Chapter 7 Quantification of Exposure: Development of the Emissions Inventory for the Inhalation Risk Assessment

Table of Contents

7.1 Introduction

An emission inventory is a comprehensive listing, by source, of the air pollutant emissions within a specific geographic area in a specific time period. EPA prepares a **National Emissions Inventory (NEI)** with input from numerous state, local, and tribal (S/L/T) air agencies (see Chapter 4 and http://www.epa.gov/ttn/chief/net/index.html for more information on the NEI). NEI data are used for air quality modeling, regional strategy development, regulation setting, air toxics risk assessment, and tracking trends in emissions over time. The NEI Input Format (NIF) is the format most widely used by S/L/T agencies to transfer data to the NEI. The current versions of the NIF and all user documentation are available on the website noted above. The advantages, disadvantages, and uncertainties associated with NEI data are discussed in Chapter 4.

Emission inventories generally serve as the first step in quantifying exposure for an air toxics risk assessment. In addition to source information (e.g., location, chemicals released), they provide most of the critical input data for air quality models used to predict air toxics fate and transport in the atmosphere. The Emission Inventory Improvement Program (EIIP)[1] has published a ten-volume set of technical reports on the development of emissions inventories for the NEI.[2] Related technical documents, updates, reports, and information regarding the organization and progress of EIIP in developing new methods can be found linked to the main EIIP webpage. These include training manuals that provide in-depth descriptions of each step of the process, for various types of sources and air pollutants. Emissions inventories that are prepared in a manner consistent with these methods and guidance will provide data of known quality for a risk assessment.

For risk assessments, local enhancements of existing air toxics emissions inventories may be advantageous to a particular air toxics assessment effort as a very critical initial step. Air toxics inventories are not always at the quality that would provide the results desired in a modeling assessment, and improving the entire statewide toxics inventory may be unrealistic. An enhancement of the local air toxics inventory in the assessment area of interest may be beneficial for providing more accurate and precise risk assessment results and, consequently, a better basis for any air toxics risk- or airshed-program management decisions. Also, local emissions inventory work in specific areas of concern or study makes these air toxics efforts smaller and easier for agencies and participating facilities to manage and conduct, particularly in the shorter time frames commonly sought in local air toxics assessment projects.

The remainder of this chapter describes a process that can be used to develop an emissions inventory, including the general steps for developing an emissions inventory (Section 7.2), and data sources (Section 7.3)

7.2 Process for Developing an Emissions Inventory

There are eight steps for developing an emissions inventory:[3] (1) planning; (2) gathering information; (3) estimating emissions; (4) compiling data into a database; (5) data augmentation; (6) quality control/quality assurance; (7) documentation; and (8) access to data. Each is described in a separate subsection below.

The Emissions Inventory Improvement Program (EIIP)

To develop a systematic method for preparing an emission inventory, EPA's Emission Factor and Inventory Group (EFIG) has worked as a key member of the EIIP. The EIIP is a jointly sponsored effort of the State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) and EPA. Both of these organizations are represented in the Standing Air Emissions Work Group (SAEWG), which endorsed the original EIIP plan. Funding is provided by S/L/T agencies through the Federal 105 grant programs. While EPA coordinates the EIIP efforts, all of the tasks are performed by working committees. The EIIP Steering Committee and technical committees are composed of S/L/T, industry, and EPA representatives. Membership on technical committees is open to any S/L/T agency representative, industry group, and the public; interested individuals can contact the appropriate committee co-chair for information.

7.2.1 Planning

Planning is the first stage in preparing an emissions inventory. Perhaps the most important activity in compiling an inventory, planning ensures a focused and streamlined process and avoids later costly and embarrassing mistakes. The Inventory Preparation Plan (IPP) is developed during the planning stage and is the overarching guidance document for the entire emission inventory development process.[4] First, the IPP identifies the end-use(s) of the inventory (e.g., to support a risk assessment) and subsequently, an acceptable data quality level for those uses. Once the end-use(s) are determined, the risk manager defines the inventory to be created, identifying the necessary components:

- The air toxics to be carried through the risk assessment (i.e., the COPCs);
- The specific sources or source categories to be assessed;
- The geographic area (scale) of the assessment area; and
- The time interval over which emissions are to be inventoried.

Generally, the IPP reflects the complexity of the risk assessment being conducted. That is, an assessment of a single stationary source with known pollutants and well-documented emissions would not require as elaborate a plan as would a risk assessment addressing multiple sources and source types affecting a broad community. Exhibit 7-1 lists the steps in developing an IPP.

Exhibit 7-1. Steps in Developing an Inventory Preparation Plan

- Identify the end-uses of the inventory
- Determine Data Quality Objectives
- Define the inventory to be created
- Select an inventory data management and reporting system
- Summarize data reporting and documentation
- Establish QA/QC procedures
- Determine staffing and resource requirements
- Develop a schedule
- Identify partners and develop a communication plan

Source: Pope, A. *Inventory Preparation for Toxics*.[3]

The level of precision for emissions data required may differ among different tiers of analysis. For example, screening-level risk assessments often incorporate conservative assumptions (e.g., all sources are co-located, all emissions are of the most toxic species of a particular chemical) in order to minimize the time and effort required to develop the emissions inventory. If the screening-level analysis indicates that there is a potential for a risk, then additional effort is made to characterize sources and emissions with greater precision. The IPP for a given risk assessment will identify the requisite level of precision for each potential tier of analysis.

7.2.2 Gathering Information

The next step in the development of an emission inventory is to gather the relevant information from existing sources. The information gathered should, at a minimum, include applicable pollutants, their sources, and emissions data (e.g., chemicals, emissions rates over time). If air quality modeling will be a part of the exposure assessment, the emissions inventory will need to include all of the source term data required by the model(s) to be used (e.g., latitude and longitude coordinates for each source, building size and shape for assessing downwash, chemical speciation).

