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TECHNICAL PROCEDURES FOR DEVELOPING AP-42 EMISSION FACTORS AND PREPARING AP-42 SECTIONS

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Office Of Air Quality Planning And Standards
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Chapter 1

INTRODUCTION

The document series *Compilation Of Air Pollutant Emission Factors*, AP-42, published since 1972 by the U. S. Environmental Protection Agency (EPA), is a compilation of emission factor information. An emission factor relates the quantity (weight) of pollutant(s) emitted to a unit of source(s) activity.

Supplements to the series, which is commonly called simply AP-42, are published periodically to provide new or revised information on emission source categories. The term "emission source category" is used to indicate a specific industry classification producing emissions. AP-42 segments may be categorized by industry, process, product, fuel, or other common denominators. As new information about sources and control of emissions becomes available, AP-42 will be updated by EPA in a timely and consistent manner.

This manual describes the procedures, technical criteria and standards for developing and reporting emission information to be published in *Volume I: Stationary Point And Area Sources* of AP-42. It is a guide for both EPA personnel and the contractors who prepare AP-42 sections. There are special requirements for *Volume II: Mobile Sources*, which are mentioned below.

The emission factors reported in AP-42 have many uses. They provide persons working in air pollution control with documented, technically acceptable estimates of source emission rates. Emission factors can be used in making:

1. Estimates of areawide emissions
2. Emission estimates for a specific facility
3. Evaluation of emissions in relation to ambient air quality.

Further description of the purpose and uses of AP-42 is given in Chapter 2.

Chapter 3 details procedures which are followed by the Emission Factor And Methodologies Section (EFMS) of the Emission Inventory Branch (EIB), Technical Support Division (TSD), of EPA's Office Of Air Quality Planning And Standards (OAQPS), in preparing or revising an AP-42 section. It includes reasons for initiating a review and then describes section preparation, review and publication procedures.

Chapter 4 details the actual tasks involved in section preparation or revision: gathering and reduction of data; writing, documentation, and review of the draft section; and incorporation of comments into the final section. These tasks are done by EPA and/or a contractor, after authorization of the work by the EFMS Chief.

Chapter 5 discusses standard procedures regarding nomenclature, graphics presentation, units, and reporting format. It also describes the technical specifications for reporting data for total organic compounds, particulate matter (including PM-10), lead, toxics, and other pollutants.

Chapter 2

PURPOSE OF AP-42

An emission factor is an estimate of the rate at which a pollutant from some activity (e. g., fuel input to a boiler or industrial production) is released into the atmosphere, divided by the level of that activity. Realizing that persons working in air pollution control need guidance when estimating the quantities of pollutants released to the atmosphere by different operations, EPA has compiled all emission factor information into the single report commonly referred to as AP-42.

AP-42 presents emission factors also in the form of empirical formulas for use in estimating emissions under the effects of specific conditions. Data used to calculate the emission factors in AP-42 are obtained from source tests, material balance studies, and engineering estimates.

The author(s) of an AP-42 section must consider how the emission factors will be used and must identify for the user any qualifications or limitations of the data. AP-42 factors represent the best available information on average emissions from the subject source categories. Statistical averages such as AP-42 emission factors seldom will specifically represent any of the individual data used to compute the averages, and they may describe none of the specific parts of the sample population. Still, the averages are useful for many decision-making purposes.

The three purposes of emission factors are described in the following below.

2.1 ESTIMATES OF AREAWIDE EMISSIONS

The largest use of AP-42 emission factors is in the development of criteria pollutant emission inventories.

In compiling an inventory, emission factors are applied to numerous emission sources within a source category. When the recommended procedures are followed, the resultant inventory of areawide emissions is likely to be quite accurate. Because AP-42 emission factors are assumed to represent a hypothetical "average" facility, individual plant differences tend to cancel out when numerous like sources are considered. Where one or relatively few facilities produce a large portion of an area's emissions, it is more important that the inventory be based on facility-specific emission rates, whenever available, rather than on emission factors. When a certain facility is contributing more than about 10 percent of an area's emissions, it is probably worthwhile to consider applying a source-specific test program.

In cases where a source category either contributes either a large percentage of overall emissions of a pollutant, or contains a relatively small number of sources, that source category (e. g., anthracite combustion) is divided in AP-42 into subcategories (e. g., traveling grate, etc.). Factors given for combustion emissions from large boilers will be based on specific information about the type of boiler and the fuel being used, because detailed information is available on just the few large facility types which produce the most emissions from boilers (e. g., power plants). Conversely, emissions from concrete or asphalt batching plants are produced by numerous sources and do not generally constitute a major percentage of the emissions in an inventory. Applying an "average" factor to these sources introduces only a small potential for error into the overall inventory.

Emission inventories are compiled for numerous statutory reasons, as well as for simply finding out which sources constitute the major emitters of specific pollutants. State Implementation Plan (SIP) regulations require that emission inventories be compiled for present and future years. SIP submissions must show reasonable further progress toward the attainment of National Ambient Air Quality Standards (NAAQS) for criteria pollutants. To show reasonable progress toward attainment, control agencies in nonattainment areas must estimate emissions annually.

Estimates based on emission factors are used in the SIP process to identify major emission sources that may need more stringent regulation. These estimates are also used as a starting point for regulation development. For example, AP-42 factors may be used to estimate a source category's emissions for the purpose of assessing its contribution to an ambient air quality problem.

2.2 EMISSION ESTIMATES FOR A SPECIFIC FACILITY

AP-42 emission factors are sometimes used to estimate facility-specific emissions. Although many such applications are legitimate, some (e. g., in enforcement litigation) are clearly improper. Legitimate facility-specific uses include the following:

- Comparison with emission estimates submitted by the owner of the facility.
- Prediction of emissions from a proposed facility.
- Development of emission estimates where the cost of source testing is not justified.
- Development of emission estimate submittals when other methods are not available. Note that AP-42 factors should <u>not</u> be used when reliable and representative stack test data exist for a facility.

Because emission factors may be used in making facility-specific estimates, particularly regarding emissions from proposed facilities, an AP-42 section should note any conditions under which an emission factor is not reliably applicable. Such qualifications should be described in the section text and should be clearly footnoted in the AP-42 emission factor table.

Statutory requirements for which AP-42 emission factors may be used include Prevention Of Significant Deterioration (PSD) permit applications and Aerometric Information Retrieval System (AIRS) submissions. It is necessary to estimate the effects of pollutants from a proposed facility before it is built, and in many cases, AP-42 emission factors provide the best mechanism for estimating emissions. Because most of the factors in AP-42 represent uncontrolled emissions, control efficiencies corresponding to Reasonably Available Control Technology (RACT), Best Available Control Technology (BACT), Lowest Achievable Emission Rate (LAER), etc., may be applied to emission factors when estimating facility air emissions after any controls.

2.3 EMISSIONS IN RELATION TO AMBIENT AIR QUALITY

The Clean Air Act requires eventual attainment of NAAQS. Pollutant emission rates can be used with dispersion modeling to estimate ambient levels of pollutants.

In many cases, however, there is a very complicated relationship between what is emitted by a

source and what is measured in ambient air. Numerous dispersion models are used to establish this relationship. Models inherently assume that the model input represents actual emissions to the atmosphere. For instance, pollutants that are emitted as vapor because of high stack temperatures, but which condense upon reaching the air, are assumed to have reached ambient conditions. Certain stack test methods that do not fully account for condensibles may thus lead to incorrect predictions of ambient levels if not adjusted.

Predicting ambient concentrations is an important use of AP-42 emission factors. Dispersion model input requirements are to be considered in the preparation of AP-42 sections. Although a section is not designed around the specific needs of dispersion models, when changes in report format or units can ease the use of the factor in modeling, these changes should be suggested to the Project Officer. For example, speciation of total organic compounds (TOC) and PM-10 should be included in the emission factor report when available, to assist in photochemical, dispersion and receptor modeling.

Chapter 3

INTERNAL PROCEDURES

The Emission Factor And Methodologies Section is responsible for all aspects of emission factors, including the development of new factors and the periodic revision of existing ones. EFMS directs a limited amount of source testing for development or revision of emission factors by contractors, and it coordinates with EPA's Office Of Mobile Sources in mobile source emission factor development. Most source testing relating directly to emission factor development or revision is performed by TSD's Emission Measurement Branch and the Air And Energy Engineering Research Laboratory (AEERL). The Emission Standards Division (ESD) of OAQPS also develops emissions data through various means to support regulation development, and EIB routinely uses these data for developing emission factors.

3.1 REASONS AND METHODS FOR INITIATING SECTION PREPARATION AND REVISION

The functional groups now constituting EFMS/EIB previously acquired their data for use in AP-42 entirely from other parts of the Agency, and did not themselves generate data for emission factor development. The Clean Air Act Amendments of 1990 added greatly to the number of air pollution sources for which emission factor development was required, and also called for the improvement of existing factors. This increased emphasis on emission factor availability and quality contributed extensively to the formation of EIB and also led to funding to initiate EIB's source testing program for generating new emission factors and updating existing factors.

Given this new emphasis on expanding the coverage and quality of AP-42 emission factors, it is important to rank emission factor needs so that the Agency's limited resources are best applied. Assignment of priorities regarding development or revision of emission factors may be affected by the following:

Outside requests for better source and emission factor information, or for information on a category not already addressed by AP-42. Requests may come from other OAQPS branches, EPA laboratories and regional offices, state agencies, trade associations, special interest groups, or private individuals. The requests may take the form of directives, letters, oral inquiries, or comments on published emission factors.

New information developed initially for ESD background documents involving New Source Performance Standards, Maximum Achievable Control Technologies (MACT), and National Emissions Standards For Hazardous Air Pollutants (NESHAP), and for reports by various EPA laboratories.

Contractor or consultant expertise on a source category may have developed during previous work, either for EPA or for other clients, and may be used in a low-expense update and expansion of available AP-42 information.

In addition to these possibilities, Section 130 of the Clean Air Act Amendments emphasizes the process through which any party may submit valid information to EFMS for emission factor development and revision. Before initiating a factor development or revision effort, the Project

Officer analyzes the proposed work as it relates to existing needs and priorities, to contract funding, or to EFMS personnel availability, the likely magnitude of the effort, and other criteria. Based on his or her analysis, priorities for AP-42 revisions are established, and recommendations are made to the EFMS Chief.

The tasks of section preparation will be done either by Agency personnel or by a contractor, depending on cost, time, and contractor qualifications, as the EFMS Chief directs. These tasks include compilation or generation of data, data evaluation, and preparation of the draft section and background document, as well as EPA review, coordination of outside review, final editing and formatting, and publication.

3.2 OVERVIEW OF SECTION PREPARATION/REVISION

A diagram of the process of section preparation or revision is shown in Figure A-1 in Appendix A. The first task is assembly of all available data on the emission source and the pollutants it emits. For existing emission sections, this task includes a complete review of EFMS documents on file. Other possible data sources are:

- A literature search through EPA Library Services of all data bases currently available.
- The AP-42 reference files in EFMS.
- The Aerometric Information Retrieval System in EPA's National Air Data Branch (NADB).
- EPA's research laboratories.
- Criteria and toxic air pollutant information in ESD.
- Control Techniques Guidelines (CTG), Available Control Techniques (ACT), and Background Information Documents for NSPS and NESHAPS in ESD.
- Trade associations.
- EPA Regional Offices.
- State and local air pollution control agencies.
- Operating permit files and applications.
- Contractor expertise.

After assembly of all available data, they are reviewed, organized, and analyzed. Using the standards given below in Sections 5.1 through 5.3, the EPA Project Officer decides whether the collected data are sufficient to justify preparation or revision of a section. This Project Officer review must occur even when a contractor has compiled the data.

When sufficient data to calculate the emission factor(s) have been gathered, a new or revised section is drafted, reviewed by the EPA Project Officer and the EFMS Chief, and corrected if

needed. The section is then distributed for further technical review. Concurrent with section production, a background document discussing all primary references, calculations, and other pertinent information is prepared and reviewed similarly. The background report should identify all data, discuss their quality rating, and document all decisions on their use. Analysis and any statistical manipulations of the data should also be clearly documented. If estimates of data accuracy or precision can be derived, it should be clearly noted here.

Technical review comments shall be incorporated into the background document draft, which may then be distributed for further review to selected outside groups having technical expertise in the subject area, such as trade associations. Following satisfactory completion of section and background document review, the AP-42 section is ready for publication.

3.3 PUBLICATION

Publication of an AP-42 section entails editing, clearance, and final printing. The section is first edited by a technical editor who reviews grammar, clarity, and adherence to AP-42 format. If necessary, the section is then returned to the author with editorial comments, and any needed revision to the section is made. This process is greatly facilitated when the author constructs the section from the beginning according to EPA format or has made use of a technical editor throughout the process.

After editing, the section is prepared for publication in the format described in Chapter 5. When the section is deemed acceptable for publication by the author, the EPA editor and the Project Officer, the EFMS Chief will enter the section into the necessary OAQPS and EPA clearance processes.

