VOLUME III: CHAPTER 1

INTRODUCTION TO AREA SOURCE EMISSION INVENTORY DEVELOPMENT

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Emission Inventory Improvement Program

DISCLAIMER

As the Environmental Protection Agency has indicated in Emission Inventory Improvement Program (EIIP) documents, the choice of methods to be used to estimate emissions depends on how the estimates will be used and the degree of accuracy required. Methods using site-specific data are preferred over other methods. These documents are non-binding guidance and not rules. EPA, the States, and others retain the discretion to employ or to require other approaches that meet the requirements of the applicable statutory or regulatory requirements in individual circumstances.

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ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS

ACT	Alternative Control Techniques
AFS	AIRS Facility Subsystem
AIRS	Aerometric Information Retrieval System
AMS	AIRS Area and Mobile Subsystem
BEA	Bureau of Economic Analysis
BID	background information document
CAAA	Clean Air Act Amendments of 1990
CAS	Chemical Abstract Services
CD-ROM	compact disc read-only memory
CE	control efficiency
CHIEF	Clearinghouse for Inventories and Emission Factors
CO	carbon monoxide
CO_2	carbon dioxide
CTC	Control Technology Center
CTG	Control Techniques Guidelines
DOT	Department of Transportation
DQOs	Data Quality Objectives
EFIG	Emission Factor and Inventory Group
EIA	Energy Information Administration
EIIP	Emission Inventory Improvement Program
EIQA	emission inventory quality assurance
EPA	U.S. Environmental Protection Agency
FIRE	Factor Information Retrieval System
FTP	file transfer protocol
GIS	Geographical Information System
GPO	Government Printing Office
HAPs	hazardous air pollutants
ID	identification
L&E	Locating and Estimating
LAEEM	Landfill Air Emissions Estimation Model
MACT	maximum achievable control technology
MPO	metropolitan planning organization
MSA	metropolitan statistical area
NAPAP	National Acid Precipitation and Assessment Program
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
OAQPS	Office of Air Quality Planning and Standards

ABBREVIATIONS AND ACRONYMS (CONTINUED)

ORD	Office of Research and Development
PM	particulate matter
POTW	publicly owned treatment works
PSD	Prevention of Significant Deterioration
QA	quality assurance
QC	quality control
RE	rule effectiveness
ROP	rate of progress
RP	rule penetration
SAF	seasonal activity factor
SAMS	SIP air pollutant inventory management system
SARA	Superfund Amendments and Reauthorization Act
SCC	source classification code
SIC	standard industrial classification
SIMS	Surface Impoundment Modeling System
SIP	State Implementation Plan
SSCD	Stationary Source Compliance Division, now Office of Enforcement and Compliance Assurance (OECA)
TRIS	Toxic Release Inventory System
TSD	Technical Support Documents
TSDF	treatment, storage, and disposal facility
U.S.	United States
USDA	U.S. Department of Agriculture
VMT	vehicle miles traveled
VOCs	volatile organic compounds
XATEF	Crosswalk/Air Toxic Emission Factor Database

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INTRODUCTION

This chapter is one of a series of documents developed to provide cost-effective, reliable and consistent approaches to estimating emissions for area source inventories. Multiple methods are provided in the chapters to accommodate needs of state agencies with different levels of available resources and skills; and different levels of needs for accuracy and reliability of their estimates. More information about the EIIP program can be found in Volume 1 of the EIIP series, *Introduction and Use of EIIP Guidance for Emissions Inventory Development.*

Throughout this chapter and other EIIP area source methods chapters, we stress that area source categories should be prioritized by the inventory planners so that resources can be spent on the source categories that are the largest emitters, most likely to be subject to regulations or are already subject to regulations, or require special effort because of some policy reason. Prioritization is particularly important for area source inventories, because in some cases, a difficult to characterize source category may contribute very little to overall emissions and attempting a high quality estimate for that source category may not be cost effective.

EIIP chapters are written for the state and local air pollution agencies, with their input and review. EIIP is a response to EPA's understanding that state and local agency personnel have more knowledge about their inventory area's activities, processes, emissions, and availability of information; and require flexible inventory methods to best use their sometimes limited resources. These EIIP area source chapters are written as a set of options presented to inventory professionals capable of using their own experience and judgement to apply the method that best fits their overall needs and constraints.

Emissions from area sources are an important component of regional air pollution inventories. With the passage of the Clean Air Act Amendments (CAAA) in November 1990, the need for specific and standardized procedures for the preparation of area source inventories has increased. Over the years, the United States (U.S.) Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards (OAQPS) has established several standard procedures for the preparation of State Implementation Plan (SIP) emission inventories. The Emission Inventory Improvement Program's (EIIP's) Area Sources Committee has sought to update and expand the EPA guidance through the development of this guidance document. The objectives of Volume III, Area Sources, are to:

- Establish standard procedures for the preparation of area source emission inventories;

- Present preferred and alternative methods for estimating emissions from selected area source categories; and

- Describe new and innovative emission estimation methods in addition to methods that have been commonly used.

1.1 Overview of Volume

This chapter describes the process of planning and developing an area source inventory. Fundamental emission estimation approaches for area sources as well as data management, quality assurance, and documentation requirements are described. Subsequent chapters present preferred and alternative methods for specific area source categories, and include new and innovative estimation methods whenever they are available. Methods chapters in this volume describe and recommend procedures for estimating emissions from an area source category. Each methodology chapter is divided into eight sections.

In this chapter:

- Section 1 outlines the contents of this chapter and defines the area source category.

- Section 2 describes the planning process involved in developing an inventory.

- Section 3 provides an overview of available emission estimation approaches.

- Section 4 provides details on how to make adjustments to the emission estimates, and

- Section 5 discusses data management.

- Section 6 discusses the quality and uncertainty associated with each method.

- Section 7 is the reference section.

In addition, technical abstracts providing limitated amounts of information are available for downloading from the EIIP Website www.epa.gov/ttn/chief/eiip. When it was recognized that inventory preparers needed assistance with a particular source category, yet limited information existed, that information was compiled into a brief technical document describing the category and how to estimate emissions. These documents are called abstracts.

1.2 DEFINITION OF AREA SOURCES

An area source may be defined as a collection of similar emission units within a geographic area. Commonly, area sources have been defined at the county level, and most area source methods are designed to estimate area source emissions at the county level. However, any specified area (e.g., city, town, or census division) could be used to define an area source. User-defined areas such as grid cells or polygons could also be used.

Area sources collectively represent individual sources that are small and numerous, and that have not been inventoried as specific point, mobile, or biogenic sources. Individual sources are typically grouped with other like sources into area source categories. These source categories are grouped in such a way that they can be estimated collectively using one methodology. For example, gasoline stations and dry cleaning establishments are often treated as area sources. The main reason not to treat them as point sources is that the effort required to gather data and estimate emissions for each individual facility is great although emissions per facility are generally small. For these sources, the distinction between point and area is usually defined by a cutoff point typically based on annual emissions. SIP ozone inventories, for example, define volatile organic compound (VOC) point sources as individual facilities emitting more than 10 tons of VOCs per year. Emissions from smaller facilities are treated as an area-source group.

True area-wide sources, such as pesticide use and commercial/consumer product use, are examples of this source type. The boundaries of the individual activities associated with these sources are often hard to determine or are, at best, arbitrary. Even within a point source facility, some activities occur that are more easily treated as area source emissions. Some emissions associated with surface coating operations such as equipment cleaning, for example, can be more practically estimated using area source methods even though other surface coating emissions may be reported as part of the point source inventory.

The main distinction between point and area sources is the methodology used to estimate emissions. Point sources are inventoried individually, and area sources are inventoried collectively. While all stationary sources could be treated as either point sources or area sources, for practical reasons some cutoff is usually set to distinguish between them. The end use of the inventory, the desired accuracy of the emissions, and the resources available for inventory development all affect where that cutoff is set. Volume III of this EIIP series provides guidance for area source emissions estimation methods for many common area source processes.

The term “process” is used here to name an operation or activity that produces emissions. Area sources include the following broad groups of processes:

- Commercial and consumer organic solvent usage (surface coating, dry cleaning, degreasing, graphic arts, rubber and plastics);

- Stationary fuel combustion (heating, including waste oil combustion);
- Material storage and distribution;
- Waste treatment and disposal;
- Miscellaneous industrial manufacturing operations;
- Comfort and industrial cooling towers;
- Miscellaneous sources (agricultural/forest burning, structure fires, mining or construction, for example);
- Gasoline service stations; and
- Hospital and laboratory sterilizers.

Each of these broad groups of processes contain a number of more specific groups that share similar emission processes and emission estimation methods.

Although mobile and biogenic sources could be inventoried as area sources, specialized methods have been developed for these categories. These methods are described in EIIP Volumes IV and V, respectively.

Finally, in this volume of EIIP documents, ozone precursors and the criteria pollutant particulate matter (PM) are emphasized. Where it was possible, emission factors or speciation profiles for other criteria pollutants, hazardous air pollutants (HAPs), and greenhouse gases were included. However, the lack of information for other pollutants in these methodologies should not be construed to mean that a source does not emit those pollutants.

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INVENTORY PLANNING

Thorough planning at the beginning of the inventory development process is essential for the efficient development of sound emissions inventories. An essential part of the area source inventory planning process is to coordinate complementary point, mobile, and biogenic inventory activities to ensure that overall inventory requirements are met. The overall role of planning is discussed in some detail in Volume I of this series (*Introduction to Area Source Emission Inventory Development*, July 1997); the role of planning in the quality assurance (QA) program is described in Volume VI (Chapter 2). This section concentrates on issues relevant to area source inventories.

Figure 1.2-1 provides an overview of inventory planning and information flow at a typical agency. Note that the area source inventory group has more interactions with other groups than any other inventory group. Therefore, it is essential that the area source inventory team:

- Identify other departments or agencies that need to be contacted for inventory information;

- Define the role that the departments or agencies will have, and communicate their role clearly before work begins;

- Ensure that the other departments or agencies are aware of procedural and documentation requirements before work begins; and

- Identify points of contact in each department.

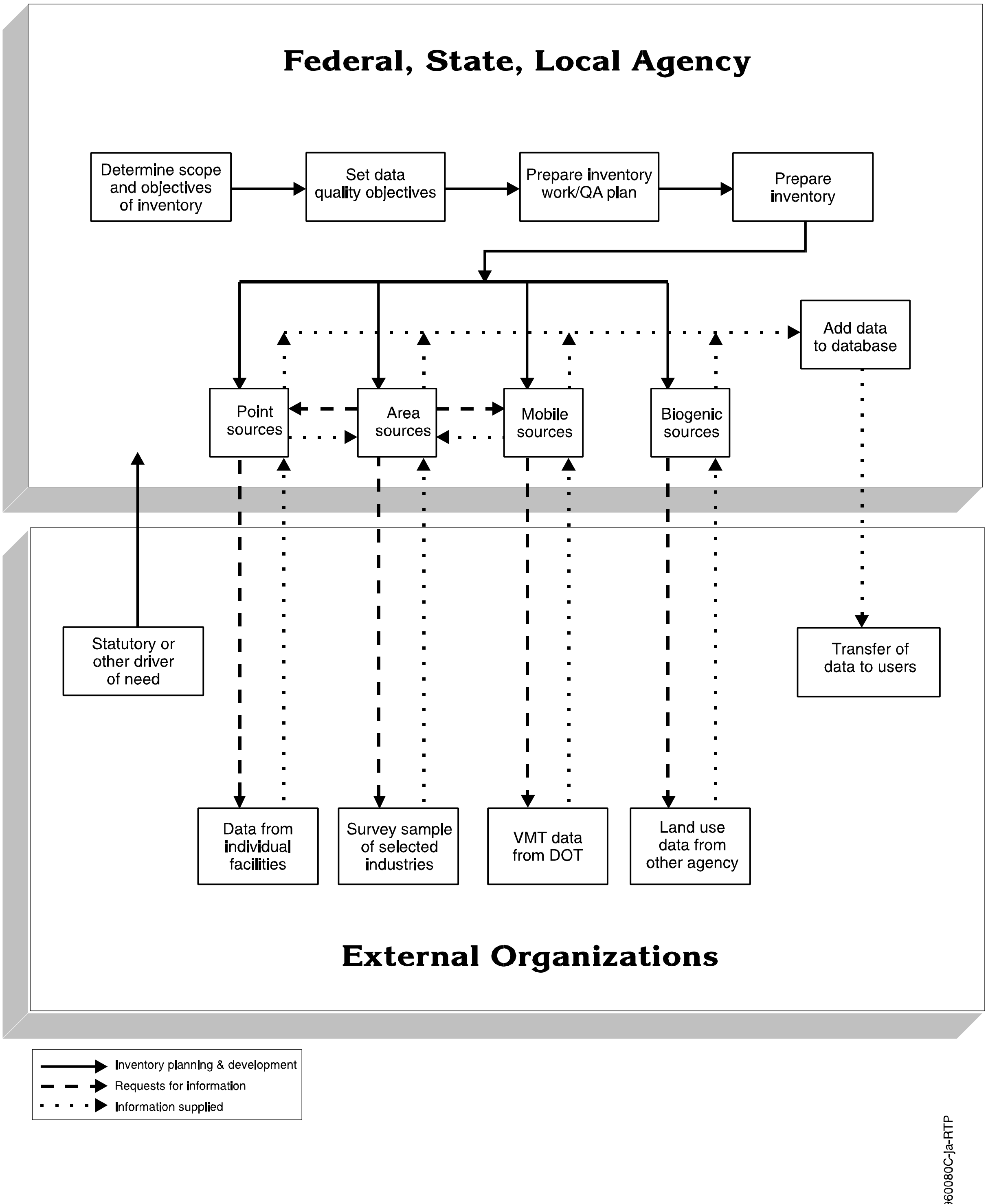

FIGURE 1.2-1. COMMUNICATION AND INFORMATION SHARING DURING INVENTORY PREPARATION

The flow chart emphasizes the importance of good communication both among members of the inventory staff as well as between different agencies and individuals. Careful planning will facilitate good communication. The activities associated with the planning process can be classified into five general groups:

- Defining the scope of the inventory including the pollutants, geographic boundaries, sources, and end uses;
- Planning the quality assurance and control activities and documenting them in a QA plan;
- Choosing the appropriate methods for calculating emissions and identifying the data needed;
- Identifying the appropriate types and comprehensiveness of the documentation and preparing an inventory work plan; and
- Developing a plan for collecting and managing the data.

