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From: TOM PACE 541-5634
To: RTPMAINHUB.INTERNET.MASSER-CHUCK, RTPMAINHUB.WPXGA...
Date: 1/8/97 2:49pm
Subject: Internal Review of Emission Factors Procedures Doc - DRAFT

Resent 1/08 Added Kuykendal and Misenhiemer. Date extended to 1/24.

Reviewers:

Please review the subject Internal Draft which is being sent to you thru the mail. We'd appreciate your review by January ~~10~~ 24th. Following this, we'll address the comments as appropriate and make the document available for external review. Concurrently, the Contractors that currently write AP-42 sections will be asked to provide comments on the workability of the Draft.

Background:
Although emission factor development has been accomplished by EPA or contractors acting on behalf of the EPA, it is hoped that State and Local Agencies and/or industry associations will assume increased responsibilities in emission factor development. Chapter 4 of the attached draft publication attempts to describe how a variety of information related to air emissions and production levels are assembled, summarized, analyzed and reduced to a single emission factor and associated quality rating for a specific source category emission point. As a result of your experiences and/or interest in the development of emission factors, you are being asked to review this draft. This draft will be revised based upon your comments. Following the revision, the revised draft will be sent to selected State/Local agencies and industry associations for review. As part of your review we would like you to consider the expanded role of State/Local agencies, industry associations and the contractors of these groups. As a result we would like that you pay particular attention to the balance between presenting prescriptive analytical methodologies vs flexibility to use alternatives which are also valid.

Specifically, we would like you to identify those areas which should be more detailed or specific to arrive at a consistent emission factor and rating, identify those areas which are too detailed or specific to allow for the valid use and interpretation of available information to arrive at an emission factor or interpret a pollutants' behavior in a consistent manner. Although we are not asking for correction of grammatical or spelling errors, we would like to know those areas where the text lacks clarity or is inconsistent with other parts of the document or recent emission factor development actions. Please make specific suggestions to text changes where appropriate.

Thanks, The Emission Factor Team

CC: MOBLEY-DAVID, PACE-TOM

EPA-454/R-95-

PROCEDURES FOR

PREPARING EMISSION FACTOR

DOCUMENTS

Third Revised Draft Version

Office of Air Quality Planning and Standards
Office of Air and Radiation
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

November 1996

This report has been reviewed by the Office of Air Quality Planning and Standards, U.S. Environmental protection Agency, and has been approved for publication as received from the contractor. Approval does not signify that the contents necessarily reflect the views and policies of the Agency, neither does mention of trade names or commercial products constitute endorsement or recommendation for use.

EPA-454/R-95-___

CONTENTS

CHAPTER 1

PURPOSE OF THIS DOCUMENT

The purpose of this document is to describe the procedures, technical criteria, and standards and specifications for developing and reporting air pollutant emission factors or equations for publication in either the *Compilation Of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources*, (AP-42) or the "Locating and Estimating" (L&E) document series. Both AP-42 Volume I and the L&E series are published by the Emission Factor and Inventory Group (EFIG) in EPA's Office of Air Quality Planning and Standards (OAQPS). Different procedures may apply to AP-42 *Volume II: Mobile Sources*, produced by EPA's Office of Mobile Sources in Ann Arbor, Michigan.

Previous editions of this manual have served as a guide for EPA personnel and their contractors who prepared AP-42 sections. This edition has been revised to include guidance for preparing L&E documents and to assist industry, trade associations, and state and local agencies that may be interested in developing emission factors or equations. Guidance has also been added to describe how to report the factors developed for AP-42 or an L&E document into EPA's electronic distribution mechanisms. Most of the material in this document is intended as guidance, rather than strict rules. Creative solutions which meet the goal of providing unambiguous documentation for EPA's current recommendations for emission factors are always welcome.

Emission factors have long been used as a cost-effective means to develop area-wide emission inventories. Emission inventories are fundamental tools for air quality management, used for identifying major contributors of atmospheric pollutants, developing emission control strategies, determining applicability of permitting programs, and other related applications by an array of users including federal, state, and local agencies, consultants, and industry. Data from source-specific emission tests or continuous emission monitors are usually preferred for estimating a source's emissions, but they are not available for most sources due to their high cost.

AP-42 has been published since 1972 as the primary compilation of EPA's emission factor information. It contains emission factors and process information for more than 200 air pollution source categories. A source category is a specific industry sector or group of similar emitting sources. The emission factors have been developed and compiled from source test data, material balance studies, and engineering estimates. The Fifth Edition of AP-42 was published in January 1995. Supplements to the Fifth Edition will be published approximately annually and will contain new sections on additional source categories as well as revisions to existing sections.

The L&E series was initiated in 1984, and now consists of 34 individual documents. Unlike the source category organization of AP-42, each L&E document focuses on all sources of a specific hazardous air pollutant or related group of pollutants. L&E documents make use of AP-42 factors if

available, and they also revise or supplement those factors when necessary to present the most complete assessment of the sources of the specific air pollutant. In addition to providing factors and process descriptions, L&E documents attempt to quantify the national emissions of the pollutant.

Chapter 2 provides some background on emission factors and their uses and limitations. It describes the pollutant terminology used in AP-42 and discusses some of the test methods used to develop emission factors for these pollutants. The reasons and mechanisms for initiating revisions to emission factors are also discussed.

Chapter 3 provides an overview of all of the tasks involved in revising or developing emission factors, in sequence. It describes the desirable review steps, highlights the documents' relationship to the other distribution mechanisms, and shows a typical timeline for the whole process.

Chapter 4 provides the details for how the tasks outlined in Chapter 3 can best be accomplished, from data collection through data evaluation and external reviews to the determination of final factors. Sections are included on typical contents, data collection, data review, developing and presenting factors, and background documentation.

Appendix A presents a typical AP-42 section and an L&E document as examples of the editorial specifications to be used. Specifications are given for both the published paper copy and electronic versions of the documents. Appendix B contains EFIG's Public Participation Procedures and Appendix C contains a description of using the F-factor method for relating fuel combustion emissions to fuel rates. Appendix D is a listing of the 189 Hazardous Air Pollutants. Electronic template "typical format" setup disks in WordPerfect® Version 5.1 are available for AP-42 on the Clearinghouse for Inventories and Emission Factors (CHIEF) Bulletin Board System (BBS).

CHAPTER 2

INTRODUCTION TO EMISSION FACTORS

2.1 DEFINITION OF AN EMISSION FACTOR

An emission factor is a tool that is used to estimate air pollutant emissions to the atmosphere. It relates the quantity of pollutants released from a source to some activity associated with those emissions. Emission factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., pounds of particulate emitted per ton of coal burned). Emission factors are used to estimate a source's emissions by the general equation:

$$E = A \times EF \times [1-(ER/100)]$$

where:

E = emissions,
A = activity rate,
EF = emission factor, and
ER = overall emission reduction efficiency, %.

(ER is the product of the control device destruction or removal efficiency and the capture efficiency of the control system. When estimating emissions for a long time period (e.g., 1 year), both the device and the capture efficiency terms should account for upset periods as well as routine operations.)

In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average). Usually, data are insufficient to indicate the influence of various process parameters such as temperature and reactant concentrations. For a few cases, however, such as in estimating emissions from petroleum storage tanks, the AP-42 document contains empirical formulas (or emission models) that relate emissions to variables such as tank diameter, liquid temperature, and wind velocity. Emission factor formulas that account for the influence of such variables tend to yield more realistic estimates (if information for all variables is accurate) than would factors that do not consider those parameters. Emission factor ratings in the AP-42 or L&E document series provide indications of the robustness, or appropriateness, of emission factors for estimating average emissions for a source activity.

The extent of completeness and detail of the emissions information in emission factor documents is determined by the information available from published references. Emissions from some processes are better documented than others. For example, several emission factors may be

listed for the production of one substance: one factor for each of a number of steps in the production process such as neutralization, drying, distillation, and other operations. However, because of less extensive information, only one emission factor may be given for production facility releases for another substance, though emissions are probably produced during several intermediate steps. There may be more than one emission factor for the production of a certain substance because different production processes may exist, or because different control devices may be used. Therefore, it is necessary that users look at more than just the emission factor for a particular application and observe details in the text and in table footnotes.

2.2 USES AND LIMITATIONS OF FACTORS

Emission factors may be appropriate to use in situations such as making emission estimates for areawide inventories. These inventories have many purposes including ambient dispersion modeling and analysis, control strategy development, and screening of sources for compliance investigations. Emission factors may also be used to estimate emissions for air permitting applications, where estimates are needed for applicability determinations or for establishing operating permit fees.

Emission factors in AP-42 or L&E documents are neither EPA-recommended emission limits (e.g., best available control technology or BACT, or lowest achievable emission rate or LAER) nor standards (e.g., National Emission Standards for Hazardous Air Pollutants or NESHAP, or New Source Performance Standards or NSPS). Use of these factors as source-specific permit limits and/or as emission regulation compliance determinations is not recommended. Because emission factors essentially represent an average of a range of emission rates, approximately half of the subject sources will have emission rates greater than the emission factor and the other half will have emission rates less than the factor. As such, a permit limit using an AP-42 or L&E emission factor would result in half of the sources being in noncompliance.

For some sources, emission factors may be presented for processes having air pollution control equipment in place. Factors noted as being influenced by control technology do not necessarily reflect the best available or state-of-the-art controls, but rather reflect the level of (typical) control for which data were available at the time the information was published. Sources often are tested more frequently when they are new and when they are believed to be operating properly, thus raising the possibility that some AP-42 emission factors are biased low.

The fact that an emission factor for a pollutant or process is not available in AP-42 does not necessarily mean that the Agency believes the source does not emit that pollutant or that the source should not be inventoried. While it may be true that the source emits very little or none of that

pollutant, it may be simply be that the Agency has no data for that source category because the category has not been studied for regulatory controls as a large emitter nationwide. Therefore, the facilities which do not have a large number of similar facilities across the country may not be covered in AP-42. The question of whether the source likely emits enough of a pollutant to warrant developing an emission estimate by some other method must necessarily be made on a case-by-case basis, taking account of the needs or requirements of the applicable air program.

Source-specific tests or continuous emission monitors can determine the actual pollutant contribution from an existing source better than emission factors. Even then, the results will be applicable only to the conditions existing at the time of the testing or monitoring. To provide the best estimate of longer-term (e.g., yearly or typical day) emissions, these conditions should be representative of the source's routine operations.

A material balance approach also may provide reliable average emission estimates for specific sources. For some sources, a material balance may provide a better estimate of emissions than emission tests would. In general, material balances are appropriate for use in situations where a high percentage of material is lost to the atmosphere (e.g., sulfur in fuel, or solvent loss in an uncontrolled coating process.) In contrast, material balances may be inappropriate where material is consumed or chemically combined in the process, or where losses to the atmosphere are a small portion of the total process throughput. As the term implies, one needs to account for all the materials going into and coming out of the process and for the uncertainty of each of the measured materials to make a credible and reliable estimate of emissions.

If representative source-specific data cannot be obtained, emissions information from equipment vendors, particularly emission performance guarantees or actual test data from similar equipment, is better information for permitting decisions than an AP-42 or L&E emission factor. When such information is not available, use of emission factors may be necessary as a last resort. Whenever AP-42 or L&E factors are used, one should be aware of their limitations in accurately representing a particular facility, and the risks of using emission factors in such situations should be evaluated against the costs of further testing or analyses.

Figure 2-1 depicts various emission estimation approaches that one should consider when analyzing the tradeoffs between the cost of obtaining the estimates and the quality of the resulting estimates. Where risks of either adverse environmental effects or adverse regulatory outcomes are high, more sophisticated and more costly emission determination methods may be chosen by the user. Where the risks of using a poor estimate are low, and the costs of more extensive methods are not warranted, then less expensive estimation methods such as emission factors and emission models may be both satisfactory and appropriate. In cases where no emission factors are available but adverse

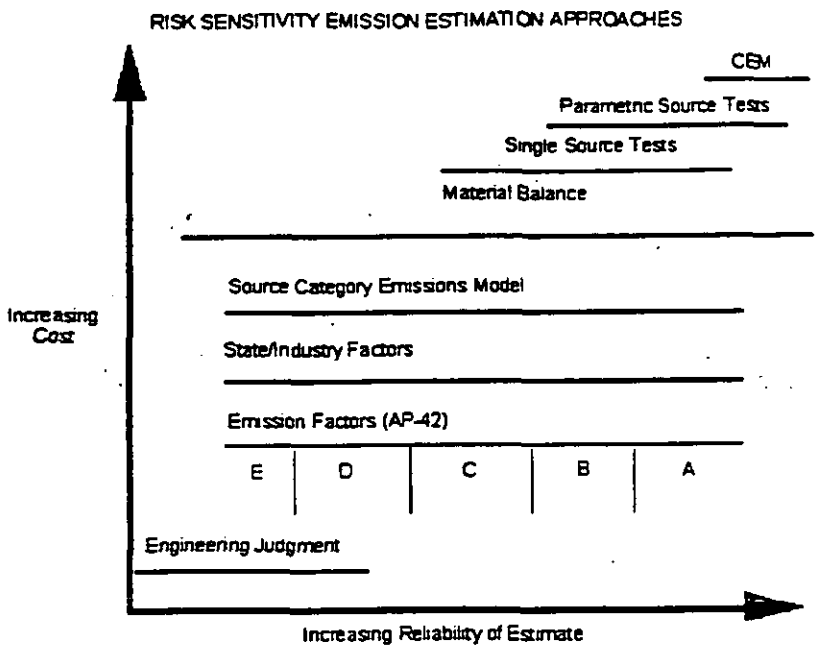


Figure 2-1. Approach to emission estimation.

risk is low, it may even be acceptable to apply factors from similar source categories using engineering judgment. Selecting the method to be used to estimate source-specific emissions warrants a case-by-case analysis considering the costs and risks in the specific situation. All sources and regulatory agencies should be aware of these risks and costs and should assess them accordingly. Note that Figure 2-1 only indicates a typical relationship between cost and reliability and that there is a wide range of reliability possible for any one approach.

2.3 VARIABILITY OF EMISSIONS

Average emissions differ significantly from source to source and, therefore, emission factors frequently may not provide adequate estimates of the average emissions for a specific source. The extent of between-source variability that exists, even among similar individual sources, can be large depending on process, control system, and pollutant. Although some of the causes of this variability may be considered in emission factor development, this type of information is seldom included in emission test reports used to develop AP-42 or L&E factors. As a result, some emission factors are derived from tests whose results may vary by orders of magnitude. Even when the major process variables are accounted for, the emission factors developed may be the result of averaging source tests

that differ significantly.

Air pollution control devices also may cause differing emission characteristics. The design criteria of air pollution control equipment affect the resulting emissions. Design criteria include such items as the type of wet scrubber used, the pressure drop across a scrubber, the plate area of an electrostatic precipitator, and the alkali feed rate to an acid gas scrubber. Often, design criteria are not included in emission test reports (at least not in a form conducive to detailed analysis of how varying process parameters can affect emissions) and therefore may not be accounted for in the resulting factors.

Before simply applying AP-42 or L&E emission factors to predict emissions from new or proposed sources, or to make other source-specific emission assessments, the user should review the latest literature and technology to be aware of circumstances that might cause such sources to exhibit emission characteristics different from those of other, typical existing sources. Care should be taken to assure that the subject source type and design, controls, and raw material input are those of the source(s) analyzed to produce the emission factor. This fact should be considered, as well as the age of the information and the user's knowledge of technology advances.

Estimates of short-term or peak (e.g., daily or hourly) emissions for specific sources are often needed for regulatory purposes. Using emission factors to estimate short-term emissions will add further uncertainty to the emission estimate. Short-term emissions from a single specific source often vary significantly with time (i.e., within-source variability) because of fluctuations in process operating conditions, control device operating conditions, raw materials, ambient conditions, and other such factors. Emission factors generally are developed to represent long-term average emissions, so testing is usually conducted at normal operating conditions. Thus, using emission factors to estimate short-term emissions will cause even greater uncertainty. The AP-42 and L&E user should be aware of this limitation and should evaluate the possible effects on the particular application.

To assess within-source variability and the range of short-term emissions from a source, one needs either a number of tests performed over an extended period of time or continuous monitoring data from an individual source. Generally, material balance data are not likely to be sufficient for assessing short-term emission variability because the accuracy of a material balance is greatly reduced for shorter time intervals. In fact, one of the advantages of a material balance approach is that it averages out all of the short-term fluctuations to provide a good long-term average.

2.4 POLLUTANTS REPRESENTED

The following sections describe the pollutant definitions and conventions typically used in AP-42 and L&E documents, and some of the difficulties in deriving emission factors for those pollutants from the available source tests.

2.4.1 Pollutant Terminology and Conventions

The AP-42 document now provides emission factors for three main types of air pollutants: criteria pollutants and their precursors; hazardous air pollutants (HAPS); and greenhouse gases. The criteria pollutants are the most extensively covered, because they were the original focus of AP-42 and the Agency's regulatory efforts. Emission factors for HAPs and greenhouse gases are being added as resources allow.

Many chemical species belong to more than one of these types, particularly VOCs (a precursor of the criteria pollutant ozone), which also act as greenhouse gases and many of which are individually identified as HAPs. In such a case the AP-42 section should present emission factors for any HAPs that can be individually quantified and an emission factor for VOCs as a whole which would include any HAP species which are also a VOC.

Any information on the individual chemical species which make up a pollutant class, such as VOC, PM, or POM, may be included, even though the quantification may not be as robust as for the total class. When individual compounds that comprise a class are identified (e.g., benzo(a)pyrene, anthracene, etc. as congeners of POM), they should be grouped as subsets of the class for clarity of presentation to the reader and to avoid double counting of emission totals. Information on the split of organic compounds or particulate matter into more specific classes or individual compounds is very useful for some applications and should be included in the documents to the extent possible.

It is often the case that the ideal measure of a pollutant for a specific application may not be available, or even possible, because of test method or data limitations, costs, or other problems. When such qualifications exist, they should be noted in the document. There may also be some potential overlap in measuring some compounds (e.g., organic condensable PM and VOC). Acknowledgement of this should be noted in the document in either the text or as a footnote to an emission factor table.

Criteria Pollutants and Precursors. The six criteria pollutants are sulfur dioxide, nitrogen oxides, carbon monoxide, lead, particulate matter less than 10 microns in diameter, and ozone. Nitrogen oxides, carbon monoxide, and volatile organic compounds (VOC) are considered precursors to ozone formation.

Sulfur Dioxide - The primary product from combustion of sulfur is sulfur dioxide, SO_2. However,

other oxidation states are usually formed as well. Emission factors can be reported separately for SO_2 and SO_3, or a combined emission factor for SO_x, sulfur oxides, can be presented. A combined factor for SO_x should be reported on the basis of the molecular weight of SO_2. This means that an SO_3 emission factor should be multiplied by the ratio of the molecular weights of SO_2 to SO_3 (64/80) before being added to an SO_2 emission factor. Sulfates, or SO_4, should be reported separately.

Nitrogen Oxides - The primary combustion product of nitrogen is nitrogen dioxide, NO_2. However, several other nitrogen compounds are usually emitted at the same time (nitric oxide or NO, nitrous oxide or N_2O, etc.), and these may or may not be distinguishable in available test data. They are usually in a rapid state of flux, with NO_2 being, in the short term, the ultimate product emitted or formed shortly downstream of the stack. The convention followed in emission factor documents is to report the distinctions wherever possible, but to report total NO_x on the basis of the molecular weight of NO_2.

Carbon Monoxide - Emission factors for carbon monoxide are straightforward, since there is only one compound involved. The factors are reported on the basis of the molecular weight of CO.

Lead - Lead is emitted and measured as particulate and often will be reported for a process both separately and as a component of the particulate matter emission factor. The lead may exist as pure metal or as compounds (considered a HAP). The convention followed in emission factor documents is that all emissions of lead are expressed as the weight of the elemental lead. Lead compounds will also be reported on the basis of the weight of those compounds if the information is available.

Particulate Matter - Emission factor documents generally contain factors for pollutants that are expected to be primary particulate matter. Primary particulate matter includes that solid, liquid, or gaseous material at the pressure and temperature in the process or stack that would be expected to become a particulate at ambient temperature and pressure. Primary particulate matter includes matter that may eventually revert to a gaseous condition in the ambient air, but it does not include secondary particulate matter. Secondary particulate matter is gaseous matter that may eventually convert to particulate matter through atmospheric chemical reactions. The term "total particulate" is also used to describe the emissions that are primary particulate matter. Total particulate may consist of filterable, condensable organic, and condensable inorganic fractions. Total particulate and the filterable fraction are also commonly followed by a size cut indicator. Thus, PM-10 refers to the total particulate matter less than 10 microns in diameter, and PM-10 filterable refers to just the filterable fraction of particulate that is less than 10 microns.

Unless noted, it is reasonable to assume that the particle emission factors for processes that operate above ambient temperatures are for filterable particulate, as defined by EPA Method 5 or its

equivalent (a filter temperature of 250°F). The condensable portions of the particulate matter consist of vaporous matter at the filter temperature that is collected in the sampling train impingers and is analyzed by EPA Method 202 or its equivalent. Emission factor documents follow conventions in attempts to define Total Particulate and its subcomponents, filterable particulate, condensable particulate, and PM-10 and their interrelationships. Because of test method and data limitations, this attempt may not always be successful, and some sources may not generate such components.

Emission factors often may characterize only in-stack filterable PM-10. It is reasonable to assume that, where a test report does not define the components of particulate clearly and specifically, the PM-10 factor includes only the filterable portion of the total PM-10. Therefore, an evaluation of potential condensable particulate emissions should be based upon additional data or engineering judgment. Users should also note that many hazardous or toxic compounds may be emitted in particulate form. In such cases, factors for particulate matter represent the total, and factors for such compounds or elements are reported as mass of that material.

Organic Compounds - Many organic compounds react photochemically along with nitrogen oxides and carbon monoxide to form the criteria pollutant "ozone". EPA regulates a class of compounds called Volatile Organic Compounds (VOC) defined (in Title 40, Code of Federal Regulations, Part 51.100, February 3, 1992) as "any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric chemical reactions." A number of compounds are deemed to have "negligible photochemical reactivity," and are therefore exempt from the definition of VOC. The list of exempt compounds is occasionally expanded by subsequent Federal Register notices, but as of June 1995 it included methane, ethane, methylene chloride, methyl chloroform, acetone, many chlorofluorocarbons, and certain classes of perfluorocarbons.

For AP-42 sections, the goal is to present emission factors for VOC, as a minimum. Values for any of the exempted compounds, particularly methane as a greenhouse gas, may also be presented if sufficient data are available. Factors for "total organic compounds" (TOC) may also be presented, although not as a substitute for the desired VOC factors. TOC is a term used to indicate all organics, including VOCs, all exempted organic compounds, any hazardous organics, aldehydes, and semivolatile compounds.

In many cases, data are not available to identify and quantify either the total mass of VOC (due to some oxygenated compounds that are not completely measured by many common test methods) or the specific components of TOC which should be subtracted to yield VOC. In such cases, the VOC emission factor is annotated in an effort to provide clear and unambiguous data to the user. It is important for the emission factor document author to note the test method and any assumptions that

were necessary to develop the factors. Please note that formaldehyde is a common organic pollutant which is considered a VOC (as well as a HAP), but which is not detected by Method 25a. Therefore, the results of a Method 25a test should be augmented by the amount of any formaldehyde determined by another method when developing a VOC emission factor for sources where formaldehyde is present.

It is preferred that the factors be given in terms of actual weight of the emitted substance. However, in some cases the actual species present are unknown, because many test methods yield only the total concentration of carbon atoms present. In such cases the author should develop an emission factor using the best assumption possible regarding the carbon weight to total compound weight ratio, and should note this assumption in a footnote. Source profiles contained in the SPECIATE data system should be reviewed for potential data for this judgment. If the species distribution is later determined, actual mass can be calculated based on molecular weight of each compound present. Note that factors given in terms of "as methane" or "as propane" usually indicate the compound which was used to calibrate the test instrument, as well as the carbon to total compound weight ratio assumed for the ensuing calculations.

Many organic compounds are also HAPs. Where individual HAP species can be quantified, an emission factor representing their individual mass should be presented. This quantity should also be included in the VOC or TOC factors, as appropriate.

Hazardous Air Pollutants. Title III of the CAAA lists 189 toxic air pollutants defined for EPA regulatory purposes as HAPs. Appendix D provides a list of these pollutants along with an indication of those considered "high priority" for the Urban Air Toxics program. However, many states and other authorities designate additional toxic or hazardous compounds, organic or inorganic, that can exist in gaseous or particulate form. Few EPA Reference Test Methods exist for these compounds, which may come from the myriad sources covered in emission factor documents. However, test methods are available to allow reasonably reliable quantification of many compounds, and test results of sufficient quality should be included in emission factor documents. Emission factors for such compounds should represent the actual total mass of the compounds as emitted, not just the major element's mass. (Note that many test methods quantify only the major element's mass, such as chromium or mercury.) PM and VOC totals should include any component species which are also separately identified and quantified as HAPs. There are a limited number of gaseous HAPs that may not be VOCs, and whenever they occur they should be identified separately.