Revised sections are usually collected and held for printing in an AP-42 supplement. All sections completed and cleared, but not yet published, are put on the CHIEF electronic bulletin board (BB) in a portion designated as an AP-42 "Supplement".

When the finished candidate material for a new supplement has received the required clearance, the material is sent by EPA to the Government Printing Office for printing, returning of copies to EFMS, and stocking copies for sale. Section authors should have thoroughly reviewed these new sections and their background documents, especially to confirm that the approved sections and their background documents are in full accord. At this point in the process, each author shall submit copies of the final version of his or her section(s), the background document(s), and all references to be placed in the AP-42 files in EFMS.

Chapter 4

GUIDE TO SECTION PREPARATION/REVISION

This chapter is a guide for the individuals who prepare or revise emission factor reports for publication in AP-42. Such new or revised emission factor reports are continually being prepared. Since the AP-42 document has many authors, following a standard approach to section preparation and revision will help to make the information presented in the document more consistent, and therefore more accessible, to the AP-42 user.

4.1 DESCRIPTION OF A TYPICAL AP-42 SECTION

The typical AP-42 section consists of the following elements:

- General process description, with flow diagram(s)
- Discussion of emissions and any controls
- Table of emission factors and/or equations for calculating emission factors
- References

Appendix B of this document presents a typical AP-42 section, and it should be consulted early in the section process, by both the prospective author and the clerical staff who will produce the final section.

The AP-42 user often turns first to the table to obtain the emission factors. If the tabular information is not clear, the user may then consult the illustration or the text, and if need be, the references.

The emission factor table should provide the user with an emission factor for a source and should give the user all the information needed to apply the factor correctly. The user is assumed to have an engineering or other technical background, to be somewhat familiar with the source operations, and to need information only about any qualifications placed on the factors. The most important part of an AP-42 section, therefore, is its emission factor table(s), which must be able to stand alone for use by the reasonably well informed user. A principal point to keep in mind in table preparation is to give emission factors for as many different subcategories within the source activity as reasonably possible.

For example, subcategorization is usually appropriate by throughput, age of facility, or control device. When information does not exist for a particular subcategory, such needs to be stated.

Provide footnotes which explain any and all qualification of factors that might need explanation. These notes may be as brief as a recommendation to read the text before applying a particular factor, or as lengthy as necessary to assist with correct factor usage.

For a simple process, a flow diagram may not be necessary. When provided, it should be designed to complement the emission factor tables. Use the same terminology in the table and the

diagram. Emission sources not covered in the table, either because the emissions are insignificant or because data are unavailable, should be shown on the flow diagram for the user's information. Illustrations are preferred, instead of simple blocks in the diagram, if they do not detract from the primary purpose of complementing the emission factor table. Source classification codes should be clearly marked on the diagram.

The process description text explains the flow diagram and gives a very general idea of the process. It is not intended to give a complete explanation of the industry. The description may refer the reader to specific references where more information can be obtained, if needed.

The emission and controls portion of the text explains the information given in the emission factor table. Factors given in the table may also be given in the text. Footnotes in this table can refer the user to specific information in the text, if needed to explain about an emission factor and its application.

The references to an AP-42 section can be extremely important to a user who wishes to apply an emission factor in detail to a specific source. Although AP-42 factors do not apply to specific sources with absolute accuracy, factors can be used with their references to develop reasonably accurate information about an emission source. A good reference list, including a background document containing basic information, will be quite helpful to the user. The information in any proper reference citation will 1) identify the reference clearly, and 2) tell the reader where to obtain a copy of it.

4.2 SUMMARY OF SPECIFICATIONS AND FORMAT DEFINITION

The specification and format topics discussed throughout this document are summarized below. Additional explanations are found in the noted parts of this document.

Section Length

AP-42 sections are intended to be updated periodically and are therefore written in discrete portions, or subsections. Authors should make the best possible use of the page space. "White space" should be held to a minimum by judicious sizing and placement of figures, tables and text.

Table Format

As stated earlier, the emission factor table must be able to stand alone. All emission points and pollutants are contained in the same or similar tables. Any qualifications of the data are mentioned in footnotes to the table.

References

All data used to develop the emission factors are referenced at the end of the section. It is desirable also to include general references on the industry to supplement the general process description. Primary data sources and references should be preferred. Primary data sources are those containing the original data that are being referenced. All data sources should be traced back to their primary source. Reference format examples are given below in Chapter 5.

EFMS Emission Factor File

This file contains the background documents for all AP-42 sections. The file contains copies of all versions of the AP-42 sections, all references used in the sections, and documentation of all calculations. A more extensive description of the reference file is given in Chapter 4.

Agency/Outside Review

All new or revised sections must be reviewed within the Agency and by outside organizations before release. Several reviews may be conducted within a single reviewing group. Ultimate responsibility for thorough section review lies with the EFMS Chief and the Project Officer. A more detailed discussion is found in Section 4.9.

Data Standards/Test Methods

Minimum standards for useful data are given in Chapter 5. The quality of data from acceptable tests indicates a rating for those tests on a descending scale of A to D. When AP-42 sections are revised, all data (including old data) are subject to these minimum standards and are rated accordingly.

Statistical Methods

If the number of A-rated source tests is sufficient, B-, C-, and D-rated tests are not to be used to calculate an emission factor. If the number of A-rated tests is not sufficient, B-rated tests are used. Tests rated C and D are generally not combined with A- or B- rated tests and are to be used only if no other higher quality data are available. However, higher ranked data may be "downgraded" and used with lower ranked data, providing that the lower rating is maintained. Tests for each individual facility are reduced to a single value (arithmetic mean), and the arithmetic mean of these values is the emission factor. If the data are suitable for other statistical reduction methods, the use of such methods should be clearly footnoted in the AP-42 section and documented in the background report. These methods are described further in Chapter 5.

Quality Rating/Statistical Confidence

A letter rating system descending from A to E is applied to individual factors within the section's emission factor table. Although these ratings do not represent a numerical statistical confidence, they do give the user a general idea of the quality of the emission factor. Guidance for the application of these ratings is given in Chapter 5.

Units

An activity factor is a measurement of source activity. Typically, this factor is multiplied by the emission factor to calculate the emissions from that source. The activity factor that best relates to emissions is used. Consideration is also given to accepted standards of measurement in the industry and in enforcement regulations. More extensive guidelines on activity factors are given in Chapter 5.

Nomenclature

Any abbreviation or chemical formula is introduced in parentheses at first mention. The use of vague or general terms is avoided when specific terms can be used. A glossary should be included of definitions of terms that are industry-specific, and chemical names and pollutant classifications are standardized. Nomenclature guidelines are given in Chapter 5.

Reporting Format

While the essence of the section is contained in the emission factor table, this can be complemented with figures, a general process description, subsections on emissions and controls, and references. Specific format guidelines are given in Chapter 5.

Figures

A flow diagram should relate directly to the emission factor table (i. e., specific processes identified in the diagram should have a corresponding entry in the table). Both box and equipment schematics may be used. Control devices are generally not shown in the flow diagram. Additional figures or illustrations should relate directly to the flow diagram. More extensive guidelines are given in Chapter 5.

Criteria/Noncriteria Pollutants

Emission factors for criteria pollutants, toxic pollutants, global warming gases and compounds responsible for depletion of stratospheric ozone are to be included in AP-42 when data allow. More detailed information is contained in Chapter 5.

Controlled/Uncontrolled Emissions

Emission factors in AP- 42 should represent uncontrolled emissions. Information on controls is contained in the text. More detailed information is contained in Chapter 5.

Organic Emissions

Organic emission factors are reported as total organic compounds (TOC), methane, total nonmethane organic compounds (TNMOC), ethane, and other volatile and semivolatile speciated data. Other information and composition data are presented in footnotes or in the text. Complete guidelines are contained in Chapter 5.

Lead Emissions

Lead emission factors are being added to the emission factor tables as sections are prepared or revised. Lead is reported as elemental lead, representing both front- and back-half catches of EPA Method 12. Data on chemical compositions or weight percent of particulate emissions are given in a footnote or in the text.

Particulate Matter Emissions

Particulate Matter (PM) emissions should be presented as filterable PM, filterable PM-10, condensible inorganic PM, condensible organic PM, total PM, and total PM-10.

4.3 GENERAL

This chapter presents the purposes and objectives to be met during the preparation or revision of an AP-42 section. The three major goals are:

- Meeting the needs of the user
- Assuring conformity of the new AP-42 section with the existing document
- Documenting all work adequately.

4.3.1 User Needs

Throughout the preparation of an AP-42 section, the needs of the user are the primary consideration. These needs include the development of emission factors that are related to source activity level information that is normally available to the user. The author may organize the emission factor presentation in several levels, with each level being more specific to the source. User needs are considered in deciding whether to provide more detail on an emission factor, as well as in decisions for format, figure presentation, and selection of units. Before beginning preparation or revision, the author prepares a list of the uses of emission factors (e. g., preparation of permit applications) contained in the section. As the section develops, the presentation is evaluated in regard to these uses.

4.3.2 Document Uniformity

The individual section being prepared is only a small part of the much larger AP-42 document. A new or revised section must physically conform to the present emission factor reports, by following current section organization and data presentation.

4.3.3 Documentation

Material included in a new or revised section must be documented. The starting point for a revision will be the existing section and its documentation, as discussed above. Such documentation includes the section references and the emission factor file. If the documentation is insufficient, unnecessary problems and errors in emission factor selection and application may occur.

Many users take the information in AP-42 as a basis for research. Such investigations are encouraged by EPA and may result in factor improvement in the future. Researchers will need to trace factors back to original material (i. e., primary reference material) for proper evaluation, hence documentation of the AP-42 source data is essential for this purpose.

4.4 EMISSION DATA/DATA COLLECTION

Many possible sources of emission data are investigated in the preparation of an AP-42 section.

4.4.1 Literature Search

A literature search for source test and background information is conducted for the emission source category in question. This search is conducted through EPA, other library systems, or entities such as the National Technical Information Service. If contractor effort is involved, it usually saves money to request/conduct searches from Agency library services directly through the EPA Project Officer.

4.4.2 AP-42 Emission Factor File

The AP-42 emission factor file is the beginning point for any section update effort and is reviewed for any section being updated. The file contains the background document for the existing section, as well as its references. The file also contains additional pertinent information accumulated by various EPA personnel. The background file is maintained by EFMS and is readily accessible to EPA engineers and to contractors.

4.4.3 Aerometric Information Retrieval System (AIRS)

The AIRS Facility Subsystem (AFS) point source records, located at TSD's National Air Data Branch (NADB), will yield information on various kinds of process equipment and control devices. AFS data also may be used to identify plants where source tests have been performed, or states that have developed emission factors on their own for a Source Classification Code (SCC) category. Several sort and select options are available to retrieve needed information from AIRS.

4.4.4 The EPA Research Laboratories

The various EPA research laboratories may engage in work and produce reports that contain emission factor information. These laboratories include the Risk Reduction Engineering Laboratory (RREL) in Cincinnati, and both the Air And Energy Engineering Research Laboratory (AEERL) and the Atmospheric Research And Exposure Assessment Lab (AREAL) in Research Triangle Park (RTP). Although these laboratories are generally more research oriented than OAQPS, they often develop and report emission data that are usable in AP-42.

4.4.5 Information Gathered For NSPS And NESHAP Development

The Emission Standards Division of OAQPS is responsible for developing and promulgating regulations for stationary sources of air pollutants. In doing this, ESD produces numerous source test reports, background information documents (BID), and other useful technical reports.

ESD reports should be reviewed for data on the industry in question. In addition, the Industrial Studies Branch (ISB) and the Chemicals And Petroleum Branch (CPB) of ESD maintain files of articles on each source category for which standards are being developed. ESD's Pollutant Assessment Branch (PAB) collects information on hazardous air pollutants. These files should be checked for information that may be pertinent to AP-42 section development.

4.4.6 Trade Associations

Affected trade associations, which are usually aware of AP-42 and its uses, generally possess the most current process information available, including successful process modifications, control devices, etc. Whenever possible, these associations should be consulted, especially for comments on the draft version of a section. EIB maintains a computerized list of potential and past contacts, by section, and their phone numbers and addresses.

4.4.7 The EPA Regional Offices

The Regional Offices can be surveyed for general data and source test reports, if there are reasons to believe such data exist. This information may be especially pertinent when a source category under review involves a particular Region. Examples would be anthracite coal in Region III, sulfite paper mills in Regions I and X, and bagasse-fired boilers in Regions IV and IX.

The EFMS Project Officer will make the initial contact with a Regional Office for such data. Initial requests should be specific. It is helpful to find Region personnel who have visited the sources being studied and who can offer invaluable detailed information on equipment configurations, control devices, emissions, etc., maybe not otherwise be available.

4.4.8 State And Local Control Agencies

State agencies are contacted if a source category is concentrated in the state, with initial contact made by the EFMS Project Officer. As with the EPA Regions, it is desirable to contact someone who has visited the source types of concern. U. S. Office Of Management And Budget (OMB) regulations dictate that no more than nine state agencies may be contacted with the same request. State agencies may be contacted through the respective EPA Regional Offices.

