DRAFT

DETAILED PROCEDURES FOR PREPARING EMISSIONS FACTORS

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1.1 PURPOSE

The purpose of this document is to describe the specific tasks involved in the development of air pollution emissions factors and their subsequent incorporation into EPA's web-based Factor Information and REtrieval (*WebFIRE*) system. The material in this document is intended as guidance that should be followed when practicable. A companion document, *Overview of Procedures for Preparing Emissions Factors*, provides background information on the uses, limitations, variability, and measurement of air pollution emissions factors, and describes the reasons and procedures for initiating revisions to emissions factors. Together, these two reports document significant changes to the emissions factor development procedures that were previously presented in *Procedures for Preparing Emission Factor Documents*, EPA-45/R-95-015, http://www.epa.gov/ttn/chief/efdocs/procedur.pdf.

1.2 BACKGROUND

Emissions factors have long been used as a cost-effective means of estimating emissions over large geographic areas containing many individual facilities. The Clean Air Act Amendments (CAAA) of 1990 added greatly to the number of air pollution sources for which emissions factor development was required, and also called for the improvement of existing emissions factors.
Stationary point and area source emissions factors have been published in the *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources,* (AP-42) and the *Locating and Estimating Air Emissions from Sources of [Substance]* (L&E) document series published by EPA's Office of Air Quality Planning and Standards (OAQPS). *Procedures for Preparing Emission Factor Documents* served as a guide for EPA personnel and their contractors preparing AP-42 sections and L&E documents, and as an aid to industry, trade associations, and federal, state, tribal and local agencies that were involved in developing or revising emissions factors or equations.

In addition to making emissions factors available in AP-42 and L&E documents, EPA has historically made the same emissions factors available in a downloadable version of the *WebFIRE* database system known as FIRE. As with the AP-42 emissions factors, the emissions factors presented in FIRE typically are representative of average (arithmetic mean) values and very limited information regarding the uncertainty associated with the emissions factor values is presented.

As noted in the guidance for AP-42, AP-42 emissions factors are intended by EPA for use in developing regional and national emissions inventories, which are fundamental tools for air quality management. However, emissions factors are currently used for many other non-inventory purposes including:

- Developing site-specific emissions estimates
- Identifying and evaluating control strategies and implementation plans
- Determining applicability of permit and regulatory requirements
- Conducting risk assessments
- Compliance determination
- Emissions offsets/emissions banking confirmation
- Permit limit determinations
- Toxic Release Inventory (TRI) reporting
- Emissions statement/fee collection
- International treaty reporting

Emissions factors are also used in other related applications by an array of users including federal, state, tribal, and local agencies; consultants; and industry. EPA recognizes that other methods of obtaining emission estimates from specific sources may be more accurate than industry-average emissions 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. These alternative methods include continuous emissions monitoring, source testing, material balances, and engineering calculations. The remainder of this chapter provides an overview of the tasks involved in the development of emissions factors and subsequently incorporating them into *WebFIRE*. Figure 1-1 displays the steps that must be performed. Chapter 2 provides the details on how the tasks outlined in this chapter can best be accomplished, from data collection through data evaluation and external reviews, to the publishing of emissions factor data to *WebFIRE*.

The new *WebFIRE* database system is designed to continue to improve the coverage and quality of emissions factors and make it easier for interested parties to publish new emissions factor data

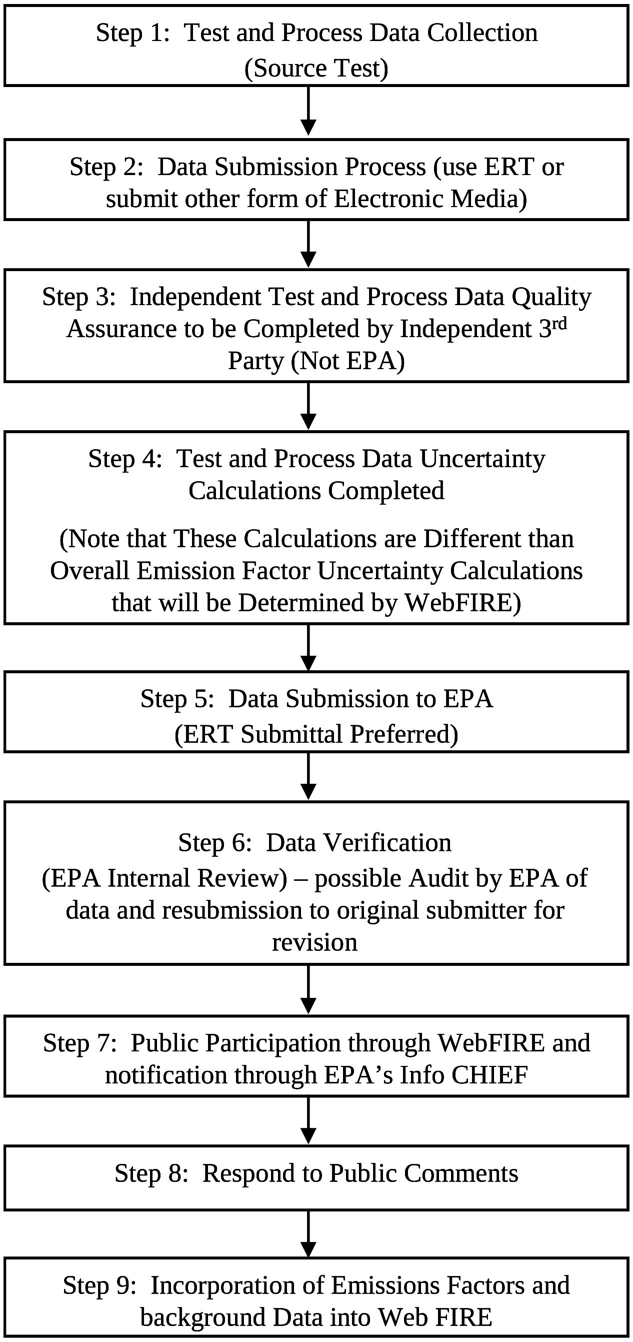


Figure 1-1. Overview of the Emissions Factor Development and Update Procedures

and find the best emissions factors available. *WebFIRE* is moving toward a system that provides emissions factors with a quantitative estimate of their uncertainty to give users a more informed basis for use of the emissions factors. The change of format from a downloadable application to a web-based system facilitates frequent updates to the system. In addition, *WebFIRE* establishes one-stop shopping for emissions factors and related information by linking historical AP-42 and L&E process and control descriptions to emissions factors in *WebFIRE*. *WebFIRE* contains emissions factors and process information for more than 200 air pollution source categories, i.e., specific industry sectors or groups of similar emitting sources.

To further facilitate the addition of quality source test data to *WebFIRE*, the Electronic Reporting Tool (ERT) has been created by EPA to provide a standard reporting format for use in compiling and submitting the results of source tests conducted using EPA methods. The ERT can be used directly by source testers for calculation of source test uncertainty and submittal of the source test to regulatory agencies.

1.3 EMISSIONS FACTOR UPDATES

The following subsections summarize the steps that must be completed to develop or update air pollution emissions factors. In order to support a more streamlined approach to the development of emissions factors, EPA has made substantial changes to the data collection procedures that were documented in *Procedures for Preparing Emission Factor Documents*. These changes are necessary for data to be collected in a standardized format and to capture additional relevant process information necessary to provide the basis for the emissions factor.

The first step (**Figure 1-1**, Step 1) to making emissions factor updates involves source test and process data collection. These tasks require cooperation from source testing entities and local/state agencies that oversee source testing efforts to meet EPA’s data needs.

The second step (**Figure 1-1**, Step 2) requires that source and process data be submitted to either the EPA or a State agency (depending on the use or generation requirement of the data). The data transfer process can be accomplished by using the ERT, or other suitable means of transferring data.

In the third step (**Figure 1-1**, Step 3) an independent third party, generally a state agency representative, quality assures all data that are collected for compliance determinations, rule development, or emission factor generation. Data collected for any of these reasons can be used for emission factor development. It should be noted that EPA's emissions factor program does not perform quality assurance reviews of test data nor does it review test program designs, test plans, or test reports. The only exception is for testing conducted by or funded by the emissions factors group or for tests for which the group has agreed to serve as the quality assurance assessor before the test program is undertaken.

A key step in the quality assurance review of the source test data is the assessment of compliance with the appropriate EPA test method(s). Any deviations should be noted so that they can be accommodated in the assessment of compliance and used in calculating the estimated uncertainty of the source test. The uncertainty of the source test is the result of instrumentation inaccuracies and imprecision and testing procedure errors, while the uncertainty of the process data is caused by inaccurate and imprecise quantification of process variables.

Once the emissions and process data have been quality assured, the uncertainty of the source test can be calculated (**Figure 1-1**, Step 4). The basis for the assignment of uncertainty to both the test data and the process data are the responses to the data quality questions (DQQs) described later in this document. At this stage, the data may be submitted to EPA, preferably through the use of the ERT (**Figure 1-1**, Step 5). Any interested party may submit emissions data to EPA for inclusion in *WebFIRE*; however, the data must include certain elements to allow EPA to calculate emissions factors and must have been previously quality assured by a third party.

Step 6 involves third party review by EPA personnel of data submitted to EPA (**Figure 1-1**, Step 6). The first step in internal review will be to verify that the data were collected in accordance with the specified method, sufficient data are included to calculate the emissions factor and the uncertainty, and that the third party QA steps were completed appropriately. If a Source Classification Code, (SCC) has not already been assigned to the processes, the submitter should contact EPA's emissions factors group for an assignment. Once these steps are complete, the processes will be grouped by the appropriate SCC, emissions factors will be calculated and the uncertainty assigned, and the emissions factors will be reviewed for engineering plausibility.

EPA's internal review of data will be facilitated by using the new data submission structure as described in the ERT discussion. This will give the internal reviewers sufficient information to properly assess the veracity of the information submitted, characterize the quality of the data, and identify data that need further review. Documenting the more important aspects of source testing programs and consistently assessing and documenting the uncertainty of such data will improve the overall quality of the compliance assessment and emissions factor programs.

Step 7 of the emissions factor update process involves external review on a periodic basis (e.g., every 6 to 12 months) of the emissions factor and supporting data (**Figure 1-1**, Step 7). The review opportunity will be initiated by posting the source test data on *WebFIRE* and sending out a notification through EPA's Info CHIEF list server. External review of data will allow interested parties including those that provided the data to examine the application of the data. State and local agency personnel, EPA Regional offices, industry associations, corporate environmental staffs, consultants, and emissions inventory developers are encouraged to review the submitted data and backup information. Questions and responses to public comments regarding the new data or factors could lead to an audit be EPA's emissions factor group (**Figure 1-1,** Step 8). If the audit determines that the data are not suitable for publishing or revising an emissions factor, problems with the data would be identified and referred to the original submitter for revision.