Greenhouse Gases. Carbon dioxide, methane, and nitrous oxide (N_20) are the principal greenhouse gases being reported in AP-42. Each should be reported on the basis of the compound's total molecular weight. Therefore, reported CO_2 tonnages can be converted to moles assuming a

molecular weight of 44. Note that this is not consistent with the convention used in some applications of only accounting for the carbon mass of the emissions. CO_2 factors for fuel combustion are usually based on the assumption that all of a fuel's carbon content is converted to CO_2, thereby neglecting the small amount of carbon double-counted by carbon monoxide and VOC emission factors. Industrial processes which produce CO_2 emissions only from the combustion of fuel rather than from the chemical reaction of some other raw material do not need to have CO_2 emission factors developed and reported in AP-42, since the emissions could be better estimated from the processes' fuel usage.

2.4.2 Test Methods

Source test methods have been the basis of estimating emissions from individual process units from the beginning of air pollution evaluations. These source test methods have been used to develop emission factors for preparing inventories of pollutants emitted in a region or from a specific source. They have also been used as methodologies to verify that a specific source is being controlled to the degree that is required by regulations. In some cases, the source test method is an unbiased estimator of the actual emissions from a process. However, there are cases where the test method is only an indicator of actual emissions or the performance of the air pollution control systems utilized by a facility.

EPA has published reference methods for measuring emissions of PM/PM-10, SO_2, NO_x, CO, inorganic lead, and VOC. The reference methods, given in the 40 CFR 60, Appendix A, define and describe the test equipment, materials, and procedures to be used in stack tests for the various criteria pollutants. Reference methods for estimating HAP emissions are published in 40 CFR 61, Appendix B. The EPA publication, *Screening Methods for the Development of Air Toxics Emission Factors*, presents an overview of the use of these reference methods for specific HAPs. For further information, the reader can consult with the EMTIC, which provides technical guidance on stationary source emission testing. Individuals may access EMTIC on the EPA's Technology Transfer BBS or by calling EMTIC staff directly at (919) 541-0200.

Some examples of test methods that may be considered true indicators of actual emissions are the EPA reference test methods for CO, SO_2, and NO_x. The use of continuous emissions monitors (CEMs) for these pollutants will not only provide instantaneous or integrated estimates of emissions but may provide clues as to the inherent variability of the emissions and can provide insight on those process variables that may have a significant impact on the emissions. As a result CEMs have sometimes been integrated into process control loops for many facilities to improve operations.

There are other test methods that cannot be considered indicators of actual emissions. This applies to EPA reference test methods as well as test methods that have been developed by independent analysts. In many cases, the inherent lack of specificity in the measurements will have to

be accepted by the applicant, the permitting authority and the reviewers and they will have to recognize the fact that the method is the best that is available. However, there are situations where the shortcomings of a single test method can be overcome by an understanding of the test methods and their shortcomings and adjusting accordingly.

Most of the EPA reference test methods were developed as a result of some standards development project such as for a New Source Performance Standard (NSPS), National Emission Standard for Hazardous Air Pollutant (NESHAP) or Maximum Air Pollution Control Technology (MACT). The test methods developed for these projects were used as indicators of when the process was achieving the level of control that was found in the processes that were investigated during the standards development effort. Two pollutants where this is most evident are PM and VOCs. Typically, U.S. EPA Method 5 or one of its variants were used to judge whether a facility was meeting the PM standard and Method 25a was used to judge whether a facility was meeting the VOC standard.

Generally, EPA Method 5 and its variants do not measure the entire spectrum of total PM and a percentage of this value is not a good indicator of total PM-10 emissions. EPA Method 5 measures only that PM that has already condensed at the filter temperature. Analysis for the condensable PM is not accomplished. Conversely, EPA Method 25a measures more than the VOC component. VOCs are all hydrocarbon compounds except as specified as minimally photochemically reactive. Compounds such as methane, ethane, acetone, some chlorinated compounds and some chloro-fluorocarbons have been identified as non-reactive or minimally reactive in the photochemical process. Method 25a measures almost all hydrocarbon compounds. Therefore, if these exempt compounds are in the gas stream they would also be measured. In addition, Method 25a does not have an acceptable response factor for many oxygenated compounds (alcohols and aldehydes) and, therefore, underestimates emissions of these types of compounds. These response factor problems can be overcome if there is an adjustment in the calibration of the instrument.

Typically, EPA reference test methods for PM (EPA Method 17, EPA Method 5, or EPA Method 5x) collect only that material that is collected on or ahead of the filter media of the sampling device. The material collected depends upon the temperature at which the filter media are maintained. The filter media of EPA Method 17 is at stack gas conditions whereas the filter media of EPA Method 5 or 5x is maintained at about 250° F (or the temperature specified in the method). As a result, these test methods only capture the solid or semi-solid material and do not capture the vaporous material that will condense in the atmosphere. This material is referred to as the filterable particulate because it is the material that can be filtered out of the gas stream at the indicated temperature.

EPA Method 17 is similar to EPA Method 5 except that the filter is maintained at the temperature of the flue gas. As a result of this usually higher filter temperature, somewhat less particulate is collected than would be in an EPA Method 5 sampling train. Another sampling train that is similar to the EPA Method 5 train is the EPA Method 201 and 201a sampling train. The difference in these sampling trains is that the probe nozzle is replaced by a cyclone which has a cut size of 10μm aerodynamic diameter. The method requires only that the material collected behind the cyclone up to the filter be recovered and analyzed. Some source testers recover and weigh the material that is collected in and ahead of the cyclone. The summing of this material with the material following the cyclone up to the filter will result in a value similar to EPA Method 17. However, as with EPA Method 17, it will still not give the same results as EPA Method 5.

A method has been developed that will determine emissions approximating those that exist in the ambient environment when combined with EPA Method 17, EPA Method 201 or 201a, or EPA Method 5 results. In EPA Method 202, the material that is collected in the impingers undergoes an analysis that determines the two condensable fractions that may exist. The organic fraction contained in the impingers is extracted with a solvent and evaporated at room temperature and then quantitatively weighed. The remaining water is evaporated to leave the inorganic material which is also quantitatively weighed.

By combining all of the portions of quantitatively weighed material, the total particulate emissions that would occur in the ambient air can be determined. In combining all of these weighings, it should be noted that there may be errors in combining data from different test methods. For example, the combination of EPA Method 5 data with EPA Method 202 data following an EPA Method 17 sampler would result in greater emissions than may actually occur. This is because some of the material collected in EPA Method 5 would also be collected in the impinger portion following EPA Method 17. This difference becomes greater as the differences between the stack temperature and the EPA Method 5 filter temperature becomes greater and also as the relative amount of condensable material becomes greater.

The test methods that have been used to estimate organic emissions are also not precise in determining the actual emissions and have been misrepresented as VOC emission in the past. The test methods that are available for quantifying organic emissions are EPA Method 18, EPA Method 25, and EPA Method 25a. Each of these test methods have characteristics that result in differing qualities of information. The differing qualities of information depend upon the basic response factor of the instrument used and on assumptions about the molecular weight of the compounds being determined.

EPA Method 18 has the potential to come the closest to estimating actual emissions of all of the pollutants that are in the gas stream in major quantities. This is because each constituent is

separated and quantified individually. Because the individual compounds are measured, this method does have the advantage of being able to estimate emissions of VOC compounds. However, this test method is seldom used because of its complexity of operation and the time required to perform the analysis. Additionally, the test may have been terminated prior to all compounds being measured.

EPA Method 25 is potentially the next best measurement method in that all of the organic compounds in the gas stream are converted into methane prior to being quantified. As a result, the total number of carbon atoms can be determined. There is a potential error associated with estimating the mass of total organic compounds because of errors in estimating average molecular weight. There are some errors in estimating emissions of VOCs because individual compounds are not quantified. Some modifications of this method are used to arrive at non-methane organic compounds. However, other non-VOC compounds are not estimated. This test method is also seldom used because of the time and complexity of its use.

EPA Method 25a is the most commonly used test method for organic emissions. It is used because it can provide continuous emissions measurement once it is set up and it is relatively straightforward in its operation. However, the response factors for this method are variable depending upon the compounds that exist in the flue gas. Since Method 25a does measure all organic compounds, VOCs may be overestimated even when the response factors are corrected for the problem compounds.

Table 2-1 contains a list of the preferred methodologies, by pollutant, available for determining HAP and criteria pollutant emissions from stack sampling.

2.5 Reasons and Methods for Initiating Section Preparation and Revision

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 EFIG and initially supported a source testing program for generating new emission factors and updating existing factors.

Given this new emphasis on expanding the coverage and quality of 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:

Table 2-1. RECOMMENDED TEST METHODOLOGIES FOR HAZARDOUS AIR POLLUTANTS AND CRITERIA POLLUTANTS

Pollutant	Test Method
SO_2	EPA Method 6 and CEM Method
NO_x	EPA Method 7 and CEM Method
O_2/CO_2	EPA Method 3 and CEM Method
CO	EPA Method 10B
TOC*	EPA Methods 25a and 0011 (formaldehyde) or EPA Method 25 (if methane is included)
Speciated organics	EPA Methods 18, 0030, and 0010
Metals and metal compounds (including lead)	EPA Method 12
PM, filterable	EPA Methods 5 and 17
PM, condensable (considered $\leq$ 1 μm in size)	EPA Method 202
PM-10, filterable	EPA Methods 201 and 201a

* TOC is not a pollutant defined in the CAA, however TOC is used as a starting point in the development of VOC emission factors. VOC emission factors can be established by subtracting emission factors for those compounds that have been designated by EPA as nonphotochemically reactive from the TOC emission factors.

Outside requests for better source and emission factor information, or for information on a category or pollutant not already addressed. 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), National Emissions Standards For Hazardous Air Pollutants (NESHAP), and Control Techniques Guidelines (CTG), 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 warrant considering a relatively low-expense update and expansion of available information.

In addition to these possibilities, Section 130 of the Clean Air Act Amendments (related to

photochemical pollutants) emphasizes the process through which any party may submit valid information to EFIG for emission factor development and revision. Before initiating these efforts, a contract work assignment manager (WAM) analyzes the proposed work as it relates to existing needs and priorities, to contract funding, or to EFIG personnel availability, the likely magnitude of the effort, and other criteria. Based on this analysis, priorities are established, and recommendations are made to the EFIG Leader.

The tasks of emission factor document preparation will be done either by Agency personnel or by a contractor, depending on cost, time, and contractor qualifications, as the EFIG Leader directs. Recent developments have expanded to include industry groups and state/local agencies. These tasks include compilation or generation of data, data evaluation, and preparation of the draft document, as well as EPA review, coordination of outside review, final editing and formatting, and publication.

Also, EFIG periodically performs assessments of the source activities covered by the AP-42 and L&E document series and those not included to determine which, if any, source categories warrant future efforts either to update an existing document or to develop a new one.

2.6 Mechanisms for Initiating Revisions to AP-42

2.6.1 Internal Prioritizations/EPA Needs

The AP-42 Team relies on several processes to establish the priorities for selecting the source categories and sections to update or initiate. A prioritization scheme based on five characteristics reflecting the impact of the particular source category on national emissions, number of sites, localized problems, and other measures has been used in the past. However, it is often the case that a consensus-based approach, reflecting the synthesized knowledge of the section managers and current external pressures, along with budget considerations, provides a more realistic match with what is actually possible to do with the time and resources available. The availability of data for important source categories and the needs/pressures from the users is often sufficient to exceed the abilities of resources to accomplish the desired tasks.

2.6.2 State/Local Emission Factor Initiatives

Beginning in the FY 96 budget year, Section 105 funding was identified for possible use by States and local agencies for activities leading to the development and adoption of emission factors. These factors may be developed to meet a unique situation within the jurisdiction (customized to meet those specific conditions) or as a special effort to improve factors that are utilized by many. The EFIG staff expects to be heavily involved in coordinating and consulting with these activities as they develop and the expectation is that the EFIG staff will actually finalize the incoming revisions in AP-42 or will be the final reviewer and quality assurance for guaranteeing that the information put into

AP-42 is correct and complete. One of the major roles of the EFIG staff in this area will be the conduct of these reviews and steering activities to assure that funds spent on development of emission factors is carried out efficiently and with technical integrity, and that they become available to the user community at large.

2.6.3 Industry Initiatives

The atmosphere within the Agency and in the environmental community at large is such that there is a strong likelyhood that there will be increased interest and efforts to work jointly with industry, usually a trade association, to develop new and improved emission factors. This process will develop over time, but there is a liklyhood that there will be increased efforts on the part of industry to fund testing, propose new factors, and even develop proposed new sections for AP-42. Part of the purpose of this document will be to provide a clear understanding between the EPA and industry staffs of their roles and responsibilities (and limits of flexibility) and the steps that must be followed to maintain integrity, believability and realization of needs. This is the area that most addresses the public participation aspects of this work as referred to in Section 130 of the Clean Air Act (1990) and discussed next.

2.7 EPA'S PUBLIC PARTICIPATION PROCEDURES

EPA provides opportunities to participate in establishing, evaluating, and revising emission factors through a public review process. Because emission factors may affect most aspects of air pollution control and air quality management, including operating permits and fees, compliance assessments, and State Implementation Plan (SIP) emission inventories, these factors are always made available for external review and comment before publication. External reviewers include representatives of affected industries and trade associations, state and local air pollution control agencies, and environmental groups. EPA has worked cooperatively with trade associations to gather data in developing emission factors and plans to continue to do so.

EPA's published emission factors are intended to provide an affordable method of estimating emissions, particularly to characterize total emissions of a large geographic area containing many individual facilities. Therefore, these factors attempt to represent a typical or average facility or process in a given industry. EPA recognizes that other methods of obtaining emission estimates may be more accurate than industry-average emission factors, and it encourages the use of better methods whenever a source and/or the state or local regulating authority is able to support those methods, which include continuous emission monitoring, source testing, material balances, and engineering calculations.

Anyone with valid information is encouraged to submit data to establish new emission factors,

revise existing emission factors, or demonstrate improved emissions estimating techniques. Information may be submitted at any time, regardless of whether a subject source is currently addressed. The Agency encourages all interested parties to take every opportunity to review factors and to provide information for factor quality improvement. Specific details on participating in the public review of emission factors appears in the draft document, Public Participation Procedures for EPA's Emissions Estimation Guidance Materials, which appears in Appendix B.

CHAPTER 3

UPDATE PROCEDURES AND INFORMATION FLOW

Although the responsibility for developing and compiling EPA emission factors is EFIG's, the responsibility for emission factors is shared among EFIG, the industry for which the emission factor is applicable, State and local air pollution control agencies that are responsible for inventorying and permitting the sources within their jurisdiction, environmental groups, and others that have information to support the development of or revision of emission factors. EFIG's primary responsibility is to provide consistency in the development of emission factors, facilitate evaluations by EPA and outside agencies, and provide a repository of supporting documentation for the emission factors, and distribution mechanism for emission factors. The EFIG directs a limited amount of resources which are used primarily to collect and evaluate emission testing conducted by others. When factors are required to estimate emissions from an important source which has not been characterized adequately, the EFIG may perform a limited source test program in conjunction with state/local and industry partners.

An overview of the process and steps to update an existing factor document or develop a new one is described here and depicted in Figure 3-1, with the sections that follow discussing in detail each step of this process.

3.1 PRELIMINARY DATA SCREENING

A preliminary screening of in-house information is conducted to determine if a more formal process is appropriate. This may be triggered by the events in Section 2.4. This internal activity involves assembling and reviewing all data in hand and searching for additional available information. When updating existing documents, this task entails complete review of all information in EFIG internal files, including those for AP-42, the L&E documents, Source Test information Retrieval System (STIRS), FIRE (repository and distribution) and EPA's Air Emissions Species Database SPECIATE. Additional information may be available from ESD, ORD, trade associations, and other sources, as detailed in Section 4.3. The two outcomes of this preliminary screening are to do no further revisions of the source category at this time, or to make a preliminary decision to proceed and to gather more information from additional sources.

3.2 REVIEW SESSION(S)

Generally, following the preliminary decision to proceed, a request is made to external organizations to review existing information and to supply any additional data. This request is made to trade association(s) representing the source categories covered, a focused list of State and Local Agencies and selected environmental interest groups. A copy of the existing document, its background report (if available), and a list of new information is usually included with the request to

Figure 3-1. Overview of the emission factor document preparation process.

assist in their review. The industry association(s) and State and Local Agencies may be able to contribute process descriptions, source emission tests, and additional information on emission controls.

Following the receipt of comments and additional data, an analysis of the potential impact to the existing document(s) may be made. The objective of the analysis is to identify potential additions or changes to the emission factors, changes in estimated emissions and/or improvements in other information presented. Detailed evaluation of the information collected may be reserved until after the final decision to revise the document, flawed information should be identified and documented as such. Additional information about background documentation and files is given in Section 4.7.

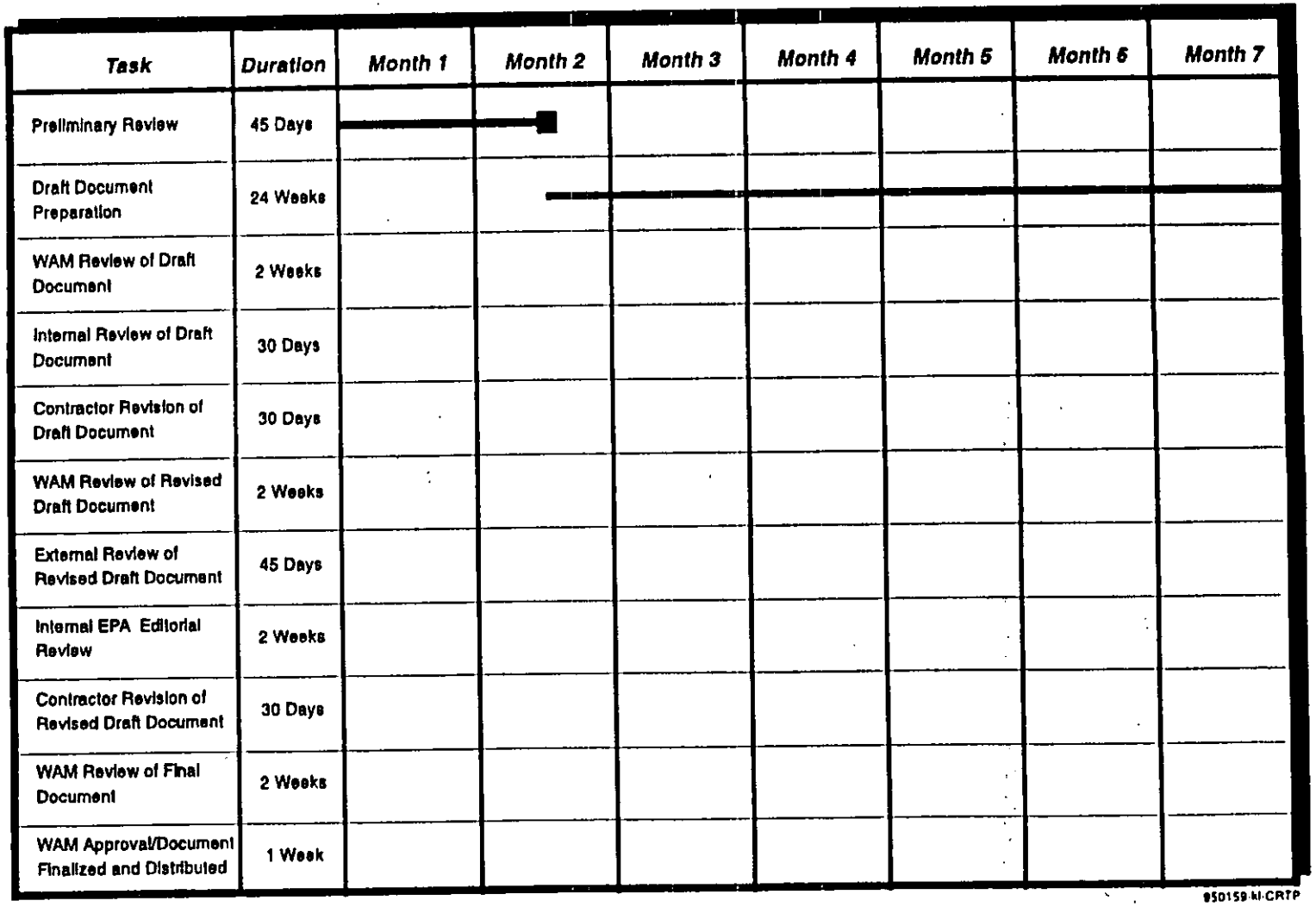
About 45 days after technical work begins, a preliminary review session should be scheduled with the project lead, emission factor team members and leader, other EFIG or ESD personnel, and appropriate contractor personnel. This group will discuss the available data, determine whether additional data are needed, and discuss all relevant issues including technical and editorial adequacy in order to reach a decision on whether to proceed with drafting a revised or new document. Existing text should be used if possible, with technical accuracy or editorial inadequacies improved where needed. Occasionally, changes in an industry or age of the existing information or data may necessitate a new start, but this should normally be avoided.

3.3 Drafting Documents

Once the decision is made to proceed with revising an existing emission factor document or preparing a new one, a finished draft is expected in about 6 months unless a significant amount of new information is identified through industry or state and local APCA contacts. Extensive information relevant to this effort is given in Chapter 4 of this document.

If an AP-42 section is being drafted or updated, work on the background document discussing all primary references, calculations, and other pertinent information (as well as the related files) is done concurrently and must undergo the same reviews. The background report should identify all data, discuss their quality rating(s), and document all decisions on their use. Analyses and any statistical manipulations of the data should also be clearly documented. If estimates of data accuracy or precision can be derived, these should be clearly noted as well.

It is possible that an emission factor document could be drafted by another organization other than Agency personnel or a contractor, and the best examples include a state agency or an industry organization. Such an effort would likely take advantage of expertise specific to a particular region or location, or experience with a specific industry or product that would result in significant savings



Task	Duration	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
Preliminary Review	45 Days							
Draft Document Preparation	24 Weeks							
WAM Review of Draft Document	2 Weeks							
Internal Review of Draft Document	30 Days							
Contractor Revision of Draft Document	30 Days							
WAM Review of Revised Draft Document	2 Weeks							
External Review of Revised Draft Document	45 Days							
Internal EPA Editorial Review	2 Weeks							
Contractor Revision of Revised Draft Document	30 Days							
WAM Review of Final Document	2 Weeks							
WAM Approval/Document Finalized and Distributed	1 Week							

Figure 3-2. Typical steps and timeline for document completion.

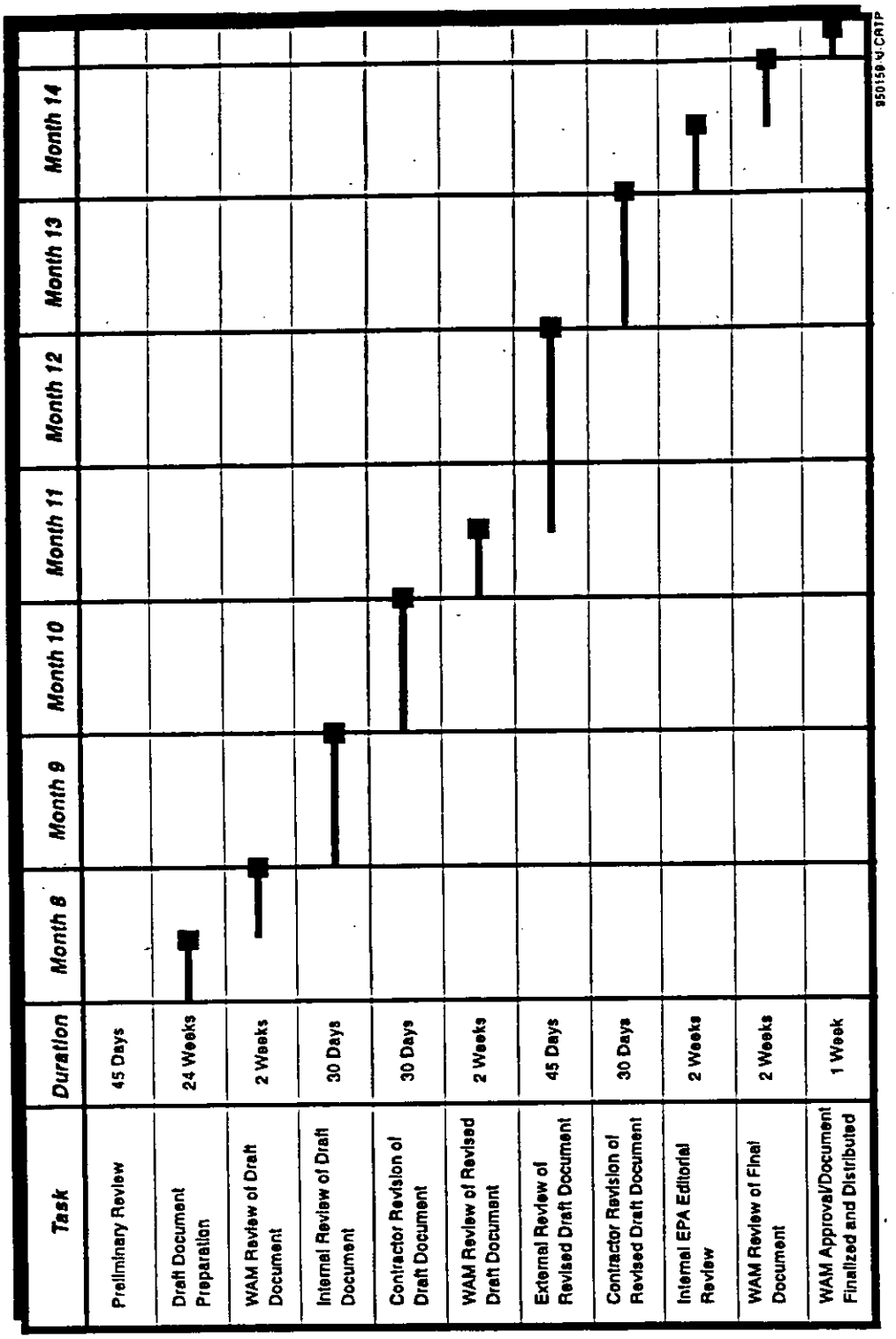


Figure 3-2. Typical steps and timeline for document completion. (Continued)

of cost or labor resources.

