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Handbook for Criteria Pollutant Inventory Development:

A Beginner's Guide for Point and Area Sources



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ACRONYMS, ABBREVIATIONS, AND TERMS

AFS	AIRS Facility Subsystem
AIRS	Aerometric Information Retrieval System
AMS	Area and Mobile Source
ANSI	American National Standards Institute
AP-42	Compilation of Air Pollutant Emission Factors
ACT	Available Control Technique
AQCR	Air Quality Control Region
AWMA	Air & Waste Management Association
BID	Background Information Document
CAA	Clean Air Act
CAAA	1990 Clean Air Act Amendments
CARB	California Air Resources Board
CEM	Continuous Emissions Monitoring
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CHIEF	Clearinghouse for Inventories and Emission Factors
CO	Carbon Monoxide
CTG	Control Techniques Guideline
DOT	Department of Transportation
DQI	Data Quality Indicator
DQO	Data Quality Objective
DUNS	Dun & Bradstreet
EDI	Electronic Data Interchange
EDR	Electronic Data Reporting
EFIG	Emission Factor and Inventory Group

TABLE OF ACRONYMS, ABBREVIATIONS, AND TERMS (CONTINUED)

EGAS	Economic Growth Analysis System
EI	Emission Inventory
EIA	Energy Information Administration
EIIP	Emission Inventory Improvement Program
EMTIC	Emission Measurement Technical Information Center
EPA	United States Environmental Protection Agency
FIPS	Federal Information Processing Standards
FIRE	Factor Information Retrieval System
GCVTC	Grand Canyon Visibility Transport Commissions
GPO	Government Printing Office
HAP	Hazardous Air Pollutant
IDEA	Integrated Data for Enforcement Analysis
IPP	Inventory Preparation Plan
L&E	Locating and Estimating
MACT	Maximum Achievable Control Technology
MPS	Multiple Projection System
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards
NCASI	National Council of the Paper Industry for Air and Stream Improvement
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NET	National Emission Trends
NMFRC	National Metal Finishing Resource Center
NO _x	Nitrogen Oxides
NSPS	New Source Performance Standards

TABLE OF ACRONYMS, ABBREVIATIONS, AND TERMS (CONTINUED)

NTIS	National Technical Information Service
O ₃	Ozone
OAQPS	Office of Air Quality Planning and Standards
OECA	Office of Enforcement and Compliance Assurance
OTAG	Ozone Transport Assessment Group
Pb	Lead
PCRC	Paint and Coating Resource Center
PM	Particulate Matter
PM _{2.5}	Particulate matter with aerodynamic diameter less than or equal to 2.5 microns
PM ₁₀	Particulate matter with aerodynamic diameter less than or equal to 10 microns
POTW	Publicly Owned Treatment Works
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RE	Rule Effectiveness
RFP	Reasonable Further Progress
RO	Regional Office
RP	Rule Penetration
RTK NET	Right-To-Know Network
RTP	Research Triangle Park
SAEWG	Standing Air Emissions Work Group
SARA	Superfund Amendments and Reauthorization Act
SCC	Source Classification Code
SIC	Standard Industrial Classification
SIP	State Implementation Plan

TABLE OF ACRONYMS, ABBREVIATIONS, AND TERMS (CONTINUED)

SO ₂	Sulfur Dioxide
SO _x	Sulfur Oxides
STAPPA/ALAPCO	State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials
THC	Total Hydrocarbons
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total Organic Compounds
TRI	Toxic Release Inventory
TRIS	Toxic Release Inventory System
TSDF	Treatment, Storage, and Disposal Facility
TTN	Technology Transfer Network
UATW	Unified Air Toxics Web Site
USDA	United States Department of Agriculture
UTM	Universal Transverse Mercator
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

1.1 How Will This Document Help Me?

This document will help state, local, and tribal air pollution control agency personnel compile an inventory of criteria pollutant emissions from **stationary (point and area) sources**. **The information contained in this document is intended to serve as a reference guide only, and is not intended to serve as new guidance or policy.**

This document discusses point and area sources separately. Under ideal circumstances, all stationary sources would be considered point sources for purposes of developing emission inventories. In reality, however, only sources emitting more than a specified cutoff level of an air pollutant are considered point sources. Usually, due to available resources, larger stationary point sources are typically inventoried individually on a facility-by-facility basis and smaller sources are usually inventoried collectively as area sources.

This document describes “top-down” as well as “bottom-up” inventory preparation procedures and contains valuable information on obtaining reference materials (Section 3.4 describes these two types of procedures). Although this document does not include an exhaustive list of references, it does provide a list of the most commonly used and readily available materials. This document also does not mandate specific emission estimation methods, but rather presents those methods that can be used taking into consideration an agency’s resources and goals.

Note: This document does not provide guidance on how to compile an inventory of criteria pollutant emissions from mobile sources. Mobile sources include all non-stationary sources. This includes on-highway vehicles (i.e., light-duty cars and trucks, heavy-duty trucks) and nonroad engines and equipment (i.e., lawn and garden, recreational, construction, logging, agricultural, industrial, light commercial, airport service, and recreational marine equipment, as well as commercial marine operations, aircraft, and locomotives). Guidance on how to compile an inventory of emissions from mobile sources can be obtained from the EPA’s Office of Mobile Sources (OMS) (<http://www.epa.gov/oms>) and from the Emission Inventory Improvement Program (EIIP) Mobile Source Committee (http://www.epa.gov/ttn/chief/eiip/eiip_ms.htm).

Note: This document does not provide guidance on how to compile an inventory of biogenic or geogenic sources. Biogenic sources include vegetation sources (e.g., plants, trees, grasses, and agricultural activity). Geogenic sources include primarily gas seeps, soil wind erosion, geysers, and volcanoes. Guidance on how to compile an inventory of emissions from biogenic and geogenic sources can be obtained from the EIIP Biogenic Source Committee (http://www.epa.gov/ttn/chief/eiip/eiip_bio.htm).

1.2 What Assumptions Were Made In Preparing This Document?

This document was prepared based on the following premises:

- That agency personnel using this document lack experience in developing emission inventories;
- That inexperienced agency personnel have access to useful technical information within their agency and have experienced state staff or regional office staff available as a technical resource;
- That all state and local agencies have an existing emissions inventory of criteria pollutants;
- That all state and local agency personnel have access to the World Wide Web (Web) and personnel are computer literate;
- That agency managers are responsible for establishing the priority or hierarchy of source categories and pollutants that will be inventoried; and
- That agency managers are familiar with U.S. Environmental Protection Agency (EPA) published procedures for compiling emissions inventories.

NOTE: All Web sites referenced in this document were valid at the time this document was prepared. If you try to use a Web page address and find that it has expired, check the primary Web address, or call the Info CHIEF help desk at (919) 541-1000.

NOTE: In addition to available EPA guidance materials, you should become familiar with basic emission inventory preparation procedures by consulting the Emission Inventory Improvement Program (EIIP) reference materials described in Appendix A, or review some of the available materials on the Clearinghouse for Inventories and Emission Factors (CHIEF) World Wide Web site at <http://www.epa.gov/ttn/chief/>.

1.3 How Is This Document Organized?

The document is divided into two major parts. The main body consists of Sections 1 through 7 and presents various tools and techniques you can use to:

- Identify issues to consider when planning and compiling an emissions inventory;
- Identify sources and pollutants of concern;

- Locate activity data;
- Locate emission factors; and
- Estimate emissions.

The second part of this document provides a series of appendices that complement the main body. Each of these appendices serves as a useful source of information for some aspect of emissions inventory preparation and compilation. The appendices provide greater detail for estimating emissions and preparing inventories than the main body.

1.4 How Should I Use This Document?

If you are familiar with the inventory development process, characteristics of criteria pollutants, and general source category definitions, you may want to skip Section 2. Everyone should read Sections 3 through 6, which contain the detailed information needed to compile an inventory.

If you need information about...	Then read...
General definitions and uses of inventories	Sections 2.1, 2.4, and 2.5
General characterization of criteria pollutants	Section 2.3
Issues to consider when planning an inventory	Sections 3.1, 3.2, and 3.3
General approaches and methodologies for estimating emissions and collecting technical data	Sections 3.4 through 3.8
How to apply rule effectiveness and rule penetration to the inventory	Sections 3.9 and 3.10
Quality assurance and quality control procedures	Section 4
Compiling point source inventories	Section 5
Compiling area source inventories	Section 6
Resources used to prepare this document	Section 7

1.5 Whom Do I Contact for Help?

Many agencies in the United States focus their efforts on emission inventory issues. Various EPA offices and programs and other federal agencies as well as state agencies may be able to provide information on characterizing and estimating emissions.

Potential sources of information among federal agencies include:

- EPA's Emission Factor and Inventory Group (EFIG) within the Office of Air Quality Planning and Standards (OAQPS) (<http://www.epa.gov/ttn/chief/efig/>);
- EPA's Regional Offices;
- The U.S. Department of Energy (<http://home.doe.gov/>); and
- The U.S. Department of Agriculture (<http://www.usda.gov/>).

These federal agencies conduct projects to characterize and assess air pollutants and may have valuable information pertaining to pollutants and source categories of interest to you.

Potential sources of information among regional, state, and local air pollution control agencies include:

- The State and Territorial Air Pollution Program Administrators (STAPPA)/Association of Local Air Pollution Control Officials (ALAPCO) membership directory on the Web at <http://www.4cleanair.org>; and
- State or local air pollution agencies, for example, the Texas Natural Resource Conservation Commission (TNRCC) and the California Air Resources Board (CARB).

1.5.1 STAPPA/ALAPCO

STAPPA and ALAPCO are two national associations that represent air pollution control agencies in the 50 states, 4 U.S. territories, and over 150 major metropolitan areas across the United States. STAPPA/ALAPCO has participated in several ventures with EPA aimed at improving the understanding of air pollution issues. For example, the EIIP is a jointly sponsored effort of STAPPA/ALAPCO and EPA, and is an outgrowth of the Standing Air Emissions Work Group (SAEWG). STAPPA/ALAPCO also maintains working committees that address modeling and emission inventory issues. These committees serve as liaisons between EPA and the state and local air pollution control agencies.

1.5.2 Texas Natural Resource Conservation Commission

TNRCC provides a series of guidance documents on characterizing and estimating emissions from both point and area sources. The documents provide detailed step-by-step guidance to assist in calculations. The series is available on the TNRCC Web site at http://www.tnrcc.state.tx.us/air/nsr_permits/guidedoc.html.

1.5.3 California Air Resources Board

One of CARB's stated goals is to continuously improve the understanding of the nature and causes of California's air quality problems. To achieve this goal, CARB conducts research to develop and improve emissions estimation methods and emission factors. CARB activities and publications can be obtained from CARB's Web site at <http://www.arb.ca.gov/homepage.htm>.

1.5.4 Other Contacts

Several agencies provide public forums for information exchange such as a question and answer board or "chat room" on their Web site. For example, the OAQPS Emission Inventory (EI) Public Forum is a Web-based discussion site dedicated to the preparation of emission inventories. Anyone may submit questions, comments, and responses.

The objective of the EI Public Forum is to provide an easy and effective venue for seeking and providing information about air pollution. Because this is a public discussion, statements made on the EI Public Forum do not necessarily represent any official policy. You can access the EI Public Forum on the World Wide Web at <http://www.epa.gov/cgi-bin/netforum/nei/a/1>. You may participate by submitting a message or responding to a previous message.

The Technology Transfer Network (TTN) is operated by OAQPS and includes CHIEF where you can access the latest information on emission inventories and emission factors. The CHIEF Forum (<http://www.epa.gov/cgi-bin/netforum/chief/a/1>) is another Web-based discussion site about air emission inventories, emission factors, and closely related subjects. You may initiate discussion by submitting a message or responding to a previous message. Because this is a public discussion, statements made on the CHIEF Forum do not necessarily represent EPA policy.

Examples of topics discussed on the CHIEF Forum are:
<ul style="list-style-type: none">• Methods for assembling emission inventories;• Methods for arriving at activity levels for area sources; and• Methods for developing emission factors for point and area sources.

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2.0 BACKGROUND

2.1 What Is an Emission Inventory?

An emission inventory is a current, comprehensive listing, by source, of the air pollutant emissions, and covers a specific geographic area for a specific time interval.

An emission inventory contains the following information:

- Tabular summary of emission estimates by source category. An example is shown in Table 2-1;
- Background information including the reasons for compiling the inventory;
- Geographic area covered by the inventory;
- Time interval represented by the emissions inventory (e.g., annual, seasonal, hourly);
- Population, employment, and economic data used to estimate and allocate emissions;
- Narrative for each source category to include:
 - Procedures used to collect the data
 - Sources of data (where data are acquired)
 - Copies of questionnaires and results (number of questionnaires sent, the number of responses received, methods for extrapolating data to account for nonrespondents, and any assumptions made)
 - Citations for all emission factors
 - Identification of methods used to calculate emissions, including example calculations
 - Complete documentation of all assumptions made
 - Identification of sources of emissions not included in the inventory
 - List of references

Table 2-1.

**Example Summary of Emission Inventory Results
Lead Emissions Estimates, 1996
(Tons per year)**

Area Source Category Name	SIC Code	AMS Code	Emissions
Adhesives and Sealants	2891	2301000000	0.17
Aluminum Foundries	3365	2303000000	0.37
Asphalt Concrete Manufacturing		2306000000	0.043
Autobody Refinishing Paint Application		2401005000	1.66
Aviation Gasoline Distribution: Stage I & II		2561000000	0.005
Brick and Structural Clay Tile	3251	2305000000	0.005
Chemical Preparations	2899	2301000000	0.2
Copper Foundries	3366	2303000000	3.37
Copper Rolling and Drawing	3351	2304000000	0.26
Custom Compound Purchased Resins Manufacturing	3087	2401035000	1.08
Electric Lamps	3641		0.53
Electrometallurgical Products Manufacturing	3313	2304000000	0.29
Electron Tubes Manufacturing	3671		0.12
Electronic Components, nec	3679		0.09
Fabricated Metal Products, nec	3499	2309000000	0.11
Fabricated Rubber Products, nec	3069	2308000000	0.02
Fluid Power Pumps and Motors	3594	2312000000	0.08
Hardware Manufacturing	3429	2309000000	0.12
Hazardous Waste Incineration		2601000000	3.98
Industrial Boilers: Coal, all types		2102000000	0.027
Industrial Boilers: Distillate Oil		2102004000	0.011
Industrial Boilers: Residual Oil		2102005000	0.1
Industrial Boilers: Waste Oil		2102012000	0.022
Industrial Inorganic Chemical Manufacturing	2819	2301000000	0
Institutional/Commercial Heating: Anthracite Coal		2103001000	0
Institutional/Commercial Heating: Bituminous and Lignite		2103002000	0.022
Institutional/Commercial Heating: Distillate Oil		2103004000	0.082
Institutional/Commercial Heating: Residual Oil		2103005000	0.034
Metal Heat Treating Manufacturing	3398	2304000000	0.02

Table 2-1.

**Example Summary of Emission Inventory Results
Lead Emissions Estimates, 1996
(Tons per year) (Continued)**

Area Source Category Name	SIC Code	AMS Code	Emissions
Minerals, Ground or Treated Production	3295	2305000000	0.3
Miscellaneous Organic Chemical Processes		2301000000	0
Nonferrous Foundries, nec	3369	2303000000	0.32
Nonferrous Rolling and Drawing	3356	2304000000	0.62
Nonferrous Wire Drawing and Insulating	3357	2304000000	0
Open Burning: Scrap Tires		2830000000	0
Paints and Allied Products Manufacturing	2851	2301000000	0
Plastic Parts and Products (Surface Coating)		2401035000	0.68
Porcelain Electrical Supplies	3264	2305000000	0.77
Power Transmission Equipment	3568	2312000000	0.12
Pressed and Blown Glass and Glassware Manufacturing	3229	2305000000	3.84
Primary Metal Products Manufacturing	3399	2303000000	0.007
Residential Heating: Anthracite Coal		2104001000	0.006
Residential Heating: Bituminous and Lignite Coal		2104002000	0.015
Residential Heating: Distillate Oil		2104004000	0.16
Residential Heating: Wood/Wood Residue		2104008000	0.78
Secondary Nonferrous Metals Production	3341	2304000000	0.91
Stationary Internal Combustion Engines - Diesel			0
Steel Pipe and Tubes Manufacturing	3317	2304000000	0.055
Steel Wire and Related Products Manufacturing	3315	2304000000	1.24
Storage Batteries Manufacturing	3691		0.21
Taconite Iron Ore Processing			0
Telephone and Telegraph Apparatus	3661		0
Toys and Sporting Goods	3940		0.55
Unsupported Plastics Film & Sheet	3081	2308000000	0.01
Valves And Pipe Fittings, Nec	3494	2309000000	0.008
Vitreous Plumbing Fixtures	3261	2305000000	2.66

2.2 How Are Emission Inventories Used?

Emission inventories are used for a wide variety of purposes, but are most often developed in response to regulation. Emission inventory data are used to evaluate the status of existing air quality as related to air quality standards, air pollution problems, assess the effectiveness of air pollution policy, and to initiate changes as needed. Individual states may have their own specific inventory requirements, while at the federal level, requirements for emission estimates stem mainly from the Clean Air Act (CAA).

Emission inventories provide the technical foundation for state, local, and federal programs designed to improve or maintain ambient air quality. Specific examples of end uses for emission inventories include:

- Meet CAA mandates for specific inventories as part of State Implementation Plans (SIPs);
- Tracking progress towards National Ambient Air Quality Standards (NAAQS) attainment and emission reductions;
- Determine compliance with emission regulations and set the baseline for policy planning;
- Identifying sources and general emission levels, patterns, and trends to develop control strategies and new regulations;
- Serve as the basis for modeling of predicted pollutant concentrations in ambient air;
- Provide input for human health risk assessment studies;
- Conduct environmental impact assessments for proposed new sources;
- Serve as the basis for construction and operating permits;
- Serve as a tool to support future trading programs; and
- Siting ambient air monitors.

2.3 Why Is a Complete, Accurate Emissions Inventory Important?

A technically defensible emissions inventory serves as the foundation for sound public policy. Formulation of appropriate control strategies requires a reliable base of quality emissions estimates. If the data used to derive control strategies are flawed, the public policy resulting from

the strategy will also be in error. These errors can be costly to the public being exposed, the industry subject to control, and to the environment.

2.4 What Are Criteria Pollutants?

The Clean Air Act directs the EPA to identify and set NAAQS for the most common air pollutants. EPA uses these “criteria pollutants” as indicators of air quality. These pollutants are:

- Ozone (O₃);
- Carbon monoxide (CO);
- Nitrogen oxides (NO_x);
- Sulfur dioxide (SO₂);
- Particulate matter with aerodynamic diameter less than or equal to 10 micrometers (PM₁₀);
- Particulate matter with aerodynamic diameter less than or equal to 2.5 micrometers (PM_{2.5}); and
- Lead (Pb).

In addition to these pollutants, EPA also regulates emissions of volatile organic compounds (VOC) under criteria pollutant programs. VOC are ozone precursors—they react with nitrogen oxides in the atmosphere to form ozone. VOC are emitted from motor vehicle fuel distribution, chemical manufacturing, and a wide variety of industrial, commercial, and consumer solvent uses.

EPA’s current regulatory definition of VOC (40 CFR § 51.100) excludes constituents considered to be negligibly photochemically reactive. These include methane, ethane, methylene chloride 1,1,1-trichloroethane (TCA), several Freon compounds, acetone, perchloroethylene, and others. It is anticipated that additional compounds may be exempted from this VOC definition. The exempt compounds are considered negligibly reactive, although some can influence the formation of ozone when present in sufficient amounts. If you encounter a situation where your emission estimation methodology includes emissions exempted from EPA’s definition of VOC, you should consult with your EPA Regional Office for guidance, and document exactly what compounds you are reporting as VOC.

2.4.1 Ozone

Ozone, a colorless gas, is the major component of smog. Ozone is not emitted directly into the air but is formed through complex chemical reactions between precursor emissions of VOC and NO_x in the presence of sunlight. These reactions are accelerated by sunlight and increased temperatures. Peak ozone levels typically occur during the warmer times of the year. Ozone causes health problems because it damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants.

Ozone occurs in two layers of the atmosphere. The layer surrounding the earth's surface is the troposphere. Here, ground-level or "bad" ozone is an air pollutant that damages human health, vegetation, and many common materials. It is a key ingredient of urban smog. The troposphere extends to a level about 10 miles up, where it meets the second layer, the stratosphere. The stratospheric or "good" ozone layer extends upward from about 10 to 30 miles and protects life from the sun's harmful ultraviolet rays (UV-b).

2.4.2 Carbon Monoxide

Carbon monoxide is a colorless, odorless, and poisonous gas produced by incomplete burning of carbon in fuels. More than 75 percent of the CO emissions in the United States are from transportation sources, particularly highway motor vehicles. Other major CO sources are wood-burning stoves, incinerators, and fuel combustion at industrial sources. When CO is inhaled, it enters the bloodstream, and reduces the delivery of oxygen to organs and tissues.

2.4.3 Nitrogen Oxides

Nitrogen oxides are important precursors to both ozone and acid rain, and as a result may affect not only human health, but also both terrestrial and aquatic ecosystems. Nitrogen oxides can interact with other compounds in the air to form PM.

Nitrogen oxides form when fuel is burned at high temperatures. The two major emissions sources are motor vehicles and stationary fuel combustion sources such as electric utility and industrial boilers. The major mechanism for the formation of nitrogen dioxide (NO_2) in the atmosphere is the oxidation of the primary air pollutant nitric oxide (NO). When inhaled, nitrogen dioxide can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections.

2.4.4 Sulfur Dioxide

Sulfur dioxide is a colorless, pungent gas that is a respiratory irritant and like NO_x , is a precursor to acid rain. Sulfur dioxide can also interact with other compounds in the air to form PM. Thus, sulfur compounds in the air contribute to visibility impairment in large parts of the country that is especially problematic in national parks. Ambient sulfur dioxide results largely from stationary

sources such as coal and oil combustion, steel mills, refineries, pulp and paper mills, and nonferrous smelters.

2.4.5 *PM₁₀ and PM_{2.5}*

Air pollutants called particulate matter include dust, dirt, soot, smoke, and liquid droplets. PM originates from a variety of sources, such as:

- Natural sources such as windblown dust and fires;
- Combustion sources such as motor vehicles, power generation, fuel combustion at industrial facilities, residential fireplaces, and wood stoves. Combustion sources emit particles of ash or incompletely burned materials;
- Activities such as materials handling, crushing and grinding operations, and travel on unpaved roads; and
- Interaction of gases (such as NH₃, SO₂, NO_x, and VOC) with other compounds in the air to form PM.

The chemical and physical composition of PM may vary depending on the location, time of year, and meteorology. “Fine” particles (PM_{2.5}) are generally emitted from combustion sources. Sulfate and nitrate secondary particles represent significant components of PM_{2.5}. “Coarse” particles (PM₁₀) can be emitted from sources including windblown dust, travel on unpaved roads, and materials handling.

2.4.6 *Lead*

Elemental lead emitted by stationary and mobile sources can cause several types of developmental effects in children including anemia and neurobehavioral and metabolic disorders. Non-ferrous smelters and battery plants are the most significant contributors to atmospheric lead emissions.

2.5 What Is a Point Source?

Point sources are large, stationary, sources of emissions that release pollutants to the atmosphere. Point sources are defined as sources that emit quantities above an emission threshold. For criteria pollutants, the emission thresholds in attainment areas are shown below.

Pollutant	Emission Threshold for Point Sources ^a (tons per year)
Carbon monoxide	1,000
Nitrogen oxides	100
Sulfur oxides	100
Particulate matter $\leq 10 \mu\text{m}$	100
Particulate matter $\leq 2.5 \mu\text{m}$	100 ^b
Lead or lead compounds	5
Volatile organic compounds ^c	100

^a Emission threshold as stated in 40 CFR 51; Subpart Q 51.322.

^b Emission threshold as stated in 40 CFR 51; Subpart 51.025.

^c VOCs are not criteria pollutants, but are precursors of the criteria pollutant ozone.

Any stationary source emitting pollutants at levels equal to or greater than those shown in the preceding table must be inventoried and reported as point sources. In addition, many states also inventory and report stationary sources **below** these thresholds as point sources.

Note: Point source thresholds vary in nonattainment areas depending on classification.

2.6 What Is an Area Source?

Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively they can release significant amounts of a pollutant. For example, a single dry cleaner within an inventory area typically will not qualify as a point source, but collectively the emissions from all of the dry cleaning facilities in the inventory area may be significant; thus they must be included in the inventory.

Emission inventories for area sources are usually not compiled using the same methods as emission inventories for point sources. The level of effort required to collect data and estimate emissions from the large number of individual facilities or activities would be very high, especially with respect to the relatively low levels of pollutants emitted by each. To estimate emissions from area sources, the individual facilities or activities are grouped with like facilities or activities into broad source categories so that emissions can be collectively estimated using one methodology. Examples of area source categories include residential wood combustion, architectural surface coating, pesticide use, prescribed burning, solvent use, and traffic marking.

Unlike point sources for which you collect specific data for each individual source, you will generally estimate area source emissions by:

- Using emission factors or allocating national or regional estimates to the local level; or
- Collecting data for a representative subset of individual area sources. You will derive emission estimates or activity data for a subset of facilities or activities in the source category (specific to your inventory area) and scale the estimate to reflect the entire population of the source category in the inventory area.

2.7 What Do Attainment and Nonattainment Areas Mean?

These designations refer to the compliance status of an area with respect to the NAAQS. An attainment area is an area considered to have air quality as good or better than required by a NAAQS. Nonattainment areas have not reached the level of air quality required by a NAAQS. An area can be an attainment area for one or more pollutants and a nonattainment area for others.

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3.0 OVERVIEW OF THE EMISSIONS INVENTORY PROCESS

This section presents a broad overview of the emissions inventory process, defining terms, identifying procedures, and providing references for additional information. Figure 3-1 graphically illustrates the activities involved in preparing an inventory.

If you need information about...	Then read...
Planning the inventory	Sections 3.1 through 3.3
Top-down and bottom-up approaches	Section 3.4
Types of emissions	Section 3.5
Methods available for estimating emissions	Section 3.6
Selecting methods for estimating emissions	Section 3.7
Data sources	Section 3.8
Data collection methods	Section 3.9
Rule effectiveness	Section 3.10
Rule penetration	Section 3.11
Documentation of the inventory	Sections 3.12 and 3.13
Data handling	Sections 3.14 through 3.16
Required data elements	Section 3.17
Reporting results of the inventory	Section 3.18
Emissions projections	Section 3.19
Inventory maintenance and update	Section 3.20

3.1 Why Is Planning Required Before the Inventory Process Begins?

Careful and thorough planning of the inventory procedures will greatly facilitate the process and can prevent the need for costly revisions to the inventory during and after review. Air quality agencies compile emission inventories for a variety of purposes; for example, to provide data required to evaluate ambient air quality, in response to legislation, or to assess the effectiveness of an air pollution policy. The anticipated purpose of the inventory will dictate the level of complexity and accuracy required, but each inventory requires extensive advanced planning.