Many of these activities are performed by personnel outside of the area source inventory group or are provided by others at the beginning of inventory development. Specific area source inventory concerns within each of these groups are described in the remainder of this section.

2.1 DEFINING THE SCOPE

The overall inventory planning process should result in defining the end uses for the data, the data quality objectives (DQOs) for the pollutants of interest, the geographic area to be inventoried, and the appropriate spatial and temporal resolutions of the data. The next steps in defining the area source inventory scope are to identify source categories to be inventoried and to ensure that the area source inventory will completely cover sources that are not being inventoried as point, mobile, and biogenic sources. Then the sources that will be included in the inventory should be prioritized to facilitate efficient allocation of resources.

To determine which area sources to include:

- Compile a comprehensive and exhaustive list of sources from guidance documents, other inventories, business directories, EPA guidance, and any other information on emissions activities in the inventory area;
- Prioritize the list based on the expected magnitude of emissions or some other measure of importance;
- Review the list carefully and eliminate any sources that are not relevant or are insignificant sources in the inventory region; and

- Define and develop a good understanding of the process and industries that make up the source.

Table 1.2-1 gives an example list of potential area source categories for a state's ozone precursor inventory. Early in the process, the inventory preparers should eliminate any sources that are not found within the inventory area. For example, volcanoes and geysers are rarely of concern in most states. However, it is not always possible to determine the applicability of a source without some research. The initial list should, therefore, be as comprehensive as possible so that no source is overlooked.

Sources should be prioritized based on their importance in the inventory. The agency's resources should be allocated preferentially to the sources that are most important for meeting the inventory objectives. The sources can be prioritized by checking previous or other agencies' inventories to identify the largest-emitting area sources. Alternatively, the end-users may specify the sources that are most important to them. High-priority sources will include those that are:

- Known or inferred significant contributors;
- Regulated sources;
- Sources under consideration for future regulation;
- Sources of specific, targeted pollutants (e.g., photochemically reactive VOCs); and
- Sources most likely to impact human health.

If the source list is prioritized on the basis of the largest area-source emitters, information from a previous inventory may be used. An example of a prioritized list is shown in Example 1.2-1.

2.2 THE QA PROGRAM

Before any area source emission calculations take place, data collection, data handling, emission reporting, and documentation procedures should be carefully planned. Volume VI of this series provides detailed discussions on general QA issues for planning and documentation of inventories. This section will focus on the planning issues, including QA planning, that specifically pertain to area source inventories.

An essential component of planning is the development of a QA plan that specifies all QA and quality control (QC) procedures to be followed in preparing the inventory. Early in the planning

TABLE 1.2-1

POTENTIAL AREA SOURCES (BY EPA TRENDS TIER 1 CODE) OF OZONE PRECURSOR EMISSIONS

Category (Tier 1 Code)	PM	VOC	NO_x	CO	HAPs	NH_3
Fuel Combustion - Electric Utility (01)						
Internal Combustion		✓	✓	✓	✓	✓
Fuel Combustion - Industrial (02)						
Coal	✓	✓	✓	✓	✓	
Gas	✓	✓	✓	✓	✓	✓
Internal Combustion	✓	✓	✓	✓	✓	✓
Oil	✓	✓	✓	✓	✓	✓
Other	✓	✓	✓	✓	✓	✓
Fuel Combustion - Other (03)						
Commercial/Institutional Coal	✓	✓	✓	✓	✓	
Commercial/Institutional Gas	✓	✓	✓	✓	✓	✓
Commercial/Institutional Oil	✓	✓	✓	✓	✓	✓
Residential Wood	✓	✓	✓	✓	✓	✓
Residential Other	✓	✓	✓	✓	✓	✓
Miscellaneous Fuel Combustion except Residential	✓	✓	✓	✓	✓	
Chemical and Allied Products Manufacturing (04)						
Inorganic Chemicals			✓		✓	
Organic Chemicals			✓	✓	✓	
Pharmaceuticals			✓		✓	
Polymers and Resins		✓				
Metal Processing (05)						
Ferrous Metals			✓	✓	✓	
Nonferrous Metals		✓	✓		✓	
Metals Processing NEC	✓	✓	✓	✓	✓	
Petroleum and Related Industries (06)						
Asphalt Manufacturing		✓	✓	✓	✓	
Oil and Gas Production	✓	✓	✓	✓	✓	
Petroleum Refineries and Related Industries		✓			✓	

TABLE 1.2-1

(CONTINUED)

Category (Tier 1 Code)	PM	VOC	NO_x	CO	HAPs	NH_3
Other Industrial Processes (07)						
Agricultural, Food, and Kindred Products	✓	✓	✓	✓	✓	✓
Machinery Products		✓	✓		✓	
Mineral Products	✓	✓	✓	✓	✓	
Rubber and Miscellaneous Plastic Products	✓	✓			✓	
Wood, Pulp and Paper, and Publishing Products	✓	✓	✓	✓	✓	
Construction	✓				✓	
Miscellaneous Industrial Processes	✓	✓	✓	✓	✓	✓
Solvent Utilization (08)						
Degreasing		✓			✓	
Dry Cleaning		✓			✓	
Graphic Arts		✓			✓	
Nonindustrial		✓	✓	✓	✓	
Other Industrial		✓			✓	
Surface Coating		✓	✓	✓	✓	
Solvent Utilization NEC					✓	
Storage and Transport (09)						
Bulk Terminals and Plants		✓			✓	
Organic Chemical Storage		✓			✓	
Petroleum and Petroleum Product Storage		✓	✓		✓	
Petroleum and Petroleum Product Transport		✓			✓	
Service Stations: Breathing and Emptying		✓			✓	
Service Stations: Stage I		✓			✓	
Service Stations: Stage II		✓			✓	
Waste Disposal and Recycling (10)						
Incineration	✓	✓	✓	✓	✓	
Industrial Waste Water		✓			✓	
Landfills		✓	✓	✓	✓	
Open Burning	✓	✓	✓	✓	✓	
POTWs		✓			✓	✓

TABLE 1.2-1

(CONTINUED)

Category (Tier 1 Code)	PM	VOC	NO_x	CO	HAPs	NH_3
TSDFs		✓	✓	✓	✓	
Other		✓			✓	
Natural Sources (13)						
Biogenic		✓	✓		✓	✓
Geogenic, Wind Erosion	✓	✓				
Miscellaneous (14)						
Agriculture and Forestry	✓	✓			✓	
Other Combustion (Structure Fires, Forest Fires, Slash Burning, Prescribed Burning, Managed Burning)	✓	✓	✓	✓	✓	
Catastrophic/Accidental Releases		✓			✓	
Health Services		✓			✓	
Agricultural Crops (Tillage)	✓				✓	✓
Paved Roads	✓					
Unpaved Roads	✓					
Other Fugitive Dust (e.g., Mining and Quarrying)	✓					

References: EPA. 1999. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

EPA. 2000. National Air Pollutant Emission Trends, 1900-1998. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

PM = Particulate matter
VOC = Volatile organic compounds
NO_x = Nitrogen oxides
CO = Carbon monoxide
HAP = Hazardous air pollutant
NH_3 = Ammonia

<u>Example 1.2-1</u>

Based on summaries of data submitted for the CAAA-mandated 1990 SIP VOC inventories, the following area sources reported in the Aerometric Information Retrieval System (AIRS) Area and Mobile Subsystem (AMS) are responsible for 90 percent of the VOCs from area sources:

- Architectural surface coating
- Gasoline service stations
- Consumer solvents
- Degreasing
- Auto refinishing
- Commercial pesticide application
- Industrial surface coating
- Graphic arts
- Dry cleaning
- Traffic marking
- Residential fuel use
- Open burning
- Managed burning and forest wildfires

Many of the above categories have subcategories that contribute to the total.

process, the area source inventory developers may be asked to specify estimation methods or QC procedures that will ensure that the inventory meets its DQOs. The agency should also include a discussion in the QA plan that addresses how QC checks will be used for the different emissions estimation methods. The inventory documentation should also clearly describe the QA and QC procedures, checks, and results. QA activities for a particular emissions estimation method may include a detailed review of the data sources, documentation of procedures, and the development of specific QC checks, such as verifying emissions calculations. Examples of QC checks can be found in Chapter 3 of EIIP *Quality Assurance Procedures* (Volume VI) and in Section 6 of this chapter.

The best possible emissions estimation method to use for a particular source can vary depending on the source category and local conditions. Within each source category, several estimation methods and emission factors may be available. The agency should identify in the inventory work plan the procedures it will use to ensure that the methods and emission factors used are the best choice considering the DQOs, the constraints on the inventory, and the priority of the source. The agency should identify the requirements for each method, including time frame, funds, data, and the availability of experienced personnel available for inventory preparation.

In planning the QA/QC program for area sources, the following elements should be considered:

- Ensure that double counting does not occur;

- Determine if temporal adjustment to emissions were done appropriately;

- Determine how the peak seasons for the inventory pollutants were defined; and

- Determine how emissions will be projected and the projection period, including end year and intermediate years for projection inventories.

Double counting is an especially important issue for area sources. It is caused by overlaps between inventoried area source categories, or overlaps between area source and point source categories. For example, emissions from large dry cleaners (major point sources) are included in an inventory. Emissions from small dry cleaners (below some specified cutoff) have been treated as an area source using a top-down estimation approach. The area source inventory must be adjusted downward by subtracting the major source contributions to avoid double counting. Double counting leads to inaccuracies in the final inventory and should be avoided.

The inventory work plan needs to identify and eliminate potential double counting of emissions with the following steps:

- Identify categories that have a point source component. The area source activity must be adjusted to account for point source activity in order to avoid double counting emissions; and

- Identify potential overlap among area source categories and document how to avoid it.

The QA plan should include procedures to ensure that these specified steps were done correctly.

2.3 EMISSION ESTIMATION METHODS

Emission estimation methods should be determined for each source during the planning phase. The choice of methods will be based on a number of factors, including agency resources, source category priority, and the information needs of the inventory. The preferred methods specified in this volume will yield a higher-quality estimate of emissions and should be used when a source is ranked as a high priority or when a specific local characteristic would skew the results obtained from an alternative method. In contrast, alternative methods usually will yield lower-quality estimates of emissions and are best used for source categories that are not highly prioritized.

For each area source category, the rationale for the method used should be stated in the work plan. This can be as simple as stating that the preferred method is from EIIP Area Source Preferred and Alternative Methods guidance. More explanation is warranted if the method used deviates from the preferred method. If alternative emission factors or activity data are available, the reason for using the factors or data chosen should be stated in the work plan. Similarly, any assumptions used in developing the activity data or emission factors should also be clearly stated.

Area sources subject to regulatory controls should be identified in the inventory planning process so that the appropriate control information will be collected. Control information may include the portion of the category affected by the regulation (rule penetration), the type of control, the amount of emissions that are controlled (control efficiency), and the estimated effectiveness of the control (rule effectiveness). Controls are discussed further in Section 4 of this chapter.

2.4 DOCUMENTATION

Documentation is an integral part of an emissions inventory, and is of critical importance for QA/QC activities. All inventory documentation should fulfill some basic requirement. The guiding principle is reproducibility. It should be possible for anyone reading the document to reproduce the results. Complete and well-organized documentation will result in a more reliable and technically defensible inventory. Internal review of the written documentation of an inventory's data sources and procedures by an agency's QA and technical personnel will uncover errors in assumptions, calculations, or methods.

More information on the role of QA/QC review of inventory documentation can be found in *Quality Assurance Procedures* (Volume VI) of this series. General guidance on documentation is given in Volume I. Area source inventories rely on more diverse types of data sources than any other type of inventory. It is very important that all sources be thoroughly documented, including databases or information from other agencies.

Reporting requirements for inventory data are usually specified by the agency or regulation requiring the inventory. In general, the data used to develop the input variables should be supplied if at all possible. For example, where employment in several standard industrial classification (SIC) Codes is summed to produce the activity parameter, the original employment data by SIC Code should be shown in an appendix unless prohibited by the size of the data set or confidentiality issues. Alternatively, if the data were derived from a published data set, the source should be referenced (supplying page and table numbers, if necessary). All conversion factors used should be explicitly stated.

If models are used in any part of the calculations, the input data used for the model should be provided. Any statistical analyses should also be clearly documented; the complete data set used and the output from the statistical analysis should be provided. Similarly, survey results should be provided in as much detail as possible along with, at a minimum, the survey questionnaire, the number of facilities surveyed, the percentage responding, and some descriptive statistics of the results.

Sufficient information should be given to document the completeness of the area source inventory. Categories excluded should be specified, and the reasons for their exclusion stated. Some explanation of the process used to identify source categories also must be provided.

In addition to text explaining the process used to develop the inventory, sample calculations should be provided. This is particularly important for complicated calculations or if several steps were required to develop the estimates.

Referencing of all data sources and assumptions is part of reproducibility. The sources of all data, methods, and assumptions should be fully documented. If the source is a person at a government agency, trade group, or other organization, that person's name, affiliation, and the date of the contact should be documented, at a minimum. Reports and other documents should be referenced by author (if known), year, title of document, publishing agency, and location. Documents published by most government agencies usually have an identifying number that should be included.

2.5 DATA COLLECTION/MANAGEMENT

To some extent, overall data management decisions are made by personnel who specialize in data consolidation and transfer, and the final repository of the area source data may not be under the control of the area source team. However, collection and management of data that will ultimately become part of the area source inventory are usually under the control of the area sources staff. Consider the following in planning data collection and management for an area source inventory:

- Determine the role of existing inventory data and ensure that any previously omitted data and sources have been identified;

- Select data collection methods that are most appropriate to the estimation methods; and

- Review overall inventory data management system requirements to ensure compatibility.