Finally, in Step 9 of the emissions factor update process, once all of the data collection, calculation, and review steps are complete, the new or updated emissions factor will be incorporated into *WebFIRE* where it will be easily accessible for use to calculate average emissions for applicable sources (**Figure 1-1**, Step 9).

2.0 DEVELOPMENT OF EMISSIONS FACTORS

This chapter is a guide to the procedures that are to be used to prepare emissions factors and emissions factors data for inclusion in *WebFIRE*. The procedures follow the order of steps that were introduced in Figure 1-1 of this document.

2.1 DATA COLLECTION

2.1.1 General Data Requirements

The data collection process must result in sufficient data to calculate the emissions factor, estimate the uncertainty associated with the factor, allow for a thorough QA review, and provide for an accurate characterization of the source (e.g., assignment of the proper SCC, any associated control devices, equipment capacity rating, equipment manufacturer, etc.). In order to accomplish this goal, sufficient process and test data should be collected for the calculation of the emissions factor. In most instances, data requirements for the development of emissions factors are essentially the same as EPA's data collection and data quality specifications for compliance test reports. The following is a list of the common data needed to characterize the source and process. Each test program should collect data specific to that source.

- process name or description
- process feedstock or fuel type
- plant capacity, operating rate, and throughput during the test
- control devices and their operating parameters
- the age of the facility and the control devices
- dates of last maintenance performed on control devices
- description of last maintenance performed on control devices
- any process or control device upsets during the test
- the pollutants tested for and the test methods used
- any deficiencies and/or deviations in the test procedures
- the number and duration of test runs
- the completeness of QA/QC documentation

2.1.2 Source Description Data.

A source category is a generally broad collection of similar sources, such as gasoline storage tanks, polymer manufacturing facilities, and glass manufacturing facilities. Many source categories have been catalogued in the current list of SCCs, and have been used to categorize emissions and emissions factors. The most current list of SCCs and their descriptions can be downloaded from EPA's website (http://cfpub.epa.gov/oarweb/download/WebFIRESCCs.csv or (http://www.epa.gov/ttn/chief/codes/scc_feb2004.xls). SCCs are used to identify sources with similar production characteristics. In some instances, similar sources may have multiple SCCs because additional production characteristics have been identified that offer the possibility to differentiate alternative production characteristics. For example, wet or dry cement manufacturing (wet kiln, dry kiln, preheater kiln, preheater-precalciner kiln). Also, there may be situations where one SCC is used for production methods that are slightly different but there has not been a need to further subcategorize them. These situations may be characterized in notes in the test report. Emissions factors for these and other sources are derived from multiple emission tests. Developing emissions factors for sources within a source category is then an exercise in evaluating the emissions data from the different source tests and determining if one can combine the data and, if so, how.

If there is only one set of emissions data available for a source category, there is no issue as to what emissions factors to present. The issue is to present information concerning the derivation of the emissions data (e.g., source test, equipment tested, conditions under which the test was performed, etc.) so that the end user can assess the applicability of the emissions factors to their specific source.

The next more complex scenario is that there will be emissions data from more than one source in a source category. In this instance, the more demanding task is to determine if and to what extent the emissions data from the different tests can be combined to create a single, average emissions factor. This is most likely to be assessed on an emission point-by-emission point basis.

In addition, where a single, average emission factor can be derived, the next task is to assign a range or level of uncertainty to the average emission factor. In combining emissions factors with different levels of uncertainty, it will be important to provide a representative emissions factor with the lowest level of uncertainty.

Factors to take into account to determine whether multiple emission data can be combined to create an average emissions factor related to all of the different parameters that affect the level of emissions (as was previously discussed). The more alike raw materials, process designs, and operating parameters among facilities for which emissions test data exist, the more likely an average can be created that is meaningful. If there are significant differences in the operating parameters, the benefits of combining or averaging the data should be weighed against assignment of test data to different SCCs. The ultimate decision is highly dependent on the source category and the degree of specificity available in existing SCCs. New SCCs can be created when necessary to specify greater levels of source detail. For some parameters, differences might reflect normal process operating conditions. In such instances, averaging the data is reasonable, using the individual data points to illustrate potential ranges. As when dealing with single test emission data, providing as much description as to the derivation of the average emission factor and the source conditions associated with the emission factor is still important to allow the end user to use the emission factor appropriately.

The following examples for PET manufacturing illustrate several parameters and how one might consider using emission data from multiple source tests. Other similar examples of segregating or combining emissions data for a source category which have processing or control parameters that might affect emissions are included in the Hot Mix Asphalt, Portland Cement, and various combustion related sections of AP-42.

- **Production process ─** Emissions data from a PET/DMT facility and from a PET/TPA facility are available (see Tables 6.6.2-1 and 6.6.2-2 in AP-42). Because of the basic differences between the two processes, combining the emissions data would not be recommended.
- **Production steps ─** Emissions data from a polystyrene facility using a continuous process and from a polystyrene facility using a batch process. Are available (see Tables 6.6.3-1 and 6.6.3-2 in AP-42). Because of differences in the type of reactors, combining emissions data for the reactors would not be recommended. However, because of the similarities in raw materials, combining emission factors associated with raw material storage might be reasonable.
- **Seasonal Differences ─** Emissions data from a tank storing organic liquids during the warmest months and from a tank storing organic liquids during coolest months are provided in AP-42 (see section 7.1 in AP-42). Combining emission data to create a single emission factor might be reasonable to allow emission estimates on an annual basis. The warmest and coolest emissions data could still be presented as a range, allowing those concerned about emissions during the warmest months to estimate emissions from such tanks during ozone season.

A description of the emissions source category is provided with each emissions factor included in *WebFIRE*. Previously, these source category descriptions were included in AP-42 along with the emissions factors themselves. If a source category is currently included in *WebFIRE*, a review should be made to determine whether the source category description accurately depicts the source that was tested. If the description is accurate, then no further action is required. However, if a source category is not currently included in *WebFIRE* or if the existing source category description is insufficient, then data and supporting documentation must be provided to develop a new or revised source category description.

The content and format of emission source description documents will follow the format previously used in AP-42. The typical source description document consists of the following elements:

- General process description, with flow diagram(s) indicating emission points and pollutants
- Discussion of emissions and any applicable or typical control devices
- Dated listing of changes to text discussions since last revision (not revisions/changes to the WebFIRE EF or EF references.)
- List of references (excluding test report references)

The process description text explains the flow diagram and gives a general overview of the process. It includes descriptions of control devices and their general range of effectiveness. Detailed process schematics are preferred, instead of simple block diagrams. Schematics and diagrams must be compatible with the electronic distribution of the final documents. The process description text is not intended to give a complete description of the industry, and may refer the reader to specific references where more information can be obtained.

The user is assumed to have an engineering or other technical background, to be generally familiar with the source operations, and to need information about any qualifications placed on the emissions factors. Qualifications consist of a description of process variables that might cause emissions to be higher or lower, and the range of variation that could be expected. Source SCCs should be included to assist in tying the process descriptions back to the emissions factors.

Emission factors from one facility producing a product are not always transferable to another facility producing the same product. This occurs because there will inevitably be variations in those aspects of production that affect emissions. Although it may seem that variations are likely to be more significant between two different facilities, these variations can also occur within a facility or a single process unit. For example, the age of equipment at a new facility is likely to vary from a facility built 20 years earlier. But within a facility, there may be a new production line with the newest equipment along side a line that has been around for 20 years.

Some aspects that may affect emissions include:

- **Raw materials**. The raw material used can affect both the level of emissions and the specific compounds that are emitted. In addition, raw materials may vary at the same process unit. For example, the source of sulfur dioxide emissions from most brick kilns is the raw material, which sometimes contain sulfur compounds. Some facilities use raw material with a high sulfur content, and have higher sulfur dioxide emission than facilities that use low-sulfur raw material. Further, data indicate that sulfur contents of surface soils are highly variable, and it is likely that sulfur contents of brick raw materials are also highly variable (see section 11.3.3 of AP-42).
- **Production process**. The basic production process can have a significant effect on the level of emissions. For example, uncontrolled particulate emission rates for fluidized bed prill towers are higher than those for nonfluidized bed prill towers when making agricultural grade prills (see section 8.2.3 of AP-42). Further, production processes of similar type (for example, continuous processes) may involve different steps (e.g., recovery of materials on-site versus off-site).
- **Production parameters**. Production of products may involve such parameters as temperature, pressure, residence time, etc. Each of these parameters can affect the level of emissions. For example, variations in emission rates among glass melting furnaces are attributable, in part, to varying operation temperatures (see section 11.13.2 of AP-42).
- **Production equipment**. The type, size, and number of equipment used in the same basic process can vary, affecting emission levels. For example, the type of electrode used in electric arc welding greatly affects the level of emissions (see Table 12.19-1 in AP-42). As another example, the type of stripper (e.g,. two-row, pulled tractor vs two-row with basket vs four-four with basket) used in cotton harvesting operations affects the level of particulate emissions (see Table 9.3.1-2 of AP-42).
- **Age of equipment**. Older equipment may be less technologically advanced than newer equipment. This is illustrated by gas turbines, where the combustion takes place in such a manner that there is more thermal formation of nitrogen oxides than in newer models (see section 3.1-3 of AP-42). Also, different O&M requirements imposed by State or Federal rules, different technologies used (seals, pumps, valve designs, etc.). These factors could cause differences in the emissions.

- **Condition of equipment**. Some equipment may not be in as good condition as other equipment. This may be due to simply the age of the equipment or to different levels of maintenance. For residential wood stoves, over a period of operation, degradation of seals and gaskets over time can lead to a loss in the effectiveness of a wood stove control device, leading to increased emissions (see section 1.10.3 of AP-42). For internal combustion engines, proper maintenance is the most effective method of preventing blue smoke emissions from all types of internal combustion engines (see section 3.3.3.4 of AP-42).
- **Operational practices**. How production workers operate equipment could affect emissions. For example, emissions from bath evaporation in cold cleaning degreasing operations are affected based on how regularly workers use a cover (see section 4.6.2 of AP-42). Open top vapor degreasing emissions related heavily to proper operating methods (see section 4.6.2 of AP-42).
- **Workplace conditions**. Production processes located within buildings may have different conditions (e.g., temperature) at different times of year. Use of personal fans and doors left open may create disturbances across product lines that could affect emission rates. For example, emissions from the polymeric coating of supporting substrates are affected by air turbulence in the coating area (see section 4.2.2.7.2 of AP-42) and from bath operations in degreasing by drafts in the workshop (see section 4.6.2 of AP-42).
- **Ambient conditions**. For emission sources located out-of-doors, the time of year (e.g., summer versus winter) can affect emission rates. For example, ambient conditions affect emissions from gas turbines (see section 3.1.3.1 of AP-42). For a given fuel firing rate, lower ambient temperatures lower the peak temperature in the flame, lowering thermal nitrogen oxides significantly. The location relative to buildings, trees, etc. could affect the amount of shading (e.g., shading of tanks storing organic liquids), which in turn could affect emissions.