4.4.9 Contractor Expertise

Certain contractors, consultants, and teachers may have acquired expertise in past field work that may be useful in studying a source category. This expertise can be of assistance to the author in the preparation, revision or review of an AP-42 section.

4.4.10 Other EPA Divisions, Branches Or Sections

Other parts of the Agency, such as OAQPS's Stationary Source Compliance Division (SSCD) and Emission Measurement Branch (EMB) of TSD, and the Office Of Research And Development (ORD) should be contacted in seeking information on a source category.

4.5 DATA REDUCTION

Data for emission factor development are gathered from many sources and in many forms. The quality of the data varies from precise to an educated guess. Standard methods are used in the reduction of these data to a single-value emission factor. The data reduction is well documented, and the user is informed in the section of any deviations from the procedures set forth in Chapter 5, Technical Specifications And Rationale.

Chapter 5 presents minimum standards for accepting test data. Acceptable source tests are quality rated from "A" to "D". All similarly rated tests from a facility are combined by computing the arithmetic mean of the data.

Data with similar quality ratings but from different facilities are combined by computing the arithmetic mean of the data. Rules for combining data with different quality ratings are detailed in Chapter 5.

In the finished AP-42 section, a rating system descending from "A" to "E" is applied to all factors in the emission factor table. Although this emission factor rating is influenced by the quality of test data, it is determined by a different system from that used to rate source tests. Rules for applying this subjective rating system are contained in Chapter 5.

4.6 DATA PRESENTATION

The most critical component of an AP-42 section is its emission factor table. The process flow diagram correlates with the emission factor table. It may show nonemitting process operations not listed in the table, but all emitting operations listed in the factor table must be shown in the flow diagram. Other illustrations are included if they relate directly to the flow diagram. The section text addresses both the emission factor table and the process flow diagram.

The units of measurement chosen are those that best relate to emissions and that are reasonably understandable by the user. Both metric units and English equivalents are given, with the metric unit information always presented first, as is required by government regulations. Abbreviations or chemical formulae may be used, but their full meaning is always indicated at first usage. Jargon is to be avoided, unless it is fully explained.

A more extensive guide to data presentation is given in Chapter 5 of this report.

4.7 GENERAL PROCESS INFORMATION

Although supplying general source information is not the primary purpose of AP-42, such information sometimes helps in applying emission factors correctly. The inclusion of general industry information can familiarize the AP-42 user with the basic workings of a source category, what is produced, the process used to produce end product, and the raw materials used in the process. Descriptive information is usually quite brief, a page or less, unless more is needed to explain complex processes. More detailed description of the activity should be restricted to the background document when preparing AP-42 sections. The author should assume that the user has little prior knowledge of the specific source category, but it should also be assumed that the reader has some engineering or other technical background and is somewhat knowledgeable of emissions from air pollution sources.

4.8 BACKGROUND FILES

The file containing the documentation and background for every AP-42 section is maintained by EFMS. This file for each section contains all information on that source category obtained by the EFMS in the past.

When work on a new or revised AP-42 section is completed, its author is required to furnish EFMS the final section and all information used in producing it. This material will then be added to the information already supporting that section. Every section file should contain:

- A copy of the current and all previous versions of the AP-42 section, and background documents.
- The emission factor documentation, presenting the data and calculations used to produce the emission factors.
- A paper copy or a microfiche of all section references, unless the Project Officer agrees that front covers with just the cited text will be sufficient to support inquiry on the section while conserving file space.
- Any unreferenced documents, reports or articles that provide supplemental information for the section.
- Space for new documents, reports and data to be filed for consideration in making future revisions.

The emission factor documentation submitted by the author provides a record of the data used to produce the factor, the sources of those data, and the actual data calculations.

The emission factor documentation is a completely adequate record of how each emission factor was produced. Copies of the documentation will be provided to persons who call or write requesting such information after the section is published. Specifically, the emission factor documentation contains the following:

- A list of the primary references from which the factor data were derive, as listed in the AP-42 section.
- A list of all collected data, with specific references to page or table numbers in the material in which these data were found.
- A complete record of all calculations, including units.
- A complete record of all assumptions, technical procedures, and rationale used in calculating or reducing the data.

The purpose of the full AP-42 file in a section is twofold: (1) to allow quick location of supporting references when the applicability or accuracy of factors is questioned, and 2) to provide knowledge of both the background of, and basis for, current factors when deciding whether new data should make changes necessary.

This section file is labelled according to the section numbering system used in AP-42. The cover of each section file should show the following information:

Chapter and section name and number, e. g., Chapter 10, Wood Products Industry: Section 10.1, Chemical Wood Pulping.

- A numbered list of the section references contained in the folder.
- A list of commonly available references, such as EPA documents, or textbooks such as *Perry's* which contain pertinent information on the source category. All references must be primary references.
- A list of any references found elsewhere in the file (give location).
- A list of any references that are not available, such as old publications and personal communications.
- A list of any material such as bulky test reports and contract reports that can be found in other, clearly designated, sections of the emission factor files (e. g., special contract section, source test report section, etc.).

All references for a section should be accounted for in one of the above categories of required file contents. The references themselves are to be clearly identified (title, author, place of origin,date, page, etc.) and be numbered, with the corresponding date of the AP-42 revision in which they are used plainly included in the heading.

A section file includes as many of the referenced documents as can be obtained. For instance, transcripts are to be made of personal and telephone communications. If only a few pages from a lengthy work are cited, only these need to be copied and included in the file. When pertinent source test results are summarized in a few pages, include this summary as well as the source test itself. In copying tables, graphs and test results, the specific information that is used directly from the reference is identified. This saves time (and may avoid ambiguity) when someone else revises the section at a later date.

4.9 AGENCY/EXTERNAL REVIEW

After the draft section and background report are prepared, both are reviewed by the Project Officer and the EFMS Chief for clarity, technical accuracy, and thoroughness. Others in EFMS will likely participate in the review. Their suggestions to the author will be incorporated until the section is approved.

After this stage, the draft section is then sent for review outside of EFMS, as directed by the Project Officer. In general, anyone who supplied technical data for the section is asked to review the draft report. External reviewers should include appropriate representatives of industry, state/local agencies, environmental organizations and other technical experts who will consent to comment.

4.10 FINAL REVISION

With the Project Officer, the author reviews all comments for incorporation into the section. Whenever significant changes are made in response to review comments, a further draft may be circulated for external review. All comments and recommendations are seen by the EFMS Project

Officer, who approves any proposed revisions. The author makes approved changes before the next submission.

Upon incorporation of the accepted changes, the Project Officer and the EFMS Chief will again review the section and background report and then consider giving final approval. The final approved version is then prepared and sent to the Project Officer for inclusion in AP-42. During the review and revision stages, the emission factor documentation should be completed for submission to EFMS for inclusion in the section file.

Chapter 5

TECHNICAL SPECIFICATIONS AND RATIONALE

Because the AP-42 document series contains many sections produced at different times by different authors, uniform reporting and editorial practices are essential. This chapter sets forth standards to be followed in data collection, units, nomenclature, report format, and figure presentation. Technical guidance and rationale are provided on areas for which specifications cannot be easily verbalized.

5.1 DATA STANDARDS/TEST METHODS

Emission factors in AP-42 typically are based on data obtained from several sources, including, but not limited to, published technical papers and reports, documented emission test results, and personal communication. The provided data may vary from single values to ranges of minimum and maximum values, and even to data from replicated source tests. Some data sources provide complete details about their collection and analysis procedures, while others provide relatively little information in this regard.

It is important that each factor in AP-42 receive a quality rating, which serves as an assessment of the confidence the author places in the accuracy of the emission factor. The first step is to rate the test data used in deriving the factor. In many cases, this will require review of primary sources of numerical data (source tests or other raw data) to ensure that consistent and current criteria applied to rate the data. This is especially true for the ratings assigned to emission factors in EIB's *Factor Information And Retrieval System* (*FIRE*), which may not be the same ratings as those in AP-42. Ratings from *FIRE* should not be used with-out first subjecting the primary sources of numerical data to the criteria presented in this chapter. Most data in *FIRE* and *SPECIATE* are of unknown quality and will likely be unratable, or "E" at best (see "Quality Ratings/Statistical Confidence" below), because of poor technical foundations (engineering estimates), small source test populations, lack of source test documentation, etc. Where data quality precludes the assignment of ratings, the data may be qualitatively referenced in the AP-42 section or in tabular form, and/or the reader may be referred to *SPECIATE* for additional information.

Two EPA publications may be used to assist the reviewer in examining source test reports for AP-42, the *Guidebook: Preparation And Review Of Emission Test Reports*, and the *Guidebook: Preparation And Review Of Site Specific Test Plans*. These references are designed to acquaint the reader with common protocols employed for source testing, including information on test programs, sampling locations, Quality Assurance/Quality Control activities, sampling and analytical procedures, and reporting and data reduction requirements. These guidebooks may be accessed through the Emission Measurement Technical Information Center (EMTIC) electronic bulletin board (BB) or by direct request for copies to EMTIC at (919) 541-0200.

In some cases, a review of information used to develop an existing factor will result in a downgrading of its rating. Example reasons for this are (1) the use of less stringent rating criteria in the past, (2) questionable data quality for some of the older factors, or (3) changes in test methods.

It may be necessary to introduce other rating criteria for data quality not addressed in this document. This may be done if it is adequately explained in the background report. Keep in mind

that the rating process is an imperfect attempt to introduce objectivity into a judgmental process, and that professional judgment may influence some ratings.

The author should select data on the basis of the quantity and quality of data available. The following types of data should be treated with caution before using information from such tests:

1. Test series averages reported in units that cannot be converted to the selected reporting units (see below).

2. Test series involving incompatible test methods (i. e., comparison of the EPA Method 5 front half with the EPA Method 5 front and back half).

3. Test series of controlled emissions for which the control device is not fully specified.

4. Test series in which the source process is not clearly identified and described.

5. Test series in which it is not clear whether the emissions measured were controlled or uncontrolled.

If there are no reasons to exclude certain test data or data sets from consideration, each data set is assigned a quality rating of from A (best) to D (worst). Such a rating system is needed to indicate data reliability, since some data may be used when little other information is available but the same data would be excluded when sufficient high-quality data exist. The data are rated as follows:

A - When tests are performed with sound methodology and are reported in enough detail for adequate validation. These tests are not necessarily the EPA reference method tests, although such reference methods are preferred and certainly to be used as a guide.

B - When tests are performed by a generally sound methodology, but they lack enough detail for adequate validation.

C - When tests are based on an untested or new methodology or are lacking a significant amount of background data.

D - When tests are based on a generally unacceptable method, but the method may provide an order-of-magnitude value for the source.

While this rating system provides guidelines for data/source test ratings, it is important to recognize that it allows for discretion on the part of the reviewer. For example, if the reviewer is examining data that are based on a generally unacceptable method (i. e., a rating of "D" as described above), but it is known that, in this case, the method provides accurate values, the reviewer can upgrade the data from a "D" rating, but the rationale for the upgrade must be indicated.

The following criteria should be used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. Sampling procedures. If actual procedures deviated from standard methods, the deviations are well documented. Procedures often must be altered in testing an uncommon type of source. When this occurs, an evaluation is made of how such alternative procedures could influence the test results.

3. Sampling and process data. Many variations can occur without warning during testing, sometimes without being noticed, that can induce wide deviation in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and may be given a lower rating.

4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used are compared with those specified by EPA, to assure equivalency. The depth of review of the calculations is dictated by the reviewers' confidence in the ability and conscientiousness of the tester, which in turn is based on factors such as consistency of results and completeness of other areas of the test report.

An "A" rated test may be a stack test, material balance, or some other methodology, provided it is generally accepted as a sound method of measuring emissions from that source. In some cases, a material balance calculation may be more applicable, and therefore rated higher, than a stack test.

Because just one combined value is used to calculate the AP-42 emission factor for each process, only the results of tests of equal quality ratings are retained when multiple-series tests are run at the same process. However, higher rated test data may be averaged with lower rated data, provided the overall emission factor rating is adjusted to reflect the use of lower rated data.

Although the test rating system described above is subjective, it provides a basis for excluding poor data when a sufficient quantity of better data is available. The compiler must attempt to ascertain how representative the tested facility is of the entire industry. For example, source tests performed for the preparation of New Source Performance Standards (NSPS) are generally conducted at well designed and well operated facilities that are not always typical of an industry. If a substantial portion of the data used in deriving an emission factor comes from NSPS tests, this fact is footnoted in the emission factor table.

When an existing AP-42 section is revised, the quality standards must be applied to the data used to calculate the current factor. Because some valid data may have been excluded in the past because of poor documentation, all new data must be clearly documented, and the reasons for assigning the rating clearly stated, in the background information. When data rated lower than B are used in calculating an emission factor, the table is footnoted to explain any limitations the emission factor may have. An example of this may be found in the sample AP-42 section in Appendix B.