A comprehensive information search may include guidance documents, existing emissions data, preliminary screening studies, emission factors, models, source characterization documents, and activity data references. A good starting point in this search is EPA's *Handbook for Air Toxics Emission Inventory Development*.[5]

7.2.3 Estimating Emissions

After gathering data from existing information sources, the analyst estimates the emissions to be reported in the inventory. There are two main approaches for estimating emissions: the top-down approach and the bottom-up approach.

- In the **top-down approach**, national- or regional data are allocated to a state or county based on a surrogate parameter such as population or employment in a specific sector. This approach typically is used for nonpoint sources when: (1) local data are not available, (2) the cost to gather local information is prohibitive, or (3) the end-use of the data does not justify the required cost. The top-down approach requires minimum resources, but at the expense of emissions accuracy.

- In the **bottom-up approach**, the inventory is developed from site-specific information on emissions sources, activity levels, and emission factors. This approach, typically used for point sources, requires more resources, but results in more accurate estimates than the top-down approach.

Exhibit 7-2 compares several methods for estimating point source emissions. Available methods for nonpoint sources include material balance, emissions factors, emissions estimation models (all listed in Exhibit 7-2), and surveys and questionnaires. Mobile source emissions estimates come from models, such as EPA's NONROAD[6] model for nonroad mobile sources (construction equipment, lawn mowers, airplanes, trains, and others) and MOBILE[7] for on-road mobile sources (automobiles, trucks). Section 7.3 below provides additional information on potential sources of emissions data.

Exhibit 7-2. Point Source Emission Estimation Methods		
Method	**Advantages**	**Disadvantages**
Continuous Emission Monitors (CEM)	• Measures actual emissions • Can be used to estimate emissions for different operating periods • Considered high quality data	• Often cost prohibitive
Source (Manual Stack) Testing	• Yields more accurate estimates than Emission Factors or Material Balance • Data can be used to develop emission factors • Data can be extrapolated to other representative (nonpoint) emission sources	• Cost prohibitive (especially if large number of pollutants to be tested) • Uncertainty issues due to representativeness of estimates over time • There may be no standardized testing reference methods
Material Balance	• Useful when other developed methods are not available or practical • Useful for sources resulting in evaporative losses	• Must have specific knowledge of all process parameters (amount of material entering and leaving the process, amount of material packaged as product itself)
Fuel Analysis	• Useful when other developed methods are not available or practical	• Estimates not as accurate due to inherent uncertainties in input parameters
Emission Estimation Models	• Useful for complex calculations	• Estimates not as accurate due to inherent uncertainties in input parameters
Emissions Factors	• Ease of availability	• Uncertain accuracy
Engineering Judgment	• Useful as a last resort when no other methods generate accurate emission estimates	• Estimates based on individual judgment and therefore not as defensible as more developed methods

Determining the best method for estimating emissions requires a trade-off between cost and the accuracy of results obtained. When estimating emissions, it is important to consider:

- Intended end-use of the inventory (as described in the IPP);
- Availability of data of the specified quality (preliminary screening can be helpful here);
- Practicality of the method for the specific source category;
- Source category priority; and
- Resources (time, staffing, funding) available to prepare the inventory.

The Emissions Inventory Improvement Program (EIIP) series of documents provides further guidance in choosing the most appropriate method for the specific inventory's needs.[1]

7.2.3.1 Direct Measurement

Direct measurement of source-specific emission rates is relatively infrequent except for certain permitted facilities with specific monitoring requirements written into their permits. For example, source monitoring is typically available for large point source releases at facilities covered under the Title IV emissions tracking system associated with the acid rain control program. Various state and local permitting programs that may also require intermittent or continuous monitoring, depending on the nature of the process.

In some instances, source testing is required as part of the process of obtaining a permit. For example, a hazardous waste incinerator must do stack testing during trial burns to ensure that the incineration units and air pollution control equipment meet the limits established in the permit before full operation is allowed to begin. Subsequent to full operation, the facility will usually be required to perform continuous monitoring of stack emissions to ensure continued compliance.

EPA's **Emission Measurement Center (EMC)** provides linkages to available source monitoring methodologies in five general categories (Exhibit 7-3).

7.2.3.2 Emission Estimation Models

Specific emission measurements are generally the best and most accurate method to quantify emissions; however, source data are not always available and/or practical to obtain. As an alternative, emission estimation software and accompanying models may be used to generate emissions data. Emission estimation models are used when a large number of complex calculations must be undertaken in order to estimate a given emission or when a combination of parameters has been identified that affect emissions but individually do not provide a direct correlation. EPA provides a variety of approved models that can be used to determine point, nonpoint, and mobile source emissions based on a variety of known input parameters. Some of these emission estimation models are discussed below.

CHEMDAT8

CHEMDAT8 is a Lotus® 1-2-3 spreadsheet prepared by EPA's Emissions Standards Division that includes analytical models for estimating VOCs from treatment, storage, and disposal facility processes. The models cover releases from disposal impoundments, closed landfills, land treatment facilities, and aeration and nonaeration impoundment processes. Additional information is available for download from the CHIEF software index website at: http://www.epa.gov/ttn/chief/software/index.html.

Exhibit 7-3. Categories of Source Monitoring Methodologies

EPA has established the EMC (http://www.epa.gov/ttn/emc/tmethods.html), as part of its Technology Transfer Network, which is a collection of technical internet sites containing information about many areas of air pollution science, technology, regulation, measurement, and prevention. The EMC identifies five general categories of source monitoring methods:

- **Category A: Methods Proposed or Promulgated in the Federal Register**. These methods have been proposed or promulgated in the Federal Register and codified in the Code of Federal Regulations (CFR).