3.4 INTERNAL REVIEW

All documents must be reviewed for clarity, technical accuracy, and thoroughness and approved within the Agency. Suggestions made to address these goals should be incorporated or addressed before a document can be released for external review.

The project lead's review should be completed in about 4 weeks and, pending approval, will be distributed for internal review by other selected emission factor team members, including the Group Leader, and other relevant Agency personnel. This internal review should be completed in 30 days. The project lead should collect and consolidate all comments on this review draft, keep a copy of the draft with all comments and revisions that is sent to the contractor for revision, ensure comments are addressed and incorporated within 30 days, and then review the revised draft within 2 weeks after receipt. Pending the project lead's review and approval that this draft is technically satisfactory, it is then ready for external review. If the project lead cannot approve a revised draft because of technical deficiencies, then additional drafts, revisions, and reviews may be necessary before proceeding.

3.5 EXTERNAL REVIEW

As discussed above, a document must undergo internal review and receive approval before it can be released for external review. In general, anyone who supplied technical data for the document is asked to review it. External reviewers should include appropriate representatives of industry, state or local agencies, environmental organizations, and other technical experts who will agree to provide comments.

For external review, the project lead should provide an electronic edition of the revised draft AP-42 section containing all graphics and tables, the revised background report, and any files (such as spreadsheets, results and statistical analyses and databases), which has been compared with and agrees with the paper copy, to the CHIEF Sysop for posting on the CHIEF bulletin board. A "caution" page (included on the "typical format" disks) should be included as the first page of each draft AP-42 section. This page emphasizes the fact that this is draft information, is subject to change, and should not be cited, quoted, or used for regulatory purposes. For AP-42 sections, this should include an electronic edition of the background document. External review is projected to take about 45 days unless additional review time is approved by the project lead. Announcements of this review and a list of reviewers to whom the document is mailed should be provided by the project lead to the CHIEF Sysop to post messages on the CHIEF BBS to alert reviewers. When significant or extensive

changes are made in response to review comments, further review(s) of additional drafts may be necessary.

3.6 FINALIZATION OF DOCUMENT

All external review comments should be sent to the project lead for review and resolution with assistance from the editor and contractor. At this point, all revisions to be made addressing technical comments should be approved by the project lead, consolidated onto one copy, and delivered to the contractor to be completed within 30 days. The project lead should retain a copy of this next marked up draft consolidating all comments for checking against if another version is needed.

When the approved revisions are incorporated, the final draft document should be sent to the project lead for review to ensure satisfactory resolution and incorporation of all technical comments. After this, any editorial or final technical comments should be addressed and incorporated at this point by the project lead or contractor, the contractor must return the marked up copy to the project lead, and this draft is considered final. No additional technical or editorial changes should be made unless technical responses are inadequate or major modifications or additions resulted from the external and editorial reviews.

After the project lead is satisfied that all technical and editorial comments are resolved, a comparison of a printout from the electronic file must be made with the paper copy supplied. The project lead is responsible for the review to ensure that both the electronic and paper versions agree exactly after this comparison. Also, the project lead is the responsible authority for distribution of the completed document, which can be given pending the project lead's approval of the final version.

Once new data have been finalized, they should be entered into the FIRE database. See Sections 3.10.4 and 4.11 for more details regarding FIRE entry.

3.7 DISTRIBUTION MECHANISMS

After the project lead has authorized final distribution of the document, only the project lead keeps a paper copy for future reference and submits the electronic file for the document and two paper copies to the CHIEF Sysop with assurances that they agree exactly. One paper copy will be used in publishing the annual update of the AP-42 and the other will be used for the Fax CHIEF, both of which are discussed in further detail below. The electronic file will be posted on the CHIEF BBS and used for the periodic update of the Air CHIEF CD-ROM.

The project lead is responsible for ensuring that the electronic file given to the CHIEF Sysop and the paper copy agree. It is extremely important to maintain consistency in emission factor documents, especially in AP-42 sections, because of the various delivery formats to the user community, and the distribution procedures are to be strictly followed to ensure this. L&E documents are ready for publication and distribution when completed and have no annual cycle like the AP-42 except possibly the updates on the Air CHIEF CD-ROM.

Upon receiving the final, approved electronic file(s) and paper copies from the project lead, the CHIEF Sysop then notifies the individual(s) responsible for both the Air CHIEF CD and paper supplements to AP-42 that these updates are complete and ready for updating of the electronic and paper media. The Sysop is responsible for copying the final electronic file of an AP-42 section onto the writable disks that have been specially designated only for final, approved versions of AP-42 sections. Care should be taken not to mix up the final file with older draft copies. The AirCHIEF CD-ROM is used as the archival copy of all the sections of AP-42. The Sysop will maintain master files between printing of the Air CHIEF CD-ROM.

3.7.1 Hard Copy

Individual new or revised AP-42 sections will be held for publication together as a supplement to the Fifth Edition. L&E documents will be printed and made available as they are ready.

Because all items within emission factor documents are to be prepared and made available electronically, including graphics, the hard copy outputs of the electronic files should be of good quality and satisfactory as camera-ready copy suitable for a printing master.

3.7.2 Fax CHIEF

The Fax CHIEF will contain the printed version of all AP-42 sections (not L&Es) contained on the CHIEF BBS. A separate document will be maintained on the Fax CHIEF listing all AP-42 sections changed since the last publication of an edition or supplement.

3.7.3 CHIEF BBS

The CHIEF BBS is an electronic repository of the most up-to-date information on inventories and emission factors, including AP-42 sections, L&E documents, FIRE, SPECIATE, and the AIRS (Aerometric Information Retrieval System) Facility Subsystem Emission Factors (or AFSEF). It is accessible on the OAQPS Technology Transfer Network (TTN), phone number (919) 541-5742.

The CHIEF BBS will contain electronic files of the most current versions of final emission factor documents. A separate Errata File (see Section 3.8) will be maintained on the CHIEF BBS listing all AP-42 sections or L&Es changed since the publication of the last paper version. Historical

or archival copies of both AP-42 and L&E electronic files will not be maintained on the CHIEF BBS.

For final AP-42 sections, the CHIEF BBS will also be the repository for the electronic files of background information to support the assignment of emission factors and ratings. The background file shall contain the following electronic files:

- The full text of the background report;
- Any spreadsheet or database files that were used in the development or documentation of information contained in the AP-42 section or background report;
- Graphics files in the native format of the software used to generate those files and any exported format that was necessary to enable retrieval into WordPerfect® Version 5.1 for DOS, and that were used in the AP-42 section contained on the CHIEF BBS or the background report; and
- Any other electronic file that is deemed by the EPA project lead for the section designated as germane for documentation purposes.

In addition, the CHIEF BBS will be the repository for the electronic files of draft AP-42 sections, L&Es, and the background information to support the assignment of emission factors and ratings contained in the draft AP-42 sections. The file shall contain all the items listed above as well as the draft version of the AP-42 section.

3.7.4 FIRE

The FIRE database will contain emission factors from final, not draft, AP-42 sections and L&E documents that are available at the time of the annual FIRE update. The FIRE project lead is responsible for designating the updated or new AP-42 sections and L&E documents to be incorporated into FIRE, and will provide the data files to the FIRE contractor.

3.7.5 Air CHIEF CD-ROM

The Air CHIEF CD-ROM will contain the most recent electronic version of final emission factor documents as of the cutoff date for the most recent paper copy. The Air CHIEF CD-ROM will serve as the archival copy of the electronic version of AP-42 sections and L&E documents as revised or new editions are prepared.

3.8 ERRATA PROCEDURES

In the event that errors are detected and corrected in AP-42, an errata file will be available on the BBS. For L&E documents, errors would be corrected only when and if the document is revised. The L&E errors will also be in an errata file and posted on the BBS.

The project lead is responsible for any necessary changes, including updating footer dates, and preparing notices to be posted on the CHIEF BBS and Fax CHIEF, and *The CHIEF Newsletter*, if deemed necessary by the EFIG leader. The project lead will notify the CHIEF Sysop of what material on the CHIEF BBS must be revised and will provide an updated paper copy and electronic file for the pages, in addition to an Errata File notice to be posted on CHIEF.

The Sysop will then put the corrected edition on the CHIEF BBS and post the Errata File notice. The project lead will submit the corrected paper version to update Fax CHIEF, and to the coordinator of printing of the next supplement.

In addition, the project lead is responsible for the same reviews for consistency between the electronic and paper versions as well as the requisite authorizations that are essential as in a full, regular update. The project lead also must prepare a memo for the document file to record any such revisions, and a log for this process will be maintained by the project lead so that the revisions to be printed are done appropriately.

CHAPTER 4

FACTOR DEVELOPMENT AND PRESENTATION DETAILS

This chapter is intended as a compilation of procedures to be used as a guide for the individuals who prepare or revise emission factor documents to be published as AP-42 sections or L&E documents. Such new or revised emission factor documents are continually being prepared. Following a standard technical and editorial approach to preparing and revising these documents will maintain internal consistency within each document and will help to make the information presented in both document series more consistent in format. Since the procedures for AP-42 and the L & E documents are similar, they will be discussed on the same basis hereafter, except where specific differences need to be noted.

Format and style specifications for both AP-42 and L&E documents appear in Appendix A and should be reviewed early in the course of preparing a new or revised AP-42 section or L&E document, by both the prospective author and the clerical staff who will produce the final section.

4.1 CONTENT AND FORMAT 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 applicable or typical control devices
- Table of emission factors and/or equations for calculating emission factors
- List of references

The emission factor tables, usually presented toward the end of the emission discussion portion of the section, will be the most critical component of the section. The text and flow diagrams explain and qualify the tabulated emission factor data.

Users often turn first to the tables to obtain the emission factors. If the tabular information is not clear, the user may then consult the diagram 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 about any qualifications placed on the factors. The most important part of an AP-42 section, therefore, is its emission factor tables, which must be able to stand alone in terms of clear technical content 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. Source Classification Codes (SCCs) should be included in the tables for each emission source.

Footnotes to tables that explain any and all qualification of factors and conversions should be provided. 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. The same terminology should be used 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 block diagrams, if they do not detract from the primary purpose of complementing the emission factor table. However, be aware that all illustrations and diagrams must be in a certain format in order to be compatible with CD-ROM, Internet, and CHIEF BBS requirements.

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.

The references for 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 identify the reference clearly, and provide the reader with sufficient information to obtain a copy of it.

Because the AP-42 and L&E document series contain 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 document format and electronic publishing requirements.

The single, most important point about the format of any emission factor document is that all elements including, but not limited to, text, tables, figures, diagrams, and reference lists, must be prepared electronically, and the final version must be suitable as a camera-ready master for printing and electronic distribution. EFIG has designated that the word processing software WordPerfect® Version 5.1 be used for all emission factor documents. Any graphic drawings or figures should be prepared in a software, such as Corel Draw®, that is compatible for producing a camera-ready master without significant additional effort. Details regarding format for AP-42 sections and L&E documents can be found in Appendix A.

4.2 Content and Format of a Typical L&E Document

The major purposes of L&E documents are to locate the significant sources of the pollutant of interest and to identify techniques for estimating emissions for these sources. Each L&E document typically begins with an executive summary listing an overview of the primary categories of emissions. This summary should include a table illustrating the national emission estimates developed for the predominant categories emitting the pollutant. Due to the evolving nature of toxic air pollutant programs, it is often difficult to develop supportable national emission estimates for all source categories. As new information is developed, the magnitude of the national total emissions will be adjusted as well as the relative rankings of source categories.

The first section, usually entitled "Purpose of Document," typically states general information about the series of L&E documents and contains a current list of pollutants for which published L&E documents exist and their EPA publication numbers. The remainder of Section 1.0 usually provides details on any relevant standards, their history and their current status, issued by EPA or possibly other agencies, such as the Occupational Safety and Health Administration (OSHA) or the U.S. Consumer Product Safety Commission, and which may affect emissions of the pollutant of interest. This section typically concludes with paragraphs advising readers about how to best use the document, cautions about the data, and opportunities for document review and comment as well as providing additional data.

The second section usually begins with an overview of the entire document, which briefly outlines the main focus of each subsequent section and any appendices. The remainder of Section 2.0 usually describes the ratings assigned to emission factors and the criteria for assigning these ratings, and also describes the criteria for data quality ratings for source tests from which the emission factors were derived. Chemical and physical property data are typically included in Section 3.0.

The remaining sections vary significantly and will be structured according to the types of sources and processes that emit the pollutant being addressed. Information such as how the substance is created or prepared for use, or any manufacturing operations in which it is used are discussed. However, like AP-42, L&E sections include process flow diagrams, discussion of emissions and controls, and emission factor tables. Process descriptions in one document could theoretically be interchanged with that in the other if they were both revised at the same time and to the same level of detail.

The last section in an L&E document prior to the references describes typical sampling and analytical methods for the pollutant in question. The last text section usually lists the references used to prepare the L&E document.

Required appendices include one in which methods for estimating the national emissions are described, and another containing a summary table of all emission factors (by SCC) presented in the L&E document. Details regarding format for L&E documents can be found in Appendix A.

4.3 Data Collection and Review

The first step in characterizing sources and pollutants for emission factor documents involves a search for and collection of available emissions information associated with the sources or pollutants of interest. The purpose of this effort is to gather current that can be used to write process descriptions, identify facilities, pollutants, and emission points, and develop emission factors and emission estimates. This information search should include the following sources: (1) current AP-42 background files; (2) literature searches; (3) emission factor databases and bulletin boards; (4) EPA and other federal agency contacts; (5) State and local agency contacts; and (6) industry contacts and trade associations.

4.3.1 AP-42 Background Files

The AP-42 background files are the beginning point for any AP-42 section update effort and should be reviewed for any section being updated. The file contains the background document for the existing section, copies of emission test reports used to establish the emission factors, copies of other emission test reports cited in the background report, as well as copies of other references. The file may also contain recent information or test reports accumulated by various EPA personnel.

4.3.2 Literature Search

A literature search for source test and background information should be conducted for the emission source category or pollutants in question. This search can be conducted by EPA library services. The request for a search from Agency library services should be made directly through the EPA Project Manager. It should be noted, however, that the EPA search may be limited and may need to be augmented by additional external searches.

The following references and documents are examples of sources of information that should be reviewed. If a contractor is involved, the project lead should develop a list of the best places to look.

- Background Information Documents (BIDs) for New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) or Maximum Achievable Control Technology (MACT) standards;

- Locating and Estimating (L&E) documents;

- Control Techniques Guidelines (CTG) documents;
- Control Technology Center (CTC) documents;
- References in the National Technical Information Service (NTIS);
- References in the Compendex Plus computerized data file in DIALOG, a computerized bibliographic utility;
- *Kirk-Othmer Encyclopedia of Chemical Technology* (for process information);
- Mannsville *Chemical Products Synopsis*;
- SRI *Directory of Chemical Producers*;
- *Chemical Marketing Reporter: Chemical Profiles*;
- Technical Trade Associations;
- AWMA's Engineering Manual and Journal Articles;
- University libraries;
- Emission factor reports produced by States or local agencies or Europe and elsewhere;
- Information in AP-42 background file pending review.

4.3.3 Emission Factor Databases

The following databases and bulletin boards are sources of emission factors and supporting data. A search of these databases early in the data collection process can identify data leads and possible sources of information to characterize a particular industry.

- EPA's Factor Information Retrieval (FIRE) System - a consolidation of criteria and HAP emission factors from the AP-42 Fifth Edition, L&E documents, state source test reports, and Aerometric Information Retrieval System (AIRS)-Facility Subsystem (AFS).

- VOC/PM Speciation Database Management System (SPECIATE) - clearinghouse for speciation profiles (not emission factors) for VOCs and PM used primarily for atmospheric modeling.

- Toxic Release Inventory (TRI) database. Most useful for preparing L&E documents, but it can also help in identifying facilities related to an AP-42 section and it may identify additional toxics being emitted by those facilities.

- National Air Toxics Information Clearinghouse (NATICH) database.

- Source Test Information Retrieval System (STIRS) - 2000+ stack test reports collected from states by EPA.

- The emissions estimation code in the AIRS database may identify which States have developed their own emission factor or rely on individual source tests to estimate emissions for the category of interest.

- Source Characterization Group source test files, including the TSAR database.

4.3.4 EPA and Other Federal Agency Contacts

Various EPA offices and other Federal Agencies may also be able to provide information characterizing emissions and should be contacted. Potential sources of information include the ESD and the EPA research laboratories, the Department of Energy, the Department of Defense, and the Department of Agriculture.

The ESD 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, and other useful technical reports. ESD reports should be reviewed for data on the industry in question. In addition, EFIG, the CTC, and the Air Quality Strategies and Standards Division should be contacted for information that may be pertinent to emissions document development.

Other parts of the Agency, such as the Acid Rain Division of EPA's Office of Air and Radiation, and Climate Change Division of EPA's Official Policy Planning and Evaluation should be contacted by the EFIG engineer in seeking information on a source category.

EPA laboratories that might provide useful data include the Risk Reduction Engineering Laboratory (RREL) in Cincinnati, and both the Air Pollution Prevention and Control Division

(APPCD) and the National Exposure Research Laboratory (formerly AREAL) in Research Triangle Park (RTP), NC. These laboratories are generally more research oriented than OAQPS, and often develop and report emission data that are usable in emission factor documents.

The EPA 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 is concentrated in 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.

Initial requests should be specific. It is helpful to find personnel who have visited the sources being studied and who can offer valuable detailed information on equipment configurations, control devices, emissions, etc., that may not be otherwise available. Avoid recontacting and recollecting the same data already solicited and incorporated into STIRS and other databases. The project lead should also make the initial contact to other Federal Agencies.

4.3.5 State and Local Agency Contacts

State agencies are contacted if a source category is concentrated in certain states, with initial contact made by the EPA WAM. As with the EPA Regions, it is desirable to contact someone who has visited the source types of concern. The Federal Report Act dictates that no more than nine state agencies or private entities may be contacted with the same request. State agency contacts may be obtained through the respective EPA Regional Offices. In order to avoid redundancy, make all requests in the context of work already done.

4.3.6 Industry Contacts and Trade Associations

Companies may be contacted to obtain copies of test reports and process information. To select which companies to contact, a list of plants can be compiled from current directories and the companies with the most plants can then be identified. By contacting the headquarters of such companies, requests can be centralized and coordinated and information can be collected on a large number of plants and pollutants. In cases where contacting the major companies would not provide sufficient information, additional companies may be identified.

Affected trade associations 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 or document. EFIG maintains a computerized list of potential and past contacts, by section, and their phone numbers and addresses which should be used as a starting point when contacting these associations. Due to the dynamic nature of individuals and organizations, this information is often dated and must be augmented by direct contact with individuals to ensure currency of information. In

addition, many relevant trade association are listed in the *National Trade and Professional Associations of the United States* directory.

4.4 DATA REVIEW AND ANALYSIS

After the data have been collected, the next step is to review and analyze the data to determine which data should be used for the development of emission factors and how that data should be grouped. The developer must evaluate the validity of individual source tests, how well the tested sources represent the source category as a whole, and whether subdividing the source category is warranted. The results of each source test must have a data quality rating assigned. A clearly written summary of all data evaluated, any necessary assumptions that were made, and all decisions reached should be developed for incorporation into the background report. Both the data that is excluded from eventual use in any emission factor and the data that is used should be described in a concise manner.

4.4.1 Source Test Report Review

Emission factors in AP-42 sections and L&E documents are typically based on data obtained from a variety of sources including, but not limited to, published technical papers and reports, documented emission test results, and personal communication. The data obtained 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.

Source test reports should be reviewed and summarized for at least the following items. The reviewer should also make note of any other items about the facility, test method, or the test report that might have impacted the total emissions or the emissions per throughput unit.

- process, feedstock, or fuel type
- plant capacity and operating rate during the test
- control devices and their operating parameters
- the age of the facility and the control devices
- any process or control device upsets during the test
- the pollutants tested for and the test methods used
- any deficiencies in the test procedures
- the number of test runs

Two EPA publications may be used to assist the reviewer in examining source test reports, *Guidebook: Preparation and Review of Emission Test Reports*, and *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) on the OAQPS TTN electronic bulletin board at (919) 541-5742. The reviewer should also be familiar with the pollutant definitions and conventions used in AP-42 and L&E documents, and with some of the difficulties in deriving emission factors for the pollutants of interest from the available source tests. Section 2.4 describes the pollutant terminology preferred for emission factors and how the available test methods relate to those pollutants.

In reviewing source test reports, the following general criteria can be used to avoid analyzing excessive amounts of data and to ensure that proper data are used in updating emissions documents.

- Emissions data should be obtained from a primary source (i.e., test reports) whenever possible. It is necessary to assess the primary references in order to develop accurate data quality ratings and to ensure that valid assumptions and procedures were followed in calculating the facility's emission rates. Report summaries should not be used, and if a source of information cannot be identified, it should be eliminated.

- If sufficient data exist, focus efforts on test reports for those technologies and emission controls that are most commonly used in the industry. Processes and controls at some industries change periodically due to market trends, improvements in production efficiency or product quality and pressures to reduce pollution. Test reports which are less than ten years old are therefore more likely to be representative of the most common technologies and emission controls. However, this may vary depending on the specific industry, so some knowledge of changes in the industry is necessary in deciding how best to use older data. Although efforts should focus on current technologies, information on older technologies is of value for the purpose of tracking historical trends in emissions.

- Source tests where more than one test run was performed at each site are preferred.

- Test reports should contain sufficient detail to evaluate both the testing procedures (e.g., sampling methodologies and test methods used) and the source's operating conditions (e.g., charge rate or throughput data).

- Source test data should normally be used only if the data were obtained under conditions that are representative of operating conditions typically encountered at the source in question.

- The following data are usually excluded from further consideration:

  - Test series reported in units that cannot be converted to the selected reporting units using reasonable assumptions that will not significantly increase the uncertainty of the emissions rate;

  - Test series in which the process or emission source or control device is not clearly identified and described; and

  - Test series in which it is not clear whether the emissions measured were controlled or uncontrolled, or if other emission sources may have contributed to the measurements.

If actual production data for the time period of the test series are not available, production rates for periods of similar operations can be used, or an annual average production rate can be used. If such alternative production rate data are used, an attempt should be made to confirm and document that the facility was operating near the alternative production rate. Note that the data quality rating should be reduced if actual production rates for the test period are not available and surrogate methods for determining production are not reliable or are not documented.

For fuel combustion sources, the F-factor method can also be used to determine emission factors from stack concentration data when fuel throughput rates are not available. This method relies on the fact that the CO_2 concentration in the stack can be closely correlated to the heat input rate because the heat content of a fuel is closely related to its carbon content and almost all carbon is converted to CO_2 in an efficient combustor. The F-factor for a specific fuel or fuel type allows a pollutant concentration to be expressed as an emission factor in units of pounds per BTU. For most fuels a conversion to pounds per weight or volume of fuel combusted can be made if desired by using an average heat content for the fuel. Appendix C contains a detailed description of how to use the F-factors.