5.2 STATISTICAL METHODS

AP-42 emission factors are based on data from published and unpublished reports, technical papers, and personal communications among individual investigators. Emission data extracted from source documents may have been determined by emission source testing, material balance, or engineering analysis.

Thus the emission factors represent statistical averages derived from a sample of emission sources, or single values determined through engineering judgment to be representative of the data available on a specific source category.

In the ideal situation, a large number of "A" rated source test sets representing a cross section of the industry are reduced to a single value for each individual source by computing the arithmetic mean of each test set. The emission factor is then computed by calculating the arithmetic mean of the individual source values. No "B", "C", or "D" rated test sets are used in the calculation of the emission factor, because the number of "A" rated tests is sufficient. This ideal method of calculating an emission factor is not always possible, usually because of a shortage of "A" rated data.

The number of "A" rated tests needed to represent a cross-section will vary among source categories. Several variables influence this number:

- The total number of facilities in the nation (sample size vs. total population).
- The variability of emissions within the industry.
- The variability of emissions from within each facility.
- The representativeness of the sample in the total industry

Because rating judgments can be subjective, the rationale behind a decision is to be documented in the background information. If possible, estimates of these variables are made. At a minimum, the author attempts to estimate the total number of facilities in the nation.

Specific information in the background document should include, but not be limited to, the following:

- Number of facilities tested.
- Estimate of number of facilities in the United States.
- Range of emissions nationwide (minimum to maximum).
- Range of emissions for each facility tested (minimum to maximum, and number of tests).
- A description of how the sample was chosen (i. e., random, NSPS tests, etc.) and whether this may cause bias in the data.

If the number of "A" rated tests is such that the inclusion of "B" rated tests would likely

improve the emission factor, then "B" rated test data are included in the compilation of the arithmetic mean. However, no "C" or "D" rated test data may be averaged with "A" or "B" rated data. The rationale for using any "B" test data is always documented in the background information. As more "A" rated data become available, the "B" test data must be dropped from the emission factor calculation. A footnote to the emission factor table should inform the user of any limitations on applying the emission factor.

If no "A" or "B" rated test results are available, the emission factor is the arithmetic mean of the "C" and "D" rated test data. When "C" and "D" test data are used, any limitations on the use of the emission factor are clearly footnoted in the emission factor table. "C" and "D" rated data are used only when sufficient "A" and "B" data are not available,
and provide only an order-of-magnitude value.

Throughout the statistical process, test results from an individual source are reduced to a single value by using the arithmetic mean, and individual source emission factors are combined by computing the arithmetic mean. In some industries where the median may be more representative of a typical value, the more appropriate statistical method (mean or median) is used. The rationale for its use is documented in the background information. An explanatory footnote should be added to the emission factor table, lest a user could conclude that the emission factor represents an arithmetic mean.

The author should attempt to reduce the data to a single emission factor, rather than to a range of values. However, if a range of values can be categorized, the author may present several emission factors related to facility variables (e. g., age, throughput, fuel), or even formulae for that purpose.

5.3 QUALITY RATING/STATISTICAL CONFIDENCE

In an AP-42 section, a table of emission factors is presented for each pollutant emitted from each of the emission points associated with a polluting activity. The reliability of each factor is clearly indicated in the table by an Emission Factor Rating ranging from "A" (excellent) to "E" (poor). These ratings take into account the quality and quantity of data from which the factors were calculated.

The use of a statistical confidence interval may seem desirable as a more quantitative measure of the reliability of an emission factor. However, because of the way an emission factor data base is generated, prudent application of statistical procedures precludes the use of confidence intervals, unless the following conditions are met:

- The sample of sources from which the emission factor was determined is representative of the total population of such sources.

- The data collected at an individual source are representative of that source (i. e., temporal variability resulting from typical source operating conditions may bias the data).

- The measurement method was properly applied at each source tested.

Because of the extremely difficult task of assigning a meaningful confidence limit to the above variables and to other industry-specific variables (e. g., differences in determining fuel

characteristics), using a statistical confidence interval for an emission factor is not usually practical. Therefore, some subjectivity in a quality rating is necessary. The following emission factor ratings are applied to the emission factor table. Note that the following descriptions are suggested guidance, and that not all data combinations for each rating are addressed.

A - Excellent. Developed only from "A" rated source test data taken from many randomly chosen facilities in the industry population. The source category is specific enough to minimize variability within the source population.

B - Above average. Developed only from "A" test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested are a representative sample of the industries. As with the "A" rating, the tested source is specific enough to minimize variability within the source population.

C - Average. Developed from only "A" and "B" rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the "A" rating, the source category is specific enough to minimize variability within the source population.

D - Below average. Developed from only "A" and "B" test data from a small number of facilities, with a reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source population. Any limitations on use of the emission factor are footnoted in the factor table.

E - Poor. Developed from "C" and/or "D" rated test data, with a reason to suspect that the facilities tested do not represent a random sample of the industry. There may also be evidence of variability within the source category population. Any limitations on the use of these factors are always clearly noted.

Because the assignment of these ratings is subjective, the reasons for each rating are documented in the background information. Calculation of individual confidence limits is encouraged for all variables associated with a factor in assigning the "A" to "E" ratings. Stringent adherence to these criteria should be coupled with knowledge and experience with the industry, and the rater should apply good engineering judgement to the assignment of ratings and to whether any quantitative statistics would be meaningful. Documentation for this determination is to be presented in the background information.

5.4 UNITS

An emission factor is an estimate of the rate at which a pollutant is released to the atmosphere because of some activity, divided by the level of that activity (activity factor). The units chosen for an activity factor depend on the data available to the person preparing the emission factor and on the data available to the AP-42 user. The activity factor is chosen according to how the industry in question tabulates production data and on how emission tests were performed. Units may be as varied as "megagrams of solvent in ink", "tons of wood treated", "surface area of storage pile" and "bales of cotton ginned". When both input and output rates are readily available from the industry, the rate that best correlates to emissions and is most likely to be familiar to the user should be selected.

With a few exceptions, values throughout AP-42 are presented in both metric and English units. As stated earlier, metric units are given preference in AP-42. The U. S. Government encourages the use of the modern metric system (the International System Of Units, better known as SI units) in all federal documents and activities.

These guidelines are to be followed when choosing an activity factor.

1. Use the one that best relates to the pollutant emitted

2. Give preference to accepted standards of measurement to which the user is likely to have easy access

3. Give consideration to units specified in enforcement regulations.

When an appropriate activity factor has been decided upon, the author obtains the approval of it from the Project Officer. Sometimes it may be desirable to have more than one set of equivalent units.

In certain industries, the most appropriate activity factor or factors for more source-specific breakdowns may not be available to all users. In these cases, an activity factor is given for the overall facility, and source-specific information is included when available. One of the dual factors is to be labeled "preferred" to avoid confusion or double counting.

As noted, metric units are used before equivalent English units, in both text and tables. In special cases, the author, with the Project Officer's agreement, may choose units that are not strictly metric or English, but which the user will be more familiar with, for example, "grams per mile (g/mi)" for mobile source emissions. A unit no longer accepted is the metric ton (MT), because the equivalent megagram (Mg) is a standard unit. The metric units to be used are those set forth in the *Standard Practice For Use Of The International System Of Units (Modernized)*, American Society For Testing And Materials, Philadelphia, PA, 1992.

5.5 NOMENCLATURE

"Nomenclature" is the set of terms and symbols used throughout AP-42. Industries and organizations often support a vocabulary of terms, a jargon, that is unique and specific to itself, or some industries may share common terminology. Any such terms used in AP-42 must be clearly defined.

Terms and symbols used imprecisely will confuse the reader. The following nomenclature guidelines are to be used in AP-42 to minimize this confusion.

1. Introduce each abbreviation or chemical formula in parentheses after it is first mentioned, e. g., ". . . sulfur dioxide (SO_2)". Thereafter, use the abbreviation or formula freely.

2. Avoid the use of vague or general terms where specific terms or qualifying adjectives would improve clarity.

3. If needed, include a glossary at the end of section text before the references. Give simple but precise definitions of terms that are part of the jargon or special vocabulary of a process being described, or of common terms that have specific meanings in that context. Do not use any jargon without first giving its equivalent technical term or a definition.

4. Use standard names of chemicals that appear in the emission factor tables and cite CAS numbers.

5. Include any legal definitions necessary to the proper use of the factor in an emission inventory.

6. SCCs should be clearly labeled on process charts and figures and may be included in the text.

5.6 REPORTING FORMAT

The format of sections in AP-42's *Volume I: Stationary Point And Area Sources* is common and consistent, such that each section of the parent volume can be easily updated, published, and distributed as new data become available. An example of a typical AP-42 section is given in Appendix B, and it should be followed by both the author of any new section production and the clerical personnel rendering the work into final form.

As mentioned, the general organization of each AP-42 section is as follows:

- General description of the process
- Discussion of emissions (and if applicable, typical control devices)
- Emission factor tabulations
- List of references

The emission factor table(s), usually presented toward the end of the emission discussion portion of the section, will be the most critical component of the document and should essentially stand alone in terms of clear technical content. The section text, illustrations and flow diagrams explain and qualify the tabulated emission factor data. Within the standard format, some complex source category sections will contain general process information which is then divided into discrete subsections to provide the necessary detail to the user. Consult Section 5.13 of AP-42, "Plastics", as an example with numerous "subsections".

EPA has no single, authorized, definitive guidance on publication format, grammar, punctuation, rhetorical style, or editorial policy. The long-running AP-42 format to be used in figures, tables and references is exemplified by the "typical" section in Appendix B of this document. Whenever the complexity or special character of a section raises format questions not depicted in that example section, the author should consult with the EPA Project Officer for direction.

The following format guidelines are to be applied:

1. Prepare and submit the draft section on 8-1/2 x 11 inch paper as it would look in final form, except in space-and-a-half. The draft section should also be submitted on 3.5" disc in the latest version of the Word Perfect® program. The final version of the section shall be submitted in these same two media.

2. Text, tables and figures must fit on 8-1/2 x 11 inch paper with 1" margins. Both may be placed on the page in a vertical, or "landscape" position. See "Figures" below for more information. Examples of tables and figures may be found in Appendix B.

3. Figures must complement the emission factor tables. The text complements the figures and tables. The "Emissions" part of a section fully explains the emission factor tables. The "Process Description" portion fully explains the flow diagram. Figures may be submitted in a separate electronic file having a format compatible with Word Perfect software.

4. All references used must be primary references (the original source of the data), and must be cited in a numbered list, in the order in which they are invoked in the text, as the last part of each section.

5. Citing a specific reference in section text should be by superscript arabic number placed at the end of the last pertinent sentence of that text. If referenced material is not discrete in the text, citations may be placed by the heading of that portion of the text. For obvious reasons, keep all citations away from formulae or other uses of number(s).

In general, tabular data should be presented by pollutant rather than by source. In complex cases, as with necessary additional information included in the tables (such as speciated data), it may be difficult to present emission factors for all pollutants in one table. Therefore, if needed, pollutants should be grouped in tables as follows:

- NO_x, SO_x, and CO
- PM and PM-10
- TOC

Speciated compounds for TOC, PM and PM-10 should be shown as subcategories in the appropriate emission factor tables. Lead emission factors should be included as speciated components of PM and PM-10. A table for inorganic gases should be provided also, as appropriate. Speciated compounds listed under Title III of the Clean Air Act (i. e., Hazardous Air Pollutants) should be footnoted.

Factor references should be footnoted in the tables. Where multiple data sources were used to develop emission factors, it may be appropriate also to refer the reader to background reports. Every emission factor in the table(s) must have its rating clearly indicated. Separate tables should be presented for metric and English units, unless there are so few factors in a table that both measures can be clearly presented (see Appendix B).

Tabulation is not required if there are no data for a pollutant from a source, but if it is suspected that there are significant emissions of this pollutant, a footnote would be useful, to advise the reader and to foster development of data for future updates.

Tables of speciated organic compounds should include all compounds and not be limited to either the hazardous air pollutant list of 189 compounds in Title III of the Clean Air Act or to other compounds that EPA has targeted for analysis under its enhanced ozone ambient air monitoring program. Compounds that EPA has exempted from the definition of VOC should also be included (methane; ethane; 1,1,1 trichloroethane; methylene chloride; and chlorofluorocarbons). Any compounds listed in Title III should be demarked with a footnote.

The inclusion of compounds in *FIRE* and *SPECIATE* does not constitute providing AP-42 emission factors, but is more of an indicator that emissions of these compounds exist and should be examined as candidates for rated emission factor development.

Separate tables should not be provided for stratospheric ozone-depleting and global warming gases. Methane and CFCs should be included in the speciated TOC table. In general, CO_2 should be footnoted in the CO table, and N_2O footnoted in the NO_x table. Where CO_2 and N_2O are process related, it may be more appropriate to include headings and emission factors for these compounds in the tables.

Text references have two important functions, to credit the source of the information and to guide interested users to more information on the subject. One common referencing error is the failure to supply sufficient information to tell the user specifically and clearly how to obtain a copy of the referenced material. Another error is the failure to cite the primary source of material, citing a source that obtained the information from some other source instead (i. e., citing a secondary or tertiary source). References that are consistently clear and direct are of the most use to readers and researchers.