- **Category B: Source Category Approved Alternative Methods**. These methods are approved alternatives to the methods required by 40 CFR Parts 60, 61, and 63 as described by the General Provisions of the corresponding Parts.

- **Category C: Conditional Methods**. EPA has evaluated these methods, and they may be applicable to one or more categories of stationary sources. EPA confidence for these methods is based upon review of various technical information including, but not limited to, field and laboratory validation studies, EPA understanding of the most significant quality assurance (QA) and quality control (QC) issues, and EPA confirmation that the method addresses these QA/QC issues sufficiently to identify when the method may not be acquiring representative data. The method's QA/QC procedures are required as a condition of applicability.

- **Category D: Preliminary Methods**. The performance of these methods is not as well defined as that of the conditional methods of Category C. EPA is providing these as they may be useful in limited applications until more supporting information is available (i.e., can be '"gap filling'" methods). EPA expects the methods to work under the conditions of the applicability statement but is uncertain of the methods' applicability without additional data on broader application. EPA encourages submission of data to support broader applicability.

- **Category E: "Idea box."** The idea box includes method concepts intended to promote information exchange only, and the concepts may not be used by sources to fulfill Federal requirements. These technical ideas have been provided to EPA for posting on the EMC web site. Concepts in the idea box generally have had little or no EPA review or analysis and are not technically supported by EPA. However, information that resides here may be considered for further assessment by EPA and non-EPA entities for the purposes of method development for placement into higher categories.

WATER9

WATER9 is a Windows-based computer program available for estimating air emissions of individual waste constituents in wastewater collection, storage, treatment, and disposal facilities. It also contains a database listing many of the organic compounds and describes procedures for obtaining reports of constituent fates, including air emissions and treatment effectiveness. WATER9 is a significant upgrade of features previously contained in WATER8, CHEM9 (a compound properties processor that can estimate compound properties that are not found in EPA's database of over 1000 compounds), and CHEMDAT8, and contains a set of models that can provide a holistic picture of emissions from a facility. The models produce emission estimates for each individual compound that is identified as a constituent of the wastes leaving

the facility based on the physical/chemical properties of the compound and its concentration in the wastes. Therefore, the analyst should be able to identify the constituent compounds and provide their respective concentrations. WATER9 has the ability to use site-specific compound property information and the ability to estimate missing compound property values. Estimates of the total air emissions from the wastes are obtained by summing the estimates for individual compounds. Program software may be downloaded from http://www.epa.gov/ttn/chief/software/water/index.html.

Landfill Gas Emissions Model v2.01

The Landfill Gas Emissions Model is a program specifically designed for use by state and local regulatory agencies to monitor the air emissions from landfills. The system allows the user to enter specific information regarding the characteristics and capacity of a landfill and to project the emissions of methane, carbon monoxide, nonmethane organic compounds, and individual HAPs over time using the Scholl Canyon decay model for landfill gas production estimation. The Scholl Canyon Model is a first-order decay equation that uses site-specific characteristics for estimating the gas generation rate. In the absence of site-specific data, the program provides default values for regulatory uses of the model and provides default values drawn from EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) for inventory uses. For additional information, contact EPA's Air Pollution Prevention and Control Division, Office of Research and Development at (919) 541-2709. Program software may be downloaded from http://www.epa.gov/ttn/chief/software/index.html.

TANKS

TANKS is a Windows-based computer software program that estimates emissions of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) from fixed- and floating-roof storage tanks and is designed for use by S/L/T and Federal agencies, environmental consultants, and others who need to calculate air pollutant emissions from organic liquid storage tanks. The calculations are performed according to estimation procedures outlined in EPA's *Compilation of Air Pollutant Emission Factors* (AP-42). The user provides specific information concerning the storage tank and its contents, and the program then estimates annual or seasonal emissions and produces a report. The tank contents can consist of single or multiple liquid components. The program may be downloaded from http://www.epa.gov/ttn/chief/software/tanks/index.html.

MOBILE6 Vehicle Emission Modeling Software

MOBILE6 is an emission factor model for predicting gram per mile emissions of hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x), carbon dioxide (CO_2), particulate matter (PM_{10} and $PM_{2.5}$), and other toxics from cars, trucks, and motorcycles under various onroad conditions. The program is available for download from http://www.epa.gov/otaq/m6.htm.

NONROAD Model

The Draft NONROAD Model is a Windows-based software program intended for use by professional mobile source modelers for their use in estimating emissions specifically for emissions inventory development. The model is still in draft form, so EPA warns that some

emission rates and activity levels predicted from NONROAD may substantially change in future versions. The program is available for download from http://www.epa.gov/otaq/nonrdmdl.htm.

Please note that EPA's Office of Transportation and Air Quality is currently developing a new modeling system, Multi-scale mOtor Vehicles and equipment Emission System (MOVES) that will replace the existing MOBILE6 and NONROAD models. This new system will estimate emissions for onroad and nonroad sources, cover a broad range of pollutants, and allow multiple scale analysis, from fine-scale analysis to national inventory estimation. For further information on MOVES, visit http://www.epa.gov/otaq/ngm.htm.

7.2.3.3 Emission Factors

Emission factors are constants that assessors can use to relate release rates to the amount of specific activities that occur at a source. An emission factor is typically represented as a mass of chemical released per unit of activity. For example, releases from a coal burning combustion device are represented as pounds of pollutant emitted per BTU coal burned. Depending on the emission source, there may be a lot of emissions testing data, just one or two measurements (the usual case), or none. For a screening-level assessment it may be possible to obtain an estimate of maximum emissions in one of several ways.

- If sufficient data are available, the assessment could use the highest available value.