An important planning consideration is whether and to what extent information contained in existing emissions inventories can be used. Existing inventories should be examined to determine whether the appropriate emission sources have been included and if the emissions data represent current conditions. Existing inventories serve as a starting point for developing lists of sources. They also should provide extensive data and support information, such as documentation of procedures and data ranges for identifying outlier values. Simple sensitivity analyses of existing inventories can be used to prioritize categories and identify key data needs (see Section 6, *Sensitivity Analysis*, in Chapter 3 of Volume VI of the EIIP series).

The data for a new inventory may or may not be available from a previous inventory in the correct level of detail depending upon the objectives and degree of success of prior inventory efforts. Even though some data are not required in the basic inventory, an agency may find it expedient to collect additional information as part of a routine update of the inventory. If the agency anticipates the need for special data (for use in a photochemical model, for instance) it is more efficient to collect that data at the same time as the required data for the basic inventory.

Any needs or restrictions of the data management system should be identified in the planning phase and compared to the form of the information produced by the various emission estimation methods. The data management system will be used to store inventory information and to transfer the information to other users, such as photochemical modelers, so the further uses of this information should be considered. Issues of particular concern for area sources are mismatches in source identification codes, units, or levels of detail, and incompatibility between the data management system's data input formats and the format of the data generated by the area source estimation method. An example of the latter is when emissions are estimated using a computer model, but the data management system uses an emission factor and activity data.

3

EMISSION ESTIMATION APPROACHES

Emissions from area sources are nearly always estimated using some type of calculation procedure. Direct measurement of area source emissions is hardly ever practical because of technical and cost considerations. This section describes the methods that are commonly used to estimate area source emissions. There are four basic approaches for developing an area source emission estimate:

- Extrapolation from a sample set of the sources (surveys, permit files, or other databases);
- Material balance method
- Mathematical models; and
- Emission factors applied to activity levels. Detailed descriptions of emission estimation methods and example calculations for specific area sources are included in the following chapters of this volume.

As described in the previous section, an emission estimation approach should be chosen during the inventory planning phase and depends on inventory objectives, available resources (including availability of quality data needed), source category priority, intended use of the inventory, and the available methods for a source. Information needed for choosing emission estimation approaches is:

- The source's ranking in the prioritization scheme (see Section 2.1);
- The schedule for completing the inventory and the resources available;
- The level of detail needed (based on current or future regulations, knowledge about local differences, modeling and data storage needs, etc.); and
- Descriptions of the source categories and the methods that can be used to estimate emissions from them.

A list of decisions for choosing among area source methodologies is shown in Example 1.3-1.

Example 1.3-1

- Identify the priority sources for the inventory area;

- Assign resources based on prioritization of the sources;

- Investigate possible emission estimation methods for area sources;

    - Reject methods that obviously cannot be used (e.g., using a mathematical model or permit information for architectural surface coating).

- Compare the needs of the inventory with the information that the available methods produce;

    - The method calculates the pollutant at the required level of detail in terms of speciation, and temporal or spatial allocation; and
    - The method results reflect economic or regional differences that would affect emissions, (e.g., if the inventory area is mostly high-density housing with a lower than average per capita architectural coating use).

- Consider subcategorizing sources and using different methods for the subcategories;

    - Subcategorization of a source may allow more detailed estimation of the most significant portion of a source, and may be the most efficient way to achieve inventory goals of more accurate emission estimates, more detailed inventory information, or other quality goals that improve the estimate.

- If available methods vary in the amount of resources that they require, rank them according to the amount of resources that they need. Determine if the increase in needed resources is justified by an increase in accuracy or detail.

3.1 EXTRAPOLATING FROM A SAMPLE OR OTHER DATABASE

For many area sources, the EIIP preferred approach is to extrapolate from a sample set of data for the industry/activity to the entire population. This often requires a survey of a statistically valid sample set, but sometimes existing data sets can be used as a starting point. An agency may have files or databases that can be accessed for use in emissions inventory development. Permits are typically required for construction, startup, and modifications of an emission source. Permit applications generally include enough information about a potential source to describe the nature of the source and to estimate the magnitude of emissions that will result from its operations. Some permits also include source test data. These files are often used for point sources but may include information that is useful for area source estimation as well.

Permits for emissions of pollutants not included in a particular inventory can also be useful. Permits for emissions of air toxics may be useful to identify or characterize sources of VOCs, for example. Rules unrelated to air emissions may be useful if they require facilities to report information that could be used in the inventory. Title V permits, solid waste permits, and National Pollutant Discharge Elimination System (NPDES) permits could be useful sources of information. A category may be subdivided to use information where available and use another approach for the remaining sources.

If an agency has previously estimated emissions based on a survey of the industry, those data can sometimes be used to estimate emissions for the newer inventory. This may be as simple as applying a growth factor to the emissions, or it may require further adjustments to account for other changes in the industry. If possible, a survey of a representative cross-section of the sources should be used to update information. For example, more sources may be controlled than were previously, new types of controls may be in use, or processes may have changed.

For some source categories, an industry-wide survey may be warranted. If the category represents a significant proportion of emissions, has the potential for further controls, or is poorly characterized by other methods, the agency should consider surveying the population of sources. If this includes a very large number of facilities, a statistically valid sampling method can be used. Figure 1.3-1 illustrates the decision-making process that might be followed to arrive at this method.

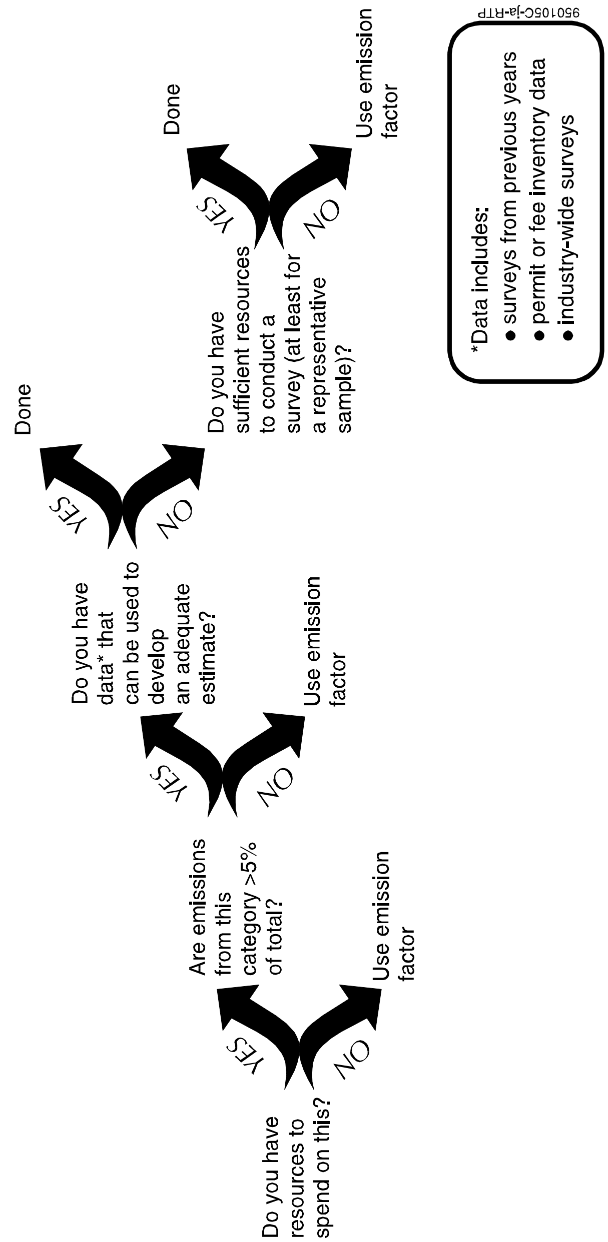

FIGURE 1.3-1. EXAMPLE DECISION TREE FOR CHOOSING AN ESTIMATION METHODOLOGY

3.2 MATERIAL BALANCE METHOD

An agency can, in some cases, use a material balance technique to develop emission factors or total emissions for an inventory period. For some sources, a material balance is the only practical method of estimating VOC emissions; it also can be the most accurate, especially when the balance covers the entire inventory period, and the nonair losses are small or easily quantified. Source testing of low-level, intermittent, or fugitive VOC exhaust streams can be difficult, costly, and highly variable in many instances. Emissions from these and other solvent evaporation sources are most commonly determined by the use of material balances.

Use of material balances involves the examination of a process to determine whether emissions can be estimated solely upon knowledge of operating parameters, material compositions, and total material usage. The simplest material balance assumes that all solvent used in a process will evaporate to become air emissions somewhere at the facility. For instance, for many surface coating operations, it can be assumed that all of the solvent in the coating evaporates to the atmosphere during the application and drying processes. In such cases, emissions equal the amount of solvent contained in the surface coating plus any added thinners and cleanup solvents.

Material balances are greatly simplified and very accurate in cases where all of the consumed solvent is emitted to the atmosphere. But many situations exist where a portion of the evaporated solvent is captured and routed to a control device such as an afterburner (incinerator) or condenser. In these cases, the captured portion must be measured or estimated by other means and the disposition of any recovered material must be accounted for. As a second example, in degreasing operations, emissions will not equal solvent consumption if waste solvent is removed from the unit for recycling or incineration. A third example is where some fraction of the diluent (which is used to liquify cutback asphalt, for example) is believed to be retained in the substrate (pavement) rather than evaporated after application. In these examples, a method of accounting for the nonemitted solvent is required to avoid an overestimation of emissions.

Material balances cannot be accurately employed at a reasonable cost for some evaporation processes because the amount of material lost is too small to be determined accurately. As an example, applying material balances to petroleum product storage tanks is not generally feasible because the losses are too small relative to the uncertainty of any metering devices. In these cases, using emission factors or equations from EPA's *Compilation of Air Pollution Emission Factors, Volume I: Stationary Point and Area Sources*, commonly referred to as *AP-42* (EPA, 1995), is recommended.

3.3 MATHEMATICAL MODELS

A model may be used to estimate emissions when emissions are not directly related to any one parameter. A model may be a simple equation, but is typically in the form of a computer program. This facilitates the processing of a large number of equations and interactions. Data requirements for models vary, depending on the model. Mathematical models used for predicting area source emissions attempt to reproduce the "real world" behavior of processes that generate emissions. A model will incorporate mathematical relationships derived from experimental data and/or some statistical or advanced computational intelligence technique. Models that have been thoroughly tested and validated should be capable of estimating area source emissions to a high level of accuracy. However, when using any model, please remember that the accuracy of the results will depend on the accuracy of the data entered into the model and the suitability of the model to the particular emissions source.

Some examples of available emissions models are shown in Table 1.3-1. All of these and other emission estimation models are available through the Clearinghouse for Inventories and Emission Factors (CHIEF) website. A detailed summary of these models may also be found in Volume II, *Point Sources*, of the EIIP series. See Section 3.4.2 of this chapter for more information about CHIEF.

3.4 EMISSION FACTORS

One of the most useful tools available for estimating emissions from area sources is the emission factor. An emission factor is an estimate of the quantity of pollutant released to the atmosphere as a result of some activity such as combustion or industrial production, divided by the level of that activity. In most cases, emission factors are expressed simply as a single number, with the underlying assumption that a linear relationship exists between emissions and the specified activity level over the probable range of application. Thus, emission factors may be thought of as simple forms of emission models where there is a direct relationship between emissions and a single parameter.

An emission factor relates a quantity of an air pollutant to a process parameter, or a surrogate parameter, so that if the parameter is known, an estimate of emissions can be made. For example, an emission factor in the form of pounds of VOCs per ton of solvent used in a process can be used to estimate VOC emissions from a source if the weight of the solvent used is known or can be determined. In this case, the emission factor and activity are parameters for direct estimation of emissions from a source. However, area sources sometimes are not easily estimated by a direct measure of throughput. In that case, an emission factor that is based on a surrogate measure for activity level such as population or employment in an industry will need to be devised.

TABLE 1.3-1

EMISSION ESTIMATION MODELS USEFUL FOR AREA SOURCES

Model Name	Description/Features	Contact/Reference
CHEMDAT8	• Estimates VOC emissions from TSDF processes. • Lotus 1-2-3® spreadsheet. • Default input parameters provided to demonstrate calculations.	Elaine Manning, EPA Emissions Standards Division, (919) 541-5499
WATER8	• Estimates emissions from wastewater treatment systems. • Menu-driven computer program.	Elaine Manning, EPA Emissions Standards Division, (919) 541-5499
Landfill Air Emissions Estimation Model (LAEEM)	• Estimates HAP, VOC, methane, and CO_2 emissions from a landfill. • Computer model. • Site-specific data can be entered; defaults (conservative) provided.	Susan Thorneloe-Howard, EPA Air Pollution Prevention and Control Division, (919) 541-2709
TANKS, version 2.0	• Estimates organic chemical emissions from storage tanks. • Variety of tank types included. • User enters site-specific data; defaults provided. • Computer model.	Info CHIEF (MD-14) United States Environmental Protection Agency Research Triangle Park, NC 27711,
MECHANICAL	• Estimates fugitive PM emissions from roads, materials handling, agricultural billing, and construction/demolition.	*Control of Open Fugitive Dust Sources*, EPA-450/388-008
WIND	• Estimates PM emissions from wind erosion.	*Control of Open Fugitive Dust Sources*, EPA-450/388-008

3.4.1 EMISSION FACTOR ACCURACY

Because emission factors are typically averages obtained from data with wide ranges and varying degrees of accuracy, emissions calculated this way for a given source are likely to differ from that source's actual emissions. Because they are averages, factors will indicate higher than actual emissions for some sources and lower than actual emissions for others. Only specific source measurement can determine the actual pollutant contribution from a source under conditions existing at the time of the test. For the most accurate emissions estimate, it is recommended that source-specific data be obtained whenever possible. This is rarely possible for area sources that represent a collection of sources in an area that are usually individually small. In an area source inventory, emission factors are appropriately used to estimate the collective emissions of a number of small individual sources that would be difficult or impossible to estimate using other methods. If factors are used to predict emissions from new or proposed sources, an agency should review the latest literature and technology to determine whether such sources would likely exhibit emissions characteristics different from those of typical existing sources.