Telephone conversations are generally not cited as references. If used, a signed written record of the conversation is placed in the background file.

The following are selected examples of the reference format used in AP-42.

Legislation:
The Rehabilitation Act Of 1973, §504, 29 U.S.C. 794.

***Federal Register* Notice (Vol. 36, p. 6934):**
Federal Certification Test Results For 1971 Model Year, 36 FR 6934, April 10, 1971.

***Code Of Federal Regulations* Notice (Title 40, Part 60, Subpart N):**
"Standards Of Performance For Iron And Steel Plants", 40 CFR 60.N.

EPA publications (with an EPA document number):
J. S. Mosby and R. R. Bridgers, *Source Assessment: Cattle Feedlots*, EPA-007/7-77-777, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1977.

One of a bound collection of papers:
D. C. Current, "Commercial Bakeries As A Major Source Of Reactive Volatile Organic Gases", *Emission Inventory/Factor Workshop: Volume I*, EPA-450/3-78-042a, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1978.

With contract number only (if no EPA Number is assigned):
Particulate And Lead Emission Measurements From Lead Oxide Plants, EPA Contract No. 68-02-9999, Bimbo Research Corp., Youpon, OH, August 1973.

Source test:
Source Testing Of A Waste Heat Boiler, EPA-75-CBK-3, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1975.

With three or more authors:
Emma Thompson, *et al.*, *Trace Emissions From The Ingestion Of Metallic Ores*, EPA-450/W-93-900, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1993.

Unnumbered:
S. Wyatt, *et al.*, *Preferred Standards Path Analysis On Lead Emissions From Stationary Sources*, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1974.

Periodical:
D. G. T. Beauregard, *et al.*, "Concentration And Size Of Trace Metal Emissions From A Power Plant, A Steel Plant, And A Cotton Gin", *Environmental Science And Technology*, *9*(7):643-67, July 1975.

Paper:
James B. Gordon, "Characterization Of Hardball Smelter Dust", Presented at the 69th Annual Meeting of the Air Pollution Control Association, Portland, OR, June 1976.

Book:
L. Sullivan Agnew, *et al.*, *Flow Of Information In Visionary Heavy Metal, Volume I: Notwithstanding The Rumor*, Purdue University, West Lafayette, IN, June 1973.

Privately published report:
Final Report Of The API Task Force On Used Oil Disposal, American Petroleum Institute Committee On Air And Water Conservation, New York, NY, May 1970.

Privileged information:
Confidential test data, Bozo Contractors, Inc., Caries, NC, December 10, 1941.

Personal or official conversation:
Written (or Telephone) communication from (or between or among) Michael Hamlin, U. S. Environmental Protection Agency, Research Triangle Park, NC, to (or and) Joan de la Chaumette, Bureau Of Mines, U. S. Department Of The Interior, Washington, DC, January 15, 1993.

5.7 FIGURES

Figures in AP-42 sections include process flow diagrams, nomograms and graphs, and equipment illustrations. Their principal functions are to augment the presentation of emission factors and to provide a view of the processes as typically encountered. The extent of graphics use depends entirely on the complexity of processes discussed.

AP-42 flow illustrations are to assist the user in the proper application of the emission factors. Any figure that can assist a user in applying these factors is important. The author should assume that the user is not thoroughly familiar with the industry in question, but that she/he does have an engineering or other technical background and is somewhat knowledgeable of emissions from air pollution sources.

For a simple or well known process, a clearly written description may be sufficient. If the process is complicated or obscure, a process flow diagram is necessary to assist in the understanding of the process. If similar processes have different emission rates, an illustration is needed clearly distinguishing the processes.

The following guidelines are to be applied in designing process flow diagrams:

1. The flow diagram relates directly to the emission factor table. The terminology is identical, and all emission points listed in the emission factor table are shown in the flow diagram. SCCs should be shown on the Table.

2. Box or equipment flow schematics, or both, are used.

3. When an equipment schematic is needed which can not be presented with sufficient detail within the overall flow diagram, a separate more detailed figure is included, with a reference to the flow diagram.

4. In general, controls are not specified on the flow diagram. The location of possible controls and manner of release (e. g., fugitive) are indicated, however.

5. Inclusion of a process flow diagram or other illustrations is decided by whether the information is necessary to a proper application of the emission factors.

6. All information on the figures is designed to be clearly legible in final reproduction.

An example process flow diagram is shown in the representative AP-42 section in Appendix B. AP-42's format has been used over the years because it best enables the user to apply the emission factors given in the table.

5.8 CRITERIA/NONCRITERIA POLLUTANTS

Criteria pollutants are ozone (O_3) (formed from organic compound emissions), nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), lead (Pb) and particulate matter of 10 microns diameter or less (PM-10). These pollutants, in the judgment of the Environmental Protection Agency,

and as designated by Congress, may reasonably be expected to endanger public health or welfare. Through the regulatory process, EPA establishes standards for concentrations of these pollutants in ambient air. The individual states are responsible for achieving and maintaining these standards through EPA-approved State Implementation Plans (SIP). The author of an AP-42 section provides emission factors for all criteria pollutants emitted by the subject source process(es). To accomplish this goal, the author ascertains what pollutants are emitted by a source and whether data exist to quantify them. If more specific information on criteria pollutants (such as particle size for PM-10, or chemical composition for TOC) will help the user, this information may also be included in the text.

Through the 1990 Amendments to the *Clean Air Act*, Congress also designated a total of 189 compounds as hazardous air pollutants (also referred to as noncriteria pollutants). These and other compounds will be included in AP-42 in the future, as data allow, (1) to assist in the development and implementation of standards for hazardous air pollutant emissions and (2) to assist agencies wanting to inventory hazardous air pollutants to assess human health risks from exposure to such pollutants. Speciation of all compounds of organics and particulate matter is desirable, when possible, to provide information useable by photochemical, dispersion and receptor modelers.

5.9 CONTROLLED/UNCONTROLLED EMISSIONS

Controlled emissions are nonfugitive pollutants that are emitted after passing through an emission control device. Uncontrolled emissions are emissions that occur beyond the point of either product recovery or process-enriching controls. These emissions are either directed to a pollution control device or emitted directly to the atmosphere as fugitive or stack discharged uncontrolled emissions. When information on typical control efficiencies is given in the text of a section, a range is preferred over a specific number.

If a control device is common to an entire industry and is considered an integral part of a process or system, it is not appropriate to label emissions from such a device as controlled, e. g., chillers added to solvent operations for vapor recovery or cyclones used to recover catalyst in petroleum catalytic cracker systems. The primary purpose of the equipment determines whether it is considered a control device or part of the process equipment.

Emission factors listed in AP-42 should normally represent uncontrolled emissions. Any emission factors previously listed as controlled will be converted to uncontrolled factors, whenever possible. If such a conversion would be based on poor data, however, the current factor may be retained, if clearly labeled as controlled. It is desirable to present both controlled and uncontrolled factors when data warrant.

The section text contains information on controls, and where appropriate, Control Techniques Guidelines (CTG) or other documents are referenced. The text also notes the probability of rapid developments in control technology and the likelihood that any typical control efficiencies mentioned will change. Where applicable, emission factors are based upon data from sources subject to NSPS.

When a control device reduces emissions of another pollutant besides the one for which it was designed, this is known as secondary or coincidental control. For example, electrostatic precipitators (ESP) have been known to reduce SO_x and lead emissions as well as particulate emissions. Such secondary control effects may be less efficient than the primary control, but they are nevertheless real and measurable. Secondary control emission reductions are to be noted in the text.

5.10 PARTICULATE

The ambient air quality standard for particulate matter has been revised from simply "total suspended particulate" to deal with particulate matter having a mean aerodynamic diameter of 10 micrometers or less (PM-10). Although the ambient air quality standard has changed, many federal, state and local regulations for particulate-emitting sources continue to refer to all particulate matter without regard to particle size. While large diameter particle emissions may not constitute a significant public health concern, uncontrolled emissions of such particulate would pose public welfare concerns such as soiling of automobiles, clothes, etc. In addition, particulate control devices, while most effective in dealing with large diameter particles, do achieve a lesser but still significant reduction of particulate emissions in the PM-10 range. It is desirable, therefore, to retain existing controls on total particulate while also applying a PM-10 standard necessary to protect public health. Accordingly, a need exists for estimating total particulate emissions as well as the emission of particles with diameters of 10 micrometers or less.

5.11 CONDENSIBLES

Condensibles are materials that are emitted as vapor and that later condense to form homogeneous and/or heterogeneous aerosol particles. Condensation depends on three key physicochemical variables: temperature, concentration and equilibrium vapor pressure. Meteorological conditions in the atmosphere dictate the ambient formation rate of condensed particles. Condensible materials may (1) readily condense to particulate form, (2) condense, then reevaporate, or (3) remain indefinitely in the atmosphere in the vapor state.

Condensible particulate may be organic, inorganic or both. It often contains sulfates, polycyclic organic matter (POM), or heavy metals such as lead, cadmium or arsenic. Condensed materials, as measured by ambient sampling methods, are more likely to be found at smaller sizes ($\leq$ 2 microns).

In EPA Method 5, emissions are collected in two fractions, known as the front-half and back-half catches, indicating the part of the Method 5 sampling train in which the particulate is collected. Similar fractions are collected using EPA Method 17 for determining the total suspended particulate at stack conditions, and EPA Methods 201 and 201A for determining PM-10 emissions.

These two fractions are often referred to as the filterable and condensible fractions. This attempt at distinction is misleading. Filterable particles are those trapped by the glass fiber filter in the front half of the sampling train. Particles of about 0.3 micrometers or larger are included in the filterable particulate catch. Also included are materials that condense to solid or liquid form at or above the front-half filtration temperature for Method 5 (120 $\pm$ 14°C; 248 $\pm$ 25°F). Smaller particles and vapors (especially water) pass through the filter to a series of cold water impingers in the back half of the train.

Materials that are found in the back-half catch include water and condensed forms of organics, metals and other chemicals. These materials, like water, pass through the front half of the sampling train as vapors, but condense in the back half where a temperature of near 0°C is maintained in the cold water impingers. The impinger water containing the condensible catch may be analyzed using Method 202 to determine the condensible particulate emissions. The organic fraction is extracted with methylene chloride, and the inorganic fraction remains in the impinger water. The two fractions are weighed after evaporation and desiccation.

Because condensed material is removed in both the front- and back-half catches of Method 5, the use of the terms "filterable" and "condensible" to describe the two catches is not accurate. Source test evidence, however, suggests that the larger portion of emitted condensed material (by weight) is in the back-half catch. Method 202 includes recommended procedures which counteract possible chemical changes and interferences that may occur when determining condensible particulate emissions from sources emitting SO2 and/or ammonia. The back-half collection conditions and analysis procedures of other test methods may cause some chemical or physical changes that would not occur upon reaching standard conditions in the atmosphere and may then result in inaccurate information on the emissions of condensible particulate. Filterable particulate emissions, as measured by the front-half catch of Methods 5, 17, 201 and 201A, are normally controlled at the source by systems that operate at temperatures well above ambient levels. This temperature level is necessary to keep water and other materials in a source stream from condensing inside the control device and fouling the operation. Filterable particulate can be controlled efficiently (95 percent or more) by cyclones, ESPs, fabric filters and wet scrubbers. The first three systems would have relatively little effect on condensible particulate, because they are generally operated at temperatures above 135°C (275°F), the upper limit of the front-half of Method 5. Most condensible material would remain vaporized and pass through the control device. Wet scrubbers, however, reduce the gas stream temperature to below 94° C (200°F) and thus could theoretically remove some of the condensible material.

Through new source testing, EPA and others have found that most industries emit condensible particulate, in amounts that depend primarily on the specific industry, on operating conditions at individual sites, and on the trace-element content of the feed stock. Under some conditions, the contribution of condensed vapors to total mass emissions can be significant. For example, calculations show that condensed sulfates constitute one third of the total mass emitted from a boiler burning coal with a ten percent ash content and a one percent sulfur content, through a control system with a particulate removal efficiency of 99 percent. In other processes (e. g., smelters), the fraction of total mass emitted from the stack as hot vapors that later condense at cooler ambient temperatures far exceeds the fraction exiting in solid form.

Because Method 202 has been developed only recently, and "back-half catch" may mean different things to different industries, the terms "filterable" and "condensible" are to be used with great care in AP-42 in referring to EPA Method 5 front-half and back-half catches. The following guidelines are to be applied when presenting emission factors for total particulate mass emissions:

1. When presenting particulate emission factors, report the front-half catch as filterable particulate.

2. Back-half catches are to be reported as both organic condensible particulate and the inorganic condensible particulate.

3. Care should be taken when combining different test methods (filterable particulate, organic condensible particulate, or inorganic condensible particulate) to calculate an emission factor.

4. Particulate sizing information is to be reported, where data allow, on the filterable particulate.

5. Emission control efficiencies are to be reported by particle size on the filterable particulate and the organic and inorganic portions of the condensible particulate.

