gas
Refinery Gas-fired Boilers, Refinery and Natural Gas-fired Process Heaters, Natural Gas/CVR-fired Steam Generators

		AP-42				PATEF				Factor	
Substance	**CAS No.**	**Factor (lb/MMBtu)**	**AP42 Rating**	**# of Tests**	**Non-Detect?**	**Factor (lb/MMBtu)**	**EPA Rating**	**# of Tests**	**Detect Ratio**	**Ratio (EPA/PATEF)**	**Quality Flag**
Fluorene	86-73-7	2.75E-09	E	2		4.76E-08	A	9	1.00	**0.058**	Excellent
Indeno(1,2,3-cd)pyrene	193-39-5	1.76E-09	E	1	Yes	7.06E-08	A	13	0.99	**0.025**	Excellent
Naphthalene	91-20-3	5.98E-07	E	2		3.90E-07	A	9	1.00	1.53	Excellent
Phenanthrene	85-01-8	1.67E-08	D	4		3.21E-08	A	9	1.00	0.52	Excellent
Pyrene	129-00-0	4.90E-09	E	1		9.76E-09	A	9	1.00	0.50	Excellent
Polycyclic Compounds - Total		6.44E-07				5.15E-07	A	9	0.99	1.25	Excellent
SVOC											
2-Methylnaphthalene	91-57-6	2.35E-08	D	4							Below Ave.
3-Methylchloranthrene	56-49-5	1.76E-09	E	1	Yes						Poor
Ethylbenzene	100-41-4					1.62E-05	A	6	0.80		Excellent
Phenol	108-95-2					3.97E-06	NR	12	0.95		NR
VOC											
Acetaldehyde	75-07-0					1.20E-05	NR	20	0.88		NR
Acrolein	107-02-8					1.74E-05	A	5	0.93		Excellent
Aldehyde Total						6.61E-05	NR	19	0.95		NR
Benzene	71-43-2	2.06E-06	B	18		6.01E-05	NR	16	0.79	**0.034**	Good
BTX Total						5.40E-05	A	12	0.51		Excellent
Butane	106-97-8	2.06E-03	E	1							Poor
Ethane	74-84-0	3.04E-03	E	4							Poor
Formaldehyde	50-00-0	7.35E-05	B	22		5.16E-05	NR	20	0.97	1.42	Good
Hexane	110-54-3	1.76E-03	E	2							Poor
Hydrogen Sulfide	7783-06-4					8.54E-05	B	3	0.56		Good
Pentane	109-66-0	2.55E-03	E	1							Poor
Propane	74-98-6	1.57E-03	E	1							Poor
Propylene	115-07-1					1.50E-04	A	10	0.69		Excellent
Toluene	108-88-3	3.33E-06	C	12		1.52E-04	NR	23	0.81	**0.022**	Average
Xylene (Total)	1330-20-7					2.50E-05	A	7	0.78		Excellent

TABLE A-3 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion - Crude Oil/Pipeline Oil

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	FIRE Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Dioxin/Furan											
Dioxin:4D 2378	1746-01-6					3.46E-12	E	1	0.00		Poor
Dioxin:5D 12378	40321-76-4					1.74E-11	E	1	0.00		Poor
Dioxin:6D 123478	39227-28-6					1.53E-11	E	1	0.00		Poor
Dioxin:6D 123678	57653-85-7					2.08E-11	E	1	0.07		Poor
Dioxin:6D 123789	19408-74-3					3.33E-11	E	1	0.04		Poor
Dioxin:7D 1234678	35822-46-9					9.30E-11	E	1	1.00		Poor
Dioxin:8D						3.26E-10	E	1	1.00		Poor
Furan:4F 2378	51207-31-9					6.23E-10	E	1	1.00		Poor
Furan:5F 12378	57117-41-6					5.98E-11	E	1	0.00		Poor
Furan:5F 23478	5711-31-4					1.06E-10	E	1	0.00		Poor
Furan:6F 123478	70648-26-9					1.34E-10	E	1	0.01		Poor
Furan:6F 123678	57117-44-9					4.27E-11	E	1	0.02		Poor
Furan:6F 123789	72918-21-9					3.46E-12	E	1	0.00		Poor
Furan:6F 234678	60851-34-5					6.11E-11	E	1	0.03		Poor
Furan:7F 1234678	67562-39-4					1.36E-10	E	1	1.00		Poor
Furan:7F 1234789	55673-89-7					8.33E-12	E	1	0.00		Poor
Furan:8F						7.29E-11	E	1	1.00		Poor
Halogens											
HCl	7647-01-0					1.25E-06	D	1	1.0		Below Ave.
Metals											
Arsenic	7440-38-2					6.67E-06	NR	3	1.00		NR
Beryllium	7440-41-7					1.92E-06	E	2	0.51		Poor
Cadmium	7440-43-9					2.25E-06	NR	4	1.00		NR
Chromium (Hex)	18540-29-9					1.09E-06	NR	3	0.47		NR
Chromium (Total)	7440-47-3					8.74E-06	NR	4	1.00		NR
Copper	7440-50-8					9.54E-06	NR	4	1.00		NR
Lead	7439-92-1					1.93E-06	NR	4	0.55		NR
Manganese	7439-96-5					1.81E-05	NR	4	0.87		NR
Mercury	7439-97-6					1.04E-05	NR	4	1.00		NR
Nickel	7440-02-0					2.40E-03	NR	4	1.00		NR

TABLE A-3 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion - Crude Oil/Pipeline Oil

		AP-42				PATEF				Factor	
Substance	**CAS No.**	**Factor (lb/MMBtu)**	**FIRE Rating**	**# of Tests**	**Non-Detect?**	**Factor (lb/MMBtu)**	**EPA Rating**	**# of Tests**	**Detect Ratio**	**Ratio (EPA/PATEF)**	**Quality Flag**
Phosphorus	7723-14-0					1.78E-04	E	2	1.00		Poor
Selenium	7782-49-2					7.95E-06	NR	3	0.96		NR
Zinc	7440-66-6					4.24E-04	NR	4	0.94		NR
Polycyclic Compounds											
Acenaphthene	83-32-9					1.74E-07	C	3	1.00		Average
Acenaphthylene	208-96-8					2.33E-08	C	3	1.00		Average
Anthracene	120-12-7					3.72E-08	C	4	1.00		Average
Benzo(a)anthracene	56-55-3					3.16E-08	C	3	1.00		Average
Benzo(a)pyrene	50-32-8					1.39E-08	D	2	0.96		Below Ave.
Benzo(b)fluoranthene	205-99-2					5.55E-09	D	1	1.00		Below Ave.
Benzo(b+k)fluoranthene						8.06E-08	D	1	0.00		Below Ave.
Benzo(e)pyrene	192-97-2					3.87E-09	D	1	1.00		Below Ave.
Benzo(g,h,i)perylene	191-24-2					1.92E-08	D	2	0.94		Below Ave.
Benzo(k)fluoranthene	207-08-9					2.35E-10	D	1	1.00		Below Ave.
Chrysene	218-01-9					7.53E-08	C	4	0.73		Average
Dibenz(a,h)anthracene	53-70-3					1.23E-08	D	1	1.00		Below Ave.
Fluoranthene	206-44-0					6.88E-08	C	4	0.71		Average
Fluorene	86-73-7					2.01E-07	C	4	1.00		Average
Indeno(1,2,3-cd)pyrene	193-39-5					1.93E-08	D	2	0.94		Below Ave.
Naphthalene	91-20-3					5.45E-06	C	4	1.00		Average
Polycyclic Compounds - Total						7.20E-06	C	3	0.96		Average
Phenanthrene	85-01-8					1.67E-07	C	4	1.00		Average
Pyrene	129-00-0					1.15E-07	C	4	0.82		Average