Because of the number of aspects to production that can affect emissions, it is imperative that as much information as possible on the specific process, including material used, be obtained during an emission source test. Table 2-1 provides and example of factors affecting inter- and intra-facility emissions variations within a source category.

It is therefore critical that a detailed source description be provided with an emissions factor data report so that a user can select the appropriate factor for a specific source. Because an emissions factor measured at one source does not precisely transfer to another source in that category, the additional process characterization together with emissions factor uncertainty data from *WebFIRE* may enable a user to more accurately estimate emissions from a source of interest. A good reference list, including a background document containing basic information, will be quite

Table 2.1: Factors that Affect Inter- and Intra-Facility Emissions Differences for Polyethylene Terephthalate (PET) Manufacturing

Aspect	Between Facilities	Within Facility
Raw materials	DMT vs TPA	DMT vs TPA
Production process	Continuous vs batch	Continuous vs batch
Production parameters	Facility A – short residence time Facility B – long residence time	
Production equipment	Facility A – two reactors Facility B – three reactors	
Age of equipment	New facility vs 20-year old facility	New line vs 20-year old line
Condition of equipment	Facility A – poor maintenance Facility B – good maintenance	
Operational practices	Facility A – blend coatings with covers open Facility B – blend coatings with covers closed	Different personnel shifts may use different practices
Workplace conditions	Facility A – climate-controlled Facility B – not climate-controlled	Cooling in summer vs heating in winter
Ambient conditions	Facility A is located in Ohio, Facility B is located in Alabama	Summer vs winter

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. Reference material should either be readily available or supplied to the EPA emissions factors group along with the test data. All elements including, but not limited to, text, tables, figures, diagrams, and reference lists, should be submitted electronically.

2.2 QUALITY ASSURANCE

All source test data must be quality assured by an independent third party before being submitted to EPA. For compliance source tests, the independent third party would typically be the state or local agency to whom the source test report is submitted. The independent third party could also be any other independent body, such as a contractor that was not associated with the test or the facility (company) for which the test was conducted.

For guidance on proper quality assurance of stationary source tests, EPA's Emission Measurement Center (EMC) Quality Assurance (QA) Team continues to improve source test quality assurance guidance. An example Quality Assurance Project Plan (QAPP) is available on the EPA QA website www.epa.gov/ttn/emc/qaqc.html, along with other QA related instructional and guidance materials at www.epa.gov/quality/qa_docs.html. Context sensitive help screens with explanatory text and examples are provided in the ERT software, with links to specific sections of the guideline documents (useable only if there is an internet connection available).

Regional, state and local agencies are also sources of information on quality assurance of source tests. The reader is referred to two guidance documents available on EMC's website www.epa.gov/ttn/emc/guidlnd.html, *Preparation and Review of Site Specific Test Plans* and *Preparation and Review of Emission Test Reports.*

2.3 UNCERTAINTY CALCULATIONS

The second step in the Emissions Factor development process is to address the level of confidence to be placed on the precision and accuracy of the site specific emissions factor. This confidence level is based on the documentation supporting the underlying source test data and is arrived at through an evaluation of the errors and uncertainties associated with emissions testing and process data collection. When fully documented, test data uncertainty is defined as the errors and uncertainties associated with the individual measurements taken during a source test (e.g., velocity pressure or sample volume) and those activities that may affect test results in a less quantifiable manner (e.g., leak checks or sample recovery activities). When taken together, these factors will impact the accuracy of the emissions test and are generally understood well enough to permit estimation of their impact on accuracy of the test results.

Process data errors and uncertainties also have an impact on the accuracy of the emissions factor. Unlike emissions tests, however, the contribution of individual measurement errors on process data uncertainty is less well defined due to the multitude of differences encountered from one process stream to another and the relative importance of a measurement error will vary accordingly.

When both the emissions test data uncertainty and the process data uncertainty are combined, a range of values is generated for the emissions factor that is assumed to encompass the lowest and highest emission values possible for that test period. When source test data and process data are not fully documented, estimates of the increased level of uncertainty are calculated. For some parameters, knowledge of the basic measurement method allows for an estimate of increased uncertainty. For other parameters, good engineering judgment is used to assess the uncertainty.

To be able to assess these factors as objectively and consistently as possible, a minimum level of documentation is required at the time of the data submission. When using the ERT, the uncertainty calculations for that particular data set are generated automatically through the independent assessors responses on the validity of documentation of critical parameters provided with the ERT. When data are submitted outside of the ERT process, an assessment of the uncertainty associated with that data must be made using a well defined, reproducible, procedure that allows the individual using the emissions factor to understand the limitations of the data with respect to a facility type and the specific operating conditions in effect during the testing period.

As with the ERT, the level of documentation and supporting evidence is used to characterize the uncertainty associated with the source test data. Appendix A of this procedure provides a description of the approach that is recommended to develop uncertainty estimates for emissions test data not submitted using ERT. This approach is based on the process utilized in the ERT for determining quantifiable errors of the test parameters and the rationale for establishing uncertainty values associated with the operations of a test program that will impact results but do not have an easily quantifiable error associated with them.

In the approach described here and presented in Appendix A, the overall uncertainty is defined as a lower or upper bound on a specific parameter in the emissions factor equation, or in the estimation of a process rate. The bounds are generally derived using engineering judgment of manufacturer’s specifications, but occasionally are derived using empirical testing. The bounds are not generally derived using standard statistical calculations (e.g., the 95% upper bound on a sample mean value).

Uncertainty bounds can be assigned for source test data either through collaborative testing with multiple test teams or by calculating errors from ranges in directly measured and indirect parameters used by each method. Because of the large number of methods that can provide data for emissions factors and the long time frame and high cost required to conduct collaborative testing, it is likely that most uncertainties will be calculated as maximum uncertainty bounds from the parameters used for the emission determination. The approach is demonstrated in Appendix A by an example calculation for EPA Methods 5 and 202.

Measured emissions are governed by equipment used, procedures followed, sample processing and handling, level of pollutant emissions, and measured parameters. All of these items have uncertainty associated with them. The uncertainties associated with some parameters and equipment are routinely measured experimentally and assigned quantitative uncertainties, or reported by instrument manufacturers. Uncertainties associated with certain procedures and choices of equipment are generally not measured, but can be estimated by experienced testers. For example, the upper and lower bounds of a temperature measurement made with a thermocouple are generally determined by comparisons to NIST traceable standards. On the other hand, quantitative uncertainties resulting from taking measurements with a sample train that was not leaked checked before and after a test are generally not available.

The quantitative uncertainty for an emission measurement made using an EPA Reference Method can be estimated using method measured (reported) values (RVs) and other parameters that affect test results. The maximum quantitative deviation around the expected average value can be calculated by assuming that all parameters that affect an emission value have simultaneous values that maximize the deviation of the calculated error relative to the “true” value. Implicit in this calculation is the assumption that if all parameters were measured accurately and precisely, the calculated emissions would be correct.

There are two types of parameters to be considered in the calculation. The first group consists of those that are used explicitly in the equation for calculating the emissions value (e.g., sample volume). The other category consists of items that can affect a measurement, but are not explicitly included in the emissions calculation (e.g., use of a pitot tube that has been calibrated vs. one that uses a default calibration coefficient). This procedure can be used to calculate upper and lower bounds of emission measurement uncertainties.

Process uncertainty is determined by the submitting entity. The process data collected during the source test must also have an uncertainty value associated with the reported data. This uncertainty is based on an assessment made by the plant as to why the process data is believable, reliable, and valid. In other words, what actions did the plant perform that substantiates the reported process data. The ERT will include the process uncertainty data provided by the plant and how the uncertainty values were derived. If there are no uncertainty values submitted, then default values will be used.

Because the error bounds for each test run are assigned conservatively based on maximum parameter measurement errors, emissions factors and error bounds should be calculated using maximum errors, rather than statistical procedures. It is recommended that the emissions factor for a test should be reported as the arithmetic average of all runs. The error bounds for each run should be converted to a percent error relative to the reported value for each run. The upper and lower percent errors should be averaged and the results applied to the average emissions factor to provide upper and lower error bounds for the average factor.

A specific SCC in *WebFIRE* may have data from many source tests with a wide range of site specific emissions factors and associated error bounds. The differences may be due to variations in operating conditions at a facility, differences in process details at similar facilities, differences in test procedures among tests, or differences in test quality. To the extent possible, significant differences in emissions attributable to identifiable and quantifiable process, feedstock, or control measure variable, are minimized. This is only possible if this information is documented in the source test report. When data are available from several sources supporting a quantitative relationship, consideration can be given to assigning additional SCC codes or using empirical equations that relate emissions to significant process, feedstock, or control device parameters.

EPA assumes that most tests submitted for use in developing emissions factors would be at similar facilities operated similarly and have relatively small error bounds, but that some would have significantly different average factors and some would have much larger errors. Therefore, a lognormal distribution would most appropriately describe the distribution of emissions factors and associated upper and lower error bounds.

2.4 DATA SUBMISSION TO EPA

Once the data have been quality assured by a third party and the uncertainty analysis has been completed, the data are ready for submittal to EPA. EPA cannot accept data until all data verification, uncertainty determination, and QA steps have been completed. In order to streamline the data entry and review process, EPA recommends that data be submitted in a standardized format. Data may be submitted electronically or in hard copy; however, electronic submission is preferred and hardcopy is unlikely to be incorporated into *webFIRE*. Table 2.2 lists the data elements required for *WebFIRE*. EPA has created the ERT to simplify the electronic data submission process.

Table 2.2: Data Elements Required by *WebFIRE*

Name	**Type**	**Size**
Index	Numeric (Double)	8
SCC	Text	11
SCC8Desc	Text	70
CTL_CODE1	Text	3
CONTROL1	Text	50
CTL_CODE2	Text	3
CONTROL2	Text	50
EmisControlDesc	Text	50
FuelFire	Text	50
FuelSulfur	Text	55
Process Description	Memo	-
Process Parameter 1	Text	20
Process Parameter 1 description	Text	55
CAS	Text	12
POLLUTANT	Text	67
Pollutant synonym	Text	67
Method used	***Text***	***?***
Average emission factor, kg/Mg	Numeric (Double)	8
Average emission factor Uncertainty, + kg/Mg	Numeric (Double)	8
Average emission factor Uncertainty, - kg/Mg	Numeric (Double)	8
Average emission factor, lb/ton	Numeric (Double)	8
Average emission factor Uncertainty, + lb/ton	Numeric (Double)	8
Average emission factor Uncertainty, - lb/ton	Numeric (Double)	8
Ref No	Numeric (Double)	8
Reference citation	Memo	-
Test Description	Memo	-
Test Evaluation	Memo	-

It is intended that all source tests are to be submitted using the ERT. Alternative submission formats would be a searchable text file (preferred), an Adobe Acrobat image, or a text file with the associated electronic data file (e.g., Excel, Access, XML, or ASCII text) containing all of the record elements required to be submitted for the *WebFIRE* data base. The minimum data elements should be provided in an electronic format using EPA's template; missing or undefined data elements will cause delay in the review process, and may prevent the data from ultimately being posted on *WebFIRE* for use in calculating an emissions factor. Although at this time, the full range of ways EPA would accept data have not been determined, the following ways seem likely: 1) CD-ROM delivered via common carrier, 2) downloadable file maintained on a state web site, and 3) collected from state agency via a visit to locate and retain data of limited focused characteristics. Source test data submitted in hardcopy are unlikely to be incorporated into *WebFIRE* due to the limited availability of resources to image process the test report into an appropriate format. Also, no confidential data should be submitted.

