

AIR TOXIC EMISSION FACTORS FOR COMBUSTION SOURCES USING PETROLEUM-BASED FUELS

GRAPHICAL-USER-INTERFACE DATABASE
AND USER'S MANUAL
VERSION 2.0.1

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Air Toxic Emission Factors for Combustion Sources Using Petroleum-Based Fuels

Graphical-User-Interface Database and User's Manual Version 2.0.1

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ABSTRACT

The Western States Petroleum Association (WSPA) and American Petroleum Institute (API) sponsored a program to develop air toxics emission factors for petroleum industry combustion devices from source test data collected under California Assembly Bill 2588 (AB2588), entitled the *Air Toxics "Hot Spots" Information and Assessment Act of 1987*. The California Air Resources Board (CARB) provided WSPA and API with access to more than 161 petroleum industry combustion source reports, from which data were extracted to derive emission factors. The types of devices represented include process heaters, boilers, reciprocating internal combustion engines, gas turbines, steam generators, asphalt blowers, and coke calciners. The substances quantified include: trace metals; polychlorinated dibenzo[*p*]dioxins and dibenzofurans; polycyclic aromatic hydrocarbons and other semivolatile organic compounds; benzene, toluene, and other volatile organic compounds; formaldehyde and other aldehydes; and hydrochloric acid.

Procedures developed in a separate CARB-sponsored program were used to screen and validate data, eliminating those data points or sets with significant problems and/or reporting deficiencies. Through this process, the best data sets were selected for emission factor development. Emission factors were developed using two different approaches: One approach resulted in emission factors for inclusion in a CARB-sponsored database encompassing all industries in California; a second approach was used for petroleum-industry-specific emission factors. While the data review and validation procedures are identical for both approaches, in the latter approach, emission factor derivation differs to improve the quality of emission factors for petroleum industry combustion devices. Specifically, additional pooling of source test data and elimination of low sensitivity detection limit data produced more robust emission factors for those sources.

As a result of this study, air toxics emission factors for petroleum industry combustion devices have been developed using the best available source testing information. These emission factors can be used by petroleum industry environmental, health, and safety engineers to develop more accurate and complete emission inventories without additional source testing.

The CARB graphical user interface (GUI) was used to display the emission factors and quality information for each group. The GUI allows the user to sort, list, print, and export emission factors from any emission factor group or combination of emission factor groups. This report describes the contents and structure of the GUI, installation procedures, and guidance on using the GUI.

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1.0 Introduction

This project was performed with the cooperation of the California Air Resources Board (CARB) to develop updated air toxics emission factors for petroleum industry combustion sources. The emission factors developed in this project will be integrated into a larger database being developed by CARB called the California Air Toxics Emission Factor (CATEF) database. They also may be used by petroleum industry environmental, health, and safety engineers to develop air toxics emissions inventories to comply with state and federal requirements. In addition, these emission factors provide an improved scientific basis for technical and policy decision-making related to the development of new environmental regulations such as federal National Emission Standards for Hazardous Air Pollutants (NESHAPs) for petroleum industry sources.

California Assembly Bill 2588 (AB2588), entitled the *Air Toxics "Hot Spots" Information and Assessment Act of 1987*, requires facilities to provide an inventory of their air emissions for the purpose of assessing the potential health risk to communities surrounding such facilities. Source testing to characterize air toxics emissions is required when recognized emission factors or reliable engineering estimating techniques do not exist. The results of the source testing performed to comply with AB2588 were used to develop emission factors, which relate the quantity of emissions of a substance to a process-related rate.

1.1 Data Validation

To develop emission factors based on the best available source test results, the petroleum industry AB2588 source test results were screened using a data validation procedure developed by CARB for the CATEF database. This procedure identifies data points and data sets with significant problems and/or reporting deficiencies in three steps including: initial screening, detailed validation, and outlier analysis. Initial screening identifies source tests which do not have sufficient documentation for emission factor development and assessment of data quality. The results of 93 of the 161 source tests were eliminated during the screening procedure. Most of the 93 source tests were eliminated because process rates needed for emission factor derivation were not provided. The detailed validation step was conducted on the remaining 68 source tests. Detailed validation includes checking to ensure the correct sampling and analysis procedures were used, qualifying significant problems such as high field blanks, checking calculations, and evaluating the accuracy of the test results. The impact of problems identified in the detailed validation process is quantified by conducting an outlier analysis. Outliers are identified statistically using the Dixon method. Each outlier is examined to determine if a process and/or method problem occurred as documented in the results of the detailed validation. If a documented problem occurred, the outlier is eliminated.