TABLE A-3 - COMPARISON OF EPA AND API EMISSION FACTORS
External Combustion - Crude Oil/Pipeline Oil

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	FIRE Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
SVOC											
2-Chloronaphthalene	91-58-7					8.16E-08	D	1	1.00		Below Ave.
2-Methylnaphthalene	91-57-6					2.51E-07	D	1	1.00		Below Ave.
Benzaldehyde	100-52-7					4.74E-05	E	1	0.00		Poor
Perylene	198-55-0					5.17E-10	D	1	1.00		Below Ave.
VOC											
1,3-Butadiene	106-99-0					1.36E-04	D	1	0.00		Below Ave.
Acetaldehyde	75-07-0					1.08E-05	E	2	0.88		Poor
Acrolein	107-02-8					3.30E-06	E	1	0.00		Poor
Aldehyde Total						2.57E-05	NR	3	0.36		NR
Benzene	71-43-2					4.07E-06	D	2	0.36		Below Ave.
BTX Total						4.97E-05	D	2	0.39		Below Ave.
Chloroform	67-66-3					6.02E-05	D	1	0.00		Below Ave.
Formaldehyde	50-00-0					1.14E-05	NR	3	0.18		NR
Propylene	115-07-1					4.36E-05	D	2	0.00		Below Ave.
Toluene	108-88-3					3.53E-05	B	3	0.38		Good
Xylene (Total)	1330-20-7					2.89E-06	D	1	0.00		Below Ave.

TABLE A-4 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Diesel-fired, Oxygen < 13%, > 600 hp

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Polycyclic Compounds											
Acenaphthene	83-32-9	4.68E-06	E	1		4.54E-06	D	1	1.00	1.03	Below Ave.
Acenaphthylene	208-96-8	9.23E-06	E	1		8.97E-06	D	1	1.00	1.03	Below Ave.
Anthracene	120-12-7	1.23E-06	E	1		1.20E-06	D	1	1.00	1.03	Below Ave.
Benzo(a)anthracene	56-55-3	6.22E-07	E	1		6.14E-07	D	1	1.00	1.01	Below Ave.
Benzo(a)pyrene	50-32-8	2.57E-07	E	1		2.49E-07	D	1	0.45	1.03	Below Ave.
Benzo(b)fluoranthene	205-99-2	1.11E-06	E	1	Yes	1.08E-06	D	1	0.27	1.03	Below Ave.
Benzo(g,h,i)perylene	191-24-2	5.56E-07	E	1		5.42E-07	D	1	1.00	1.03	Below Ave.
Benzo(k)fluoranthene	207-08-9	2.18E-07	E	1	Yes	2.13E-07	D	1	0.76	1.02	Below Ave.
Chrysene	218-01-9	1.53E-06	E	1		1.49E-06	D	1	1.00	1.03	Below Ave.
Dibenz(a,h)anthracene	53-70-3	3.46E-07	E	1	Yes	3.36E-07	D	1	0.00	1.03	Below Ave.
Fluoranthene	206-44-0	3.71E-06	E	1		3.92E-06	D	1	1.00	0.95	Below Ave.
Fluorene	86-73-7	1.28E-05	E	1		1.25E-05	D	1	1.00	1.03	Below Ave.
Indeno(1,2,3-cd)pyrene	193-39-5	4.14E-07	E	1	Yes	4.01E-07	D	1	0.34	1.03	Below Ave.
Naphthalene	91-20-3	1.30E-04	E	1		1.27E-04	D	1	1.00	1.03	Below Ave.
Phenanthrene	85-01-8	4.08E-05	E	1		3.97E-05	D	1	1.00	1.03	Below Ave.
Pyrene	129-00-0	3.71E-06	E	1		3.61E-06	D	1	1.00	1.03	Below Ave.
Polycyclic Compounds - Total		2.11E-04	E	1	Yes	2.06E-04	D	1	0.99	1.03	Below Ave.
VOC											
Acetaldehyde	75-07-0	2.52E-05	E	1		2.44E-05	E	1	1.00	1.03	Poor
Acrolein	107-02-8	7.88E-06	E	1		7.57E-06	E	1	0.56	1.04	Poor
Aldehyde Total						1.01E-04	E	1	1.00		Poor
Benzene	71-43-2	7.76E-04	E	1		7.11E-04	D	1	1.00	1.09	Below Ave.
BTX Total						1.16E-03	D	1	1.00		Below Ave.
Formaldehyde	50-00-0	7.89E-05	E	1		7.68E-05	E	1	1.00	1.03	Poor
Propylene	115-07-1	2.79E-03	E	1		2.71E-03	D	1	1.00	1.03	Below Ave.
Toluene	108-88-3	2.81E-04	E	1		2.63E-04	D	1	1.00	1.07	Below Ave.
Xylene (Total)	1330-20-7	1.93E-04	E	1		1.89E-04	D	1	1.00	1.02	Below Ave.

TABLE A-5 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Diesel-fired, Oxygen > 13%, < 600 hp