There are also situations where throughput data are not necessary or even desirable for use in an emission factor. The pollutant concentration by itself may be the best way to express an emission factor for the outlet of many control devices and air conveying systems. In such a case the air flow from the device becomes the throughput.

4.4.2 Assign Data Quality Ratings

After reviewing the test reports it should be possible to assign a data quality rating to each pollutant emission rate for each test series. The individual data quality ratings are not to be confused with the overall emission factor ratings. The data quality ratings are an appraisal of the reliability of the basic emission data that will be used to later develop the factor. The emission factor rating is an appraisal of the ability of the overall average factor to represent a national annual average emission rate for the source category. Emission factor rating determinations are discussed in section 4.6.7.

Test data quality is rated A through D, based on the following criteria:

A - Tests are performed by a sound methodology and are reported in enough detail for adequate validation.

B - Tests are performed by a generally sound methodology, but lacking enough detail for adequate validation.

C - Tests are based on an unproven or new methodology, or are lacking a significant amount of background information.

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

The quality rating of test data helps identify good data, even when it is not possible to extract a factor representative of a typical source in the category from those data. For example, the data from a given test may be good enough for a data quality rating of "A," but the test may be for a unique feed material, or the production specifications may be either more or less stringent than at the typical facility.

In following the general guidelines discussed above, four specific criteria can be considered to evaluate the emission data to ensure that the data are based on a sound methodology, and documentation provides adequate detail. A test series is initially rated "A through D" in each of the following four areas.

- Source operation. If the manner in which the source was operated is well documented in the report, and the source was operating within typical parameters during the test, an A rating should be assigned. If the report stated parameters were typical, but lacked detailed information, a B rating is assigned. If there is reason to believe operation was not typical, a C or D rating is assigned.

- Test method and sampling procedures. In developing ratings, the accuracy of the test method as well as the adequacy of the documentation are considered. In general, if a current EPA reference test method appropriate for the source was followed, the rating should be higher (A or B). If other methods are used, an assessment is made of their validity. If it is judged that the method was likely to be inaccurate or biased, a lower rating (C or D) is given. A complete report should indicate whether any procedures deviated from standard methods and explain any deviations. If deviations were reported, an evaluation is made of whether these were likely to influence the test results.

- Sampling and process data. During testing, many variations can occur without warning and sometimes without being noticed. Such variations can induce wide deviations in sampling results. If a large spread between test run results cannot be explained by information contained in the site test report or from test reports of other sources, the data are suspect and are given a lower rating. However, it should be recognized that a process may have highly variable emissions and a lower rating may not be appropriate solely on the basis of wide deviations in sampling results.

- Analysis and calculations. Ideally, test reports should contain original raw data sheets and other QA documentation. If there are data sheets, the nomenclature and equations used are compared with those specified by EPA to establish equivalency. The depth of review of the calculations is dictated by the reviewers' confidence in the ability and conscientiousness of the tester, based on such factors as consistency of results and completeness of other areas of the test report. Reports may indicate that raw data sheets were available but were not included. If the test report is of high quality based on the other criteria, the quality rating should not be lowered due to a lack of data sheets.

An overall emission data quality rating is developed considering the scores on the four criteria. There is no precise equation for the relative weighting of the factors, because each report presents different issues, and the rating system needs to provide flexibility to consider the strengths and weaknesses of each test series and reach a judgment on the overall rating. However, the two criteria concerning (1) the test method and sampling procedures and (2) the sampling and process data should be weighted most heavily. If either of these two criteria are assigned a low rating, this low rating should be assigned as the overall data quality rating, no matter how complete the documentation is. Because ratings are somewhat subjective, detailed comments describing the discrepancies identified in the test report during the evaluation and the rationale for assigning the overall test report rating should be included in the background documentation.

After assigning a preliminary emission data quality rating based on the four criteria, the quality of the production data is considered. Production data quality can only reduce the emission data quality rating. General guidelines for maintaining or reducing the preliminary data quality rating are described below. The emission data rating can be lowered by as many as three quality levels. However, if the emission data quality is already low (e.g., had a C rating) and cannot be lowered two or three levels, then the final data can be assigned a D rating. This approach is reasonable because the D rating reflects data that may be in error by an order of magnitude. The alternative approach is to omit the data from consideration altogether. The guidelines for reviewing production data and assigning final data quality ratings are the following:

- Do not change preliminary emission data quality rating if production was measured during the test series or during the testing period. (If measured during the testing period but not during the test series, it can usually be assumed that the facility continued to operate at the same rate throughout the test period.)

- Reduce quality rating to one level below preliminary emission data rating if production was measured during a different test period and it can reasonably be assumed that the facility was operated at a similar rate during both test periods.

- Reduce quality rating to two levels below preliminary emission data rating if production data are based on annual capacity or annual production data, and the facility provides information concerning the rate at which the facility operated during the test period and the number of days per year that the facility operated.

- Reduce quality rating to a D rating if production data are based on annual capacity or annual production data, and it is necessary to make assumptions that are not confirmed by the facility concerning the capacity at which the facility operated during the test period and the number of days per year that the facility operated.

4.5 GROUP THE EMISSION DATA

After the individual data points have been reviewed and rated, the data must be grouped into related clusters for which the average emission factors will be developed. It may be straightforward to group the data for industries where similar processes are used by most of the facilities tested, but it is more likely that considerable engineering judgement will be required for at least some of the emission points in the source category. The developer should use an understanding of the processes used by the industry and a consideration of the factors that might significantly affect the emissions to group similar data together. Statistical techniques may be used to refine the initial groupings where

there is sufficient data. Examples of some of the criteria to be considered when grouping the data are given below.

- Source Category. Among the test data for the specific source category under review there may be some test data for generic emission sources, such as combustion sources. If the combustion gases do not contact the industry's process material and there is no reason to believe that the combustion equipment used is peculiar to the industry, then the combustion data might be better grouped with a potentially larger data base for combustors in all industries. Even where the combustion gases do contact the process material, there may be no need to develop CO_2 or SO_2 emission factors if the only carbon or sulfur available comes from the fuel and not from the industry's process material.

- Process Type. Data from two or more distinct processes used to producing the same product, such as wet and dry processes for cement manufacturing, should usually be put in separate groups. But there may be individual steps common to the two processes which could be expected to have similar emissions.

- Representativeness of Source. Data from some sources may be considered for a separate grouping based on the facility's size or age. However, such a separation should be verified by a comparison of the data set as well consideration of why the size or age of the facility might impact emissions.

- Emission Source. Primary crushers versus downstream size reduction equipment, smelting furnaces versus refining furnaces.

- Equipment Design. Direct-fired versus indirect-fired heaters, countercurrent versus parallel flow dryers.

- Operating Conditions. Dryer temperatures, moisture start and end points, batch versus continuous operation, wet scrubber pressure drop.

- Raw Material or Fuel Characteristics. Moisture content, sulfur content, hardness.

- Control Devices. Do not group emissions data from different control devices together, except where for pollutants which are not expected to be controlled by those devices. (But note that the comparison of controlled to uncontrolled for the same test series may be extremely useful.) Also note that emissions of some pollutants should be grouped

with "uncontrolled" data even though they were measured downstream of a device which controlled other pollutants, such as NO_x or CO after a baghouse.

- Test Method Used. The test method used defines what pollutant was actually measured. For example, do not group NMOC data with TOC data unless it can be assumed that the compounds which are not detected by either method are not likely present. Also, the same test methods may produce non-comparable results if run at differing stack temperatures.

The discussion in the next section on handling of outliers may also be of use in determining if a data point is non-representative due to some of the criteria given above. All data found should be rated, grouped, and identified in the background document. A clear description of what data was grouped together and why should be provided in the background document. Any data which could not be rated or grouped should also be identified in the background document.

4.6 Develop Candidate Emission Factors and Draft Section

After the emissions data have been grouped, the author develops the candidate emission factors for each process or grouping. This process may involve eliminating some data from further consideration or converting some data to a different format in order to allow for averaging. It may also involve adjusting some of the grouping choices made earlier, depending on the quantity or quality of data available. In this regard the author should keep in mind that the goal is not to calculate a number of unrelated averages, but is to present an internally consistent representation of uncontrolled emissions and how controls affect those emissions. Therefore, PM10 factors should always be less than or equal to total particulate factors, and controlled emissions should always be less than uncontrolled emissions. As always, any decisions on how or if to use any data should be clearly documented in the background report. The purpose of this section is not to present a statistical treatise, but merely to describe the conventions and preferences which have been used in developing emission factors. Deviations from these practices are allowable as dictated by the specific situation.

4.6.1 Averaging of Data

An emission factor should represent the expected emissions from a collection of emission sources of a similar type. They can be based on emission source testing, material balance, or engineering analysis, and they can be presented as a simple average or mean, median, geometric mean, or as a formula which accounts for the significant parameters affecting emissions. The presentation may include additional information on ranges, confidence intervals and other measures of uncertainty or variability, depending upon the extent of data available. The arithmetic mean is

usually used for emission factor development and is the preferred measure unless there are strong reasons to use an alternative measure.

Before determining an average emission factor for all sources tested, a single average emission rate for each single source should be determined. Therefore, the results of individual test runs on a given source are reduced to a single value for that source using the arithmetic mean. If tests of the same source are available for several years they are also usually combined into a single value to represent that source. The average emission factor for the source category is then determined by computing the arithmetic mean of the single values for each source tested. In this way a single facility's emissions rate does not disproportionately affect the emission factor just because it has been tested many times.

In some cases the data available may exhibit characteristics suggesting that a geometric mean is a more appropriate descriptor of the central tendencies of the data. Also, there are cases where the median may be more representative of a typical emission value. The rationale for utilizing a geometric mean or median instead of the arithmetic should be decided with the EPA lead for specific applications and should be documented in the background report. An explanatory footnote should also be added to the emission factor table indicating the use of a non-arithmetic mean approach.

Emission factors should be represented as a single value whenever possible, or as a formula where significant effects of additional parameters can be quantified. If a formula is presented it is good practice to also include example calculations of factors using the formula and typical ranges or even default values for the variables. An indication of the variability, such as a range of values, may be accompany an emission factor if it will contribute to an understanding of the scatter of the data. Any insights into how the range can be further sub-categorized or explained should be included. If necessary and supportable by the data, the author can break the emission source into smaller sub-source types based on age, size, operating temperatures or other parameters, and present separate emission factors rather than ranges for each sub-type.

Confidence intervals can provide valuable information on the uncertainty and variability of emission factor data. However, rarely are there sufficient data to allow valid confidence intervals to be generated. Prudent application of statistical procedures precludes the development and presentation of confidence intervals in emission factor documents 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., the source is operating at typical conditions); and

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

When developing a factor, the investigator should always be sensitive to situations where data are sufficient (probably only when there are about 10 or more data points and they are predominantly rated A or B) for such intervals to be meaningful and valid. When sufficient data are available, the author should provide the resulting confidence interval information in the background report and the AP-42 section or L&E document. Documentation such as data plots (histograms) may be included with the background information if desired.

4.6.2 Combining Tests of Different Quality Ratings

In the emission data review process, individual source tests were each given a data quality rating of "A" to "D" (section 4.4.2 above). In developing the average emission factors from these rated source tests, the author should attempt to develop the most reliable factor by using only the most reliable tests. In the ideal situation, a large number of A-rated source tests for typical sources 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 rarely possible due to the shortage of A-rated data. If the number of A-rated tests is such that the inclusion of B-rated tests would increase the confidence of the emission factor, then B-rated test data are included in the calculation of the average factor. It is also possible to include C- or even D-rated test data with the A- and B-rated data in some situations. This should only be done where the number of A- and B-rated tests is so small that the representativeness of those tests is suspect and where the author has determined that the lower-rated tests do not appear to be biased versus the better documented and higher-rated tests. In such a case the inclusion of more tests, even of a lower quality, is warranted because it increases the confidence that the average is representative of the source category as a whole. Unrated ("U") test data are used only when no better data are available, and provide only an order-of-magnitude value. They should not be combined with any rated test data.

4.6.3 Controlled Emission Factors

An effort should be made to obtain and present data for both uncontrolled and controlled emissions in emission estimation documents. Emission factors should be clearly identified as uncontrolled or controlled by a specific control device, either in the table heading or in individual entries in the table or in footnotes. One method of showing both controlled and uncontrolled factors

in a table is to give the process name with its SCC code on one line and use indented lines underneath this overall process name for uncontrolled and specific control device descriptions and factors.

If a control device is common to an entire industry and is used as an integral part of a process in order to make it economically viable, it should not be labeled "controlled". However, the emission factor table and the text should describe the standard process equipment used to arrive at these uncontrolled emission rates. Example of such equipment are cyclones used to separate products from air in pneumatic conveying systems, cyclones used to recover catalyst in petroleum catalytic crackers, and chillers added to degreasers in order to reduce solvent loss.

The text should contain information on applicable control techniques and should reference Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), New Source Performance Standards (NSPS) Background Information Documents, or other documents that contain details on application of these techniques to the source category. The text should also note if there is a probability of rapid developments in control technology which may alter any typical control efficiencies mentioned in the text.

The information presented should enable the user to estimate both controlled and uncontrolled emissions wherever possible. This may be accomplished by either determining both the controlled and uncontrolled emission factors, or by developing only one factor (either controlled or uncontrolled) and providing a default control efficiency. The preparer should exercise caution and judgement in deciding how to determine and present emission factors or control efficiencies. If both controlled and uncontrolled emission rates are determined, the control efficiency implied by the ratio of the controlled to the uncontrolled source emissions should be reviewed to determine the plausibility of the implied control efficiency. Alternatively, the average control efficiency can be determined and shown explicitly, rather than a controlled factor, in cases where tests are available for both pre- and post-control situations on the same sources. Also, one must be careful that the process conditions for both controlled and uncontrolled emissions tests are comparable.

A limited discussion of the typical range of control efficiencies and the parameters affecting the implied or default emission factor should be included in the Section if the information is available. Note that this discussion of the control efficiencies is generally not necessary for straight-forward applications of traditional control devices.

A basic description of the techniques typically used by industry to control PM/PM-10, VOC's, SO2, NO_X, CO and HAP's can be found in the following EPA documents:

Control Techniques for Particulate Emissions from Stationary Sources - Volume 1 - EPA 450/3-81-005a - September 1982

Control Techniques for Particulate Emissions from Stationary Sources- Volume 2 - EPA 450/3-81-005b - September 1982

Control Techniques for Sulfur Oxide Emissions from Stationary Sources - EPA 450/3-81-004 - April 1981

Control Techniques for Carbon Monoxide Emissions from Stationary Sources - EPA 450/3-79-006 - June 1979

Control Techniques for Nitrogen Oxide Emissions from Stationary Sources- Revised - Second Edition - EPA 450/3-83-002 - January 1983

Control Techniques for Volatile Organic Compound Emissions from Stationary Sources - EPA 450/3-??-0?? - Date?

Handbook: Control Technologies for Hazardous Air Pollutants (HAP Manual) EPA-625/6-91-014, NTIS # PB92-135904

These documents briefly describe the efficiencies commonly achieved by major types of control devices in current use and describe how to estimate emission reductions using control systems. A Computer software program, HAP-PRO, can also be used to estimate control efficiencies of various devices for Hazardous Air Pollutants. This computer software program is available on the OAQPS Technology Transfer Network Bulletin Board in the Control Technologies Center Area.

Some control devices reduce emissions of another pollutant besides the one for which they were designed. This is known as secondary or coincidental control. For example, venturi scrubbers have been known to reduce SO_x and lead emissions as well as particulate emissions. There are also cases where the application of controls for one pollutant may slightly increase emissions of another pollutant, such as NO_x controls leading to increased CO or VOC emissions. Secondary control emission reductions should be noted in the text, and if quantifiable, should be included in the emission factor table or its footnotes.

Tables should be designed or footnoted so that those pollutants not affected by a particular control device are not labeled as "controlled" and do not have an emission factor presented for them unless it is different than the uncontrolled factor. For example, SOx emissions would not be

considered "controlled" if the control device were a flare, and the table should reflect that distinction.

4.6.4 Outliers

An outlier is a data point that does not conform to the pattern established by other data. Generally, a suspected outlier is much smaller or larger than the other data points. There are three basic ways an outlier can occur: (1) mistakes in readings, (2) different processes being lumped together, and (3) real deviation. Mistakes in readings can occur during any stage of the data processing or in the data measurement process. Transcription errors and calculational errors are common, but unusual readings from instruments may be caused by power failures, improper calibration, misreading instruments, contamination of samples, leaks, chemical interaction, etc. Not adhering to an experimental design or a standard operating procedure (SOP) can also affect recorded data. Because many hand calculations are needed to derive an emission rate per production rate from the initial concentration and flow measurements, these should also be checked for any data point that appears suspect. Many mistaken readings can never be detected or verified.

Finally, an apparent outlier may not, in fact, be an outlier at all, but rather an unusually high (or low) value that is real - a rare deviation that is legitimate. Moreover, the rare deviation may be a datum of vital interest in assessing human or environmental risks.

A number of statistical tests are available for treatment of outliers. Most of the statistical tests allow selection of a level of significance which is related to the probability of being correct, if the test concludes that a datum is an outlier. It is recommended that a statistician be consulted on the appropriate outlier test to use, and what the results of the test mean.

No observation should be rejected or deleted solely on the basis of statistical tests, since there is always a predictable risk of rejecting a "perfectly good" datum. Only if a mistake can be identified and verified should an apparent outlier reasonably be rejected. Suspected outliers should remain in the database and be clearly identified as suspected or confirmed outliers (i.e., whether they are included or excluded from calculation of the average factor). Even though statistical tests are a key component in justifying the exclusion of datum that is believed to be nonrepresentative of the source category, exclusion of a suspected outlier requires more than a statistical test; it also requires experience and judgment on the part of the technical personnel reviewing the data set. In emission factor work, incorrectly grouping sources into different sub-types (or into one general type) may be responsible for producing the suspected outliers.

4.6.5 Detection Limits

Sometimes the result of a stack test is not an emission rate, but the knowledge that the pollutant was not present at or above the limit of detection of the test method. Given below are some guidelines on how to use method detection limits (MDLs) for developing emission factors in such cases. Note that a run is a single, complete traverse of the stack, and a test is the average of several runs, usually three.

- Determining a facility's average emission rate from a single test. If all of the runs from a test are below the MDL, record the emission rate for that test as "BDL" (below method detection limits), with the MDL clearly referenced. For clarity, the MDL may be expressed in emission factor units, i.e., lb/ton coal. If some of the runs are above detection limits and some are below, use half of the MDL for the runs that were below in the calculation of the facility's average emission rate (unless the BDL run's MDL was much higher than the other runs'detect values).

- Determining a source category emission factor from multiple tests. If all facilities have their average emission rate recorded as "BDL", report the average emission factor as BDL, with the MDL clearly referenced. If there is a mixture of "BDL"s and numeric average emission rates, use half of the test MDL for each "BDL" test as that facility's average emission rate, and include that rate for the facility in the calculation of the average source category emission factor (unless the BDL test's MDL was much higher than the other tests' detect values).

- Determining an emission factor when the MDL varies among tests or runs. Some tests or runs may have much higher MDLs than others in the same data set. This can potentially lead to a situation where averaging in half of a high MDL will bias the average high. If half of the MDL for a BDL test is larger than all other single run detect values for the other tests in the data set, then disregard the BDL test in calculating the average emission factor. If half of the MDL for a BDL run is larger than all other single run detect values for that test series, then disregard the BDL run in calculating the facility's average emission rate.

The following example illustrates these principles for the case where tests are available for three facilities:

Test A : Three runs (all BDL); DL=50 mg/Kg coal.
Report the results as "BDL, DL=50 mg/Kg coal".

Test B : Three runs (7, 9, and 11 mg/Kg coal); DL=5 mg/Kg coal.

Report the emission rate for the test as the average of the three runs, which is 9 mg/Kg coal.

Test C : Three runs (6 and 10 mg/Kg coal, and one run BDL; DL=5 mg/Kg coal. Report the emission rate for the test as the average of the three runs, using 2.5 for the run that was BDL, i.e., (6+10+2.5)/3=6.2 mg/Kg coal.

To determine an overall emission factor from the three tests, use only the Test B and C data because in Test A, half of the DL (50) is 25, and that value is greater than any other single run detect value from Tests B and C. Therefore, (9+6.2)/2 = overall emission factor = 7.6 mg/Kg coal.

- If a statistical outlier test is to be performed to determine whether any data points should be eliminated from further analysis, then half of the MDL should be used as a numeric value for those cases where a pollutant was below method detection limits.

- There are no "standard" criteria concerning how far above the MDL the data must be to be considered quantitative rather than qualitative (e.g., 4 x MDL or 5 x MDL). The data would not necessarily be considered non-quantitative if they were less than four or five times the MDL. However, the precision of the values would be decreased the closer the data are to the MDL, thus increasing the uncertainty of the values. The data would still be quantitative but should be used with more caution.

4.6.6 Use of Blanks

When reviewing source test reports, blank analysis results should be noted to determine the existence and magnitude of contamination problems. The criteria for evaluating blanks apply to any blank (method, field, etc.) associated with the samples. If problems with any blank exist, all data associated with the test report must be carefully evaluated to determine whether or not there is an inherent variability in the data, or if the problem is an isolated occurrence not affecting other data.

Guidelines for blanks analysis to be followed when evaluating test reports are:

- Positive sample results should be treated as suspect if the concentration of the compound in the sample is not at least 10 times the amount in any blank for the following common contaminants: methylene chloride, acetone, toluene, 2-butanone, and common phthalate esters; or at least five times the amount for other compounds.

- In instances where more than one blank is associated with a given sample, qualification should be determined by a comparison with the associated blank having the highest concentration of a contaminant.

- If a compound is found in a blank but not found in the sample, no action is necessary.

- The resulting data should reflect the source test report's treatment of blanks. For example, if in a test, results were corrected by subtracting any blank values, use the blank corrected values for developing emission factors. If, however, test results were not blank corrected, do not adjust the results, but use the uncorrected values for developing factors.

4.6.7 Units of Measure and Activity Parameter Selection

An emission factor is an estimate of the amount of a pollutant emitted due to some activity divided by some measure of the level of that activity (commonly labeled as "thruput units"). In order to be useful an emission factor must be a reasonably accurate and easy to apply estimate of emissions for sources other than those that were tested to develop the emission factor. The emission factor preparer should choose both the activity and the measurement units for the activity after considering the following guidelines.

- Choose an activity which directly influences the emissions, rather than just the most readily-available units given in the test reports. Factors for fugitive dust from haul roads are thus typically given in terms of vehicle miles traveled rather than tons of production. Combustion-only emissions should usually be related to fuel use rather than to tons of production. Reasonable assumptions should be made by the emission factor preparer when necessary to convert test report units to a common or more appropriate basis.

- Choose an activity such that a facility which does things differently or more or less efficiently than the tested facilities will have these differences reflected in the resulting emissions estimate. In the example above, a facility with longer haul roads but the same production tonnage would show larger dust emissions. If a more energy-efficient dryer were used the combustion emissions would be lower.

- If an additional parameter greatly influences emissions, consider including it in the emission factor. Sulfur oxide emissions from coal combustion are usually based on both the amount of coal burned and the sulfur content of the fuel,

because the emissions depend on the amount of sulfur burned, not the amount of fuel burned. Similarly, surface coating emission factors based on the amount of solvent in a coating, rather than just the amount of the coating, will provide a more representative estimate for more facilities.

- Choose an activity which can be easily tracked by the facilities in the source category, and use measurement units which the industry uses if possible. If the industry uses its own unique terminology or if the industry is moving towards metric units, those terms and units can be used for an emission factor.

- For revisions to existing source category documents, try to use the activity and measurement units which have historically been used, if they are still appropriate. The AIRS AFS database has thruput units associated with each existing SCC. These units can also be found in the SCC list included as part of the FIRE database.

- If possible, use units which can be readily converted between metric and English. An emission factor in units of lbs/1000 lbs is the same in units of kg/Mg, and one emission factor table with both units in the title can suffice. Units of lbs/ton can be quickly converted to kg/Mg, especially where a footnote reminds the reader to just divide by two.

- Due to their continued common usage, English units are required for emission factor tables. Conversions for metric units can be handled by one of the methods cited above, or separate columns or tables for metric units can be added, at the discretion of the emission factor preparer. When revising existing sections or documents, evaluate whether it makes sense to revise duplicate tables.

- Satisfy needs for other units by providing conversion factors in footnotes. It is also helpful to document the assumptions used in deriving values within the tables in the footnotes, e.g., the BTU content of fuels or the thermal efficiency of engines.