- If only one or two measurements are available, the assessment could assume that all the emissions occur in a short period of time (such as only for 8 hours a day) and/or assume that all sources of emissions are co-located.

- If no data are available, the assessor may need to rely on professional judgment based on similar types of sources.

Certain types of sources (e.g., incinerators) typically undergo various test or trial "burns" to establish emissions factors pursuant to RCRA permitting requirements. Data to support the development of emissions factors also may be collected to support compliance with maximum achievable control technology (MACT) standards or Toxics Substances Control Act (TSCA) permitting. For stable and well established processes, the emission factors are usually reliable estimates. However, for sources that are subject to different operational conditions, with limited testing, the emission factors may represent an estimate of a higher or lower release rate.

Frequently, emission factors contain an associated confidence level by species, which assists in determining the appropriate emission factor. Thus, the use of the emission factor for any specific source may over- or under-predict actual release rates. In some cases, accurate measurements of the activity rates are not available and estimates of activity rates can also contribute uncertainty to the release rate estimate for any particular source type. An example is for individual motor vehicles; this source model estimates an average emission factor for a fleet of vehicles in a particular location. Modeling approaches for traffic activity estimate the total amount of miles driven by vehicle class. Finally, multiplying the emissions factor by the number of vehicle-miles driven produces the total emissions. Thus, any individual motor vehicle may have a release rate significantly far removed from the average, but when averaged across the fleet, the release rate provides a more reliable estimate.

EPA suggests emission factors for criteria pollutants and HAPs in its national database, Factor Information Retrieval System (FIRE), which includes emission factors from EPA documents (such as *Compilation of Air Pollutant Emission Factors* (AP-42) and the *Locating and Estimating Air Emission* series) factors derived from state-reported test data, and factors taken from literature searches. FIRE is available for download at http://www.epa.gov/ttn/chief/software/fire/.

7.2.3.4 Mass Balance

Assessors can use the mass balance approach in complex processes in which a known amount of air toxics material is introduced to a process, and at the end of the process, a known amount of air toxics material is still retained in the final product. The difference between the two represents the production release. Engineering estimates can then suggest into what medium the process released the air toxic (e.g., to air or water, or as solid waste).

As an example, consider the use of a VOC as a carrier medium for a solid (e.g., paint particles). In this surface coating situation, the organic solvent that suspends the solids makes application of the coating possible. Once the mixture is exposed to the air, the solvent evaporates, leaving the solid coating film on the object. Mass balance techniques in this type of application may assume that 100 percent of the solvent is released to the air through evaporation. Other mass balance estimates may assume that some stable amount of the solvent is retained in the product that is shipped to customers. Mass balance estimates also may need to consider how much of the solvent is recycled at various stages in its life-cycle.

7.2.3.5 Engineering Judgment

With engineering judgment, users can estimate emission releases through engineering and operational observations about a process. For example, if a certain process must be operated at a set temperature and pressure to achieve the ideal result, engineers who understand the history of the process can often estimate how the release rate actually varies under changing operational conditions. Engineering judgment is a less desirable approach for estimating releases than actual measurements; however, it is often used because of a lack of any better information or options (e.g., it may not be possible to measure all fugitive leaks at a large facility with thousands of joints and valves).

7.2.4 Compiling Data Into a Database

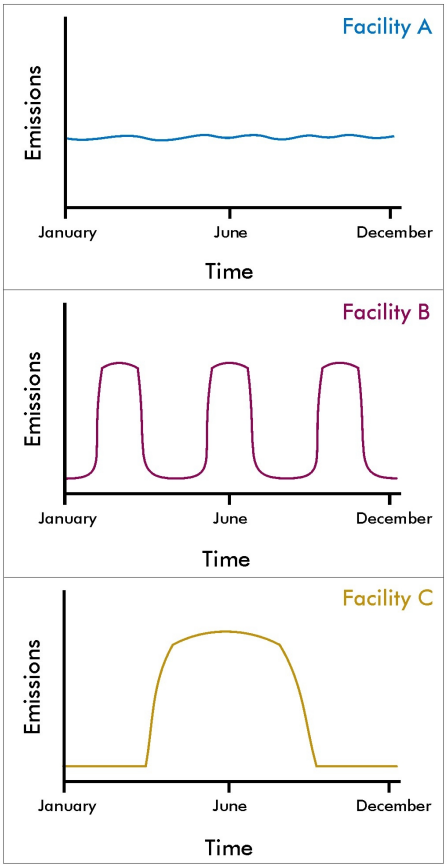
After estimating the applicable emissions from each source, the analyst compiles the data into the inventory database, based on the data management system delineated in the Inventory Preparation Plan. Three elements of data compilation are of note for a risk assessment: selection of production rates; unusual conditions; and how emissions are quantified for risk assessment purposes. Each is discussed in a separate subsection below.

7.2.4.1 Selection of Production Rates

The variability in a source's emissions rate can make it difficult to arrive at a single source-specific emissions level. Prior to collecting or reviewing data in support of a risk assessment, assessors will need to decide whether to use release data that reflects either annual average

emissions or "worst-case" operating conditions (or both). In some limited cases, it may be possible to obtain data on daily and seasonal variable emissions, although this is not common. Likewise, information on both the actual release rates and maximum permitted or allowable release or potential emission rate may be available. In addition to information on annual releases, a description of the release pattern over the year (see examples in Exhibit 7-4) and during the weeks of operation will be useful in characterizing the resultant ambient air concentrations over the exposure duration (e.g., is release occurring around-the-clock or only during the work week?).

Exhibit 7-4. Examples of Variable Patterns of Emissions



Emissions patterns may vary over time. In this hypothetical example, Facility A's emissions occur at a fairly constant rate. In contrast, Facility B's emissions levels fluctuate with spikes in their emissions evident at different times of the year. Facility C's emissions occur only during a specific part of the year.