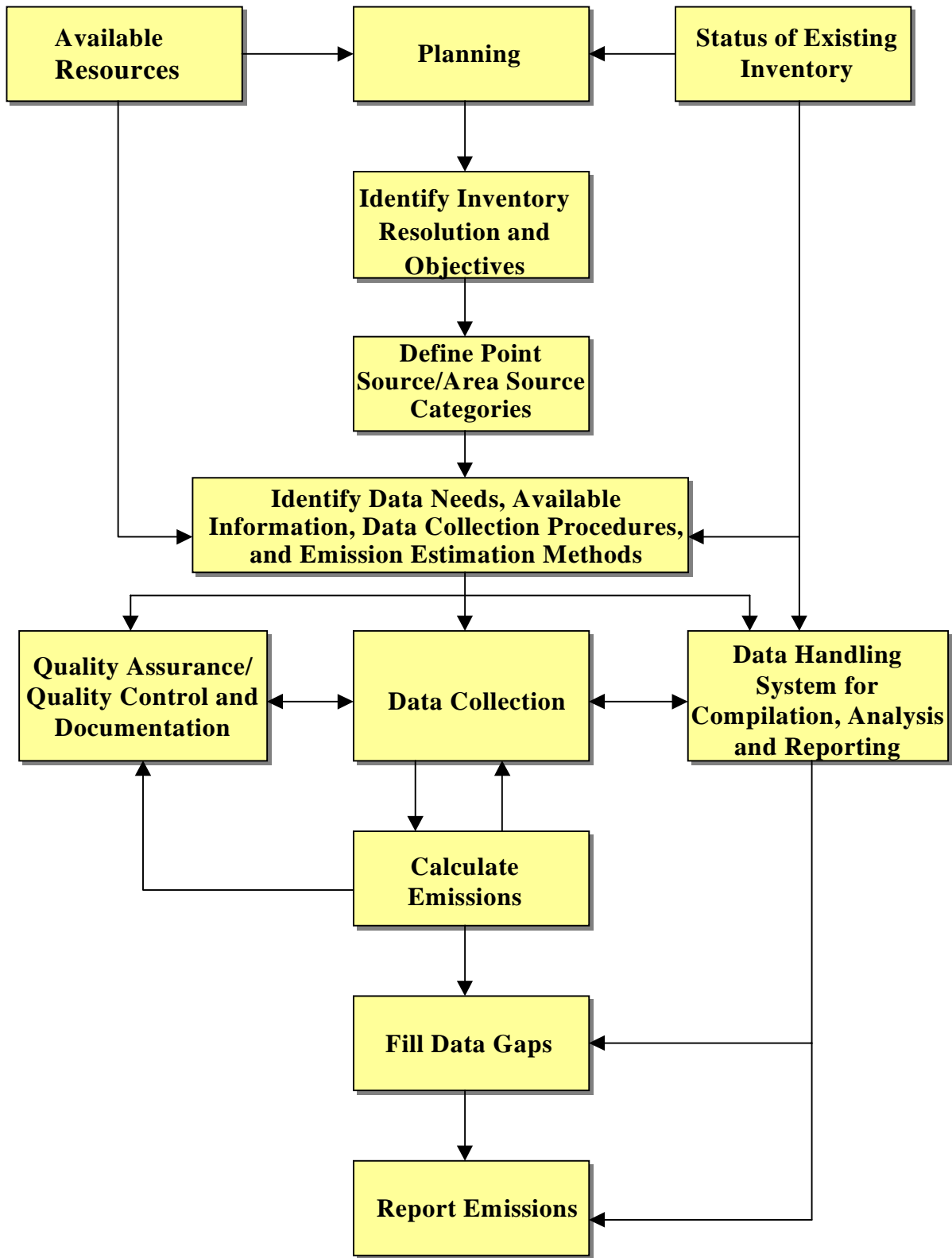


Figure 3-1. Activities For Preparing an Inventory

Before the inventory process begins, your agency should prepare an inventory preparation plan to identify the required staffing levels and resource allocations. The inventory preparation plan will also specify the methods and procedures to be used by each member of the inventory team to collect, handle, review, and report emissions data.

3.2 What Is an Inventory Preparation Plan and How Can It Help Me?

An inventory preparation plan (IPP) is a concise, prescriptive document that states exactly how an agency intends to develop and present its inventory. The plan should include inventory objectives and general procedures, and should clearly describe how the inventory preparer will present and document the inventory for submission to EPA and/or others.

As part of the IPP process, you should consider the following:

- End uses of the data;
- Scope of the inventory;
- Availability and usefulness of existing data; and
- Strategy for data collection and management.

Although no specific format is required by EPA, generally, the inventory preparation plan should:

- Define the geographic inventory area by attainment or nonattainment status;
- Define the scope of the inventory (i.e., identify which sources and pollutants will be covered);
- Define the data quality objectives;
- Provide the background/basis for the inventory (i.e., describe previous efforts that are related and describe purpose of this inventory);
- Specify who is responsible for preparing the inventory, with a detailed organization chart of key personnel/consultants;
- Specify each person's responsibilities;
- Specify the QA coordinator and the technical reviewers (which are different than the technical team generating the inventory);

- Describe the approach to be used to estimate emissions (i.e., identify plans for data collection, analysis, source definition thresholds, emission estimation methods by source category type, and data reporting and storage procedures);
- Describe QA/QC procedures; and
- Describe how the agency plans to present and document the inventory for submittal to EPA and/or others.

3.3 What Resource Issues Must Be Considered?

Resources to consider are:

- **Time:** How much time will it take to gather the information, calculate the emissions, compile the inventory, and perform the quality assurance/quality control (QA/QC) tasks? What will the effort cost the agency in labor hours and time?
- **Staff assignment:** What experience level is required and who is available to perform the task?
- **Data processing:** Do you have adequate computer hardware (including storage capacity and backup capability) and the necessary software capable of processing and exchanging data with other organizations?

NOTE: Most of the resource planning issues will be handled by your agency's managers. However, you should review their plan to make sure that you can accomplish the goals set by your managers within the allotted resources.

Your managers are responsible for working with you in the planning phase and making decisions on these issues listed above. Once the uses of the inventory and the constraints on its development have been identified, data quality objectives (DQOs) can be defined and you can begin planning your tasks. Section 4.3 discusses DQOs and how to define them for your inventory development task. In general, the data quality needs of the program will dictate the level of effort required for planning, executing, and quality assuring the results. The EIIP guidance series is focused on the emission inventory development process, including planning and quality assurance activities. For additional information, you should refer to the available guidance at <http://www.epa.gov/ttn/chief/eiip>.

3.4 What Are the Main Approaches to Inventory Development?

There are two main approaches that your agency can follow in estimating emissions: the top-down approach and the bottom-up approach.

A top-down approach means that your agency develops emission estimates based on national or regional estimates. You scale the national or regional estimates to your inventory area using some measure of activity data thought to be directly or indirectly related to the emissions in your area of study. Typically, sales data, or per employee, or per capita emission factors are used. For example, the amount of fuel burned in combustion processes can be used to estimate fuel combustion emissions if you have other known information such as an emission factor based on pounds of pollutant emitted per gallon of fuel burned. The total amount of gasoline sold at a gas station is another example of activity data used to estimate evaporative emissions. The population in an inventory area can be used as the activity data to estimate VOC emissions from dry cleaning facilities if you have available an emission factor based on amount of VOC emitted per person.

Characteristics of a top-down approach are:

- Typically used to inventory area sources;
- Requires minimum resources by grouping like emission sources together and making use of readily available activity and emission data;
- Used when (1) local data are not available, (2) the cost to gather local information is prohibitive, or (3) the end use of the data does not justify the cost of collecting detailed site-specific data;
- Emission factors or national- or regional-level emissions estimates are used to estimate emissions in a state or county based on a surrogate parameter such as population or employment in a specific sector; and
- One potential problem with this approach is that an emission estimate will lose some accuracy due to the uncertainty associated with the estimate and the representativeness of the estimate once extrapolated to the local level.

A bottom-up approach means you estimate emissions for individual sources and sum all sources to obtain state- or county-level estimates.

Characteristics of a bottom-up approach are:	
<ul style="list-style-type: none">• Typically used to inventory point sources; however, it can be used to inventory area sources when resources are available to collect local activity data through a survey effort.• Requires more resources to collect site-specific information on emission sources, activity levels, and emission factors; and• Results in more accurate estimates than a top-down approach because data are collected directly from individual sources and not derived from a national or regional estimate.	

3.5 What Types of Emissions Can Be Inventoried?

Irrespective of whether a top-down or a bottom-up approach is used, inventories can be compiled using actual emissions, allowable emissions, or emissions based on a facility’s potential to emit (potential emissions) depending on the purpose of the inventory. Each type of estimate is described in more detail below.

3.5.1 What Are Actual Emissions?

Actual emissions are defined as the actual rate of emissions of a pollutant from a source (or emission unit within a source) calculated using actual operating hours, production rate, and where applicable, fuel combusted during the period of interest. For example, base year inventories developed in support of a SIP are compiled using actual emissions.

3.5.2 What Are Allowable Emissions?

Allowable emissions are the product of an enforceable emissions rate (e.g., pounds of VOC per gallon of solids applied), the anticipated operating rate or activity level (e.g., gallons of solids applied per hour), and the anticipated operating schedule (hours per day). In general, allowable emissions are used when emission projections are being developed for use in SIP modeling.

3.5.3 What Are Potential Emissions?

Potential to emit (i.e., potential emissions) is the capability of a source, at maximum design capacity, to emit a pollutant after the application of air pollution control equipment. Potential to emit estimates are based on the maximum capacity of a source after taking into consideration enforceable permit conditions such as the type of materials combusted, the type of material

processed, and the annual hours of operation. In general, potential emissions are estimated and reported in inventories in support of permitting activities under Title V of the CAA.

3.6 What Are the Methods for Estimating Emissions?

The methods most commonly used in estimating emissions of criteria pollutants include:

- Continuous emission monitors (CEMs): CEMs continuously measure (with very short averaging time) and record actual emissions during the time of monitor operation. CEMs data can also be used to estimate emissions for different operating and longer averaging times.
- Source testing: Emission rates are derived from short-term emission measurements taken at a stack or vent. Emission data can then be extrapolated to estimate long-term emissions from the same or similar sources.
- Material balance: Emissions are determined based on the amount of material that enters a process, the amount that leaves the process, and the amount shipped as part of the product itself.
- Emission factors: An emission factor is a ratio that relates the emission of a pollutant to an activity level at a plant that can be easily measured, such as an amount of material processed, or an amount of fuel used. Given an emission factor and a known activity level, a simple multiplication yields an estimate of the emissions. Emission factors are developed from separate facilities within an industry category, so they represent typical values for an industry, but do not necessarily represent a specific source. Published emission factors are available in numerous sources.
- Fuel analysis: Emissions are determined based on the application of conservation laws. The presence of certain elements in fuels may be used to predict their presence in emission streams. For example, SO₂ emissions from oil combustion can be calculated based on the concentration of sulfur in the oil. This approach assumes complete conversion of sulfur to SO₂. Therefore, for every pound of sulfur (molecular weight = 32g) burned, two pounds of SO₂ (molecular weight = 64g) are emitted.
- Emission estimation models: Emission estimation models are empirically-developed process equations used to estimate emissions from certain sources. An example emission estimation model is the TANKS software for estimating volatile organic compounds emissions from fixed- and floating-roof storage tanks.

- Surveys and questionnaires: Surveys and questionnaires are commonly used to obtain facility-specific data on emissions and their sources.
- Engineering judgment: An engineering judgement is made when the specific emission estimation techniques such as stack testing, material balance, or emission factor are not possible. This estimation is usually made by an engineer familiar with the specific process, and is based on whatever knowledge may be available.

These methods, and their applicability, are described in detail in Sections 5 and 6 of this document. **Appendix C lists the EIIP point and area source categories and their applicable preferred and alternative emissions estimation methods. In addition, Appendices D and E provide example calculations on the use of these methods in estimating emissions from point and area sources, respectively.**

3.7 How Do I Select a Method When Multiple Methods Are Applicable?

Selecting a method to estimate source specific emissions warrants a case-by-case analysis considering the cost and required accuracy in the specific situation. When selecting an emissions estimation method, you should consider several issues when analyzing the tradeoffs between cost and accuracy of the resulting estimates. These issues include:

- Availability of quality data needed for developing emissions estimates;
- Practicality of the method for the specific source category;
- Intended end use of the inventory (e.g., an inventory in support of significant regulatory implications such as residual risk or environmental justice issues may require that more accurate and costly emission estimation methods be used than would an inventory intended for simply a source characterization);
- Source category priority (e.g., if a source category is of relatively high priority, it may require a more accurate emission estimation method);
- Time available to prepare the inventory; and
- Resources available in terms of staff and funding.

To help you decide which estimation methods to use, you should refer to the EIIP series of documents. An important aspect of the EIIP's selection of methods was the identification of "preferred" and "alternative" methods. Refer to Volume I of EIIP for a complete discussion on how to select emission estimation methods. **Appendix A provides a complete list of available EIIP documents.**

3.8 What Data Sources Should I Use?

This section introduces the various data sources available to you in compiling an emissions inventory. The types of data you will need to compile a complete emissions inventory include:

- Inventory guidance;
- Existing emission data;
- Emission factor resources;
- Models resources;
- Source characterization documents (documents that characterize an industry, including a description of processes, operating parameters, equipment used, emissions generated; and volume and type of output produced); and
- Activity data references.

Note that in many cases a single document can provide information on one or more of the types of data needed for your inventory. For example, EIIP is an excellent resource for inventory guidance as well as source characterization, and *AP-42* is an excellent resource for both emission factors and source categorization.

3.8.1 Where Do I Find Inventory Guidance?

The primary guidance on emission inventory development is summarized in the EIIP volumes. The EIIP volumes were developed through a joint process involving state and local agencies and EPA. These volumes present EPA's recognized standard for the development of reliable, quality-rated inventories. The EIIP documents present preferred and alternative methods for estimating emissions from point, area, mobile, and biogenic source categories. **A complete list of EIIP documents is provided in Appendix A.** Hard copies of these manuals are available from the National Technical Information Service (NTIS). Electronic copies of the EIIP documents can be downloaded off the World Wide Web through the EIIP Web site at <http://www.epa.gov/oar/oaqps/eiip/>.

Additional emissions inventory guidance, such as memoranda from OAQPS, can be downloaded off the World Wide Web through EPA's CHIEF Web site at http://www.epa.gov/ttn/chief/ei_guide.html#egmemo and <http://www.epa.gov/ttn/chief/reptdesc.html>. For example, one guidance document published by EPA is the *1995 Protocol for Equipment Leak Emission Estimates* (EPA, 1995a).

3.8.2 *Where Do I Find Existing Emission Data?*

A well-documented, existing air emissions inventory is a good source of emissions data. If an agency has previously estimated emissions based on a survey of the industry, sometimes you can use those data 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 such as new controls. Information contained in these inventories can at least serve as a starting point for developing extensive data and support information, such as documentation of procedures.

NOTE: Many existing inventories may focus on pollutants other than those needed in the inventory being prepared. Thus, certain sources that emit only one type of pollutant may not be well represented.

The most current and accessible national emission databases available for review and assessment in developing a criteria air pollutants inventory include:

- The National Emission Trends (NET) Database:
FTP://www.epa.gov/pub/EmisInventory;
- Aerometric Information Retrieval System (AIRS): (800) 334-2405 or (919) 541-7862; and
- AIRSWeb: *http://www.epa.gov/airsweb/sources.htm.*

Detailed descriptions of these databases are provided in Appendix F.

A less desirable but possible source of emissions data is through the extrapolation of emissions from one geographic region to another. This approach may be most appropriate when the socioeconomic conditions between two regions are comparable. In these situations, the emissions data for one region can be extrapolated to the other region based on population, employment, or other representative surrogates of the activity causing the emissions.

3.8.3 *Where Do I Find Emission Factor Information?*

The most commonly used emission factor resources are listed below and described in greater detail in Appendix G.

- *AP-42*: One of the most frequently cited resources for emission factor information is the EPA document, *Compilation of Air Pollutant Emission Factors (AP-42)*. This document contains criteria pollutant emission factors for point and area sources. *AP-42* is available on the World Wide Web at *http://www.epa.gov/ttn/chief/ap42.html*. *AP-42* is also available on the Air

CHIEF CD-ROM, and in hard copy from the Government Printing Office (GPO) at (202) 512-1800.

- Emission factor databases: Several emission factor databases are currently available in easy-to-access formats to state and local agencies. Two of these tools include:
 - Factor Information Retrieval (FIRE) Data System (EPA, April 1999a), <http://www.epa.gov/ttn/chief/fire.html>
 - Air Clearinghouse for Inventories and Emission Factors (Air CHIEF) CD-ROM, <http://www.epa.gov/ttn/chief/airchief.html#order> or (202) 512-1800.

In addition, you should conduct a search of technical papers for source test and background information for the emission source category or pollutants in question. You can conduct this search using EPA library services or through government document depositories at local universities. Examples of references and documents that you should review include:

- Miscellaneous private sector resources. For example, the National Council of the Paper Industry for Air and Stream Improvements, Inc. (NCASI) compiles, through a highly focused research program, reliable environmental data and information on the forest products industry.
- Emission factor reports published by other state and local agencies, and other states' databases and source tests. This information can be identified and acquired through direct communication with the agencies.
- Source test data used for compliance purposes and in developing operating permits for stationary sources may be readily available through state and local air permitting agencies. The use of source test data reduces the number of assumptions regarding the applicability of emission factors to a source.
- Professional societies (e.g., AWMA) symposia publications contain up-to-date information.

Additional databases and documents that contain emission factors for use in inventories are listed in the applicable source methodology chapters in EIIP Volumes II and III.

3.8.4 Where Do I Find Information on Emission Estimation Models?

Several emission estimation models are available for download free-of-charge.

- Landfill Gas Emissions Model (EPA, June 1999)
<http://www.epa.gov/ttn/catc/products.html#software>
- TANKS to estimate emissions from fixed- and floating-roof storage tanks (EPA, May 1999) *<http://www.epa.gov/ttn/chief/tanks.html>*
- WATER8 (EPA, November 1995) and CHEMDAT8 (EPA, November 1994) to estimate air emissions from wastewater collection and treatment systems
<http://www.epa.gov/ttn/chief/software.html#water8>
- MECH for estimating particulate emissions from paved roads, unpaved roads, materials handling, agricultural tilling and construction and demolition (EPA, August 1992b) *<http://www.epa.gov/ttn/chief/software.html#fugitive>*
- PM Calc for estimating PM_{2.5} emissions (EPA, May 1998)
<http://www.epa.gov/ttn/chief/software.html#fugitive>

3.8.5 Where Do I Find Source Characterization Information?

You will need source categorization information to identify the sources you must include in the inventory. Source categorization information includes:

- Description of the sources, facilities, or activities included in the source category. For example, the boiler source category comprises sources that combust fuels to produce hot water and/or steam. The source category definition can include the SIC code or the EPA AIRS AMS source category code.
- Description of emission sources within the source category. For example, the boilers category includes coal-fired boilers, oil-fired boilers, boilers using other types of fuel, cogeneration units, and auxiliary sources.
- Discussion of the factors influencing emissions such as control techniques, influences of weather conditions, or process operating factors.

Several resources are available to you for source characterization. Primary resources include:

- *AP-42*: See Section 3.8.3 for a description.

- *Locating and Estimating Air Emissions from Sources of (Source Category or Substance) (L&E) Documents.* About 30 L&E documents are currently available. Although L&E documents concentrate on hazardous air pollutants (HAPs), these documents can be useful for criteria pollutant inventories because each volume includes general descriptions of the emitting processes, and provides source characterization. L&E documents are available on the CHIEF Web site at <http://www.epa.gov/ttn/chief/ap42etc.html#LE>. **A complete list of L&E documents is included in Appendix H.**
- Industry Sector Notebooks: The EPA's Office of Compliance has developed a series of notebooks profiling selected major industrial groups. Each sector-specific notebook brings comprehensive details that include an environmental profile, industrial process information, and bibliographic references. **A detailed description of the Industry Sector Notebooks project is provided in Appendix F.** Industry Sector Notebooks are available on the World Wide Web at <http://es.epa.gov/oeca/sector/index.html>

Additional resources include:

- EPA reports presenting the results of engineering investigations of air emissions from various industrial processes, such as Control Techniques Guidelines (CTGs) and Available Control Techniques (ACT) documents, and Background Information Documents (BIDs) for New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) or Maximum Achievable Control Technology (MACT) standards. These reports are available through the GPO, the National Technical Information Service (NTIS), and on the World Wide Web at <http://www.epa.gov/ttn/>
- The Integrated Data for Enforcement Analysis (IDEA) system: IDEA is an interactive data retrieval and integration system developed by EPA's Office of Enforcement and Compliance Assurance (OECA). IDEA integrates facility data across EPA's various program office databases. **A detailed description of IDEA is provided in Appendix F and on OECA's Web site at <http://es.epa.gov/oeca/idea/>**
- Air pollution control agency files: Compliance, enforcement, permit application, or other air pollution control agency files may provide valuable information on the location and types of sources in the area of concern. For example, permit applications generally include enough information about a point source to describe the nature of the source and to estimate the magnitude of emissions that will result from its operations. A compliance file might contain a list of air pollution regulations applicable to a given source, a history of contacts made with

that source on enforcement matters, and an agreed-upon schedule for the source to effect some sort of control measures.

- Annual emission statements: Most states require facilities emitting above a certain threshold to submit an annual emission statement listing various processes and their emissions. Annual emission statements should be examined to determine whether the appropriate sources have been included and that the emissions data represent current conditions.
- Other government-funded agencies, such as the Paint and Coating Resource Center (PCRC) and the National Metal Finishing Resource Center (NMFRC): The main function of these Centers is to provide regulatory compliance and pollution prevention information on their respective industries. The PCRC can be accessed on the World Wide Web at <http://www.paintcenter.org/> and the NMFRC can be accessed at <http://www.nmfrc.org/>.

3.8.6 *Where Do I Find Applicable Activity Parameters?*

You may need to use different types of activity data to estimate emissions from area and point sources - even within the same source category. Point sources may require direct measurement or direct activity (i.e., throughput) applied to an emission factor, while emissions from area sources are often estimated using surrogate activity factors, such as population or employment.

Activity Parameters for Point Sources

For point sources, activity parameters are generally reported as fuel consumption rates or process weight rates for fuel-burning equipment and industrial processes, respectively. You will need detailed data on process equipment, throughput, capacity, and other parameters to estimate emissions from point sources. You can obtain this information from contacts with individual facilities. The two most common types of plant contacts are (1) surveys and questionnaires, and (2) direct plant inspections. A type of indirect plant contact also commonly employed is the use of permit applications or compliance files. Other traditional sources of activity data for point sources include:

- State and local industrial directories;
- State Departments of Commerce and Labor statistics;
- National and state directories of manufacturers;
- Data compiled by private research and development companies such as the *Directory of Chemical Producers* compiled by SRI International; and

- Trade and professional associations.

Activity Parameters for Area Sources

Area source emission estimates are generally based on surrogate activity data and an emission factor developed specifically for that activity. Activity data include population, employment, fuel or product usage, product sales, and types of land use correlated with air emissions.

Traditional sources of activity data for area sources include:

- U.S. Department of Commerce publications including *County Business Patterns*, *Census of Population*, *Census of Manufacturers*, *Census of Agriculture*, *County and City Data Book*, *Current Industrial Reports*, *Annual Housing Survey*, and *Census of Retail Trade*;
- U.S. Department of Energy publications such as *State Energy Data Reports*, *Natural Gas Annual*, and *Petroleum Marketing Annual*;
- State Departments of Transportation and State Energy Offices (for information on gasoline consumption and paving activities);
- State Departments of Labor (for employment data by SIC [Standard Industrial Classification] code)
- Local industrial directories (these are often organized by SIC code and provide employment data);
- Regional planning commissions;
- Agency-sponsored surveys;
- State Agricultural Offices and U.S. Department of Agriculture (for pesticide application data);
- State Solid Waste Management Agencies;
- Fire marshals (for information on structural fires);
- Port authorities and waterborne commerce (for information on petroleum vessels loading and unloading activities);
- State Health Departments (for information on hospital sterilizers); and
- Miscellaneous statistical government and trade group publications.

The first 5 sources of information listed are generally the most widely used and provide a great deal of useful information.

3.9 What Data Collection Methods Should I Use?

This section presents information on the different data collection approaches to be used when inventorying point and area emissions sources.

3.9.1 What Methods Are Used to Collect Data for Point Sources?

For point source inventories, you can obtain information by contacting each point source in the inventory area. The two most common types of plant contacts are:

- Surveys; and
- Plant inspections

You can also use indirect plant contact techniques to gather data for point source inventories, such as examining state files (permit applications and compliance files).

You may need to use a combination of data gathering techniques to ensure complete and accurate data are available for compilation of an inventory. Appropriate method(s) are selected during the planning phase of the inventory process, based on data quality objectives and availability of resources.

Surveys

You can use the survey technique to obtain source and emissions data, sending a questionnaire to each point source in the inventory area. To conduct a survey you will need to:

- Identify the facilities to be surveyed;
- Prepare the mailing list, including facility addresses and appropriate plant contact personnel;
- Design and assemble the questionnaire;
- Deliver the questionnaire;
- Establish tracking systems to monitor the status of each step in the survey process;
- Prepare data handling procedures; and

- Establish systems to respond to questions or concerns of survey recipients.

While paper questionnaires and return forms are still in use, it is rapidly becoming more common for these forms to be sent to sources, and responses to be returned, in an electronic format. You can send questionnaires to facilities via e-mail, or post them on the Internet. By using standardized electronic forms for data submittal, you can simplify the process for both the surveyed facilities and your agency. Electronic data systems reduce the chance of data entry errors by inventory preparers.

Appendix M provides a detailed description of how to conduct a survey.

Plant Inspections

Plant inspections give you the opportunity to examine the various processes at a particular facility, interview plant personnel, and review operations and process schematics. While plant inspection is a very resource-intensive data collection technique, it has several advantages over the survey technique:

- Plant inspection provides more complete and accurate information about a facility than a questionnaire;
- Plant inspection allows you to obtain a more complete understanding of an exceptionally complex or unique process;
- Plant inspections reduce errors that can result from misinterpretation of a question by the plant contact responding to the survey; and
- Plant inspections reduce errors that can result from the inventory agency misinterpreting a response by the plant contact.

Examination of State Files

You can also use files maintained by your state/local agency as sources of information. Files that might include data relevant to emissions inventories include:

- Permit files: Permits are generally required for construction, start-up, modifications, and continuing operation of existing facilities. Permit applications include information that can be useful to describe the nature of the source and to estimate the magnitude of emissions that might result from operations.
- Compliance files: Some agencies also maintain compliance files for point sources. These files contain records of communication concerning enforcement

issues, as well as a list of air pollution regulations applicable to the specific source.

3.9.2 What Methods Are Used To Collect Data For Area Sources?

Data sources for area source inventories vary much more than those for point sources. You will collect area source data from a number of diverse sources.

Surveys

You can use surveys of a representative sample to collect data that can be extrapolated to the area source category. You must use caution to ensure that the surveyed subset is representative of the entire population. You may use the same steps to survey area sources as you use for point sources, but often the steps taken are driven by available resources and data.

Appendix M provides a detailed description of how to conduct a survey.

Examination of Local, State, and Federal Documents and Databases

State, local, and federal agencies such as the U.S. Bureau of the Census and the Energy Information Administration generate summary reports containing information on population trends, land use, business patterns, agricultural trends, fuel use, chemical production and use, and meteorological conditions. You will find that these documents are often valuable resources for determining appropriate activity data or parameters for apportioning data. Many of these documents are available on the Internet. You may also find that personnel at these agencies can be valuable data resources.

Examination of Trade Association Reports, Journals, and Databases

Trade association documents, journals, and market research reports can provide information on past sales and future trends for specific industry sectors. You can use this information to determine appropriate activity data or parameters for apportioning data.

3.10 What Is Rule Effectiveness?

Regulatory programs often achieve fewer reductions than anticipated for most source categories in most areas of the country. **Rule effectiveness (RE)**, expressed as a fraction or percent, is an adjustment which reflects the ability of a regulatory program to achieve the required emission reductions. The intent behind the RE factor is to account for the fact that most emission control equipment does not achieve emission reductions at the designed rates at all times and under all conditions, and that some intentional noncompliance exists. Process upsets, control equipment malfunctions, operator errors, equipment maintenance, and other non-routine operations are examples of times when control device performance is expected to be less than optimal.

Rule effectiveness should be applied for all applicable regulations whether federal, state, or local. **Therefore, the RE factor applies to both point and area sources that are controlled. No RE is needed in cases where no control is applied or there is no applicable regulation.**

You should take several factors into account when estimating the effectiveness of a regulatory program. These include:

- The nature of the regulation (e.g., whether any ambiguities or deficiencies exist, whether test methods and/or recordkeeping requirements are prescribed);
- The nature of the compliance procedures (e.g., taking into account the long-term performance capabilities of the control);
- The performance of the source in maintaining compliance over time (e.g., training programs, maintenance schedule, recordkeeping practices); and
- The performance of the implementing agency in assuring compliance (e.g., training programs, inspection schedules, follow-up procedures)

The basic emission estimation equation when RE is applied:

$$E_C = E_{UC} \times (1 - CE \times RE)$$

where:

E_C	=	Emissions after control
E_{UC}	=	Emissions before control
CE	=	Estimated control efficiency (expressed as a fraction)
RE	=	Rule effectiveness (expressed as a fraction)

Additional guidance on estimating and applying RE is provided in the draft paper titled *Clearing Up the Rule Effectiveness Confusion* which is presented in Appendix B. Another draft paper, *Emission Inventories and Proper Use of Rule Effectiveness* is available online from the EIIP at <http://www.epa.gov/ttnchie1/eiip/pointsrc.html>.

An example of the use of RE is provided in Appendix E, Example 10.

3.11 What Is Rule Penetration?

Another important regulatory consideration is the extent to which a regulation covers emissions from an **area** source category. **Rule penetration (RP)** is the percentage of an area source category that is covered by an applicable regulation. 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.

When estimating emissions using area source methods for source categories where a rule or regulation applies, agencies should incorporate an estimate of the amount of rule penetration.

Use this formula to apply RP:
$\text{Rule Penetration} = \left(\frac{\text{Uncontrolled emissions covered by the regulation}}{\text{Total uncontrolled emissions}} \right) \times 100\%$

An example of the use of RP is provided in Appendix E, Example 10.

3.12 How Should I Document the Emission Inventory Process?

This section presents proper documentation procedures that should be followed by the inventory preparer.