4.6.8 Assign Emission Factor Ratings

Where possible, each emission factor is given a rating from A through E, with A being the best. In some cases, a U for "unratable/unknown" is assigned. A factor's rating is a general indication of the reliability, or robustness, of that factor. This rating is assigned based on the

estimated reliability of the tests used to develop the factor and on both the amount and the representative characteristics of those data. In general, factors based on many observations, or on more widely accepted test procedures, are assigned higher rankings. Conversely, a factor based on a single observation of questionable quality, or one extrapolated from another factor for a similar process, would probably be rated much lower. Because ratings are subjective and only indirectly consider the inherent scatter among the data used to calculate factors, the ratings should be seen only as approximations. Factor ratings do not imply statistical error bounds or confidence intervals about the emission factor for a specific facility. At most, a rating should be considered an indicator of the accuracy and precision of a given factor being used to estimate emissions from a large number of sources. A highly rated factor for a highly variable process may be a very imprecise estimator of each individual facility's emissions, although it would provide a credible estimate of the population's average emissions. Emission factor ratings include a component which is largely a reflection of the professional judgment of the authors and reviewers concerning the reliability of any estimates derived with these factors. As a result, the quality ratings should not be used to judge the relative reliability of one emission factor compared to another emission factor.

Because emission factors can be based on source tests, mass balance, or other information, factor ratings can vary greatly. Some factors have been through more rigorous quality assurance than others. In addition, some of the older factors have been evaluated by a more qualitative methodology which is less stringent and may be rated higher than some newer factors which are based upon information of the same level of data quality. It should be noted that some source categories (particularly some area sources) are not conducive to conventional source testing and, therefore, their data cannot be rated according to the rating procedure. In those cases, qualified engineering judgment should supersede the rating protocol, and ratings should be assigned accordingly.

The emission factor rating is an overall assessment of how good a factor is, based on both the quality of the test(s) or information that is the source of the factor and on how well the factor represents the emission source. Higher ratings are for factors based on many unbiased observations, or on widely accepted test procedures. For example, 20 or more source tests on different randomly selected plants would likely be assigned an "A" rating if all tests are conducted using a single valid reference measurement method. Likewise, a single observation based on questionable methods of testing would be assigned an "E". Factors extrapolated from higher-rated factors for similar processes would be assigned a rating based on the amount of similarity of the processes. The extrapolated factor would thus be rated no higher than the original factor and possibly lower depending upon the similarity of the processes. Material balance (such as combustion SOx or solvent loss) and theory-based factors (such as vapor displacement equation) are special cases. Generally, material balance factors can be assigned an A rating if the process emissions are consistent and well-

characterized. Lower ratings should be assigned if the material loss is variable or difficult to characterize.

Emission factor ratings are best characterized as follows:

A = Excellent. Factor is developed primarily from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The process described by the A-factor is not highly variable.

B = Above average. Factor is developed primarily from A- or B-rated test data from a moderate number of facilities. Although no specific bias is evident, is not clear if the facilities tested represent a random sample of the industry. The process described by the B-factor is not highly variable.

C = Average. Factor is developed primarily from A-, B-, and C-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. The process described by the C-factor is not highly variable.

D = Below average. Factor is developed primarily from A-, B- and C-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of process variability within the source population.

E = Poor. Factor is developed from C- and D-rated test data from a very few number of facilities, and there may be reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of significant process variability within the source category population.

U = Unratable. Factor is developed from source tests which have not been thoroughly evaluated, research papers, modeling data, or other sources that may lack supporting documentation. The data are not necessarily "poor," but there is not enough information to rate the factors according to the rating protocol. "U" ratings are commonly found in L&E documents and FIRE rather than in AP-42.

To provide some uniformity or structure the following equation should be used as a first step in determining an emission factor rating:

$$\text{Points} = 5A + 4B + 2C + D$$

where:

A, B, C, D are the number of A, B, C or D-rated tests used to support the emission factor.

The total points determines a preliminary emission factor rating as follows: A is 100, B is 50, C is 25, D is 15 and E is less than 15. However, there are two additional requirements for the assignment of an A or B emission factor rating. The first requirement is that at least half of the emission tests should be rated A or B. The second requirement is that the lower-rated data should be determined to be consistent with the A- and B-rated data before combining the data with the A- and B-rated data. An analogous requirement applies to the assignment of a C emission factor rating.

Following the assignment of a preliminary factor rating, the following adjustments to the emission factor rating may be made.

- A one letter grade adjustment may be made to emission factors if they are based upon tests at more that five facilities. Emission factor ratings may be reduced based upon a high (>1.75) relative standard deviation. Or emission factor ratings may be raised based upon a low (<0.5) relative standard deviation. The relative standard deviation is the ratio of the standard deviation to the mean of the population.

- An increase of one letter grade may be made to emission factors which are based on source tests from a relatively high percentage ($>15\%$) of the industry capacity or number of facilities in the industry. This allows higher ratings for source categories with relatively few facilities.

- An increase of one letter grade may be made if there is sufficient information and a sufficient number of tests to allow for the segregation of facilities by the key operational characteristics that have been shown to have a measurable effect on emissions.

- Other situations that may be justification for raising or lowering the emission factor rating include whether the sources were truly selected at random from the full population as opposed to some criteria that might bias the results (e.g., the tests were gathered as a result of either indications of non-compliance or demonstration of superior performance), or whether testing was performed as part of a research project to demonstrate performance of untested controls or during modified operations versus

testing performed to characterize emissions during a variety of normal operating conditions.

As with documentation of the test report ratings, a thorough explanation of the basis for the emission factor rating assignment must be provided in the background documentation or the emission factor document. Explanations should include what evaluations were performed to make the decision to combine or not combine data sets and justifications for the decision. Similar explanations should be provided on what adjustments were made to the preliminary emission factor ratings and justifications for these adjustments. As with data quality ratings, emission factor ratings are somewhat subjective, and in some cases, there may be reason to differ from the general procedures described above. Variations from the general procedures should be thoroughly explained and justified in the background report.

4.6.9 *Rounding and Significant Figures*

To express numbers with the proper number of significant figures, it is frequently necessary to "round" numbers. However, rounding of data should be done only when presenting the final emission factor data in the tables, after all the calculations with a particular data set have been completed. Therefore, carry as many digits as possible throughout the calculations from beginning to the end. When it is time to summarize and tabulate the final results, the final numbers should be rounded to the appropriate significant figures.

To round a number, if the left-most digit to be removed is 5 or greater, then round up the right-most digit. If the digit to be removed is less than 5, the right-most digit remains the same. For example, when rounding the following numbers to three significant figures:

3.43	rounds to	3.4;
3.45	rounds to	3.5; and
3.46	rounds to	3.5.

The term "significant figures" refers to how a number is described. For example 232,000 is a number with three significant figures. All of the following numbers have three significant figures:

$$204{,}000;\ 204;\ 20.4;\ 0.204;\ 0.000204;\ \text{and}\ 2.04\times10^{-3}.$$

However, 204.0 implies that there are four significant figures. It should be noted that numbers less than 1.0 should have a leading zero as 0.204, not .204 without the leading zero. Leading zeros (0.204, 0.0204, or 0.00204) are not considered to be significant figures. With numbers like 100, or

100., it is not possible to know how many significant figures the number contains unless it is expressed as 1.00×10^2, which implies that there are three significant figures.

It is suggested that for consistency when rounding numbers for final emission factor tables, that the values be rounded to two significant figures, where possible. It some cases, the data may permit rounding three significant figures. A general rule of rounding is that the final rounded figure should contain no more significant digits than the number with the least number of significant digits used in the calculations.

4.7 Background Documentation

4.7.1 Background Documents

Concurrent with AP-42 section preparation a background document discussing all references, calculations, and other pertinent information is prepared to undergo external review along with the section. The background report should identify all data, discuss their quality ratings, 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.

Each piece of information that is evaluated for use in developing the section should be summarized. Emission test report summaries should include the available description of the process being tested, existing controls, individual test results for all pollutants evaluated, problems identified by the test contractor, and problems identified during the review of the test by the section author.

Each emission factor should be documented so that the basis for the factor is clear. Specific material to be summarized and contained in the background document is as follows:

- Text describing the results of the data gathering effort. Items to address are where the data come from, the type of sources were tested, all relevant process design and operational data available in the report, the quality of the data, the test methods used, the size of the units tested, how well does the data represent the source category, etc.

- A summary of each emission test report, with a list of all relevant data for each individual test run considered for use in calculating the emission factor, with specific references to page or table numbers in the material in which these data were found. Note that for updates to AP-42 sections this may include older, but still relevant, data. Any corrections or adjustments that were made to a test report should be noted and explained.

- A complete description of all calculations. If appropriate, sample calculations are highly recommended. (A hard copy of all electronic spreadsheets should be included in the background files).

- A complete record of all assumptions, technical procedures, and rationale used in calculating or reducing the data.

- A list of the primary references actually cited in the emission factor document from which the factor data were derived, as listed in the AP-42 section and L&E document

- A list of secondary references used for background information during development of the emission factor document but not cited explicitly.

- The draft AP-42 section for external review, clearly labeled as such.

- A summary of the comments received on the external review draft, the resolution of those comments, and any other significant changes made to the draft to create the final published section. This summary is added to the background document after external review.

All background documents should be in WordPerfect version 5.1 for DOS or version 6.1 for Windows in order to be included on Air CHIEF CD-ROM and the CHIEF BBS. The background document on Portland Cement (BC11S06.ZIP) is available from the CHIEF BBS or on the Air CHIEF CD for guidance on format and content.

In order to help BBS users find the files and to avoid having electronic section and background files overwritten on the BBS due to duplicate names, the following file naming conventions are suggested:

For Background Documents: BXXSYY-Z.WP5 (or .WPD for WP6)

For Final AP-42 Sections: CXXSYY-Z.WP5 (or .WPD for WP6)

For Draft AP-42 Sections: DXXSYY-Z.WP5 (or .WPD for WP6)

where: XX is Chapter number
YY is Section number, and
Z is Subsection

Note that all of the files will appear on the BBS with a .ZIP extension.

4.7.2 Background Files

A file containing all of the references (test reports, journal articles, etc) should be maintained to allow quick location of supporting references when the applicability or accuracy of factors is questioned, and to provide knowledge of both the background of, and basis for, current factors when deciding whether new data should make changes necessary. For instance, transcripts of personal and telephone communications should be made and included. 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 the document may be revised at a later date. For ease of use, this file should be labeled according to the section numbering system used in AP-42. For L&E documents, the pollutant name should be clearly labeled. Note that the EPA has a long range goal of storage of the background files electronically. The background file should include the following information, clearly labeled and stored in the following categories.

- The current AP-42 section or L&E document.
- The current version of the background document supporting the current version of the AP-42 section or L&E document.
- A hard copy of any electronic spreadsheets used to perform emission factor calculations or statistical analyses.
- Previous versions of the AP-42 section in reverse chronological order (newest first, oldest last)
- A marked-up copy of the previous published AP-42 section, clearly showing the revisions.
- A list of the people and organizations which were requested to review the latest document.
- References cited in the current document.
- References cited in the background report which are not cited in the current document.

- References not cited in the background document but which provide supporting information for future use.

4.8 AFTER EXTERNAL REVIEW

All of the material presented thus far in this chapter is necessary in order to prepare a draft emission facor document with supporting documentation for external review. After external review comments have been received, the author should meet with the EPA project manager to discuss how the comments will be addressed and whether extensive changes to the draft are warranted. If sufficient additional data becomes available during the external review period, or if extensive changes are otherwise needed, a revised draft should be prepared for a second external review. If a second external review is not needed the section can be finalized by addressing the comments, adding Source Classification Codes (SCCs) to the document, and preparing a summary of the emission factor changes to be made to the Factor Information REtrieval (FIRE) database.

4.8.1 SCC/AMS Code Assignments

SCCs are a means of organizing air pollutant sources into related groups. Because they are used as a key identifier for emission sources by both inventory preparers and permit reviewers, it is desirable to assign the emission factors to these identifiers as well. Emission factors must be tied to an SCC in order to appear in the AIRS or FIRE systems. The emission factor developer should use his or her familiarity with the source category to revise or add to the SCCs in AIRS and FIRE where necessary to improve the clarity of the data presented. The SCCs should be included in the emission factor tables as a minimum. It is suggested that they appear on the flow diagrams as well. Addition of the SCC codes should be done after the section has been externally reviewed if extensive changes are anticipated, or it can be done earlier if the author is confident in the process description and the subcategorization of the data.

The SCC is an eight-digit code divided into four fields in the pattern "A-BB-CCC-DD," with each level having a corresponding description as follows:

- Field 1 - the major emissions type;
- Field 2 - the major industry;
- Field 3 - the fuel consumed or the end product; and
- Field 4 - specific combustion equipment or unit operations.

SCCs vary in detail from product to product. For some products there are SCCs for individual release points within the process. In other cases, an entire process may be represented by a single SCC. In addition, an emission source may be represented both individually and as part of an overall process SCC. SCCs should not be used to distinguish all of the add-on control devices that may be used and which will have different emission factors. The SCC is used to identify the process, not the level of control. However, different process designs which result in different emissions levels should be assigned different SCCs.

Area and mobile sources are sources for which emission calculations are not made for each individual source, but are instead calculated as an aggregation of individual sources (e.g., architectural coating, pesticide application, and on-road motor vehicles). To "extend" the SCC system of codes to area and mobile sources, EPA developed a separate coding system, called Area and Mobile Source (AMS) codes, that follows the same general structure as SCCs, but instead uses a 10-digit code patterned "AA-BB-CCC-DDD."

The complete and current version of the SCC and AMS codes resides on EPA's mainframe computer in tables within AIRS. The FIRE database also contains a file of the combined SCC and AMS codes current as of the FIRE release date. The emission factor developer should review the FIRE SCC list to assign SCC or AMS codes to each emission source included in AP-42 and L&E tables. Full 8- or 10-digit SCCs or AMS codes should be identified. If there is no existing code for an emission source, or if the description for an existing code needs to be revised for clarity, the author should contact EFIG to have an SCC assigned to the source.

4.8.2 FIRE Data Entry

The Factor Information Retrieval (FIRE) System database is EPA's electronic listing of rated and unrated emission factors, including those from AP-42 and L&E documents. It is used by EPA's AIRS mainframe and by many States and private software vendors as the source of updated emission factors for their computer systems. Therefore, it is essential that the results of any AP-42 or L&E updates be accurately reflected in FIRE. This requires that the emission factor document be unambiguous, that SCC codes be assigned and used in the emission factor document, and that the information related to each emission factor update be submitted to the EPA project lead in the form that it should appear in FIRE. Submittal of all updates in such a form will also allow EPA to explicitly tell users what has been added, deleted, or revised as a result of an AP-42 Supplement or L&E document publication. In addition to just getting new emission factors into FIRE, the author should insure that old factors are revised, deleted, or confirmed as being still valid. These decisions should already have been addressed throughout the factor development process if the author checked the FIRE database for existing information at the start of the project.

Preparation of the materials described below should occur as part of the final revisions to the factor document. Any needed SCC codes must already have been assigned per the preceding section, and no updates to FIRE will be made until the AP-42 section or L&E document has been placed on the CHIEF BBS as "Final". The author should prepare and submit a Lotus spreadsheet file containing the information shown below. Actual entry of the data into FIRE will be done by EPA. The file should contain the following columns, with each row representing all of the information for a given emission factor.

ACT	new, rev, del, or ok
SCC	8-digit code, or 10-digit AMS code with A preceding
POL	pollutant name (from existing FIRE list, if possible)
CTL1	primary control device (from existing FIRE list, if possible)
CTL2	secondary control device (from existing FIRE list, if possible)
REC_ID	FIRE record id number
OLD_EF	existing emission factor
OLD_STD	T if units are standard for SCC, or F if not, w/expl)
NEW_EF	new or revised emission factor
NEW_STD	T if units are standard for SCC, or F if not, w/expl)
REF	primary reference code (?? if not yet in FIRE, w/footnote)
QUAL	new factor's quality rating
RANGE	lowest and highest facility avgs, if desired
TESTS	number of facilities averaged, if desired
METH	test method used, if desired
NOTES	any notes necessary to use the factor
PARAM	any process parameters that may have influenced emissions
EXPLN	explanations for OLD_STD or NEW_STD entries, or to identify what was revised if not the ef - does not go into FIRE

For revised records, all columns should be filled in with the information to appear in FIRE. The last six columns are optional. The same applies to any new records, except OLD_EF and REC_ID will be left blank by the author. EPA will fill in the REC_ID. For deleted and ok records, only the first eight columns only should be filled in.

APPENDIX A
AP-42/L&E STYLE GUIDE AND EXAMPLE SECTION

AP-42/L&E FORMAT/STYLE SPECIFICATION SHEET

These are the style guidelines used to produce the AP-42 5th Edition and should also be followed to produce L&E documents. This style sheet consists of three sections, the first intended as an aid for technical writers and editors, and the second as an aid for secretaries preparing sections, and the third for use for word processing and graphics support.

ATTACHMENTS TO THIS STYLESHEET:

- Example disk with file templates.
- Example from AP-42 5th Edition (Note that because of the recent decision to use the same style for L&E documents that is now used for AP-42 sections, L&E documents will not resemble those prepared so far.)

SECTION 1: GUIDELINES FOR WRITERS AND EDITORS

SECTION 2: GUIDELINES FOR TYPISTS

SECTION 3: ELECTRONIC PUBLISHING REQUIREMENTS

SECTION 1: GUIDELINES FOR WRITERS AND EDITORS

SECTION HEADINGS

- Number all section headings through the 3rd level. It is acceptable not to number 4th- or 5th-order headings if few occur in a section. Do not number the heading for references.

- ALL words initial caps always (including the words "**and, of, to, for**", *etc.*) for ALL levels of headings after chapter titles

ACRONYMS

- Always introduce in parentheses after the first use in a section, as singular even if plural in context, then use as singular or plural depending on context, e. g., VOC or VOCs not VOC's. It is OK to start sentences with acronyms after introduced, e. g., "EPA. . ." (*note:* not "The EPA. . .") and "CO *emissions decrease*. . ."

- Specific cases:

    - NA = not applicable (ONLY; not "not available"; if "NA = not available" is used, change it to ND)
    - ND = no data
    - PM-10, not PM_{10}
    - SCC = Source Classification Code

SPELLING

Use standard and check variants, e. g., use phosphorus, not phosphorous.

- Specific cases:
    - add-on (not addon or add on)
    - byproduct (not by-product)
    - condensable (not condensible)
    - data base (not database)
    - feedstock (not feed stock)
    - firebox (not fire-box)
    - flow rate (not flowrate)
    - fly ash (not flyash)
    - half-life (not halflife or half life)
    - offgas (not off gas)
    - waste water (not wastewater)
- Capitalization specifics:
    - federal (not Federal)
    - state (not State)

- The correct definition of PM-10 is particles "equal to or less than 10 micrometers in aerodynamic diameter."

- Regarding mentions of particulate matter, the term "particulate" is preferred over "particulates".

HYPHENATION

- Use legitimate hyphens within text and at end of lines. Usually delete for prefixes and avoid; be consistent with terms throughout document.

UNITS AND THEIR ABBREVIATIONS

If the unit and correct abbreviations for emission factors used in tables are not introduced in the text, they should be added as follows: "Factors are expressed in units of. . .[spelled out version. followed by abbreviation in parentheses]".

- Always spell units out the first time used, except for temperatures, then introduce the abbreviation in parentheses, and then use abbreviation consistently thereafter. For temperatures only, use #°F and do not spell out Celsius or Fahrenheit; also see below

- Specific cases:
  - liter (L) not lower case "L" (l) or script "l"
  - micrometer (μm), not micron
  - Temperature: always "solid" (no spaces): 572°F not 572 °F, etc.

- Scientific notation and decimals are both acceptable within a table

TABLES

- AP-42 tables should use English units common to the source category described. Conversion factors to metric units can be given in footnotes or metric emission factors can be given in a separate table or in the same table as the English factors, space allowing.

- Standard text for Clean Air Act HAPs footnote: "Hazardous air pollutant in the *Clean Air Act*."

REFERENCES

- Always place all author's initials first or first name first (not inverted, with last name first)

- Always italicize "*et al.*,"; if ≥ 3 authors, delete all but first author's name, then a comma, "*et al.*,"

- Titles of documents and publishing organization: Use initial caps for all words (e. g., "Oregon Department Of Environmental Quality"). Always italicize titles

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

Legislation:

1. *The Rehabilitation Act Of 1973*, §504, 29 U.S.C. 794.

EXAMPLE ENGLISH UNIT TABLE

Source Category	Pollutant	Emission Factor (Units are lb of pollutant/ton Al produced.)	EMISSION FACTOR RATING	Notes
Aluminum Production Soderberg Process	CO_2	1.83 - 1.85	C	Assumes carbon consumption of 0.50 lb C/lb Al produced.
Prebake Process	CO_2	1.54 - 1.77	C	Assumes carbon consumption if 0.42 lb C/lb Al produced.
Aluminum Production	CF_4	0.6 - 1.8	E	Varies with duration of anode effect, frequency, and current efficiency.
Aluminum Production	C_2F_6	0.06 - 0.18	E	Varies with duration of anode effect, frequency, and current efficiency.

[a] References 11,14-15. To convert from lb/ton to kg/Mg, multiply by 0.5.

Federal Register **Notice (Vol 53, p. 5573):**
2. *Standards Of Performance For New Stationary Sources: New Residential Wood Heaters*, 53 FR 5573, February 26, 1988.

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

EPA publications (with an EPA document number):
4. 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.

With three or more authors:
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.

One of a bound collection of papers:
6. 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 document number is assigned):
7. *Particulate And Lead Emission Measurements From Lead Oxide Plants*, EPA Contract No. 68-02-9999, Bimbo Research Corp., Youpon, OH, August 1973.

Unnumbered:
8. 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.

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

Non-EPA Source test:
10. S.G. Barnett, *In-home Evaluation Of Emissions From Masonry Fireplaces And Heaters*, OMNI Environmental Services, Inc., Beaverton, OR, September 1991.

Other Agency reports:
11. 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.

Privately published report:
12. S. Dernbach, *Woodstove Field Performance In Klamath Falls, OR*, Wood Heating Alliance, Washington, DC, April 1990.

Periodical:
13. 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:

14. 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.

Book:

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

Privileged information:

16. Confidential test data, Bozo Contractors, Inc., Caries, NC, December 10, 1941.

Personal or official conversation:

17. 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.

INITIAL CODES

• Software Text:	WordPerfect® Version 5.1 for DOS
• Document Font:	CG Times 11 pt
• Superscripts and Subscripts (83% in text and tables)	CG Times 9 pt
• Left/Right Margin	1"/1"
• Top/Bottom Margin for Chapter Introduction Page only:	2"/.5"
• Top/Bottom Margin for First Page of Section only:	1.5"/.5"
• Top/Bottom Margin for Subsequent Pages:	1"/.5"
• Footer A/Footer B	See Section on Footers
• Tabs: Absolute (w/first tab at 1", every 0.5")	1"/.5"
• Text Spacing:	1"
• Justification:	Left
• Widow/Orphan Protection:	On
• Table and Figure Options: Borders	None
• Figure Options: Captions	Placed Below Figure
• Print Options in Initial Settings:	

1 Binding Offset		0"
2 Number of Copies		1
Multiple Copies Generated by		WordPerfect
3 Graphics Quality		High
4 Text Quality		High
5 Redline Method		Printer Dependent
6 Size Attribute Ratios	Fine	60%
(% of Normal)	Small	80%
	Large	120%
	Very Large	150%
	Extra Large	200%
	Super/Subscript	83%
7 Banner		No
8 Form Number		0

FOOTERS

For all pages, these should be 0.5 inch above the bottom of the page. Note the following examples. For odd-numbered pages:

1/95	Stationary Internal Combustion Sources	3.1-1
(not 01/95) [or use date given]	*[Chapter title, initial caps only]*	*[Section Number w/page number]*

For even-numbered pages, nearly the same information is used, but order reverses:

3.1-2	EMISSION FACTORS	1/95

[Section number w/page number] *[Volume title, all caps]* *[date]*

TEXT, HEADINGS, & SUBHEADINGS

All text should be CG Times 11 pt. **Always use super- and subscripts that are 9 pt.** (83% in text and tables). Headings to introduce a chapter should be 15 pt. & all caps. The main heading of a section should be formatted as a 1st-order heading (i. e., initial caps and bold) regardless of the number of digits (some sections will begin with a 3- or 4-digit heading number). Number all section headings through the 3rd level. Mark all heading for the table of contents, but just headings (i. e., no superscript numbers). Do not, under any circumstances, use the paragraph numbering or outline features. Note the following specifics:

- Spacing between section number and heading should always be 2 spaces; it may not align with ¶ indent because number of digits (width) of section numbers vary
- Amount of ¶ indents should always be 0.5 inch. Always use indents (F4); do not use tabls even for lists that use number or bullets (reset amount of indent if necessary)
- Do not use hard returns within text paragraphs or lists that begin with numbers or bullets
- No right text margin justification
- Style of 3rd-, 4th-, 5th-, or higher-order headings may vary depending on what heading level a section begins with and whether the subsection is numbered. Always flush to left margin (not indented); use hyphen with 1 space before and a hard return after; see the following examples (*note*: [] = required space, imbedded WordPerfect command, or note to reader):

  Subheading Title[]-[*Hard return*]
  After only a 0.5-inch ¶ indent and no intervening line of space, text follows. . . [*unnumbered heading*] OR

  2.1.3.3[][]Acid Gases[]-[*Hard return*]
  After only a 0.5-inch ¶ indent and no intervening line of space, text follows,
  "The chief acid gases. . . [*numbered heading*]

- It is imperative to use required spaces in text as follows: Appendix[]A, Table[]#, and #[]unit; do not allow such items to split at the end of text lines
- Capitalize terms such as the following (and above) as specific referrals: Section[]2.2, Chapter[]2
- Do not use hard returns within text paragraph or lists that begin with numbers or bullets

EXAMPLE OF AP-42 SECTION HEADING LEVELS

1.1 First Order Heading

1.1.1 Second Order Heading[1,2]

Text for this section should begin on this line.