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Polycyclic Compounds											
Acenaphthene	83-32-9	1.42E-06	E	2	Yes	1.43E-06	D	2	1.00	0.99	Below Ave.
Acenaphthylene	208-96-8	5.06E-06	E	2	Yes	5.08E-06	D	2	1.00	1.00	Below Ave.
Anthracene	120-12-7	1.87E-06	E	2		1.86E-06	D	2	1.00	1.00	Below Ave.
Benzo(a)anthracene	56-55-3	1.68E-06	E	2		1.67E-06	D	2	1.00	1.01	Below Ave.
Benzo(a)pyrene	50-32-8	1.88E-07	E	1	Yes	1.03E-08	D	1	0.00	**18.3**	Below Ave.
Benzo(b)fluoranthene	205-99-2	9.91E-08	E	1	Yes	1.87E-07	D	1	0.50	0.53	Below Ave.
Benzo(b+k)fluoranthene						1.03E-08	D	1	0.00		Below Ave.
Benzo(g,h,i)perylene	191-24-2	4.89E-07	E	1		4.12E-07	D	1	1.00	1.19	Below Ave.
Benzo(k)fluoranthene	207-08-9	1.55E-07	E	1	Yes	3.00E-07	D	1	0.50	0.52	Below Ave.
Chrysene	218-01-9	3.53E-07	E	2		3.52E-07	D	2	1.00	1.00	Below Ave.
Dibenz(a,h)anthracene	53-70-3	5.83E-07	E	1	Yes	4.10E-07	D	1	1.00	1.42	Below Ave.
Fluoranthene	206-44-0	7.61E-06	E	2		7.59E-06	D	2	1.00	1.00	Below Ave.
Fluorene	86-73-7	2.92E-05	E	2		2.90E-05	D	2	0.99	1.01	Below Ave.
Indeno(1,2,3-cd)pyrene	193-39-5	3.75E-07	E	1	Yes	2.71E-07	D	1	1.00	1.38	Below Ave.
Naphthalene	91-20-3	8.48E-05	E	2		8.48E-05	D	2	1.00	1.00	Below Ave.
Phenanthrene	85-01-8	2.94E-05	E	2		2.93E-05	D	2	1.00	1.00	Below Ave.
Pyrene	129-00-0	4.78E-06	E	2		4.78E-06	D	2	1.00	1.00	Below Ave.
Polycyclic Compounds - Total		1.68E-04	E	2		1.68E-04	D	2	0.99	1.00	Below Ave.
SVOC											
Benzaldehyde	100-52-7					9.01E-05	E	1	0.68		Poor
VOC											
1,3-Butadiene	106-99-0	3.91E-05	E	1	Yes	3.86E-05	D	1	0.00	1.01	Below Ave.
Acetaldehyde	75-07-0	7.67E-04	E	2		7.64E-04	E	2	1.00	1.00	Poor
Acrolein	107-02-8	9.25E-05	E	2	Yes	9.37E-05	E	2	0.82	0.99	Poor
Aldehyde Total						1.95E-03	E	2	1.00		Poor
Benzene	71-43-2	9.33E-04	E	2		8.81E-04	D	2	1.00	1.06	Below Ave.
BTX Total						1.56E-03	D	2	0.95		Below Ave.
Formaldehyde	50-00-0	1.18E-03	E	2		1.19E-03	E	2	1.00	0.99	Poor
Propylene	115-07-1	2.58E-03	E	2		2.58E-03	D	2	1.00	1.00	Below Ave.
Toluene	108-88-3	4.09E-04	E	2		3.96E-04	D	2	1.00	1.03	Below Ave.

TABLE A-5 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Diesel-fired, Oxygen > 13%, < 600 hp

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Xylene (m,p)						1.54E-04	D	1	1.00		Below Ave.
Xylene (o)	95-47-6					1.49E-04	D	1	0.00		Below Ave.
Xylene (Total)	1330-20-7	2.85E-04	E	1		2.59E-04	D	1	1.00	1.10	Below Ave.

TABLE A-6 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Gas-fired, 2-Stroke, Lean-burn

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Polycyclic Compounds											
Acenaphthene	83-32-9	1.33E-06	C	4		7.06E-07	D	1	0.00	1.89	Average
Acenaphthylene	208-96-8	3.17E-06	C	4		1.05E-05	D	1	1.00	0.30	Average
Anthracene	120-12-7	7.18E-07	C	4		4.29E-06	D	1	1.00	**0.17**	Average
Benzo(a)anthracene	56-55-3	3.36E-07	C	3		8.54E-07	D	1	1.00	0.39	Average
Benzo(b)fluoranthene	205-99-2	8.51E-09	D	1		1.41E-07	D	1	0.00	**0.060**	Below Ave.
Benzo(g,h,i)perylene	191-24-2	2.48E-08	D	1		8.95E-08	D	1	0.00	0.28	Below Ave.
Benzo(k)fluoranthene	207-08-9	4.26E-09	D	1		4.35E-06	D	1	1.00	**0.0010**	Below Ave.
Chrysene	218-01-9	6.72E-07	C	3		1.61E-06	D	1	1.00	0.42	Average
Fluoranthene	206-44-0	3.61E-07	C	4		1.58E-07	D	1	0.00	2.28	Average
Fluorene	86-73-7	1.69E-06	C	3		2.32E-06	D	1	0.00	0.73	Average
Indeno(1,2,3-cd)pyrene	193-39-5	9.93E-09	D	1							Below Ave.
Naphthalene	91-20-3	9.63E-05	C	7		2.09E-04	D	1	1.00	0.46	Average
Phenanthrene	85-01-8	3.53E-06	C	4		4.68E-06	D	1	1.00	0.75	Average
Pyrene	129-00-0	5.84E-07	C	4		2.27E-07	D	1	0.64	2.57	Average
Polycyclic Compounds - Total		1.34E-04	D	2		2.40E-04	D	1	0.98	0.56	Below Ave.
VOC											
1,1,2,2 Tetrachloroethane	79-34-5	6.63E-05	C	3							Average
1,1,2 Trichloroethane	79-00-5	5.27E-05	C	3							Average
1,1 Dichloroethane		3.91E-05	C	3							Average
1,2,3 Trimethylbenzene		3.54E-05	D	2							Below Ave
1,2,4 Trimethylbenzene	95-63-6	1.11E-04	C	4							Average
1,2 Dichloroethane	107-06-2	4.22E-05	D	2							Below Ave
1,2 Dichloropropane	78-87-5	4.46E-05	D	3							Below Ave
1,3,5 Trimethylbenzene		1.80E-05	D	1							Below Ave
1,3 Butadiene	106-99-0	8.20E-04	D	16							Below Ave
1,3 Dichloropropene	542-75-6	4.38E-05	C	3							Average
2,2,4-Trimethylpentane	540-84-1	8.46E-04	B	10							Good
Acetaldehyde	75-07-0	7.76E-03	A	58		8.36E-03	E	1	1.00	0.93	Excellent
Acrolein	107-02-8	7.78E-03	A	48		1.90E-03	E	1	1.00	4.09	Excellent
Aldehyde Total						3.29E-02	E	1	1.00		Poor
Benzene	71-43-2	1.94E-03	A	31		7.48E-03	D	2	1.00	0.26	Excellent

TABLE A-6 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Gas-fired, 2-Stroke, Lean-burn

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Biphenyl	92-52-4	3.95E-06	C	3							Average
BTX Total						1.10E-02	D	2	1.00		Below Ave.
Butane		4.75E-03	C	3							Average
Carbon Tetrachloride	56-23-5	6.07E-05	C	3							Average
Chlorobenzene	108-90-7	4.44E-05	C	3							Average
Chloroform	67-66-3	4.71E-05	C	3							Average
Ethylbenzene	100-41-4	1.08E-04	B	27							Good
Ethylene Dibromide	106-93-4	7.34E-05	C	3							Average
Formaldehyde	50-00-0	5.52E-02	A	58		4.85E-02	E	2	1.00	1.14	Excellent
Methanol	67-56-1	2.48E-03	A	43							Excellent
Methylene Chloride	74-87-3	3.38E-04	C	4							Average
n-Hexane	110-54-3	4.45E-04	C	9							Average
Phenol	108-95-2	4.21E-05	C	3							Average
Propylene	115-07-1					2.37E-02	D	2	1.00		Below Ave.
Styrene	100-42-5	5.48E-05	A	21							Excellent
Toluene	108-88-3	9.63E-04	A	31		2.72E-03	D	2	1.00	0.35	Excellent
Vinyl Chloride	75-01-4	2.47E-05	C	3							Average
Xylene (m,p)						5.75E-04	D	2	1.00		Below Ave.
Xylene (o)	95-47-6					2.74E-04	D	2	1.00		Below Ave.
Xylene (Total)	1330-20-7	2.68E-04	A	15							Excellent