When the information used to develop an emission factor is based on national data, such as a wide range of source tests or national consumption estimates, the inventory preparer should be particularly careful with potential local variations. Emissions calculated using national emission factors may vary considerably from actual values at a specific source or within a specific geographic area. National emission factors should be used either when no locally derived factor exists, the local mix of individual sources in the category is similar to the national average, or the source is a low priority in the inventory.

A locally derived emission factor is preferred when either a national-level emission factor does not account for local variations or the category is a high priority in the area. These emission factors are developed either thorough local surveys or measurements, are based on local consumption for solvent categories, or are adapted from emission information in permits or another inventory. Typically, the information gathering necessary for developing a local emission factor can be significant, but the benefits are that the emissions for the source will be well characterized, and the emission factor or the information used to develop it can be used in subsequent inventories.

3.4.2 EMISSION FACTOR REFERENCES

The following emission references may also be sources for other information needed for emission calculations, like VOC speciation, source controls, rule effectiveness and rule penetration, and fuel loading. Other databases and documents that contain emission factors for use in inventories are listed in the individual source methodology chapters.

Factor Information Retrieval (FIRE) System

The EPA's FIRE System is a consolidation of emissions estimation data (factors) for criteria and HAPs that currently includes the information contained in the EPA databases such as Crosswalk/Air Toxic Emission Factor (XATEF), the Air Emissions Species Database SPECIATE, and the AIRS Facility Subsystem (AFS), as well as emission factors from EPA documents such as *AP-42* and the EPA's Locating and Estimating (L&E) series of emission factor documents. These databases and documents are the basic sources of emission factors that have been used in the preparation of inventories, as well as economic analyses, permit preparation for Prevention of Significant Deterioration (PSD) and New Source Review applications, and other federal, state, and local agency assessments of air pollution sources.

Additional emission factors for FIRE have been collected from the literature, material balance calculations, and source tests. Each emission factor in FIRE includes information about the pollutant (Chemical Abstract Services [CAS] numbers and chemical synonyms) and about the source (SIC Codes and descriptions, and source classification codes [SCCs] and descriptions). Each emission factor includes comments about how it was developed in terms of the calculation methods and/or source conditions, as well as the references where the data were obtained. The emission factor also includes a data quality rating.

The FIRE database is divided into two main sections. One section contains all the emissions data as described above, as well as any additional data that are collected by the EPA. This section is called the “Repository Subsystem.” The other section will contains only a single emission factor that is recommended for each source/pollutant combination. This section is called the “Distribution Subsystem” and is provided to users for loading onto their own computers or local area network.

The FIRE database has been designed to be very user friendly. Data can be searched in many different ways and can be downloaded to print or data files, or can be printed in a report format that is designed by the user. The FIRE database can be downloaded from the EPA's CHIEF electronic system (see below). FIRE is also available in a compact disc read-only memory (CD-ROM) form from Air CHIEF (see below).

CHIEF

CHIEF is maintained by the Emission Factors and Inventory Group (EFIG) of EPA's Emissions, Monitoring and Analysis Division in Research Triangle Park, North Carolina. As a clearinghouse, CHIEF is the repository of the most up-to-date information on inventories and emission estimation data, such as emission factors. The original method of relaying this information to the public was through a newsletter. Currently, CHIEF maintains a site on the Internet, http://www.epa.gov/ttn/chief.

CHIEF contains all of the *AP-42* stationary source volume and draft revisions, the SPECIATE database, and the L&E series of documents, all of which can be used as sources of emission factors. CHIEF also contains the models mentioned in this section, the MOBILE5a model, and the AFS database.

Fax CHIEF

Fax CHIEF provides emission calculation information through fax.

Air CHIEF

Air CHIEF is designed to combine parts of the emission estimation information from CHIEF into CD-ROM. Currently, Air CHIEF includes some data from FIRE, the SPECIATE database, emission factors from *AP-42*, and the L&E documents. Copies of the Air CHIEF CD-ROM and the user's manual are available from the Emission Factor and Inventory Group, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711

AP-42

AP-42 compiles source descriptions, process descriptions, emission factors, and control information for processes resulting in emissions from combustion, waste disposal, solvent evaporation, industry and manufacturing, agricultural operations, and miscellaneous sources. *AP-42* is a primary reference for the information needed to estimate emissions.

EPA's Emission Factor Inventory Group recently released a major update and expansion of factors in *AP-42*, including a more detailed breakout of VOCs and other organic emissions by compound or compound class, PM, and additional factors for greenhouse gases where data are available. It is expected that this more detailed breakout of VOCs and other pollutants will better meet the needs of inventory compilers for generating speciated VOC, HAP, PM and greenhouse gas emission inventories.

A paper copy of the entire *AP-42* can be ordered from the Government Printing Office (GPO), Box 371954, Pittsburgh, Pennsylvania 15250-7954, Stock No. 055-000-00500-1, $56.00 total. Telephone orders can be made to (202) 512-1800, and orders by via facsimile to (202) 512-2250. *AP-42* can also be found on Air CHIEF. Sections of the *AP-42* can be downloaded from the CHIEF and by using Fax CHIEF. EPA's EFIG develops and maintains the *AP-42* series.

3.4.3 Updating Emission Factors

An updated emission factor may be needed when the rate of emissions from a source has changed relative to the activity. For instance, if industrial solvent use per employee has been reduced through the 1980s because of the substitution of water-based products, then an older employee-based emission factor will not reflect that change. The keys to developing an updated emission factor are:

- Identify the nature of the change;
- Estimate the amount of change in emissions;
- Apportion the emission factor to reflect the change, and
- Document the reasoning behind the change, the assumptions, and calculations used.

In the case of the altered solvent use Equation 1.3-1:

$$\frac{\text{New emission factor}}{\text{Old emission factor}} = \frac{\text{Current amount of solvent used in the process}}{\text{Old amount of solvent used in the process}} \qquad (1.31)$$

3.4.4 Emission Factor Calculations

Part of the appeal of the emission factor method is its simplicity. To calculate emissions, the activity and emission factor are multiplied. Corrections for rule effectiveness, rule penetration, and control efficiency, and seasonal adjustments or point source emissions still need to be applied. The calculation for emissions is shown in Equation 1.3-2:

$$\text{Emissions} = \begin{matrix}\text{Activity}\\\text{Level}\end{matrix} * \begin{matrix}\text{Uncontrolled}\\\text{Emission}\\\text{Factor}\end{matrix} \qquad (1.3\text{-}2)$$

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4

ADJUSTMENTS TO EMISSION ESTIMATES

In the previous section, emission estimation methods were discussed. This section presents general procedures for refining area source emissions estimates to account for point sources, emission controls, pollutant speciation, spatial and temporal allocation of emissions, and general information about projection of emissions estimates. In the simplest case of emissions estimation, area source emissions are estimated using Equation 1.3-2. In other cases, an emissions model may be used, which incorporates calculation procedures to account for some or all of the factors noted above.

Adjustments are needed to make emissions estimates reflect the local conditions that differ in some way from the average conditions on which an emission factor is based or for which an estimation model is designed. Adjustments may compensate for regional meteorologic differences or seasonal activity differences, or they may be used to weight the allocation of emissions to subdivisions of an area such as counties in a region or grid cells in a modeling domain. Emission estimates will sometimes need to be corrected to reflect emission controls or to show the effect of projected growth.

For maximum flexibility, it is desirable to perform these adjustments in separate, independent steps. This facilitates the ability to calculate emissions for different scenarios (e.g., different levels of control, different species profiles). Keeping each step separate allows one factor to be easily changed while all others are held constant. Inventory documentation also benefits from clear, discrete calculations using factors that are each well defined.

4.1 ACCOUNTING FOR POINT SOURCE EMISSIONS

When a point source inventory and an area source inventory estimate emissions from the same process, there is the possibility that emissions could be double counted. For example, emissions from large dry cleaning establishments may be included in the point source inventory. Emissions from small dry cleaners (below some specified cutoff) may be treated as an area source. The area source inventory must be adjusted to avoid double counting.

Certain area sources such as consumer solvent use and architectural surface coating do not require any point source adjustments, but many other source categories should at least be examined for possible double counting. Examples of area sources that may share processes with point sources are shown in Table 1.4-1.

TABLE 1.4-1

SOURCE CATEGORIES THAT MAY HAVE AREA AND POINT SOURCE CONTRIBUTIONS[a]

Process	**Category Examples**	**AMS Source Category Codes**
Fuel Combustion		
	Electric Utilities	21-01-
	Industrial Fuel Combustion	21-02-
Industrial Processes		
	Chemicals and Allied Products	23-01-
	Metals Production	23-03- 23-04-
	Rubber and Plastics	23-08-
	Oil and Gas Production	23-10-
	Mineral Processes, Mining and Quarrying	23-25-
	Construction/Demolition	23-11-
	Machinery	23-12-
	Petroleum Refining	23-06
Solvent Utilization		
	Graphic Arts	24-25-
	Surface Coating	24-01-
	Dry Cleaning	24-20-
	Degreasing	24-15-

TABLE 1.4-1

(CONTINUED)

Process	Category Examples	AMS Source Category Codes
Storage and Transport		
	Petroleum and Petroleum Product Storage and Transport	25-01- 25-05-
	Organic Chemical Storage and Transport	25-10- 25-15-
	Inorganic Chemical Storage and Transport	25-10- 25-15-
	Rail and Tank Car Cleaning	25-**-***-900
Waste Disposal, Treatment and Recovery		
	Commercial and Industrial Incineration	26-01-
	Industrial and Municipal Open Burning	26-10-
	Wastewater Treatment	26-30-
	TSDFs	26-40-
	Scrap and Waste Materials	26-50-
	Landfills	26-20-
Miscellaneous Sources		
	Cooling Towers	28-20-
	Health Services	28-50-
	Firefighting Training	28-10-035-
	Engine Testing	28-10-040-

[a] Common examples based on AIRS source codes are listed. Any category could include point sources. Coordination between point and area source inventory developers is required to ensure that all sources are properly accounted for.

If the potential for double counting exists, the area source emission estimate must be adjusted. This is best done by subtracting the point source activity from the total activity as shown in Equation 1.4-1:

$$\text{Area Source Activity} = \text{Total Activity of Source Category} - \text{Sum of Point Source Activity} \qquad (1.4\text{-}1)$$

From Equation 1.4-1, area source activity represents whatever activity is not accounted for as point source activity. Area source activity is estimated by subtracting out the point source activity total.

Where area source emissions are calculated using employment data, the employment at the point sources should be subtracted from the inventory region employment to give the area source employment. If the exact employment at the point sources is unknown, it can be approximated using *County Business Patterns*.[a] Details of this procedure are provided in the relevant area source category sections of this volume.

If the resulting area source activity is less than zero, the point source data should be reviewed for errors and any errors found should be corrected. If area source activity is still less than zero, then the area source activity is assumed to be equal to zero. The geographic area for which this adjustment is done may have an effect on the results. Subtracting state totals is less likely to produce negative results than subtracting at the county level, for example, especially if data were collected at the state level. Often, the county-level data used for each source has been allocated to counties using a surrogate. Thus, the county-level data are less reliable.

Sometimes the activities used to calculate point and area source emissions for the same category are not similar. Emissions from area sources are often estimated using surrogate activity factors, such as population, while for the comparable point sources direct measurement or direct activity applied to several emission factors may be used. The area source emission factor may also be combined with activity data in order to estimate total uncontrolled emissions (for point as well as area sources). This results in emissions estimates for total uncontrolled emissions (developed using the area source emission factor) plus the emissions calculated for the point sources using point source methods. In these cases, total and point source uncontrolled emissions can be used to estimate the contribution of uncontrolled area sources as Equation 1.4-2 shows:

$$UAE_A = \begin{bmatrix} \text{Total} \\ \text{Uncontrolled} \\ \text{Emissions} \end{bmatrix} - \begin{bmatrix} \text{Uncontrolled} \\ \text{Point Source} \\ \text{Emissions} \end{bmatrix} \qquad (1.4\text{-}2)$$

[a] See the most recent publication, which can be obtained from the U.S. Bureau of Census, Department of Commerce, Washington, D.C.

where:

UAE_A = uncontrolled area emissions of pollutant A

Please note that this equation takes into account the difference in the level of control between area and point sources. When activity levels are adjusted for their point source components before area source emissions are calculated, it is unnecessary to subtract out point source controls.

4.2 CONTROL, RULE EFFECTIVENESS, AND RULE PENETRATION

Inventories performed before 1987 assumed that regulatory programs would be implemented with full effectiveness, achieving all required or intended emissions reductions and maintaining the reduction level over time. However, experience has shown regulatory programs to be less than 100 percent effective for most source categories in most areas of the country.

Control efficiency (CE), rule effectiveness (RE), and rule penetration (RP) are applied to an area source emission estimate if regulations are in place that affect any of the individual sources within a source category. CE, RE, and RP are used to estimate the effect of controls being applied in an imperfect world. Sources that are completely uncontrolled do not have CE, RE, or RP applied.

4.2.1 CONTROL EFFICIENCY

CE is the emission reduction efficiency, and is a percentage value representing the amount of a source category's emissions that are controlled by a control device, process change, or reformulation. For area sources in particular, controls can vary widely. CE values for area sources represent the weighted average control for the category.

4.2.2 RULE EFFECTIVENESS

RE is an adjustment to the CE to account for failures and uncertainties that affect the actual performance of the control. For example, control equipment performance may be adversely affected by age of the equipment, lack of maintenance, or improper use. A default value of 0.80 for RE is recommended by EPA if information cannot be acquired to substantiate the true value of RE.