1.1.1.1 *Third Order Heading* -
Text for this section should begin on this line.

Fourth Order Heading -
Text for this section should begin on this line.

PUNCTUATION/SPACING

- Punctuation should always be outside quotes unless it is a part of the quoted passage
- Use 2 spaces after a colon, ":", except in ratios: "10:1" or in periodical references: "*9*(7):643-67".
- Always use 1 space (required) in cases such as "e. g.," or "i. e.,"
- Always use 1 space between authors' initials in list of references
- Always use 1 space (required) in U. S.; use U. S. even as a noun (but do not change it if it is spelled out)
- Delete any space between # & "%": e. g., "77%", not "77 %"
- Do not use apostrophes with years, i. e., use "1970s", not "1970's"
- Dashes are always "en" dashes, with a required space to each side

LISTS WITHIN A TEXT PARAGRAPH

If numbered, use both parentheses: e.g., "(1)" not "1)". For unnumbered lists outside text, use NO bullets; instead use hyphens. From left margin, use the 0.5-inch ¶ indent, then a hyphen followed by another F4 indent set for 2 spaces, as shown in the following example:

- Text starts with capital letter and usually no end punctuation, but **this is case-specific**; if internal punctuation is used (i. e., a series of items with commas), each item might end with a semicolon ";". If this is done, the next to last item should end with "; and", and the final one should end with a period.

Also, a numbered list outside the text is fine, and the format should be similar with 1 or more levels to the list:

1. After the number (or letter) and a period, use a 2-space indent, then text starts with a capital letter, and end punctuation is case-specific if needed.

    a. Text again starts with a capital letter; use case-specific end punctuation if needed for clarity.

NUMBERS

- Always use numerals, e. g., 3 to 5 days, 4 plants, 5 percent (not five percent) except at the beginning of a sentence. Use % sign in tables and table footnotes (column heads and footnotes); but not in text
- In 4-digit numbers, comma use is optional except when used with numbers of 5 or more digits, e. g., 1000°F is OK, but also 1,000 to 10,000 lb
- Insert a zero before the decimal if none is used in a given number
- Be sure a space appears before the "E" in "1.10[]E-03" or "1.10[]E+03"
- Style for ranges (values & references):
    - Text and table guts: 1 - 2 (1 required space on each side of hyphen)
    - Text reference citations and table footnotes; use: 1-2 and 3,5 (*note:* no spaces, not "3, 5")
- SCC numbers: should be "solid", i. e., no spaces; insert hyphens per the formula 1-2-3-2 as follows: #-##-###-##

FIGURES

Figures should not have borders.

- For text references, always cite the word "Figure" and the full number for each. Text references should not cite a range (e. g., Figures 5.2-1 through 5.2-4)
- Caption font: Should match text font style (CG Times 11 pt.)
- Caption style: 1st word only initial cap (not all words), ends with a period, and centered relative to the figure. If SCCs appear in the figure, on the next line (no intervening line of space), center the following statement: "(Source Classification Codes in parentheses.)" If a figure must be presented in "landscape" orientation, the caption must be centered below the figure within (and parallel to) the right margin. Do not place "SCC" before the SCCs given throughout the figure

TABLES

- Landscaped tables are to be put into Table Boxes
- For text references: use "Tables 9.3.2-1 and 9.3.2-2", not "Tables 9.3.2-1 and -2". If a range of tables is mentioned, each full number should be cited (e. g., "Tables 5.2-2, 5.2-3, and 5.2-4"), but the word "Table" does not need to be repeated
- Font sizes: title, entries, and footnotes: should always be same size as text font (11 pt.). Table entries ("guts") ONLY may use 9-pt. font to avoid continuing table. Do not make title or footnotes the same size font as table if a 9-pt. font is used

- Title format, if too long to fit on 1 line: Avoid only 1 or 2 words on second line and split at a logical place, e. g., "EMISSION FACTORS FOR [hard return] ABRASIVE MANUFACTURING"

- If the table title subhead "EMISSION FACTOR RATING: [rating letter here]" is used and any exceptions are footnoted, add the following after the rating letter: "(except as noted)"

- Style if continued: use only header with table # and "(cont.)", no footers: do not repeat title: e. g., "Table 9.3.2-1 (cont.)." Note that no period follows the table number but use a period both after "cont." and following the closing parenthesis

- Boxes, "downlines": all tables should use only single-line boxes (not double) and no horizontal lines after column headings. Use vertical downlines from top to bottom only for major column subheads (not subcolumn headings)

- Column headings: placement & style: centered over column [except possibly first column may be flush left; this is case-specific)], "stacked" from the "bottom up" (i. e., the line between column headings and table guts). Use all initial caps for words, with one exception: EMISSION FACTOR RATING; this term should always be all caps within a table column heading or subheading or footnote, or as a subheading for table title. Capitalization of unit abbreviations must be case-specific

- Columns: Widths should be equalized as much as possible. *Use column command to decimal align and center numbers within the individual column except in cases where space problems may arise (i. e., to avoid continuing a table or using a smaller font). Always use tabs and adjust spacing if not standard; do not use spaces.

*In Table Edit:
2 Format
2 Column
3 Justify
5 Decimal Align

For Centering Columns w/decimals:
2 Format
2 Column
4 #Digits (Enter a number of decimal places to achieve a centered column of numbers with decimals.)

EXAMPLE TABLE WITH DECIMAL ALIGNED NUMBERS

VOC[a]			
	National Emissions	Per Capita Emission Factors	
Use	tons/yr	lb/yr	lb/day
Aerosol products	37.6	3.5	9.6
Household products	2.01	1.9	5.2
Toiletries	14.5	1.4	3.8
Rubbing compounds	6.8	0.64	1.8
Polishes and waxes	5.3	0.49	1.3

- When the only entry is a footnote, precede with an "em" dash (control V: 4.34)
- Left column terms: capitalize 1st word only (except possibly for specific terms. e. g., "Pre-Phase")
- Align text entries on the left and indent subsequent lines 2 spaces relative to first character. Entries in subsequent columns should align with last "spillover" line of table text entry (but not SCC number in parentheses)
- Footnotes:
    - Within a footnote, the term "EMISSION FACTOR RATING" must lead. and can be preceded only by a reference number.
    - Order: always left to right and top to bottom; correct as necessary; use ONLY superscript letters
    - Specific letters not to use or to double: i, l, & o; but aa, bb, etc., are ok if needed
    - Placement: no return or line of space between table bottom (except that resulting from use of superscript letters to avoid overstriking table box line)
    - Alignment: Should align with table width on the left and right and not extend beyond. Use an indent (with 1 space only) after superscript so subsequent lines align with first text character, not text flush to left margin; also a second column on same page is OK to avoid continuing table if not confusing
    - Use 1 space between superscript letter & text as noted above; use the advance down code (0.05) between the bottom line of table and the beginning of superscript letters

EXAMPLE TABLE REFLECTING POSITION OF SUPERSCRIPTED LETTERS

Particle Size[a] (μm)	Cumulative Mass % ≤ Stated Size			Cumulative Emission Factor[b] ([lb/ton] Coal, As Fired)		
	Uncontrolled	Multiple Cyclones	ESP	Uncontrolled	Multiple Cyclones	ESP
15	40	99	83	2.8A	1.38A	0.046
15	40	99	83	2.8A	1.38A	0.046

[a] Expressed as aerodynamic equivalent diameter.
[b] A = coal ash weight %, as fired.

- ALL acronyms used in table but not defined previously in text should be defined at the end of footnote "a" (but not chemical terms/nomenclature; if any are used that were not previously introduced/identified in the text, it is OK because it is assumed all readers will recognize standard chemical terms)

EQUATIONS

Make sure first thing is "Func {" and do not use "vertical" (for Super and Subscripts) or "scalesym"

$$E = \frac{(6.234 \times 10^{-4})\ P\ A\ t\ V_o\ D_o}{V_s\ T} + L_d\ D_d$$

```
FUNC {E ~=~ {(6.234' x '10^{-4})~{P ~A ~ t~V_o~'D_o}}
over {V_s~T} ~+~ {L_d~D_d}}
```

Number equations if more than 1. In building an equation Also, placement of "where:" should be alone on a line below equation, usually flush to left margin (or possibly indented; these will be case-specific), with list of terms defined beginning on line below, aligned by "="

where:

E_v = emission factor for VOC, mass per vehicle (lb/vehicle) (exclusive of any add-on control devices)
A_v = area coated per vehicle (ft^2/vehicle)
c_1 = conversion factor: 1 ft/12,000 mil
T_f = thickness of the dry coating film (mil)

REFERENCES

- Use the endnote feature for numbering text references; do not use superscripts or footnotes
- List should start immediately following text (no white space) unless table(s) follow text (i. e., tables should not split up references). Also, style for text citations should be: "...blah.[10]" not "...blah[10]."
- The subheading for references should be "References For Section [insert section number]". Do not number this subheading
- Only in list of references, set a 0.5-inch tab from the left margin so all reference text aligns on the left regardless of the reference number digits

EXAMPLE:

1. *Second Review Of Standards Of Performance For Sewage Sludge Incinerators*, EPA-450/3-84-010, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1984.

SECTION 3: ELECTRONIC PUBLISHING REQUIREMENTS

In order to incorporate AP-42 sections and L&E documents to an electronic form, such as a CD-ROM version, the document must be compatible with CD-ROM format. The following are requirements for electronic publishing of these documents that should be adhered to.

FONTS

Change the Font to CG Times 11pt (Make absolutely sure that the Base Font, shift-F8, 3,3 also is CG Times 11pt and that the 3D printer is defaulted to CG Times 11pt) and change the tabs to absolute tabs 1,.5 or whatever the tabs should be for special circumstances.

HEADINGS

Make sure each heading is as follows:

- [Center]SECTION 2.0[HRt]
  [Center]EMISSIONS FROM MANUFACTURING[HRt][HRt][HRt]
- 2.1[Tab]EMISSIONS SUMMARY[HRt][HRt]
- 2.1.1[Tab]Motor Vehicle Emissions[HRt][HRt]
- 2.1.1.1[Tab]Process Emissions--[HRt]

FIGURE QUALITY

Check each figure and make sure that it can be seen properly in WordPerfect. Mark table titles and figures for the List of Tables and List of Figures.

- Drawings are created in a drawing program with excellent export capabilities (that is, vectored graphics with editable text capability, such as with Corel Draw, WordPerfect Presentations, or the graphics software of WordPerfect for Windows. Note that other graphics software (e.g., Freelance for Windows) can be used but only if fixed font size is used to avoid the problem of text extending beyond space designed for it.).
- Arrow heads are sized: .008
- Lines are sized: .02
- Fonts: Times Roman, 9 pt within the graphic
- Save original drawing file
- Select all & export as .pcx (selected only):
  COLORS: black & white
  SIZE: 1 to 1
  RESOLUTION: 300 DPI
- Select all, group & export as .wpg (selected only):
  COLORS: 16 colors
  EXPORT TEXT AS: Curves

LANDSCAPE FIGURES/FIGURE TITLES

Figure Box Specifications:

Selection 6.	Horizontal: Left
Selection 7.	Size: 6" wide by 8.99" high

Selection 9. Rotate 90 degrees (Alt F9)
Selection 1. Type in figure filename.

Below are requirements for captions when creating landscape figures.
Selection 6. Horizontal: Right
Selection 7. Size: 0.168" wide by 8.99" high
Selection 9. Rotate 90 degrees (Alt F9)

Center and type in figure title.

Note: These numbers are chosen from "definition": Figure Screen.

FORMATTING

- Do not use the Columns feature in WordPerfect, Use the table layout instead.
- Make sure the center and right justify functions in table cells are used. Do not center using the regular center command and do not right justify using the regular right justify command. Folio interprets these as a tab and a center and pulls all columns to the center of the page. When using bullets or dashes in tables, set a tab, do not space over from bullets or dashes, TAB.
- Do not use the WordPerfect 5.1 line draw feature. There is no line draw feature in Folio. However, you can set a left tab and a right tab and use the underline tabs and spaces feature to draw a line underneath grouped heads in tables.
- If there are landscaped or legal size tables, include them at the end of the file, not in separate files. This will help to ensure all of the files needed to complete a section are included.
- Use hard spaces and hard hyphens when typing phrases that should be kept together. At this time Folio does not have these features and there is no way to put them in. The WordPerfect 5.1 text wraps because Folio is designed to display text horizontally within the window for ease of viewing.
- Use the automatic Table of Contents feature in WordPerfect 5.1. This will be automatically translated by Folio.
- Use the endnote feature in WordPerfect 5.1 for references. These come over as pop-up links in Folio and no further formatting has to be done for them.
- Use hard returns only at the end of paragraphs. A hard return in Folio indicates the end of a record.
- Convert Lotus 1-2-3 and Quattro worksheets to Ascii format.
- If there are WordPerfect 5.1 graphics (*.wpg files) in a document, make sure they are exactly the way they should appear. They cannot be edited in WordPerfect 5.1 or Folio.
- Make sure all disk files for each section, including appendices, are together in one zip file and that a systematic file naming scheme is used.
- Do not use outline or paragraph feature. Folio does not translate this feature.

EQUATIONS

Make sure first thing is Func {. Do not use vert in equations, use super or subscripts. Do not use scalesym.

SUBSCRIPTS AND SUPERSCRIPTS

Do not use the Advance Up or Advance Down feature in WordPerfect 5.1. Folio does not recognize this. Use superscripts and subscripts instead. Printer description file (*.prs) should be modified to default to CG Times 9pt. Also, the WP51 setup under Initial Settings, Print Options, Size Attribute ratios, Super/Subscript, should be 83%.

EXAMPLE AP-42 SECTION

12.1 Primary Aluminum Production

12.1.1 General[1]

Primary aluminum refers to aluminum produced directly from mined ore. The ore is refined and electrolytically reduced to elemental aluminum. There are 13 companies operating 23 primary aluminum reduction facilities in the U. S. In 1991, these facilities produced 4.5 million tons of primary aluminum.

12.1.2 Process Description[2-3]

Primary aluminum production begins with the mining of bauxite ore, a hydrated oxide of aluminum consisting of 30 to 56 percent alumina (Al_2O_3) and lesser amounts of iron, silicon, and titanium. The ore is refined into alumina by the Bayer process. The alumina is then shipped to a primary aluminum plant for electrolytic reduction to aluminum. The refining and reducing processes are seldom accomplished at the same facility. A schematic diagram of primary aluminum production is shown in Figure 12.1-1.

12.1.2.1 Bayer Process Description -

In the Bayer process, crude bauxite ore is dried, ground in ball mills, and mixed with a preheated spent leaching solution of sodium hydroxide (NaOH). Lime (CaO) is added to control phosphorus content and to improve the solubility of alumina. The resulting slurry is combined with sodium hydroxide and pumped into a pressurized digester operated at 221 to 554°F. After approximately 5 hours, the slurry of sodium aluminate ($NaAl_2OH$) solution and insoluble red mud is cooled to 212°F and sent through either a gravity separator or a wet cyclone to remove coarse sand particles. A flocculent, such as starch, is added to increase the settling rate of the red mud. The overflow from the settling tank contains the alumina in solution, which is further clarified by filtration and then cooled. As the solution cools, it becomes supersaturated with sodium aluminate. Fine crystals of alumina trihydrate ($Al_2O_3 \bullet 3H_2O$) are seeded in the solution, causing the alumina to precipitate out as alumina trihydrate. After being washed and filtered, the alumina trihydrate is calcined to produce a crystalline form of alumina, which is advantageous for electrolysis.

12.1.2.2 Hall-Heroult Process -

Crystalline Al_2O_3 is used in the Hall-Heroult process to produce aluminum metal. Electrolytic reduction of alumina occurs in shallow rectangular cells, or "pots", which are steel shells lined with carbon. Carbon electrodes extending into the pot serve as the anodes, and the carbon lining serves as the cathode. Molten cryolite (Na_3AlF_6) functions as both the electrolyte and the solvent for the alumina. The electrolytic reduction of Al_2O_3 by the carbon from the electrode occurs as follows:

$$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2 \quad (1)$$

Aluminum is deposited at the cathode, where it remains as molten metal below the surface of the cryolite bath. The carbon anodes are continuously depleted by the reaction. The aluminum product is tapped every 24 to 48 hours beneath the cryolite cover, using a vacuum siphon. The aluminum is then transferred to a reverberatory holding furnace where it is alloyed, fluxed, and degassed to remove trace impurities. (Aluminum reverberatory furnace operations are discussed in detail in Section 12.8, "Secondary Aluminum Operations".) From the holding furnace, the aluminum is cast or transported to fabricating plants.

Three types of aluminum reduction cells are now in use: prebaked anode cell (PB), horizontal stud Soderberg anode cell (HSS), and vertical stud Soderberg anode cell (VSS). Most of the aluminum produced in the U. S. is processed using the prebaked cells.

All three aluminum cell configurations require a "paste" (petroleum coke mixed with a pitch binder). Paste preparation includes crushing, grinding, and screening of coke and blending with a pitch binder in a steam jacketed mixer. For Soderberg anodes, the thick paste mixture is added directly to the anode casings. In contrast, the prebaked ("green") anodes are produced as an ancillary operation at a reduction plant.

In prebake anode preparation, the paste mixture is molded into green anode blocks ("butts") that are baked in either a direct-fired ring furnace or a Reid Hammer furnace, which is indirectly heated. After baking, steel rods are inserted and sealed with molten iron. These rods become the electrical connections to the prebaked carbon anode. Prebaked cells are preferred over Soderberg cells because they are electrically more efficient and emit fewer organic compounds.

12.1.3 Emissions And Controls[2-10]

Controlled and uncontrolled emission factors for total particulate matter, gaseous fluoride, and particulate fluoride are given in Table 12.1-1. Table 12.1-2 gives available data for size-specific particulate matter emissions for primary aluminum industry processes.

In bauxite grinding, hydrated aluminum oxide calcining, and materials handling operations, various dry dust collection devices (centrifugal collectors, multiple cyclones, or ESPs and/or wet scrubbers) have been used. Large amounts of particulate are generated during the calcining of hydrated aluminum oxide, but the economic value of this dust leads to the use of extensive controls which reduce emissions to relatively small quantities.

Emissions from aluminum reduction processes are primarily gaseous hydrogen fluoride and particulate fluorides, alumina, carbon monoxide, carbon dioxide (CO_2), volatile organics, and sulfur dioxide (SO_2) from the reduction cells. The source of fluoride emissions from reduction cells is the fluoride electrolyte, which contains cryolite, aluminum fluoride (AlF_3), and fluorospar (CaF_2). The dissociation of the molten cryolite is the source of the perfluorinated carbons (PFCs) - tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) - which are formed during anode effects. The factors related to the formation of PFCs are not currently well understood, but they can be formed either by direct reaction of the fluorine with the carbon anode or electrochemically.[11] Table 12.1-3 presents emission factors for greenhouse gases.

Particulate emissions from reduction cells include alumina and carbon from anode dusting, and cryolite, aluminum fluoride, calcium fluoride, chiolite ($Na_5Al_3F_{14}$), and ferric oxide. Representative size distributions for fugitive emissions from PB and HSS plants, and for particulate emissions from HSS cells, are presented in Table 12.1-2.

Emissions from reduction cells also include hydrocarbons or organics, carbon monoxide, and sulfur oxides. These emission factors are not presented here because of a lack of data. Small amounts of hydrocarbons are released by PB pots, and larger amounts are emitted from HSS and VSS pots. In vertical cells, these organics are incinerated in integral gas burners. Sulfur oxides originate from sulfur in the anode coke and pitch, and concentrations of sulfur oxides in VSS cell emissions range from 200 to 300 parts per million. Emissions from PB plants usually have SO_2 concentrations ranging from 20 to 30 parts per million.

Table 12.1-1 (cont.).

Operation	Total Particulate[b]	Gaseous Fluoride	Particulate Fluoride	Reference
Vertical Soderberg stud cell (SCC 3-03-001-03)				
Uncontrolled	78.0	33.0	11.0	2,12
Fugitive (SCC 3-03-001-10)	12.0	4.9	1.7	12
Emissions to collector	66.0	28.1	9.3	12
Spray tower	16.5	0.3	2.3	2
Venturi scrubber	2.6	0.3	0.4	2
Multiple cyclones	33.0	28.1	4.7	2
Dry alumina scrubber	1.3	0.3	0.2	2
Scrubber plus ESP plus spray screen and scrubber	7.7	1.5	1.3	2
Horizontal Soderberg stud cell (SCC 3-03-001-02)				
Uncontrolled	98.0	22.0	12.0	2,12
Fugitive (SCC 3-03-001-09)	10.0	2.2	1.2	2,12
Emissions to collector	88.0	19.8	10.8	2,12
Spray tower	22.0	7.5	2.7	2,12
Floating bed scrubber	19.4	0.4	2.4	2
Scrubber plus wet ESP	1.8	0.2	0.2	2,12
Wet ESP	1.8	1.0	0.2	12
Dry alumina scrubber	1.8	0.4	0.2	12

[a] To convert from lb/ton to kg/Mg, multiply by 0.5. SCC = Source Classification Code. Neg = negligible. ND = no data. NA = not applicable.

Sulfur oxides may be estimated, with an EMISSION FACTOR RATING of C, by the following calculations.

Anode baking furnace, uncontrolled SO_2 emissions (excluding furnace fuel combustion emissions):

$$40(C)(S)(1-0.01\ K)\ \text{lb/ton}$$

Prebake (reduction) cell, uncontrolled SO_2 emissions:

$$0.4(C)(S)(K)\ \text{lb/ton}$$

where:

C = Anode consumption* during electrolysis, lb anode consumed/lb Al produced
S = % sulfur in anode before baking
K = % of total SO_2 emitted by prebake (reduction) cells.

*Anode consumption weight is weight of anode paste (coke + pitch) before baking.

[b] Includes particulate fluorides, but does not include condensable organic particulate.
[c] For bauxite grinding, units are lb of pollutant/ton of bauxite processed.
[d] For aluminum hydroxide calcining, units are lb of pollutant/ton of alumina produced.
[e] After multicyclones.

Table 12.1-3. GREENHOUSE GAS EMISSION FACTORS FOR PRIMARY ALUMINUM PRODUCTION PROCESSES[a]

Source Category	Pollutant	Emission Factor (lb/ton Al produced)	EMISSION FACTOR RATING	Notes
Aluminum Production Soderberg Process	CO_2	1.84	C	Assumes carbon consumption of 0.50 lb C/lb Al produced.
Prebake Process	CO_2	1.65	C	Assumes carbon consumption of 0.42 lb C/lb Al produced.
Aluminum Production	CO_2	1.65	E	Industry average if type of reduction cell is not known.
Aluminum Production	CF_4	0.6 - 1.8	E	Varies with duration of anode effect, frequency, and current efficiency.
Aluminum Production	C_2F_6	0.06 - 0.18	E	Varies with duration of anode effect, frequency, and current efficiency.

[a] References 11,14-15. To convert from lb/ton to kg/Mg, multiply by 0.5.

No8 needed

2. *Engineering And Cost Effectiveness Study Of Fluoride Emissions Control, Volume I*, APTD-0945, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1972.

3. *Air Pollution Control In The Primary Aluminum Industry, Volume I*, EPA-450/3-73-004a, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1973.

4. *Particulate Pollutant System Study, Volume I*, APTD-0743, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1971.

5. *Inhalable Particulate Source Category Report For The Nonferrous Industry*, Contract No. 68-02-3159, Acurex Corporation, Mountain View, CA, October 198[illegible]

6. *Emissions From Wet Scrubbing System*, Y-7730-E, York Research Corporation, Stamford, CT, May 1972.

7. *Emissions From Primary Aluminum Smelting Plant*, Y-7730-B, York Research C[illegible] Stamford, CT, June 1972.