Information on variability in operating conditions and the factors or conditions influencing that variability will be useful. This will assist in the selection of the release data for the scenario of interest in the assessment. For example, if the assessment is evaluating what may be released under current permit conditions, it may be appropriate to use release rate data corresponding to the maximum permitted release rate, regardless of reported actual rates. This method is best-suited for screening-level analyses, where the objective is to conduct a risk assessment for the purposes of screening out sources that pose negligible risk while efficiently conserving available resources (i.e., time and money), which may be needed for a more refined analysis of the remaining sources. However, use of reported release data (e.g., annual estimates) may be more appropriate for refined analyses of facilities with well-defined production capabilities and limited

operational variability. Note that more detailed information on variability may be needed for analysis of air concentrations (and resultant exposures) over shorter periods (e.g., acute analysis).

7.2.4.2 Unusual Conditions: Process Upsets, Accidental Releases, and Maintenance

Release characteristics frequently differ during atypical operations. Process upsets often result in the venting of large amounts of raw materials, intermediate products, finished products, or wastes to the air. Sources often flare organic releases during process upsets (i.e., burned as the chemicals are being released to the air) to reduce the mass of potentially toxic compounds, which can result in releases of particulate matter or other chemicals as a result of incomplete combustion. Shutting down and starting up processing equipment results in a period of time when the process is operating at less than ideal conditions, and release rates can change significantly during these shut down and start up procedures. Accidental releases associated with truck accidents, train derailments, or chemical spills from shipping operations can also cause significant releases that affect a local area for a short period of time.

Many operating permits require sources to report periods of process upset and maintenance activities, although assessors may not estimate release rates during these periods because measurement data are often unavailable. Local emergency authorities often possess information on accidental releases from trucking accidents and train derailments. These reports may be useful to provide modeling input data in subsequent acute risk assessment activities. Risk assessors can contact local HazMat Teams, and state or federal emergency response personnel to gather available information on accidental and upset releases. This type of information could be quite useful in local episodic acute risk analysis,[(a)] but may not be included in long-term risk evaluations.

Another source of startup/shutdown/malfunction data may be available in state/local/tribal permit files for the facilities. Specifically, many permitted facilities must file routine reports in which the provide information on spills, excursions, and other unusual circumstances where non-routine releases occur.

7.2.4.3 Quantifying Emissions for the Risk Assessment

Once the assessor has compiled the above information about the source in question, he or she would quantify the emission rate as the amount of pollutant released per unit of time. Most air toxics releases are expressed as tons of pollutants released per year in emissions inventories. However, as noted above, a yearly value may not provide the level of information required to evaluate the risk assessment questions, and more detailed information may be necessary. For example, are there seasonal fluctuations in emissions? Are the releases continuous around-the-clock, seven days a week, or more intermittent with a different schedule? The particular air dispersion model may require that emission rates be expressed in different units (e.g., pounds per

[a]EPA's Chemical Emergency Preparedness and Prevention Program web page describes the development of emergency management plans relying on such acute risk analysis to assist in the response to accidental releases: http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/RMPoverview.htm

Process Upset and Accidental Release Information Sources

The **National Response Center (NRC)** has an on-line query system that provides access to all non-Privacy Act data collected by the NRC since 1990. This information may be accessed at http://www.nrc.uscg.mil/foia.html.

The U.S. Chemical Safety and Hazard Investigation Board maintains a database of **Incident News Reports**, which may contain information on process upsets and accidental releases. The Incident News Reports database is available at http://www.chemsafety.gov/circ/.

RMP*Info is a national database that provides information on risk management plans (RMPs). Each RMP contains a hazard assessment that includes an accident history covering the facility's previous five years of operation. This information can be obtained by submitting a written request for the RMP database (without the Offsite Consequence Analysis data) to the RMP Reporting Center, P.O. Box 1515, Lanham-Seabrook, Maryland 20703-1515.

hour, grams per second). The NEI contains emission estimates of HAPs for periods of a year or less. Risk assessors generally consult the emission period table in the NEI and use the emission type field to determine the period for which emissions are reported. The EPA summarizes NEI data in summary files to annual emissions, but more detail on the reporting period is available in the NEI. The NEI also contains emissions estimates for actual, allowable, potential, and maximum emissions for the same emission release points.

7.2.5 Data Augmentation

If previous efforts at estimating emissions fail to obtain data to assemble an emissions inventory of sufficient quality or to provide the necessary inputs for an emissions model, the next step would be data augmentation. The analyst first identifies any missing information, most notably emission data, vent parameters, and location coordinates.

- **Emissions data**. When developing emission inventories for nonpoint sources, analysts sometimes find that no direct measure of activity exists at the local level. In cases where this occurs, national, regional, or state-level emission estimates already in existence may be allocated to the local level (i.e., a top-down approach). This practice is know as **spatial allocation** and is a common form of data augmentation. Similarly, emissions can be temporally allocated to the time period required by an emissions model. Other suggestions for filling emission data gaps include:
  - Additional searches of databases to identify appropriate surrogate data;
  - Extrapolation of emissions from other geographic areas; and
  - Estimation of emissions data from past inventories within the same geographic area.

- **Vent parameters**. Common vent parameters required for air quality modeling include height, diameter, temperature, exit velocity, and flow rate. If measures for any of these parameters are missing or incomplete, the NEI provides default lookup tables generated from Source Category Classification (SCC) and Standard Industrial Classification (SIC) codes.