6. PM-10 emissions factors are to be reported as the sum of the in-stack filterable portion of the particulate, as well as the organic and inorganic condensible portion.

7. Calculate emission factors for lead as outlined below in Section 5.13, "Lead".

When presenting emission factors for PM-10, an alternative approach is employed. Recognizing that considerable in-stack PM-10 emissions exist in volatilized form which will eventually contribute to atmospheric particulate, PM-10 emission factors are to be presented as the sum of both the instack filterable and the condensible portion of the particulate. This is counter to historical reporting of emission factors for the total mass of particulate, which excluded the back half.

5.12 TOTAL NONMETHANE ORGANIC COMPOUNDS

Volatile organic compounds have been defined according to the *Federal Register* (57 FR 3945) as any organic compounds, not including carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participate in atmospheric chemical reactions. A number of compounds have been deemed to be of "negligible photochemical reactivity" and also are exempt from the definition of VOC: methane, ethane, methyl chloroform, methylene chloride, and most chlorinated-fluorinated compounds (commonly referred to as chlorofluorocarbons, or CFCs). Although the low photochemical reactivity rates of these compounds render them "exempt" from most ozone control programs, they are of concern when developing the complete emission inventories necessary in designing effective ozone control strategies. Therefore, the following criteria are to be applied for reporting volatile organic compound emissions in AP-42:

1. The term "Total Organic Compounds" (TOC) includes <u>all</u> VOC compounds, that is to say "exempt" compounds, including methane and ethane, toxic compounds, aldehydes, perchloroethylene, semivolatiles (as measured by EPA reference methods), etc.

2. The emission factor table should discreetly report the quantity of methane, ethane and other organic species emitted by a source, whenever such information exists in referenced documents, and when the quality of data is sufficient to assign an emission factor quality rating. Where the data quality is insufficient to permit an A to E rating, the reader is referred to *FIRE* and/or *SPECIATE* for additional information. It may be acceptable in AP-42 to present speciated data that do not meet the requirements for assigning quality ratings but that do appear in a credible reference. Such data must be properly footnoted to advise the reader of data quality limitations and to indicate that its use as a factor is "speculative".

3. The value used with all compounds should be the actual weight of the emitted substance. It is not acceptable to report the equivalent carbon of the compounds with the expressions "as methane", "as hexane", "as propane", etc., unless no other data exist. If the author chooses to give factors with the expressions "as methane", etc., he or she <u>must</u> describe the limitations of the factors.

4. Test method anomalies which result in improper characterization of compounds known to be present shall be properly footnoted. One example is the inability of Reference Method 25 to detect formaldehyde and to be acceptably sensitive to other aldehydes. In such instances, where aldehyde data are available from acceptable tests, total VOC should include the aldehydes.

5. All AP-42 factors for volatile organic compounds will conform to these standards, and background documentation prepared for AP-42 files will show that the factors do conform.

The format for presenting VOC emission factors in AP-42 tables should include the headings shown below, when data allow, and any deviations or clarifications should be footnoted. A heading for Total Nonmethane Organic Compounds (TNMOC) is included because most existing data are in this form. Factors shall be expressed as mass of emissions/mass of output. The recommended VOC headings are:

TOC	METHANE	TNMOC	ETHANE	OTHER VOLATILE AND SEMIVOLATILE SPECIATED DATA

5.13 LEAD

Lead emissions can result from combustion furnace operations, smelting processes, mechanical processing operations, fugitive dust sources, and the use of leaded gasoline. Other sources include the combustion of waste oil, coal and fuel oil, and the incineration of municipal wastes. Industrial processes emitting lead include primary and secondary ferrous and nonferrous metals and alloys, lead oxides, lead acid batteries, cable coverings, can soldering cement, printing type metals, metallic lead products, and leaded glass.

The most common chemical forms of lead emissions from all sources are elemental lead (Pb) or lead oxides (PbO, PbO_2, Pb_2O_3, etc.). Other forms emitted include lead sulfide (PbS), lead sulfate ($PbSO_4$), lead halide particulate (alpha and beta forms), and organic alkyl lead vapors (tetraethyl lead and tetramethyl lead).

Lead may be emitted as a dust having particle diameters ranging from less than one micron to 150 microns. Lead is also emitted in fumes, mists and vapors. Particle sizes of 10 microns or less in diameter are generally considered to be inhalable and therefore quite hazardous to health.

Most gasoline sold in the United States does not contain lead, however, any leaded gasoline that is used may contain a maximum of 0.1 grams of lead per gallon, about 75 percent of which is emitted to the atmosphere through the exhaust. The rest is deposited in the exhaust system or in the crankcase oil. Lead in crankcase oil may eventually be emitted to the atmosphere, if the waste oil is used as fuel.

EPA has adopted Method 12 as the standard method for measuring inorganic lead emissions at the source. In sampling, glass fiber filters are used to trap the particulate lead in the front half of the sampling train, and impingers containing nitric acid are used to trap lead condensates in the back half. Lead particulate is then extracted from the front-half catch of the sample with nitric acid and combined with the back-half catch, to give total lead. Analysis is performed by atomic absorption.

The following guidance is to be used in preparing or revising AP-42 sections describing processes from which lead is emitted:

1. Lead emission factors are to be expressed as the weight of elemental lead, not as the weight of the compounds that are actually emitted.

2. The emission factor table is to be footnoted to caution the user not to compare the lead emission weight to the particulate matter emission weight.

3. The lead emission factor should be the sum of both the front-half and back-half catches of EPA Method 12. If not, indicate the measurement method in a footnote.

4. If data are available on the specific compounds emitted, present this information in a footnote to the emission factor table.

5. If the weight percent of lead compounds in the particulate emissions is known, present this information in a footnote.

Appendix A.

AP-42 SECTION REVISION PROCEDURES

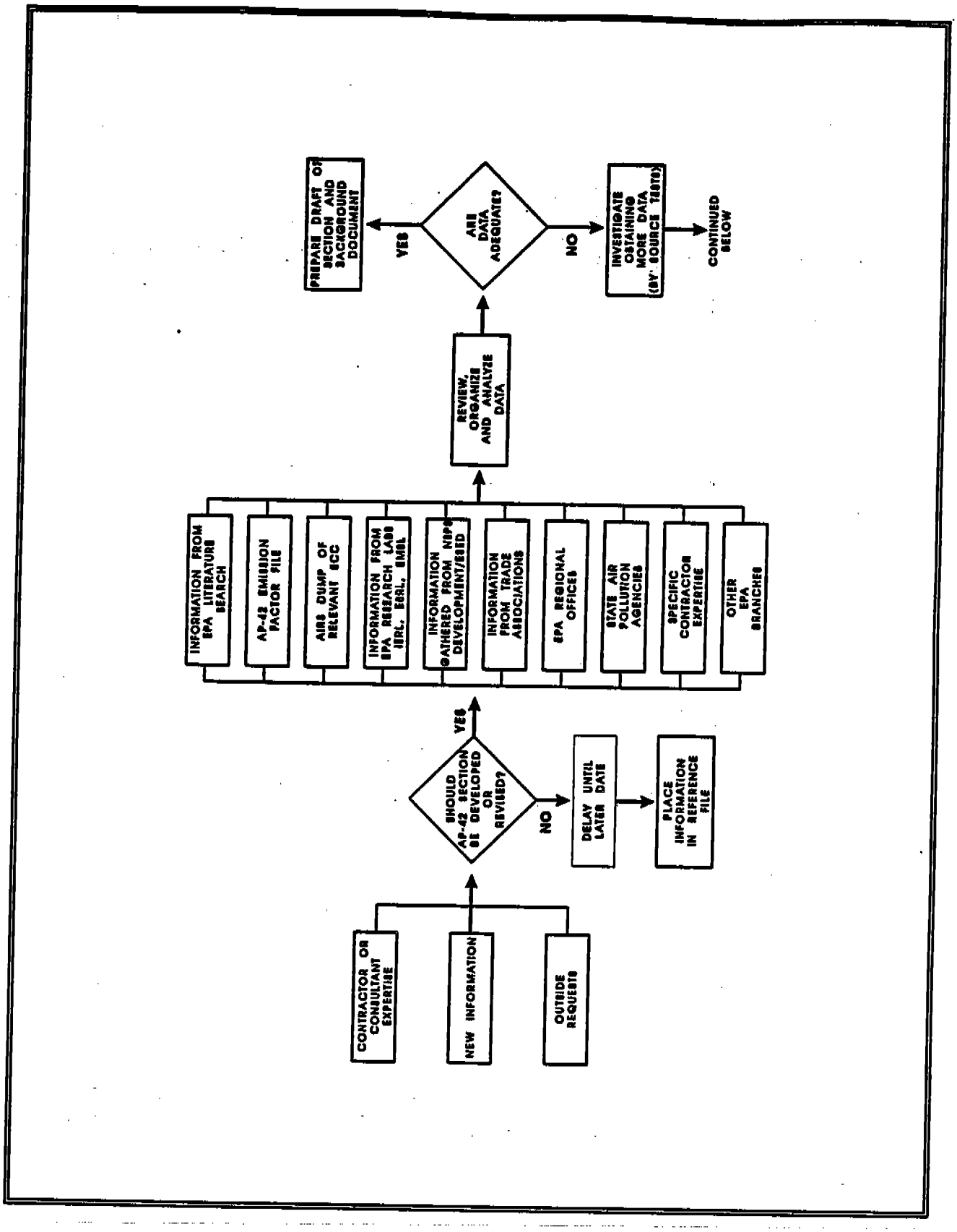

Figure A. AP-42 Section Revision Procedures.

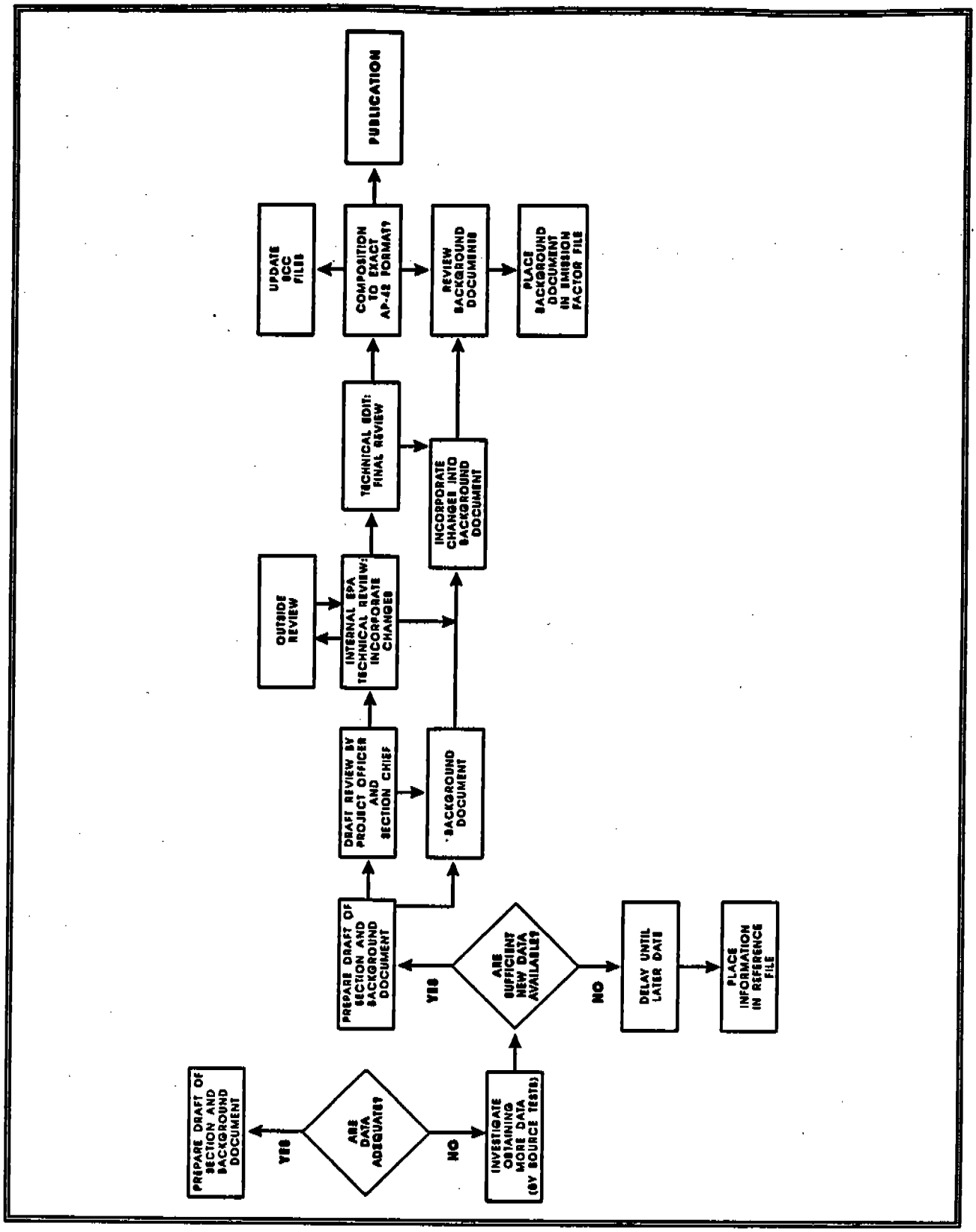

Figure A (cont.). AP-42 Section Revision Procedures.