Although RE reflects the assumption that regulations are rarely 100 percent effective, when controls are irreversible process changes or reformulations, RE can be set to 100 percent.
RE can be developed for area sources in the following ways:

- Assume an 80 percent default value for all sources;
- Perform a survey (with EPA approval for SIP inventories) to determine a source-specific RE value; or
- Use a Stationary Source Compliance Division (SSCD) (now Office of Enforcement and Compliance) Protocol Study specific to a category and geographic area, and in accordance with SSCD procedures to calculate RE.

Alternative methods of developing RE values should be approved by the statutory authority guiding or dictating the inventory requirement.

4.2.3 RULE PENETRATION

RP is the percentage of the area source category that is covered by the applicable regulation or is expected to be complying to the regulation. The RP value can be based on a percentage of the source that is regulated, a cutoff level, or regulation of an activity. Both RE and RP are applied to entire source categories when calculating area source emission estimates.

RP is a measure of the extent to which a regulation covers a source category. For example, regulations on gasoline underground tank filling may apply only to stations above a specified size cutoff, or the regulation may apply to facilities built after a certain date. Rule penetration is calculated by Equation 1.4-3:

$$\text{Rule Penetration} = \frac{\begin{array}{c}\text{Uncontrolled Emissions}\\ \text{Covered by Regulation}\end{array}}{\text{Total Uncontrolled Emissions}} * 100 \qquad (1.4\text{-}3)$$

For example, if a rule only affects sources built since 1987 and 20 percent of the facilities have been built since that time, then RP is equal to 0.2. Default values are not feasible for RP because it is highly category- and location-dependent.

4.2.4 EXAMPLE SHOWING APPLICATION OF CE, RP, AND RE

Area source controls are less common than point source controls except in a few large urban areas. Area sources that are most likely to be controlled are:

- Industrial surface coating;

- Gasoline marketing (Stage I);
- Cutback asphalt use;
- Surface cleaning;
- Autobody refinishing;
- Automobile refueling (Stage II);
- Architectural surface coating;
- Open burning; and
- Printing processes.

If an area source is controlled, emissions are calculated by Equation 1.4-4:

$$CAE_A = (EF_A)(Q)\ [(1 - (CE)(RP)(RE)] \qquad (1.4\text{-}4)$$

where:

CAE_A = Controlled area source emissions of pollutant A
EF_A = Uncontrolled emission factor for pollutant A
Q = Category activity
CE = % Control efficiency/100
RP = % Rule penetration/100
RE = % Rule effectiveness/100

Alternatively, in the case where only uncontrolled area source emissions are known, such as those where the point source correction has been made, Equation 1.4-5 can be used to calculate controlled area source emissions:

$$CAE_A = (UAE_A)\ [(1 - (CE)(RP)(RE)] \qquad (1.4\text{-}5)$$

where:

UAE_A = Uncontrolled area estimate of pollutant A

The values for RE and RP need to be known to perform these calculations.

In practice, Equations 1.4-4 and 1.4-5 are difficult to apply in some situations. CE is not always clear-cut and must sometimes be calculated. Table 1.4-2 lists example sources where special consideration is required when calculating area source VOC emissions because of difficulty determining CE and, in some cases, RP, as well. CE, RE, and RP for these source categories are discussed in their respective methodology chapters. Where CE, RE, and RP for a source category require special consideration, this is also discussed in its respective methodology chapter.

TABLE 1.4-2

EXAMPLES OF AREA VOC SOURCES REQUIRING SPECIAL CONSIDERATION WHEN CALCULATING EMISSIONS

Special Calculation Issue	Example Sources
VOC content control device by regulation	Architectural Surface Coating Industrial Surface Coating Autobody Refinishing Commercial/Consumer Solvent Use Emulsified Asphalt Paving
Activity is banned	Cutback Asphalt Paving Open Burning
Controls reduce consumption, not emission rate	Degreasing (Surface Cleaning)
Emission factor based on control device emissions	Gasoline Stage I Marketing (Submerged Balance Fill Method) Automobile Refueling (Stage II) Landfill Flares

4.2.5 TEMPORAL ADJUSTMENTS

Temporal adjustments are made because of seasonal differences in the rate of emissions or activity, or to apportion emissions to a particular season, day or hour. The need to make these adjustments will be based on the needs for the particular inventory. A SIP ozone inventory, for instance, will need to have emissions either calculated for just one typical ozone season day, or have emissions corrected for the season, and apportioned for the typical ozone season day.

The best method to get the most accurate emission estimates for an inventory day or period is to directly collect the emission information or the activity data for that particular time period.

Because area source inventories rarely have sufficient resources to do this detailed level of data collection, the preferred method for temporal adjustment is the one that produces the most accurate activity or adjustment factors for a source category reflecting the inventory time period and locality. If a survey is being used to collect emission or activity data, then the questionnaire can also be used to gather information about working hours and production for the inventory time period. Other less direct sources of information, such as state or national business and labor statistics, or Department of Energy statistics, may also be used, but may not reflect local variations. If no information is available that is recent or representative of local conditions, then national average adjustment factors can be used. These approaches are discussed further in the following section.

4.2.6 Seasonal Activity

Source activity for many categories fluctuates on a seasonal basis. Because emissions are generally a direct function of source activity, seasonal changes in activity levels should be examined. For all categories, seasonal variations in activity must be considered if seasonal or daily emissions are to be estimated. A VOC inventory covers an ozone season typically defined as the months of June, July, and August. A carbon monoxide (CO) season will be the coldest months of the year, December, January and February. The months covered by an ozone or CO season may vary by region. Emission factors for some categories may also be dependent on seasonal variables. The type of information needed to calculate emissions depends on the source category and the desired temporal resolution of the emissions estimates.

Some operations, such as architectural surface coating, might be more active in the warmer months in some inventory regions because of the warmer weather, and may be more active because there are more hours of daylight for the activity. In some cases, a activity may take place *only* during the warmer months. On the other hand, some sources, because of summer vacation shutdowns or decreased demand for the product, may be less active during the ozone season. Such sources (e.g., residential heating), may exhibit greater activity in colder months and, thus, emissions are greater for a typical CO season. However, many sources, particularly industrial facilities, will show no strong seasonal change in activity and little adjustment will need to be made to estimate the seasonal emissions component.

An important seasonal variable is temperature. Sources such as petroleum product handling and storage operations, breathing losses from fixed-roof tanks, and loading of rail tank cars, tank trucks, and marine vessels are significantly influenced by temperature changes. Empirical formulas and reference tables can be found in *AP-42* to calculate these losses, and the TANKS model can be used to estimate emissions from fixed-roof storage tanks under varying temperatures.

There are several other source categories with emissions that are affected by variations in temperature for which temperature-dependent equations are not currently available. EPA is currently investigating methods for use in future inventories to estimate these emissions that will reflect the effects of both temperature and vapor pressure. For more information, contact the EPA Emission Factor and Inventory Group at (919) 541-4676.

4.2.7 Activity Days per Week

If daily emissions are to be calculated, the activity days per week must be identified so they can be used in the emission equation. For most industrial sources, the number of days per week is five. For many consumer or commercial activities, six or seven days are generally used. Table 1.4-3 shows the activity days per week for some common area source categories.

4.2.8 Calculations for Temporal Adjustments

Seasonal or percent period throughput, discussed above, is required to calculate daily or seasonal emissions. Of course, the best situation is to obtain activity data that are specific for the season of interest.

The best way to calculate daily or seasonal emission estimates is to obtain activity data that are specific for the season of interest. However, if this is not possible, an estimate of seasonal activity can be calculated using an adjustment factor applied to the annual activity. In cases where a surrogate activity factor is used to calculate emission estimates, an adjustment factor is applied to the calculated annual emission estimates. Factors for making seasonal adjustments may be expressed as fractions, percentages, or ratios. Thus, an adjustment factor is typically expressed as:

- A fraction: seasonal activity factor (SAF) representing the amount of annual activity or emissions within a period (such as 4/12 = 0.33);

- A percentage: percent period throughput, the percent value of the SAF for a period (such as 0.33 * 100 = 33); or

- A ratio: seasonal adjustment factor, the ratio of seasonal activity or emissions to average period activity or emissions (such as 0.33/0.25 = 1.33).

For example, if a VOC source category has one third more emissions during the 3-month ozone season than the rest of the year, the SAF would be 0.33, the percent period throughput would be 33 percent, and the seasonal adjustment factor would be 1.33. If annual estimated emissions are 2,000 tons of VOCs, the calculation for the ozone season using a SAF (0.33) would be as shown in Equation 1.4-6:

$$\begin{aligned} AE_{VOC,O} &= 0.33 * 2{,}000 \text{ tons VOCs} \\ &= 666 \text{ tons VOCs} \end{aligned} \qquad (1.4\text{-}6)$$

TABLE 1.4-3

AREA SOURCE SEASONAL ACTIVITY FACTORS AND DAYS PER WEEK FOR THE PEAK OZONE AND CO SEASONS

Area Source	Seasonal Activity Factors: Ozone	Seasonal Activity Factors: CO	Activity Days Per Week
Gasoline Service Stations			
Tank Trucks in Transit	Seasonal variations in throughput vary from region to region. Use average temperature for a summer day where appropriate.		6
Tank Truck Unloading (Stage I)			6
Vehicle Fueling (Stage II)			7
Storage Tank Breathing Losses			7
Solvent Usage			
Degreasing	0.25		6
Dry Cleaning	0.25		5
Surface Coatings			
Architectural	0.33		7
Auto Refinishing	0.25		5
Other Small Industrial	0.25		5
Graphic Arts	0.25		5
Cutback Asphalt	Refer to local regulations and practices		
Pesticides	0.33		6
Commercial/Consumer	0.25		7
Waste Management Practices			
POTWs	0.35		7

TABLE 1.4-3

(CONTINUED)

Area Source	Seasonal Activity Factors		Activity Days Per Week
	Ozone	CO	
Hazardous Waste TSDFs	0.30		7
Municipal Landfills	0.25		7
Stationary Source Fossil Fuel Use			
Residential	0.08	0.43	7
Commercial/Institutional	0.15	0.35	6
Industrial	0.25	0.25	6
Solid Waste Disposal			
On-site Incineration	0.25	0.25	7
Open Burning	Refer to local regulations and practices	Refer to local regulations and practices	7
Structural Fires	0.20	0.33	7
Field/Slash/Prescribed Burning	Refer to local regulations	0.10	7
Wildfires	Refer to local fire conditions	0.05	7

where:

$AE_{VOC,O}$ = Area emissions of VOCs for ozone season

The calculation using a percent period throughput factor would be quite similar as shown in Equation 1.4-7:

$$AE_{VOC,O} = 33/100 * 2{,}000 \text{ tons VOCs} = 666 \text{ tons VOCs} \quad (1.4\text{-}7)$$

However, the calculation using the seasonal adjustment factor must take the number of months into account, as shown in Equation 1.4-8:

$$AE_{VOC,O} = 1.33 * (3/12 * 2{,}000 \text{ tons VOCs}) = 666 \text{ tons VOCs} \quad (1.4\text{-}8)$$

Further adjustments to the emission estimate would be made to calculate a daily emission estimate. To determine daily emission estimates from facilities with uniform annual production or throughput, the Equation 1.4-9 can be used:

$$\text{Typical Annual Emissions per day} = \frac{\text{Emissions per year}}{\left(\text{Operating days/week}\right)\left(\text{Operating weeks/year}\right)} \quad (1.4\text{-}9)$$

For sources that require a seasonal adjustment, seasonal daily emission estimates can be calculated as in Equation 1.4-10:

$$\text{Typical Seasonal Emissions per day} = \frac{\text{Emissions per season}}{\left(\text{Operating days/week}\right)\left(\text{Operating weeks/season}\right)} \quad (1.4\text{-}10)$$

An example calculation of a peak ozone season daily emission estimate where the peak ozone season is the 3 months of summer, is shown in Equation 1.4-11:

Example:

Annual Emissions = 1.3 tons of VOCs
SAF = 0.28 (28 percent)
Peak Ozone Season = 0.25 (25 percent or 3 months)
Operating Schedule = 6 days per week, 52 weeks per year

$$\text{Typical Ozone Season Daily Emissions} = \frac{\left(\frac{1.3 \text{ tons}}{\text{year}}\right)\left(\frac{2{,}000 \text{ lb}}{\text{ton}}\right)\left(\frac{0.28}{0.25}\right)}{(6 \text{ days/week})\ (52 \text{ weeks/year})} = 9.3 \text{ lb VOCs per day} \qquad (1.4\text{-}11)$$

Table 1.4-3 shows default SAF values for some area source categories.

In some cases the season affects the calculation of emission factors, rather than, or in addition to, activity factors. The volatility of VOCs depends partly on temperature so that the temperature relationship must be included in emission factor calculation.

It is important to bear in mind that although temperature enters into many different calculations, the temperature used may vary depending on the source category. For gasoline distribution emission factors, the temperature of the product--not the ambient temperature--is the input variable. However, as an example, the evaporative losses from automobile gas tanks (usually included in the mobile sources) may use temperatures closer to ambient. Therefore, although some coordination of seasonal variables is needed, the values used may not necessarily be the same for all area sources in the inventory region.

If an agency wishes to develop its own SAF, it must establish the peak period (in number of months) for its area, choose the inventory year for its investigation, identify the sources within the source category under consideration, and develop an approach for collecting seasonal activity information for these sources. Approaches include questionnaires, researching more recent SAFs, or researching trade groups, or labor or economic statistics.

A questionnaire for collecting SAF information should request data for the inventory year, including annual process activity data, peak period activity data, and, if possible, the emission factor or estimate. The agency can then develop its own seasonal activity factor for the source category for any inventory season using the following equation:

$$\text{SAF} = \left[\frac{\text{Peak Period Activity}}{\text{Annual Activity}}\right] * \left[\frac{\text{Months of Inventory Season}}{\text{Months of Peak Activity}}\right] \qquad (1.4\text{-}12)$$

This SAF can then be applied to annual activity information to estimate seasonal emissions, just as *AP-42* emissions factors are applied to estimate annual emissions. The SAF can be converted to the percent period throughput (PPT) by multiplying by 100.