TABLE A-7 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Gas-fired, 4-Stroke, Lean-burn

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Polycyclic Compounds											
Acenaphthene	83-32-9	1.25E-06	C	3		6.83E-07	D	1	1.00	1.83	Average
Acenaphthylene	208-96-8	5.53E-06	C	3		7.23E-06	D	1	1.00	0.77	Average
Anthracene	120-12-7					2.44E-07	D	1	1.00		Below Ave.
Benzo(a)anthracene	56-55-3					7.41E-08	D	1	1.00		Below Ave.
Benzo(a)pyrene	50-32-8					3.38E-08	D	1	0.76		Below Ave.
Benzo(b)fluoranthene	205-99-2	1.66E-07	D	2		3.11E-07	D	1	0.95	0.53	Below Ave.
Benzo(e)pyrene	192-97-2	4.15E-07	D	2							Below Ave.
Benzo(g,h,i)perylene	191-24-2	4.14E-07	D	2		9.80E-08	D	1	1.00	4.22	Below Ave.
Benzo(k)fluoranthene	207-08-9					5.04E-07	D	1	0.98		Below Ave.
Chrysene	218-01-9	6.93E-07	C	3		9.19E-08	D	1	1.00	**7.54**	Average
Dibenz(a,h)anthracene	53-70-3					1.04E-08	D	1	1.00		Below Ave.
Fluoranthene	206-44-0	1.11E-06	C	3		2.38E-07	D	1	1.00	4.67	Average
Fluorene	86-73-7	5.67E-06	C	5		4.38E-07	D	1	0.00	**12.9**	Average
Indeno(1,2,3-cd)pyrene	193-39-5					1.14E-07	D	1	1.00		Below Ave.
Naphthalene	91-20-3	7.44E-05	C	6		1.16E-04	D	1	1.00	0.64	Average
Phenanthrene	85-01-8	1.04E-05	D	2		8.50E-07	D	1	1.00	**12.2**	Below Ave.
Pyrene	129-00-0	1.36E-06	C	3		1.18E-07	D	1	1.00	**11.6**	Average
Polycyclic Compounds - Total		2.69E-05	D	1		1.27E-04	D	1	1.00	0.21	Below Ave.
VOC											
1,1,2,2-Tetrachloroethane	79-34-5	4.00E-05	E	9	Yes						Poor
1,1,2-Trichloroethane	79-00-5	3.18E-05	E	9	Yes						Poor
1,1 Dichloroethane		2.36E-05	E	9	Yes						Poor
1,2,3 Trimethylbenzene		2.30E-05	D	1							Below Ave
1,2,4 Trimethylbenzene	95-63-6	1.43E-05	C	3							Average
1,2 Dichloroethane	107-06-2	2.36E-05	E	9	Yes						Poor
1,3 Butadiene	106-99-0	2.67E-04	D	1							Below Ave
1,3-Dichloropropene	542-75-6	2.69E-05	E	9	Yes						Average
2,2,4-Trimethylpentane	540-84-1	2.50E-04	C	3							Average
Acetaldehyde	75-07-0	8.36E-03	A	31		3.80E-03	NR	5	1.00	2.20	Excellent
Acrolein	107-02-8	5.14E-03	A	32		1.56E-03	NR	5	1.00	3.30	Excellent
Aldehyde Total						3.15E-02	NR	5	1.00		NR

TABLE A-7 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Gas-fired, 4-Stroke, Lean-burn

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Benzene	71-43-2	4.40E-04	A	16		1.30E-03	A	10	1.00	0.34	Excellent
Biphenyl	92-52-4	2.12E-04	D	2							Below Ave.
BTX Total						1.99E-03	A	10	1.00		Excellent
Carbon Tetrachloride	56-23-5	3.67E-05	E	9	Yes						Poor
Chlorobenzene	108-90-7	3.04E-05	E	10	Yes						Poor
Chloroform	67-66-3	2.85E-05	E	9	Yes						Poor
Ethyl Benzene	100-41-4	3.97E-05	B	14							Good
Ethylene Dibromide	106-93-4	4.43E-05	E	9	Yes						Poor
Formaldehyde	50-00-0	5.82E-02	A	32		3.10E-02	NR	10	1.00	1.88	Excellent
Methanol	67-56-1	2.50E-03	B	15							Good
Methylene Chloride	74-87-3	2.00E-05	C	9							Average
n-Hexane	110-54-3	1.11E-03	C	5							Average
Phenol	108-95-2	2.40E-05	D	2							Below Ave.
Propylene	115-07-1					1.70E-02	A	10	0.98		Excellent
Styrene	100-42-5	2.36E-05	E	26	Yes						Poor
Toluene	108-88-3	4.08E-04	B	14		4.94E-04	A	10	1.00	0.83	Excellent
Vinyl Chloride	75-01-4	1.49E-05	C	9							Average
Xylene (m,p)						1.44E-04	A	10	1.00		Excellent
Xylene (o)	95-47-6					5.86E-05	A	10	0.97		Excellent
Xylenes	1330-20-7	1.84E-04	B	14							Good

TABLE A-8 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Reciprocating Engine, Gas-fired, 4-Stroke, Rich-burn

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Polycyclic Compounds											
Naphthalene	91-20-3	9.71E-05	E	13	Yes						Poor
Polycyclic Compounds - Total		1.41E-04	D	2							Below Ave
VOC											
1,1,2,2-Tetrachloroethane	79-34-5	2.53E-05	C	3							Average
1,1,2-Trichloroethane	79-00-5	1.53E-05	E	3	Yes						Poor
1,1 Dichloroethane		1.13E-05	E	3	Yes						Poor
1,2 Dichloroethane		1.13E-05	E	3	Yes						Poor
1,3 Butadiene	106-99-0	6.63E-05	D	2							Below Ave.
Acetaldehyde	75-07-0	2.79E-03	C	9		1.63E-03	E	1	1.00	1.72	Average
Acrolein	107-02-8	2.63E-03	C	9		5.15E-04	D	2	1.00	**5.11**	Average
Aldehyde Total						1.13E-02	E	1	1.00		Poor
Benzene	71-43-2	1.58E-03	B	18		9.93E-03	D	2	1.00	**0.16**	Good
BTX Total						1.35E-02	D	2	1.00		Below Ave.
Carbon Tetrachloride	56-23-5	1.77E-05	E	3	Yes						Poor
Chlorobenzene	108-90-7	1.29E-05	E	3	Yes						Poor
Chloroform	67-66-3	1.37E-05	E	3	Yes						Poor
Ethyl Benzene	100-41-4	2.48E-05	E	7	Yes						Poor
Ethylene Dibromide	106-93-4	2.15E-05	E	3	Yes						Poor
Formaldehyde	50-00-0	2.05E-02	A	18		4.98E-03	C	3	1.00	4.11	Excellent
Methanol	67-56-1	3.06E-03	D	2							Below Ave.
Methylene Chloride	74-87-3	4.12E-05	C	3							Average
Propylene	115-07-1					2.03E-02	D	2	0.93		Below Ave.
Styrene	100-42-5	1.19E-05	E	3	Yes						Poor
Toluene	108-88-3	5.58E-04	A	18		2.84E-03	D	2	1.00	0.20	Excellent
Vinyl Chloride	75-01-4	7.18E-06	E	3	Yes						Poor
Xylene (m,p)						4.66E-04	D	2	1.00		Below Ave.
Xylene (o)	95-47-6					2.31E-04	D	2	1.00		Below Ave.
Xylene (Total)	1330-20-7	1.95E-04	A	18							Excellent