Appendix B.

EXAMPLE AP-42 SECTION

1.10 RESIDENTIAL WOOD STOVES

1.10.1 General[1-2]

Wood stoves are commonly used in residences as space heaters. They are used both as the primary source of residential heat and to supplement conventional heating systems.

Because of differences in both the magnitude and the composition of the emissions, five different categories should be considered when estimating emissions from wood burning devices:

- the conventional wood stove,
- the noncatalytic wood stove,
- the catalytic wood stove,
- the pellet stove, and
- the masonry heater.

Among these categories, there are many variations in device design and operation characteristics.

The conventional stove category comprises all stoves without catalytic combustors not included in the other noncatalytic categories (i. e., noncatalytic and pellet). Conventional stoves do not have any emission reduction technology or design features and, in most cases, were manufactured before July 1, 1986. Stoves of many different air flow designs may be in this category, such as updraft, downdraft, crossdraft and S-flow.

Noncatalytic wood stoves are those units that do not employ catalysts but that do have emission reducing technology or features. A typical noncatalytic design includes baffles and secondary combustion chambers.

Catalytic stoves are equipped with a ceramic or metal honeycomb device, called a combustor or converter, that is coated with a noble metal such as platinum or palladium. The catalyst material reduces the ignition temperature of the unburned volatile organic compounds (VOC) and carbon monoxide (CO) in the exhaust gases, thus augmenting their ignition and combustion at normal stove operating temperatures. As these components of the gases burn, the temperature inside the catalyst increases to a point at which the ignition of the gases is essentially self sustaining.

Pellet stoves are those fueled with pellets of sawdust, wood products, and other biomass materials pressed into manageable shapes and sizes. These stoves have active air flow systems and a unique grate design to accommodate this type of fuel. Some pellet stove models are subject to the 1988 New Source Performance Standards (NSPS), while others are exempt because of a high air-to-fuel ratio (i. e., greater than 35 to 1).

Masonry heaters are large, enclosed chambers made of masonry products or a combination of masonry products and ceramic materials. These devices are exempt from the 1988 NSPS because of their weight (i. e., greater than 800 kg). Masonry heaters are gaining popularity as a cleaner burning and heat efficient form of primary and supplemental heat, relative to some other types of wood heaters. In a masonry heater, a complete charge of wood is burned in a relatively short period of time. The use of masonry materials promotes heat transfer. Thus, radiant heat from the heater warms the surrounding area for many hours after the fire has burned out.

1.10.2 Emissions[1,3,29]

The combustion and pyrolysis of wood in wood stoves produce atmospheric emissions of particulate matter, carbon monoxide, nitrogen oxides, organic compounds, mineral residues, and to a lesser extent, sulfur oxides. The quantities and types of emissions are highly variable, depending on a number of factors, including stages of the combustion cycle. During initial burning stages, after a new wood charge is introduced, emissions (primarily VOCs) increase dramatically. After the initial period of high burn rate, there is a charcoal stage of the burn cycle characterized by a slower burn rate and decreased emissions. Emission rates during this stage are cyclical, characterized by relatively long periods of low emissions and shorter episodes of emission spikes.

Particulate emissions are defined in this discussion as the total catch measured by the EPA Method 5H (Oregon Method 7) sampling train. A small portion of wood stove particulate emissions includes "solid" particles of elemental carbon and wood. The vast majority of particulate emissions is condensed organic products of incomplete combustion equal to or less than 10 micrometers in aerodynamic diameter (PM-10). Although reported particle size data are scarce, one reference states that 95 percent of the particles emitted from a wood stove were less than 0.4 micrometers in size.

Sulfur oxides (SO_x) are formed by oxidation of sulfur in the wood. Nitrogen oxides (NO_x) are formed by oxidation of fuel and atmospheric nitrogen. Mineral constituents, such as potassium and sodium compounds, are released from the wood matrix during combustion.

The high levels of organic compound and CO emissions are results of incomplete combustion of the wood. Organic constituents of wood smoke vary considerably in both type and volatility. These constituents include simple hydrocarbons of carbon numbers 1 through 7 (C1 - C7) (which exist as gases or which volatilize at ambient conditions) and complex low volatility substances that condense at ambient conditions. These low volatility condensible materials generally are considered to have boiling points below 300°C (572°F).

Polycyclic organic matter (POM) is an important component of the condensible fraction of wood smoke. POM contains a wide range of compounds, including organic compounds formed through incomplete combustion by the combination of free radical species in the flame zone. This group, which is classified as a Hazardous Air Pollutant (HAP) under Title III of the 1990 Clean Air Act Amendments, contains the subgroup of hydrocarbons called Polycyclic Aromatic Hydrocarbons (PAH).

Emission factors and their ratings for wood combustion in residential wood stoves, pellet stoves and masonry heaters are presented below in Tables 1.10-1 through 1.10-8. The analysis leading to the derivation of these emission factors is contained in the emission factor documentation. These tables contain emission factors for criteria pollutants (PM-10, CO, NO_x, SO_x), CO_2, Total

Organic Compounds (TOC), speciated organic compounds, PAH, and some elements. The emission factors are presented by wood heater type. PM-10 and CO emission factors are further classified by stove certification category. Phase II stoves are those certified to meet the July 1, 1990 EPA standards; Phase I stoves meet only the July 1, 1988 EPA standards; and Pre-Phase I stoves do not meet any of the EPA standards but in most cases do necessarily meet the Oregon 1986 certification standards. The emission factors for Particulate and CO in Tables 1.10-1 and 1.10-2 are averages, derived entirely from field test data obtained under actual operating conditions. Still, there is a potential for higher emissions from some wood stove, pellet stove and masonry heater models.

As mentioned, particulate emissions are defined as the total emissions equivalent to those collected by EPA Method 5H. This method employs a heated filter followed by three impingers, an unheated filter, and a final impinger. Particulate emission factors are presented as values equivalent to those collected with Method 5H. Conversions are employed, as appropriate, for data collected with other methods.

Table 1.10-7 shows net efficiencies by device type, as determined entirely from field test data. A net or overall efficiency is the product of combustion efficiency multiplied by heat transfer efficiency. Wood heater efficiency is an important parameter used, along with emission factors and percent degradation, when calculating PM-10 emission reduction credits. Percent degradation is related to the loss in effectiveness of a wood stove control device or catalyst over a period of operation. Control degradation for any stove, including noncatalytic wood stoves, may also occur as a result of deteriorated seals and gaskets, misaligned baffles and bypass mechanisms, broken refractories, or other damaged functional components. The increase in emissions which can result from control degradation has not been quantified. However, recent wood stove testing in Colorado and Oregon should produce results which will allow estimation of emissions as a function of stove age.

Table 1.10-1 (Metric Units). EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION[a]

Pollutant/EPA Certification[b]	Emission Factor Rating	Wood Stove Type			Pellet Stove Type[c] (SCC 2104008053)		Masonry Heater (SCC 2104008055)
		Conventional (SCC 2104008051)	Noncatalytic (SCC 2104008050)	Catalytic (SCC 2104008030)	Certified	Exempt	Exempt[d]
PM-10[e]							
Pre-Phase I	B	15.3	12.9	12.1			
Phase I	B		10.0	9.8			
Phase II	B		7.3	8.1	2.1		
All	B	15.3	9.8	10.2	2.1	4.4	2.8
Carbon Monoxide[e]							
Pre-Phase I	B	115.4					
Phase I	B			52.2			
Phase II	B		70.4		19.7		
All	B	115.4	70.4	52.2	19.7	26.1	74.5
Nitrogen Oxides[e]		1.4[f]		1.0[g]	6.9[g]		
Sulfur Oxides[e]	B	0.2	0.2	0.2	0.2		
Carbon Dioxide[h]	C				1,475.8	1,835.6	1,924.7
TOC[j]	E	24.3		12.1			
Methane	E	2.4		4.3			
TNMOC	E	21.9		7.8			

[a]Units are grams of pollutant/kg of dry wood burned. SCC = Source Classification Code.
[b]Pre-Phase I = Not certified to 1988 EPA emission standards; Phase I = Certified to 1988 EPA emission standards; Phase II = Certified to 1990 EPA emission standards; All = Average of emission factors for all devices.
[c]Certified = Certified pursuant to 1988 NSPS; Exempt = Exempt from 1988 NSPS (i. e., air:fuel >35:1).
[d]Exempt = Exempt from 1988 NSPS (i. e., device weight >800 kg).
[e]References 6-14,23-27,29. PM-10 is defined as equivalent to total catch by EPA method 5H train.
[f]EMISSION FACTOR RATING = C.
[g]EMISSION FACTOR RATING = E.
[h]References 13,24-27,29.
[j]References 13,17-18. TOC = Total organic compounds. TNMOC = Total nonmethane organic compounds. Data show a high degree of variability within the source population. Factors may not be accurate for individual sources.

Table 1.10-2 (English Units). EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION[a]

Pollutant/EPA Certification[b]	Emission Factor Rating	Wood Stove Type			Pellet Stove Type[c] (SCC 2104008053)		Masonry Heater (SCC 2104008055)
		Conventional (SCC 2104008051)	Noncatalytic (SCC 2104008050)	Catalytic (SCC 2104008030)	Certified	Exempt	Exempt[d]
PM-10[e]							
Pre-Phase	B	30.6	25.8	24.2			
Phase I	B		20.0	19.6			
Phase II	B		14.6	16.2	4.2		
All	B	30.6	19.6	20.4	4.2	8.8	5.6
Carbon Monoxide[e]							
Pre-Phase I	B	230.8					
Phase I	B			104.4			
Phase II	B		140.8	107.0	39.4		
All	B	230.8	140.8	104.4	39.4	52.2	149.0
Nitrogen Oxides[e]		2.8[f]		2.0[g]	13.8[g]		
Sulfur Oxides[e]	B	0.4	0.4	0.4	0.4		
Carbon Dioxide[h]	C				2,951.6	3,671.2	3,849.4
TOC[j]	E	48.6		24.2			
Methane	E	4.8		8.6			
TNMOC	E	43.8		15.6			

[a]Units are lbs. of pollutant/ton of dry wood burned. SCC = Source Classification Code.
[b]Pre-Phase I = Not certified to 1988 EPA emission standards. Phase I = Certified to 1988 EPA emission standards. Phase II = Certified to 1990 EPA emission standards; All = Average of emission factors for all devices.
[c]Certified = Certified pursuant to 1988 NSPS. Exempt = Exempt from 1988 NSPS (i. e., air:fuel >35:1).
[d]Exempt = Exempt from 1988 NSPS (i. e., device weight >800 kg).
[e]References 6-14,23-27,29. PM-10 is defined as equivalent to total catch by EPA method 5H train.
[f]EMISSION FACTOR RATING = C.
[g]EMISSION FACTOR RATING = E.
[h]References 13,24-27,29.
[j]References 13,17-18. TOC = Total organic compounds. TNMOC = Total nonmethane organic compounds. Data show a high degree of variability within the source population. Factors may not be accurate for individual sources.

Table 1.10-3 (Metric And English Units). ORGANIC COMPOUND EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION[a,b]

EMISSION FACTOR RATING: E

Compounds	Wood Stove Type			
	Conventional (SCC 2104008051)		Catalytic (SCC 2104008030)	
	g/kg	lb/ton	g/kg	lb/ton
Ethane	0.735	1.470	0.688	1.376
Ethylene	2.245	4.490	1.741	3.482
Acetylene	0.562	1.124	0.282	0.564
Propane	0.179	0.358	0.079	0.158
Propene	0.622	1.244	0.734	0.734
i-Butane	0.014	0.028	0.005	0.010
n-Butane	0.028	0.056	0.007	0.014
Butenes[c]	0.596	1.192	0.357	0.714
Pentenes[d]	0.308	0.616	0.075	0.150
Benzene	0.969	1.938	0.732	1.464
Toluene	0.365	0.730	0.260	0.520
Furan	0.171	0.342	0.062	0.124
Methyl Ethyl Ketone	0.145	0.290	0.031	0.062
2-Methyl Furan	0.328	0.656	0.042	0.084
2,5-Dimethyl Furan	0.081	0.162	0.011	0.022
Furfural	0.243	0.486	0.073	0.146
O-Xylene	0.101	0.202	0.093	0.186

[a]Reference 17. Units are g of pollutant/kg and lb. of pollutant/ton of dry wood burned. SCC = Source Classification Code.

[b]Data show a high degree of variability within the source population. Factors may not be accurate for individual sources.

[c]1-butene, i-butene, t-2-butene, c-2-butene, 2-me-1-butene, 2-me-butene are reported as butenes.

[d]1-pentene, t-2-pentene, and c-2-pentene are reported as pentenes.