A study to improve and augment existing temporal allocation factors using data from more current data sources has been completed by EPA's Office of Research and Development (EPA, 1994). This study developed new temporal allocation factors and amended previous allocation factors for a significant number of point source categories to better represent the intended source categories. Information was gathered from the literature, state and local regulatory air pollution agencies, and other government and private organizations. In many cases, source test data were used to develop the new or improved temporal allocation factors files. When the point source process and the area source category are well matched, point source factors would be suitable to use for an area source emission inventory.

The report (EPA, 1994) describes all of the available data in detail. A temporal allocation factor file, based on the results of the study, is available from the Emissions Characterization and Prevention Branch, Research Triangle Park, North Carolina (phone: (919) 541-4593). Temporal allocation factors for seasonal, weekday/Saturday/ Sunday and hourly periods are recorded for most AIRS AFS SCCs and AIRS AMS area source category codes.

These data may be used as default factors for temporal allocation when no local data are available. For the most part, the area source factors represent temporal allocation factors that were derived for the 1985 National Acid Precipation and Assessment Program (NAPAP) national emissions inventory.

Labor and economic statistics can also be used to develop default temporal allocation factors. The statistics are published on varying temporal resolutions: seasonally, monthly, and weekly. Data may be supplemented by industry surveys for further temporal resolution to an hourly basis. The basic assumption is that operating or economic statistics are surrogate indicators of industrial processes releasing pollutants. For example, the number of hours worked by employees or the industry's production rate are assumed to be directly related to that industry's potential emissions during that time frame.

The following data sources may provide sufficient information to support development of temporal allocation factors:

- Business and labor statistics data;
- Department of Energy data pertaining to production/consumption from various energy industries;
- State source test reports;
- State stationary source operating schedule data;

- Waste-to-energy data;[a]
- *Business Statistics*;[b]
- *Employment and Earnings*;[c] and
- *Commodity Research Bureau Year Book.*[d]

4.3 SPATIAL ALLOCATION

Spatial allocation factors can be applied to the activity levels used to calculate emission estimates, or the emission estimates themselves. An instance when activity may need to be allocated to a smaller geographic area would be when state-level gasoline sales need to be apportioned to the county level. Spatial allocation of emissions estimates is done when the emissions need to be assigned to a more specific and smaller area. This may need to be done when using the information from a base year SIP inventory for an air quality model that needs gridded emissions data, or when activity data apply to a larger area than that needed for the inventory. The techniques for allocating activity and emissions are typically the same for a particular source category and emissions estimation method.

Area source inventories are often prepared for state or county geographical extents. In some cases, it may be desirable to allocate these emissions to smaller individual geographic areas, either subsections of a county or grid cells for use in a model. The amount of effort required to implement this resolution will vary depending on the type of source. Emissions that have been estimated by an individual facility may be reported to within a fraction of a kilometer in the existing inventory; hence, assigning emissions from these sources to the appropriate grid cell is simple.

By contrast, spatial resolution of more diffuse area source emissions requires substantially more effort. Two basic methods can be used to apportion area source emissions to grid cells. The most accurate (and resource-intensive) approach is to obtain area source activity level data directly for each grid cell. This information is possible to collect when the activity data are of a

[a] Found in the annual *Resource Recovery Yearbook, Directory and Guide*, Governmental Advisory Associates, Inc., New York, New York.

[b] Obtained from the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C.

[c] Obtained from the Bureau of Labor Statistics, U.S. Department of Labor, Washington, D.C.

[d] Obtained from the Commodity Research Bureau, Chicago, Illinois.

type that can be directly assigned to a specific geographic area. Examples of these types of activity data would be population when detailed census data are available, or land use that can also be assigned to grid cells. This approach is the preferred approach, when it can be used. The alternative (and more commonly employed) approach is to apportion the county-level emissions from the existing annual inventory to grid cells using representative apportioning factors for each source type.

This latter approach requires:

- Identification of a spatial surrogate indicator of emission levels or activity such as population, census tract data, or type of land use for each grid cell that is appropriate for the source category;
    - A surrogate apportioning factor takes the place of the actual activity level, but is assumed to be a reasonable indicator of the actual activity level.
- Creation of apportioning factors based on the distribution of these spatial surrogates; and
- Application of these factors to the county-level emissions.

These steps will yield estimates of emissions from that source category by grid cell. The process can also be applied to state or regional activity or emissions to yield activity or emissions at the county or subcounty level. The major assumption underlying this method is that emissions from each area source behave spatially in the same manner as the spatial surrogate indicator. In developing spatial apportioning factors, the agency should emphasize the determination of accurate factors for the more significant sources. The purpose of the inventory and the capabilities of the agency may also need to be considered when choosing an apportioning method. For most large urban areas, local planning agencies can provide the agency with detailed land use or population data, or in some cases employment statistics at the subcounty level; these data can be used to spatially apportion most of the area source emissions in the inventory.

A Geographical Information System (GIS) can be a useful tool in handling spatially distributed data. A GIS uses sophisticated computer technology to store, retrieve, analyze, update, and display spatially arranged data (maps). This type of system can locate each point source, define the boundaries around each area source, and map road networks. Map coverages are available in digital formats from transportation departments, tax offices, planning/zoning offices, and emergency response agencies. Information stored in a GIS can be the most direct method of spatially allocating activity data and may allow the use of more detailed surrogates that would be too labor-intensive to use without a GIS. In most cases, using a GIS with good quality map coverages and well-chosen surrogates will be the preferred spatial allocation method.

Further information about the potential applications of the GIS technologies in emissions inventory preparation can be obtained from the Air Quality Modeling Group of the EPA Office of Air Quality Planning and Standards (OAQPS) and the EPA Office of Research and Development (ORD), both in Research Triangle Park, North Carolina; local colleges or universities with geography, civil engineering, or natural sciences departments; state and local land/resource management agencies or environmental protection agencies; and private organizations that provide mapping services.

Commonly used spatial surrogate indicators include land use parameters, employment in various industrial and commercial sectors, population, and dwelling units. Different surrogate indicators may be used to apportion emissions for the various area source categories depending on which of the available indicators best describes the spatial distribution of the emissions. EPA guidance and good engineering judgment should be used to select appropriate indicators for apportioning area source emission totals. Local authorities should be contacted to verify the applicability of the source category/spatial surrogate indicator pairings for a particular inventory region.

The table in Example 1.4-1 lists example spatial allocation surrogate indicators for area source categories as utilized in various urban areas. These indicators could be used to spatially apportion emissions from these source types in the absence of more detailed or locally specific data; however, the agency should make a special effort to choose spatial surrogate indicators for the various source categories that accurately reflect the distribution of activity for those sources in the inventory region. Other references that contain useful information for developing spatial resolution for some specific source categories are:

- *Census of Business Selected Services Area Statistics* (for county-level gasoline handling source categories);[a] and

- *Sales of Fuel Oil and Kerosene* (for state-level commercial and institutional fuel combustion).[b]

Other resources, which will be addressed in detail below, include land use patterns (from maps and/or computerized databases) and Census Bureau demographic statistics by traffic zone or census tract. Planning, land use, and transportation models are already in use in many regions, a and can provide the agency with much of the data necessary to allocate emissions. Local agencies and metropolitan planning organizations should always be contacted during the

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[a] Obtained from the U. S. Department of Commerce, Bureau of the Census, Washington, D.C.

[b] Obtained from Mineral Industry Surveys, Bureau of Mines, Washington, D.C.

Example 1.4-1

EXAMPLE SPATIAL ALLOCATION SURROGATE INDICATORS FOR SELECTED AREA SOURCE CATEGORIES

Emissions Category	**Surrogate Indicators**
Residential fuel combustion	Housing
Commercial/institutional fuel combustion	Urban land use
Industrial fuel combustion	Urban land use
Gasoline marketed	Population, VMT
Unpaved roads	County area, land use
Unpaved airstrips	County area, airport location
Forest wildfires	Composite forest
Managed burning--prescribed	Composite forest
Agricultural operations	Agricultural land use
Structural fires	Housing
Degreasing	Population, employment
Dry cleaning	Population, employment
Graphic arts/printing	Population, employment
Rubber and plastic manufacturing	Population, employment
Architectural coating	Population, employment
Auto body repair	Population, employment
Motor vehicle manufacturing	Population, employment
Paper coating	Population, employment
Fabricated metals	Population, employment
Machinery manufacturing	Population, employment

Example 1.4-1

(CONTINUED)

Emissions Category	Surrogate Indicators
Furniture manufacturing	Population, employment
Flat wood products	Population, employment
Other transportation equipment manufacturing	Population, employment
Electrical equipment manufacturing	Population, employment
Ship building and repair	Water proximity, employment
Miscellaneous industrial manufacturing	Population, employment
Miscellaneous solvent use	Population, employment
Publicly owned treatment works (POTWs)	Population, employment
Cutback asphalt paving operation	Population, VMT
Fugitive emissions from synthetic organic chemical manufacturing	County area, employment
Bulk terminal and bulk plants	Population, employment
Fugitive emissions from petroleum refinery operations	Population, employment
Process emissions from bakeries	Population, employment
Process emissions from pharmaceutical manufacturing	Population, employment
Process emissions from synthetic fibers manufacturing	Population, employment
Crude oil and natural gas production fields	Population, employment
Hazardous waste treatment, storage, and disposal facilities (TSDFs)	Population, land use

inventory planning process to determine what planning models are being utilized and how the data available from these models can be used in the emissions inventory effort. Trying to independently develop all the necessary information that should be available from local planning boards requires much redundant effort on the part of the agency. Additionally, any subsequent conclusions drawn from the inventory might likely be challenged if there is inconsistency with other information available to the public.

4.4 APPLYING GROWTH FACTORS FOR PROJECTIONS

General projection issues for inventories are discussed in Volume I of this series.
Area source projections can be made using local studies or surveys or through surrogate growth indicators, such as Bureau of Economic Analysis (BEA) data, to approximate the rise or fall in indicators activity. The most commonly used surrogate growth indicators are those parameters typically projected by the local metropolitan planning organization (MPO) such as population, housing, land use, and employment. Regardless of the growth indicator employed, the calculation is the same: the ratio of the value of the growth indicator in the projection year to its value in the base year is multiplied by the area source activity level in the base year to yield the projection year activity level.

The EIIP Projections Committee has developed a series of guidance documents containing information on options for forecasting future emissions. You can refer to these documents at http://www.epa.gov/ttn/chief/eiip/project.htm.

If activity is not used in emission calculations, which would be the case if base year emissions were measured directly, or material balance methods or mathematical models are used, then a growth factor reflecting the change from the base year to the projection year can be calculated.

The purpose of developing a projection inventory is to either determine the emissions reductions that will be needed to attain air quality standards or to project future compliance. In general, projection year emissions are based on base year allowable emissions, but in certain circumstances, it may be appropriate to use base year actual emissions. For CAAA 15 percent Rate of Progress (ROP) Plans, actual emissions can be used for source categories that are currently subject to a regulation and for which the state does not anticipate subjecting the source to additional regulation, or for source categories that are currently unregulated and are not expected to be subject to future regulations.

Actual emissions are based on a source's actual operating hours, production rates, and control equipment for processes at the source. Allowable emissions are based on the expected future operating rates or throughput and maximum emissions limits. Maximum emission limits may be process-based emissions factors, capture and/or control device efficiencies, or emission rate limits. Emission factor limits and capture and/or control device efficiency limits should take

Example 1.4-2

EXAMPLE GROWTH INDICATORS FOR PROJECTING EMISSIONS FOR AREA SOURCES

Source	Growth Indicators	Information Sources
Gasoline marketing	Projected gasoline consumption	MOBILE fuel consumption model
Dry cleaning	Population: retail service employment	Solvent suppliers; trade associations
Degreasing (Cold cleaning)	Industrial employment	Trade associations
Architectural refinishing	Population or residential dwelling units	Local MPO
Automobile refinishing	Industrial employment	BEA
Small industrial surface coating	Industrial employment	BEA
Graphic arts	Population	State planning agencies; local MPO
Asphalt use: Paving	Consult industry	Consult state DOT and industry
Asphalt use: Roofing	Industrial employment; construction employment	Local industry representatives
Pesticide applications	Historical trends in agricultural operations	State department of agriculture; local MPO
Commercial/Consumer solvent use	Population	Local MPO; state planning agencies
POTWs	Site-specific information	State planning agencies
Hazardous waste TSDFs	State planning forecasts	State planning agencies: local MPO
Municipal solid waste landfills	State Waste Disposal Plan	Local MPO; state planning agencies

Example 1.4-2

(CONTINUED)

Source	Growth Indicators	Information Sources
Commercial/Industrial fuel combustion	Commercial/Institutional employment; population	Local MPO; land use projections
Industrial fuel combustion	Industrial employment (SIC Code 10-14, 50-51); or industrial land use	Local MPO; land use projections; state planning agencies
Construction equipment	Industry growth (SIC Code 16)	Local MPO
On-site incineration	Based on information gathered from local regulatory agencies	Local agencies; state planning agencies; local MPO
Fires: Managed burning agricultural field burning, frost control (Orchard heaters)	Areas where these activities occur	U.S. Forest Service, state agricultural extension office
Forest wildfires	Historical average	Local, state, and federal forest management officials
Structural fires	Population	Local MPO; state planning agencies

precedence over emission rate limits when they are available. In determining the maximum emissions limit, existing regulations must be considered in addition to future planned regulations.

A major difference between making area source projections for the basic, county-wide inventory and for a detailed, photochemical inventory is that, in the latter, emission estimates must be resolved at the grid-cell level. This adds a dimension of complexity to the projection effort, since changing growth patterns may require that different apportioning factors be determined for the projection years. Fortunately, in most large urban areas where photochemical models are employed, the local MPO will be able to provide land use maps, as well as detailed zonal projections of employment, population, etc., for future years. Hence, these projections can be used directly, as described above, to determine changes in spatial emission patterns.

If the surrogate indicators used for apportioning certain area source emissions are not projected at a subcounty level, engineering judgment must be used to decide whether spatial distributions of various activities will change enough to warrant the effort of identifying new patterns. Changes may be warranted in rapidly growing areas for the more important area source emitters. For regions where little growth is expected, and especially for minor area sources, the same apportioning factors can be used in baseline and projection inventories.