  SCC codes serve as a primary identifying data element in the NEI (as well as other EPA databases) and many S/L/T agency emissions data systems. These codes are assigned to

specific release points within a facility based on the process to which the release point is linked and on various characteristics of the release point. A complete listing of SCC codes along with additional background information is available from EPA.[8]

SIC codes are numerical codes developed by the U.S. government as a means of consistently classifying the primary business of business establishments. A list of the industry groups that are required to report to the Toxics Release Inventory (TRI) is provided in Chapter 4 and also can be found at http://www.epa.gov/tri/report/siccode.htm.

For facilities that are regulated pursuant to a National Emissions Standard for Hazardous Air Pollutants (NESHAP), the MACT codes, based on the MACT source category into which a specific process falls, may provide additional information about the nature of the business, primary production processes, or activities related to the release of air pollutants.

If no SCC or SIC code is available for the emission source in question, the analyst may use the national default values for each parameter (see Exhibit 7-5).

Exhibit 7-5. National Vent Parameter Default Values

Parameter	Default Value
Height	10 ft.
Diameter	1 ft.
Temperature	72° F
Velocity	15 ft./sec.
Flow Rate	12 $ft.^3$/sec.

Source: Pope, A. *Inventory Preparation for Toxics*.[3]

- **Location coordinates** may be identified from the NEI (stationary sources) or topographic maps (discussed in Chapter 6).

7.2.6 Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) procedures are vital to the validity of the emissions inventory and ensure that the modeling input parameters derived from the inventory are of specified quality. The quality assurance plan (QAP) for the emissions inventory is usually a part of the quality assurance project plan (QAPP) for the overall risk assessment that is developed during problem formulation (see Chapter 6). The QAP documents the procedures of the QA/QC elements of the emissions inventory. Quality control measures include:

- Technical reviews;
- Use of approved standardized procedures for emissions calculations;
- Data verification procedures;
- Completeness checks;
- Consistency checks;
- Accuracy checks; and
- Reasonableness tests.

To the extent practicable, risk assessors have emissions data verified by external review and audit procedures conducted by a third party. Exhibit 7-6 identifies the typical errors that occur in developing an emissions inventory.

Exhibit 7-6. Typical Errors in Developing an Emission Inventory		
Facility Errors • Missing facilities • Duplicate facilities • Closed facilities • Improper facility locations	**Data Errors** • Missing operating or technical data • Erroneous technical data • Errors in calculations • Data entry and transposition errors • Data coding errors • Failure to identify all HAPs	**Double-counting Errors** • Overlap between point and nonpoint sources • Overlap between nonpoint source categories

7.2.7 Documentation

Documentation is the next step in developing an emission inventory. The key documents to be compiled into a final written report include:

- Inventory Preparation Plan (IPP);
- Quality Assurance Plan (QAP);
- Methods;
- Assumptions;
- Raw data (database); and
- Calculations.

7.2.8 Access to Data

The risk manager generally ensures appropriate access to the data compiled in the emission inventory. A key part of the planning and scoping process for the risk assessment is determining who needs access to the emissions data and how they will access the data. If it is necessary to report the results of the emission inventory to the EPA as part of a S/L/T agency's responsibilities under the Consolidated Emission Reporting Rule, data preparation and submission procedures prepared by EPA for HAP data should be followed.

7.3 Data Sources

The two data sources for emissions inventory information that are most applicable to air toxics risk assessments are S/L/T agencies and the NEI. The TRI can provide some helpful information about the types of emissions from sources, but TRI data have not been collected to support air toxics risk assessments and therefore may be of limited value. The following subsections describe several other sources of information that may provide information to assist in developing an emissions inventory for the risk assessment.

7.3.1 Permit Files

Most stationary sources (especially large sources) are subject to one or more emissions limitation standards to control criteria emissions and/or HAP emissions. These sources are usually subject to a Title V operating permit that will include all of the operating and emissions limit requirements subject to that facility. In addition, they may be subject to additional S/L/T regulations. Operating permits require routine reporting to confirm that the operating conditions and emission limits are being met. Frequently, these reports are based on some kind of monitoring information that is directly related to the release process(es). In most cases, actual release rates are reported. Therefore, permit compliance reports represent an excellent source of information that will provide the actual release rate directly through continuous emissions monitoring, or they will provide sufficient information to estimate the release rates with a fairly high level of reliability.

Unfortunately, using the permit compliance system is not always an attractive source for data on release rates that are suitable for risk assessment activities. EPA does not maintain a central database of Title V permit or compliance information. Therefore, gathering data from the permit program can be a time-consuming task if many sources are needed for the risk analysis. The reports will also be represented in terms that match the requirements of the permit (e.g., if the permit conditions specify an annual release limit, release rates may be presented as an annual average; if the permit conditions specifies a maximum release rate for any hour, then the compliance report will document the maximum hourly rate observed at the facility). Therefore, some adjustments and assumptions may be necessary. In addition, the permit compliance report will only include the specific pollutants named in the regulations to which the permit applies. For example, for NESHAPs that are applicable to the source, only HAPs specifically listed in the rule may be included on the permit; other HAPs may also be emitted which are not required to be reported. Additionally, not all important HAP sources are required to have a Title V permit, and even small annual release rates of certain highly toxic HAPs may post significant risk.

In general, EPA has made an effort to include permit data in the NEI database (via data submissions from S/L/T offices) where appropriate and has taken steps to review the data. In many cases, it may be more reasonable to consult the NEI prior to attempting to gather release rates directly from permit files.