EPA methods for source testing each have a unique set of requirements for parameters and process variables that must be measured. These measurements are specific to the pollutant species that is being measured. Ultimately these parameters and process variable measurements are used to calculate an emissions factor for the source. They are also used to calculate the uncertainty associated with the method and the specific test that was performed. The measurements that must be collected are detailed in the method itself, and have also been included in the ERT. The most efficient way for this data to be submitted to EPA is through the use of the ERT. The ERT is designed to format and transfer all the necessary measurements that are recorded during the performance of an EPA method. Use of the ERT will help to avoid problems with data transfer to state agencies and EPA, and misinterpretation of data submitted in a non-standard format.

An example of the measured data that must be collected for Method 5 is provided in Table 1 in Appendix A of this document. Note that non-measurement data is not included in the table, information such as the date and time of the test, plant location, sampling location, etc. This type of required information is in Table 2.2 previously referenced.

In addition to the minimum data elements for use in *WebFIRE*, other data related to calibration and supporting documentation, necessary to establish the validity of the measurements by the independent assessor, to estimate measurement uncertainties, to provide for easy auditing, and to provide for transparency of information collection, must also be submitted. As a result, as much supporting documentation as feasible should be submitted along with the necessary data elements. Examples of this data are source/process flow diagrams; meter box, nozzle, pitot, and thermocouple calibrations; sample location dimensions and point locations, field data sheets, chain of custody forms, moisture recovery data, observer comments, and other information that may be relevant to the testing procedure.

EPA encourages sources that monitor emissions with continuous emissions monitoring systems (CEMS) to submit data to EPA for calculation of emissions factors. Stack tests collect data at a single point in time under one operating condition. CEMS can provide data over a broad range of operating conditions. CEMS measuring SO_2, NO_x, and CO_2 emissions are required by EPA Acid Rain program as part of the allowance trading program. The CEMS are subject to certification requirements, QA/QC procedures, and record keeping rules (40 CFR Part 75). The EPA's Clean Air Markets Division (CAMD) receives hourly data from over 2,600 units each quarter.

CEMS are also required for 20 NESHAPS categories under 40 CFR 63 and four NSPS source categories under 40 CFR 60. Pollutants monitored under these standards are SO_2, NO_x, CO, TRS, VOCs, and THC. Performance specifications for these CEMS are specified in Appendix F to 40 CFR 60. In addition, many states require continuous emission monitoring of sources in addition to the federal requirements. For example, Pennsylvania requires the operation of about 500 CEMS in addition to those required under the federal ARP, NESHAPS, and NSPS programs. Because CEMS installed for NESHAPS, NSPS, and state mandates are used to monitor continuous compliance with emission standards, they generally measure pollutant concentrations, not mass emissions. Although the concentration data, in many cases, could be used to calculate mass emissions, this is generally not done and these data have not been used in calculating emission factors.

Requirements for submission of CEMS data to *WebFIRE* for use in calculating emissions factors are the same as for stack test data. Data submitted to comply with a Federal or State program that is QA'd by the cognizant agency may be submitted to the EPA emissions factor group for inclusion in *WebFIRE*. CEMS typically record and report data on an hourly basis (although data are collected much more frequently). Data can be summed to calculate daily, weekly, monthly, seasonal, and annual emissions.

In order to take maximum advantage of CEMS data, it is critical that process data are provided covering the same time scale as emissions data. Ideally, CEMS and process data will be provided for time periods of constant operation. If this is not feasible, then data can be reported for time periods during which operational changes occur including startup, shutdown, malfunctions, and load changes. It is critical that any CEMS data that are invalid be flagged for exclusion from use in calculating emissions factors.

CAMD has developed procedures for calculating the uncertainty of CEMS data. These procedures are contained in Appendix B.

2.5 DATA VERIFICATION (INTERNAL REVIEW)

Once EPA receives data, the completed *WebFIRE* data template will be analyzed to verify that the minimum required data elements are completed, and that all data elements import into WebFIRE successfully. Data sets may be reviewed either as part of a quality assurance process or if some question should arise during the use of the data set. The first step in the data review process is to determine that the data has been transferred or entered into *WebFIRE* accurately, and that the minimum required data fields are complete. If any errors or omissions are found in the data fields the problem is corrected or, if the required information is not available, the data set is flagged as incomplete and should not be used in further data analysis efforts. Once the *WebFIRE* data set has been reviewed, the underlying emissions test data and process data is reviewed for accuracy and completeness. If the data has been submitted using the ERT, the review process utilizes the data completeness and Data Quality Questions (DQQs) review process integral to the ERT to assess the data. If the emissions data and process data have been submitted in an alternate format, each element of the data must be reviewed for completeness, accuracy of data transfer, and accuracy of each calculation. Uncertainty assessments must also be reviewed using the procedures and evaluation criteria listed in Appendix A of this procedures document.

It is the responsibility of the data submitter to assign the appropriate SCC for indexing in *WebFIRE*. In most cases, it will be possible to assign the source test to an SCC or SCCs that already exist in the master SCC list maintained by *WebFIRE*. The source test will be indexed in *WebFIRE* by SCC, control device, and pollutant. It is strongly suggested that the people responsible for the emissions testing and for data assessment provide additional details on the facility's design and operation in the test report and the *WebFIRE* process description field. It is also strongly suggested that the people responsible for the emissions testing and for data assessment provide additional details on the facility's APCDs in the test report and the *WebFIRE* "EmisControlDesc" field.

EPA will then use the data to calculate an emissions factor and the associated uncertainty. If more than one source test was conducted at a specific operating unit, the data from the individual runs may be combined and the uncertainty of the emissions recalculated. Combination of multiple source tests conducted during very similar or identical operating conditions at one facility also prevents individual emissions factors in *WebFIRE* from being heavily weighted with data from one facility and one set of operating conditions.

Most source tests provide direct measurements of the specific compound for which the method was designed. However, for pollutant classes such as PM and VOC, which are not individual compounds or species, but rather generic categories, individual test methods (including EPA test reference methods) provide values for specific subsets of each category. Generally, tests are conducted to show compliance with applicable requirements. These requirements may not provide data converted into mass emissions of the total pollutant load to the atmosphere or total load of a regulated Clean Air Act (CAA) pollutant. As a result, some additional processing is required to convert emissions as calculated in the test report to acceptable emissions factor units. In many cases, this lack of direct measurement 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, understanding the method's constraints can improve the resulting emissions factor. A standardized way of converting the compliance-based unit-of-measure to the emissions factor unit-of-measure is still to be determined.

Source test data used to develop PM, VOC, and other chemical and chemical category emissions factors must be further processed before posting on *WebFIRE*. Data used to develop VOC emissions factors require further manipulations based upon the measurement method used. For example, to calculate a VOC emissions factor from Method 25A results, known quantities of methane, ethane, and other non-reactive compounds are subtracted, total organic compounds are calculated using a molecular weight of 44, and any formaldehyde (determined by anothermethod) is added. Just as VOC cannot be defined by the results from Method 25A, PM source test data must also be modified to define specific fractions or forms of particulate matter. There are other groups of chemical compounds that cannot be defined by the results of performing one source test method.

2.5.1 Verifying PM Source Test Data

Since the initial promulgation of the CAA, the definition of particulate matter (PM) has evolved as the regulations have been updated. The actual definition of PM is provided in the National Ambient Air Quality Standard (NAAQS) and was originally identified as total suspended particulates (TSP) which was made up of all solid material in the air up to 100 micrometers in diameter. The NAAQS was subsequently revised and the component of PM used as the health indicator was redefined as material with a diameter less than 10 micrometers (PM10) in diameter, and later, as material suspended in the air with a diameter less than 2.5 micrometers in diameter (PM2.5) which includes condensable aerosols. The most recently proposed revision will, if promulgated, add the definition of “inhalable coarse particulate” as particles between 10 and 2.5 micrometers in diameter. As the definition of PM has evolved, so have the available test methods to determine the concentration of PM in exhaust gases from a source.

Particulate matter emissions can generally be classified as filterable or condensable, whether the emissions are PM, PM10, PM2.5, or any other size fraction. Typically, EPA reference test methods for PM (EPA Methods 5 and 17) measure only that material that is collected on and ahead of the filter media of the sampling device. The material collected depends upon the temperature at which the filter media is maintained. The filter media of EPA Method 17 is at stack temperature whereas the filter media of EPA Method 5 is maintained at about 250ºF or 320ºF as required by the applicable rule. For the variations of Method 5 (5A, 5B, 5D, 5F, and 5I) the filter temperature is specified in each method. As a result, these test methods only capture the non-gaseous particulate material and do not capture the vaporous material that will condense in the atmosphere. This captured material is referred to as filterable particulate matter because it is the material that can be filtered out of the gas stream at the indicated temperature. As a result of the usually higher filter temperature used in Method 17, somewhat less particulate matter is collected than would be in a Method 5 sampling train. The results of either Method 5 or Method 17 tests should be reported as *total filterable PM*.

Other methods that are similar to Methods 5 and 17 are the PM10 methods, Methods 201 and 201A. These methods measure in-stack PM10 and the difference in these sampling trains and Methods 5 and 17 is that the probe nozzle is replaced by a cyclone which has an aerodynamic cut size of 10 micrometers. 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 larger than 10 micrometers 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 Method 17. However, as with Method 17, it may not give the same results as Method 5. With Methods 201 or 201A, the results should be reported as *filterable PM10*. If the larger than 10 micrometer material is added to the PM10 material, the results should be reported as *total filterable PM*, with a note that describes the sampling train.

EPA has a conditional test method, CTM-040, that combines two cyclones in series, a PM10 cyclone followed by a PM2.5 cyclone. The cyclones are located in the stack, as in a Method 201 or 201A train. Normally the results of a CTM-040 test are reported as PM10 and PM2.5. These results should be reported as *filterable PM10* and *filterable PM2.5*. It is possible to recover the material collected in and ahead of the PM10 cyclone and add it to the PM10 plus PM2.5 catches to approximate a Method 17 result. If this is done, the results approximate filterable PM as obtained with a Method 17 and should be reported as *total filterable PM*, with a note that describes the sampling train.