5

DATA COLLECTION AND MANAGEMENT

Data management comprises data collection, data storage, and updates to the database, as well as the planning and QA/QC of the process. The collection and storage of data, particularly as it applies to area sources, is addressed in this section. The development and implementation of surveys as a data collection method merit particular attention in this section. Inventory QA/QC is addressed in Volume VI of this series, *Quality Assurance Procedures*, and in Volume I of this series, *Introduction to the EIIP*.

5.1 DATA COLLECTION AND STORAGE

5.1.1 DATA RESOURCES

Area source inventory data can come from a number of diverse sources. Surveys and agency pollution files are methods typically used for point sources that may also be useful in collecting data for area source emissions, activity, and control data. Other commonly used area source data resources are U.S. Census Bureau documents such as *County Business Patterns, Census of Agriculture, Census of Manufactures, and Current Industrial Reports*; documents and reports from other federal agencies such as the Energy Information Administration (EIA); locally collected activity information, trade contacts, journals, and databases; and data compilations such as the Frost & Sullivan *Industrial Solvents* report or the *Chemical Marketing Reporter*. Accessing these types of market research reports is discussed below. Sources for inventory procedural guidance include *AP-42* and guidance manuals such as this one. Data sources for source category characterization include EPA reports such as Background Information Documents (BIDs), Control Technique Guidelines (CTG) documents, Locating and Estimating (L&E) documents, emission model manuals, Technical Support Documents (TSDs), Alternative Control Techniques (ACT) documents, and *AP-42*.

Market research reports are one source for information on the past sales of, and future trends in the use of, different products. Occasionally, these reports can be found in a business school library or large university library, but because they can be quite expensive, not many libraries collect them. On-line bibliographic utilities such as Knight Ridder's DIALOG, offer databases containing the full text of market research reports. These databases include Freedonia Market Research, BCC Market Research, and Frost & Sullivan Industrial Solvents.

Some state libraries offer on-line literature search services, and should be able to locate the information needed. If not, information brokers who do literature searches for a fee will be able to help. These services can be found in the telephone directory under the headings "Information Brokers," "Information Processing and Retrieval Systems & Services," or "Information Search and Retrieval."

Rather than purchasing an entire report, the librarian or information broker can retrieve the information needed, usually at a fraction of the cost of the whole report. On-line computer charges for the databases listed above run about $60.00 per hour plus $16.00 per item typed or printed out (as of July 1995).

Because charges are usually based on time spent on-line plus the per-item cost, it helps to be as precise as possible in explaining information needs to the librarian or information specialist. Some background on the context of the request (i.e., how the information is to be used) can be very useful and cost-effective.

5.1.2 DATA HANDLING

Typically, the data used for area source emissions estimates are retrieved from a variety of sources. Data collection methods for area sources vary much more than those for point sources. Specific data collection methods and data sources are provided for a number of area source categories later in this volume. Often, data availability (or unavailability) determines the method that must be used to estimate emissions.

If the area source inventory is being prepared by more than one person, coordination is needed to assure consistency of activity data and to avoid duplicating effort. A table showing the area source category, estimation procedure, activity data needed, and activity data source should be prepared. Table 1.5-1 gives an example for a hypothetical ozone inventory. Note that categories may use common activity data; for example, emissions for three source categories can be calculated using population data. Where alternative sources of information exist, the preferred source of information should be identified and used consistently throughout the inventory.

All data collected, regardless of the source, should be documented and logged into a central file. In particular, information gathered over the telephone needs to be well documented in writing, including the date of the call and the names of the participants. These procedures are covered in more detail in the Volume I of this series. It is very important to begin data collection as soon as possible because obtaining data is not always straightforward. If the data are not already published, contacting the right person and then eliciting the information in the required format can take weeks or even months.

TABLE 1.5-1

ACTIVITY DATA EXAMPLE SOURCES FOR AN OZONE INVENTORY

Area Source Category	Estimation Procedure	Activity Data	Source of Activity Data
Commercial/Consumer Solvent Use	Per capita	Population	U.S. Census data
Architectural Surface Coating	Survey	Gallons of paint	Paint manufacturers
Gasoline Distribution	Gasoline consumption	Gallons of gasoline	State Department of Transportation (DOT), State Energy Office
Industrial Surface Coating	Per employee	Employment by SIC	State Labor Department
Surface Cleaning Operations	Per employee	Employment by SIC	State Labor Department
Dry Cleaning Operations	per employee	Employment by SIC	State Labor Department
Automobile Refinishing	Per capita	Population	U.S. Census data
Graphic Arts Facilities	Per employee	Employment by SIC	U.S. Census data
Asphalt Paving	Consumption	Barrels of asphalt	State DOT, paving contractors
Traffic Paints	Consumption	Gallons of paint	State DOT
Agricultural Pesticides Application	Application rate, acres of crops	Crop type by acre, types of pesticides	State Agriculture Office, U.S. Department of Agriculture (USDA)
Commercial Bakeries	Per capita	Population	U.S. Census data

TABLE 1.5-1

(CONTINUED)

Area Source Category	Estimation Procedure	Activity Data	Source of Activity Data
Structure Fires	Per fire	Number of fires	Fire marshall
Municipal Landfills	Statistical models	Tons of refuse, landfill age	State Solid Waste Management Agency
Residential Fuel Combustion	Fuel use	Amount of fuel used	State Energy Office, Energy Information Administration (EIA)
Industrial Fuel Combustion	Fuel use	Amount of fuel used	State Energy Office, EIA
Commercial/Institutional Fuel Combustion	Fuel use	Amount of fuel used	State Energy Office, EIA
Petroleum Vessel Loading/Unloading	Petroleum products loaded/unloaded	Gallons of fuel	Port Authority, Waterborne Commerce
Aircraft Refueling	Aviation fuel consumption	Gallons of fuel	State Energy Office, airports
Wastewater Treatment	Surface impoundment modeling system (SIMS)	Gallons of wastewater and portions of industrial wastewater	Publicly owned treatment works (POTW) operators
Hospital Sterilizers	Per hospital bed	Hospital beds	State Health Department
Forest Fires	Acres burned	Acres burned	State Forester
Breweries	State beer production	Barrels of beer	State Commerce Office, trade groups

TABLE 1.5-1

(CONTINUED)

Area Source Category	Estimation Procedure	Activity Data	Source of Activity Data
Barge, Tank Car, Railcar, Drum Cleaning	Survey	Vessels cleaned, material cleaned out of vessels	Trade groups, drum-cleaning facilities
Medical Waste Incinerators	Survey	Waste incinerated	State Health Department
Asphalt Roofing Kettles	Per square paper	Material throughput	Trade groups
Orchard Heaters	Fuel consumption	Amount of fuel used	Extension agents, agricultural schools
Distilleries	Distilled spirits production	Barrels of spirits	State Commerce Office, trade groups
Agricultural/Slash Burning	Acres burned	Acres burned	Extension agents, agricultural schools
Wineries	Wine production	Barrels of wine	State Commerce Office, trade groups
TSDFs	Survey	Material type, material throughput, treatment type	State Environmental Office
Superfund Sites	Survey	Material type, material throughput, treatment type	State Environmental Office
Open Burning	Survey	Occurrence of burning	State Environmental Office

In addition to those staff members usually responsible for compilation and maintenance of emission inventories, the agency should enlist the services of: (1) a computer programmer or systems analyst to plan the storage and manipulation of the large amounts of emission data needed, (2) an urban or regional planner to analyze land use data from local planning agencies, and (3) a chemist familiar with the various classes of chemicals that will need to be speciated into the individual components.

5.1.3 DATA STORAGE

Computerized data handling is preferable to paper files for large areas with diverse sources. Computerized data handling becomes significantly more cost-effective as the database, the variety of tabular summaries, or the number of iterative tasks increase. In these cases, the computerized inventory requires less overall time involvement and has the added advantage of forcing organization, consistency, and accuracy.

Some activities that can be performed efficiently and rapidly by computer include:

- Printing mailing lists and labels;
- Maintaining status reports and logs;
- Calculating and summarizing emissions;
- Performing error checks and other audit functions;
- Storing source, emissions, and other data;
- Sorting and selectively accessing data; and
- Generating output reports.

Phone logs, paper copies of notes, references, and other noncomputerized data should be stored in a project file that allows access by the inventory staff and safety from loss. The inventory staff should be issued notebooks that are used exclusively for the inventory preparation. These notebooks can become a useful history of the inventory process.

Additional data management concerns are discussed in the following sections.

5.1.4 NECESSARY DATA ELEMENTS

The data elements needed for a source category will be determined by the emission estimation method and the information requirements of the inventory. The inventory preparer should check the EPA website (http://www.epa.gov/ttn/chief/) for the latest information (codes) available to characterize emission estimates from the source category. A complete list of Source Classification Codes (SCC) can be retrieved at http://www.epa.gov/ttn/chief/codes/.

Available codes and process definitions influence and help guide the preparation of emission estimates for a category. Data transfer formats should be taken into account when an inventory preparer plans for data collection, calculation, and inventory presentation. Consistent categorization and coding will result in greater continuity between emission inventories for use in regional and national scale analyses.

5.1.5 SPECIAL ISSUES

For modeling inventories that are more detailed in terms of speciation and spatial or temporal allocation, additional data may need to be collected for assigning emissions to grid cells, for determining temporal distributions, or for selecting the appropriate speciation factors to be assigned to the compound classes. Ideally, emissions data (including speciation information) would be available for each source for each hour of any day selected. In practice, however, this degree of detail is neither necessary nor practical for all sources because of the inordinate amount of effort required to procure such data and because for many sources and applications inclusion of these data would have little effect on the end use of the data.

As a general rule, the maximum degree of source category resolution from the annual inventory should be maintained in the modeling inventory. For example, if separate emissions estimates have been prepared for dry cleaners using perchloroethylene and dry cleaners using petroleum-based solvents, this distinction should be maintained in the modeling inventory because it will permit more accurate speciation of the emissions associated with these sources.

Some area source categories may be treated as point sources in a modeling inventory; other source categories may be represented in both the point and area source inventories depending on the emissions cutoff level used to make this distinction. The agency should be aware of all such distinctions for the existing inventory and may need to institute certain changes to ensure that the modeling inventory meets its objectives.

Projection inventories also require collection of data beyond that needed for a base-year inventory. The primary difference is the need for growth factors and indicators, which are applied to the base-year emissions, as discussed in Section 4.4 of this chapter.

5.1.6 NATIONAL EMISSIONS INVENTORY (NEI) INPUT

If the category emissions data will be transferred to EPA for incorporation into the national criteria and toxics air pollutant inventory, specific data transfer formats are acceptable. The acceptable data transfer format(s) are described and available for download at http://www.epa.gov/ttn/chief/net/. The acceptable data transfer formats contain the data elements necessary to complete the data set for use in regional or national air quality and human exposure modeling. The inventory preparer should review the area source portion of the acceptable file format(s) to understand the necessary data elements. The EPA describes its use and processing of the data for purposes of completing the national inventory, in its Data Incorporation Plan, also located at http://www.epa.gov/ttn/chief/net/.

5.2 SURVEYS

For some area source categories, a survey of a representative sample of facilities within the source category may be necessary. Although it is beyond the scope of this document to thoroughly address survey and sample design, guidance on conducting area source surveys is provided in Chapter 24 of this volume, "*Conducting Surveys for Area Source Inventories*."

6

INVENTORY QUALITY AND UNCERTAINTY

The EIIP QA guidance stresses the importance of distinguishing between data quality and uncertainty. Area source emissions estimates tend to be more uncertain than point sources; given this, the data quality can (and should) be high. Inventory data quality is specified in the data quality objectives (DQOs), and is attained by following a prescribed set of QC and QA activities. The details of developing DQOs and QA plans, and QA/QC methods are covered in Volume VI of this series.

The Data Attribute Rating System (DARS) has been developed as a tool to rate emission inventories. A description of the system and the EIIP recommendations for its use can be found in Appendix F of EIIP Volume VI, Quality Assurance Procedures. The following discussion uses the DARS rating system as a way to compare the estimation approaches presented in this chapter and analyze their strengths and weaknesses.

6.1 QA/QC DATA VERIFICATION PROCEDURES FOR AREA SOURCE INVENTORIES

In this section, some QA/QC issues particularly relevant to area sources are discussed. In general, QA/QC procedures for an area source inventory involves (1) data verification to ensure that the information being used is complete, accurate, and current and produces reasonable estimates; (2) checks of data entry to minimize transcription errors when data are entered into an electronic format, and (3) calculation checks to verify that arithmetic errors were not made.

Data verification involves the use of QA procedures at critical stages in the inventory development to ensure that completeness, consistency, double counting, and reasonableness evaluations are conducted. The procedures usually are facilitated by using checklists (see Figure 1.6-1). The QA procedures also should be described in the inventory report. Data validation procedures can be implemented manually or electronically. The QA Plan should state how and when these will be used during the inventory process.

Completeness Checks

Completeness checks are designed to ensure that all emission sources have been represented in the inventory. Manual completeness checks may include comparing the agency's list of area

Inventory Identification____ Assessed By ___
________________________ Date _____________________

Provide the information requested along with the corresponding resource document [ref] or data. After completing the checklist, indicate the actions to be taken, deadline for completion, and date the actions are completed.