TABLE A-9 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Gas Turbine, Refinery/Natural Gas-fired, Duct Burners

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Metals											
Arsenic	7440-38-2										
Cadmium	7440-43-9					2.92E-06	E	2	0.49		Poor
Chromium (Hex)	18540-29-9					1.73E-06	E	1	0.00		Poor
Chromium (Total)	7440-47-3					4.99E-05	E	2	1.00		Poor
Copper	7440-50-8					1.16E-05	D	2	0.88		Below Ave.
Lead	7439-92-1					3.58E-05	E	1	0.00		Poor
Manganese	7439-96-5					4.77E-05	D	2	1.00		Below Ave.
Mercury	7439-97-6					4.35E-06	D	2	1.00		Below Ave.
Nickel	7440-02-0					7.70E-05	E	2	1.00		Poor
Zinc	7440-66-6					1.16E-04	D	2	1.00		Below Ave.
Polycyclic Compounds											
Acenaphthene	83-32-9					2.21E-08	D	1	1.00		Below Ave.
Acenaphthylene	208-96-8					1.07E-08	D	1	1.00		Below Ave.
Anthracene	120-12-7					2.48E-08	D	1	1.00		Below Ave.
Benzo(a)anthracene	56-55-3					1.49E-08	D	1	0.86		Below Ave.
Benzo(b)fluoranthene	205-99-2					2.50E-08	D	1	0.82		Below Ave.
Chrysene	218-01-9					1.07E-07	D	1	1.00		Below Ave.
Fluoranthene	206-44-0					9.90E-08	D	1	1.00		Below Ave.
Fluorene	86-73-7					1.76E-07	D	1	1.00		Below Ave.
Naphthalene	91-20-3	1.30E-06	C	5		3.74E-05	D	1	1.00	**0.035**	Average
Phenanthrene	85-01-8					6.37E-07	D	1	1.00		Below Ave.
Pyrene	129-00-0					1.19E-07	D	1	1.00		Below Ave.
Polycyclic Compounds - Total		2.20E-06	C	5		3.87E-05	D	1	1.00	**0.057**	Average
SVOC											
Phenol	108-95-2					2.24E-05	D	2	0.68		Below Ave.
VOC											
1,3-Butadiene	106-99-0	4.29E-07	D	2	Yes						Below Ave
Acetaldehyde	75-07-0	4.00E-05	C	9		4.11E-06	E	1	1.00	**9.73**	Average

TABLE A-9 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Gas Turbine, Refinery/Natural Gas-fired, Duct Burners

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Acrolein	107-02-8	6.40E-06	C	7							Average
Aldehyde Total						1.58E-04	E	1	1.00		
Benzene	106-99-0	1.20E-05	A	27							Excellent
Ethylbenzene	100-41-4	3.20E-05	C	5							Average
Formaldehyde	50-00-0	7.10E-04	A	33		3.09E-03	E	2	1.00	0.23	Excellent
N-nitrosodimethylamine	62-75-9										
N-nitrosomorpholine	59-89-2										
Propylene Oxide	75-56-9	2.84E-05	D	1	Yes						Below Ave
Toluene	108-88-3	1.27E-04	C	11		1.62E-04	E	1	0.00	0.79	Average
Xylene (Total)	1330-20-7	6.40E-05	C	7		3.74E-04	E	1	0.00	**0.17**	Average

TABLE A-10 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Gas Turbine, Refinery/Natural Gas-fired, No Duct Burners

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Metals											
Arsenic	7440-38-2										
Cadmium	7440-43-9					5.28E-06	E	1	1.00		Poor
Chromium (Hex)	18540-29-9					1.45E-06	E	1	0.00		Poor
Chromium (Total)	7440-47-3					1.31E-05	E	1	0.82		Poor
Copper	7440-50-8					4.12E-05	E	1	1.00		Poor
Lead	7439-92-1					2.84E-05	E	1	0.30		Poor
Manganese	7439-96-5					1.29E-04	E	1	1.00		Poor
Mercury	7439-97-6					1.53E-05	D	1	1.00		Below Ave.
Nickel	7440-02-0					1.66E-04	E	1	1.00		Poor
Zinc	7440-66-6					4.98E-03	E	1	1.00		Poor
Polycyclic Compounds											
Acenaphthene	83-32-9					3.25E-09	D	2	0.66		Below Ave.
Acenaphthylene	208-96-8					2.90E-09	D	2	0.54		Below Ave.
Anthracene	120-12-7					3.43E-08	D	2	1.00		Below Ave.
Benzo(a)anthracene	56-55-3					2.78E-09	D	2	0.34		Below Ave.
Benzo(b)fluoranthene	205-99-2					3.30E-09	D	2	0.44		Below Ave.
Benzo(g,h,i)perylene	191-24-2					1.93E-09	D	1	0.56		Below Ave.
Benzo(k)fluoranthene	207-08-9					2.33E-09	D	1	0.64		Below Ave.
Chrysene	218-01-9					4.93E-09	D	2	0.31		Below Ave.
Fluoranthene	206-44-0					1.16E-08	D	2	1.00		Below Ave.
Fluorene	86-73-7					1.49E-08	D	2	1.00		Below Ave.
Indeno(1,2,3-cd)pyrene	193-39-5					1.75E-09	D	1	0.52		Below Ave.
Naphthalene	91-20-3	1.30E-06	C	5		7.29E-07	D	2	1.00	1.78	Average
Phenanthrene	85-01-8					6.46E-08	D	2	1.00		Below Ave.
Pyrene	129-00-0					2.25E-08	D	2	1.00		Below Ave.
Polycyclic Compounds - Total		2.20E-06	C	5		9.06E-07	D	2	0.98	2.43	Average
SVOC											
Phenol	108-95-2					6.71E-06	D	1	1.00		Below Ave.