3.12.1 Why Is Proper Documentation Important?

Complete and well-organized documentation is necessary to prepare a reliable and technically defensible inventory document. The goal of inventory documentation is to ensure that the final written compilation of the data accurately reflects the inventory effort.

In addition, thorough documentation is necessary to:

- Support QA/QC assessments of the inventory. During the inventory compilation process, QA/QC and technical review of the documentation can identify errors in assumptions, calculations, or methods. Remedial actions can be taken to correct any errors.
- Ensure the reproducibility of the inventory estimates. The inventory documentation should include all of the information necessary for an inventory user or reviewer to reproduce the results of each estimate. A well-documented inventory will provide a “paper trail” for each data point, allowing a user or reviewer to identify all of the resources used to calculate each value presented in the report.
- Enable an inventory user or reviewer to assess the quality of the emission estimates and identify the data references.

- Ensure that the inventory will serve as a solid foundation for future inventories compiled for that inventory area.

3.12.2 *What Records Must Be Kept?*

The documentation of an inventory compilation process involves two phases:

- Documentation of all data collection and emission estimation activities; and
- Compilation of the inventory into a final written report.

Documentation of data collection and emission estimation activities includes the daily recordkeeping that occurs during the inventory preparation process. This documentation is critical to both the integrity of the inventory process and the preparation of the final report. The procedures you use for documentation will be established in the inventory preparation plan (See Section 3.3).

Documentation includes:

- Complete documentation of methods used for all data collection, including explanation of any deviations from the prescribed methods;
- Explanation of all assumptions made in the data collection or analysis;
- All raw data, including identification of the source of each data point;
- All calculations, including copies of work conducted manually and all electronic spreadsheets or databases;
- Records of all relevant communication with team members and data contacts;
- QA/QC records, including responses to issues identified by audits; and
- Identification of sources of emissions not included in the inventory.

The source and type of the raw data will determine what type of information you need to place in the project file.

If the data were collected from...	Then you must maintain the following records...
Surveys	Original survey forms
Site visits	Site visit notes and reports

If the data were collected from...	Then you must maintain the following records...
Source test reports	Complete copies of the reports
Internet pages or electronic bulletin boards	<ul style="list-style-type: none"> - Hard copy printouts of the pertinent data - Electronic copies of complete original data - Complete reference citation
Published document	<ul style="list-style-type: none"> - Complete reference citation - When possible, copies of the pages with the data used in the inventory
Unpublished documents or reports	<ul style="list-style-type: none"> - Complete reference citation - Copies of all pages with data used in the inventory - When possible, a copy of the entire document
Personal communication - written	<ul style="list-style-type: none"> - Complete reference citation (contact name, affiliation, address or phone number, data of communication) - Copies of all pages with data used in the inventory - When possible, a copy of the entire document
Personal communication - verbal	<p>Standardized Contact Report Form should be completed to record information obtained by telephone or at a meeting. An example Contact Report form is presented in EIIP Volume VI, Chapter 2.</p>

You should include the following information on all manual calculation sheets:

- Preparer's name;
- Date prepared;
- Date modified, if applicable;
- Signature of reviewer;
- Date of review;
- References and documentation for all data used in the calculation;

- Explanation of all assumptions; and
- Page number on each page, showing total number of pages.

You must also document calculations performed using spreadsheets. The spreadsheet contains all of the pertinent information used to estimate emissions, but much of the information is often hidden on the summary printout. You must be certain that spreadsheets include the following information:

- Preparer's name;
- Date prepared;
- Date modified, if applicable;
- Spreadsheet version number;
- Name of reviewer;
- Date of review;
- All constants, factors, or other data used in the calculations must be presented; that is, all data needed to reproduce the value should be shown;
- Citations for all data used in the calculation;
- Explanation of all assumptions; and
- Page number on each page, showing total number of pages.

Refer to Appendix N for detailed instructions on procedures to follow when developing, documenting, and reviewing spreadsheet data.

3.13 What Documentation Procedures Must Be Followed?

For all steps in the inventory process, you should follow these procedures:

- Each member of the project team should be assigned a numbered, project-specific, notebook for recording all calculations and assumptions;
- All entries should be initialed and dated;
- Calculations and documentation should be done in ink - not pencil; and

- Errors should be corrected by drawing a single line through the original entry and writing the correct value nearby. All corrections must be initialed and dated by the person making the change.

In order to maintain credible inventory records, the inventory preparation plan will establish documented procedures for:

- File contents: Each member of the team should be aware of what materials must be placed in the project files;
- Location of all paper and electronic records;
- Ensuring that all hard copy records, as well as electronic databases and spreadsheets, are kept up-to-date;
- Adding data or background documentation to the file, including log-in procedures;
- Data tracking: To document who entered or manipulated data;
- Access to files: Checkout policies for paper documents, computer security policies for electronic files;
- Backup and maintenance of electronic files; and
- File name conventions.

3.14 How Do I Track Data Entry?

The procedures you use for tracking data entry will be established in the inventory preparation plan. Emissions inventory efforts often generate large quantities of data from a variety of sources. Development of emissions estimates generally requires data manipulation, including manual calculations, electronic data entry into computer programs, and data checking activities. Sometimes data will change hands several times during the emissions estimation process. This makes it very important that you use the procedures prescribed in the inventory preparation plan to record the **names** of the persons responsible and the **dates** of **each** data manipulation activity.

3.15 How Do I Check the Accuracy of Data Inputs and Manipulations?

The procedures you use for checking the accuracy of data entry and calculations will be established in the inventory preparation plan. It may be possible to build some of these checks into the computer database that is handling the data. For example, a computer program can be set to reject an entry that exceeds a reasonable or expected value. More often, manual QC checks, tracking the data from receipt to final result, are necessary.

It is important to check the transcription of data during the inventory preparation. Data manipulation steps that you need to monitor include:

- Transcription of data from raw data sheets into electronic spreadsheets or for use in manual calculations;
- Transcription of data results into summary tables or reports.

You must also have procedures in place to confirm the accuracy of calculated values. Many of these checks can be conducted with computer programs, others will require manual checks.

Refer to Appendix N for guidance on evaluating accuracy of spreadsheet data.

3.16 How Do I Document QA/QC Procedures?

Each member of the inventory project team should follow the QA/QC documentation procedures prescribed in the inventory preparation plan. All QA/QC activities and results must be documented and reported, either as part of the inventory report, or as a separate document. The report should include:

- Procedures used to meet the QA/QC objectives of the project;
- Technical approach used to implement the QA plan;
- Dates of each audit, and the names of the reviewers;
- Results of QA activities, including problems found, corrective actions, and recommendations; and
- Discussion of the inventory quality.

3.17 What Data Elements Are Required In The Inventory?

The data elements shown in Table 3-1 should be reported in the inventory. The term data element refers to any piece of information used in the inventory compilation process. You will use many types of data, and collect it from a wide range of data sources.

These data element requirements may be modified over time and your agency should contact the EPA Regional office for the most recent list of required data elements.

Table 3-1.

Emission Inventory Data Reporting Elements

Data Element	Point Sources	Area Sources
Start date (Inventory year)	✓	✓
State Federal Information Processing Standards (FIPS) code	✓	✓
County FIPS code	✓	✓
Federal ID code (plant)	✓	
Federal ID code (point)	✓	
Federal ID code (process)	✓	
Site name	✓	
Physical address	✓	
SIC code	✓	✓
SCC	✓	✓
Heat content (fuel, annual)	✓	
Pollutant code	✓	✓
Activity/throughput (annual)	✓	✓
Work weekday emissions	✓	
Summer/winter work weekday emissions		✓
Annual emissions	✓	✓
Emission factors	✓	✓
Winter throughput (%)	✓	✓
Spring throughput (%)	✓	✓
Summer throughput (%)	✓	✓
Fall throughput (%)	✓	✓

Table 3-1.

Emission Inventory Data Reporting Elements (Continued)

Data Element	Point Sources	Area Sources
Hours per day in operation	✓	✓
Start time (hour)	✓	
Days per week in operation	✓	✓
Weeks per year in operation	✓	✓
Federal ID code (stack number)	✓	
X coordinate (latitude)	✓	
Y coordinate (longitude)	✓	
UTM coordinates	✓	✓
Stack height	✓	
Stack diameter	✓	
Exit gas temperature	✓	
Exit gas velocity	✓	
Exit gas flow rate	✓	
Boiler design capacity	✓	
Maximum design rate	✓	
Maximum nameplate capacity	✓	
Primary control efficiency (%)	✓	
Secondary control efficiency (%)	✓	
Control device type	✓	
Control efficiency		✓
Rule effectiveness (%)	✓	✓
Rule penetration (%)		✓

Source: EPA, 1999b

3.18 How Are the Results of an Emission Inventory Reported to EPA?

Your report must meet the format and content requirements specified by the regulation or the agency requiring the inventory. Information on the data and documentation that you are required to submit is presented in Section 5 for point sources and Section 6 for area sources.

Your final report should include:

- Introduction describing the purpose for the inventory development;
- Executive summary of the inventory results;
- Base year of the inventory;
- Geographic area;
- Summary of the emissions data, presented in a matrix format to include pollutant, source, and geographic area;
- Procedures used to collect the data;
- Sources of data, including citations for all emission factors and activity data;
- Methods used to calculate emissions, including example calculations;
- Complete explanation of all assumptions made in the estimation process;
- QA/QC checklists and all audit reports;
- Sample copies of questionnaires, and information concerning the number of questionnaires sent, the number of responses received, methods for extrapolating data to account for nonrespondents, and any assumptions made; and
- Identification of sources of emissions not included in the inventory.

Each EPA Regional Office will determine what information must be submitted as hard copy documentation. You must submit your data to EPA in an electronic form. Use of an appropriate reporting format, for both hard copy and electronic submissions, is important because it:

- Makes the data easily accessible for review;
- Allows for efficient transfer of information;

- Makes it simple to share your data with other air pollution control agencies or interested parties;
- Makes your data easy to compare with data from other sources; and
- Allows the data to be efficiently added to existing databases.

You can submit your data to EPA using one of several data transfer options. The appropriate data transfer method is identified during the planning stage of the inventory process, based on the end use of the inventory and availability of resources.

You should keep in mind that information technology is a rapidly changing field, and electronic reporting of inventory data is an evolving issue. Refer to the EPA Data Submission page at <http://www.epa.gov/ttn/chief/ei/eisubmit.html> for updates on emissions reporting.

Four options are available for data reporting to EPA; refer to Appendix I for a detailed description of these methods. The reporting options are:

- Aerometric Information Retrieval System/Aerometric Information Retrieval Facility Subsystem (AIRS/AFS);
- NET Input Format;
- EIIP EDI X12; and
- Direct Source Reporting.

NOTE: At this time, the NET Input Format and the AIRS/AFS are both viable options for submitting the point source data, although the NET option is the preferred option because the emissions component of AIRS/AFS will be phased out by the end of September, 2000, and the data transferred to the NET format. The NET Input Format is the preferred option for submitting area source data. You should consult the AIRS/AFS Web site at <http://www.epa.gov/ttn/airs/afs/index.html> for the latest memos and information on the plans to migrate the emissions components of AIRS/AFS to the NET database.

If your agency decides not to use any of these methods, they are still required to submit their data in electronic form. Your agency can make special arrangements with EPA to submit another electronic format, but, because of limited resources, EPA may not be able to enter the data into the EPA system. **If your agency does not submit data to EPA in a form it can process, EPA may generate data to represent the emissions from your area.**

3.19 What Are Emission Projections?

Emission projections are needed to determine if a given area will achieve or exceed the NAAQS in future years, and to plan compliance strategies. The basic reference for information on emissions projections is EPA's projection guidance document titled *Procedures for Preparing Emissions Projections* (EPA, July 1991). General projection issues for inventories are also discussed in Volume I of the EIIP series.

The EIIP Projections Committee addresses the needs of local, state, and regional agencies by providing guidance on options for forecasting future emissions. The Committee examines alternatives for projecting emissions changes into the future and develops lists of recommended approaches for applying specific indicators. The EIIP Projections committee technical papers can be accessed on the World Wide Web at <http://www.epa.gov/ttn/chief/eiip/project.htm>. Additional emission projection resources such as the Economic Growth Analysis System (EGAS) and the Multiple Projection System (MPS) can be accessed on the World Wide Web at http://www.epa.gov/ttn/chief/ei_data.html.

There are two types of emission projections:

- Baseline emissions projections; and
- Control strategy emissions projections.

3.19.1 What Are Baseline Emissions Projections?

Baseline emissions projections are estimates of future year emissions that take into account:

- Expected growth in an area;
- Existing air pollution control regulations in effect at the time the projections are made; and
- Promulgated regulations **expected to take effect at future intervals**.

Baseline projections provide a reference point for measuring reasonable further progress (RFP) and determining if additional emission reductions are necessary to attain the NAAQS.

3.19.2 What Are Control Strategy Emission Projections?

Control strategy projections are estimates of future year emissions that also include the expected impact of **modified or additional control** regulations. Control strategy emission projections are used because while baseline emissions projections take into account promulgated regulations

expected to take effect at future intervals, they often do not reflect all of the growth and control scenarios that the agency may wish to evaluate.

3.20 How Do I Maintain the Emission Inventory?

You must monitor and record changes in the total number of sources as well as changes in operation of existing sources. During a year, changes can occur that might impact the emissions inventory. For example:

- Existing facilities could deactivate process equipment or close completely;
- New facilities and/or processes could come online;
- Existing facilities could increase or decrease production schedules;
- Existing facilities could modify their product line;
- Population changes could affect the number and type of area sources;
- Changes in land use patterns could affect the number and type of area sources;
- Changes in regulations could impact the inventory scope; and
- Updates in emission factors or other emission estimation tools could require recalculation of certain emission estimates.

It is necessary to collect new data and information to calculate emissions to represent current conditions. Existing inventories should serve as a starting point because they contain extensive data and support information files. For effective use of resources, you should build upon and improve the quality of existing data to fulfill inventory requirements. Document these changes as you become aware of them and update the emission estimates accordingly.

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4.0 QA/QC PROCEDURES FOR EMISSION INVENTORY PREPARATION

This section presents a general overview of quality assurance (QA) and quality control (QC) procedures. You should read Volume VI of the EIP document series for more detail on QA/QC.

If you need information about...	Then read...
The difference between QA and QC	Section 4.1
DQIs	Section 4.2
DQOs	Section 4.3
QC procedures to follow during inventory development	Section 4.4
QA audits	Section 4.5
Errors typically found in emissions inventories	Section 4.6
Completeness checks	Section 4.7
Double counting emissions	Section 4.8

4.1 Why Is a QA Program Important?

A comprehensive QA program is essential to the preparation of a reliable, defensible emissions inventory. A QA program comprises two distinct components:

- **Quality Control:** A system of routine technical activities implemented by the inventory development team to measure and control the quality of the inventory as it is being compiled. QC procedures include technical reviews, accuracy checks, and the use of approved standardized procedures for emissions calculations.
- **Quality Assurance:** A system of external review and audit procedures conducted by personnel **not** involved in the inventory development process. QA is an independent, objective review by a third party to assess the effectiveness of the QC program and the quality, completeness, accuracy, precision, and representativeness of the inventory.

NOTE: As a member of the inventory preparation team, you will be actively involved in the QC activities, but will not take part in the QA activities.

A common shortcoming of many inventory development programs is that inadequate resources are devoted to QA/QC activities. A general rule of thumb used by many QA professionals is that 10 percent of the allocated resources should be used for QA activities. This does not include the costs of QC, which are assumed to be built into the process. Too often, QA activities are concentrated at the end of the inventory process. An effective QA program will include planning, numerous QC checks during inventory development, and QA audits at strategic points in the process. It is vital that you obtain the commitment of your management to the quality program. This will require the commitment of resources to provide training and proper equipment (e.g., computers) as well as providing sufficient time for the inventory staff to get the work done.

It is your responsibility to perform the appropriate level of QC and technical review prior to releasing your inventory to EPA or others. Do not rely on the recipient or end users of the inventory to perform the QC checks that are your responsibility.

Although the QA/QC process can take significant time and effort, it will save you time in the long run by reducing invalid results. In addition, a thorough QA/QC system ensures confidence in the inventory.

4.2 What are DQIs?

DQIs, data quality indicators, are qualitative and quantitative descriptors used to interpret the degree of acceptability or utility of the data. The principal DQIs are:

- Accuracy: The closeness of a measurement to the true value, or the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of error (precision) and systematic error (bias) that are due to sampling and analytical operations;
- Comparability: The degree to which different methods, data sets, or decisions agree or can be represented as similar;
- Completeness: The amount of valid data obtained compared to the planned amount; and
- Representativeness: Degree to which an inventory is representative of the region and sources it is meant to cover.

Refer to EIIP Volume VI for additional information about DQIs.

4.3 What Are DQOs?

DQOs, data quality objectives, are qualitative and quantitative statements to identify the level of uncertainty that a decision-maker is willing to accept. The purpose of DQOs is to ensure that the final data will be sufficient for the intended use.

DQOs are identified as part of the inventory planning process. They are determined based on the end use of the inventory, but should realistically reflect the limitations resulting from time constraints, resource (staff and funding) limitations, and lack of data. A statement of DQOs should be prepared as part of the inventory preparation plan.

NOTE: Your task manager is responsible for defining the DQOs for the inventory. Your responsibility as the inventory preparer is to make sure your results meet the agreed upon DQOs.

The development of a DQO statement is an iterative process. The managers must work together to balance the quality objectives and the available resources. It is important to acknowledge the constraints that limit the ultimate quality of the inventory, especially if the achievable DQOs fall short of the desired DQOs.

Refer to EIIP Volume VI for additional information about DQOs.

4.4 What Quality Control Procedures Should I Follow?

You should follow prescribed QC procedures while inputting and manipulating data. You should also conduct some of the technical reviews and accuracy checks listed in Table 4-1. These procedures are briefly described below. Carefully review the QA/QC portion of your inventory preparation plan to identify the QC activities you are responsible for.

Quality control is best implemented through the use of standardized checklists that assess the adequacy of the data and procedures at various intervals in the inventory development process. The EIIP series of documents addresses QC procedures and provides detailed checklists to assist you. You should refer to Section 7, Quality Assurance/Quality Control, in Chapter 1, *Introduction to Stationary Point Source Emission Inventory Development*, and to Volume VI of the EIIP series for detailed instructions on how to perform QC checks on your inventory.

Specifically, you should use QC checklists to monitor the following procedures and tasks:

- Data collection;
- Data calculations;

Table 4-1.

Primary QA/QC Functions Of General Types Of Methods

Method	Ensure Reasonableness of Emissions, Data	Ensure Validity of Assumptions, Methods	Ensure Mathematical Correctness	Ensure Valid Data Were Used	Optimize QA/QC Efforts	Ensure Proper Implementation of QA/QC Program	Assess Accuracy of Estimates
Reality checks	✓						
Peer review	✓	✓	✓	✓			✓
Sample calculations			✓	✓			✓
Computerized checks	✓		✓	✓			✓
Sensitivity analysis		✓			✓		
Statistical checks	✓		✓				
Independent audits	✓	✓	✓	✓	✓	✓	
Emissions estimation validation	✓	✓					✓

- Evaluation of data reasonableness;
- Evaluation of data completeness;
- Data coding and recording; and
- Data tracking.

Checklists can assist you in finalizing the inventory prior to submitting it to a reviewing agency (e.g., EPA). The checklist includes questions concerning completeness, use of approved procedures, and reasonableness. **An example QC checklist is included in Appendix N.**

Since most, if not all, of the emission calculations activities are performed electronically, rather than manually, it is critical that the spreadsheets used to generate the emission estimates be checked for accuracy. **Appendix N provides procedures for developing, documenting, and evaluating the data in spreadsheets.**

4.4.1 What Is a Reality Check?

The reality check is the most commonly used QA/QC method and is used to catch large errors early in the estimation process. This check is in the form of the questions “Is this number reasonable?” or “Does this number make sense?” **You should never use the reality check as the sole criterion of quality.** Each reviewer should carefully document the results of the reality check, using standardized forms or report formats, when applicable.

When using the reality check as a QC check of the data, you must keep in mind:

- In order to answer the reality check questions with confidence, the reviewer must have a sound understanding of what is reasonable for the value being estimated;
- An estimate can appear to be reasonable, and be incorrect;
- An estimate can appear to be not reasonable, and be correct; and
- This method does not yield any information about the source of the error.

Table 4-2 summarizes the EIIP preferred and alternative methods for performing reality checks.

Table 4-2.

Reality Checks: Preferred and Alternative Methods

Method	Procedure
Preferred	Compare data or estimate to a standard reference value.
Alternative 1	Compare data or estimate to a value from a previous or alternative inventory (or database) for the same region.
Alternative 2	Compare data to values used for other regions.
Alternative 3	Use expert or engineering judgment to assess the reasonableness of the values.
Alternative 4	Compare estimates for similar categories within the same inventory.

4.4.2 What Is Peer Review and How Does It Benefit the Inventory Process?

Peer review is an independent review of calculations, assumptions, and/or documentation by a person with a moderate to high level of technical experience. Peer review generally involves reading or reviewing documentation. Peer review is conducted to ensure that assumptions and procedures are reasonable, but might not include rigorous certification of data or references.

When using peer review as a QC check of the data, you must keep in mind:

- Peer review is a form of reality check, and therefore has the same limitations;
- For large or complex inventories, it is easy for a peer reviewer to overlook errors.

No specific tools are required to conduct a peer review, but the use of checklists or review forms is recommended. A checklist ensures that reviewers have a clear understanding of what they are expected to do. Also, checklists provide an efficient means to document the QC procedure. Each reviewer should carefully document the results of the peer review, using standardized forms or report formats, when applicable. Table 4-3 summarizes the EIIP preferred and alternative methods for performing peer reviews.

Table 4-3.

Peer Review: Preferred and Alternative Methods

Method	Procedure
Preferred	Use of a checklist showing elements to be covered by the review. Provides a guide for the peer reviewer and can be tailored to fit a specific
Alternative 1	Written comments by reviewer identifying issues noted.
Alternative 2	Written notes summarizing reviewer's comments identifying issues noted by reviewer as told to author of notes.

4.4.3 What Does Replication of Calculations Mean?

Replication of calculations is the most reliable way to detect computational errors and can be done by any team member involved in the inventory. Replication of calculations should be conducted throughout the inventory process by the author of the original calculations as a self-check, by the team member conducting QC checks, and as part of the QA audit.

When using replication of calculations as a QC check of the data, you must keep in mind:

- Replication of calculations does not check to ensure that the approach and assumptions are correct;
- Replication of calculations does not involve a check of the accuracy or quality of the original data; and
- This is a labor-intensive process.

No specific tools are required to conduct replication of calculations, but the use of checklists or review forms is recommended. A checklist ensures that reviewers have a clear understanding of what they are expected to do. Also, checklists provide an efficient means to document the QC procedure. Each reviewer should carefully document the results of the replication of calculations, using standardized forms or report formats when applicable.

Because replication of calculations is a labor-intensive process, you must follow procedures presented in the QA/QC portion of the inventory plan to determine the percentage of calculations to be checked. As a general rule, a minimum of ten percent of calculations is checked, but this percentage will vary depending on:

- The complexity of the calculations;
- The inventory DQOs; and
- The rate of errors encountered in the data that are checked.

Table 4-4 summarizes the EIIP preferred and alternative methods for replication of calculations.

Table 4-4.

Calculation Checks: Preferred and Alternative Methods

Method	Procedure
Preferred	Hand replication of one complete set of calculations.
Alternative 1	Hand replication of most complex calculations.
Alternative 2	Hand calculation using a different method, attempting to approximate the result.

4.4.4 What Are Computerized Checks?

Automated data checks can be built-in functions of databases, models, or spreadsheets or can be designed as stand-alone programs. You can use automated QA/QC functions to facilitate peer review or, in some cases, replace manual reality checks. Computer-based QC checks can process large volumes of data quickly, significantly reducing the amount of time needed to compile and QA an inventory. You can use automated data checks to:

- Check for data format errors. For example, a program can be used to ensure that characters cannot be entered in a field that requires a numerical value;
- Conduct range checks to ensure that data falls within a specified minimum and maximum range; or
- Provide look-up tables to define permissible entries.

When using automated data checks as a QC check of the data, you must keep in mind:

- Human reasoning and judgment are necessary to evaluate the data for errors. Automated data checks are not a substitute for evaluation of the data by an auditor; they serve as a tool to allow an auditor to evaluate the data efficiently;

- These checks provide only the information requested. Data not subject to computerized checks must be evaluated by another means;
- Automated data checks do not check to ensure that the approach and assumptions are correct;
- Automated data checks do not involve a check of the accuracy or quality of the original data; and
- Each reviewer should carefully document the results of the review, using standardized forms or report formats when applicable.

Table 4-5 presents examples of computerized data checks.

4.4.5 *What Are Statistical Checks and How Are They Used?*

Commonly used statistical methods for QC of an emissions inventory are:

- Descriptive statistics - mean, standard deviation, frequency distributions. These are used to summarize the data set and facilitate peer review;
- Statistical procedures to identify outliers; and
- Statistical tests, such as the t-test, can be used for comparability checks, for data validation, or to evaluate the relationships between parameters used in an inventory.

Statistical procedures can be used as tools to facilitate reality checks, peer reviews, and independent audits. They can be used to compare results or to identify unusual or unlikely values. Statistical data checks can process large amounts of data and reduce the subjectivity of informal reality checks. Refer to EIIP Volume VI for additional information.

When using statistical methods for QC checks of the data, you must keep in mind:

- Human reasoning and judgment are necessary to evaluate the data for errors. Statistical analyses are not a substitute for evaluation of the data by an auditor; they serve as a tool to allow an auditor to evaluate the data efficiently;
- Common statistical methods are based on the assumptions of normality. Emissions data are often not normally distributed;
- Statistical data checks do not check to ensure that the approach and assumptions are correct;

Table 4-5.**Summary of Common Automated Checks**

Type of Automated Check	Description	Examples	Strengths/Limitations
Variable type check	Alerts user if wrong data type or inappropriate value is entered.	Numeric value is expected, character string entered: a warning is issued immediately or field is flagged in subsequent report.	Reduces errors early in process, especially if warning issued interactively and/or if incorrect data entry prohibited. Report in which error is flagged is easily ignored.
Range (value) checks	Checks value entered to determine if it is within an expected or acceptable range.	Range of stack heights is used to flag a stack height that is too high or low.	Flags suspicious data for further review. Does not eliminate possibility that wrong value entered is within range, or that value outside range could still be correct.
Look-up table	Uses a parameter (such as user-supplied input variable) to select other appropriate parameters from a table.	User enters a source category code (SCC) and program supplies appropriate emission factor.	Eliminates some types of data entry errors; assures data consistency. If wrong value added (i.e., incorrect SCC), all dependent values will also be wrong.
Pull-down menu, pop-up window	Presents selection of possible values for a particular field.	List of possible fuel types is presented to user when entering data to calculate boiler emissions.	Eliminates transcription errors, reduces chance of using wrong value due to user not understanding what is wanted. Does not eliminate possibility that wrong choice will be made by user.
Completeness/ Consistency checks	These two terms are often used to describe similar operations; include a wide array of checks and/or comparisons.	Checks verify that some specified amount of data for certain fields has been entered; or, if a certain field has data, verifies that other required fields also have data. Assure that units, equipment types, IDs, and other parameters are consistent.	Completeness is often difficult to quantify; in practice, a minimum expected value is used to determine completeness. Does not assure that data are correct. Impossible to completely automate these types of checks, some expert judgment usually required. If too much consistency automated into process, inflexibility may result.

- Statistical data checks do not involve a check of the accuracy or quality of the original data; and
- Each reviewer should carefully document the results of the review, using standardized forms or report formats when applicable.

4.5 How Will Quality Assurance Audits Benefit the Emission Inventory Process?

Independent audits (QA audits) involve a systematic evaluation of the emission inventory preparation process. They are a managerial tool to evaluate how effectively the emissions inventory team complies with predetermined specifications for developing an accurate and complete inventory. QA audits are conducted to determine whether QC procedures in place are effective, are being followed, and if additional QC is necessary to the inventory development process.

Because QA audits are conducted by personnel outside of the emissions inventory team, you will not be involved in this process. You should be prepared to fully cooperate with any auditor who requests information or documentation.

Specifically, QA audits are managerial tools used to:

- Identify staffing issues such as understaffing, or inadequate training of staff;
- Evaluate the effectiveness of the technical and quality procedures used to develop the emissions data;
- Provide confidence in the accuracy and completeness of the emissions data;
- Determine if DQOs are being met;
- Identify the need for additional QC measures; and
- Streamline the costs associated with the inventory development.