EPA Method 202 is used to determine condensible PM emissions. Method 202 is usually run in conjunction with a filterable PM method (Method 5, 5A, 5B, 5D, 5F, 5I, 17, 201, 201A, or CTM-040) and the results from the Method 202 train are added to the filterable train results. If the filterable train is a Method 5, 5A, 5B, 5D, 5F, 5I, or 17, the combined results should be reported as *total PM*. If the Method 202 results are combined with one of the particle sizing methods, the results should be reported as *total PM10, total PM2.5,* or *total PM*, with a note that describes the how the sample fractions were assembled.

There is one EPA method, CTM-039, which provides results directly in terms of *total PM 10* and *total PM2.5*. CTM-039 is a dilution sampling procedure that approximates the formation of particles that form in a plume downstream of a stack as the stack gases are cooled by mixing with ambient air. CTM-039 uses a PM10 cyclone followed by a PM2.5 cyclone so both size cuts can be obtained as with CTM-040. The difference in the two methods is that CTM-039 does not have to be combined with Method 202 to obtain both filterable and condensible fractions whereas CTM-040 does. CTM-039 has the added advantage of not having the artifact formation issues that can be associated with Method 202 if the method is not followed exactly. Care must be taken when dealing with dilution train data to be sure that data are assessed properly. First, CTM-039 incorporates a requirement that limits the filtration temperature to a maximum of 29°C (85°F). Higher temperatures may bias the results low. Second, CTM-039 includes a quantitative dilution chamber deposition recovery. If recovery of deposition on the dilution chamber walls is not performed, the data will most likely underestimate the condensible fraction. For the data to be valid, the tester must either demonstrate that deposition was insignificant or they must recover the deposition for each test run.

When inputting data into *WebFIRE*, it should be noted that there may be errors in combining data from different test methods. For example, if one were trying to estimate total PM emissions by combining existing Method 5 filterable PM data with condensable PM Method 202 data that was collected following a Method 17 sampler, the result could overstate the actual total PM emissions. This is because the lower temperature Method 5 filter collects some material that would have passed through the higher temperature Method 17 filter and be collected in the Method 202 impingers. Adding the Method 202 condensable catch that was collected behind a Method 17 train to a Method 5 filterable catch would double count that portion of the collected emissions. 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 PM methods and the fractions they measure are summarized in Figure 2-1 and Table 2.4.

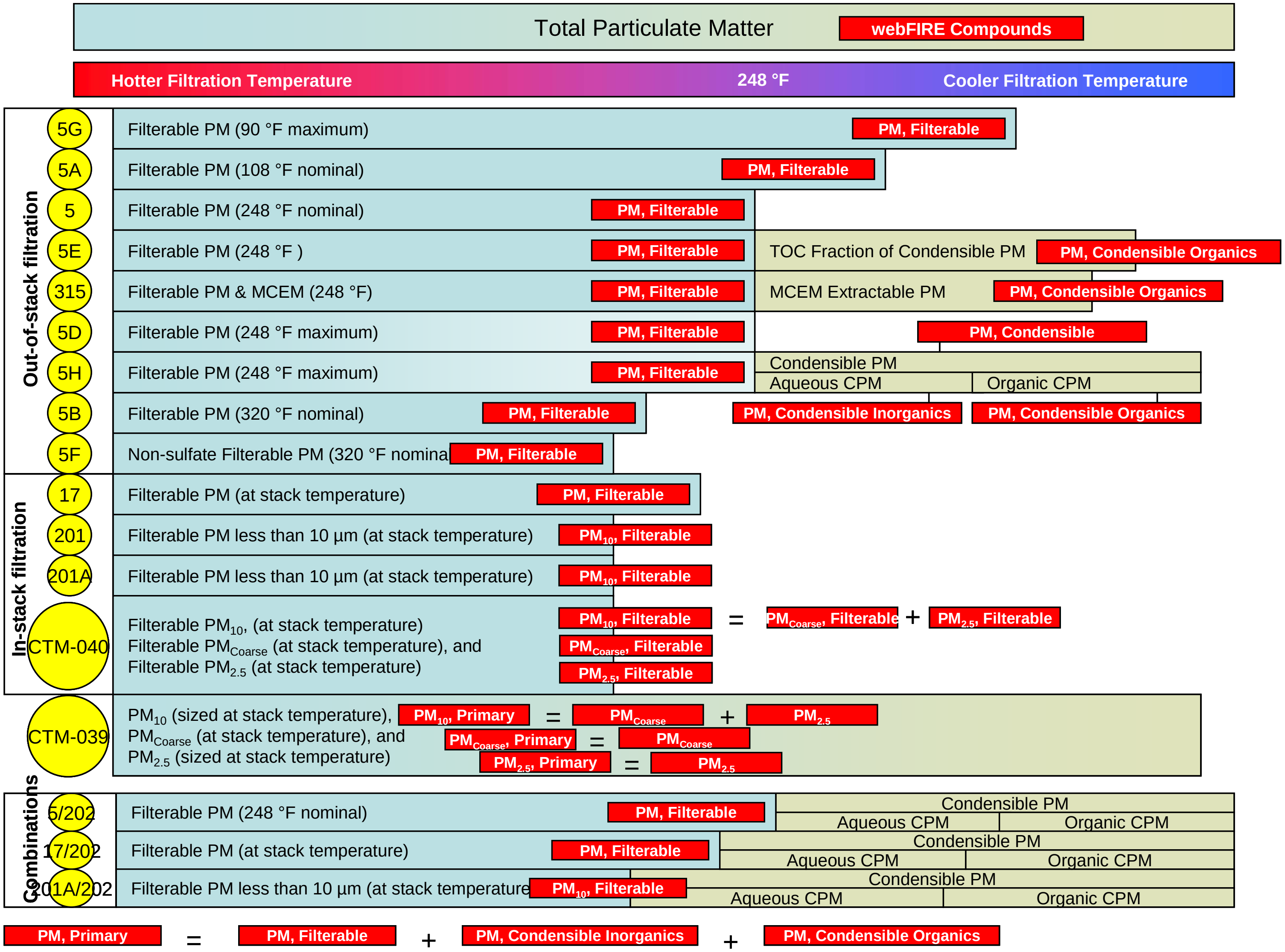


Figure 2-1: PM Methods and *WebFIRE* PM Fractions Cross-reference.

Table 2.4: PM Methods and *WebFIRE* PM Fractions Cross-reference.

FIRE Compounds	PM Component Fractions	Using Methods
PM, Condensable	Inorganic + Organic	See Component Methods
PM, Condensable Inorganics	Inorganic (aqueous)	202
	Impinger Inorganics (not filterable)	315
PM, Condensable Organics	Organic (extractable)	202
	Impinger Organics (not filterable or MCEM)	315
PM, Extractable Organic plus Filterable	MCEM + Inorganic Filterable	315
PM, Filterable	Filterable	5, 5A-5H, 17 (315??)
PM, Organic Extractable	Organic (MCEM extractable)	315
PM, Primary (aka Total)	Filterable + Inorganic + Organic	See Component Methods
PM1, Filterable	Na	Size Assigned
PM10, Filterable	Filterable	201A
	Coarse + Filterable PM2.5	CTM-40
PM10, Primary	Coarse + PM2.5	CTM-039
	Filterable + Inorganic + Organic	201A + 202
	Coarse + PM2.5 + Inorganic + Organic	CTM-040 + 202
PM2.5, Filterable	Filterable	CTM-040
PM2.5, Primary	PM2.5	CTM-039
	Filterable + Inorganic + Organic	CTM-040 + 202

2.5.2 Verifying VOC Test Data

Volatile organic compounds (VOC) are defined as compounds of carbon which participate in atmospheric chemical reactions but do exclude carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. Also excluded (or labeled exempt) are carbon containing compounds which have been determined to have negligible photochemical reactivity. These compounds include methane, ethane, methylene chloride, methyl chloroform, acetone, chlorofluorocarbons, and perfluorocarbons.

The test methods that have been used to estimate organic emissions may not determine the actual emissions of the pollutant defined as VOC. The test methods that are available for quantifying organic emissions are EPA Methods 18, 25, 25A, Fourier Transform Infrared (FTIR) spectroscopy methods, and portable Gas Chromatography/Mass Spectography (GC/MS). Each of these test methods measures organic compounds differently. These differences depend on the basic measurement technique, specific response factor to the VOC of the instrument used, and on assumptions about the molecular weight of the compounds being determined. If the appropriate sample collection methodology (Tedlar bags, sorbent traps, liquid absorbents) is combined with an appropriate analytical technique calibrated for each of the major species present in the stream, the sum of all of the species can be an accurate measure of VOC or TOC. However, it is often not possible to identify all of the species present and to calibrate for each one.

EPA Method 18 is a gas chromatography based method utilizing a variety of detection techniques that permits the speciation of organic compounds. Method 18 procedures do not designate specific configurations for the analytical equipment because the complex nature of organic compounds measured requires a flexible approach to equipment selection. Instead, the method provides a detailed description of the calibration and operating requirements and documentation to insure the quality of the data generated from this analytical technique. Method 18 may be used in conjunction with EPA Method 25A to determine VOC by subtracting the methane and ethane components of the sample, measured with Method 18, from the total organic carbon present measured with Method 25A. Also, individual compounds may be measured using Method 18, with the total VOC concentration calculated as the aggregate of all appropriate organic compounds. GC/MS techniques fall under the umbrella of Method 18 even though the measurement method, mass spectroscopy, is not specified in the method.

EPA Method 25 separates methane from collected organic compounds and then converts all of the non-methane organics to methane prior to being analyzed. As a result, the detector only sees methane, so the response factor is constant and the total number of carbon atoms can be accurately determined. However, there is a high minimum detectable limit and a potential error is introduced when estimating the total mass of the compounds as emitted because of errors in estimating the number of chlorine, oxygen, hydrogen, or other atoms associated with each carbon atom. High concentrations of carbon dioxide in combination with high moisture concentrations have a positive bias on the results. The bias becomes significant when the product of the carbon dioxide (%) and the moisture (%) exceeds 100. Note that modifications of this method are often used to subtract ethane as well as methane from the sample. However, if other non-reactive compounds are present, they would still be counted by this modified method, leading to an overestimate of VOCs if non-reactive species are present in a significant quantity. There is a conditional test method (CTM-035 or SCAQMD Method 25.3 - *Determination of Low Concentration Non-Methane Non-Ethane Organic Compound Emissions From Clean Fueled Combustion Sources*) that can be used to measure low concentration NMOC.

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 its operation is relatively straight-forward. However, the response factors for this method vary for the different compounds that exist in the flue gas. VOC molecules containing oxygen or halogens have lower response factors than VOC molecules containing only carbon and hydrogen. In fact, the method has almost no response to small chlorinated or oxygenated compounds, such as methylene chloride and formaldehyde. Therefore, the results of a Method 25A test should be augmented by the amount of any formaldehyde determined by a separate method when developing a VOC emissions factor for sources where formaldehyde is present. Because Method 25A does measure methane, ethane, and some other non-reactive compounds, VOCs may be overestimated even when the response factors are corrected for the problem compounds.