7.3.2 Regional Inventories

Several regional organizations provide emission data specific to their geographic area of concern. For example, the Great Lakes Commission (a partnership among EPA, the eight Great Lakes states, and the province of Ontario, Canada), with funding from EPA and the Great Lakes Protection Fund, have developed the Regional Air Pollutant Inventory Development System (RAPIDS). This ongoing initiative seeks to provide researchers and policy makers with detailed, basin-wide data on the source and emission levels of toxic contaminants. Originally focused on 49 toxic air pollutants, the inventory database has been expanded to include 82 toxic air pollutants which have been identified as significant contributors to the contamination of the Great Lakes. RAPIDS uses the FIRE database to estimate emissions for both point and nonpoint sources. The software may be downloaded from http://www.glc.org/air/rapids/.

Additionally, EPA provides funding to five regional planning organizations throughout the U.S. to address regional haze and visibility impairment issues. These organizations exist to evaluate technical information to better understand how their states and tribes impact national park and wilderness areas (Class I areas under the CAA) across the country and to then pursue the development of regional strategies to reduce emissions of particulate matter and other pollutants contributing to regional haze. To this end, each regional planning organization assesses its member states' emission inventories, and some provide funding through EPA for the development of regional emission inventories. Information regarding regional emission inventorying activities may be found at the organizations' respective websites as listed below:

- Central Regional Air Planning Assocation (CENRAP) – http://www.cenrap.org/
- Western Regional Air Partnership (WRAP) – http://www.wrapair.org/
- Midwest Regional Planning Organization (Midwest RPO) – http://64.27.125.175/
- Mid-Atlantic/Northeast Visibility Union (MANE - VU) – http://www.manevu.org/index.htm
- Visibility Improvement State and Tribal Association of the Southeast (VISTAS) – http://www.vistas-sesarm.org/

7.3.3 Industry Profiles

To help assessors understand the nature of releases from sources, EPA has compiled a variety of guidance documents and information resources that explain how various industries operate and the types and locations of emissions that commonly are associated with their processes. Two key groups of these documents are the "Sector Notebooks" and the TRI Facility Specific profile.

The sector notebooks are a series of profiles or notebooks containing information on selected major industries. These notebooks, which focus on key indicators that holistically present air, water, and land pollutant release data, have been thoroughly reviewed by experts from both inside and outside EPA. Each notebook provides:

- A comprehensive environmental profile;
- Industrial process information;
- Pollution prevention techniques;
- Pollutant release data;
- Regulatory requirements;
- Compliance/enforcement data;
- History government and industry partnerships;
- Innovative programs contact names;
- Bibliographic references; and
- Description of research methodology.

The notebooks cover a wide variety of activities, including:

- Agricultural chemical, pesticide and fertilizer industry;
- Dry cleaning industry;
- Ground transportation industry;
- Inorganic chemicals industry;
- Fossil fuel electric power generation industry;
- Metal fabrication industry; and

- Organic chemical industry.

Regarding TRI resources, the TRI website provides a number of very industry-specific and chemical-specific guidance documents that were developed to help stakeholders understand the nature of major industrial process and how emissions may occur from those processes (see http://www.epa.gov/tri/guide_docs/index.htm#industry_sp). Example titles include:

- Presswood and Laminated Products Industry;
- Coal Mining Facilities;
- Electricity Generating Facilities;
- Petroleum Terminals and Bulk Storage Facilities;
- Rubber and Plastics Manufacturing;
- Printing, Publishing, and Packaging Industry;
- Textile Processing Industry;
- Leather Tanning and Finishing Industry; and
- Semiconductor Industry.

Assessors can take advantage of these materials to help them better understand the nature of potential risk posed by facilities on local populations.

7.3.4 AP-42 Emissions Factors

Emission factors and emission inventories have long been fundamental tools for air quality modeling. The Emission Factor and Inventory Group (EFIG) in EPA's Office of Air Quality Planning and Standards (OAQPS) develops and maintains emission estimating tools. The AP-42 series is the principal means by which EFIG can document its emission factors. It is available from EPA online.[9] These factors are cited in numerous other EPA publications and electronic databases, but without the process details and supporting reference material provided in AP-42. Information about emission factors for mobile sources can be found on EPA's Office of Transportation and Air Quality website (http://www.epa.gov/otaq/).

So just what is an AP-42 Emission Factor? It is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).

7.3.5 Factor Information Retrieval System

The Factor Information Retrieval (FIRE) Data System is a database containing EPA's recommended release rate estimation factors for criteria and hazardous air pollutants. FIRE 6.24 (released March 2004) is a Windows-based program. Users can browse through records in the database or select specific emission factors by source category, source classification code (SCC), pollutant name, chemical CAS number, or control device. FIRE 6.24 contains emission factors from the Compilation of Air Pollutant Emission Factors (AP-42 Fifth Edition) through March

2004, the Locating and Estimating (L&E) series of documents, and the retired AIRS/Facility Subsystem Emission Factors (AFSEF) and Air Toxic Emission Factor Database Management System (XATEF) documents. FIRE can be accessed at: http://www.epa.gov/ttn/chief/software/fire/index.html.

7.3.6 Locating and Estimating Documents

This report series characterizes some of the source categories for which releases of a toxic substance have been identified. These volumes include general descriptions of the emitting processes, identifying potential release points and emission factors. Some of the locating and estimating documents were prepared as early as 1984 and the information may be dated. Others have been developed since 1994 and will provide more up-to-date information (see http://www.epa.gov/ttn/chief/le/index.html). EPA does not maintain L&Es and has not published new L&Es since the mid 1990s.