4.6 What Types of Errors Are Typically Found in an Emissions Inventory?

Errors commonly found in emissions inventories include:

- Missing facilities;
- Duplicate facilities: name changes through corporate acquisitions;
- Improper facility location data;

- Missing operating or technical data;
- Erroneous technical data: misinterpretation of data or transcription errors;
- Inconsistent point and area source size designation: failure to designate inventory size cutoffs;
- Errors in calculations: transposition of digits; decimal errors; entering wrong numbers; misinterpreting emission factor applications; and
- Data entry and transposition errors; data coding errors.

The QA/QC activities outlined in the inventory preparation plan should address how to avoid these errors, and how to make corrections to the inventory when these errors are found.

4.7 How Do I Identify and Fill Data Gaps?

Data gaps in the inventory may be the result of:

- Pollutants unaccounted for due to a lack of credible emission factors;
- Facilities that are missing or unaccounted for due to incomplete source lists; and
- Source categories that have not been considered due to a lack of credible emission factors or activity data.

Filling data gaps is done on a case-by-case basis and depends on the nature of the data gap and the importance of the source category under review. You should prioritize your gap filling effort. Tools available for gap filling include:

- Performing additional searches of databases to identify appropriate surrogate activity data and emission factors;
- Using the NET database to spatially allocate emissions to the area of study;
- Extrapolating emissions from other geographic areas; and
- Projecting emissions data from past inventories within the same geographic area.

You must carefully document your gap filling actions, including all assumptions made and all resources used.

Data quality issues may surface when filling data gaps. For example, you might derive emissions from a certain source category by projecting emissions from previous national inventories based upon growth indicators. These emissions estimates may not adequately capture facility shutdowns, new facilities, changes in operations relative to the previous inventory levels, or additions of new controls. Thus, while there are emission estimates available for gap filling, the data quality will not be of the same level as the emission estimates developed using actual and current data. You should discuss this tradeoff between accuracy and completeness with your task manager before you make a decision on gap filling strategy.

You can check for completeness by manually comparing your inventory with the lists of pollutants and source categories shown in Appendices J, K, and L. You can also check existing inventories and permit files by source category to ensure that all source types were included. Volume VI of the EIIP document series addresses completeness checks and should be consulted for more information.

4.8 What Is Double Counting and How Do I Avoid It?

Double counting occurs when the emissions from one source are included twice in the same inventory. Double counting can result from:

- **Overlap between point and area sources:** For example, emissions from large dry cleaning facilities (above the threshold for point sources) are included in the point source inventory. If you do not take steps to ensure that these emissions are not included in the area source inventory for dry cleaning facilities, the emissions will be counted twice. Inventory preparers should compare the lists of point and area emission sources to see if any sources have been included in both inventories. If the emissions from a process at a facility have been included in both the point and area source inventories, then the area source inventory must be adjusted downward to avoid double counting the emissions. Examples of area sources that may overlap with point sources are listed in EIIP Volume III. A list of sources you should evaluate for double counting resulting from point and area source overlap is presented in Table 4-6.
- **Overlap between area source categories:** For example, when compiling an emission estimate for the prescribed burning area source category, you must be careful not to include emissions from agricultural burning. To avoid this type of double counting, you must become very familiar with the definitions of each area source category and understand the processes. The chapters in EIIP Volume III provide source categorization information and advise you when to be alert for possible double counting.

Table 4-6.

Source Categories That May Have Area and Point Source Contributions^a

Process	Category Examples
Fuel Combustion	
	Electric Utilities
	Industrial Fuel Combustion
	Commercial Fuel Combustion
Industrial Processes	
	Chemicals and Allied Products
	Metals Production
	Rubber and Plastics
	Oil and Gas Production
	Mineral Processes, Mining and Quarrying
	Construction/Demolition
	Machinery
	Petroleum Refining
Solvent Utilization	
	Graphic Arts
	Surface Coating
	Dry Cleaning
	Degreasing
Storage and Transport	
	Petroleum and Petroleum Product Storage and Transport
	Organic Chemical Storage and Transport
	Rail and Tank Car Cleaning
Waste Disposal and Recycling	
	Wastewater Treatment
	Treatment, Storage and Disposal Facilities (TSDFs)
	Scrap and Waste Materials
	Landfills
Miscellaneous Sources	
	Cooling Towers
	Firefighting Training
	Engine Testing

^a Common examples based on AIRS source codes are listed. Almost any source category could include point sources. Coordination between point and area source inventory preparers is required to insure that all sources are properly accounted for and that emissions are not double counted.

In each of these cases, care to prevent double counting must be taken during the area source inventory process. When area sources overlap with point sources, the area source inventory must be adjusted downward by subtracting out the emissions contributions from the major sources.

Use this equation to adjust area source inventories for point source contributions:

$$\text{Area Source Activity} = \text{Total Activity of Source Category} - \text{Sum of Point Source Activity}$$

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5.0 POINT SOURCE INVENTORIES OF CRITERIA POLLUTANTS

This section describes issues relevant only to point sources.

If you need information about...	Then read...
What emission sources to include in the inventory	Sections 5.1 and 5.2
Level of detail of inventories	Sections 5.3
Special issues to consider during inventory development	Section 5.4
Emissions estimation methods	Section 5.5
Temporal allocation of emissions	Section 5.6

5.1 What Sources Should Be Included?

The pollutants to be inventoried must be determined before the relevant source categories can be identified and prioritized. The pollutants of interest for ozone precursor inventories are VOC, NO_x, and CO. If needed, it is efficient to inventory pollutants such as SO₂, PM, Pb, and CO at the same time.

After you identify the pollutants to be inventoried, you will need to identify the source categories to be included in the emissions inventory. The number and types of the sources to be included is generally determined by the regulations driving the need for the inventory. For example, a SIP inventory requires that point, area, mobile, and biogenic sources be inventoried and a very thorough accounting of sources within each of these groups is expected. It is important that the inventory planners specify clearly which sources are to be included.

EPA has published several documents containing general guidance for compiling emissions inventories:

- EIIP Volumes I through VIII;
- *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources* (EPA, May 1991);

- *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations* (EPA, April 1999b); and
- EPA publishes annual estimates of national emissions from criteria air pollutants for over 450 individual source categories that include all major sources of anthropogenic emissions (EPA, December 1998).

Through all these documents, EPA identifies numerous source categories for point and area sources. These references are good starting points for developing a list of source categories in the inventory area. Note however, that not all the sources listed in these documents may be operating in your inventory area. Since the source category coverage is driven by the pollutants of interest, you should research possible sources for the particular pollutants and determine if any are operating in the inventory area.

You should also be aware that while some source categories (such as electric utilities) are usually treated as point sources, others (such as dry cleaners and service stations) can be either point or area sources depending on the size of the operation and the corresponding emission levels. 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.

Appendix J provides summary tables based on the 1997 National Air Pollutant Emission Trends Update (EPA, December 1998). These tables present criteria pollutants, by pollutant, emitted from stationary and natural sources. Appendix J also shows the emissions contributions of various source categories relative to the overall emissions levels, and relative to the emissions from each main source category. For example, the CO table in Appendix J shows that in 1997, 24 percent of the CO emissions from stationary and natural sources were emitted from fuel combustion sources. The table also shows that electric utilities were responsible for 8 percent of the CO emitted from fuel combustion sources. Moreover, the CO table shows that coal-fired boilers at electric utilities resulted in 63 percent of CO emissions from all electric utilities.

A list of potential point source categories and the associated criteria air pollutants emitted from each is provided in Appendix K. Appendix K is based on an analysis of EPA's NET database and is provided to help you focus the point source inventory efforts (EPA, April 1999b). Appendix K shows where EPA's database indicates that significant point source emissions occur. The H (high), M (medium), and L (low) designations indicate the level of significance of the emissions from a source category to the overall emissions of that pollutant. A "✓" indicates that emissions of the pollutant may occur from that category but are not considered significant. A blank cell indicates that no emissions of the pollutant were recorded in EPA's NET database for that source category.

Point sources are typically categorized into the following broad groups:

- Fuel combustion (external combustion boilers, internal combustion engines);
- Waste disposal;
- Food and agriculture industry;
- Metallurgical industry;
- Petroleum-related industries;
- Mineral products industry;
- Chemical process industry;
- Wood products industry; and
- Storage Tanks.

Because the source categories included in the inventory are driven by the pollutants of interest, you should research possible sources of criteria pollutants and determine if any are operating in your inventory area. Specifically, you should:

- Research all of the documents and tools made available by EPA, the historical and current knowledge of your inventory area, and current research publications. All possible source categories for the given pollutant and inventory type should be investigated;
- Eliminate any sources that are not found within the inventory area. For example, in the mineral products industry, hot mix asphalt manufacturing may not occur in the inventory area;
- Prioritize the list of remaining categories based on the expected magnitude of emissions or some other measure of importance, such as the purpose of the inventory, regulated sources, sources under study for future regulations, or sources of specifically targeted pollutants;
- Consider the time and budget constraints under which you are operating; such constraints may require that the list of remaining source categories be reduced

further. Resources should be allocated preferentially to the sources that are most important for meeting the inventory objectives;

- Eliminate from your source category list any categories for which no emission factors or acceptable methods have been developed.
- Document your decisions for the benefit of future preparers who may be able to expand the inventory's coverage or scope.

5.2 How Do I Identify Specific Point Sources in the Inventory Area?

Compiling a list of facilities to be included in the inventory is the first necessary step in developing an inventory. The list should identify each facility by name, address, size, and SIC.

NOTE: Because the SIC code assigned to a facility denotes the principal economic activity of the firm, the code may not correspond to the activity contributing to emissions. Appropriate source classification codes (SCCs) that identify process operations producing emissions, should be assigned to the facility, as well.

If possible, a facility contact name and phone number of the person responsible for working with the agency should also be identified in the facility list. You can use the facility list to determine if the resources allocated for the inventory development effort are sufficient. Frequently, you will identify more sources during the inventory process than you believed to exist during the initial planning stages.

As a starting point, you should review the information in Appendices J and K. These include information relating criteria pollutants to source categories. Your review of these tables will provide you with a general understanding of which pollutants are likely to be emitted from which source categories.

Other sources of information that are useful for identifying which point sources to inventory are as follows:

- NET report/database;
- State and local commerce directories;
- Existing state inventories of criteria pollutants and HAPs. An existing point source inventory is the best source of information, particularly if it has been frequently updated and well documented. A list prepared from the existing inventory will require updating by:
 - Deleting any point source that has discontinued operation;

- Making appropriate changes for any source that has changed status; and
 - Adding new point sources.
- Other agency files: Existing registration program of point sources (through annual inventory submittal programs, permit renewal programs, Risk Management Plan submittals, and/or upset and malfunction reports) though such programs usually do not include smaller significant point sources or fugitive emissions. Also, compliance, enforcement, and permit files are a useful source of information;
 - TRI data for your state, <http://www.epa.gov/opptintr/tri/access.htm>
 - Files of other government agencies (labor, tax, commerce and trade agencies). State and local industrial directories typically contain companies listed alphabetically by SIC code and county;
 - Standard and Poors, Registration of Corporations;
 - Thomas Register;
 - Trade and professional societies;
 - The *Dun and Bradstreet Million Dollar Directory* listing companies with sales over \$1,000,000 per year by SIC code and county, <http://www.dnb.com/>; and
 - Information regarding industries that are prevalent in the state (the agency may establish emission cutoff levels to exclude smaller sources from the inventory).

You should be cautious when using HAP inventories or existing registration programs as sources of information on facilities emitting criteria pollutants. In general, you will be dealing with the same type of sources in both criteria and HAP inventories because most HAPs are a subset of either PM or VOC. However, **not every source of criteria pollutant emissions will be included in the HAPs inventory. Moreover, you must not rely solely on existing HAP inventories for a complete list of sources to be covered in your criteria pollutant inventory.**

5.3 At What Level of Detail Are Point Source Inventories Compiled?

Point source inventories are compiled at differing levels of complexity. The appropriate level of complexity is determined during the planning phase of the inventory process, based on the end use of the inventory, data quality objectives, and availability of resources.

Note: If the inventory is to be used in a regional modeling effort, modelers should be aware that data must be collected in a consistent manner across the participating states.

Levels of complexity for point source inventories are distinguished by the entity defined as the emission source:

- Plant level: The emission source is defined as an entire plant or facility;
- Process level: The emission source is defined as a process or operation within a facility; and
- Unit level: The emission source is defined as a stack, vent, or other unique point of emission to the ambient air.
- Segment level: The emission source is defined by the operating scenario of a process or operation within a facility (for example, two or more fuels).

5.4 What Special Issues Should I Consider When Estimating Criteria Pollutant Emissions from Point Sources?

When compiling an emissions inventory, you should consider the issues presented in Table 5-1.

5.5 What Emissions Estimation Methods Should I Use?

Inventories of point sources are usually approached on a facility-by-facility basis due to the significance of their emissions. The methods most commonly used in estimating emissions of criteria pollutants from point sources include:

- Continuous emissions monitor (CEMs);
- Source testing;
- Material balance;
- Emission factors;
- Fuel analysis;
- Emission estimation models (usually software); and
- Engineering judgment.

Table 5-1.

Issues to Consider When Estimating Criteria Pollutant Emissions from Point Sources

For a point source inventory, you should...	Because...	Helpful references include...
Carefully consider what source categories to include in the inventory.	Attempting to inventory all source categories may overburden an agency's resources, especially if a majority of the sources are deemed insignificant contributors to pollution by the state. A screening study will help you focus the inventory effort.	Guidance on how to conduct screening studies for the purpose of inventory development is available in Appendix L.
Consider threshold levels of emissions for sources to be included in the inventory.	If the agency does not preclude reporting of emissions below specific exemption or <i>de minimis</i> levels, the effect on agency resources may be similar to that of inventorying all source categories for all criteria pollutants.	
Consider the differences in the source definition(s) for the purposes of criteria and HAP inventories when using a HAP inventory as a starting point for the criteria pollutant inventory.	Some industrial sources with PM or VOC emissions below typical cutoff levels may be categorized as area sources for the purpose of a criteria pollutant inventory, but may qualify as major point sources for the purpose of a HAP inventory.	
Check the results of any survey for completeness.	When surveying sources directly, there may be a need to follow-up with a facility, particularly if you believe it is emitting a certain pollutant it does not report.	

Table 5-1.

Issues to Consider When Estimating Criteria Pollutant Emissions from Point Sources (Continued)

For a point source inventory, you should...	Because...	Helpful references include...
Stay informed of air regulations and rule development activities and implementation information.	Some MACT standards may also contain information that addresses emission limits on criteria pollutants (e.g., a standard may use PM concentration as a surrogate to measure non-volatile metals concentration as part of total HAP reductions).	You can access comprehensive MACT rule-specific information including <i>Federal Register</i> publications and citations, compliance dates, and MACT rule contact names and phone numbers through the UATW site at http://www.epa.gov/ttn/uatw/eparules.html .
Keep in mind that nationally-derived emission factors may not apply directly to your area and may need to be adjusted.	Emissions calculated using national emission factors may vary considerably from actual values at a specific source or within a specific geographic area.	
Avoid double counting of sources and emissions.	Overlap can occur between point and area sources.	Section 4.8 of this document and EIIP Volumes II and III.
Know your pollutants.	For example, several VOC are considered photochemically nonreactive by the U.S. EPA as defined in the CAA and are not included in VOC emissions inventories (63 FR 17331, April 9, 1998: Part 51 “Air Quality Revision to Definition of VOC - Exclusion of Methyl Acetate.”).	

Table 5-1.

Issues to Consider When Estimating Criteria Pollutant Emissions from Point Sources (Continued)

For a point source inventory, you should...	Because...	Helpful references include...
Make sure you account for fugitive emissions. Fugitive emissions are emissions that are technically infeasible to collect and control such as emissions from stockpiles, material handling and transfer operations, and process leaks.	Fugitive emissions may account for a substantial portion of actual emissions from many facilities.	
Account for factors influencing emissions such as process variability and/or equipment malfunctions and upset conditions.	Variations in emissions due to normal process variability or abnormal operating conditions can result in emissions increases which can be difficult to quantify.	Volume II, Chapter 12, of the EIIP document series addresses this topic and should be reviewed for details on how control device malfunctions affect emissions. The document also provides example calculations.

It is important for you to select estimation methods and approaches based on the best available data. You will need to conduct the selection process for each source category and pollutant being inventoried. The EIIP guidance documents refer to “preferred” and “alternative” methods for estimating emissions for each source category. Selection of a preferred or alternative emission estimation procedure takes place in the planning phase of the inventory development process, and should be documented in the inventory preparation plan.

Inventory planners should consider these factors when choosing a methodology:

- Source category priority;
- Agency resources;
- Data quality objectives;
- Availability of data; and
- Intended use of the inventory.

5.5.1 *Continuous Emissions Monitors*

Continuous emissions monitors (CEMs) measure and record actual emissions during the time period the monitor is operating and the data produced can be used to estimate emissions for different operating periods. CEMs are typically used to measure stack gas concentrations of NO_x, CO₂, CO, SO₂, and total hydrocarbons (THC). CEMs can either be permanently installed at a source to generate data 24-hours a day or they can be used for emissions monitoring during a defined source testing period (e.g., 1 to 4 hours).

Appendix D includes example calculations illustrating the use of CEM data for estimating emissions from point sources.

5.5.2 *Source Tests*

Source tests are short-term emission measurements typically taken at a stack or vent. The raw data contained in source test reports can be used to develop emission factors for each pollutant and emission source of interest. There are several advantages for using source test data in emissions inventories:

- Source test data are of great value for obtaining general information on the characteristics of a particular industry and for obtaining specific information on pollutants being emitted and control device operational parameters.

- Although site-specific, source test data can be extrapolated to apply to other representative emission sources for purposes of calculating emissions.
- Source testing reduces the number of assumptions regarding the applicability of generalized emission factors, control device efficiencies, operating procedures, and fuel characteristics. As a result, source testing generally yields more accurate emission estimates than emission factors or material balance.

However, the use of source test data in emissions inventories may be limited for several reasons:

- Source testing can be expensive, especially if the cost is compounded by a large number of processes to be tested; and
- Source testing provides a “snapshot” of emissions from a process. As a result, uncertainties in source testing emission estimates arise because the process conditions may change over time while the test results can only reflect the emission rate and conditions during the test runs.

Two items should be noted when using source test data to calculate emissions:

- Because most source tests are only conducted over several hours or days at most, adjustments may need to be made when using these data to estimate emissions over longer time intervals. Emission data from a one-time source test can be extrapolated to estimate annual emissions only if the process stream does not vary and if the process and control devices are operated uniformly. **Refer to the example calculations in Appendix D.**
- A source test may not adequately describe a given facility’s annual or seasonal operating pattern. For example, there may be variations in process operation throughout the year or the efficiency of control device performance may vary due to fluctuations in ambient temperature or humidity. In such cases, multiple tests must be conducted for source testing to be useful in generating an emission estimate for extended periods that are longer than the test period.

Source test reports usually summarize emissions for each pollutant by expressing them in terms of:

- Mass loading rate: Weight of pollutant emitted per unit time;
- Emission factor: Weight of pollutant emitted per unit of process activity; or

- Flue gas concentration: Weight or number of moles of pollutant per weight or volume of flue gas.

Generally, when a mass loading rate or emission factor is provided in a test report, the resulting emission estimates can be easily calculated by multiplying the mass loading rate by the total hours of operation or by multiplying the emission factor by the throughput. (Throughput is a measure of output or production over a period of time). However, if the report provides a flue gas concentration, the emissions calculations are more detailed.

Appendix D includes example calculations illustrating the use of source testing data for estimating emissions from point sources.

EPA has developed reference and equivalent methods for measuring emissions of PM, SO₂, NO_x, CO, Pb, and VOC. **The reference methods are published in Title 40, Code of Federal Regulations, Part 60, Appendix A.** The Emission Measurement Technical Information Center (EMTIC) provides technical guidance on stationary source emission testing.

5.5.3 Material Balance

When you use material balance, you will determine emissions by knowing the amount of a certain material that enters a process, the amount that leaves the process by all routes, and the amount shipped as part of the product itself. The simplest method of material balance is to assume that all solvent consumed by a source process will evaporate during the process.

The material balance method:

- Can be used where source test data, emission factors, or other developed methods are not available;
- Is most appropriate to use in cases where accurate measurements can be made of all process parameters except the air emission component;
- Is particularly useful for processes like solvent degreasing operations, and surface coating operations.
- Is equally applicable to point and area sources.
- Should not be used for processes where material reacts to form secondary products or where the material otherwise undergoes significant chemical changes.

The basic emission estimation equation for mass balance is:

$$E_x = (Q_{in} - Q_{out}) \times C_x$$

where:

- E_x = total emissions for pollutant x
- Q_{in} = quantity of material entering the process
- Q_{out} = quantity of material leaving the process as waste, recovered, or in product
- C_x = concentration of pollutant x in the material.

The term Q_{out} could involve several different “fates” for an individual pollutant. This could include the amount recovered (or recycled) or the amount leaving the process in the product or waste stream.

If a material balance method is used to estimate emissions and if the actual emissions are a small fraction of the throughput, the throughput estimate or measurement can be even more critical. For example, applying material balances to petroleum product storage tanks is not generally feasible because the losses are too small to quantify using a metering device. In these cases, *AP-42* or equations or TANKS can be used.

Because the emissions are estimated to be the difference between the material input and the known material output, a small percentage error in estimating the input or output can result in a much larger percentage error in the emission estimate. For this reason, material balances are sometimes inappropriate for estimating relatively small losses.

Appendix D includes example calculations illustrating the use of material balance.

5.5.4 Emission Factors

Emission factors allow the development of generalized estimates of typical emissions from source categories or individual sources within a category. Emission factors, used extensively in point source inventories, estimate the rate at which a pollutant is released to the atmosphere as a result of some process activity. For example, the emission factor for NO_x emissions from the combustion of anthracite coal is 9 pounds of NO_x per 1 ton of coal burned (9 lb/ton). If you know the emission factor and the corresponding activity level for a process, you can estimate the emissions. 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. The use of emission factors is straightforward when the relationship between process data and emissions is direct and relatively uncomplicated. Note, however, that emission factors may be developed assuming no control device is in place. These are referred to as “uncontrolled emission

factors.” When emission factors are derived from data that was obtained from facilities with a control device in place, then emission factors are referred to as “controlled emission factors.”

While the emissions calculated using emission factors may differ from actual emissions for a specific facility, emission factors nevertheless provide a reasonable estimate of pollutant emissions across an entire source category. 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 indicate higher than actual emissions for some sources and lower than actual emissions for others.

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, you should be aware of 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 when:

- No locally derived factor exists;
- The local mix of individual sources in the category is similar to the national average; and
- The source is a low priority in the inventory.

Locally derived emission factors are preferred when:

- A national level emission factor does not account for local variations; and
- The category is a high priority in the area.

Locally derived emission factors are developed based on:

- Local surveys or measurements;
- Local consumption data; and
- Adaptation of 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.

If you use factors to predict emissions from new or proposed sources, you should review the latest literature and technology to determine whether such sources would likely exhibit emission characteristics different from those sources from which the emission factors were derived.

Emission factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. To calculate emissions using emission factors, four basic inputs to the estimation algorithm are required:

- Activity information for the process as specified by the relevant emission factor;
- An emission factor to translate activity information into uncontrolled or controlled emission estimates;
- Rule effectiveness factor; and
- When applicable, information on capture and control efficiencies of any control device when using an “uncontrolled” emission factor.

The basic emission estimation equation when using an uncontrolled emission factor is:	
	$E = A \times EF \times (1 - C \times RE)$
where:	
E	= emission estimate for the process
A	= activity level such as throughput
EF	= emission factor assuming no control
C	= capture efficiency x control efficiency (expressed in percent); C equals zero if no control device is in place
RE	= rule effectiveness, an adjustment to C to account for failures and uncertainties that affect the actual performance of control.

The basic emission estimation equation when using a controlled emission factor is:	
	$E = A \times EF \times RE$
where:	
E	= emission estimate for the process
A	= activity level such as throughput
EF	= “controlled” emission factor
RE	= rule effectiveness

5.5.5 Fuel Analysis

Fuel analysis can be used to predict emissions based on the application of conservation laws. The presence of certain elements in fuels may be used to predict their presence in emission streams. This includes elements such as sulfur which may be converted to SO₂ during the combustion process.

The basic equation used in fuel analysis emission calculations is:

$$E = Q_f \times \text{Pollutant concentration in fuel} \times (MW_p/MW_f)$$

where:

Q_f	=	throughput of the fuel, mass rate (e.g., lb/hr)
MW_p	=	molecular weight of pollutant emitted (lb/lb-mole)
MW_f	=	molecular weight of pollutant in fuel (lb/lb-mole)

Appendix D includes an example calculation illustrating the use of the fuel analysis equation in estimating SO₂ emissions.

5.5.6 Emission Estimation Models

You can use emission models to estimate emissions in cases where:

- The calculations are very complex; and
- A combination of parameters has been identified that affect emissions, but individually, do not provide a direct correlation.

Some of the available emission estimation models are based on measured or empirical values. Models often use computers, so that a large number of equations and interactions can be easily manipulated and the effect of many different parameters can be accounted for. **The most widely used emission estimation models are listed in Section 3.8.4 and described in detail in Appendix G.**

Additional emission estimation models are described in the various chapters of the EIIP series. Specifically, Chapter 5 of Volume II of the EIIP series describes additional models for estimating air emissions from wastewater collection and treatment systems. Chapter 10 of Volume II describes programs available for estimating emissions from oil and gas field processing operations.

NOTE: If you choose to use a non-EPA model to estimate emissions, you should do a thorough evaluation of that model/software and you should get prior approval from your EPA Regional Office.

5.5.7 Engineering Judgment

You should consider “engineering judgment” to be a last resort to be used only if none of the methods described above can be used to generate accurate emission estimates. Engineering judgment may involve the application of speculative or innovative ideas, a poorly documented emission factor, or a crude material balance. In cases where no emission factors are available but adverse risk is low, it may be acceptable to apply factors from a similar source category using engineering judgment.

5.6 Is Temporal Allocation Necessary for Point Source Inventories?

5.6.1 What Is Temporal Allocation?

Temporal adjustments are made because of seasonal differences in the rate of emissions or high activity, or to apportion emissions to a particular season or day. For example, high photochemical ozone levels are generally associated with the warmer months of the year, while CO emission levels are generally associated with the colder months of the year. For air quality planning purposes, ozone precursor emissions should be determined during the months constituting the ozone season for ozone inventories. Peak ozone season for most areas of the United States is May through September. Likewise, the CO emissions inventory should reflect the conditions when peak CO air quality conditions occur. For many, but not all areas of the country, the peak CO season will be in the winter months (December through February). Regional air quality modeling efforts may require hourly emission rates.

You may need to adjust your emissions estimates to account for temporal differences in:

- **Activity level:** The level of activity of some area sources varies throughout the calendar year. Some industrial activities are conducted only five days per week. Some operations, such as architectural surface coating, are more active in Spring through Fall, because of the warmer temperatures and the increased number of daylight hours. Other sources, such as residential heating, are active only in the colder months.
- **Rate of emissions:** Seasonal variations in temperature can impact the rate of emissions, even for sources that maintain constant activity levels. For example, at petroleum product handling and storage operations, breathing losses from fixed-roof tanks are significantly influenced by changes in the temperature of the product.

5.6.2 *How Do I Make Temporal Adjustments?*

Emission estimates or activity data for point sources are often presented as a rate per unit time (e.g., pounds per hour or tons per year). You may need to adjust these data to apportion the emissions over time for the inventory period. You can use source-specific data for annual or daily hours of operation to apportion emission estimates and to scale up or down as needed.

Default temporal profiles (i.e., hours/day, days/week, weeks/year) are often used to develop hourly estimates from annual estimates. Temporal allocation factor files are available in a text file or a Microsoft Access[®] database file from EPA's Emissions Characterization and Prevention Branch, RTP, NC (919-541-4593).

6.0 AREA SOURCE INVENTORIES OF CRITERIA POLLUTANTS

This section describes issues relevant only to area sources.

If you need information about...	Then read...
What emission sources to include in the inventory	Sections 6.1 and 6.2
Level of detail of inventories	Section 6.3
Special issues to consider during inventory development	Section 6.4
Emissions estimation methods	Section 6.5
Temporal allocation of emissions	Section 6.6

6.1 What Sources Should Be Included?

The pollutants to be inventoried must be determined before the relevant source categories can be identified and prioritized. The type of pollutant(s) to be covered in the inventory depends on the purpose of the inventory. For example, the pollutants of interest for ozone precursor inventories are VOC, NO_x, and CO. If needed, it is efficient to inventory pollutants such as SO₂, PM, Pb, and CO at the same time.

An area source inventory enables the agency to estimate emissions collectively for those sources that release small amounts of a given pollutant and/or are too numerous to be inventoried individually as part of the point source inventory. While most stationary sources of NO_x, CO, and SO₂ are associated with combustion processes and considered point sources, VOC and PM sources are generally relatively low emitters (i.e., fall below the threshold for point sources) and are treated as area sources. VOC emissions are usually associated with solvent use, and PM emissions are associated mostly with combustion sources and fugitive dust from unpaved roads and other sources.