The general method to follow to calculate VOC emissions based on Method 25A data is to (1) calculate the total organic compounds using a molecular weight of 44 (propane), (2) subtract out any known quantities of methane, ethane, and other non-reactive compounds, and (3) add in any formaldehyde determined by another method such as Method 18. Thus care should be taken to evaluate what compounds are expected from a source before labeling Method 25A results as "VOC."

FTIR measurement of VOC may be made with validated (EPA Method 301 or Method 321) sample collection and analysis techniques or using non-validated techniques that follow well documented procedures with rigorous QA procedures. FTIR analysis utilizes infrared absorption spectroscopy to identify molecules by their unique absorption pattern and quantifies the concentration of the organic compound by the intensity of absorbance. FTIR has the advantage of being able to provide speciated organic concentrations of very complex gas mixtures.

Figure 2-2 and Table 2.5 depict the "universe" of organic compounds and attempts to provide guidance in manipulating the results of source test data for application into the *WebFIRE* database.

Numeric conversion methodologies which combine information available from Method 18 and Method 25A can be used to estimate VOC emissions. One calculation technique is presented in the equation below. Another technique of converting carbon (or propane) mass emission values to specific VOC emission values is to use the "Midwest Scaling Protocol" developed for VOC sampling at Grain Mills and Ethanol Production Facilities. This methodology, described in Appendix C, details the procedures used to generate site specific scaling factors for individual VOC compounds contained in an exhaust gas based on data collected via EPA Method 18. These scaling factors are then used to correct either Method 25 or Method 25A total organic carbon data as necessary to reflect actual VOC emissions.

First, calculate VOC Emission Rate as C:

$$E\_lb/hr\_C = \frac{\text{ppmvw as C3H8}}{(1 - Bws)} \times \frac{(K\__{M25A})(MW_C)(Q_{sd})}{(385.3 \times 10\hat{}6)}$$

where: $K\__{M25A}$: carbon equivalent correction factor from EPA Method 25A, Equation 25A-1, based on calibration gas (ethane = 2, propane = 3, butane = 4, X = appropriate response factor for other organic calibration gas) ppmvw: parts of pollutant per million parts of air, by volume, on a wet basis

MW_C: molecular weight of carbon, 12.01 lbs./lb.-mole

B_{ws}: proportion of water vapor, by volume, in the effluent

Q_{sd}: volumetric flow rate of the effluent in dscf per hour

Then, calculate VOC Emission Rate as target (VOC):

$$\text{E\_lb/hr\_voc} = (\text{E\_lb/hr\_C}) \times \frac{\text{MW\_target\_voc}}{(\text{\#C atoms\_voc})\ (\text{MW\_C})} \times \frac{\text{RRF\_C3H8}}{\text{RRF\_target\_voc}}$$

where: RF: response factor (the response of 1 ppm of a reference compound to 1 ppm of a measured compound. The response factor can be determined in accordance with the procedures in EPA Method 204A, 204F, or an equivalent method.)

RRF_{C3H8}: response factor of propane divided by the number of carbon atoms in propane.

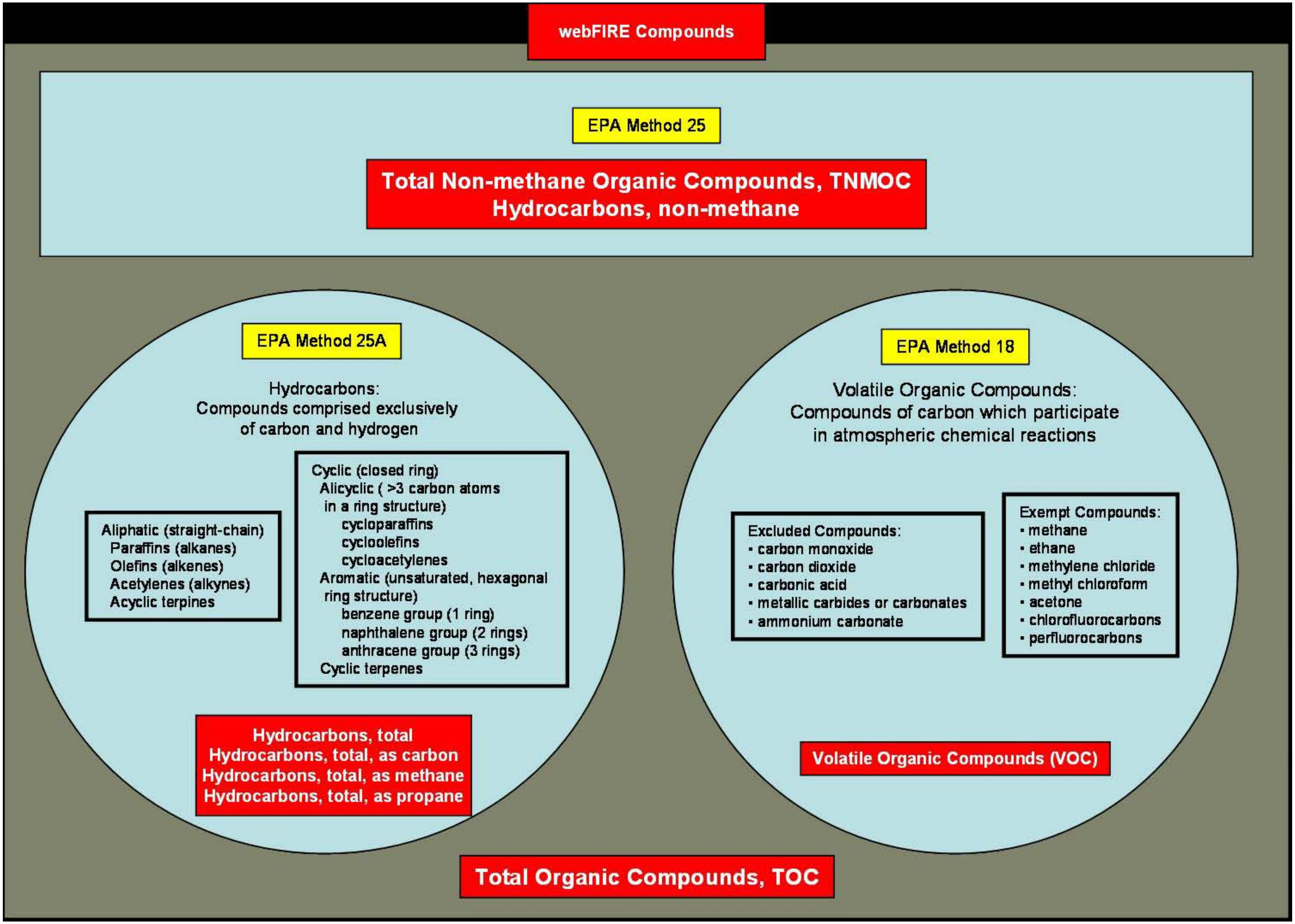
RRF_{Target}: response factor of target VOC divided by the number of carbon atoms in target.

MW_{Target_voc}: molecular weight of target VOC, lbs./lb.-mole

#C atomsvoc: number of carbon atoms in target VOC compound

2.6 PUBLIC PARTICIPATION (EXTERNAL REVIEW)

Section 130 of the CAA requires EPA to allow for public participation in the emissions factor development process. This subsection describes the public review process that takes place once emissions factor data have been reviewed internally by EPA.



webFIRE Compounds

EPA Method 25

Total Non-methane Organic Compounds, TNMOC
Hydrocarbons, non-methane

EPA Method 25A

Hydrocarbons:
Compounds comprised exclusively of carbon and hydrogen

Aliphatic (straight-chain)
  Paraffins (alkanes)
  Olefins (alkenes)
  Acetylenes (alkynes)
  Acyclic terpines

Cyclic (closed ring)
  Alicyclic (>3 carbon atoms in a ring structure)
    cycloparaffins
    cycloolefins
    cycloacetylenes
  Aromatic (unsaturated, hexagonal ring structure)
    benzene group (1 ring)
    naphthalene group (2 rings)
    anthracene group (3 rings)
  Cyclic terpenes

Hydrocarbons, total
Hydrocarbons, total, as carbon
Hydrocarbons, total, as methane
Hydrocarbons, total, as propane

EPA Method 18

Volatile Organic Compounds:
Compounds of carbon which participate in atmospheric chemical reactions

Excluded Compounds:
- carbon monoxide
- carbon dioxide
- carbonic acid
- metallic carbides or carbonates
- ammonium carbonate

Exempt Compounds:
- methane
- ethane
- methylene chloride
- methyl chloroform
- acetone
- chlorofluorocarbons
- perfluorocarbons

Volatile Organic Compounds (VOC)

Total Organic Compounds, TOC

Table 2.5: TOC And VOC Methods and *WebFIRE* Cross-reference.

FIRE Compounds	Component Fractions	Using Methods
Total Non-methane Organic Compounds, TNMOC	Total Gaseous Non-methane Organic Compounds (as C), TGNMOC	25
Hydrocarbons, non-methane	Total Gaseous Non-methane Organic Compounds (as C), TGNMOC	25
Hydrocarbons, total	Total Hydrocarbons	25A
	minus methane	18
	minus ethane	18
	minus other non-reactive	18
	plus formaldehyde	316, 318
Hydrocarbons, total, as carbon	Total Hydrocarbons	25A
Hydrocarbons, total, as methane	Total Hydrocarbons	25A
Hydrocarbons, total, as propane	Total Hydrocarbons	25A
Total Organic Compounds (TOC)	Total Gaseous Organic Compoiunds by GC	18
Volatile Organic Compounds (VOC)		

Once EPA has completed an internal review of an emissions factor test report or other data set, those data that are judged to be complete are posted to *WebFIRE*. Within *WebFIRE*, the data are flagged as "preliminary" and, as such, are not included in any of *WebFIRE*'s internal calculations (e.g., calculation of average emissions factors or uncertainties). However, these data may be viewed by the public at any time and their preliminary status is displayed.

Preliminary data are published to *WebFIRE* on a continuous basis as the internal review is completed. Comments on the preliminary data and any other aspect of the *WebFIRE* database, associated emissions factors data, and emissions factors are welcome at any time. However, to avoid over burdening the public with announcements each time preliminary data are published to *WebFIRE*, public comments on a specific source category are only requested formally on an annual or semi-annual basis. The announcements are distributed by EPA through Info CHIEF and indicate the opening of a 60-day comment/review period.

The public is requested to comment on three aspects of the emissions factor data published in *WebFIRE*:

1. The process description for the source category and the associated text that is currently presented in the AP-42 sections.
2. Interpretation of the results of the source test reports, production information, assessments of the uncertainty associated with the individual source test reports (i.e., the DQQ process), the validity of the SCCs, etc.
3. Potential improvement of the emissions factors by subdividing the data or combining the data to arrive at emissions factors that provide more accurate estimates, with lower associated uncertainty and with a clearer indication of critical parameters affecting emissions.