8. *Emissions From The Wet Scrubber System*, Y-7730-F, York Research Corpor[illegible] Stamford, CT, June 1972.

9. T. R. Hanna and M. J. Pilat, "Size Distribution Of Particulates Emitted From A Horizontal Spike Soderberg Aluminum Reduction Cell", *Journal Of The Air Pollution Control Association*, 22:533-536, July 1972.

10. Written communication from T. F. Albee, Reynolds Aluminum, Richmond, VA, to A. A. McQueen, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 20, 1982.

11. *Inventory Of U. S. Greenhouse Gas Emissions And Sinks: 1990-1993*, EPA 230-R-94-014, U. S. Environmental Protection Agency, Office Of Policy, Planning And Evaluation, Washington, DC, 1994.

12. *Background Information For Standards Of Performance: Primary Aluminum Industry: Volume I, Proposed Standards*, EPA-450/2-74-020a, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1974.

13. *Primary Aluminum: Guidelines For Control Of Fluoride Emissions From Existing Primary Aluminum Plants*, EPA-450/2-78-049b, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 1979.

14. *Inventory Methods Manual For Estimating Canadian Emissions Of Greenhouse Gases*, Environment Canada, Ottawa, Ontario, 1994.

15. *Greenhouse Gas Emissions In Norway - Inventories, And Estimation Methods*, Report 94.02, Norwegian State Pollution Control Authority, Norway, 1994.

Appendix B
Public Participation Plan

PUBLIC PARTICIPATION PROCEDURES
for
EPA'S EMISSIONS ESTIMATION GUIDANCE MATERIALS

Introduction and Purpose

The purpose of this report is to document and publicize the public participation procedures which the U.S. Environmental Protection Agency (EPA) will follow for the submittal, evaluation, and revision or addition of air pollutant emission factors and other emission estimation techniques. The procedures provide the public with the opportunity to participate in the establishment of emission factors and techniques both by the submittal of new material and by the evaluation of that material via a public review process. These procedures are required by Section 130 of the Clean Air Act of 1990. Revisions or additions submitted and evaluated per these procedures and subsequently accepted by EPA will be incorporated into EPA's publication "Compilation of Air Pollutant Emission Factors", Volume I, Stationary Sources, or Volume II, Mobile Sources (AP-42), and its' associated databases.

Background

EPA has compiled results from various emissions testing programs for over 25 years in AP-42. The results are most often presented as the mass of emissions expected per unit of process throughput. These quotients are generally referred to as emission factors, and they are often useful for estimating emissions from processes similar to those tested. Such estimates are most appropriately used to develop the area-wide emission inventories used for air quality modeling and control strategy development. In addition to AP-42, EPA has distributed a number of guidance documents, memoranda and computer databases containing emission factors, some of which do not appear in AP-42. Examples of these materials are "Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone" (EPA-450/4-91-016), "Locating and Estimating Air Emissions from Sources of Styrene" (EPA-454/R-

93-011), the Factor Information Retrieval database system (FIRE), the Volatile Organic Compound (VOC)/Particulate Matter (PM) Speciation Data System (Speciate), the MOBILE5 model, and various memoranda on estimating emissions from particular area source categories issued by the Emissions Inventory Branch.

For several years EPA has solicited comments on draft sections of AP-42 and other emissions estimation guidance from trade associations, environmental organizations, State and local air pollution agencies, and individual industry experts. EPA has also worked cooperatively with several trade associations to gather data in support of emission factor development. Both of these types of interactions are expected to continue in the future using the procedures described herein. These procedures extend the opportunity to participate in the development and evaluation of the EPA's emission factor guidance materials to any member of the public.

The Clean Air Act Amendments of 1990 renewed and strengthened national efforts to reduce air pollution. In particular, Title I of the Amendments addressed the continuing problem of high ambient ozone levels in many areas of the U.S., resulting in their designation as "ozone non-attainment areas". The Amendments require comprehensive emission inventories and control strategies to reduce ambient ozone concentrations. Much of the emission inventory data on which control strategies are developed are based on emission factors. Therefore, it is critical that these factors be accurate and current. The 1990 Amendments recognized this and made provisions to ensure that timely and accurate data are used.

Section 804 of the 1990 Amendments addressed the revision process for emission factors by adding Section 130 to Part A of Title I of the Act. Section 130 states:

> "Within 6 months after enactment of the Clean Air Act Amendments of 1990, and at least every 3 years thereafter, the Administrator shall review and, if necessary, revise, the methods (emission factors) used for the purposes of this Act to estimate the quantity of emissions of carbon monoxide, volatile organic compounds, and oxides of nitrogen from sources of such air pollutants (including area and mobile sources).
>
> "In addition, the Administrator shall establish emission factors for sources for which no such methods have previously been established by the Administrator. The Administrator

shall permit any person to demonstrate improved emissions estimating techniques, and following approval of such techniques, the Administrator shall authorize the use of such techniques. Any such technique may be approved only after appropriate public participation. Until the Administrator has completed the revision required by this section, nothing in this section shall be construed to affect the validity of emission factors established by the Administrator before the date of the enactment of the Clean Air Act Amendments of 1990."

As seen, the 1990 Amendments reinforced the role of public participation in the emission factor development process. Anyone in the public is allowed to submit data to establish new emission factors, revise existing emission factors, or demonstrate improved emissions estimating techniques. (For purposes of this discussion, EPA is considering emission factors, emissions estimating techniques, and methods of estimating as interchangeable terms.) The EPA is to evaluate these data and, if found acceptable, approve their use. Any approvals of new or revised emission factors, whether originating from EPA or the public, can occur only after the public has had sufficient opportunity to review and comment.

Scope and Limitations

These procedures allow anyone to submit for review emission estimating techniques for any air pollutants emitted by any stationary point or area source or mobile source, regardless of whether or not the source is currently addressed by either Volume of AP-42. The procedures can be used to request revisions to existing factors or to establish emission factors for sources not yet addressed by EPA. Information may be submitted at any time and may address any aspect of AP-42 or any other EPA emissions estimating materials.

Although Section 130 requires these procedures to be established only for carbon monoxide (CO), oxides of nitrogen (NO_x), and volatile organic compounds (VOC), EPA intends to follow the same general procedures to address any criteria, toxic, or other air pollutant, although not necessarily under the same priority.

These procedures are not a means for individual facilities to obtain EPA approval of a site-specific emission factor or to determine the appropriateness of applying a published EPA factor to a specific facility. EPA does not approve site-specific factors or judge the appropriateness of its factors for specific facilities. The responsibility for such decisions continues to be that of the State or local regulating authority, as well as the facility operators themselves.

EPA's published emission factors are intended to provide an affordable method of estimating emissions where no better data are available. They are best used to characterize the total emissions loading of a large geographic area containing many individual facilities. Therefore, these factors attempt to represent a typical or average facility or process in a given industry. EPA recognizes that other methods of obtaining emissions estimates may be more accurate than industry-average emission factors, and encourages the use of better methods whenever the source and/or the State or local regulating authority is able to support those methods. Methods which may provide more accurate estimates when properly applied include continuous emissions monitors (CEMs), source testing, material balances, and engineering calculations. (See Introduction to AP-42 for further details.)

Procedures for Submittal and Evaluation of Techniques

1. A request for revision or addition of an emissions estimating technique or any other aspect of AP-42 or other emissions estimation guidance should be submitted in writing to EPA at the following address:

   Chief, Emission Factor and Methodologies Section
   MD-14
   USEPA
   Research Triangle Park, NC 27711

   Appendix A contains a list of the items that must be addressed by a request in order for it to be considered complete and widely applicable. Appendix B contains the criteria that EPA will use to evaluate whether the request is technically acceptable. The requestor should be familiar with the material in both of these Appendices and should ensure that their request addresses all items.

2. EPA will perform a first-step review of the request for completeness and applicability using the criteria given in Appendix A. The requestor should be familiar with the items listed in Appendix A and should ensure that their request addresses all required items. The emission source for which information is submitted should be non-unique and the emission estimation technique should be widely applicable to similar sources in order to be considered further by EPA. EPA will inform the requestor of its evaluation of completeness and applicability within 30 days of receipt of the request.* If deemed incomplete or not widely applicable by EPA, the requestor may amend and resubmit the request.

   If the request is deemed complete and applicable, EPA will place a notice to the public describing the requested revision(s) on the Clearinghouse for Inventories and Emission Factors (CHIEF) area of the Office of Air Quality Planning and Standards' (OAQPS) Technology Transfer Network (TTN) bulletin board system. This notice will identify the existing public review group members to receive EPA's initial recommendation, and it will solicit additional members. (See Procedures for Participating as a Public Reviewer).

3. After finding the request complete and applicable, EPA will begin an internal review for technical acceptability. Appendix B describes the criteria that EPA will use to evaluate the proposed revisions for acceptability. Requestors should be familiar with the criteria in Appendix B and should evaluate their own request before submittal to ensure that all criteria are adequately addressed. EPA may have to prioritize requests for technical review if a large number are received at one time. Priority will be established based upon the guidelines given in Appendix C.

4. EPA will issue its initial recommendation to accept or reject the submitted revisions within 90 days of beginning the technical review.* This initial recommendation will be described in a second notice to the public on the CHIEF bulletin board. The request (including items 1 through 12 of Appendix A) and the initial recommendation will be sent to the public review group, including anyone who has been added to the group during the 90-day technical review period. (See Procedures for Participating as a Public Reviewer).

Detailed test reports (item 13 of Appendix A) will not ordinarily be sent to the public review group. They will be sent to individual reviewers upon request, and thus. they must be non-confidential.

5. Members of the public review group will submit their individual review comments to EPA within 90 days of receipt of the review package. Public reviewers should review the material for the same attributes addressed by EPA (Appendix B).

6. EPA will consider the review comments and issue a final decision via a third notice on the CHIEF bulletin board within 30 days.* The final decision notice will summarize the comments and describe any changes made to the initial recommendation. EPA's acceptance or rejection of any or all public reviewer's comments are final. Any changes or additions to the estimation guidance are considered "authorized" as of the date of the final notice. These changes will be reflected in the next possible update to AP-42, FIRE, guidance documents or memos.

* Deadlines for review may be extended based upon the volume and complexity of the material and other considerations. All time frames given in terms of Calendar Days, not Business or Working Days.

Procedures for Participating as a Public Reviewer

In addition to the opportunity to submit information on new or revised estimation techniques, the public may also participate by reviewing EPA's initial recommendations of whether to add or revise techniques through a public review process. Individuals may request to be on the public review group for one or more sections. Such requests should be made to EPA in writing at the address given above in item 1 of Procedures for Submitting and Evaluating Techniques. These requests may also be made via the CHIEF area of the OAQPS TTN bulletin board system. The request must identify the specific sections of AP-42 that the person is interested in reviewing.

EPA has established a list of contacts for each AP-42 section from previous and ongoing efforts to revise AP-42. This list is currently used as the starting point for developing a list of interested reviewers for draft sections. A draft section is typically sent for review to about a dozen individuals representing trade associations, environmental groups, State and local air agencies, and individual companies. EPA will use this established list as the initial public review group for complete requests submitted per these procedures. This initial public review group list will be publicized on the CHIEF area of the TTN bulletin board system as part of the notice that a request has been deemed complete and applicable. (See item #3 above.) Individuals requesting membership before the date of the initial recommendation will be sent the public review package and will be added to that section's public review group list for any future updates.

Reviewers can have their names removed from the list by contacting EPA in writing or via the CHIEF area of the TTN at the address given above in item 1 of Procedures for Submitting and Evaluating Techniques. Reviewers may also be removed from the list by EPA if they do not respond to a public review package. A "no comment" response will be sufficient to show continuing interest in order to keep the reviewer on the review list for future revisions. EPA invites and encourages any member of the public to participate in the development of improved emissions estimation techniques according to these procedures.

APPENDIX A

INITIAL EPA REVIEW FOR COMPLETENESS AND APPLICABILITY

EPA encourages the submission of any data (including industry/process descriptions, diagrams, etc.) that a submitter believes may be useful in the Agency's ongoing effort to review and revise the emission factor information presented in AP-42. Each submittal will be carefully evaluated according to the criteria and will be adopted for publication where appropriate.

In evaluating proposed emission estimation techniques from the public, EPA will conduct a two-step internal review prior to an external public review. The first step of the internal review is to ensure that all of the necessary information to conduct an evaluation has been submitted, and that the proposed technique is widely applicable to similar sources. The second step is the actual evaluation of the technique for technical acceptability. The result of the second step of the internal EPA review is an "Initial Recommendation" to accept or reject the proposed revisions. The Initial Recommendation and supporting materials are then reviewed by a public review group before a final decision is made.

This Appendix describes the minimum information that must be submitted for EPA to perform the first step of internal review for completeness and applicability. EPA will not begin the second step of internal review for technical acceptability until the material has passed the first step review. The criteria EPA will use for the second step technical evaluation are given in Appendix B. Listed below are the items that EPA will review for the first step completeness and applicability review. The submitter should insure that their proposal adequately addresses all of these items in order to receive further consideration.

ITEMS TO BE ADDRESSED BY ALL SUBMITTALS

1. Submitter's Name, Mailing Address, and Phone
2. Contact Name, Address, and Phone (if different from Submitter)
3. AP-42 section, guidance document, or database affected
4. Description of emission source affected
   (Include SCC codes if available and process flow chart if applicable)
5. Estimated number of facilities affected
6. Estimated total emissions affected
7. Description of proposed change or addition

Identify whether an estimation technique, process description, both, or other change or addition is being proposed. Also identify which of the following cases the request addresses:

a. A change to an existing estimation technique or factor without alteration of the source description. (e.g., "The NOx emission factor for Wall-fired Utility boilers burning subbituminous coal should be changed from 21 to 17 based on new source tests".)

b. An estimation technique or factor for one or more new source descriptions resulting from a finer division of an existing source description to distinguish alternative processes. (e.g., "The NOx emission factor for Wall-fired Utility boilers burning subbituminous coal should be subdivided to distinguish single-wall fired from double wall-fired boilers, based on an analysis of existing source tests which shows a significant difference in emission rates between the two.")

c. An estimation technique or factors for a finer level of resolution of an existing source description and its technique or factor. (e.g., "The VOC emission factor for a complete fabric printing operation should be subdivided into individual processes so that emissions from dryers can be estimated and controlled separately.")

d. An estimation technique for a source not currently addressed by EPA.

8. New or marked-up text of the proposed revision to AP-42, guidance document, or database citation, which clearly shows where the existing text is affected.

9. Brief description of the type and source of data or analyses supporting the request. Material balances and other analyses will be considered. If revision to an existing factor is proposed, the description should include the data supporting the current factor as well as any new data being submitted. If submittal is for Case a (see item 7 above), describe why the current factor is inadequate and why the submitted data should be considered superior to data supporting current factor. If submittal is for Cases b or c, describe why the more detailed source description is required, and why emissions are different. In all cases, describe the extent of the data available or the analyses done to develop the factor or estimation technique.

10. Estimate of the range or uncertainty of the estimation technique.

11. Describe what effect(s) the proposed change might have on your facility (e.g., it will affect the fee the company pays, it will affect the regulation applicable to the source, etc.).

12. Any significant issues associated with the request (e.g., no standard test method exists, test method used is different from that used for the existing factor, definition of pollutant is unclear).

13. All data and analyses necessary to support the request, including test reports, material balance logs, data evaluations, etc.

14. If test data are submitted:

    a. Is the point tested clearly identified?
    b. Were process parameters monitored and recorded?
    c. Were process parameters within normal ranges?
    d. Are upsets and deviations described and explained?
    e. Are the test methods and procedures described?
    f. Are the methods compatible with approved EPA methods?
    g. Is there enough detail for EPA to validate the procedures?
    h. Are deviations from the normal procedures identified?
    i. Are original raw data and field data sheets included?
    j. Are QA/QC procedures described?

APPENDIX B

EPA REVIEW FOR TECHNICAL ACCEPTABILITY

The second step of the review begins once all of the information has been received from the submitter. The submitter is encouraged to review the following information carefully in order to understand the manner in which submitted information will be evaluated and the criteria used by EPA to determine whether changes to the AP-42 are warranted. The submitter should also be familiar with the guidelines issued by EPA for preparation of emission factors (Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections, EPA-454/B-93-050, and any subsequent revisions).

It might be useful to first outline the type of test data that is not considered acceptable in making revisions to AP-42 emission factors. This will help the submitter avoid proposing unacceptable emission estimation techniques. The following data generally are excluded from consideration:

1. Test data or averages reported in units that cannot be converted to appropriate reporting units.

2. Test series for which the test method is not described or is incompatible with existing EPA approved methods.

3. Test series on controlled emissions for which the control device is not specified or is insufficiently described.

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

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

6. Test data for which the QA/QC procedures are not clearly defined and documented.

Parties with data to submit should screen the data to ensure that they satisfy these basic requirements.

EPA has issued guidelines (Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections, EPA-454/B-93-050) to ensure consistency in the reporting of emission factors for AP-42. However, the background information and data for each source category will vary with respect to volume and soundness. For this reason, the Agency exercises a certain degree of flexibility in evaluating the submitted emissions data. In the case of existing factors based on limited data, a small amount of new data may be sufficient to prompt a revision to the emission factors. Where extensive data were available to support the factors initially, more new data would likely be needed to support a change in the factors.

Each data set that passes preliminary EPA approval is assigned a rating. A rating system is needed because some data might be used when little other information is available, but would be excluded if sufficient high-quality data were already available. Test data quality is rated as follows:

A - Tests utilizing a sound methodology and reported in enough detail for adequate validation. These tests are not necessarily EPA reference method tests: however, the reference methods are used as a guide.

B - Tests that were performed by a generally sound methodology, but lack enough detail for adequate validation.

C - Tests that are based on an untested or new methodology or that lack a significant amount of background data.

D - Tests that are based on a generally unacceptable method or on pilot or simulation studies. Such tests may provide an order-of-magnitude value for emissions from the process.

EPA uses the following criteria to evaluate source test reports or summaries for sound methodology and adequate detail:

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.

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

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

Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used are compared to those specified by EPA, to establish 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.

Although the rating system described above is subjective, it provides a basis for excluding poor data when sufficient good data are available.

The emission factors presented in AP-42 generally represent single-value statistical averages determined by engineering judgement to be representative of the available data for a specific

source category operation. These results are reduced to a single value representing any of various statistical parameters, including arithmetic mean and median. In the ideal case, a large number of A-rated source tests representing a cross-section of the industry would be reduced to a single value which serves as the emission factor. However, if the number of A-rated tests is so limited that the inclusion of B-rated tests would improve the emission factor, then B-rated test data are included in the compilation of the average value. (No C- or D-rated test data would be averaged with A- or B-rated data.) If A- or B-rated tests were not available, then C- or D-rated data would be averaged to provide a lower quality emissions factor.

Normally, emission factors are grouped in tables representing source operations or related groups of operations within a source category. The reliability of these factors is indicated by an overall rating factor ranging from A (excellent) to E (poor). These ratings take into account the type and amount of data from which the factors were calculated. Like the test data rating system, the emission factor ratings are subjectively determined. These emission factor ratings are as follows:

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

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

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

D - Below Average. Developed only from A- and B-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample within the industry. There also may be evidence of variability within the source category population Limitations on the use of the emission factors would be footnoted in the emission factor table.

E - Poor. Developed only from C- and D-rated test data, and there may be reason to suspect that the facilities or processes tested do not represent a random sample within the industry. There also may be evidence of variability within the source category process population. Limitations on the use of these factors are always footnoted.

APPENDIX C

FACTORS FOR PRIORITIZING TECHNICAL REVIEWS

In the event that EPA does not have adequate resources to evaluate all submitted materials. the following criteria will be used to determine the priority for material to be reviewed.

1. Estimating techniques for sources for which EPA does not currently have a technique will receive top priority, unless the estimated magnitude of emissions for the source category is judged insignificant by EPA.

2. Estimating techniques for significant sources which currently have D, E, or Unrated emission factors will receive next priority.

3. Estimating techniques for sources with an existing emission factor which has not been revised to represent newer process technology or test methods will receive third priority.

4. Sources categories for which the total national impact is greater will receive higher priority than lesser impact categories. Consideration of national impact will take into account the magnitude of emissions nationwide, the concentration of emission sources, and the toxicity of the pollutants to be estimated. A large difference between two requests in total impacts may be sufficient to overcome the priorities established by items 1, 2, and 3, above.

5. Source categories which are being or will shortly be considered by EPA for regulation will receive lower priority, to avoid duplication of the detailed review to be done as part of the regulatory process.

Appendix C
F-Factor Method

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Summary of F-Factor Methods for Determining Emissions from Combustion Sources *

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SUMMARY OF F FACTOR METHODS FOR DETERMINING EMISSIONS FROM COMBUSTION SOURCES

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INTRODUCTION

The Federal Standards of Performance for New Stationary Sources, regulating particulate matter, sulfur dioxide, and nitrogen oxide emissions from fossil fuel-fired steam generating units, are expressed in terms of pollutant mass per unit of heat input. Many State regulations for combustion equipment are expressed in the same form. To arrive at this emission rate, the original method required the determination of the pollutant concentration, effluent volumetric flow rate, and heat input rate. In the October 6, 1975, Federal Register,[1] an "F Factor" technique, which required only the determination of the fuel type, pollutant concentration, and the oxygen (O_2) concentration, was promulgated as a procedure to replace the original method. At the same time, an F Factor approach based on either O_2 or carbon dioxide (CO_2) measurements, was promulgated for use in reducing the pollutant concentration data obtained under the continuous monitoring requirements to the desired units.[2] Recently, wet F Factors,[3] which allow the use of wet basis measurements of the same parameters, and F Factors for wood and refuse have been calculated.

The purpose of this paper is to summarize the various methods and to present the calculated F Factor values for the different types of fuels. The various uses of F Factors and errors involved in certain applications and conditions are also discussed.

SUMMARY OF METHODS

The first method, referred to simply as the F Factor Method, is based on two principles:

1. The ratio of the quantity of dry effluent gas generated by combustion to the gross calorific value of the fuel is a constant within any given fuel category. This ratio is normally called the dry F Factor; however, for purposes of this paper, it will be called the F_d Factor.
2. An excess air correction factor may be expressed in terms of the dry oxygen content of the effluent stream.

The use of this method requires dry basis measurements of the pollutant concentration (C_d) and percent oxygen ($\%O_{2d}$). The emission rate (E) is calculated by the equation:

$$E = C_d F_d \left(\frac{20.9}{20.9 - \%O_{2d}}\right) \qquad (1)$$

If the moisture content of the flue gas (B_{ws}) is determined, a natural derivative of Equation 1, which would allow direct wet basis measurements of pollutant and oxygen concentrations, i.e. C_w and $\%O_{2w}$, respectively, is as follows:

$$E = C_w F_d \left[\frac{20.9}{20.9\ (1 - B_{ws}) - \%O_{2w}}\right] \qquad (2)$$

This equation has been approved in principle by the Environmental Protection Agency and may be used if it is demonstrated that B_{ws} can be accurately determined and that any absolute error in B_{ws} will not cause an error of more than $\pm$ 1.5 percent in the term

$$\frac{20.9}{20.9\ (1 - B_{ws}) - \%O_{2w}} .$$

The second technique, called the F_w Factor Method, is based on the same two principles as the F_d Factor Method, except that the two quantities, the effluent gas and the oxygen concentration, are determined on a wet basis. The ratio of

the quantity of wet effluent gas generated by combustion to the gross calorific value of the fuel is called the wet F Factor or the F_w Factor. The use of this technique, however, requires in addition to the wet pollutant concentration (C_w) and oxygen ($\%O_{2w}$) the determination of the fractional moisture content of the air (B_{wa}) supplied for combustion. (Guidelines for this determination will be discussed later.) The equation for calculating the emission rate is:

$$E = C_w F_w \left[\frac{20.9}{20.9 (1 - B_{wa}) - \%O_{2w}} \right] \quad (3)$$

This equation is a simplification of the theoretically derived equation.[3] Under typical conditions, a positive bias of no more than 0.25 percent is introduced.

The third procedure, the F_c Factor Method, is based on principles related to but slightly different than those for the F_d Factor and F_w Factor Methods:

1. For any given fuel category, a constant ratio exists between the volume of carbon dioxide produced by combustion and the heat content of the fuel. This ratio is called the F_c Factor.
2. The ratio of the theoretical carbon dioxide produced during combustion and the measured carbon dioxide provides an exact basis for dilution correction.