You should also keep in mind that some source categories (such as forest wildfires and pesticide application), are almost always treated as area sources. Others, such as dry cleaners and service stations, can be either point or area sources depending on the size of the operation and the corresponding emission levels. 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. You may need to adjust the area source inventory to avoid double counting. The approach to correct for double counting is described in Section 4.8 of this document.

Appendix J provides summary tables based on the 1997 National Air Pollutant Emission Trends Update (EPA, December 1998). These tables present criteria pollutants, by pollutant, emitted from stationary and natural sources. Appendix J also shows the emissions contributions of various source categories relative to the overall emissions levels, and relative to the emissions from each main source category group. For example, the VOC table in Appendix J shows that in 1997, 85 percent of the VOC emissions from stationary and natural sources were emitted from industrial processes. The table also shows that solvent utilization was responsible for 66 percent of the VOC emitted from industrial processes. Moreover, the VOC table shows that degreasing operations resulted in 11 percent of VOC emissions from all solvent utilization.

A list of potential area source categories and the associated criteria air pollutants emitted from each is provided in Appendix L. Appendix L is based on an analysis of EPA's NET database and is provided to help you in focusing your area source inventory efforts (EPA, April 1999b). Appendix L shows where EPA's database indicates that significant area source emissions occur. The H (high), M (medium), and L (low) designations indicate the level of significance of the emissions from a source category to the overall emissions of that pollutant. A "✓" indicates that emissions of the pollutant may occur from that category but are not considered significant. A blank cell indicates that no emissions of the pollutant were recorded in EPA's NET database for that source category.

Area sources are typically categorized into the following broad groups:

- Fuel combustion;
- Chemical and allied products manufacturing;
- Metal processing;
- Petroleum and related industries;
- Other industrial processes;
- Solvent utilization (e.g., surface coating, dry cleaning, degreasing, and graphic arts);
- Storage and transport;
- Waste disposal and transport;
- Natural sources (e.g., wind erosion); and
- Miscellaneous sources (e.g., unpaved roads and agricultural burning).

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

The importance of area source categories may vary for different areas. Some of the area sources listed in Appendix L may not exist in a given area; others may be prohibited by regulation; and some area source categories in your inventory area may be missing from Appendix L.

Because the source categories included in the inventory are driven by the pollutants of interest, you should research possible sources of criteria pollutants and determine if any are operating in your inventory area. Specifically, you should:

- First review existing inventories for your area;
- Research all of the documents and tools made available by EPA, the historical and current knowledge of your inventory area, and current research publications. All possible source categories for the given pollutant and inventory type should be investigated;
- Eliminate any sources that are not found within the inventory area. For example, aviation gasoline distribution and open burning of scrap tires may not occur in the inventory area;
- Prioritize the list of remaining categories based on the expected magnitude of emissions or some other measure of importance, such as the purpose of the inventory, regulated sources, sources under study for future regulations, or sources of specifically-targeted pollutants;
- Consider the time and budget constraints under which you are operating; such constraints may require that the list of remaining source categories be reduced further. Resources should be allocated preferentially to the sources that are most important for meeting the inventory objectives;
- Eliminate from your source category list any categories for which no emission factors or acceptable methods have been developed.
- Document your decisions for the benefit of future preparers who may be able to expand the inventory's coverage or scope.

6.2 How Do I Identify Area Sources in the Inventory Area?

To compile an area source inventory, you will need to identify two different types of sources:

- Facilities, or activities within facilities, that emit levels of criteria pollutants below the threshold level for point sources: Such facilities include dry cleaners and segments of the graphics arts industry.
- Activities that result in emissions of criteria pollutants below the threshold level for point sources: You will need to consider a diverse group of activities including surface coating, pesticide application, solvent use, asphalt use, agricultural burning, construction, residential wood combustion, and livestock production.

As a starting point, you should review the information in Appendices J and L. These include information relating criteria pollutants to source categories. Your review of these tables will provide you with a general understanding of which pollutants are likely to be emitted from which source categories.

Compiling a list of source categories to be included in the inventory is the first necessary step in developing an inventory. Sources of information other than Appendices J and L that are useful for identifying which source categories to inventory are:

- Existing state/local inventories of criteria pollutants and HAPs. An existing area source inventory is the best source of information, particularly if it has been frequently updated and well documented. A list prepared from the existing inventory will require updating by:
 - Deleting any area source that has discontinued operation;
 - Making appropriate changes for any source that has changed status; and
 - Adding new area sources.
- TRI data for your state, <http://www.epa.gov/opptintr/tri/access.htm>;

You should be cautious when using HAP inventories or existing registration programs as sources of information on facilities emitting criteria pollutants. In general, you will be dealing with the same type of sources in both criteria and HAP inventories because most HAPs are a subset of either PM or VOC. However, **not every source of criteria pollutant emissions will be included in the HAPs inventory. Moreover, you must not rely solely on existing HAP inventories for a complete list of sources to be covered in your criteria pollutant inventory.**

6.3 At What Level of Detail Are Area Source Inventories Compiled?

Area source emissions inventories are compiled at differing levels of detail. The appropriate level of complexity is determined during the planning phase of the inventory process, based on the end use of the inventory, data quality objectives, and availability of resources.

Note: If the inventory is to be used in a regional modeling effort, modelers should be aware that data must be collected in a consistent manner across the participating states.

Levels of complexity for area source inventories are distinguished by the geographic area used for the inventory:

- Air quality control region (AQCR) level: AQCRs correspond to high pollution urban areas defined in 40 CFR. The boundaries of AQCRs tend to coincide with those of counties or states, but AQCRs can be either interstate or intrastate.
- County level: Much of the data necessary to compile an inventory is collected on a countywide basis, providing an excellent foundation for the inventory process.
- Grid level: The Universal Transverse Mercator (UTM) coordinate system is commonly used to impose uniform grid zones onto geographic areas to permit the allocation of county level activity and emission data to grid levels. Grid level inventories are conducted for specific end uses, such as dispersion modeling, when fine geographical resolution is required.

6.4 What Special Issues Should I Consider When Estimating Criteria Pollutant Emissions from Area Sources?

When compiling an emissions inventory, you should consider the issues presented in Table 6-1.

6.5 What Emissions Estimation Methods Should I Use?

It is important for you to select the estimation methods and approaches based on the best available data. This selection should be done for each source category and pollutant being inventoried. Ideally, all stationary sources would be considered point sources and inventoried using a bottom-up approach and by applying the various techniques described in Section 5.0 of this document. However, given the nature of area sources, applying a bottom-up approach to all area source categories would require resources that are beyond the capabilities of most agencies.

Table 6-1.

Issues to Consider When Estimating Criteria Pollutant Emissions From Area Sources

For an area source inventory, you should...	Because...	Helpful references include...
Carefully consider what source categories to include in the inventory.	Attempting to inventory all source categories may overburden your agency's resources. A screening study will help you focus the inventory effort.	Guidance on how to conduct screening studies for the purpose of inventory development is available in Appendix M.
Consider threshold levels of emissions for sources to be included in the point source inventory.	The point source definition used by your agency may impact which area source categories you need to include in your inventory and which area source categories will need to be adjusted for double counting.	Section 2.5 of this document.
Consider the differences in the source definition(s) for the purposes of criteria and HAP inventories when using a HAP inventory as a starting point for the criteria pollutant inventory.	Some industrial sources with PM or VOC emissions below typical cutoff levels may be categorized as area sources for the purpose of a criteria pollutant inventory, but may qualify as point sources for the purpose of a HAP inventory.	

Table 6-1.

Issues to Consider When Estimating Criteria Pollutant Emissions From Area Sources (Continued)

For an area source inventory, you should...	Because...	Helpful references include...
<p>Stay informed of air regulations and rule development activities and implementation information.</p>	<p>In addition to adjustments you make for rule effectiveness (RE) and rule penetration (RP), some MACT standards may impact criteria pollutant emissions. Regulatory standards also contain information that addresses emission limits on criteria pollutants (e.g., a standard may use PM concentration as a surrogate to measure non-volatile metals concentration as part of total HAP reductions).</p>	<p>Sections 3.9 and 3.10 of this document discuss RE and RP adjustments. You can access comprehensive MACT rule-specific information including Federal Register publications and citations, compliance dates, and MACT rule contact names and phone numbers through the UATW site at <i>http://www.epa.gov/ttn/uatw/epa_rules.html</i></p>
<p>Keep in mind that nationally-derived emission estimates or factors may not apply to your area and may need to be adjusted</p>	<p>Emissions calculated using national emission factors may vary considerably from actual values at a specific source or within a specific geographic area.</p>	
<p>Know your pollutants.</p>	<p>For example, several VOC are considered photochemically nonreactive by the U.S. EPA as defined in the CAA and are not included in VOC emissions inventories (63 FR 17331, April 9, 1998: Part 51 “Air Quality: Revision to Definition of VOC - Exclusion of Methyl Acetate.”)</p>	

Table 6-1.

Issues to Consider When Estimating Criteria Pollutant Emissions From Area Sources (Continued)

For an area source inventory, you should...	Because...	Helpful references include...
Make sure that if you survey a subset of an area source category, you have enough information to accurately scale the results up to represent the entire source category.	Your estimates may accurately reflect emissions for the subset of the category that you survey, but will not represent emissions for the entire category if they are scaled up with an inappropriate adjustment factor.	

An emission reporting threshold has been established to separate point from stationary area sources and a top-down approach may be the best option available to inventory area sources below the reporting threshold. The top-down approach is particularly useful when national or regional estimates or emission factors are the only sources of information available on emissions for a specific source category. These estimates may be the result of large studies conducted by a consortium of states or by the U.S. EPA to fulfill a regulatory requirement or a CAA mandate. The state agency may choose to use the results of such studies in a top-down approach and allocate emissions to a smaller geographic area such as a county.

The EIIIP guidance documents refer to “preferred” and “alternative” methods for each source category. The inventory preparers, with assistance from their experienced managers, select an emission estimation method during the planning phase of the inventory development process. The estimation methods should be documented in the inventory preparation plan.

You can use various approaches to estimate emissions from area sources:

- Applying point source methods to area sources (a bottom-up approach);
- Conducting local activity level surveys (a bottom-up approach); and
- Applying a top-down approach.

Table 6-2 provides examples of area source categories and the associated methods used for estimating emissions. Each method has distinct advantages and disadvantages, and you must evaluate the merits of these methods on a source category-specific basis.

6.5.1 *Applying Point Source Methods to Area Sources*

There are several situations when it is appropriate to use point source methods to inventory small sources that are included in the area source inventory:

- If there are a few area sources within the geographical area being inventoried, it may be most practical to inventory each source individually.
- If it is very difficult to correlate available activity level data for the sources to their emission levels: For example, some bulk gasoline storage plants are small sources that can easily be inventoried individually. The most readily available activity level indicator for bulk gasoline storage plants is gasoline sales in the entire inventory area. This value cannot be directly correlated to the gasoline throughput at individual bulk gasoline storage plants and therefore cannot be used to calculate emissions for individual plants. Therefore, agencies should contact the plants individually to obtain gasoline throughput data.

Table 6-2.

Example Area Source Emission Estimation Methods

Area Source Category	Example Estimation Method	Activity Data	Source of Activity Data
Commercial/ Consumer Solvent Use	Per capita emission factor	Population	US Census data
Architectural Surface Coating	Survey	Gallons of paint sold	Paint manufacturers
Gasoline Distribution	Gasoline usage	Gallons of gasoline sold	State DOT, State Energy Office
Industrial Surface Coating	Per employee emission factor	Employment by SIC code	State Labor Department
Surface Cleaning Operations	Per employee emission factor	Employment by SIC code	State Labor Department
Dry Cleaning Operations	Per employee emission factor	Employment by SIC code	State Labor Department
Automobile Refinishing	Per capita emission factor	Population	US Census data
Graphic Arts Facilities	Per employee emission factor	Employment by SIC code	US Census data
Asphalt Paving	Asphalt usage	Barrels of asphalt applied	State DOT, paving contractors
Traffic Paints	Paint usage	Gallons of paint applied	State DOT
Agricultural Pesticides Application	Application rate, acres treated	Crop type by acre, types of pesticides applied	State Agricultural Office, USDA
Commercial Bakeries	Per capita emission factor	Population	US Census data
Structure Fires	Per fire emission factor	Number of fires	Fire Marshall
Municipal Landfills	Landfill Gas Emissions estimation model	Tons of refuse in place, landfill age	State Solid Waste Management Agency
Residential Fuel Combustion	Fuel use	Amount of fuel used	Energy Information Administration (EIA)

Table 6-2.**Example Area Source Emission Estimation Methods (Continued)**

Area Source Category	Example Estimation Method	Activity Data	Source of Activity Data
Industrial Fuel Combustion	Fuel use	Amount of fuel used	State Energy Office, EIA
Commercial/ Institutional Fuel	Fuel use	Amount of fuel used	State Energy Office, EIA
Petroleum Vessel Loading/ Unloading	Petroleum products loaded/ unloaded	Gallons of fuel transported	Port Authority Waterborne Commerce
Aircraft Refueling	Aviation fuel consumption	Gallons of fuel used	State Energy Office, airports
Hospital Sterilizers	Per hospital bed emission factor	Number of hospital beds	State Health Department
Forest Fires	Acres burned emission factor	Acres burned	State Forester
Breweries	State beer production emission factor	Barrels of beer produced or sold	State Commerce Office, trade groups
Barge, Tank Car, Railcar, Drum Cleaning	Drum cleaning survey	Number of vessels cleaned, material cleaned	Trade groups, drum-cleaning facilities
Distilleries	Distilled spirits production	Barrels of spirits produced or sold	State Commerce Office, trade groups
Agricultural/Slash Burning	Acres burned emission factor	Acres burned	Extension agents, agricultural schools
Wineries	Wine production	Barrels of wine produced or sold	State Commerce Office, trade groups
TSDFs (treatment, storage, and disposal facilities)	Survey	Material type, material throughput, treatment type	State Environmental Office
Superfund Sites	Survey	Material type, material throughput, treatment type	State Environmental Office
Open Burning of Household Wastes	Survey	Occurrence of burning	State Environmental Office

- If there are sufficient data to allow the agency to estimate activity levels and emissions at the facility level: For example, records may be available from an agency showing the location and amount of solvent handled by each dry cleaner within the inventory area. You should decide whether an individual point source record will be coded and maintained for each facility or whether the resulting individual activity levels and emission estimates will be collectively handled in the area source inventory.

The various methods used to estimate emissions from point sources are described in details in Section 5.0 of this document.

Example calculations illustrating the application of point and area estimation methods are provided in Appendices D and E, respectively.

6.5.2 Local Activity Surveys

Surveys used for area sources will, for practical means, not achieve the same level of coverage as those used for the larger point sources. Emissions are estimated for area sources by selecting representative subsets of individual sources from which emission calculation parameters can be derived and then scaling the estimates up to reflect the entire population of these sources. You should also survey various local associations and agencies to determine what information is maintained and can be used in the inventory area.

When planning to collect survey data for area sources it is critical that you carefully select the subset of individual sources so that the subset is representative of the population as a whole. For example, the emission factors presented for consumer/commercial solvent use and architectural coatings in Volume III of the EIIP series were developed from surveys of manufacturers. Those surveys attempted to cover as many sources as possible, and where manufacturers could not be included, the uncovered contribution was quantified to make the emission factors more representative of the industry as a whole.

6.5.3 Applying a Top-Down Approach

If local data are not available to develop local-level emissions, state or national data can be apportioned to local areas using a top-down approach. There are two variations to a top-down approach:

- Applying source test or national (or regional) derived emission factor to the local level; or
- Allocating national (or regional) level emission estimates to the local level.

Each of these approaches is described in more detail below, and example calculations are provided in Appendix E.

Applying Source Test or National (or Regional) Derived Emission Factors to the Local Level Source

Emissions from certain area source categories, especially those associated with solvent use, are not always easily estimated by a direct measure of activity. For example, local level activity data for the use of consumer and commercial solvent evaporation products such as waxes, aerosol products, and window cleaners cannot be routinely determined for many local sources. In addition, it is impractical to develop a survey that would yield such information. In such a case, you will need to devise an emission factor that is based on a surrogate measure for activity level, such as population. The underlying assumption behind this approach is that emissions for some source categories can be reasonably associated with the size of the population. The use of population as a surrogate activity level is valid for certain area source categories such as dry cleaning, architectural surface coating, and solvent evaporation from household products. You should not develop per capita emission factors for sources whose emissions do not correlate well with population.

You can also use employment as a surrogate for local activity. VOC emissions-per-employee factors are often used to estimate emissions for source categories for which an SIC code has been assigned and for which employment data (typically by SIC code) are available at the local level. Because many facilities within the industrial classifications of interest are point sources of VOC emissions, you may be able to develop emissions-per-employee factors by SIC code for area sources using data in the point source inventory. You can also use this approach where the state/local agency surveys only a fraction of the area sources within a given category. In this case, employment is used as an indicator to “scale up” the inventory to account collectively for missing sources and emissions in the area source file. You can also use parameters other than employment, such as sales data or number of facilities, to develop local emission estimates. However, employment data are generally the most readily available parameter.

Appendix E includes example calculations illustrating the use of such emission factors for estimating area source emissions.

To calculate emissions from area sources using an emission factor, you will need five basic inputs to the estimation algorithm:

- Activity level or a representative surrogate;
- An emission factor (which may represent “controlled” or “uncontrolled” emissions);
- Rule effectiveness factor;
- Rule penetration factor; and

- When applicable, information on capture and control efficiencies of any control device when using an “uncontrolled” emission factor.

The basic emission estimation equation when using an “uncontrolled” emission factor is:

$$E = A \times EF \times (1 - CE \times RE \times RP)$$

where:

- E = emission estimate for the process
- A = activity level or a representative surrogate
- EF = emission factor assuming no control
- CE = capture efficiency x control efficiency (expressed in percent); C equals zero if no control device is in place
- RE = rule effectiveness, an adjustment to C to account for failures and uncertainties that affect the actual performance of the control.
- RP = rule penetration. Both RE and RP are applied to entire source categories when calculating area source emission estimates

For area sources, CE can vary widely. CE values for area sources should represent the weighted average control for the category. Area sources that are most likely to be controlled are:

- Industrial surface coating;
- Gasoline marketing (Stage I);
- Surface cleaning; and
- Printing processes.

The basic emission estimation equation when using a “controlled” emission factor is:

$$E = A \times EF \times RE \times RP$$

where:

- E = emission estimate for the process
- A = activity level or a representative surrogate
- EF = “controlled” emission factor
- RE = rule effectiveness
- RP = rule penetration

Allocating National (or Regional) Emission Estimates to the Local Level

You can allocate national or regional level emission estimates to the local level using representative surrogate factors.

For example, if pesticide application data are available only on a statewide basis from the agricultural department, you could apportion these data to the area of study using the number of acres of agricultural land. Once you have developed the local activity data, traditional emission estimation techniques, such as nationally or locally derived emission factors are used to estimate local-level emissions. The main disadvantage for estimating emissions using this approach is that accuracy is lost in the allocation process.

Table 6-3 provides examples of surrogate activity indicators applicable to selected area source categories. **Appendix E includes example calculations illustrating the allocation of national or regional level data to the local level.**

6.6 Are Temporal and Spatial Allocations Necessary for Area Source Inventories?

6.6.1 *Is Temporal Allocation Necessary?*

Yes. You will frequently need to adjust your emissions estimates to reflect the specific time period represented by the inventory.

6.6.2 *How Do I Make Temporal Adjustments?*

To calculate accurate emissions estimates for a specific inventory period, you must collect emission rate and activity data:

- The most accurate method is to collect activity data for each specific time period represented by the inventory. This is done by means of a survey, and is generally not used for area source inventories, because such survey is extremely resource intensive.
- If resources allow you to conduct a survey to collect area source information, you should include questions to determine if seasonal emission rate variations occur. You can collect information about production levels, working hours, fuel consumption, or other values that could provide information pertinent to the area source you are investigating.
- You can collect information from indirect sources such as business and labor statistics, energy consumption data, or meteorological data. You must be careful to use data that are both current and representative of your inventory area, or to make the appropriate adjustments.

Table 6-3.

**Examples Of Surrogate Activity Indicators Applicable
To Selected Area Source Categories**

Area Source Category	Example Surrogate Activity Indicator(s)
Residential fuel combustion	Housing, population
Commercial/institutional fuel combustion	Urban land use
Industrial fuel combustion	Urban land use
Gasoline marketing	Population, vehicle miles traveled (VMT)
Unpaved roads	County area, land use
Forest wildfires	Composite forest land
Prescribed burning	Composite forest land
Agricultural operations	Agricultural land use
Structure fires	Housing, population
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
Furniture manufacturing	Population, employment
Flat wood products	Population, employment

Table 6-3.

**Examples Of Surrogate Activity Indicators Applicable
To Selected Area Source Categories (Continued)**

Area Source Category	Example Surrogate Activity Indicator(s)
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
Cutback asphalt paving	Population, VMT
Fugitive emissions from synthetic organic chemical manufacturing	Population, employment
Bulk terminal and bulk plants	Population, employment
Fugitive emissions from petroleum refinery operations	Population, employment
Process emissions from bakeries	Population, employment
Crude oil and natural gas production fields	Population, employment
Hazardous waste treatment, storage, and disposal facilities (TSDFs)	Population, industrial land use

If you are not able to collect data specific to the inventory period, you will need to estimate area source emissions using an adjustment factor applied to annual activity data. **Refer to Appendix E for example calculations.** Factors used to make temporal adjustments are expressed as fractions, percentages, or ratios. Example 13 in Appendix E shows how to estimate a temporal adjustment factor and apply it to annual activity data. Volume III of EIIP includes adjustment factors to use as default when data specific to the inventory area is not available.

6.6.3 *What Is Spatial Allocation?*

Spatial allocation is the adjustment of activity levels or emission estimates to a smaller or larger geographic area than the area for which the activity levels or emission estimates were prepared. Spatial allocation usually requires that you identify a surrogate indicator that can be used for the scaling.

6.6.4 *How Do I Make Spatial Adjustments?*

You can make spatial allocation adjustments based on:

- Local activity level data;
- State or national data;
- Population data; and
- Employment data.

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8.0 DEFINITIONS OF COMMONLY USED TERMS

Activity Level/Factor is a measurable factor that is directly or indirectly related to the emissions of a process. An emission estimate is calculated by multiplying an activity level by an emission factor. The activity level is either directly related to the amount of emissions (as in the case of the amount of fuel used in a combustion process), or is a more easily measured surrogate, such as population for consumer product usage.

Actual Emissions are the actual rate of emissions of a pollutant from an emissions unit calculated using the unit's actual operating hours, production rates, and types of materials processed, stored, or combusted during the selected time period.

Allowable Emissions are the emissions rate that represents a limit on the emissions that can occur from an emissions unit. This limit may be based on a federal, state, or local regulatory emission limit determined from state or local regulations and/or 40 Code of Federal Regulations (CFR) Parts 60, 61, and 63.

Ambient Standards Specify the target threshold concentrations and exposure durations of pollutants based on criteria gauged to protect human health and the welfare of the environment. Ambient standards are not emissions limitations on sources, but usually result in such limits being placed on source operation as part of a control strategy to achieve or maintain an ambient standard.

Annual Emissions are actual emissions for a plant, point, or process, either measured or calculated.

Area Sources are smaller sources that do not qualify as point sources under the relevant emissions cutoffs. Area sources encompass more widespread sources that may be abundant, but that, individually, release small amounts of a given pollutant. These are sources for which emissions are estimated as a group rather than individually. Examples typically include dry cleaners, residential wood heating, auto body painting, and consumer solvent use. Area sources generally are not required to submit individual emissions estimates.

Attainment Area is an area considered to have air quality as good as or better than the National Ambient Air Quality Standards (NAAQS) as defined in the CAA. Note that an area may be in attainment for one or more pollutants but be a nonattainment area for one or more other pollutants.

Biogenic Emissions are defined as all pollutants emitted from non-anthropogenic sources. Example sources include trees and vegetation, and microbial activity.

Bottom-Up Approach means emission estimates are developed specifically for individual sources and summed to obtain state- or county-level emission estimates.

Carbon Monoxide (CO) is a colorless, odorless gas that depletes the oxygen-carrying capacity of blood. Major sources of CO emissions include industrial boilers, incinerators, and motor vehicles.

Continuous Emissions Monitor (CEM) is any monitor that "continuously" measures (i.e., measures with very short averaging times) and records emissions. In addition to measuring and recording actual emissions during the time of monitor operation, CEM data can be used to estimate emissions for different operating periods and longer averaging times.

Control Efficiency is the emission reduction efficiency of a primary control device, which shows the amount of reduction of a particular pollutant for a process' emissions due to controls or material change. Control efficiency is usually expressed as a percentage of in tenths.

Criteria Pollutants are carbon monoxide (CO), lead (Pb), nitrogen oxides (NO_x), sulfur dioxide (SO₂), Ozone (O₃), particulate matter of aerodynamic diameter less than or equal to 10 micrometers (PM₁₀) and particulate matter of aerodynamic diameter less than or equal to 2.5 micrometers (PM_{2.5}).

Data Quality Indicators are qualitative and quantitative descriptors used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are accuracy, comparability, completeness, and representativeness.

Data Quality Objectives (DQOs) are qualitative and quantitative statements developed to ensure that data of known and appropriate quality are obtained to support decisions or actions. DQOs encompass all aspects of data collection, analysis, validation, and evaluation.

Double Counting means estimation and counting of estimated emissions twice in an inventory for the same source category. Area source inventories are at risk of double counting emissions from two sources because of point and area source overlap and overlap between two area sources.

Emission means pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, aircraft, or other nonroad engines.

Emission Factors are ratios that relate emissions of a pollutant to an activity level at a plant that can be easily measured, such as an amount of material processed, or an amount of fuel used. Given an emission factor and a known activity level, a simple multiplication yields an estimate of the emissions. Emission factors are developed from separate facilities within an

industry category, so they represent typical values for an industry, but do not necessarily represent a specific source. Published emission factors are available in numerous sources.

Emission Inventory is a listing, by source, of the amount of air pollutants discharged into the atmosphere of a community.

Emission Standards are a general type of standard that limit the mass of a pollutant that may be emitted by a source. The most straightforward emissions standard is a simple limitation on mass of pollutant per unit time (e.g., pounds of pollutant per hour).

Engineering Judgment is made when the specific emission estimation techniques such as stack testing, material balance, or emission factor are not possible. This estimation is usually made by an engineer familiar with the specific process, and is based on whatever knowledge may be available.

Fuel Analysis is a method for estimating emissions based on the application of conservation laws. The presence of certain elements in fuels may be used to predict their presence in emission streams. For example, SO₂ emissions from oil combustion can be calculated based on the concentration of sulfur in the oil. This approach assumes complete conversion of sulfur to SO₂. Therefore, for every round of sulfur (molecular weight = 32g) burned, two pounds of SO₂ (molecular weight = 64g) are emitted.

Fugitive Emissions are emissions from sources that are technically infeasible to collect and control (e.g., storage piles, wastewater retention ponds).

Geogenic Emissions are defined as emissions from natural occurrences, primarily the result of gas seep and soil wind erosion.

Growth Factors are surrogate indicators based on economic or demographic parameters that predict the proportional change in the activity level or emissions for a particular emissions source.

Hazardous Air Pollutants (HAPs) are listed in Section 112(b) of the 1990 Clean Air Act Amendments (CAAA). The CAAA specifies a list of 189 HAPs to be subject to regulation. The list of HAPs includes relatively common pollutants such as formaldehyde, chlorine, methanol, and asbestos, as well as numerous less common substances. Pollutants may, under certain circumstances, be added to or deleted from the list. To date, one pollutant has been deleted from the list, resulting in 188 HAPs.

Inventory Area is generally defined by political boundaries such as county or state boundaries, where the jurisdictions that are included in an inventory area make up an air basin or experience common air problems. The pollutant or the type of air pollution inventory will determine the exact geographic area that will be covered.

Inventory Preparation Plan is a document that discusses staff assignments and responsibilities, establishes a commitment to the inventory development and QA/QC processes, and establishes a commitment to personnel training and project documentation requirements. It may either be integrated with the quality assurance plan or a separate document.

Lead (Pb) is an element that causes several types of developmental effects in children including anemia, neurobehavioral alterations, and metabolic alterations. Lead is emitted from industries such as battery manufacturing, lead smelters, and incineration. Although regulated in highway fuels, lead may also be emitted from unregulated off-highway mobile sources.

Material Balance is a method for estimating emissions that attempts to account for all the inputs and outputs of a given pollutant. If inputs of a material to a given process are known and all outputs except for air emissions can be reasonably well quantified, then the remainder can be assumed to be an estimate of the amount lost to the atmosphere for the process.