TABLE A-10 - COMPARISON OF EPA AND API EMISSION FACTORS
Internal Combustion, Gas Turbine, Refinery/Natural Gas-fired, No Duct Burners

		AP-42				PATEF				Factor	
Substance	**CAS No.**	**Factor (lb/MMBtu)**	**AP42 Rating**	**# of Tests**	**Non-Detect?**	**Factor (lb/MMBtu)**	**EPA Rating**	**# of Tests**	**Detect Ratio**	**Ratio (EPA/PATEF)**	**Quality Flag**
VOC											
1,3-Butadiene	106-99-0	4.29E-07	D	2	Yes						Below Ave.
Acetaldehyde	75-07-0	4.00E-05	C	9		2.67E-05	D	2	0.90	1.50	Average
Acrolein	107-02-8	6.40E-06	C	7		1.72E-05	D	1	0.00	0.37	Average
Aldehyde Total						3.36E-04	D	2	0.98		Below Ave.
Benzene	106-99-0	1.20E-05	A	27							Excellent
BTX Total						1.17E-04	D	2	0.70		Below Ave.
Ethylbenzene	100-41-4	3.20E-05	C	5							Average
Formaldehyde	50-00-0	7.10E-04	A	33		3.10E-04	D	2	0.98	2.29	Excellent
N-nitrosodimethylamine	62-75-9										
N-nitrosomorpholine	59-89-2										
Propylene	115-07-1					1.63E-03	D	1	1.00		Below Ave.
Propylene Oxide	75-56-9	2.84E-05	D	1							Below Ave.
Toluene	108-88-3	1.27E-04	C	11		3.06E-04	NR	3	1.00	0.42	Average
Xylene (Total)	1330-20-7	6.40E-05	C	7		7.70E-04	NR	3	0.98	**0.083**	Average

TABLE A-11 - COMPARISON OF EPA AND PATEF EMISSION FACTORS
Direct Combustion, Asphalt Blowing, Blow Cycle

		EPA				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	Data Pnts	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	Data Pnts	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Halogens											
HCl	7647-01-0					2.08E-06	E	1	1.00		Poor
Metals											
Beryllium	7440-41-7					2.47E-06	E	1	0.00		Poor
Chromium (Total)	7440-47-3					3.94E-05	E	1	1.00		Poor
Copper	7440-50-8					4.47E-05	E	1	1.00		Poor
Manganese	7439-96-5					1.16E-04	E	1	1.00		Poor
Mercury	7439-97-6					8.53E-06	D	1	1.00		Below Ave.
Zinc	7440-66-6					7.91E-04	E	1	1.00		Poor
SVOC											
Ethylbenzene	100-41-4					8.10E-04	E	1	0.00		Poor
Phenol	108-95-2					7.12E-05	D	1	1.00		Below Ave.
VOC											
Acetaldehyde	75-07-0					1.67E-06	E	1	1.00		Poor
Aldehyde Total						5.02E-06	E	1	1.00		Poor
Formaldehyde	50-00-0					3.34E-06	E	1	1.00		Poor
Hydrogen Sulfide	7783-06-4					1.95E-03	D	1	0.00		Below Ave.
Xylene (Total)	1330-20-7					8.10E-04	E	1	0.00		Poor

TABLE A-12 - COMPARISON OF EPA AND API EMISSION FACTORS
Direct Combustion, Asphalt Blowing, No Blow Cycle

		AP-42				PATEF				Factor	
Substance	CAS No.	Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Ratio (EPA/PATEF)	Quality Flag
Halogens											
HCl	7647-01-0					7.74E-07	E	1	1.00		Poor
Metals											
Beryllium	7440-41-7					2.19E-06	E	1	0.00		Poor
Chromium (Total)	7440-47-3					1.34E-05	E	1	0.00		Poor
Copper	7440-50-8					3.56E-05	E	1	1.00		Poor
Manganese	7439-96-5					1.95E-04	E	1	1.00		Poor
Mercury	7439-97-6					8.03E-06	D	1	1.00		Below Ave.
Zinc	7440-66-6					5.04E-04	E	1	1.00		Poor
SVOC											
Ethylbenzene	100-41-4					7.17E-04	E	1	0.00		Poor
Phenol	108-95-2					4.37E-05	D	1	1.00		Below Ave.
VOC											
Acetaldehyde	75-07-0					4.07E-06	E	1	1.00		Poor
Aldehyde Total						1.63E-05	E	1	1.00		Poor
Formaldehyde	50-00-0					1.22E-05	E	1	1.00		Poor
Hydrogen Sulfide	7783-06-4					1.73E-03	D	1	0.00		Below Ave.
Xylene (Total)	1330-20-7					7.17E-04	E	1	0.00		Poor

TABLE A-13 - COMPARISON OF EPA AND API EMISSION FACTORS
Direct Combustion, Coke Calcining

Substance	CAS No.	AP-42 Factor (lb/MMBtu)	AP-42 Rating	AP-42 # of Tests	AP-42 Non-Detect?	PATEF Factor (lb/MMBtu)	PATEF EPA Rating	PATEF # of Tests	PATEF Detect Ratio	Factor Ratio (EPA/PATEF)	Quality Flag
Dioxin/Furan											
Dioxin:4D 2378	1746-01-6					3.68E-11	D	1	0.00		Below Ave.
Dioxin:4D Other						4.44E-10	D	1	1.00		Below Ave.
Dioxin:5D 12378	40321-76-4					2.92E-11	D	1	0.00		Below Ave.
Dioxin:5D Other						2.74E-10	D	1	0.34		Below Ave.
Dioxin:6D 123478	39227-28-6					3.45E-11	D	1	0.25		Below Ave.
Dioxin:6D 123678	57653-85-7					4.40E-11	D	1	0.60		Below Ave.
Dioxin:6D 123789	19408-74-3					4.22E-11	D	1	0.33		Below Ave.
Dioxin:6D Other						2.06E-10	D	1	0.55		Below Ave.
Dioxin:7D 1234678	35822-46-9					4.19E-10	D	1	1.00		Below Ave.
Dioxin:7D Other						4.09E-10	D	1	1.00		Below Ave.
Dioxin:8D						5.25E-09	D	1	1.00		Below Ave.
Furan:4F 2378	51207-31-9					4.23E-11	D	1	0.62		Below Ave.
Furan:4F Other						4.35E-10	D	1	1.00		Below Ave.
Furan:5F 12378	57117-41-6					4.42E-11	D	1	0.56		Below Ave.
Furan:5F 23478	5711-31-4					4.09E-11	D	1	0.54		Below Ave.
Furan:5F Other						3.76E-10	D	1	0.66		Below Ave.
Furan:6F 123478	70648-26-9					7.88E-11	D	1	1.00		Below Ave.
Furan:6F 123678	57117-44-9					7.11E-11	D	1	1.00		Below Ave.
Furan:6F 123789	72918-21-9					2.95E-11	D	1	0.58		Below Ave.
Furan:6F 234678	60851-34-5					6.50E-11	D	1	1.00		Below Ave.
Furan:6F Other						4.81E-10	D	1	1.00		Below Ave.
Furan:7F 1234678	67562-39-4					4.75E-10	D	1	1.00		Below Ave.
Furan:7F 1234789	55673-89-7					8.04E-11	D	1	0.64		Below Ave.
Furan:7F Other						1.77E-10	D	1	0.40		Below Ave.
Furan:8F						4.13E-10	D	1	1.00		Below Ave.
Metals											
Antimony	7440-36-0					1.44E-04	D	1	0.32		Below Ave.
Arsenic	7440-38-2					1.45E-05	D	1	0.00		Below Ave.