1.2 Emission Factor Development

The validated source test data were separated into five groups: external combustion devices (boilers and process heaters), reciprocating internal combustion engines, gas turbines, asphalt blowers, and coke calciners. In general, the emissions data for each substance in each group were observed to vary over several orders of magnitude. This variability is due to a combination of measurement uncertainty and differences in the design and operation of devices tested. The variability was reduced, if possible, by identifying design and operating parameters responsible for the variation and further dividing the group into subgroups if warranted. Engineering judgment and statistical analysis were used to determine whether the design or operating parameters had a significant impact on emissions. Pooling of different system and fuel types within each of the five groups was allowed to increase the quality of the resultant emissions factors. Low sensitivity data also were eliminated from the subgroup evaluation process and emission factor calculations.

1.3 Findings

Key observations and findings from the subgroup analysis are listed below.

External Combustion Devices (Boilers and Process Heaters)

- Hazardous air pollutant (HAP) emission factors for boilers and process heaters are similar;
- HAP emission factors for external combustion sources fired by natural gas and process gas are similar;
- Polycyclic aromatic hydrocarbon (PAH) emission factors for liquid-fired sources are higher than for gas-fired sources;
- Benzene, toluene, xylene (BTX), and formaldehyde emission factors for liquid- and gas-fired sources are similar; and
- HAP emission factors for boilers and process heaters with and without NO_x emission controls are similar.

Reciprocating Internal Combustion Engines

- HAP emission factors for gas- and diesel-oil-fired sources are similar, except that formaldehyde emissions from diesel sources are lower;
- HAP emission factors for 2- and 4-stroke sources are similar, except that total BTX emissions from 2-stroke sources are higher; and
- Rich burn reciprocating internal combustion engines (RICE) have higher total BTX and lower formaldehyde emissions than lean burn RICE.

1.4 Graphical User Interface

Statistics and engineering judgment were applied to identify distinct groups of devices as described above. One set of emission factors was developed for each distinct group of devices. These groups are identified in Table 1.

It should be noted that not all emission factors in the GUI are unique. One set of emission factors has been developed for each group. Many of the groups contain results from several different source tests conducted on devices with different characteristics. These devices do not have identical designs; however, the statistical and engineering analyses indicated that the differences in each device did not impact emissions significantly. Therefore, the emission factors from all of the devices within each group were averaged together for each substance. This averaging resulted in a single emission factor per substance per group. When developing the GUI, the average results were applied to each distinct design from the set of sources that were averaged together. This was done to allow users to easily find data matching their specific device. This procedure also resulted in duplicate emission factors in the GUI. These duplicate emission factors are illustrated in Table 1 as the groups which apply to more than one line. For example, each emission factor from the group identified as External Combustion, Gas is repeated nine times in the database.

The emission factors developed under this program have been compiled into the Petroleum Air Toxics Emission Factors (PATEF) database so the CARB and facility owners/operators can quickly and reliably access these newly developed factors. PATEF uses a graphical-user-interface (GUI) to easily view, search, sort, export, and print this information. The following sections provide additional information on the database design and structure, system requirements, installation, and using the database. A complete discussion of the procedures used to develop the emission factors is provided in volumes 1 through 3 of this report.

2.0 Database Design and Structure

The user interface for PATEF was designed using Microsoft's FoxPro® Relational Database Management System for Windows™ Version 2.6a. On the exterior, the database is a set of simple windows and dialog boxes which allow you to do the basic functions just mentioned. Besides a couple of keyboard commands, most operations are activated by clicking the desktop bus, or mouse. The database's interior structure is even simpler. PATEF contains one main database table with a current total of 33 fields and 1081 records. Two subordinate tables store the user's search and sort results and have the same structure as the main data table. It should be noted that the number of emission factors in the GUI may change in the future as additional emission factors are developed by subsequent research. If additional research is conducted, the emission factors would be provided in subsequent versions of the GUI.

Table 2 lists the main database file's field attributes, display, sort, search, report and export information, and definitions/descriptions. The field names provided in the second column, "Field Name (Structure)" appear as they are coded in the database structure. The "Field Type," "Width," and "Decimal" columns provide information on the storage requirements for each field. This information is useful when formatting exported data. The "Field Name (Display)" column provides the names of the fields as they appear on various GUI windows and reports. Fields included in each GUI function are marked in the "Main Display," "List Display," "Sort," "Search," "List Report," "Detail Report," and "Export" columns in Table 2. For example, the user can search for a set of emission factors using the contents of the System Type, Material Type, SCC, APC Device, Other Description, Substance Category, Substance, and ARB Rating fields. The "Field Value Listing/Definitions" column in Table 2 provides table references for selected fields. The referenced tables provide a complete listing of items contained in each field along with definitions for any acronyms. For example, as shown in Table 8, the values listed in the category field are Dioxin/Furan, Halogens, Metals, PAH, SVOC, and VOC. Each acronym is spelled out and the number of emission factors for each field value is provided in the emission factors column.