Mathematical Emission Model is an emission estimation technique that uses a mathematical model to estimate emissions. A very simple mathematical model multiplies an emission factor and an activity level to produce an emission estimate. A more complex model may involve multiple parameters and iterations in the calculation process. A mathematical model may be used by inventory preparers as an equation or as a computer program.

Maximum Achievable Control Technology (MACT) Standards are emissions limitations developed under Section 112(d) of the CAAA National Emissions Standards for Hazardous Air Pollutants (NESHAP). The limitations are based on the best demonstrated control technology or practices in similar sources to be applied to point sources emitting one or more of the listed HAPs.

Mobile Sources include all nonstationary sources, such as automobiles, trucks, aircraft, trains, construction and farm equipment, and others. Mobile sources are a subcategory of area sources, and are generally not required to submit individual emissions estimates.

National Ambient Air Quality Standards (NAAQS) are the main ambient standards for the following criteria pollutants: carbon monoxide, lead, nitrogen oxides, sulfur oxides, ozone, particulate matter of aerodynamic diameter less than or equal to 10 micrometers and particulate matter of aerodynamic diameter less than or equal to 2.5 micrometers.

National Emissions Standards for Hazardous Air Pollutants (NESHAP) are a class of standards emitting emissions of HAPs. The NESHAPs are published in 40 CFR Parts 61 and 63.

New Source Performance Standards (NSPS) are promulgated for criteria, hazardous, and other pollutant emissions from new, modified, or reconstructed sources that the U.S. Environmental Protection Agency (EPA) determines contribute significantly to air

pollution. These are typically emission standards, but may be expressed in other forms such as concentration and opacity. The NSPS are published in 40 Code of Federal Regulations (CFR) Part 60.

Nitrogen Oxides (NO_x) are a class of compounds that are respiratory irritants and that react with volatile organic compounds (VOCs) to form ozone (O_3). The primary combustion product of nitrogen is nitrogen dioxide (NO_2). However, several other nitrogen compounds are usually emitted at the same time (nitric oxide [NO], nitrous oxide [N_2O], etc.), and these may or may not be distinguishable in available test data. They are usually in a rapid state of flux, with NO_2 being, in the short term, the ultimate product emitted or formed shortly downstream of the stack. The convention followed in emission factor documents is to report the distinctions wherever possible, but to report total NO_x on the basis of the molecular weight of NO_2 . NO_x compounds are also precursors to acid rain. Motor vehicles, power plants, and other stationary combustion facilities emit large quantities of NO_x .

Ozone (O_3) is a colorless gas that damages lungs and can damage materials and vegetation. It is the primary constituent of smog, and is formed primarily when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight. It is also emitted in insignificant quantities from motor vehicles, industrial boilers, and other minor sources.

Particulate Matter of aerodynamic diameter less than or equal to 10 micrometers (PM_{10}) is a measure of small solid matter suspended in the atmosphere. Small particles can penetrate deeply into the lung where they can cause respiratory problems. Emissions of PM_{10} are significant from fugitive dust, power plants, commercial boilers, metallurgical industries, mineral industries, forest and residential fires, and motor vehicles.

Particulate Matter of aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) is a measure of fine particles of particulate matter that come from fuel combustion, agricultural burning, woodstoves, etc. On November 27, 1996, the U.S. Environmental Protection Agency proposed to revise the current primary (health-based) PM standards by adding a new annual $PM_{2.5}$ standard.

Plant-level Emissions are consolidated for an entire plant or facility. A plant may contain one or many pollutant-emitting sources.

Plant-level Reporting is generally required if total emissions from a plant (which may be composed of numerous individual emission points) meet the point source cutoff. These data can be used by a state to conduct a detailed estimate of emissions from that plant. The plant-level reporting used by most air pollution control agencies generally requires that the facility provide data that apply to the facility as a whole. Such data include the number of employees and the Standard Industrial Classification (SIC) code designation for the plant. A plant usually has only one SIC code denoting the principal economic activity of the facility. For the purpose of clearly identifying and tracking emissions data, each plant is generally assigned a plant

(alternatively, “facility”) name and number. The plant is also identified by geographic or jurisdictional descriptors such as air quality control region, county, address, and Universal Transverse Mercator (UTM) grid coordinates (or latitude/longitude) that identify a coterminous location. An owner or operator engaged in one or more related activities is also identified. In some cases, plantwide emissions may be reported at the plant level.

Point-level Emissions typically represent single stacks or vents individually large enough to be considered point sources.

Point-level Reporting includes specific data for individual emission points (typically stacks). These data are more detailed than that submitted in plant-level reporting and may include emission-related and modeling information such as stack height of the release point, diameter of the stack, emission rate, method of determination, fugitive emissions, gas exit velocity from a stack, gas temperature, and operating schedule. Source identification information, as described under plant-level reporting, is usually also required at the point level to ensure that emission data for a single plant remain clearly identified. Regulatory agencies generally maintain individual emission-related records at the point level.

Point Sources are large, stationary, identifiable sources of emissions that release pollutants into the atmosphere. Sources are often defined by state or local air regulatory agencies as point sources when they annually emit more than a specified amount of a given pollutant, and how state and local agencies define point sources can vary. Point sources are typically large manufacturing or production plants. They typically include both confined "stack" emission points as well as individual unconfined "fugitive" emission sources.

Within a given point source, there may be several emission points that make up the point source. Emissions point refers to a specific stack, vent, or other discrete point of pollution release. This term should not be confused with point source, which is a regulatory distinction from area and mobile sources. The characterization of point sources into multiple emissions points is useful for allowing more detailed reporting of emissions information.

Potential Emissions are the potential rate of emissions of a pollutant from an emissions unit calculated using the unit’s maximum design capacity. Potential emissions are a function of the unit’s physical size and operational capabilities.

Process Emissions are emissions from sources where an enclosure, collection system, ducting system, and/or stack (with or without an emission control device) is in place for a process. Process emissions represent emissions from process equipment (other than leaks) where the emissions can be captured and directed through a controlled or uncontrolled stack for release into the atmosphere.

Quality Assurance (QA) is a planned system of activities designed to provide assurance that the quality control program is actually effective. QA is a process that involves both the inventory team and external reviewers to insure the overall quality of the inventory.

Quality Control (QC) comprises the activities undertaken by all members of the inventory team during the inventory preparation that will result in the correction of specific problems such as mistaken assumptions, lost or uncollected data, and calculation and data entry errors.

Reported Emissions are those emission estimates that are submitted to a regulatory agency. Emissions inventories can be used for a variety of purposes such as State Implementation Plan (SIP) base year inventories, environmental compliance audits, air quality rule applicability, and reporting information in an air quality permit application. Emissions can be reported on an actual, potential, or maximum basis. Many state and local air pollution control agencies have rules and regulations that define an allowable emission value for a particular piece of equipment. Because of this, a facility should first define the purpose of the inventory and then choose the appropriate means of reporting emissions to the regulatory agency. For example, SIP base year inventories for point sources would contain actual emissions. However, regulatory applicability and air quality permit applications can require that actual, allowable, and potential emissions be reported.

Rule Effectiveness is the measure of a regulatory program to achieve all of the emission reductions possible, which reflects the assumption that controls are typically not 100 percent effective, because of equipment downtime, upsets, decreases in control efficiencies, and other deficiencies in emission estimates. RE is used to adjust the control efficiency.

Rule Penetration is the percentage of an area source category that is covered by an applicable regulation.

SCC is a source classification code. It is a process-level code that describes the equipment or operation emitting pollutants.

SIC is a standard industrial classification code. It is the U.S. Department of Commerce's categorization of businesses by their products or services.

Source Tests are short-term tests used to collect emissions data that can then be extrapolated to estimate long-term emissions from the same or similar sources. Uncertainties arise when source test results are used to estimate emissions under process conditions that differ from those under which the test was performed.

Spatial Allocation entails assignment of activity levels or emission estimates to a smaller or larger geographic area than the area for which the activity level or emission estimate was prepared. Allocation usually requires the identification of a surrogate indicator that can be used for scaling.

Stack Diameter is a stack physical diameter.

Stack Height is a stack physical height above the surrounding terrain.

State Implementation Plan (SIP) is a state plan approved by EPA for the establishment, regulation, and enforcement of air pollution standards.

Sulfur Oxides (SO_x) are a class of colorless, pungent gases that are respiratory irritants and precursors to acid rain. Sulfur oxides are emitted from various combustion or incineration sources, particularly from coal combustion.

Surveys are a method to collect inventory data using telephone or written questionnaires that are answered by manufacturers or suppliers of products, or by representatives at the facilities or sites where the emitting processes take place. An area source survey may also include review and data collection from existing air pollution permits within an agency. Surveys for area source inventories usually survey a subset of the population of sources.

Top-Down Approach means emission estimates are developed from emission factors that were developed from test data or on the national- or regional-level. Estimates are scaled to the inventory area using some measure of activity data thought to be directly or indirectly related to the emissions, and some measure of emissions that can be applied to these data.

Volatile Organic Compounds (VOC) as cited in 63 FR 17331, April 19, 1998, means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate that participates in atmospheric photochemical reactions. This includes any such organic compound other than the following, which have been determined to have negligible photochemical reactivity:

- methane
- ethane
- methylene chloride (dichloromethane)
- 1,1,1-trichloroethane (methyl chloroform)
- 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113)
- trichlorofluoromethane (CFC-11)
- dichlorodifluoromethane (CFC-12)
- chlorodifluoromethane (HCFC-22)
- trifluoromethane (HFC-23)
- 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114)
- chloropentafluoroethane (CFC-115)
- 1,1,1-trifluoro-2,2-dichloroethane (HCFC-123)
- 1,1,1,2-tetrafluoroethane (HFC-134a)
- 1,1-dichloro-1-fluoroethane (HCFC-141b)
- 1-chloro-1,1-difluoroethane (HCFC-142b)

- 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
- pentafluoroethane (HFC-125)
- 1,1,2,2-tetrafluoroethane (HFC-134)
- 1,1,1-trifluoroethane (HFC-143a)
- 1,1-difluoroethane (HFC-152a)
- parachlorobenzotrifluoride (PCBTF)
- cyclic, branched, or linear completely methylated siloxanes
- acetone
- perchloroethylene (tetrachloroethylene)
- 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca)
- 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)
- 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee)
- difluoromethane (HFC-32)
- ethylfluoride (HFC-161)
- 1,1,1,3,3,3-hexafluoropropane (HFC-236fa)
- 1,1,2,2,3-pentafluoropropane (HFC-245ca)
- 1,1,2,3,3-pentafluoropropane (HFC-245ea)
- 1,1,1,2,3-pentafluoropropane (HFC-245eb)
- 1,1,1,3,3-pentafluoropropane (HFC-245fa)
- 1,1,1,2,3,3-hexafluoropropane (HFC-236ea)
- 1,1,1,3,3-pentafluorobutane (HFC-365mfc)
- chlorofluoromethane (HCF-31)
- 1-chloro-1-fluoroethane (HCFC-151a)
- 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a)
- 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$)
- 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ($((CF_3)_2CFCH_2OCH_3)$)
- 1-ethoxy-1,1,2,2,3,3,4,4, 4-nonafluorobutane ($C_4F_9OC_2H_5$)
- 2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane ($((CF_3)_2CFCH_2OC_2H_5)$)
- methyl acetate and perfluorocarbon compounds which fall into these classes:
 - (i) cyclic, branched, or linear, completely fluorinated alkanes
 - (ii) cyclic, branched, or linear, completely fluorinated ethers with no unsaturations
 - (iii) cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations and
 - (iv) sulfur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine.

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APPENDIX A

LIST OF AVAILABLE EIIP DOCUMENTS

<http://www.epa.gov/ttn/chief/eiip/>

(Current as of August 1999)

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List of Available EIIP Documents

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- Chapter 8: Preferred and Alternative Methods for Estimating Air Emissions from Paint and Ink Manufacturing
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- Chapter 10: Preferred and Alternative Methods for Estimating Air Emissions from Oil and Gas Field Production and Processing Operations
- Chapter 11: Preferred and Alternative Methods for Estimating Air Emissions from Plastic Products Manufacturing
- Chapter 12: How to Incorporate the Effect of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates (draft)

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Appendix D: Example 2 of Data Quality Audit Checklist

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Appendix F: EIIP Recommended Approach to Using the Data Attribute System (DARS)

DARS User Manual, Beta Version 1.1

DARS Software Beta Version 1.1

Volume VII: Data Management Procedures

EIIP Phase I Data Model

EIIP EDI Implementation Guideline (for air emission modeling)

Volume VIII: Estimating Greenhouse Gas Emissions

Introduction to Estimating Greenhouse Gas Emissions (Draft)

Chapter 1: Methods for Estimating Greenhouse Gas Emissions from Combustion of Fossil Fuels (Draft)

Chapter 2: Methods for Estimating Greenhouse Gas Emissions from Industrial Processes (Draft)

Chapter 3: Methods for Estimating Methane Emissions from Natural Gas and Oil Systems (Draft)

Chapter 4: Methods for Estimating Methane Emissions from Coal Mining (Draft)

Chapter 5: Methods for Estimating Greenhouse Gas Emissions from Municipal Waste Disposal (Draft)

Chapter 6: Methods for Estimating Methane Emissions from Domesticated Animals (Draft)

Chapter 7: Methods for Estimating Greenhouse Gas Emissions from Manure Management (Draft)

Chapter 8: Methods for Estimating Methane Emissions from Flooded Rice Fields (Draft)

Chapter 9: Methods for Estimating Greenhouse Gas Emissions from Agricultural Soils (Draft)

Chapter 10: Methods for Estimating Carbon Dioxide and Sinks from Emissions from Forest Management (Draft)

Chapter 11: Methods for Estimating Greenhouse Gas Emissions from Burning of Agricultural Crop Wastes (Draft)

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APPENDIX B

CLEARING UP THE RULE EFFECTIVENESS CONFUSION

Clearing Up the Rule Effectiveness Confusion

Introduction

Since its formation, EPA has been implementing rules and regulations that require states to reduce the amount of pollution being emitted into the atmosphere. Achieving the air quality anticipated by implementing a particular rule has not always been successful despite imposition of numerous emission controls. In 1987 EPA acknowledged that existing air quality regulations were not resulting in sufficient emission reductions to reach acceptable levels of air quality. The November 24, 1987 Federal Register said “The EPA believes that one reason ozone levels have not declined as much as expected is that reductions from national and local control measures have not been as high as expected.”¹ This Federal Register further stated that “the effectiveness (i.e., the ratio of actual reductions to expected reductions expressed as a percentage) of some rules is much lower than 100 percent.” To correct or compensate for the lower than anticipated amount of reductions, the Federal Register notice stated that “for both new and existing rules, EPA proposes to allow States to assume not more than 80 percent of full effectiveness unless adequate higher levels are adequately demonstrated.” Said another way, “we don’t believe your rule will get as much reduction as you think it will.” This under-performance can result from:

- Some sources not implementing (or not implementing all the time) controls required by the rule;
- Some sources not installing sufficient control equipment to achieve required emission rate;
- Some sources operating installed control equipment at less than rated control efficiency;
- New source being introduced into the local area covered by the rule.

Any of these situations could result in attainment year emissions being higher than anticipated. Even though an individual source’s emission rate is reduced to that specified in a state rule, the overall reduction within the state may not be as great because of the above considerations.

The 1987 Federal Register¹ defines “effectiveness” as:

$$\text{Effectiveness} = \frac{\text{Actual Reductions}}{\text{Expected Reductions}} \quad (1)$$

For complete compliance to occur, effectiveness must equal 100 percent. This Federal Register recognizes however, that effectiveness is usually not 100 percent. To adjust for non-compliance, the Federal Register limits the amount of reduction that a state can anticipate. This forces policy

planners to account for less than complete compliance. For example, if an agency implemented a rule to reduce emissions by 100 tpy (expected reduction), the Federal Register suggests that the actual reduction will not be as great as the expected reduction (Equation 1). For the 100 tpy goal to be met (i.e., “effectiveness” to be 100 percent), the actual reduction in Equation 1 must be modified as follows:

$$\text{Effectiveness} = \frac{\text{Reduction Target} \times (\text{Empirical Factor})}{\text{Expected Reduction}} \quad (2)$$

Where:

Expected Reduction = Emission reduction required as estimated by modeling to meet air quality standard

In this example, Equation 2 becomes:

$$100\% = \frac{\text{Reduction Target} \times 0.8}{100}$$

Solving for Reduction target: Reduction target = 125 tpy

Policy makers then develop control strategies based on this Reduction target value. If an agency implements a rule to reduce emissions by 100 tpy, the policy makers must target a 125 tpy reduction to be able to achieve the needed 100 tpy. Note that the results of equation 2 do not reflect the accuracy of the emission estimates, but only adjust for the past history of complying with a new rule.

The 1992 Federal Register² defines rule effectiveness as:

$$\text{Rule Effectiveness (RE)} = \frac{\text{Actual Reduction}}{\text{Expected Reduction}} \quad (3)$$

Where:

Actual reduction = (base year emissions) - (current year emission estimates)

In Equation 3, the new term “RE” is an indicator that compares the amount of actual emission reduction to the expected reduction. This metric is useful to decision makers as they evaluate how well their policies are achieving the intended goals or how effective the rule is in achieving expected reductions. For example, assume an agency modeling exercise indicated that 100 tpy

reduction is needed in 10 years to be able to reach attainment status. Also assume the base year inventory is 200 tpy. If a 50 tpy reduction is achieved 5 years into the implementation period, then the RE = $(200 - 150)/100 = 50$ percent. At the end of 10 years, if the entire 100 tpy has been removed, then the RE = $(200 - 100)/100 = 100$ percent.

Introducing the factors contained in these equations acknowledges the reality that, in an imperfect world, a rule intended to reduce emissions and improve air quality does not always work as planned. Equation 2 offers, for planning purposes, an empirical solution to this problem while Equation 3 measures the effectiveness of the solution after controls are implemented. The empirical approach assumes that only 80 percent (or higher if an agency can substantiate) of the required control will be achieved. To offset this shortfall, additional controls are needed. This concept was further supported in the April 16, 1992 Federal Register.² Under III(A)(2)(a)(2) it is stated that “one hundred percent rule effectiveness is the ability of a regulatory program to achieve all the emission reductions at all sources at all times.” The “extra” controls in Equation 2 compensate for parts of the air quality strategy that are not completely implemented “at all of the sources all of the time”.

As the air quality control community became more sophisticated, it realized that other causes could be contributing to the inability to reach acceptable air quality levels. Two areas of concern are the accuracy of air quality model predictions (air quality modeling issues will not be addressed in this discussion) and the accuracy of the emission inventory accounting process (quantity of emissions represented in the inventory). Policy makers use emission estimates to help develop new rules that will cause the removal of a specified quantity of pollutant. They assume that removing this amount of pollutant will lead to acceptable air quality. The amount to be removed is usually selected as a result of various air quality modeling exercises. If the initial quantity of emissions used in the model calculations is incorrect, then the amount of pollutant to be reduced, as calculated by the model, may also be incorrect.

To offset an assumed underestimate of emissions, states are required to apply a compensation factor to facility control device efficiency values. This action has the effect of reducing the assumed efficiency of the control device (a reasonable assumption since control equipment may fail, be off line due to equipment maintenance, and process upsets occur) and increasing individual source emission estimates. This factor, also called Rule Effectiveness, has a default value of 80 percent.

Very few sources measure their emissions directly using continuous emission monitors (CEM). Uncontrolled emissions at sources not monitored by CEMs are estimated using the following equation:

$$\text{Emissions} = \text{Emission Factor} \times \text{Activity Data} \quad (4)$$

If RE is used, the equation to calculate emissions from a facility containing a control device becomes:

$$\text{Emissions} = \text{Emission Factor} \times \text{Activity Data} \times (1 - \text{CE} \times \text{RE}) \quad (5)$$

Where:

CE = manufacturer stated control efficiency

The definition of RE in Equations 3 and in Equation 5 are very different. Equation 3 provides policy makers with a method to measure the amount of reduction at a point in time and judge the success of a particular rule. Equation 5 adjusts individual facility estimates to compensate for assessment techniques that do not account for all emissions. Even though the philosophy behind the emission adjustments is different in each case, the same term - RE, is used for both situations.

Why Confusion Exists

In 1992, EPA issued “Guidelines for Estimating and Applying Rule Effectiveness for Ozone/CO State Implementation Plan Base Year Inventories.”³ Under section 1.2 the document states “The appropriate method for determining and using RE depends upon the purpose for the determination: compliance program or inventory. RE discussed outside the particular purpose may be generically referred to as control effectiveness. The following three common uses for a control effectiveness estimate have historically been called rule effectiveness:

- Identifying and addressing weakness in control strategies and regulations related to compliance and enforcement activities (more accurately call *Compliance Effectiveness*);
- Defining or redefining the control strategy necessary to achieve the required emissions reductions designated in the CAAA (more accurately called *Program or SIP Design Effectiveness*); and
- Improving the accuracy or representativeness of emission estimates across a nonattainment area (hereafter called *Rule Effectiveness*)”⁽³⁾

“The inventory RE is an adjustment to estimated emissions data to account for the emissions underestimates due to compliance failures and the inability of most inventory techniques to include these failures in an emission estimate. The RE adjustment accounts for known underestimates due to noncompliance with existing rules, control equipment downtime or operating problems and process upsets. The result is a better estimate of expected emission reductions and control measure effectiveness in future years”.³

Previous paragraphs provide definitions of Compliance effectiveness and Rule effectiveness and try to make a distinction between the two. Despite these distinctions, the second sentence of the preceding paragraph inadvisely combines concepts of both rule noncompliance and the problem of overestimating collection efficiency of control equipment. Even though there is a recognition that the two situations are different, the RE term is used interchangeably in each of these examples.

Rule Effectiveness Guidance: Integration of Inventory, Compliance, and Assessment Applications was issued in January 1994.⁴ In the Introduction, the document states that “Rule Effectiveness (RE) is a generic term for identifying and estimating the uncertainty in emission estimates caused by failures and uncertainties in emission control programs. It is a measure of the extent to which a rule actually achieves its desired emission reductions.” Implying a second definition, the Introduction further states that “rule effectiveness accounts for identifiable emission underestimates due to factors including noncompliance with existing rules, control equipment downtime, operating and maintenance problems, and upsets.” As was previously noted, the RE term is again used in different contexts within the same section of the same document.

This Guidance document contributes further to the confusion by using apparently different definitions of rule effectiveness.⁴ The Glossary defines Rule Effectiveness as “a generic term for identifying and estimating the uncertainties in emission estimates caused by failures and uncertainties in emission control programs. Literally, it is the extent to which a rule achieves the desired emission reductions.”

Based on past history it is understandable that, over time, the inventory community has used RE to describe different situations and often interchanging the definitions during the same discussion. The RE definition has evolved, taking on slightly different meanings, depending on the group using the term and the program to which it is being applied. Confusion results because the inventory community often uses the term RE without indicating the context in which it is being applied. Mangat, in a paper presented at an emission inventory conference in 1992 and in a subsequent EIIP paper, recognized that dissimilar definitions were being used and tried to explain the differences.^{5, 6}

Solutions to the Confusion

RE is currently being used to describe and solve unrelated problems. In one case it is being used to address the failure of control equipment to operate at its stated efficiency for 100 percent of the time. In the second case RE is being used to address the failure of people to implement a rule with the required vigor.

Applying an adjustment factor is a valid approach in each of these situations. Unfortunately, the same term (RE) is used to describe and address both cases. The inventory community does not need more jargon. However, a solution to the current dilemma is to abandon the RE name and

replace it with two distinctive terms, each describing specifically the situation in which it applies. Separate definitions should allow those interested in measuring how well a rule is achieving its intended reductions to determine those results. Those interested in adjusting actual emission estimates to compensate for upsets, downtime, etc could also meet their needs. Each new term is described below.

The **Practical Compliance Index (PCI)** is to be used by those in policy positions to measure how well a rule is achieving its intended results. The PCI is a measure of the extent to which a rule actually accomplishes its desired emission reductions. For example, if a new rule has a PCI of 80 percent, it has caused 80 percent of the needed emission reductions to occur. A 100 percent of the expected reductions did not (has not) occurred because not all facilities implemented controls mandated by the rule, some facilities did not control at the emission rate required by the rule, or unanticipated growth occurred in the area. Additionally, policy makers using historical PCI values can develop realistic control strategies for their area.

The **Operational Adjustment Factor (OAF)** is to be used to adjust control efficiency ratings of control devices. Adjustments are necessary due to control equipment down time, subpar control device operations, and process upsets. Current methods of estimating emissions do not account for these situations. The OAF will not be used to adjust emission factors, activity data, or direct measurement of emissions.

How to Apply a PCI and an OAF

PCI

Air quality modeling is performed to support new rule development. Models are run to determine how much pollutant should be removed from the air to reach an acceptable ambient air quality concentration level. When the new rule is implemented, a strategy is developed, based on model results, that describes the sources to be controlled and the acceptable emission rate of each source.

The Practical Compliance Index (PCI) provides policy makers with two tools. The Index measures how well the control strategy is progressing toward reaching the air quality goal. The PCI is calculated by:

$$\text{PCI} = \frac{(\text{Base Year Emission Estimate}) - (\text{Current Year Emission Estimate})}{\text{Expected Reduction}} \quad (6)$$

The PCI measures progress toward meeting the new emission target in the designated attainment year. PCI can be calculated periodically to provide policy makers with information on how the policy is being implemented and the extent of compliance with new control requirements.

Past experience has shown that, even if after a new rule is fully implemented, the ambient air quality level still exceeds the standard. One reason for this failure is lack of compliance with a new rule. Policy makers can use this information to increase the likelihood that future emission targets will be met. This can be done by using an empirically derived factor is used to adjust Equation 6. Even though the air quality modeling indicates a certain number of tons of pollutant are needed to be removed to reach the standard, practical experience shows that, without additional emphasis, this target will not be reached. The compensation factor in Equation 6a offsets this lack of compliance. If the goal is to achieve a 100 percent PCI, then Equation 6 becomes:

$$PCI = \frac{\text{Reduction Target} \times \text{Compensation Factor}}{\text{Expected Reduction}} \quad (6a)$$

Where:

Compensation factor has a default value of 80 percent

The denominator is the amount of reduction necessary, as calculated by air quality modeling, to achieve acceptable ambient air pollutant levels. By setting the PCI to 1 (100 percent) and solving for the Reduction target in the numerator, policy makers will know how much pollutant reduction should be targeted for their control strategies. The compensation factor is analogous to the definition of RE in Equation 3. Guidance currently being used to calculate a RE factor can be used to estimate the compensation factor in Equation 6a.

OAF

An inventory is composed of data that are used to estimate emissions. It contains information on control efficiencies of the devices connected to the processes being inventoried. Actual emissions are estimated either from direct measurements of the source or from calculations using variables contained in the inventory. The most common approach to estimating emissions is to select an emission factor associated with a process and combine it with the activity (thruput) of the operations. This amount is adjusted by the control efficiency of the devices attached to the process. The final product is an estimate of pollutant emitted to the atmosphere. Actual emissions are calculated by:

$$\text{Actual Emissions} = (\text{Emission Factor})_{\text{unctl}} \times (\text{Activity Data}) \times (1 - \text{Control Efficiency} \times \text{OAF}) \quad (7)$$

There are several inaccuracies associated with this approach. Even though the precision of the emission factor or activity estimate may be poor, there is usually no quantifiable bias associated with these values. However, because of operational process upsets, down time of the control device, and maintenance of the control equipment, overall control efficiency of the devices attached to the process is not as great as stated by the manufacturers. This introduces a bias into

the emission estimating process that is known qualitatively, but is not accounted for in the inventory.

Equation 7 assumes there is no bias in the emission factor or activity data and that the control device operates at 100 percent of its design efficiency all the time the process is running. To reflect reality, control efficiency should be adjusted for process upsets and control device downtime. Equation 7 then becomes:

$$\text{Actual Emissions} = (\text{Emission Factor})_{\text{unct}} \times (\text{Activity Data}) \times (1 - \text{Control Efficiency} \times \text{OAF}) \quad (8)$$

$$\text{Where: OAF} = 1 - \frac{(\text{Tons by-passing control device (tpy)})}{[(\text{Tons Collected (tpy)}) + (\text{Tons by-passing control device(tpy)})]}$$

The OAF is determined by examining operating records for a control device or family of devices. The amount of time it is operating, the number of process upsets, and the quantity of pollutant that bypasses the control device during these periods can be used to create the OAF.

Recently, some emission rates are being combined with process control efficiencies to form an emission factor that consists of a process-control device combination. Equation 8a is used when the emission factor incorporates control efficiency.

$$\text{Actual Emissions} = (\text{Emission Factor})_{\text{ctl}} \times (\text{Activity Data}) \times (1/\text{CE} - \text{OAF}) \quad (8a)$$

Summary

The emission inventory community has been using RE for almost a decade. Even though the term has been used interchangeably in totally different applications, the distinctions have been poorly understood. New terminology proposed in this paper should correct this problem. The PCI measures the degree to which a rule is being implemented (by measuring the amount of actual reduction and comparing it to the expected reduction). It is based on historical results from past rule implementation efforts or from recent surveys that indicate the degree of compliance to be expected. The PCI compensates for the failure of people to fully implement a rule.