TABLE A-13 - COMPARISON OF EPA AND API EMISSION FACTORS
Direct Combustion, Coke Calcining

Substance	CAS No.	AP-42 Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	PATEF Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Factor Ratio (EPA/PATEF)	Quality Flag
Barium	7440-39-3					6.10E-05	D	1	1.00		Below Ave.
Beryllium	7440-41-7					6.03E-06	D	1	0.43		Below Ave.
Cadmium	7440-43-9					2.90E-05	D	1	0.00		Below Ave.
Chromium (Hex)	18540-29-9					2.12E-06	D	1	1.00		Below Ave.
Chromium (Total)	7440-47-3					6.90E-05	D	1	1.00		Below Ave.
Copper	7440-50-8					2.90E-05	D	1	0.00		Below Ave.
Lead	7439-92-1					1.91E-04	D	1	0.48		Below Ave.
Manganese	7439-96-5					1.44E-04	D	1	0.89		Below Ave.
Mercury	7439-97-6					1.48E-04	D	1	1.00		Below Ave.
Nickel	7440-02-0					2.87E-04	D	1	0.66		Below Ave.
Phosphorus	7723-14-0					1.45E-03	D	1	0.00		Below Ave.
Selenium	7782-49-2					1.45E-05	D	1	0.00		Below Ave.
Silver	7440-22-4					5.07E-05	D	1	0.00		Below Ave.
Thallium	7440-28-0					2.18E-04	D	1	0.00		Below Ave.
Zinc	7440-66-6					3.66E-04	D	1	1.00		Below Ave.
Polycyclic Compounds											
Acenaphthene	83-32-9					4.40E-08	D	1	1.00		Below Ave.
Acenaphthylene	208-96-8					5.59E-08	D	1	1.00		Below Ave.
Anthracene	120-12-7					5.40E-08	D	1	1.00		Below Ave.
Benzo(a)anthracene	56-55-3					2.60E-08	D	1	0.38		Below Ave.
Benzo(a)pyrene	50-32-8					2.41E-08	D	1	0.00		Below Ave.
Benzo(b)fluoranthene	205-99-2					2.41E-08	D	1	0.00		Below Ave.
Benzo(g,h,i)perylene	191-24-2					2.41E-08	D	1	0.00		Below Ave.
Benzo(k)fluoranthene	207-08-9					2.41E-08	D	1	0.00		Below Ave.
Chrysene	218-01-9					3.73E-08	D	1	0.76		Below Ave.
Dibenz(a,h)anthracene	53-70-3					2.41E-08	D	1	0.00		Below Ave.
Fluoranthene	206-44-0					1.06E-07	D	1	1.00		Below Ave.
Fluorene	86-73-7					1.70E-07	D	1	1.00		Below Ave.
Indeno(1,2,3-cd)pyrene	193-39-5					2.41E-08	D	1	0.00		Below Ave.
Naphthalene	91-20-3					7.29E-06	D	1	1.00		Below Ave.
Polycyclic Compounds - Total						8.57E-06	D	1	0.98		Below Ave.
Phenanthrene	85-01-8					5.66E-07	D	1	1.00		Below Ave.

TABLE A-13 - COMPARISON OF EPA AND API EMISSION FACTORS
Direct Combustion, Coke Calcining

Substance	CAS No.	AP-42 Factor (lb/MMBtu)	AP42 Rating	# of Tests	Non-Detect?	PATEF Factor (lb/MMBtu)	EPA Rating	# of Tests	Detect Ratio	Factor Ratio (EPA/PATEF)	Quality Flag
Pyrene	129-00-0					7.86E-08	D	1	1.00		Below Ave.
VOC											
Acetaldehyde	75-07-0					3.12E-03	D	1	1.00		Below Ave.
Acrolein	107-02-8					1.04E-03	D	1	0.00		Below Ave.
Aldehyde Total						4.16E-03	D	1	0.75		Below Ave.
Benzene	71-43-2					1.03E-03	D	1	1.00		Below Ave.
BTX Total						1.42E-03	D	1	0.86		Below Ave.
Formaldehyde	50-00-0					1.04E-03	D	1	0.00		Below Ave.
Toluene	108-88-3					1.63E-04	D	1	1.00		Below Ave.
Xylene (m,p)						8.90E-05	D	1	0.26		Below Ave.
Xylene (o)	95-47-6					1.32E-04	D	1	0.00		Below Ave.

APPENDIX B—IDENTIFICATION OF HAP GAPS AND INCONSISTENCIES

TABLE B-1 IDENTIFICATION OF HAP GAPS AND INCONSISTENCIES FOR DIOXINS/FURANS

		EPA or PATEF Quality Rating	EPA/ PATEF Ratio	Based on Non-detects?
Generally Good Quality and EPA/PATEF consistent		A,B,C	< 5x	No
EPA/PATEF ratio large or	Discrepancy	A,B,C	> 5x	No
Data set is small	Few Tests	D	< 5x	No
Data set is small or of poor quality		D	> 5x	
		E, NR		
No Factors Available				

	External Combustion			Internal Combustion									
	No.6	NG/Ref	Crude	RICE Diesel > 600hp	RICE Diesel < 600hp	RICE Gas 2-stroke Lean	RICE Gas 4-stroke Lean	RICE Gas 4-stroke Rich	Turbine Duct Burners	Turbine No Duct Burners	Asphalt Blow Cycle	Asphalt No Blow Cycle	Coke Calcining
Dioxin/Furan													
Dioxin:4D 2378													Few Tests
Dioxin:5D 12378													Few Tests
Dioxin:6D 123478													Few Tests
Dioxin:6D 123678													Few Tests
Dioxin:6D 123789													Few Tests
Dioxin:7D 1234678													Few Tests
Dioxin:8D													Few Tests
Furan:4F 2378													Few Tests
Furan:5F 12378													Few Tests
Furan:5F 23478													Few Tests
Furan:6F 123478													Few Tests
Furan:6F 123678													Few Tests
Furan:6F 123789													Few Tests
Furan:6F 234678													Few Tests
Furan:7F 1234678													Few Tests
Furan:7F 1234789													Few Tests
Furan:8F													Few Tests

TABLE B-2 IDENTIFICATION OF HAP GAPS AND INCONSISTENCIES FOR METALS

		EPA or PATEF Quality Rating	EPA/ PATEF Ratio	Based on Non-detects?
Generally Good Quality and EPA/PATEF consistent		A,B,C	< 5x	No
EPA/PATEF ratio large or	Discrepancy	A,B,C	> 5x	No
Data set is small	Few Tests	D	< 5x	No
Data set is small or of poor quality		D E, NR	> 5x	
No Factors Available				