Comments are especially requested from those who participated in the initial data submission to EPA. This is important because these individuals that are most likely to recognize errors in the process and testing data. This step will further eliminate errors and omissions that result from the data collection and factor calculation process. The overall result will be further improvements in the accuracy and the correct application of the emissions factors.

Participants should review all new data pertinent to the development of the emissions factor. This includes all of the data listed in Section 2.4, "Data Submission to EPA." These data include process data, test method data, and any other data that may lead to miscalculation or misapplication of the emissions factor. It is particularly important that the reviewers make sure that the data are properly characterized and associated with the correct group of sources. This will help to correct what would have previously been considered outliers in the emissions factor data sets instead of correct data that have been associated with the incorrect process or source.

Comments may be submitted to EPA via email or in writing. At the conclusion of the 60-day comment/review period, EPA personnel review the comments received and make any appropriate modifications to the data in *WebFIRE*. Once EPA is satisfied with the quality of the data, the "preliminary" flag is removed and the data are incorporated into the previously approved data in *WebFIRE*.

2.7 INCORPORATION INTO *WebFIRE*

As mentioned earlier, once all of the data collection, calculation, and review steps are complete, and EPA is satisfied that the data are acceptable, the new or updated data will have the "preliminary" flag in *WebFIRE* removed. The data should already have the correct SCC, pollutant ID, and control measure assigned to them. As a result, the *WebFIRE* database will automatically group these new data in with the existing data for the same group. The correct grouping of the data in the previous steps will allow the *WebFIRE* database to incorporate the new data collected into the average emissions factor that was previously calculated. The average emissions factors are not stored in *WebFIRE* as discrete calculated values, but instead will be calculated on the fly when *WebFIRE* users request emissions factors for a particular pollutant and/or SCC, control device scenario.

Once the "preliminary" flag is removed the new average emissions factor and overall uncertainty estimate can be calculated by *WebFIRE*. The database will incorporate the uncertainties for the new data into the uncertainty for the existing data in *WebFIRE*. This allows for more accurate uncertainty data available to those using the emissions factors to make informed decisions concerning when to use the factors and the potential risk of miscalculation that is involved with using the emissions factors.

The final step is the combination of the stack test data uncertainty and the process data uncertainty to an overall uncertainty for the emissions factor. This factor, in conjunction with the individual uncertainties previously discussed, will be an effective tool to help correctly apply the emissions factor and evaluate the risks associated with using the factor to determine emissions.

APPENDIX A

Example Maximum Uncertainty Calculation for EPA Methods 5 and 202

APPENDIX A – EXAMPLE MAXIMUM UNCERTAINTY CALCULATION FOR EPA REFERENCE METHODS 5 AND 202.

An example application of the ERT approach for calculating maximum uncertainty for EPA Reference Methods 5 and 202 is provided below. Table 1 lists the values reported and recorded during a typical Method 5 particulate test, and will be used as the data inputs for this example. In addition to the reported field data, Table 1 presents the default error and uncertainty values and the calculated lower and upper bound values determined as a part of the uncertainty assessment of this test data. The error and uncertainty estimates are based on the quality assurance verifications and the maximum allowable errors specified by the methods, with the values (and/or ranges) for the errors listed in Tables 2 and 3. Specifically, Tables 2 and 3 contain the default parameter errors for the field test equipment and laboratory analyses for the Method. Table 4 contains the Data Quality Questions (DQQs) and the uncertainty correction values used in the uncertainty analysis procedure. Tables 5 and 6 provide the example results when the DQQ assessment procedure is applied to a test report with partial documention and to a report with no documentation, respectively. The upper and lower bound emissions calculated from the three example assessments are summarized in Table 7.

Step 1 – Using the reported values (RV) presented in Table 1 determine the default error value (E) for each parameter using the data contained in Tables 2 and 3.

Step 2 – Select the uncertainty corrections associated with the Method DQQs (U_{DQQ}) pertinent to the test parameters. The uncertainty values are contained in Table 4. For the first example, the DQQs are all answered as “No”, meaning that the test report and data are well documented with no QA problems and that no additional adjustments to the default uncertainties are necessary (indicated by the zero (0) value in the DQQ column of Table 1).

Step 3 – Combine the two uncertainties with the RV and calculate the upper bound value (UBV) and lower bound value (LBV). In this example, the $U_{DQQ} = 0$ and the dry gas meter temperature (t_m) is the parameter.

$$UBV = RV + E + (RV * \Sigma(U_{DQQ}/100)) = 84.7 + 5.4 = 90.1$$

$$LBV = RV - E - (RV * \Sigma(U_{DQQ}/100)) = 84.7 - 5.4 = 79.3$$

Note that in order to maximize the upper bound emission (UBE) calculation, the LBV is used instead of the UBV, as shown in Table 1. This is because the meter temperature is used in calculating the standardized sample volume which is subsequently used in the denominator of the emissions calculations.

Table 1: Example Method 5 Test Data and Default Error Ranges

Variable	Parameter	Reported Value (Field Data)	Error (E) (Tables 2 & 3)	Lower Bound Values [1] (LBV)	Upper Bound Values [1] (UBV)
γ	Meter Box Correction Factor	0.991	±0.02	0.971	1.011
ΔH	Avg Meter Orifice Pressure	1.070	±0.1	0.97	1.17
P_{bar}	Barometric Pressure	30.04	±0.1	29.94	30.14
V_m	Sample Volume	36.980	±0.01	36.97	36.99
t_m	Average Meter Temperature	84.66	±5.4	79.3	90.1
P_{static}	Stack Static Pressure	-0.18	±0.1	-0.28	-0.08
t_s	Average Stack Temperature	167.25	±9.41	157.84	176.66
V_{lc}	Condensate Collected	300.0	±0.5	299.5	300.5
CO_2	Carbon Dioxide	7.00	±0.15	6.85	7.15
O_2	Oxygen	13.20	±0.15	13.05	13.35
C_p	Pitot Tube Coefficient	0.84	±0.025	0.815	0.865
Δp	Velocity Pressure	0.2784	±0.01	0.2684	0.2884
Θ	Sample Run Duration	60.7	±0.2	60.5	60.9
D_n	Nozzle Diameter	0.297	±0.002	0.295	0.299
D_{stk}	Diameter	19.5	±0.25	19.25	19.75
PM_{mg}	Particulate Catch	10.2	±0.5	9.7	10.7

[1] UBVs and LBVs used in calculating the Upper Bound Emission (LBE) are highlighted.

Table 2: Summary of Default Isokinetic Sampling Errors

(Methods 1 to 5)

Variable	Parameter	Default Error (U) [1]	Sign for UBE [2]	Sign for LBE [3]	Units	DQQ Nos.
γ	Meter Box Correction Factor Yi within 0.02 of Yavg	0.02	-	+	Ratio	14
ΔH	Avg Meter Orifice Pressure, divisions: 0.1 if > 1" or 0.01 if < 1"	0.1 0.01	-	+	in. H_2O	
P_{bar}	Barometric Pressure	0.1	-	+	in. Hg	
V_m	Sample Volume	0.01	-	+	ft^3	13
t_m	Average Meter Temperature	5.4	+	-	°F	10
P_{static}	Stack Static Pressure	0.1	+	-	in. H_2O	
t_s	Average Stack Temperature	1.5% of (t_s + 460)	-	+	°F	10
V_{lc}	Condensate Collected, 1 ml or 0.5 g	0.5	-	+	g	
CO_2	Carbon Dioxide, M3b: 3 analyses maximum difference of: [4] 0.3 if CO_2 >4% or 0.2 if CO_2 <= 4%	0.15 0.10	-	+	% by vol.	
O_2	Oxygen, M3b: 3 analyses maximum difference of: [3] 0.3 if O_2 <15% or 0.2 if O_2 >= 15%	0.15 0.10	+	-	% by vol.	
C_p	Pitot Tube Coefficient: 3% if velocity >1000 fpm or 6% if velocity is 600-1000 fpm	0.0252 0.0504	+	-		5, 7, 8, 9
Δp	Velocity Pressure, divisions @ 10" scale: 0.01 if <= 1" or 0.1 if > 1"	0.01 0.1	+	-	in. H_2O	2, 3, 4, 6, 11
Θ	Sample Run Duration	0.2	+	-	minutes	
D_n	Nozzle Diameter, (max-min) [5] <= 0.004	0.002	+	-	inches	16
D_{stk}	Diameter or Depth: 0.25" if < 7' or 1" if > 7'	0.25 1	+	-	inches	1
W_{stk}	Width (if rectangular cross-section): 0.25" if < 7' or 1" if > 7'	0.25 1	+	-	inches	1

[1] Default Error (U) is based on the errors associated with the maximum allowable error stated in the method.
[2] UBE = Upper Bound Emission
[3] LBE = Lower Bound Emission
[4] CO_2 and O_2 U is ½ of the maximum difference allowed between the three analyses.
[5] The nozzle U is ½ of the maximum difference allowed between the three readings.

Table 3: Summary of Default Analytical Errors

(Methods 5 and 202)

Variable	Parameter	Default Error (U) [1]	Sign for UBE	Sign for LBE	Units	DQQ Nos
PM_{mg}	Particulate Catch, constant weight = 0.5; (x 2 if filter/rinse separate, i.e., two weights)	0.5	+	-	mg	12, 18, 19, 22, 23, 28, 29
IO_{mg}	Condensible Inorganic Catch with purge no purge	0.5	+	-	mg	22, 23, 24, 25, 27, 28, 29`
O_{mg}	Condensible Organic Catch	0.5	+	-	mg	22, 23, 26, 28, 29

[1] Default Error (U) is based on the errors associated with the maximum allowable error stated in the method.