The OAF is a function of control equipment efficiency, the adequacy of equipment maintenance, equipment reliability, and the stability of a process. This information is available from records maintained at each facility. The OAF compensates for the failure of equipment to perform at its stated capacity.

Next Steps

- Determine how this proposed approach affects existing data;
- Determine how existing guidance must be changed to reflect new approach;
- Decide what to do about previously reported data that has RE applied; and
- Develop new guidance explaining use of PCI and OAF.

References

1. Federal Register, Vol. 52, No. 226, Tuesday, November 24, 1987, p45059.
2. Federal Register, Vol. 57, No. 74, Part III, Thursday, April 16, 1992.
3. "Guidelines for Estimating and Applying Rule Effectiveness for ozone/CO State Implementation Plan Base year Inventories," November 1992, EPA-452/R-92-010
4. "Rule Effectiveness Guidance: Integration of Inventory, Compliance, and Assessment Applications," January 1994, EPA-452/4-94-001.
5. "Developing Present and Future Year Emissions Inventories Using Rule Effectiveness Factors", presented at the International Conference and course, Emission Inventory Issues, Durham, NC, October 1992.
6. "Emission Inventories and Proper Use of Rule Effectiveness," <http://www.epa.gov/ttn/chief/eiip/pointsrc.htm>, draft report, October 1998.

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APPENDIX C

**LIST OF EIIP PREFERRED AND ALTERNATIVE METHODS
BY SOURCE CATEGORY
(Current as of August 1999)**

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**Table 1. List of EIIP Preferred and Alternative Methods
by Source Category (Point Sources)**

Source Category	Estimation Methods, Preferred (P) or Alternative (A)						
	Material Balance	Emission Factors	Source Testing	CEM Data	Emission Models/ Predictive Monitoring ^a	Fuel Analysis	Engineering Calculations
Aircraft Manufacturing, Surface Coating	P, A	A	P, A		A		
Appliances, Surface Coating	P, A	A	P, A		A		
Automobiles and Light-duty Trucks, Surface Coating	P, A	A	P, A		A		
Automobile Refinishing, Surface Coating	P, A	A	P, A		A		
Equipment Leaks		A	A		P		
Flat Wood Product Manufacturing, Surface Coating	P, A	A	P, A		A		
Heavy-duty Truck Manufacturing, Surface Coating	P, A	A	P, A		A		
Hot-Mix Asphalt Plants		P	P	A	A	P	
Magnet Wire, Surface Coating	P, A	A	P, A		A		
Metal Cans, Surface Coating	P, A	A	P, A		A		

**Table 1. List of EHP Preferred and Alternative Methods
by Source Category (Point Sources) (Continued)**

Source Category	Estimation Methods, Preferred (P) or Alternative (A)						
	Material Balance	Emission Factors	Source Testing	CEM Data	Emission Models/ Predictive Monitoring ^a	Fuel Analysis	Engineering Calculations
Metal Coil, Surface Coating	P, A	A	P, A		A		
Metal Furniture, Surface Coating	P, A	A	P, A		A		
Miscellaneous Metal Parts, Surface Coating	P, A	A	P, A		A		
Oil & Gas Field Production & Processing		P, A	A	A	P		
Paint and Ink Manufacturing	A	P, A	A		P		
Paper Coating, Surface Coating	P, A	A	P, A		A		
Plastic Products Manufacturing	P, A	A	P, A		A		
Plastic Parts, Surface Coating	P, A	A	P, A		A		
Secondary Metal Processing		P, A	P, A	P, A			
Semiconductor Manufacturing	P	A	P, A				A
Ships, Surface Coating	P, A	A	P, A		A		
Wastewater Collection and Treatment	A	A	A		P		A

**Table 1. List of EIIP Preferred and Alternative Methods
by Source Category (Point Sources) (Continued)**

Source Category	Estimation Methods, Preferred (P) or Alternative (A)						
	Material Balance	Emission Factors	Source Testing	CEM Data	Emission Models/ Predictive Monitoring ^a	Fuel Analysis	Engineering Calculations
Wood Furniture, Surface Coating	P, A	A	P, A		A		

^a Predictive emission monitoring is an estimation method where emissions are correlated to process parameters based on demonstrated correlations.

Reference: *Emission Inventory Improvement Program Preferred and Alternative Methods*. Volume I, Introduction to the EIIP, and Volume II, Point Sources.

**Table 2. List of EHIP Preferred and Alternative Methods
by Source Category (Area Sources)**

Source Category	Estimation Methods, Preferred (P) or Alternative (A)					
	Survey	Material Balance	Emission Factors	Top-Down Approach		
				Per-employee or Per-capita Emission Factors	Allocation of National Level Activity	Emission Estimation Models
Architectural Surface Coating	P	P		A	A	
Asphalt Paving	P, A	P	A			
Autobody Refinishing	P	P		A	A	
Consumer Solvents	A			P, A		
Dry Cleaning	P	P	P	A		
Gasoline Distribution, Stage I	P, A		P, A		A	
Gasoline Distribution, Stage II	P		P, A		A	P, A
Graphic Arts	P			A	A	
Industrial Surface Coating				P, A		
Landfills	P			A		P, A
Marine Vessel Loading, Ballasting and Transit	P		P			

**Table 2. List of EIIP Preferred and Alternative Methods
by Source Category (Area Sources)(Continued)**

Source Category	Estimation Methods, Preferred (P) or Alternative (A)					
	Survey	Material Balance	Emission Factors	Top-Down Approach		
				Per-employee or Per-capita Emission Factors	Allocation of National Level Activity	Emission Estimation Models
Open Burning	P	A	P			
Pesticide Use, Agriculture	P, A	A	P, A			
Pesticide Use, NonAgriculture (Municipal, Commercial and Consumer)	P			A		
Residential Wood Combustion	P		P, A		A	
Solvent Cleaning	P, A		P	A	A	
Traffic Paints	P	P	P, A	A	A	

Reference: *Emission Inventory Improvement Program Preferred and Alternative Methods*.
Volume III, Area Sources.

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APPENDIX D

POINT SOURCES EXAMPLE CALCULATIONS

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Example 1-- Coal-fired Industrial Boiler (Emission Factors and Temporal Allocation)

This example illustrates the procedures to calculate emissions from an industrial boiler firing anthracite coal.

Assumed Operating Parameters

Coal type: Anthracite
Annual coal consumption: 928,000 tons per year (tpy)
Ash content of coal: 7 percent
Sulfur content of coal: 1.87 percent

Seasonal throughput fractions: Winter = 50%;
Spring = 20%;
Summer = 10%;
Fall = 20%

Particulate emissions are controlled with a 75 percent efficient cyclone
Sulfur oxides emissions are controlled with a 93 percent efficient limestone injection system.

Boiler Type: Traveling grate stoker

AP-42 Emission Factors

Section 1.2 of AP-42 provides emission factors for pollutants from anthracite coal combustion in stoker fired boilers:

Total organic compounds (TOC): = 0.3 lb/ton (Table 1.2-6)
Particulate matter (PM): = 0.8A lb/ton for PM-filterable and 0.08A lb/ton for PM-condensable where A is the ash content of coal in weight percent (Table 1.2-3)
Lead (Pb): = 8.9E-03 lb/ton (Table 1.2-3)
Nitrogen oxides (NO_x): = 9 lb/ton (Table 1.2-1)
Sulfur dioxide (SO₂): = 39S lb/ton where S is the weight percent of sulfur in the coal (Table 1.2-1)
Carbon monoxide (CO): = 0.6 lb/ton (Table 1.2-2)

Example 1-- Coal-fired Industrial Boiler (Emission Factors and Temporal Allocation) (Continued)

Estimating Uncontrolled Emissions

The general equation for estimating uncontrolled emissions of TOC, Pb, NO_x, CO, and CO₂ from anthracite coal combustion in boilers is as follows:

$$\text{Boiler Emissions} = \text{Annual Coal Consumption} \times \text{Emission Factor}$$

$$\begin{aligned} \text{TOC} &= 928,000 \text{ tons/year} \times 0.3 \text{ lb/ton} = 278,400 \text{ lb/year} = 139.2 \text{ tpy} \\ \text{Pb} &= 928,000 \text{ tons/year} \times 8.9\text{E-}03 \text{ lb/ton} = 8,259 \text{ lb/year} = 4.1 \text{ tpy} \\ \text{NO}_x &= 928,000 \text{ tons/year} \times 9 \text{ lb/ton} = 8,352,000 \text{ lb/year} = 4,176 \text{ tpy} \\ \text{CO} &= 928,000 \text{ tons/year} \times 0.6 \text{ lb/ton} = 556,800 \text{ lb/year} = 278 \text{ tpy} \end{aligned}$$

The general equation for estimating uncontrolled emissions of PM from anthracite coal combustion in boilers is as follows:

$$\begin{aligned} \text{PM Emissions} &= \text{Annual Coal Consumption} \times (\text{Emission Factor} \times \text{Coal Ash Content}) \\ \text{PM-Filterable} &= 928,000 \text{ tons/year} \times (0.8 \text{ lb}/.056 \text{ ton} \times .07) = 51,968 \text{ lb/year} \\ &= 25.98 \text{ tpy} \\ \text{PM-Condensable} &= 928,000 \text{ tons/year} \times (0.08 \text{ lb}/.0056 \text{ ton} \times .07) = 5196.80 \\ &\text{lb/year} \\ &= 2.598 \text{ tpy} \\ \text{Total PM} &= 25.98 \text{ tpy} + 2.598 \text{ tpy} = 28.58 \text{ tpy} \end{aligned}$$

The general equation for estimating uncontrolled emissions of SO₂ from anthracite coal combustion in boilers is as follows:

$$\begin{aligned} \text{SO}_2 \text{ Emissions} &= \text{Annual Coal Consumption} \times (\text{Emission Factor} \times \text{Coal Sulfur Content}) \\ \text{SO}_2 &= 928,000 \text{ tons/year} \times (39 \text{ lb/ton} \times .0187) = 676,790.4 \text{ lb/year} \\ &= 338.4 \text{ tpy} \end{aligned}$$

Example 1-- Coal-fired Industrial Boiler (Emission Factors and Temporal Allocation) (Continued)

Estimating Controlled Emissions

Particulate emissions are controlled with a 75 percent efficient cyclone and SO₂ emissions are controlled with a 93 percent efficient limestone injection system. The general equation for estimating controlled emissions of PM and SO₂ is as follows:

$$\text{Controlled Emissions} = \text{Uncontrolled Emissions} \times (1 - \text{Efficiency}/100)$$

$$\begin{aligned} \text{Total PM} &= 28.58 \text{ tpy} \times (1-75/100) = 28.58 \text{ tpy} \times (0.25) = 7.15 \text{ tpy} \\ \text{SO}_2 &= 338.4 \text{ tpy} \times (1-93/100) = 338.4 \text{ tpy} \times (0.07) = 23.7 \text{ tpy} \end{aligned}$$

Temporal Allocation of PM Emissions

The general equation for estimating seasonal emissions is as follows:

$$\text{Seasonal emissions} = \text{Seasonal throughput fraction} \times \text{annual emissions}$$

Therefore:

$$\begin{aligned} \text{Winter emissions of PM} &= 0.5 \times 7.15 \text{ tpy} = 3.575 \text{ tons} \\ \text{Spring emissions of PM} &= 0.2 \times 7.15 \text{ tpy} = 1.43 \text{ tons} \\ \text{Summer emissions of PM} &= 0.1 \times 7.15 \text{ tpy} = 0.715 \text{ tons} \\ \text{Fall emissions of PM} &= 0.2 \times 7.15 \text{ tpy} = 1.43 \text{ tons} \end{aligned}$$

Example 2--Natural Gas And Number 6 Fuel Oil Fired Industrial Boiler Emissions (Emission Factors)

This example illustrates the use of *AP-42* emissions factors to estimate emissions from a small industrial boiler firing natural gas and Number 6 fuel oil.

Assumed Operating Parameters

Natural Gas

Annual Consumption: 99,885 MMBtu/year
Heating Value: 1,032 Btu/scf
Usage: 81% of the time

#6 Oil

Annual Consumption: 147,983 gal/year
Heating Value: 150,000 Btu/gal
Sulfur Content: 1 percent
Nitrogen Content: 0.4 percent
Usage: 19% of the time

AP-42 Emission Factors

Sections 1.3 and 1.4 of *AP-42* provide emission factors for pollutants from industrial boilers firing Number 6 fuel oil and natural gas, respectively.

Natural Gas

PM-Filterable: 1.9 lb/10⁶ scf (Table 1.4-2)
PM-Condensable: 5.7 lb/10⁶ scf (Table 1.4-2)
SO_x: 0.6 lb/10⁶ scf as SO₂ (Table 1.4-2)
NO_x as NO₂: 100 lb/10⁶ scf as NO₂ (Table 1.4-1)
CO: 84 lb/10⁶ scf (Table 1.4-1)
TOC: 11 lb/10⁶ scf (Table 1.4-2)

Number 6 Fuel Oil

All emission factors for Number 6 fuel oil are obtained from Table 1.3-1 in *AP-42* (except as noted) for boilers with firing rate less than 100 million Btu/hr:

CO: 5 lb/10³ gal
Nonmethane Volatile Organics: 0.28 lb/10³ gal [Table 1.3-3]
Methane Volatile Organics: 1 lb/10³ gal [Table 1.3-3]
NO_x as NO₂: [20.54 + (104.39 x N)] lb/10³ where N is the weight percent of nitrogen in the oil
NO₂ emission factor = 20.54 + (104.39 x 0.4) = 62.3 lb/10³ gal

Example 2--Natural Gas And Number 6 Fuel Oil Fired Industrial Boiler Emissions (Emission Factors) Continued

Particulate Matter (PM): $[9.19(S) + 3.22]$ lb/10³ gal where S is the weight percent of sulfur in the oil
 PM emission factor = $[9.19(1) + 3.22]$ lb/10³ gal = 12.41 lb/10³ gal

Sulfur Oxides as SO₂: 157(S) lb/10³ gal where S is the weight percent of sulfur in the oil
 SO₂ emission factor = 157(1) = 157 lb/10³ gal

Sulfur Oxides as SO₃: 2(S) lb/10³ gal where S is the weight percent of sulfur in the oil
 SO₃ emission factor = 2(1) = 2 lb/10³ gal

Estimating Uncontrolled Emissions by Fuel Type

Natural Gas

The general equation for estimating natural gas consumption in scf/year is as follows:

$$\text{Annual Consumption} = \frac{\text{Annual Heat Input}}{\text{Natural Gas Heating Value}}$$

$$= \frac{99,885 \times 10^6 \text{ Btu/year}}{1,032 \text{ Btu/scf}} = 96.8 \times 10^6 \text{ scf/year}$$

The general equation for estimating uncontrolled emissions from natural gas combustion is as follows:

$$\text{Natural Gas Emissions} = \text{Annual Gas Consumption} \times \text{Emission Factor}$$

PM-Filterable = $96.8 \times 10^6 \text{ scf/year} \times 1.9 \text{ lb}/10^6 \text{ scf} = 184 \text{ lb/year} = 0.09 \text{ tpy}$
 PM-Condensable = $96.8 \times 10^6 \text{ scf/year} \times 5.7 \text{ lb}/10^6 \text{ scf} = 552 \text{ lb/year} = 0.28 \text{ tpy}$
 SO_x = $96.8 \times 10^6 \text{ scf/year} \times 0.6 \text{ lb}/10^6 \text{ scf} = 58 \text{ lb/year} = 0.03 \text{ tpy}$
 NO_x = $96.8 \times 10^6 \text{ scf/year} \times 100 \text{ lb}/10^6 \text{ scf} = 9,680 \text{ lb/year} = 4.8 \text{ tpy}$
 CO = $96.8 \times 10^6 \text{ scf/year} \times 84 \text{ lb}/10^6 \text{ scf} = 8,132 \text{ lb/year} = 4.07 \text{ tpy}$
 TOC = $96.8 \times 10^6 \text{ scf/year} \times 11 \text{ lb}/10^6 \text{ scf} = 1,064.8 \text{ lb/year} = 0.53 \text{ tpy}$

Total PM emissions from the combustion of natural gas is given by the following equation:

$$\begin{aligned} \text{Total PM Emissions} &= \text{PM-Filterable} + \text{PM-Condensable} \\ &= 0.09 \text{ tpy} + 0.28 \text{ tpy} = 0.37 \text{ tpy} \end{aligned}$$

Example 2--Natural Gas And Number 6 Fuel Oil Fired Industrial Boiler Emissions (Emission Factors) (Continued)

Number 6 Fuel Oil

The general equation for estimating uncontrolled emissions from Number 6 fuel oil combustion in an industrial boiler is as follows:

$$\text{Number 6 Fuel Oil Emissions} = \text{Annual Fuel Oil Consumption} \times \text{Emission Factor}$$

PM	=	147,983 gal/year x 12.41 lb/10 ³ gal = 1,836 lb/year = 0.92 tpy
SO _x as SO ₂	=	147,983 gal/year x 157 lb/10 ³ gal = 23,233 lb/year = 11.6 tpy
SO _x as SO ₃	=	147,983 gal/year x 2 lb/10 ³ gal = 296 lb/year = 0.15 tpy
NO _x as NO ₂	=	147,983 gal/year x 62.3 lb/10 ³ gal = 9,219 lb/year = 4.6 tpy
CO	=	147,983 gal/year x 5 lb/10 ³ gal = 740 lb/year = 0.37 tpy
Nonmethane Volatile Organics	=	147,983 gal/year x 0.28 lb/10 ³ gal = 41.44 lb/year = 0.021 tpy
Methane Volatile Organics	=	147,983 gal/year x 1 lb/10 ³ gal = 148 lb/year = 0.074 tpy

Total SO_x emissions from the combustion of Number 6 fuel oil is given by the following equation:

$$\text{SO}_x \text{ Emissions} = \text{SO}_2 \text{ emissions} + \text{SO}_3 \text{ emissions} = 11.6 + 0.15 = 11.75 \text{ tpy}$$

Total Volatile Organic emissions from the combustion of Number 6 fuel oil is given by the following equation:

$$\begin{aligned} \text{Total Organic Emissions} &= \text{Nonmethane Volatile Organics} + \text{Methane Volatile Organics} \\ &= 0.021 \text{ tpy} + 0.074 \text{ tpy} = 0.095 \text{ tpy} \end{aligned}$$

Estimating Total Uncontrolled Emissions

$$\text{Total Emissions} = \text{Natural Gas Emissions} + \text{Number 6 Fuel Oil Emissions}$$

Total PM	=	0.37 tpy + 0.92 tpy = 1.29 tpy
Total SO _x	=	0.03 tpy + 11.75 tpy = 11.78 tpy
Total NO _x	=	4.8 tpy + 4.6 tpy = 9.4 tpy
Total CO	=	4.07 tpy + 0.37 tpy = 4.44 tpy
Total TOC	=	0.53 tpy + 0.095 tpy = 0.625 tpy

Example 3--Copper Coil Manufacturing (Mass Balance)

This example illustrates the use of material (mass) balances as a method for estimating emissions from a metal rolling unit that processes copper coil. Prior to a rolling step, copper coil is sprayed with oil for lubrication and heat dispersion. After rolling, the copper coil is sent to an annealer which has been shown to destroy 85 percent of the oil during the heat treatment of the copper coil. Negligible amounts of oil remain on the copper coil after annealing. The oil is assumed to be 100 percent VOC. The VOC emissions associated with this process occur from volatilization of lubricating oil during its application prior to rolling as well as the undestroyed oil exhausted from the annealer.

Assumed Operating Parameters

Mass of copper coil processed:	5,000 kg
Mass of copper coil and oil sent to annealer:	5,075 kg
Mass of lubricating oil sprayed onto the copper:	3,000 kg
Mass of lubricating oil recovered:	2,800 kg

Estimating Emissions

The general formula to complete a material balance is represented by:

$$\text{Input} + \text{Generation} - \text{Output} - \text{Consumption} = \text{Accumulation}$$

where:

Input:	mass entering the process
Generation:	mass produced in the process
Output:	mass exiting the process
Consumption:	mass consumed in the process
Accumulation:	mass that builds up within the process

For this example, the parameters listed above are described as:

Input:	mass of lubricating oil applied (3,000 kg)
Generation:	not applicable/no material generation (0 kg)
Output:	mass of oil lost as an emission
Consumption:	mass of oil destroyed in the annealer
Accumulation:	mass of lubricating oil recovered (2,800 kg)

The estimate for the Consumption parameter is calculated from the mass of copper coil processed, the mass of copper coil and oil sent to the annealer, and the oil destruction efficiency as it is exposed to high temperatures in the annealer.

$$\begin{aligned}\text{Consumption} &= (\text{mass of coil/oil to annealer} - \text{mass of coil processed}) \times 85 \text{ percent} \\ &= (5,075 \text{ kg} - 5,000 \text{ kg}) \times 0.85 \\ &= 64 \text{ kg oil destroyed in the annealer}\end{aligned}$$

Example 3--Copper Coil Manufacturing (Mass Balance) (Continued)

After simplifying the material balance formula, the estimate of the Output (emissions) from this process is:

$$\text{Input} - \text{Output} - \text{Consumption} = \text{Accumulation}$$

Or:

$$\text{Output} = \text{Input} - \text{Consumption} - \text{Accumulation}$$

$$\text{Output} = 3,000 \text{ kg} - 64 \text{ kg} - 2,800 \text{ kg}$$

$$\text{Output} = 136 \text{ kg}$$

The VOC emissions associated with this process are thus 136 kg oil per 5,000 kg of copper coil processed, or 0.027 kg oil per kg of copper coil processed.

Example 4-- Paint Manufacturing (Source Test Data)

This example illustrates the use of source test data to estimate process emissions from a spray booth at a paint manufacturing facility. The materials emitted from the spray booth stack are assumed to be 100 percent VOC.

Assumed Operating Parameters

Stack flow rate:	50,000 scm/hr
Average measured VOC concentration from stack:	0.005 kg VOC/scm
Spray booth annual operation:	2,080 hr/year

Estimating Emissions

Since the source testing provided a VOC concentration and the average stack exhaust flow rate, the concentration can be converted to a mass flow rate:

$$\begin{aligned}\text{Mass Flow rate} &= \text{volumetric flow rate} \times \text{concentration} \\ &= 50,000 \text{ scm/hr} \times 0.005 \text{ kg VOC/scm} \\ &= 250 \text{ kg VOC/hr}\end{aligned}$$

The annual VOC emissions can then be estimated using the mass flow rate and the annual hours of operation for the paint spray booth:

$$\begin{aligned}\text{Emissions} &= \text{mass flow rate} \times \text{annual hours operation} \\ &= 250 \text{ kg VOC/hr} \times 2,080 \text{ hr/yr} \\ &= 520,000 \text{ kg VOC/yr or 520 metric tons}\end{aligned}$$

Example 5 -- Boiler Emissions (Source Testing)

This example illustrates the procedure to estimate lead emissions from a boiler using stack testing results.

Assumed Operating Parameters

The results of these stack sampling test runs show that the average concentration of lead (Pb) in the stack gas is 0.0005 pound per dry standard cubic feet (lb/dscf) and the average stack gas volumetric flow rate is 51,700 dry standard cubic feet per minute (dscf/min). The boiler operates 5,840 hours per year, and is equipped with a multicyclone.

Calculating Pb Emissions

The Pb emission rate is calculated as follows:

$$\begin{aligned}\text{Pb Emission Rate} &= \text{Pb concentration} \times \text{stack gas flow rate} \\ &= 0.0005 \text{ lb/dscf} \times 51,700 \text{ dscf/min} \times 60 \text{ min/hr} \\ &= 1,551 \text{ lb/hr}\end{aligned}$$

$$\text{Annual Pb Emissions} = 1,551 \text{ lb/hr} \times 5,840 \text{ hr/yr} \times 1 \text{ ton}/2,000 \text{ lb} = 4,528 \text{ tpy}$$

Example 6--Boiler Emissions (CEM Data)

This example illustrates how average SO₂ emissions can be calculated based on raw CEM data.

Assumed Operating Parameters

Example CEM output for a boiler burning fuel oil is provided in the following table:

Period	O ₂ (%V)	SO ₂ (ppmv)	Stack Gas Flow Rate (dscfm)
11:00	2.1	1,004.0	155,087
11:15	2.0	1,100.0	155,943
11:30	2.1	1,050.0	155,087
11:45	1.9	1,070.0	154,122
12:00	1.9	1,070.0	156,123
Average	2.0	1,058.8	155,272

HHV: Fuel heating value: 18,000 Btu/lb
SO₂: Molecular weight: 64 lb/lb-mole
V: Molar volume: 385.5 ft³/lb-mole at 68°F and 1 atm
Q_f: Mass fuel throughput: 46,000 lb/hr
OpHrs: Total annual hours of operation: 5,400 hours

Calculating Hourly Emissions of SO₂

$$E_{\text{SO}_2} = \frac{(C \times \text{MW} \times Q \times 60)}{(V \times 10^6)}$$

Where:

C: Parts per million by volume dry air (ppmvd)
MW: Molecular weight in lb/lb-mole
Q: Flow rate in dry standard cubic feet per minute (dscfm)
V: molar volume in cubic feet (ft³)/lb-mole

Example 6--Boiler Emissions (CEM Data) (Continued)

$$E_{\text{SO}_2} = \frac{1,058.8 \times 64 \times 155,272 \times 60}{385.5 \times 10^6} = 1,637 \text{ lb/hr}$$

Calculating Heat Input

$$H_{\text{in}} = \frac{(Q_f \times \text{HHV})}{(10^6)}$$

$$H_{\text{in}} = \frac{46,000 \times 18,000}{10^6} = 828 \text{ MMBtu/hr}$$

Developing SO₂ Emission factors

An SO₂ emission factor expressed as lb/MMBtu is calculated as follows:

$$EF_{\text{SO}_2} = \frac{E_{\text{SO}_2}}{H_{\text{in}}} = \frac{1,637 \text{ lb/hr}}{828 \text{ MMBtu/hr}} = 1.98 \text{ lb/MMBtu}$$

Calculating Annual SO₂ Emissions

Annual SO₂ Emissions = hourly SO₂emissions x O_pHrs

$$= \frac{(1,637 \text{ lb/hr} \times 5,400 \text{ hrs})}{(2,000 \text{ lb/ton})} = 4,419 \text{ tons per year}$$

Example 7--Boiler Emissions (Fuel Analysis)

This example illustrates how SO₂ emissions from fuel combustion can be calculated using fuel analysis results.

Assumed Operating Parameters

Sulfur content of fuel: 1% by weight
Fuel throughput: 5,000 lb/hr
Hours of operation: 8,760 hours/year

Calculating SO₂ emissions:

The basic equation in fuel analysis emission calculation is:

$$E = Q_f \times \text{pollutant concentration in fuel} \times (MW_p/MW_f)$$

Where:

Q_f = Throughput of fuel in lb/hr
 MW_p = Molecular weight of pollutant emitted (lb/lb-mole)
 MW_f = Molecular weight of pollutant in fuel (lb/lb-mole)

In this example, $MW_p = 32 + (16 \times 2) = 64$ lb/lb-mole
 $MW_f = 32$ lb/lb-mole

Therefore, $E_{SO_2} = 5,000 \text{ lb/hr} \times 0.01 \times (64/32)$

$$= 100 \text{ lb/hr}$$

$$= 100 \text{ lb/hr} \times 8,760 \text{ hr/yr} \times \frac{1 \text{ ton}}{2,000 \text{ lbs}}$$

$$= 438 \text{ tons/year of SO}_2$$

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APPENDIX E

AREA SOURCES EXAMPLE CALCULATIONS

Contents

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Example 1--Surface Coating Operations (Mass Balance)

This example illustrates the procedures to calculate VOC and PM emissions from surface coating operation at a wood furniture plant.

Assumed Operating Parameters

Coating Type: A
Coating Density: 7.5 lb/gal as applied
Coating Density of Volatile Content: 6.2 lbs/gallons as applied
Coating Usage: 1,600 gallons per year
Spray Booth Type: Dry-filler spray booth
Spray Gun Transfer Efficiency: 60%
Dry Filter Collection Efficiency: 99%

Estimating VOC Emissions

VOC (tpy) = Volatile content density x annual usage
= 6.2 lbs/gal x 1,600 gal/yr = 9,920 lb/yr
= 9,920 lb/yr x 1 ton/2,000 lbs = 4.96 tpy

Estimating Uncontrolled PM Emissions

Coating density of solid content = Density of coating A - Density of volatile content
= 7.5 lb/gal - 6.2 lb/gal = 1.3 lb solids/gal

Uncontrolled PM emissions = Density of solid content x annual usage x (1 - transfer efficiency)
= 1.3 lb/gal x 1,600 gal/yr x (1 - 0.6)
= 832 lb/yr or 0.416 tpy

Estimating Controlled PM Emissions

Controlled PM emissions = Uncontrolled PM x (1 - Control efficiency)
= 0.416 x (1 - 99/100) = 0.00416 tpy of solids

Example 2-- Emissions from Benzene Loading Operations (Emission Factor)

This example illustrates the AP-42 calculation procedures, at a benzene manufacturing facility, for estimating emissions from transfer of benzene using dedicated, submerged loading transfer trucks equipped with condensers for product recovery.