This method requires measurement of the pollutant concentration and percent carbon dioxide ($\%CO_2$) in the effluent stream. Measurements may be made on a wet or dry basis. Using the subscripts, "d" and "w", to denote dry and wet basis measurements, respectively, the equations for calculating E are:

$$E = C_d F_c \left(\frac{100}{\%CO_{2d}} \right) = C_w F_c \left(\frac{100}{\%CO_{2w}} \right) \quad (4)$$

DETERMINATION OF F FACTORS

Values of F_d in dscf/10^6 Btu, F_w in wscf/10^6 Btu, and F_c in scf/10^6 Btu, may be determined on an individual case-by-case basis using the ultimate analysis and gross calorific value of the fuel. The equations are:

$$F_d = \frac{10^6\ (3.64\ \%H + 1.53\ \%C + 0.57\ \%S + 0.14\ \%N - 0.46\ \%O)}{GCV} \qquad (5)$$

$$F_w = \frac{10^6\ (5.57\ \%H + 1.53\ \%C + 0.57\ \%S + 0.14\ \%N - 0.46\ \%O + 0.21\ \%H_2O^*)}{GCV_w}$$

$$F_c = \frac{10^6\ (0.321\ \%C)}{GCV}$$

where: H, C, S, N, O, and H_2O are the concentrations by weight (expressed in percent) of hydrogen, carbon, sulfur, nitrogen, oxygen, and water from the ultimate analysis. (* Note: The $\%H_2O$ term may be omitted if %H and %O include the unavailable hydrogen and oxygen in the form of H_2O.) GCV is the gross calorific value in Btu/lb of the fuel and must always be the value consistent with or corresponding to the ultimate analysis.

For determining F_w, the ultimate analysis and GCV_w must be on an "as received" or "as fired" basis, i.e., it must include the free water. Often in practice, the ultimate analysis and/or gross calorific value of a particular fuel are not known. For most commonly used fuels, tabulated average F Factors may be used instead of the individually determined values. These average values of F_d, F_w, and F_c, calculated from data obtained from the literature,[2-14] are given in Table I. F Factors for wood and bark are also listed in Table I, and factors for various types of refuse are listed in Table II.

ULTIMATE CARBON DIOXIDE

The ratio of F_c to F_d times 100 yields the ultimate percent CO_2 the maximum CO_2 concentration that the dry flue gas is able to attain. By dividing this number into 20.9, a ratio called the F_o Factor is obtained. F_o values calculated from the ultimate analyses of the various fuels are given in Tables I and II.

F_o values can also be calculated from CO_2 and O_2 data obtained in the field by using the following equation.

$$F_o = \frac{20.9 - \%O_{2d}}{\%CO_{2d}} \quad (8)$$

These calculated F_o values can be used to check Orsat data or other analyses of CO_2 and O_2 that have been adjusted to a dry basis. The process simply involves comparing F_o values calculated from Equation 8 with the values listed in Table I or II. Further details of this validation procedure are outlined in Reference 15.

ERRORS AND APPLICATION

The derivations of Equations 1 through 4 are discussed in References 3, 4, and 5. The following discussion gives further explanation of the F Factors and describes some of the problems and errors that arise in applying the F Factor Methods. Several uses for F Factors in addition to calculating emission rates are outlined.

Deviation in F Factors

The F Factors were calculated from data obtained from the literature. In the October 6, 1975, Federal Register,[2] the values of F_d and F_c were calculated by summing all data points and dividing by the total number of samples. Then the deviations from the extreme values (highest and lowest) were determined. The

higher of the two values, termed "maximum percent deviation from the average F Factors," are listed in parenthesis in Table I. These deviations are probably due to differences in the composition of the fuel, and may also include variations due to the analytical methods and analysts (laboratories). The standard deviations of the samples were not calculated since much of the data were already averages of several samples and there may have been more samples from one locale or of one kind than another.

After publication of the F_d and F_c Factors, it was determined that the midpoint value would be a better value than the average for small samples and for data taken from the literature. Therefore, the F_w Factors and the values for wood and refuse are midpoint values rather than arithmetic averages. The associated deviations are termed, "maximum percent deviation from the midpoint F Factor."

F_w Factors for refuse, wood, and wood bark were not calculated because of the high variability of free moisture contents. For example, the moisture in bark may vary from 20 percent (air dried) to 75 percent (hydraulic debarking).[6] Free moisture content variations of $\pm$ 15 percent introduce about 5 percent variations. However, for lignite, the moisture contents vary only from about 33 to 45 percent. This range causes a deviation of 3.8 percent from the midpoint F_w Factor, which enabled an F_w Factor to be established.

Incomplete Combustion

The assumption of complete combustion is made in the derivation of all F Factor Methods. If products of incomplete combustion, such as carbon monoxide, are present in the effluent stream, the volume of effluent gas and carbon dioxide per pound of fuel burned will differ from the values used in calculating the F Factors. However, adjustments to the measured CO_2 or O_2 concentration can be made, which would minimize the magnitude of the error when applying Equations 1-5.

These adjustments are given by the following equations:

$$(\%CO_2)_{adj} = \%CO_2 + \%CO \quad (9)$$

$$(\%O_2)_{adj} = \%O_2 - 0.5\ \%CO \quad (10)$$

By making these adjustments, the error amounts to minus one-half the concentration of CO present. Thus, if 1 percent CO (an extreme case) is present, an error of minus 0.5 percent is introduced. Without adjusting the CO_2 or O_2 concentration, a combustion source having 11 percent CO_2, 1 percent CO, and 6 percent O_2 will result in about plus 9 percent error for the F_c Factor Method and about plus 3 percent for the F_d Factor and F_w Factor Methods.

Similarly, unburned combustible matter in the ash will cause the volume of effluent gas and carbon dioxide per unit of heat input to differ from the calculated F Factor values. This is true, however, only if the heat input is thought of in terms of the coal input rate times the calorific value. If the heat input rate is considered as only that calorific value which is derived from the combusted matter, the F Factor Methods are only slightly affected. In other words, if any portion of the fuel goes through the combustion process unburned, the F Factor Methods will not include as heat input the calorific value associated with the uncombusted matter, and a slight positive bias will be introduced.

The positive bias is due to the combustion process, which is said to consist first of evaporating the free moisture, then the burning of the volatile matter, and last the burning of the fixed carbon, with the ash remaining. The volatile matter includes hydrogen, which results in a lower F Factor than the calculated values. Since a higher proportion of fixed carbon than volatile matter generally remains in the ash, the F_c Factor Method is affected more than the F_d Factor and

F_w Factor Methods. For example, assume that 100 lb of a coal, which 55 8% C, 5.7% H, 1.1% N, 3.2% S, 21.5% O, and 12.6% ash (percent by weight, as received basis), is burned and 5 lb fixed carbon remains in the ash. About plus 2.3 percent error is incurred with the F_c Factor and less than 1 percent with the F_d Factor and F_w Factor Methods.

Effect of Wet Scrubbers

When wet scrubbers are used, a portion of the carbon dioxide may be absorbed by the scrubbing solution. Therefore, the F_c Factor Method will yield an emission rate higher than the actual rate. If a gas stream having 14% CO_2 before the scrubber loses 10 percent of the CO_2, or 1.4% CO_2, the error is about plus 13 percent.

The F_d Factor Method is also affected by the loss of CO_2 in the scrubber, but to a lesser degree than the F_c Factor Method. If the gas stream has 6% O_2 and 1.4% CO_2 is lost in the scrubber, the error will be about plus 2 percent.

The F_w Factor Method is not applicable after wet scrubbers since the scrubber generally adds moisture to the flue gas, thereby "diluting" the gas stream. The pollutant concentration will be lowered by the same proportion of moisture added and the O_2 concentration will be lower than actual, which would tend to yield lower than true numbers.

When the scrubbing solution is lime or limestone, the F_c Factor Method may be used after wet scrubbers. It is generally assumed that due to the optimum operating conditions, the amount of CO_2 absorption is minimized and, therefore, the application of the F_c Factor Method will not yield appreciable errors. However, with limestone scrubbers, there is a possibility of CO_2 being added to the gas stream due to the reaction of SO_2 with the limestone. Therefore, the F_c Factors must be increased by 1 percent.

Determination of Ambient Air Moisture

Guidelines have been developed for the determination of B_{wa}, the moisture fraction in ambient air, in Equation 3, which will soon be published in the Federal Register. The guidelines are presented below.

Approval may be given for determination of B_{wa} by on-site instrumental measurement provided that the absolute accuracy of the measurement technique can be demonstrated to be within $\pm$ 0.7 percent water vapor. In lieu of actual measurement, B_{wa} may be estimated as follows: (Note that the following estimating factors are selected to assure that any negative error introduced in the emissions by the estimating term $\frac{20.9}{20.9\ (1 - B_{wa}) - \%O_{2ws}}$ will not be larger than -1.5 percent. However, positive errors, or over-estimation of emissions, of as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture.)

1. B_{wa} = 0.027. This factor may be used as a constant value at any location.
2. B_{wa} = highest monthly average of B_{wa} that occurred within a calendar year at the nearest Weather Service Station, calculated using data for the past 3 years. This factor may be used on an annual basis at any facility.
3. B_{wa} = highest daily average of B_{wa} that occurred within a calendar month at the nearest Weather Service Station, calculated for each month for the past 3 years used as an estimating factor for the respective calendar month.

Sampling Location and Sampling Points

Ambient air leakage into an exhaust system may cause variations across the duct or stack in the relative concentrations of CO_2 and O_2. For this reason, the Federal regulations[2] specify that CO_2 or O_2 be measured simultaneously and approximately at the same point as the gaseous pollutants measurements.

For particulate emission performance tests, which require traversing, it is specified that the O_2 samples be obtained simultaneously by traversing the duct at the same sampling location used for each run of the Method 5. This requirement may be satisfied by attaching a stainless steel tube to the particulate sampling probe and, using a small diaphragm pump, obtaining an integrated gas sample over the duration of the run (of Reference 1). The sample should be analyzed using an Orsat apparatus.

As an alternative to traversing the same sampling points of Method 5, a minimum of 12 oxygen sampling points may be used for each run. This would require a separate integrated gas sampling train traversing the duct work simultaneously with the particulate run.

Other Applications

In addition to calculating emission rates, F Factors have several other uses. If Q_{sd}, the dry effluent volumetric flow rate, or Q_{sw}, the wet effluent volumetric flow rate, and Q_H, the heat input rate, are measured, a value of F_d, F_w, or F_c may be calculated. These equations are given below:

$$F_{d(calc)} = \frac{Q_{sd}}{Q_H} \frac{20.9 - \%O_2}{20.9} \quad (11)$$

$$F_{w(calc)} = \frac{Q_{sw}}{Q_H} \frac{20.9\ (1 - B_{wa}) - \%O_{2w}}{20.9} \quad (12)$$

$$F_{c(calc)} = \frac{Q_{sd}}{Q_H} \frac{\%CO_{2d}}{100} = \frac{Q_{sw}}{Q_H} \frac{\%CO_{2w}}{100} \quad (13)$$

The calculated values may then be compared to tabulated values of the F Factors to facilitate a material balance check.

If desired, Q_H can be calculated by using the Equations 11 through 13. In the past, it has been observed that the measurement of Q_s has been significantly greater than the stoichiometric calculations rates. The discrepancy is usually due to errors in determining Q_s. Due to aerodynamic interferences and improper alignment of the pitot tubes, higher than real readings have been obtained. Therefore, errors in measuring Q_s are positive, which leads to higher than true firing rates.

If an ultimate analysis and calorific determination of a particular fuel are made and the F Factor value is calculated, the accuracy of the results may be checked by comparison with the tabulated F Factors.

SUMMARY

The various F Factor Methods have been summarized and calculated F Factors for fossil fuels, wood, wood bark, and refuse material have been presented. In addition, some of the problems and errors that arise in applying the F Factor Method for calculating power plant emission rates were discussed and other uses of the F Factors were outlined.

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TABLE I. F FACTORS FOR VARIOUS FUELS[2-14,a,b]

Fuel Type	F_d dscf/10^6 Btu	F_w* c wscf/10^6 Btu	F_c scf/10^6 Btu	F_o
Coal				
Anthracite	10140 (2.0)	10580 (1.5)	1980 (4.1)	1.070 (2.9)
Bituminous	9820 (3.1)	10680 (2.7)	1810 (5.9)	1.140 (4.5)
Lignite	9900 (2.2)	12000 (3.8)	1920 (4.6)	1.0761(2.8)
Oil	9220 (3.0)	10360 (3.5)	1430 (5.1)	1.3461(4.1)
Gas				
Natural	8740 (2.2)	10650 (0.8)	1040 (3.9)	1.79 (2.9)
Propane	8740 (2.2)	10240 (0.4)	1200 (1.0)*	1.10 (1.2)*
Butane	8740 (2.2)	10430 (0.7)	1260 (1.0)	1.479 (0.9)
Wood	9280 (1.9)*	----------	1840 (5.0)	1.5 (3.4)
Wood Bark	9640 (4.1)	----------	1860 (3.6)	1.056 (3.9)

[a] Numbers in parenthesis are maximum deviations (%) from either the midpoint or average F Factors.

Note: To convert to metric system, multiply the above values by 1.123×10^{-4} to obtain scm/10^6 cal.

[c] All numbers below the asterick (*) in each column are midpoint values. All others are averages.

TABLE II. MIDPOINT F FACTORS FOR REFUSE[2-14,a,b]

	F_d dscF/10^6Btu	F_c wscF/10^6Btu	F_c
Paper and Wood Wastes[c]	9260 (3.6)	1870 (3.3)	1.048 (4.8)
Lawn and Garden Wastes[d]	9590 (5.0)	1840 (3.0)	1.088 (2.4)
Plastics			
Polyethylene	9173	1380	1.394
Polystyrene	9860	1700	1.213
Polyurethane	10010	1810	1.157
Polyvinyl chloride	9120	1480	1.286
Garbage[e]	9640 (4.0)	1790 (7.9)	1.110 (5.6)
Miscellaneous			
Citrus rinds and seeds	9370	1920	1.020
Meet scraps, cooked	9210	1540	1.252
Fried fats	8939	1430	1.310
Leather shoe	9530	1720	1.156
Heel and sole composition	9480	1550	1.279
Vacuum cleaner catch	9490	1700	1.170
Textiles	9354	1840	1.060
Waxed milk cartons	9413	1620	1.040

[a] Numbers in parentheses are maximum deviations (%) from the midpoint F Factors.

[b] To convert to metric system, multiply the above values by 1.123×10^{-4} to obtain scm/10^6 cal.

[c] Includes newspapers, brown paper, corrugated boxes, magazines, junk mail, wood, green logs, rotten timber.

[d] Includes evergreen shrub cuttings, flowing garden plants, leaves, grass.

[e] Includes vegetable food wastes, garbage (not described).

APPENDIX D
HAZARDOUS AIR POLLUTANTS

SECTION 112(b) LIST OF 189 HAZARDOUS AIR POLLUTANTS

CAS #	POLLUTANT NAME	37 High Priority	PM or Conden.	VOC or Not Reac.	Ozone Depl.
75070	Acetaldehyde	HI		VOC	
60355	Acetamide			VOC	
75058	Acetonitrile			VOC	
98862	Acetophenone			VOC	
53963	2-Acetylaminofluorene		PM or C	VOC	
107028	Acrolein	HI		VOC	
79061	Acrylamide	HI		VOC	
79107	Acrylic acid			VOC	
107131	Acrylonitrile	HI		VOC	
107051	Allyl chloride			VOC	
92671	4-Aminobiphenyl		PM or C	VOC	
62533	Aniline			VOC	
90040	o-Anisidine			VOC	
1332214	Asbestos		PM	NOT ORG	
71432	Benzene	HI		VOC	
92875	Benzidine		PM or C	VOC	
98077	Benzotrichloride			VOC	
100447	Benzyl chloride			VOC	
92524	Biphenyl			VOC	
117817	Bis (2-ethylhexyl)phthalate (DEHP)		PM or C	VOC	
542881	Bis(chloromethyl)ether			VOC	
75252	Bromoform			VOC	
106990	1,3-Butadiene	HI		VOC	
156627	Calcium cyanamide		PM		
105602	Caprolactam			VOC	
133062	Captan		PM or C		
63252	Carbaryl		PM or C		
75150	Carbon disulfide			VOC	
56235	Carbon tetrachloride			VOC	O3
463581	Carbonyl sulfide			VOC	
120809	Catecol				
133904	Chloramben		PM or C		
57749	Chlordane		PM or C		
7782505	Chlorine			NOT ORG	
79118	Chloroacetic acid			VOC	
532274	2-Chloroacetophenone			VOC	
108907	Chlorobenzene			VOC	
510156	Chlorobenzilate		PM or C	VOC	
67663	Chloroform	HI		VOC	
107302	Chloromethyl methyl ether			VOC	
126998	Chloroprene			VOC	
1319773	Cresols/Cresylic acid (isomers and mixture)			VOC	
95487	o-Cresol			VOC	
108394	m-Cresol			VOC	
106445	p-Cresol			VOC	
98828	Cumene			VOC	
94757	2,4-D, salts and esters		PM or C		

72559	DDE		PM or C	
334883	Diazomethane			VOC
132649	Dibenzofurans		PM or C	VOC
96128	1,2-Dibromo-3-chloropropane			VOC
84742	Dibutylphthalate		PM or C	VOC
106467	1,4-Dichlorobenzene(p)			VOC
91941	3,3-Dichlorobenzidine		PM or C	VOC
111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)	HI		VOC
542756	1,3-Dichloropropene			VOC
62737	Dichlorvos			
111422	Diethanolamine			VOC
121697	N,N-Diethyl aniline (N,N-Dimethylaniline)			VOC
64675	Diethyl sulfate			VOC
119904	3,3-Dimethoxybenzidine		PM or C	VOC
60117	Dimethyl aminoazobenzene		PM or C	VOC
119937	3,3'-Dimethyl benzidine		PM or C	VOC
79447	Dimethyl carbamoyl chloride			VOC
68122	Dimethyl formamide			VOC
57147	1,1-Dimethyl hydrazine			VOC
131113	Dimethyl phthalate			VOC
77781	Dimethyl sulfate			VOC
534521	4,6-Dinitro-o-cresol, and salts		PM or C	VOC
51285	2,4-Dinitrophenol		PM or C	VOC
121142	2,4-Dinitrotoluene			VOC
123911	1,4-Dioxane (1,4-Diethyleneoxide)			VOC
122667	1,2-Diphenylhydrazine			VOC
106898	Epichlorohydrin (1-Chloro-2,3-epoxypropane)			VOC
106887	1,2-Epoxybutane			VOC
140885	Ethyl acrylate			VOC
100414	Ethyl benzene			VOC
51796	Ethyl carbamate (Urethane)			VOC
75003	Ethyl chloride (Chloroethane)			VOC
106934	Ethylene dibromide (Dibromoethane)	HI		VOC
107062	Ethylene dichloride (1,2-Dichloroethane)	HI		VOC
107211	Ethylene glycol			VOC
151564	Ethylene imine (Aziridine)			VOC
75218	Ethylene oxide	HI		VOC
96457	Ethylene thiourea			VOC
75343	Ethylidene dichloride (1,1-Dichloroethane)			VOC
50000	Formaldehyde	HI		VOC
76448	Heptachlor			VOC
118741	Hexachlorobenzene			VOC
87683	Hexachlorobutadiene			VOC
77474	Hexachlorocyclopentadiene			VOC
67721	Hexachloroethane			VOC
822060	Hexamethylene-1,6-diisocyanate			VOC
680319	Hexamethylphosphoramide			VOC
110543	Hexane			VOC
302012	Hydrazine	HI		
7647010	Hydrochloric acid (hydrogen chloride gas only)			NOT ORG
7664393	Hydrogen fluoride (Hydrofluoric acid)			NOT ORG

123319	Hydroquinone		PM or C		
78591	Isophorone				
58899	Lindane		PM or C		
10831	Maleic anhydride		PM or C	VOC	
67561	Methanol			VOC	
72435	Methoxychlor		PM or C	VOC	
74839	Methyl bromide (Bromomethane)			VOC	
74873	Methyl chloride (Chloromethane)			VOC	
71556	Methyl chloroform (1,1,1-Trichloroethane)			NR	O3
78933	Methyl ethyl ketone (2-Butanone)			VOC	
60344	Methyl hydrazine			VOC	
74884	Methyl iodide (Iodomethane)			VOC	
108101	Methyl isobutyl ketone (Hexone)			VOC	
624839	Methyl isocyanate			VOC	
80626	Methyl methacrylate			VOC	
1634044	Methyl tert butyl ether			VOC	
101144	4,4'-Methylenebis(2-chloroaniline)		PM or C	VOC	
75092	Methylene chloride (Dichloromethane)	HI		NR	
101688	Methylene diphenyl diisocyanate (MDI)	HI		VOC	
101779	4,4-Methylenedianiline		PM or C	VOC	
91203	Naphthalene			VOC	
98953	Nitrosobenzene			VOC	
92933	4-Nitrobiphenyl		PM or C	VOC	
100027	4-Nitrophenol		PM or C	VOC	
79469	2-Nitropropane			VOC	
684935	N-Nitroso-N-methylurea			VOC	
62759	N-Nitrosodimethylamine			VOC	
59892	N-Nitrosomorpholine				
56382	Parathion		PM or C		
82688	Pentachloronitrobenzene			VOC	
87865	Pentachlorophenol		PM or C	VOC	
108952	Phenol			VOC	
106503	p-Phenylenediamine		PM or C	VOC	
75445	Phosgene	HI			
7803512	Phosphine				
7723140	Phosphorus			NOT ORG	
85449	Phthalic anhydride		PM or C	VOC	
1336363	Polychlorinated biphenyls (Aroclors)		PM or C	VOC	
1120714	1,3-Propane sultone			VOC	
57578	beta-Propiolactone				
123386	Propionaldehyde			VOC	
114261	Propoxur (Baygon)		PM or C		
78875	Propylene dichloride (1,2-Dichloropropane)			VOC	
75569	Propylene oxide			VOC	
75558	1,2-Propylenimine (2-Methyl aziridine)			VOC	
91225	Quinoline				
106514	Quinone				
100425	Styrene	HI		VOC	
96093	Styrene oxide			VOC	
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin	HI	PM or C	VOC	
79345	1,1,2,2-Tetrachloroethane			VOC	

127184	Tetrachloroethylene (Perchloroethylene)	HI		VOC
7550450	Titanium tetrachloride			
108883	Toluene	HI		VOC
95807	2,4-Toluene diamine		PM or C	VOC
584849	2,4-Toluene diisocyanate	HI		VOC
95534	o-Toluidine			VOC
8001352	Toxaphene (Chlorinated camphene)		PM or C	
120821	1,2,4-Trichlorobenzene			VOC
79005	1,1,2-Trichloroethane			VOC
79016	Trichloroethylene	HI		VOC
95954	2,4,5-Trichlorophenol			VOC
88062	2,4,6-Trichlorophenol			VOC
121448	Triethylamine			VOC
1582098	Trifluralin		PM or C	
540841	2,2,4-Trimethylpentane			VOC
108054	Vinyl acetate			VOC
593602	Vinyl bromide			VOC
75014	Vinyl chloride	HI		VOC
75354	Vinylidene chloride (Dichloroethylene)			VOC
1330207	Xylenes (isomers & mixture)	HI		VOC
95476	o-Xylenes	HI		VOC
108383	m-Xylenes	HI		VOC
106423	p-Xylenes	HI		VOC
	Antimony Compounds	HI	PM or C	NOT ORG
	Arsenic Compounds (inorganic including arsine)	HI	PM or C	NOT ORG
	Beryllium Compounds	HI	PM or C	NOT ORG
	Cadmium Compounds	HI	PM or C	NOT ORG
	Chromium Compounds	HI	PM or C	NOT ORG
	Cobalt Compounds		PM or C	NOT ORG
	Coke Oven Emissions	HI	PM or C	VOC
	Cyanide Compounds1		PM or C	NOT ORG
	Glycol Ethers2	HI		VOC
	Lead Compounds	HI	PM or C	NOT ORG
	Manganese Compounds	HI	PM or C	NOT ORG
	Mercury Compounds	HI	PM or C	NOT ORG
	Fine Mineral Fibers3		PM	NOT ORG
	Nickel Compounds	HI	PM or C	NOT ORG
	Polycyclic Organic Matter4	HI	PM or C	VOC
	Radionuclides (including radon)5		PM or C	NOT ORG
	Selenium Compounds		PM or C	NOT ORG

NOTE: For all listings above which contain the word "compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e. antimony , arsenic, etc.) as part of that chemical's infrastructure.

1 X'CN where X = H' or any other group where a formal dissociation may occur. For example KCN or Ca(CN)2

2 includes mono- and di- ethers of ethylene glycol, diethylene glycol, and triethylene glycol R-(OCH2CH2)n-OR' where

n = 1, 2, or 3

R = alkyl or aryl groups

R' = R, H, or groups which, when removed, yield glycol ethers with structure:; R-(OCH2CH)n-OH polymers are excluded from the glycol category.

3 includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micrometer or less.

4 includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100oC

5 a type of atom which spontaneously undergoes radioactive decay.