Table 1.10-4 (Metric Units). POLYCYCLIC AROMATIC HYDROCARBON (PAH) EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION[a,b]

EMISSION FACTOR RATING: E

Pollutant	Stove Type			
	Conventional[c] (SCC 2104008051)	Noncatalytic[d] (SCC 2104008050)	Catalytic[e] (SCC 2104008030)	Exempt Pellet[f] (SCC 2104008053)
PAH				
Acenaphthene	0.005	0.005	0.003	
Acenaphthylene	0.106	0.016	0.034	
Anthracene	0.007	0.004	0.004	
Benzo(a)Anthracene	0.010	<0.001	0.012	
Benzo(b)Fluoranthene	0.003	0.002	0.002	1.30E-05
Benzo(g,h,i)Fluoranthene		0.014	0.003	
Benzo(k)Fluoranthene	0.001	<0.001	0.001	
Benzo(g,h,i)Perylene	0.002	0.010	0.001	
Benzo(a)Pyrene	0.002	0.003	0.002	
Benzo(e)Pyrene	0.006	0.001	0.002	
Biphenyl		0.011		
Chrysene	0.006	0.005	0.005	3.76E-05
Dibenzo(a,h)Anthracene	0.000	0.002	0.001	
7,12-Dimethylbenz(a)Anthracene		0.002		
Fluoranthene	0.010	0.004	0.006	2.74E-05
Fluorene	0.012	0.007	0.007	
Indeno(1,2,3,cd)Pyrene	0.000	0.010	0.002	
9-Methylanthracene		0.002		
12-Methylbenz(a)Anthracene		0.001		
3-Methylchlolanthrene		<0.001		
1-Methylphenanthrene		0.015		
Naphthalene	0.144	0.072	0.093	
Nitronaphthalene		0.000		
Perylene		0.001		
Phenanthrene	0.039	0.059	0.024	1.66E-05
Phenanthrol		0.000		
Phenol		<0.001		
Pyrene	0.012	0.004	0.005	2.42E-05
Toal PAH	0.365	0.250	0.207	

[a]Units are g of pollutant/kg of dry wood burned. SCC = Source Classification Code.
[b]Data show a high degree of variability within the source population and/or came from a small number of sources. Factors may not be accurate for individual sources.
[c]Reference 17.
[d]References 15,18-20.
[e]References 14-18.
[f]Reference 27. Exempt = Exempt from 1988 NSPS (i. e., air:fuel >35:1).

Table 1.10-5 (English Units). POLYCYCLIC AROMATIC HYDROCARBON (PAH) EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION[a,b]

EMISSION FACTOR RATING: E

Pollutant	Stove Type			
	Conventional[c] (SCC 2104008051)	Noncatalytic[d] (SCC 2104008050)	Catalytic[e] (SCC 2104008030)	Exempt Pellet[f] (SCC 2104008053)
PAH				
Acenaphthene	0.010	0.010	0.006	
Acenaphthylene	0.212	0.032	0.068	
Anthracene	0.014	0.009	0.008	
Benzo(a)Anthracene	0.020	<0.001	0.024	
Benzo(b)Fluoranthene	0.006	0.004	0.004	2.60E-05
Benzo(g,h,i)Fluoranthene		0.028	0.006	
Benzo(k)Fluoranthene	0.002	<0.001	0.002	
Benzo(g,h,i)Perylene	0.004	0.020	0.002	
Benzo(a)Pyrene	0.004	0.006	0.004	
Benzo(e)Pyrene	0.012	0.002	0.004	
Biphenyl		0.022		
Chrysene	0.012	0.010	0.010	7.52E-05
Dibenzo(a,h)Anthracene	0.000	0.004	0.002	
7,12Dimethylbenz(a)Anthracene		0.004		
Fluoranthene	0.020	0.008	0.012	5.48E-05
Fluorene	0.024	0.014	0.014	
Indeno(1,2,3,cd)Pyrene	0.000	0.020	0.004	
9-Methylanthracene		0.004		
12-Methylbenz(a)Anthracene		0.002		
3-Methylchlolanthrene		<0.001		
1-Methylphenanthrene		0.030		
Naphthalene	0.288	0.144	0.186	
Nitronaphthalene		0.000		
Perylene		0.002		
Phenanthrene	0.078	0.118	0.489	3.32E-05
Phenanthrol		0.000		
Phenol		<0.001		
Pyrene	0.024	0.008	0.010	4.84E-05
Total PAH	0.730	0.500	0.414	

[a]Units are lb. of pollutant/ton of dry wood burned. SCC = Source Classification Code.
[b]Data show a high degree of variability within the source population and/or came from a small number of sources. Factors may not be accurate for individual sources.
[c]Reference 17.
[d]References 15,18-20.
[e]References 14-18.
[f]Reference 27. Exempt = Exempt from 1988 NSPS (i. e., air:fuel >35:1).

Table 1.10-6 (Metric And English Units). TRACE ELEMENT EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION[a,b]

EMISSION FACTOR RATING: E

Element	Wood Stove Type					
	Conventional (SCC 2104008051)		Noncatalytic (SCC 2104008050)		Catalytic (SCC 2104008030)	
	g/kg	lb/ton	g/kg	lb/ton	g/kg	lb/ton
Cadmium (Cd)	1.1E-05	2.2E-05	1.0E-05	2.0E-05	2.3E-05	4.6E-05
Chromium (Cr)	<1.0E-06	<1.0E-06	<1.0E-06	<1.0E-05	<1.0E-06	<1.0-E06
Manganese (Mn)	8.7E-05	1.7E-04	7.0E-05	1.4E-04	1.1E-04	2.2E-04
Nickel (Ni)	7.0E-06	1.4E-05	1.0E-05	2.0E-05	1.0E-06	2.2E-06

[a]References 14,17. Units are g of pollutant/kg and lb. of pollutant/ton of dry wood burned. SCC = Source Classification Code.
[b]The data used to develop these emission factors showed a high degree of variability within the source population. Factors may not be accurate for individual sources.

Table 1.10-7. SUMMARY OF WOOD HEATER NET EFFICIENCIES[a]

Wood Heater Type	Source Classification Code	Net Efficiency (%)	Reference
Wood Stove			
Conventional	2104008051	54	26
Noncatalytic	2104008050	68	9, 12, 26
Catalytic	2104008030	68	6, 26
Pellet Stove[b]			
Certified	2104008053	68	11
Exempt		56	27
Masonry Heater	2104008055	58	28

[a]Net efficiency is a function of both combustion efficiency and heat transfer efficiency. Percentages shown are based on in-home test data.
[b]Certified = Certified pursuant to 1988 NSPS. Exempt = Exempt from 1988 NSPS (i. e., air:fuel >35:1).

References for Section 1.10

1. *Standards Of Performance For New Stationary Sources: New Residential Wood Heaters*, 53 FR 5573, February 26, 1988.

2. R. Gay and J. Shah, *Technical Support Document For Residential Wood Combustion*, EPA-450/4-85-012, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1986.

3. J. A. Rau and J. J. Huntzicker, "Composition And Size Distribution Of Residential Wood Smoke Aerosols", Presented at the 21st Annual Meeting of the Air And Waste Management Association, Pacific Northwest International Section, Portland, OR, November 1984.

4. C. A. Simons, *et al.*, *Whitehorse Efficient Woodheat Demonstration*, The City of Whitehorse, Whitehorse, Yukon, Canada, September 1987.

5. C. A. Simons, *et al.*, *Woodstove Emission Sampling Methods Comparability Analysis And In-situ Evaluation Of New Technology Woodstoves*, EPA-600/7-89-002, U. S. Environmental Protection Agency, Cincinnati, OH, January 1989.

6. S. G. Barnett, *Field Performance Of Advanced Technology Woodstoves In Glens Falls, N.Y., 1988-1988, Vol. 1*, New York State Energy Research And Development Authority, Albany, NY, October 1989.

7. P. G. Burnet, *The Northeast Cooperative Woodstove Study, Volume 1*, EPA-600/7-87-026a, U. S. Environmental Protection Agency, Cincinnati, OH, November 1987.

8. D. R. Jaasma and M. R. Champion, *Field Performance Of Woodburning Stoves In Crested Butte During The 1989-90 Heating Season*, Town of Crested Butte, Crested Butte, CO, September 1990.

9. S. Dernbach, *Woodstove Field Performance In Klamath Falls, OR*, Wood Heating Alliance, Washington, DC, April 1990.

10. C. A. Simon and S. K. Jones, *Performance Evaluation Of The Best Existing Stove Technology (BEST) Hybrid Woodstove And Catalytic Retrofit Device*, Oregon Department of Environmental Quality, Portland, OR, July 1989.

11. S. G. Barnett and R. B. Roholt, *In-home Performance Of Certified Pellet Stoves In Medford And Klamath Falls, OR*, U. S. Department Of Energy Report No. PS407-02, Washington, DC, July 1990.

12. S. G. Barnett, *In-home Evaluation Of Emission Characteristics Of EPA-certified High-tech Non-catalytic Woodstoves In Klamath Falls, OR, 1990*, DSS File 145Q, 23440-9-9230, Canada Center For Mineral And Energy Technology, Energy, Mines and Resources, Ottowa, Canada, June 1, 1990.

13. R. C. McCrillis and R. G. Merrill, "Emission Control Effectiveness Of A Woodstove Catalyst And Emission Measurement Methods Comparison", Presented at the 78th Annual Meeting of the Air And Waste Management Association, Detroit, MI, 1985.

14. K. E. Leese and S. M. Harkins, *Effects Of Burn Rate, Wood Species, Moisture Content And Weight Of Wood Loaded On Woodstove Emissions*, EPA-600/2-89-025, U. S. Environmental Protection Agency, Cincinnati, OH, May 1989.

15. J. M. Allen and W. M. Cooke, *Control Of Emissions From Residential Wood Burning By Combustion Modification*, EPA-600/7-81-091, U. S. Environmental Protection Agency, Cincinnati, OH, May 1981.

16. D. G. DeAngelis, *et al.*, *Preliminary Characterization Of Emissions From Wood-fired Residential Combustion Equipment*, EPA-600/7-80-040, U. S. Environmental Protection Agency, Cincinnati, OH, March 1980.

17. P. G. Burnet, *et al.*, *Effects Of Appliance Type And Operating Variables On Woodstove Emissions, Vol. I.*, EPA-600/2-90-001a, U. S. Environmental Protection Agency, Cincinnati, OH, January 1990.

18. L. E. Cottone and E. Mesner, *Test Method Evaluations And Emissions Testing For Rating Wood Stoves*, EPA-600/2-86-100, U. S. Environmental Protection Agency, Cincinniati, OH, October 1986.

19. *Residential Wood Heater Test Report, Phase II Testing, Vol. 1*, Division Of Energy, Construction And Rates, Tennessee Valley Authority, Chattanooga, TN, August 1983.

20. R. S. Truesdale and J. G. Cleland, "Residential Stove Emissions From Coal And Other Alternative Fuels Combustion", delivered at the Specialty Conference on Residential Wood And Coal Combustion, Louisville, KY, March 1982.

21. S. G. Barnett, *In-home Evaluation Of Emissions From Masonry Fireplaces And Heaters*, OMNI Environmental Services, Inc., Beaverton, OR, September 1991.

22. S. G. Barnett, *In-home Evaluation Of Emissions From A Grundofen Masonry Heater*, OMNI Environmental Services, Inc., Beaverton, OR, January 1992.

23. S. G. Barnett, *In-home Evaluation Of Emissions From A Tulikivi KTU 2100 Masonry Heater*, OMNI Environmental Services, Inc., Beaverton, OR, March 1992.

24. S. G. Barnett, *In-home Evaluation Of Emissions From A Royal Crown 2000 Masonry Heater*, OMNI Environmental Services, Inc., Beaverton, OR, March 1992.

25. S. G. Barnett, *In-home Evaluation Of Emissions From A Biofire 4x3 Masonry Heater*, OMNI Environmental Services, Inc., Beaverton, OR, March 1992.

26. S. G. Barnett and R. D. Bighouse, *In-home Demonstrations Of The Reduction Of Woodstove Emissions From The Use Of Densified Logs*, Oregon Department Of Energy and U. S. Environmental Protection Agency, Salem OR, July 1992.

27. S. G. Barnett and P. G. Fields, *In-home Performance Of Exempt Pellet Stoves In Medford, Oregon*, U. S. Department Of Energy, Oregon Department Of Energy, Tennessee Valley Authority, and Oregon Department Of Environmental Quality, Salem, OR, July 1991.

28. S. G. Barnett, *Summary Report Of The In-home Emissions And Efficiency Performance Of Five Commercially Available Masonry Heaters*, The Masonry Heater Association, Reston, VA, May 1992.

29. *Emission Factor Documentation For AP-42 Section 1.10, Residential Wood Stoves*, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1993.

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This document is a guide to developing emission factors and producing portions of the Compilation Of Air Pollutant Emission Factors, AP-42. It contains guidance on the technical and editorial quality required of material to become part of the AP-42 series of EPA documents.

The guidance is a necessity for those involved in the AP-42 production process.

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