	External Combustion			Internal Combustion									
	No.6	NG/Ref	Crude	RICE Diesel > 600hp	RICE Diesel < 600hp	RICE Gas 2-stroke Lean	RICE Gas 4-stroke Lean	RICE Gas 4-stroke Rich	Turbine Duct Burners	Turbine No Duct Burners	Asphalt Blow Cycle	Asphalt No Blow Cycle	Coke Calcining
Metals													
Antimony		Few Tests											Few Tests
Arsenic													Few Tests
Barium	Few Tests	Few Tests											Few Tests
Beryllium													Few Tests
Cadmium		Few Tests											Few Tests
Chromium (Hex)													Few Tests
Chromium (Total)	Discrepancy	Few Tests											Few Tests
Cobalt	Few Tests	Few Tests											
Copper		Discrepancy							Few Tests				Few Tests
Lead		Few Tests											Few Tests
Manganese									Few Tests				Few Tests
Mercury	Discrepancy	Few Tests							Few Tests	Few Tests			Few Tests
Molybdenum	Few Tests	Few Tests											
Nickel													Few Tests
Phosphorus	Few Tests	Few Tests											Few Tests
Selenium													Few Tests
Silver													Few Tests
Thallium													Few Tests
Vanadium	Few Tests	Few Tests											
Zinc	Few Tests								Few Tests				Few Tests

TABLE B-3 IDENTIFICATION OF HAP GAPS AND INCONSISTENCIES FOR POLYCYCLIC COMPOUNDS

		EPA or PATEF Quality Rating	EPA/ PATEF Ratio	Based on Non-detects?
Generally Good Quality and EPA/PATEF consistent		A,B,C	< 5x	No
EPA/PATEF ratio large or	Discrepancy	A,B,C	> 5x	No
Data set is small	Few Tests	D	< 5x	No
Data set is small or of poor quality		D	> 5x	
		E, NR		
No Factors Available				

	External Combustion			Internal Combustion									
	No.6	NG/Ref	Crude	RICE Diesel > 600hp	RICE Diesel < 600hp	RICE Gas 2-stroke Lean	RICE Gas 4-stroke Lean	RICE Gas 4-stroke Rich	Turbine Duct Burners	Turbine No Duct Burners	Asphalt Blow Cycle	Asphalt No Blow Cycle	Coke Calcining
Polycyclic Compounds													
Acenaphthene	Discrepancy			Few Tests	Few Tests				Few Tests	Few Tests			Few Tests
Acenaphthylene	Few Tests			Few Tests	Few Tests				Few Tests	Few Tests			Few Tests
Anthracene				Few Tests	Few Tests		Few Tests		Few Tests	Few Tests			Few Tests
Benzo(a)anthracene	Discrepancy	Discrepancy		Few Tests	Few Tests		Few Tests		Few Tests	Few Tests			Few Tests
Benzo(a)pyrene	Few Tests	Discrepancy	Few Tests	Few Tests	Discrepancy		Few Tests						Few Tests
Benzo(b)fluoranthene	Few Tests	Discrepancy	Few Tests	Few Tests	Few Tests	Few Tests	Few Tests		Few Tests	Few Tests			Few Tests
Benzo(b+k)fluoranthene			Few Tests		Few Tests	Few Tests	Few Tests						
Benzo(e)pyrene	Few Tests		Few Tests				Few Tests						
Benzo(g,h,i)perylene			Few Tests	Few Tests	Few Tests	Few Tests	Few Tests			Few Tests			Few Tests
Benzo(k)fluoranthene	Few Tests	Discrepancy	Few Tests	Few Tests	Few Tests	Few Tests	Few Tests			Few Tests			Few Tests
Chrysene			Discrepancy	Few Tests	Few Tests				Few Tests	Few Tests			Few Tests
Dibenz(a,h)anthracene	Few Tests		Few Tests	Few Tests	Few Tests		Few Tests						Few Tests
Fluoranthene			Discrepancy	Few Tests	Few Tests				Few Tests	Few Tests			Few Tests
Fluorene		Discrepancy		Few Tests	Few Tests				Few Tests	Few Tests			Few Tests
Indeno(1,2,3-cd)pyrene		Discrepancy	Few Tests	Few Tests	Few Tests	Few Tests	Few Tests			Few Tests			Few Tests
Naphthalene	Discrepancy			Few Tests	Few Tests				Discrepancy				Few Tests
Phenanthrene				Few Tests	Few Tests		Few Tests		Few Tests	Few Tests			Few Tests
Pyrene				Few Tests	Few Tests		Few Tests		Few Tests	Few Tests			Few Tests
Polycyclic Compounds - Total	Discrepancy			Few Tests	Few Tests	Few Tests		Few Tests	Discrepancy				Few Tests

TABLE B-4 IDENTIFICATION OF HAP GAPS AND INCONSISTENCIES FOR ORGANIC COMPOUNDS

		EPA or PATEF Quality Rating	EPA/ PATEF Ratio	Based on Non-detects?
Generally Good Quality and EPA/PATEF consistent		A,B,C	< 5x	No
EPA/PATEF ratio large or	Discrepancy	A,B,C	> 5x	No
Data set is small	Few Tests	D	< 5x	No
Data set is small or of poor quality		D E, NR	> 5x	
No Factors Available				

	External Combustion			Internal Combustion									
	No.6	NG/Ref	Crude	RICE Diesel > 600hp	RICE Diesel < 600hp	RICE Gas 2-stroke Lean	RICE Gas 4-stroke Lean	RICE Gas 4-stroke Rich	Turbine Duct Burners	Turbine No Duct Burners	Asphalt Blow Cycle	Asphalt No Blow Cycle	Coke Calcining
VOC													
1,1,2,2-Tetrachloroethane													
1,1,2-Trichloroethane													
1,2,4 Trimethylbenzene							Few Tests						
1,2 Dichloroethane						Few Tests							
1,3-Butadiene			Few Tests		Few Tests		Few Tests	Few Tests					
1,3-Dichloropropene													
2,2,4-Trimethylpentane													
Acetaldehyde	Few Tests								Discrepancy				Few Tests
Acrolein													Few Tests
Aldehyde Total	Few Tests									Few Tests			Few Tests
Benzene		Discrepancy	Few Tests	Few Tests	Few Tests								Few Tests
Biphenyl													
BTX Total			Few Tests	Few Tests	Few Tests					Few Tests			Few Tests
Carbon Tetrachloride													
Chlorobenzene													
Chloroform	Few Tests		Few Tests										
Ethylbenzene													
Ethyl Dibromide													
Formaldehyde	Discrepancy												Few Tests
Hexane													
Methanol								Few Tests					
Methylene Chloride													
Propylene			Few Tests	Few Tests	Few Tests	Few Tests		Few Tests		Few Tests			
Propylene Oxide										Few Tests			
Styrene													
Toluene	Few Tests	Discrepancy		Few Tests	Few Tests								Few Tests
Vinyl Chloride													
Xylene (Total)			Few Tests	Few Tests	Few Tests				Discrepancy	Discrepancy			Few Tests

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