Table 4: Data Quality Questions (Methods 5 and 202)

No.	Data Quality Questions (DQQs) [1]	If Yes, U Adj % [1]
1	Is the cross-sectional area more than 5% different from a previous test?	+ 2
2	Are all the velocity head pressures (delta-p's) the same?	+ 2
3	Were the yaw angles > 20 degrees (absolute basis) at this location?	+ 3
4	Is the distance from the ports to the upstream disturbance < 2 dia.?	+ 3
5	Was a standard pitot used?	- 1
6	Was a 3-D directional probe used?	- 2
7	Was the velocity < 10 fps?	+ 5
8	Is the pitot calibration data missing or outside of the specification?	+ 5
9	Is the pitot tube coefficient different from 0.84, 0.99, or calibration data?	+ 2
10	Are the thermocouple devices calibration data missing or outside of specs?	+ 2
11	Is the flow rate more than 30% different from previous test?	+ 5
12	Is the PM mass < 10 mg?	+ 3
13	Is the leak check info missing or > 0.02 cfm?	+ 2
14	Is the DGM calibration data missing or outside of specs?	+ 2
15	Is the isokinetic sampling rate < 90 or > 110 %?	+/- 2
16	Is the nozzle calibration data missing or outside of specs?	+ 5
17	Is the raw field data missing?	+ 100
18	Is the laboratory report insufficiently detailed or missing?	+ 100
19	Are the sample custody records missing?	+ 50
20	Are the emissions > 30% different from previous results?	+ 5
21	Is the 3-run or grouped runs RPD > 30% (50%?)	+ 5
22	Was the probe temperature outside the method specs?	+ 2
23	Was the filter temperature outside the method specs?	+ 2
24	If Method 202, was purge with nitrogen omitted?	+ 2
25	If Method 202, was purge performed with air? [2]	+ 2
26	If Method 202 and source is an oil-fired boiler, was an additional filter placed between the second and third impinger omitted? [3]	+ 2
27	If Method 202, and ammonia injection was part of process, was chloride analysis/eq. NH4Cl subtraction omitted? [4]	+ 5
28	Are the Field Blank results more than 5% of the lowest sample catch or is the FB missing? (use historical FB value if no FB performed)	+ FB value
29	Does the observer note that poor sample recovery techniques were used or was the recovery not commented upon? (use multiple of FB value)	Multiple of FB

[1] *DQQs and adjustment values may be revised in the future..*

[2] *An alternative to the post-test N2 purge described in Section 5.2.1, the tester may opt to conduct the post-test purge with air at 20 liter/min. Note: The use of an air purge is not as effective as a N2 purge.*

[3] *The potential for low collection efficiency exist at oil-fired boilers. To improve the collection efficiency at these types of sources, an additional filter placed between the second and third impinger is recommended.*

[4] *In sources that use ammonia injection as a control technique for hydrogen chloride (HCl), the ammonia interferes by reacting with HCl in the gas stream to form ammonium chloride (NH4Cl) which would be measured as CPM. The sample may be analyzed for chloride and the equivalent amount of NH4Cl can be subtracted from the CPM weight. However, if NH4Cl is to be counted as CPM, the inorganic fraction should be taken to near dryness (less than 1 ml liquid) in the oven and then allowed to air dry at ambient temperature to prevent any NH4Cl from vaporizing.*

Step 4 – Use the LBV and UBV in place of the reported value and calculate the potential range of emissions (LBE and UBE) using the same equations used to calculate the reported emissions (RE). *Note: The highest potential emissions value is determined using a combination of UBV and LBV, depending on how the parameter is used in the calculation. (e.g., for dry gas meter volume, the LBV for gamma is used in the UBE calculation since that results in a lower sample volume and, subsequently, in a higher overall emissions value.)*

Step 5 – The emissions may now be stated with a range of uncertainty. In this example with no DQQs to apply, the true emission rate is estimated by the reported emission rate of 0.096 lb/hr and has a lower bound emission (LBE) of 0.082 lb/hr and an upper bound emission (UBE) of 0.112 lb/hr.

Step 6 – Process variability. Similar to the calculation of bounds for emissions (see above), bounds for process variability (e.g., total amount of coal burned per hour) can be calculated based on the estimated bounds for the process.

Step 7 – Let UP be the upper process bound and LP be the lower process bound derived in a fashion similar to UBE and LBE values (above), then the upper bound on the final emission factor (UEF) is simply

$$UEF = UBE / LP$$

and the lower bound on the final emission factor (LEF) is simply

$$LEF = LBE / UP.$$

Table 5 tabulates the results when the DQQs of Table 4 are applied to a partially documented test report. Basically, Step 3 is repeated – Combine the two uncertainties with the RV and calculate the upper bound value (UBV) and lower bound value (LBV) for the dry gas meter temperature (t_m) when the U_{DQQ} from DQQ No. 10 is 2%. If a parameter is affected by more than one DQQ, the sum of the DQQs is used as U_{DQQ}.

$$\text{UBV} = \text{RV} + \text{E} + (\text{RV} * \Sigma(U_{DQQ}/100)) = 84.7 + 5.4 + ((84.7+460) * 2/100) = 101$$

$$\text{LBV} = \text{RV} – \text{E} – (\text{RV} * \Sigma(U_{DQQ}/100)) = 84.7 - 5.4 - ((84.7+460) * 2/100) = 68.4$$

The emissions may now be stated with a range of uncertainty. For a partially documented test report, the true emission rate might be estimated as 0.096 lb/hr with an LBE of 0.014 lb/hr and a UBE of 0.24 lb/hr.

Table 5: Example Method 5 Test Data

With DQQ Adjusted Error Ranges, Partial Documentation

Variable	Parameter	Reported Value (Field Data)	Error (E) (Tables 2 & 3)	DQQ Uncertainty (U%) (Table 4)	Lower Bound Value (LBV)	Upper Bound Value (UBV)
γ	Meter Box Correction Factor	0.991	±0.02	0	0.971	1.011
ΔH	Avg Meter Orifice Pressure	1.070	±0.1	-	0.97	1.17
P_{bar}	Barometric Pressure	30.04	±0.1	-	29.94	30.14
V_m	Sample Volume	36.980	±0.01	2	36.230	37.730
t_m	Average Meter Temperature	84.66	±5.4	2 (of 460 + t_m)	68.4	101
P_{static}	Stack Static Pressure	-0.18	±0.1		-0.28	-0.08
t_s	Average Stack Temperature	167.25	±9.41	2 (of 460 + t_s)	154.5	180.0
V_{lc}	Condensate Collected	300.0	±0.5		299.5	300.5
CO_2	Carbon Dioxide	7.00	±0.15		6.85	7.15
O_2	Oxygen	13.20	±0.15		13.05	13.35
C_p	Pitot Tube Coefficient	0.84	±0.025	5+5+2 = 12	0.756	0.924
Δp	Velocity Pressure	0.2784	±0.01	2+3+5+3 = 13	0.2544	0.3023
Θ	Sample Run Duration	60.7	±0.2		60.5	60.9
D_n	Nozzle Diameter	0.297	±0.002	0	0.295	0.299
D_{stk}	Stack Diameter	19.5	±0.25	2	18.86	20.14
PM_{mg}	Particulate Catch, M5 InOrg+Org	10.2	±0.5	3+50+2+2+2 = 59 3+50+2+2+2 = 59	3.68	16.72
$E_{lb/hr}$	Emission Rate, lb/hr			2+5+5 = 12	Na	Na

[1] UBVs and LBVs used in calculating the Upper Bound Emission (LBE) are highlighted.

Table 6 tabulates the results when the DQQs of Table 4 are applied to a test report with no documentation, consisting of a summary page of results, for example. Repeating Step 3 results in emissions that would be reported as 0.096 lb/hr with an LBE of 0.00 lb/hr and a UBE of 0.51 lb/hr. The actual LBE was a negative result which was converted to a zero (0).

Table 6: Example Method 5 Test Data

With DQQ Adjusted Error Ranges, No Documentation

Variable	Parameter	Reported Value (Field Data)	Error (E) (Tables 2 & 3)	DQQ Uncertainty (U%) (Table 4)	Lower Bound Values [1] (LBV)	Upper Bound Values [1] (UBV)
γ	Meter Box Correction Factor	0.991	±0.02	2	0.9512	1.0308
ΔH	Avg Meter Orifice Pressure	1.070	±0.1	-	0.97	1.17
P_{bar}	Barometric Pressure	30.04	±0.1	-	29.94	30.14
V_m	Sample Volume	36.980	±0.01	2	36.230	37.730
t_m	Average Meter Temperature	84.66	±5.4	2 (of 460 + t_m)	68.4	101
P_{static}	Stack Static Pressure	-0.18	±0.1		-0.28	-0.08
t_s	Average Stack Temperature	167.25	±9.41	2 (of 460 + t_s)	154.5	180.0
V_{lc}	Condensate Collected	300.0	±0.5		299.5	300.5
CO_2	Carbon Dioxide	7.00	±0.15		6.85	7.15
O_2	Oxygen	13.20	±0.15		13.05	13.35
C_p	Pitot Tube Coefficient	0.84	±0.025	5+5+2 = 12	0.714	0.966
Δp	Velocity Pressure	0.2784	±0.01	2+3+5+3 = 13	0.2322	0.3245
Θ	Sample Run Duration	60.7	±0.2		60.5	60.9
D_n	Nozzle Diameter	0.297	±0.002	5	0.280	0.314
D_{stk}	Stack Diameter	19.5	±0.25	2	18.86	20.14
PM_{mg}	Particulate Catch, M5 InOrg+Org	10.2	±0.5	3+100+50+2 +2+2 = 159 3+100+50+2 +2+2 = 159	0.00	26.92
$E_{lb/hr}$	Emission Rate, lb/hr			2+100+5+5 = 112	Na	Na

[1] UBVs and LBVs used in calculating the Upper Bound Emission (LBE) are highlighted.

Table 7: Summary of Three Example Method 5 Test Data With DQQ Adjusted Error Ranges

	Emission Rates, lb/hr	DQQs Default	DQQs Partial	DQQs Maximum
UBE	Upper Bound Emission (UBE)	0.112	0.236	0.508
$E_{lb/hr}$	Reported Emission (RE)	0.096		
LBE	Lower Bound Emission (LBE)	0.082	0.0144	0.0

APPENDIX B

Example Maximum Uncertainty Calculation for CEMs

Continuous time series measurements, like those generated from continuous emissions monitors (CEMS), are generally sufficient to allow the use of standard statistical methods for the calculation of centrality and variance. Time series data generally exhibit temporal correlation among successive measurements. A measure of the degree of temporal correlation is called autocorrelation (or the autocorrelation coefficient). Autocorrelation influences the calculation of the sample variance, but does not influence the calculation of the sample mean. Data correlated over time has less information content than time-independent data. This reduces the effective sample size of the data set, reflecting the amount of independent measurements in the data. Standard variance-estimating equations are not appropriate with autocorrelated data. The Clean Air Markets Division (CAMD) published equations for estimating centrality and variance of CEMS measurements in 40 CFR 75.41. The appropriate method for adjusting the sample standard error of the mean, $\frac{S}{\sqrt{n}}$, when autocorrelation is present in the data follows:

$$\left(\frac{S}{\sqrt{n}}\right)_{adj} = \sqrt{\left(\frac{1+p}{1-p}\right) - \left(\frac{2p(1-p^n)}{n(1-p)^2}\right)}\ x\ \sqrt{VIF}\ x \left(\frac{S}{\sqrt{n}}\right)$$

where,

$$VIF = \frac{1}{1 - \frac{2p}{(n-1)(1-p)} + \frac{2p(1-p^n)}{n(n-1)(1-p)^2}}$$

p = 1^{st} order autocorrelation coefficient
n = number of observations
VIF = variance inflation factor
S = standard deviation

APPENDIX C

Midwest Scaling Protocol for the Measurement of "VOC Mass Emissions"