7.3.7 RCRAInfo

RCRAInfo is EPA's comprehensive information system providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The RCRA law is the primary statute under which EPA monitors and regulates the management of nonhazardous and hazardous solid waste by entities that produce, store, treat, transport, or otherwise manage such wastes (all of which are potential sources of air toxics emissions in a community). This RCRAInfo replaces the data recording and reporting abilities of the Resource Conservation and Recovery Information System (RCRIS) and the Biennial Reporting System (BRS).[10]

RCRIS was the national program management and inventory system of facilities that handle RCRA hazardous waste.[11] Facilities fit one or more of the following categories: treatment, storage, and disposal facilities (TSDFs); large quantity generators (LQGs); small quantity generator (SQGs); and transporters. RCRIS contains the following information:

- General information on all handlers (e.g., name, address, activity type);
- Permitting and corrective action program status, and Standard Industrial Classification (SIC) code information for TSDFs only; and
- Enforcement and compliance actions for specific facilities, regardless of type, which have been subject to inspections or other enforcement activity.

States and regions populated RCRIS with data necessary for their program implementation. Those portions of the data that were relevant for national program oversight and management were contained in a RCRIS national database.

The **BRS** was the national system that collected data on the generation, management, and minimization of hazardous waste. BRS captured detailed data on the generation of hazardous waste from large quantity generators and data on waste management practices from treatment, storage, and disposal facilities. These data were collected every other year, providing the ability to perform trend analyses. The data were reported by the facilities to EPA on even years regarding the hazardous waste activities of the previous year. EPA produced a report on hazardous waste generation and management activity that included the data files. The BRS can

be queried to identify facilities treating hazardous wastes with technologies that may generate air toxics emissions. BRS reports are available from EPA through 2003.[12]

RCRAInfo data is made available to the public through EPA's Envirofacts Data Warehouse[13] through monthly extracts or through the Right to Know Network.[14] The same files that are provided to Envirofacts and the Right to Know Network are also available for downloading from EPA's publically accessible FTP server.[b]

The RCRAInfo system that is replacing the RCRIS and the BRS allows tracking of many types of information about the regulated universe of RCRA hazardous waste handlers. RCRAInfo characterizes facility status, regulated activities, and compliance histories and captures detailed data on the generation of hazardous waste from large quantity generators and on waste management practices from treatment, storage, and disposal facilities. Although the BRS does not contain emissions monitoring data, it does identify hazardous waste constituents, quantities managed, and other facility information. For example, the RCRA files include trial burn data for hazardous waste incinerators, certification of compliance test data, and facility plot plans, all of which could be useful in risk assessments of air toxics.

7.3.8 Emissions and Dispersion Modeling System (EDMS)

For aircraft emissions, the Federal Aviation Administration has developed an emission estimation method model, Emissions and Dispersion Modeling System (EDMS), Version 4.0.[15] This model can be applied to specific airports and used to develop air toxics emissions for both commercial and general aviation emissions. The primary basis for estimating emissions is based on landing and take off data available from FAA's airport activity statistics database. EDMS includes emissions and dispersion calculations, the latest aircraft engine emission factors from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank, vehicle emission factors from EPA's MOBILE5a, and EPA-validated dispersion algorithms.

7.3.9 Summary

Exhibit 7-7 lists the different data sources that provide information on air toxics emissions that are being used or can be adapted for air toxics risk assessments.

[b] The server is available at: ftp://ftp.epa.gov/rcrainfodata/brfiles/. A comprehensive web-enabled help module (RCRAInfo_Flat_File_WebHelp.zip) is also available to explain the flat file specifications and data element values (see ftp://ftp.epa.gov/rcrainfodata/rcra_flatfiles/).

Exhibit 7-7 Summary of Emissions Inventory and Related Information				
Data Source	**Maintained By**	**Sectors Covered**	**Comments**	**Address**
S/L/T Inventories	Individual S/L/T agencies	Large point sources; nonpoint sources; mobile sources from selected S/L/T agencies; coverage is variable	Many S/L/T agencies have specific information collected for special studies; attempts have been made to include most of the S/L/T-level data into the NEI, but higher resolution data may be available	Various S/L/T-specific and other web pages http://www.cleanairworld.org/
National Emissions Inventory (NEI)	U.S. EPA	Point sources; nonpoint sources; on-road and nonroad mobile sources	Point sources are reported for individual release points (includes other modeling data); nonpoint and mobile sources are reported at the county level	http://www.epa.gov/ttn/chief/net/index.html
Title V Permit Conditions	States/EPA	Large stationary point sources and limited coverage of nonpoint sources; only HAPs greater or equal to 10 tons/25 tons per year covered	Source-specific operating conditions to achieve permitted emissions levels; actual emissions reported for compliance in many cases; includes MACT requirements	Generally available in paper format only; some regional offices maintained databases
EIIP	States/EPA	Large point sources; nonpoint sources; mobile sources	Series of reports with recommended and alternative emissions estimation methods, and recommended emission factors	http://www.epa.gov/ttn/chief/eiip/index.html
Clearinghouse for Inventories and Emission Factors (CHIEF)	U.S. EPA	Collection of information, tools, and guidance on emissions from all sectors	EPA's main web page for emissions inventories and related data	http://www.epa.gov/ttn/chief/
Emissions Tracking System (ETS)	U.S. EPA	Large electric generating units	Annual reports of actual monitored emissions of SO2, NOx and CO2 from Title IV affected facilities, no toxics reported	http://www.epa.gov/airmarkets/emissions/index.html
RCRAInfo	U.S. EPA	Generally point sources; does include information on waste transporters	Reporting of releases from Hazardous Waste Treatment Storage and Disposal Facilities (TSDF); includes data from Biennial Reporting System (BRS) and Resource Conservation and Recovery Information System (RCRIS)	http://www.epa.gov/epaoswer/hazwaste/data/index.htm#rcra-info
Toxic Release Inventory (TRI)	U.S. EPA	Generally only point sources; includes only those sources that are subject to reporting thresholds	Self reported information at facility level; no other data necessary for modeling are reported (e.g., vent characteristics); updated annually; source and pollutant coverage can be limited by reporting thresholds; generally not recommended for modeling	http://www.epa.gov/tri/

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