SOURCE CATEGORY:

Defined before data collection? [ref] _______________ Yes No

Were definitions adhered to during data collection? Yes No

Inclusive of all listed pollutants? [ref] ______________________ Yes No

____

POINT SOURCE CUTOFFS:

Identified during data collection? [ref] ___________ Yes No

Documented and reported to people involved in area source inventory? Yes No

______________________ ______________________
Report ID

Date

SURVEY RESULTS:

Was the response rate determined? ______________________ Yes No

rate

Was the percentage of missing information per returned survey estimated? Yes No

____
percent

EMISSIONS CALCULATIONS VERIFICATIONS:

Were nonreactive VOC emissions excluded from each source category emissions estimates? [ref] ____________________________ Yes No

EPA recommended estimation methodology used? Yes No

____
____
____

FIGURE 1.6-1. INTERNAL SOURCE CATEGORY CONSISTENCY AND ACCURACY CONTROL CHECKS

Emissions calculations checked? ______________ ___________ Yes No

checked by date

Are equations explicitly shown? [ref] ________________________ Yes No

REASONABLENESS CHECKS:

Were magnitudes of calculated emissions compared with other source categories? Identify second source reference or reference location of data in file. [ref] ______________________________________ Yes No

Were magnitudes compared with national/state ranks of source categories? Yes No

___________________________ ____________________

compared by date

Were other inventories and/or national averages compared to AIRS? List other inventories or reference data in master file. Yes No

Were findings reported and documented? Yes No

SOURCE DATA:

Were area source activity data reliability verified using available data sources? _______________________ _________________ Yes No

verified by date

Are emissions factor sources documented? ___________________ Yes No

where

Are local emission factors within national range? [ref] ____________ Yes No

Were facilities whose emissions and activity levels are known compared against generic emission factors to check emission factor reasonableness? _______________ _______ ____________ Yes No

compared by date project file no.

Are assumptions documented for scaling-up source category emissions and seasonal adjustment factor corrections? [ref] _______________ Yes No

Were point sources subtracted from area source emissions estimates?

[ref] ____ Yes No

Are point source corrections to area source emission estimates documented in the category calculations? [ref] _________________ Yes No

Use the worksheet on page 3 of 3 to record the actions to be taken in response to any problems found. Set a deadline for the completion of the action and indicate when the actions are implemented.

FIGURE 1.6-1. (CONTINUED)

INTERNAL SOURCE CATEGORY CONSISTENCY
AND ACCURACY QUALITY CONTROL CHECKS (Continued)

Actions To Be Taken	Deadline	Completion Date

FIGURE 1.6-1. (CONTINUED)

sources with the area source categories shown in Section 2 of this chapter, or comparing with independent listings (local business directories) of facilities by source category to ensure that all the significant types of sources in the metropolitan statistical area (MSA) are included.

Consistency Checks

Consistency checks for data should also be implemented by the agency. Figure 1.6-1 is an example inventory consistency and accuracy checklist. These example consistency checks for a VOC inventory are designed to ensure that: (1) the same geographic area was used for all source categories; (2) only reactive VOCs were counted in the inventory; (3) potential double counting of point and area source categories was taken into consideration; and (4) the use of emission factors, units of measurement, year(s) of data and information, and apportioning and distribution techniques were consistent. The agency's plan to implement these checks should be included in the QA Plan.

Double Counting

An important data verification step is to ensure that double counting of emissions does not occur in the inventory. Double counting can occur because of overlaps between point and area source inventories, and overlaps in area source groups. Inventory preparers should compare their lists of point and area emission sources to see if any emission sources have been inventoried under both point and area inventory tasks. If the emissions from a process at a facility are included in both the point and area inventories, then the area source inventory should be adjusted downward to exclude the emissions calculated for this facility's process in the point source inventory.

Overlaps in area source calculations can be minimized by careful definition of the emission sources covered by each grouping, and an understanding of the processes that take place at a source. For example, a category whose emissions are estimated using material balance may account for 100 percent of the solvent used by a facility. However, some of the solvent may actually be disposed of in wastewater and as solid waste in a landfill. Emissions estimated from the wastewater and landfill categories, then, would include a double counting of the emissions from these solvents.

Further discussion of the correction for double counting can be found in Section 4, *Adjustments to Emission Estimates*, of this chapter.

Reasonableness

The data obtained or calculated for the inventory also should be checked for reasonableness. Reasonableness checks--which should not be confused with consistency checks--are needed to ensure individual data element values and emission estimates fall within reasonable or acceptable ranges. The primary method to check for reasonableness is the comparison of the data collected with that from similar inventories or inventories from previous years.

The following questions should be considered by agency staff members, peer reviewers, and QA personnel to ensure that all data provided are reasonable:

- Were the data representative of the region being inventoried?
- Is the information up to date? If not, can reliable adjustment factors be found?
- Are data from an appropriate time frame used (e.g., annual, or CO and ozone seasons)?
- Are the collection techniques documented?

Data Entry Errors

Once the data are in the inventory format, individual data elements should be checked for data entry errors. Error checks can be random checks of a small percentage of the entries, with a higher percentage of checks being made if errors are found. All entries should be subject to error checks. Errors to check for will include missing entries, typographical errors, and misassignment of codes.

6.2 QA/QC FOR INVENTORY CALCULATIONS

Calculations should be done with computerized spreadsheets as much as possible to reduce errors. If handwritten calculations are necessary, they should be performed on worksheets or in project notebooks. Calculations should be peer reviewed for accuracy and checked to ensure that all emission and activity factors are used correctly. The agency should identify in the QA Plan (see Section 2, *Inventory Planning*) how the following QC steps will be ensured and who will perform the QA audits:

- Equations are accurately used and are consistent within each method or procedure; if not consistent, a justification is provided;
- Assumptions and engineering judgments used in the calculations are documented and reviewed;
- Correct units are used and unit conversions are accurate;

- Calculations are reviewed for data entry problems, such as transposition of digits and entering of incorrect numbers into calculators or computers;

- Procedures used to record calculations are consistent; and

- Misinterpretation of either the emission factors or their use is not done.

Random selection and duplication of calculations should be an integral part of the QC evaluations. The number or percentage of calculations that should be checked depend on the difficulty and importance of the source and the DQOs. If significant errors are found, the number of checks should be increased. In addition, the process used to derive the calculations should be checked. The frequency of these checks will depend on staff experience, staff size, inventory size, etc.

Another QA audit procedure for calculations is to check that all assumptions and engineering judgments used in the calculations are recorded in the project notebooks. The notebooks should contain all of the calculations used to develop the inventory and should contain the references for the data sources. The auditor should be able to perform QC checks on the calculations solely from the information recorded. If the data are calculated using computers, a hard copy of the program or algorithms used for all calculations and input files should be maintained in the project files.

The use of a computerized system for calculations can facilitate the QA process by assisting in inventory submittal tracking, edit checking, and data and calculation review. Chapter 3, Section 5, of EIIP Volume VI, describes some automated checks and audit tools that can be built-in to spreadsheets or database programs. CHIEF should be checked periodically for new QA information or software.

6.3 UNCERTAINTY IN AREA SOURCE INVENTORIES

Area source emissions are generally held to be highly uncertain and less accurate than point source emission estimates. While both criticisms are somewhat warranted, they are probably overstated in many cases. The first step towards reducing the uncertainty associated with area source emissions is to understand the causes of variability and inaccuracies in area source emission estimates. As this discussion indicates, although some uncertainty is unavoidable in area sources inventories, it can be minimized.

To better understand the sources of uncertainty in area source emissions, it is necessary to identify uncertainties associated with specific aspects of the estimation methods. Basically, three general forms of uncertainty are potentially applicable: variability, parameter uncertainty, and model uncertainty. Table 1.6-1 summarizes the discussion and provides examples of each

TABLE 1.6-1

SOURCES OF UNCERTAINTY IN AREA SOURCE EMISSION ESTIMATES

Source of Uncertainty	Examples	Ways to Minimize
Variability	• Fluctuation in VOC emissions for pesticide use caused by environmental conditions. • Daily/weekly variations in activity (dry cleaner, commercial fuel combustion, individual surface coating, etc.). • Seasonal variability in activity (residential fuel combustion). • Process or activities included in the category are not uniform (e.g., product formulations vary).	• Quantify variability if possible. • Make sure averaging time of emission factor and activity are appropriate for temporal scale of inventory. • If possible, subdivide category to create more uniform subcategories.
Parameter Uncertainty		
Measurement errors	• Incorrect response on a survey form. • Misclassification of data (e.g., facility in SIC Code group that does not accurately define activities).	• QA audits of survey data.
Sampling error	• Inadequate sample size. • Underlying data not normally distributed.	• Ensure adequate sample size by increasing response rate or increasing distribution of survey. • Consider distribution of data in sample design and statistical analysis.

TABLE 1.6-1

(CONTINUED)

Source of Uncertainty	Examples	Ways to Minimize
Systematic error	• Inherent bias in a survey (for example, if only largest facilities are surveyed and they do not reflect activities at smaller facilities). • Incorrect assumption (such as assuming 100% compliance with rules and ignoring rule effectiveness).	• External review of methods and assumptions by a qualified expert on the industry. • Make sure that characteristics of source population are understood and accounted for in methods.
Model Uncertainty		
Surrogate variables	• Use of population or number of employees as surrogate for emission activities that do not correlate to those surrogates.	• Use surveys of local sources instead. • Develop emission factors based on statistically correlated surrogate.
Exclusion of variables/model oversimplification	• Potentially a problem for area source estimates based on emission factors or models.	• Validate model for specific use if possible (i.e., use model to predict a known value). • Avoid use of oversimplified methods if at all possible.

type of uncertainty. More information on uncertainty can be found in EIIP Volume VI, Chapter 4, *Evaluating the Uncertainty of Emission Estimates*.

6.4 VARIABILITY

Uncertainty is often equated with variability, which is the natural fluctuation in the value of a variable. These are nonrandom fluctuations although they may appear random if the causal mechanisms are unknown. Emissions due to the application of pesticides, for example, are highly variable. They are affected by the volatility of the solvents in the pesticide, meteorological conditions, the amount of vegetation sprayed, and the effect of biological organisms (some of which metabolize the pesticide). Pesticide use and other area sources that are affected by biological or other environmental processes are extreme examples of variable sources. However, most sources show some sort of temporal variation because of variability in activity patterns. For example, residential fuel consumption is higher in the winter than in the summer. Commercial or industrial activity may be greater on weekdays than on weekends.

Preferred area source methods should minimize uncertainty due to variability whenever possible. For most sources, the main source variability is in the temporal fluctuations in activity, and is usually greatest on a daily or weekly basis (e.g., weekday versus weekend activity rates). Some sources vary significantly between years, particularly if they are driven by extreme events (spills, for example).

Good area source inventories will minimize the uncertainty due to temporal variability by assuring that factors and activity data match the scale of the inventory. If factors or activity have to be scaled up or down, adjustments must be made that account for temporal variability. Similarly, any other adjustments to the calculation to account for variability should be made.

6.5 PARAMETER UNCERTAINTY

Parameter uncertainty is caused by three types of errors: measurement errors, sampling errors, and systematic errors (nonrandom errors). Measurement errors occur because of the imprecision of the instrument or method used to measure the parameters of interest. Where emissions are measured directly, the measurement error of a particular method is usually known; EPA typically uses the concept of relative accuracy to describe the performance of a measurement method (or device) with respect to a EPA Reference Method. A more common measurement error for area sources occurs from misclassification. For example, area source categories are frequently identified by SIC Code group, and the number of employees or facilities in a particular SIC group are used as the activity data. However, some SIC groups encompass a wide variety of industrial processes and activities, not all of which are emissions sources. For example, the number of office workers at one plant may cause emission estimates to be too high if the emissions are estimated using a per employee factor. This can be a problem even when a survey is used if the sample design does not account for subpopulations adequately. In addition, facilities are sometimes listed under an incorrect SIC Code or more than one SIC Code may apply. Any of these errors results in misclassification of data and adds to uncertainty about the emissions estimates.

Sampling error is an important factor when one or more of the parameters (i.e., activity, factors, or emissions) are to be estimated from a sample of the population. Although most people recognize the importance of an adequate sample size, obtaining an adequate sample size is often not feasible. Furthermore, sample data are usually used to estimate a mean value from which the population total is extrapolated. This approach assumes that the underlying data are normally distributed--an assumption that is often violated. Again, sampling error can be minimized if proper statistical approaches are used, quality assurance procedures are followed, and sample sizes are adequate and properly obtained.

Systematic (or nonrandom) errors are the most problematic sources of parameter uncertainty because they are the most difficult to detect and reduce. They occur primarily because of an inherent flaw in the data-gathering process or in the assumptions used to estimate emissions. A common way that this happens is if the population to be sampled is not well-defined, and a sample (thought to be random) is actually nonrandom. This is a fairly common problem for certain types of industries. Take, for example, a local survey of solvent use by autobody refinishing shops. One approach would be to develop a list of facilities from business registrations, or other state/local business listings. However, this industry has a very large number of “backyard” operations that are not identified in these official lists. Therefore, any sample that did not recognize this fact would have systematic sampling errors. A solution in this case is to identify retailers or suppliers for the industry.

6.6 MODEL UNCERTAINTY

This type of uncertainty applies to nearly all area sources. A model is a simplified representation of reality. The simplest type of model uses activity multiplied by an emission factor to estimate emissions. More complex computer models such as the Landfill Air Emissions Estimation Model (LAEEM) and the Surface Impoundment Modeling System (SIMS) are also used to estimate emissions. Model uncertainty stems from the use of surrogate variables, exclusion of variables, and oversimplification of processes.

The use of surrogate variables is common in area source methods where population or the number of employees are used as surrogates for emission activities. The uncertainty in using these surrogates is especially high when emissions for a small region (i.e., county or smaller area) are estimated using a national average factor. Local variations in activity are not necessarily accounted for by using population or employment as an activity, and emissions. A common example is found in large cities that have the corporate headquarters for an industry. The number of employees may be high, but all of the manufacturing may be occurring in other areas.

Per capita emission factors are often an oversimplification of emission processes. An example would be an emission factor developed from national solvent use figures and material balance. If this type of factor is used, recognize that issues like a correspondence between emissions and population or disposal of the product may not have been addressed.

This discussion of uncertainty in area source emissions is by no means exhaustive. More details are provided in the specific area source chapters. EIIP has encouraged the reduction in uncertainty by recommending methods better than per capita or per employee factors wherever possible. Unfortunately, this is not always practical. It is important that inventory preparers recognize the sources of uncertainty, quantify it, and reduce it as much as is practical.

7

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