Assumed Operating Parameters

Transfer truck volume: 9,200 gals
Benzene loading temperature: 80°F
Vapor recovery efficiency: 95 percent
Annual benzene loaded: 820,000 gals

AP-42 Emission Factors

Emissions from uncontrolled loading operations can be estimated using the following AP-42 equation obtained from Section 5.2 of AP-42:

$$L_L = 12.46 \times S \times P \times M/T$$

where:

L_L = loading loss, in lb/10³ gal of liquid loaded
 M = molecular weight of vapors, in lb/lb-mole, obtained from Table 7.1-2
 P = true vapor pressure of liquid loaded, in psia, obtained from Table 7.1-2
 T = temperature of bulk liquid loaded, in °R (°F + 460)
 S = saturation factor, obtained from Table 5.2-1 and function of cargo carrier and mode of operation

From Table 7.1-2, M = 78 lbs/lbs-mole

From Table 7.1-2, P = 2 psia

T = 80°F = 80°F + 460 = 540°R

From Table 5.2-1, for a submerged loading, dedicated, normal service operations,
 S = 0.6

Based on the above, the emission factor for benzene loading operations is

$$L_L \text{ (lb/10}^3 \text{ gal)} = 12.46 \times \frac{0.6 \times 2 \text{ psia} \times 78 \frac{\text{lb}}{\text{lb-mole}}}{540^\circ\text{R}} = 2.16 \text{ lb benzene/1,000gal}$$

**Example 2-- Emissions from Benzene Loading Operations (Emission Factor)
(Continued)**

Estimating Uncontrolled PM Emissions

The general equation for estimating uncontrolled emissions from benzene loading operations is as follows:

$$\text{Uncontrolled Emissions} = \text{Quantity of Benzene Loaded} \times \text{Emission Factor}$$

$$\text{Uncontrolled Emissions} = 820,000 \text{ gal/year} \times 2.16 \text{ lb/1,000 gal} = 1,771 \text{ lb/year} = 0.9 \text{ tpy}$$

Estimating Emissions After Control

Emissions from controlled loading operations can be calculated by multiplying the uncontrolled emission rate by the control efficiency:

$$\text{Emission After Control} = \text{Uncontrolled Emissions} \times (1 - \text{eff}/100)$$

$$\text{Emissions After Control} = 0.9 \text{ tpy} \times (1 - 95/100) = 0.045 \text{ tpy} = 90 \text{ lb/year}$$

Example 3-- Cold Cleaners Solvent Degreasing (Emission Factors)

This example illustrates the calculation procedures required to estimate emissions from a solvent degreasing process using cold cleaners. Uncontrolled emissions from cold cleaners occur through waste solvent evaporation, solvent carryout, solvent bath, and spray evaporation.

Assumed Operating Parameters

Number of degreasing units: 5 units

Volume of virgin solvent use: 120 tpy

AP-42 Emission Factors

From AP-42 Table 4.6-2, VOC emissions are calculated using the following emission factors:

Waste solvent loss = 0.18 tpy/unit

Solvent carryout = 0.08 tpy/unit

Bath and spray evaporation = 0.07 tpy/unit

Estimating Emissions

The general equation for estimating VOC emissions from a solvent degreasing process is as follows:

$$\text{VOC Emissions} = \text{Waste Solvent Losses} + \text{Solvent Carryout} + \text{Bath and Spray Evaporation}$$

$$\begin{aligned} \text{Waste solvent losses} &= \text{solvent losses factor} \times \text{number of units in operation} \\ &= 0.18 \times 5 = 0.9 \text{ tpy} \end{aligned}$$

$$\begin{aligned} \text{Solvent carryout} &= \text{solvent carryout factor} \times \text{number of units in operation} \\ &= 0.08 \times 5 = 0.4 \text{ tpy} \end{aligned}$$

$$\begin{aligned} \text{Bath and spray evaporation} &= \text{bath and spray evaporation factor} \times \text{number of units} \\ &= 0.07 \times 5 = 0.35 \text{ tpy} \end{aligned}$$

$$\text{VOC emissions} = 0.9 \text{ ton/year} + 0.4 \text{ ton/year} + 0.35 \text{ ton/year} = 1.65 \text{ tpy}$$

Example 3-- Cold Cleaners Solvent Degreasing (Emission Factors) (Continued)

The general equation for estimating TCA emissions from the solvent degreasing process is as follows:

$$\text{TCA Emissions} = \text{TCA Factor} \times \text{Volume of Solvent Used}$$

$$\begin{aligned} \text{TCA Emissions} &= 1,920 \text{ lb/ton} \times 120 \text{ tpy} \\ &= 230,400 \text{ lb/year} \\ &= 115 \text{ tpy} \end{aligned}$$

Example 4-- Process Cooling Tower (Actual and Allowable Emissions)

This example illustrates the procedures to calculate PM₁₀ emissions (both actual and allowable) using AP-42 emission factors.

Assumed Operating Parameters

Cooling tower type: Wet with induced draft

Average cooling tower throughput rate in the past 3 years: 6,800 gallons per minute (gpm)

Average Total Dissolved Solids (TDS) concentration in the past 3 years: 2,000 ppm

Actual hours of operation in 1998: 8,424 hours

Number of cells: 8

From operating permit, the following information was obtained:

Maximum number of hours of operation: 8,760 hr

Maximum TDS concentration permitted: 2,700 ppm

Estimating Actual Emissions

From AP-42 Table 13.4-1, the total liquid drift (TLD) is 1.7 lb/1,000 gal or 0.0017 lb/gal:

Uncontrolled Actual PM₁₀ emissions are calculated as follows:

$$\begin{aligned} \text{PM}_{10} \text{ (lb/hr)} &= \text{TLD (lb/gal)} \times [\text{TDS (ppm)} \times 1 \text{ (lb TDS/10}^6 \text{ lb water)}] \times \text{throughput} \\ &\quad \text{(gpm)} \times 60 \text{ min/hr} \\ &= 0.0017 \text{ lb/gal} \times 2,000 \times 1/10^6 \times 6,800 \text{ gpm} \times 60 \text{ min/hr} \\ &= 1.3872 \text{ lb PM}_{10}\text{/hr} \end{aligned}$$

Actual hours of operation = 8,424 hr/yr

$$\begin{aligned} \text{Therefore, uncontrolled PM}_{10} \text{ emissions} &= 1.3872 \times 8,424 \\ &= 11,686 \text{ lb/yr} \end{aligned}$$

Total uncontrolled PM₁₀ emissions from all 8 cells:

$$8 \times 11,686 \text{ lb/yr} \times 1 \text{ ton/2,000 lb} = 46.74 \text{ tpy}$$

Estimating PM₁₀ Allowable Emissions

Uncontrolled allowable PM₁₀ emissions are calculated as follows:

$$\begin{aligned} \text{PM}_{10} \text{ (lb/hr)} &= \text{TLD} \times [\text{Max TDS}] \times \text{throughput} \\ &= 0.0017 \text{ lb/gal} \times 2,700 \times 1/10^6 \times 6,800 \text{ gpm} \times 60 \text{ min/hr} \\ &= 1.8727 \text{ lb PM}_{10}\text{/hr} \end{aligned}$$

**Example 4-- Process Cooling Tower (Actual and Allowable Emissions)
(Continued)**

Maximum hours of operation: 8,760

Therefore, uncontrolled allowable PM₁₀ emissions is:

$$1.8727 \text{ lb/hr} \times 8,760 \text{ hr/yr} = 16,405 \text{ lb/yr}$$

Total allowable uncontrolled PM₁₀ emissions from all 8 cells:

$$8 \times 16,405 \text{ lb/yr} \times 1 \text{ ton}/2,000 \text{ lb} = 65.62 \text{ tpy of PM}_{10}$$

Example 5-- Estimating County Level Wood Usage (Top-Down approach)

This example illustrates the procedure to allocate residential wood consumption to the county level using a top-down approach.

Assumed Operating Parameters

Wood used for residential energy in State A: 622,000 cords

(Obtained from the EIA's State Energy Data Report)

Number of households using wood as primary fuel in State A: 80,047

(Obtained from the U.S. Census data on house heating fuel)

Number of households using wood as primary fuel in county of study:

1,242 households

Allocating Wood Used to the County of Study

County Wood Use = State wood use x county households/state households

$$= 622,000 \times 1,242/80,047 = 9,651 \text{ cords burned in county of study}$$

Example 6-- Open Burning of Household Waste (Local Survey Results)

This example illustrates the procedure to scale up the results of a survey performed on a sample of households to estimate emissions from the entire county.

Assumed Operating Parameters

A survey of 200 households in a rural portion of County A showed that 6.7% of the households use burn barrels to dispose of combustible household waste. The survey was conducted in locations where no garbage pickup services are available. The survey also showed that:

- The average waste generated per household is 6.75 lb/day
- The waste generated that is combustible waste is 80%

The U.S. Census data also shows that 17,502 households are in the rural portion of County A. A telephone conversation with the County Planning Department revealed that 15% of the households in rural areas have access to public or private garbage pickup services.

Scaling up Survey Results

A number of households in rural areas with no access to garbage pickup service =
 $17,502 \times 0.85 = 14,877$ households

Number of households that use burn barrels = $14,877$ households $\times 6.7/100 =$
 997 households

Estimating Activity Level in County (Combustible Waste)

Total waste generated by households that use burn barrels:

997 households $\times 6.75$ lb/household/day = $6,730$ lb/day

Total combustible waste generated by households that use burn barrels:

$6,730$ lb/day $\times 80/100 = 5,384$ lb/day

Estimating Emissions

Total combustible waste generated = $5,384$ lb/day = 2.69 ton/day

**Example 6-- Open Burning of Household Waste (Local Survey Results)
(Continued)**

From AP-42, Table 2.5-1, the emission factors for open burning of municipal refuse are:

CO: 85 lb/ton
PM: 16 lb/ton
SO_x: 1 lb/ton
NO_x: 6 lb/ton
TOC: 21.5 lb/ton

Therefore, daily emissions from open burning of household waste in the County are:

CO: 85 lb/ton x 2.69 tons/day = 228.6 lb of CO/day
PM: 16 lb/ton x 2.69 tons/day = 43.03 lb of PM/day
SO_x: 1 lb/ton x 2.69 tons/day = 2.69 lb of SO_x/day
NO_x: 6 lb/ton x 2.69 tons/day = 16.14 lb of NO_x/day
TOC: 21.5 lb/ton x 2.69 tons/day = 57.84 lb of TOC/day
TOC = Total organic compound

Example 7-- Surface Coating (Per Employee Emission Factor)

This example illustrates the procedure to estimate VOC emissions from surface coating using a per-employee emission factor.

Assumed Operating Parameters

A survey was conducted on a subset of facilities that manufacture wood furniture. The survey indicated that the average coating usage per employee is 12 gal/year. In addition, the survey results indicate that the average coating applied has a density of 7.5 lb/gal and is 45% VOC by weight.

Calculating Area Sources Employment (Adjusting for Major Sources)

Surface coating operations occur at facilities designated as point sources and at smaller facilities designated as area sources. However, in order to avoid double counting, emissions from those facilities that are designated as point sources should not be included in the area source inventory. One approach to reducing the effect of double counting is to subtract the activity occurring at the point sources. Therefore, in this example, total employment in surface coating in the inventory is reduced by the employment at the point sources. The resulting employment is assumed to be the employment at area sources involved in surface coating operations.

Area source employment = total employment from County Business Patterns - major source employment from permit applications = 2,500 - 1,600 = 900 employees

Calculating area source emissions

VOC emissions from area sources	=	area source employment x average coating usage x % VOC x coating density
	=	900 employees x 12 gal/yr x 7.5 lb/gal x 45/100
	=	36,450 lb/yr
	=	18.23 tpy of VOC

Example 8-- Vapor Degreaser (Material Balance)

This example illustrates the procedure to estimate VOC emissions from an open-top vapor degreaser using a material balance approach.

Assumed Operating Parameters

At the beginning of each month, 50 gallons of solvent (density: 12.5 lb/gal) are added to the degreaser. During the month, an additional 10 gallons are added to replenish losses. At the end of the month, 50 gallons of waste solvent are sent to a recycling off-site. About 0.5 lb of solid waste is collected for disposal. The solvent is 100% VOC, the waste solvent is 98% VOC, and the solid waste is 5% VOC.

Calculating Solvent Used Per Month

$$\begin{aligned} Q_{in} &= (50 \text{ gal/month} + 10 \text{ gal/month}) \times 12.5 \text{ lb/gal} \\ &= 750 \text{ lb/month} \end{aligned}$$

Calculating Waste Solvent Generated Per Month

$$Q_{out} = \text{gallons of solvent sent to recycling} \times \text{solvent density} \times \text{waste solvent VOC content} + \text{solid waste} \times \text{solid waste VOC content}$$

$$\begin{aligned} Q_{out} &= (50 \text{ gal/month} \times 12.5 \text{ lb/gal} \times 0.98) + (0.5 \text{ lb/month} \times 0.05) \\ &= 612.5 \text{ lb/month} + 0.025 \text{ lb/month} \\ &= 612.525 \text{ lb/month} \end{aligned}$$

Estimating Emissions

$$\begin{aligned} E_{voc} &= Q_{in} - Q_{out} = 750 \text{ lb/month} - 612.525 \text{ lb/month} \\ &= 137.5 \text{ lb/month} \end{aligned}$$

Example 9-- Agricultural Burning (Extrapolation/Top-Down)

This example illustrates the use of activity data from one State A to estimate emissions from agricultural burning in a county in an adjacent State B of comparable agricultural conditions (i.e., similar crops, agricultural methods, climate, etc.).

Assumed Operating Parameters

- Annual VOC emissions from agricultural burning in States: 200 tons per year
- Agricultural land use in State A: 100 acres
- Agricultural land use in State B: 70 acres
- Agricultural land use in County of Study in State B: 10 acres

Extrapolating Emissions from State A to State B

$$\begin{aligned}\text{VOC in State B} &= \text{VOC in State A} \times \text{Acres in State B} / \text{Acres in State A} \\ &= 200 \text{ tpy} \times 70 / 100 = 140 \text{ tpy}\end{aligned}$$

Calculating Emissions in County of Study

Using a top-down approach, VOC emissions in county of study are calculated as follows:

$$\begin{aligned}\text{VOC}_{\text{County}} &= \text{VOC}_{\text{State B}} \times \text{Area in County} / \text{Area of State B} \\ \text{VOC}_{\text{County}} &= 140 \text{ tpy} \times 10 \text{ acres} / 70 \text{ acres} \\ &= 20 \text{ tpy}\end{aligned}$$

Example 10-- Stage I Gasoline Marketing (Rule Effectiveness/Rule Penetration)

This example illustrates the application of rule effectiveness and rule penetration in calculating VOC emissions from filling an underground gasoline storage tank.

Assumed Operating Parameters

- Total county throughput: 500,000 gal/day
- Tank filling method: slash filling
- Filling method central efficiency: 95%
- Stage I gasoline marketing emission factors: 11.5 lb/1,000 gal throughput (from AP-42, Table 5.2-7)
- RE is assumed to be 80%
- RP is assumed to be 93% (fraction of throughput that will be subject to control)

Calculating Emissions

$$E = A \times EF \times (1 - C \times RE \times RP)$$

$$\begin{aligned} A &= 500,000 \text{ gal/day} \\ EF &= 11.5 \text{ lb/1,000 gal} \\ C &= 0.95 \\ RE &= 0.8 \\ RP &= 0.93 \end{aligned}$$

$$\begin{aligned} \text{Therefore, } E &= 500 \times 11.5 \times [1 - (0.95) (0.8) (0.93)] \\ &= 1,685 \text{ lb of VOC/day} \end{aligned}$$

Example 11 -- Architectural Surface Coating (Per-Capita Emission Factor)

This example illustrates how a national per-capita emission factor can be developed and applied to a county in order to determine emissions from architectural surface coating.

Assumed Operating Parameters

Data on Paints and Allied Products from the Census indicate that 600,000,000 gallons of paints were applied. An analysis of the data shows that 75% of the paints were water-based. The U.S. population is assumed to be 250,000,000. Population in the County of Study is 450,000.

Developing National Per-Capita Emission Factors

For solvent-based paints, the national per capita emission factor is:

$$\frac{600,000,000 \times (1 - 0.75)}{250,000,000} = 0.6 \text{ gal/person/year}$$

For water-based paints, the national per capita emission factor is:

$$\frac{600,000,000 \times 0.75}{250,000,000} = 1.8 \text{ gal/person/year}$$

Estimating County-Level Emissions

Emissions at the county level are calculated as follows:

$$E = EF \times \text{county population}$$

For solvent-based paints:

$$E_{\text{solvent}} = 0.6 \text{ gal/person} \times 450,000 \text{ person} = 270,000 \text{ gal/yr}$$

For water-based paints:

$$E_{\text{water}} = 1.8 \text{ gal/person} \times 450,000 \text{ persons} = 810,000 \text{ gal/yr}$$

Example 12 -- Unpaved Roads (Empirical Equation/Computer Software)

This example illustrates the use of an empirical expression to estimate the quantity of PM_{2.5} and PM₁₀ emission from an unpaved road. Alternatively, this example could have been illustrated using the MECH model.

Assumed Operating Parameters

Unpaved road type: Publicly accessible road

Surface material: Dirt

Mean vehicle weight (W): 2.2 tons (default from AP-42, Section 13.2.2)

Vehicle miles traveled: 2.4 x 10⁶ miles per year

Assigning Values to Variables in Empirical Expression

The size-specific emission factor is calculated as follows:

$$E_{\text{lb/vmt}} = k \times \frac{\left(\frac{s}{12}\right)^a \times \left(\frac{W}{3}\right)^b}{(M/0.2)^c} [(365 - p)/365]$$

where:

- k = constant
- s = silt content of the unpaved road
- a = constant
- b = constant
- c = constant
- W = mean vehicle weight in tons
- M = surface material moisture content under dry, uncontrolled conditions
- p = number of days with at least 0.01 in of precipitation per year

From AP-42, the following values can be assigned to the variables listed above:

- s = 11 (Table 13.2.2-1 for a publicly accessible dirt road)
- k = 0.38 lb/VMT for PM_{2.5} (Table 13.2.2-2)
- k = 2.6 lb/VMT for PM₁₀ (Table 13.2.2-2)
- a = 0.8 for PM_{2.5} and PM₁₀ (Table 13.2.2-2)
- b = 0.4 for PM_{2.5} and PM₁₀ (Table 13.2.2-2)
- c = 0.3 for PM_{2.5} and PM₁₀ (Table 13.2.2-2)
- W = 2.2 tons (default value recommended in Section 13.2.2 of AP-42)
- M_{dry} = 0.2% (default value recommended in Section 13.2.2 of AP-42)
- p = 0.60 (Figure 13.2.2-1 for a county in Arizona)

**Example 12 -- Unpaved Roads (Empirical Equation/Computer Software)
(Continued)**

Calculating PM_{2.5} and PM₁₀ emission factors

$$EF_{PM_{2.5}} = 0.38 \times \frac{\left(\frac{11}{12}\right)^{0.8} \left(\frac{2.2}{3}\right)^{0.4}}{(0.2/0.2)^{0.3}} \left[\frac{365 - 60}{365}\right] = 0.26 \text{ lb/VMT}$$

Calculating Annual Emissions

$$EF_{PM_{10}} = 2.6 \times \frac{\left(\frac{11}{12}\right)^{0.8} \left(\frac{2.2}{3}\right)^{0.4}}{(0.2/0.2)^{0.3}} \left[\frac{365 - 60}{365}\right] = 1.79 \text{ lb/VMT}$$

Annual emissions = EF x VMT x 1 ton/2,000 lb
PM_{2.5} emissions = 0.2616 x 2.4 x 10⁶ x 1/2,000 = 313.92 ton per year
PM₁₀ emissions = 1.79 x 2.4 x 10⁶ x 1/2,000 = 2,148 ton per year

Example 13 -- Estimating Seasonal Wood Consumption (Temporal Allocation)

This example illustrates the use of meteorological data to temporally allocate residential wood burning activity to the inventory period. Annual activity data is apportioned using the number of heating degree days that occur annually and during the winter wood-burning season in the inventory area. This information can be obtained from state climatological offices, airport meteorological stations, or National Oceanographic and Atmospheric Administration (NOAA) climate data.

Assumed Operating Parameters

Annual Wood Consumption for Space Heating: 100,000 tons wood
Number of Heating Degree Days (HDD) During the Inventory Period: 1800
Number of Annual Heating Degree Days (HDD): 2430 days

Developing an Apportionment Factor

Seasonal Apportionment Factor (SAF) = (HDD in Season/Annual HDD)
SAF = (1800 / 2430)
SAF = 0.74

Estimating Seasonal Fuel Consumption

Seasonal Wood Consumption = Annual Wood Consumption x SAF
Seasonal Wood Consumption = 100,000 tons wood x 0.74
= 74,000 tons wood consumed during the inventory period

APPENDIX F

OVERVIEW OF REFERENCE MATERIALS

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AIRS Facility Subsystem (AFS)

The Aerometric Information Retrieval System (AIRS) is a computer-based system for the storage and retrieval of ambient air quality monitoring data and emissions and compliance data for individual facilities. Emissions data in the Airs Facility Subsystem (AFS) are used primarily by states in the preparation of State Implementation Plans (SIPs) and SIP inventories. Types of data stored in AFS include:

- Facility name, location, and SIC code;
- Stack parameters;
- Process-specific operating schedule;
- SCC codes;
- Annual process rate, and fuel parameters; and
- Annual emissions estimates for criteria pollutants.

The AIRS database resides on EPA's mainframe computer system and is not a publicly available database that can be accessed from the Web, but AFS data is publicly on EPA's **Envirofacts** at http://www.epa.gov/enviro/index_java.html. In addition, some source data are available on AIRS TTN at <http://www.epa.gov/airsdata/sources.html>. In order to retrieve information directly from AIRS, you need to obtain an account on the EPA mainframe computer system and pay the applicable computer usage charges. Information about obtaining a computer account is available by calling 1-800-334-2405 (toll free) or 919-541-7862 or can be obtained from NTIS at (703) 605-6000.

As of the time this document was prepared, the emissions component of AFS is scheduled to be discontinued in September, 2000 and the emissions data of AFS transferred to the NET. You should consult the AIRS/AFS Web site at <http://www.epa.gov/ttn/airs/afs/index.html> for the latest memos and information on the plans to migrate the emission component of AIRS/AFS to the NET database.

AIRSWeb

The AIRSWeb gives access to air pollution data for the entire United States. AIRSWeb is a collection of the most significant AIRS data elements. AIRSWeb "Source Reports" display estimates of annual emissions of criteria pollutants from individual point sources, and number of

sources and total pollutant emissions by industry. Specifically, there are six Source Reports that can be generated from AIRSWeb:

- **Ranking:** Lists each source in order of its pollutant emissions, ranking them from largest to smallest;
- **Compliance:** Indicates whether each source is complying with regulations governing air pollutant emissions;
- **Address:** The name and address of each source plus additional descriptive information;
- **Count:** The number of sources and total air pollutant emissions for each geographic area (county, state, or EPA region);
- **SIC:** The number of sources and total air pollutant emissions for each SIC; and
- **Year:** The number of sources that submitted emissions estimates for each calendar year (indicates how recent are the data).

AIRSWeb data collection is refreshed monthly, usually on the first Tuesday. AIRSWeb reports can be accessed on the World Wide Web at <http://www.epa.gov/airswb/sources.htm>.

The NET Database

The National Emissions Trends (NET) system is a national repository database compiled by EPA. The NET blends state and local-supplied data with the EPA-derived data to form a comprehensive national inventory of criteria and toxic pollutants. Estimates are added to the inventory each year, with increasing levels of detail in the more recent years. As a result, the NET reflects the latest information available. For example, the 1996 NET inventory includes state-submitted inventory data generated for the Ozone Transport Assessment Group (OTAG) and Grand Canyon Visibility Transport Commissions (GCVTC) and other inventory services. The NET inventory does not necessarily include state data for any particular source or pollutant. However, in the 1996 NET inventory, EPA intends to provide statewide emissions inventory data on a county level basis to every state in the country.

The NET inventory can be used as a starting point in compiling an emissions inventory because it can be used to compile an initial list of emission sources in the area of study for point and area sources. Additional information on the NET inventory can be obtained through the EFIG's Emissions Inventory Web site or from the Info CHIEF Help Desk.

Toxic Release Inventory

The EPA's Toxic Release Inventory (TRI) is a compilation of information about toxic chemicals used, manufactured, stored, treated, transported, or released into the environment. EPA stores TRI data in the Toxics Release Inventory System (TRIS). TRI data can be used in compiling a list of emission sources in the area of study. However, TRI data are best used when combined with information from other sources because of the following limitations associated with the TRI data:

- TRI covers only a subset of industrial sources. Non-industrial sources such as dry cleaners or automobile service stations are not covered in TRI;
- Many point sources may not be required to report data to TRIS. Facilities must meet all of the following criteria in order to report data to TRIS;
 - Facilities that conduct manufacturing operations with SIC codes 20 through 39;
 - Facilities that have 10 or more full-time employees or their equivalent;
 - Facilities that manufacture, process, or otherwise use EPCRA Section 313 chemicals at the following thresholds: 25,000 lb/yr for manufacturing and processing, or 100,000 lb/yr otherwise used.

TRI can be searched by SIC, facility name, or location. TRI reports are available in public libraries or can be downloaded off the World Wide Web at <http://www.epa.gov/opptintr/tri/access.htm>. The TRI database can also be searched online through the Right-To-Know Network (RTK NET) at http://www.rtk.net/www/data/data_gen.html.

Industry Sector Notebooks

The EPA's Office of Compliance has developed a series of profiles or notebooks containing information on selected major industrial groups. Each sector-specific notebook brings comprehensive details that include:

- Industrial process information;
- A comprehensive environmental profile;
- Pollutant release data;
- Contact names;

- Compliance/enforcement history; and
- Bibliographic references.

The following Industry Sector Notebooks are currently available:

- Profile of the Aerospace Industry;
- Profile of the Air Transportation Industry;
- Profile of the Dry Cleaning Industry;
- Profile of the Electronics and Computer Industry;
- Profile of the Fossil Fuel Electric Power Generation Industry;
- Profile of the Ground Transportation Industry;
- Profile of the Inorganic Chemical Industry;
- Profile of the Iron and Steel Industry;
- Profile of the Lumber and Wood Products Industry;
- Profile of the Metal Casting Industry;
- Profile of the Metal Fabrication Industry;
- Profile of the Metal Mining Industry;
- Profile of the Motor Vehicle Assembly Industry;
- Profile of the Nonferrous Metals Industry;
- Profile of the Non-Fuel, Non-Metal Mining Industry;
- Profile of the Organic Chemical Industry;
- Profile of the Petroleum Refining Industry;
- Profile of the Pharmaceutical Industry;
- Profile of the Plastic Resins and Man-made Fibers Industry;

- Profile of the Printing Industry;
- Profile of the Pulp and Paper Industry;
- Profile of the Rubber and Plastic Industry;
- Profile of the Shipbuilding and Repair Industry;
- Profile of the Stone, Clay, Glass and Concrete Industry;
- Profile of the Textiles Industry;
- Profile of the Transportation Equipment Cleaning Industry;
- Profile of the Water Transportation Industry; and
- Profile of the Wood Furniture and Fixtures Industry.

In addition, the Office of Compliance is planning to add new profiles to the Industry Sector Notebook Series. Copies of the Notebooks can be downloaded from EPA's Web page at <http://es.epa.gov/oeca/sector/index.html>. Printed bound copies of the notebooks can be ordered from GPO at (202) 512-1800. Some of the electronic files of the notebooks published in 1995 do not contain all the tables, graphs, charts, and illustrations that appear in the printed versions.

Integrated Data for Enforcement Analysis

The Integrated Data for Enforcement Analysis (IDEA) is an interactive data retrieval and integration system developed by EPA's Office of Enforcement and Compliance Assurance (OECA). IDEA integrates facility data across EPA's various program office databases. IDEA can be used to:

- Produce the compliance history on a specific facility;
- Retrieve data for performing multimedia analysis of regulated facilities;
- Identify a group of facilities that meet a user's specific criteria; and
- Produce aggregated data on selected industries.

IDEA allows the user to search by facility location, pollutants emitted, and by SIC. It integrates data from 17 databases including Aerometric Information and Retrieval System (AIRS)/AIRS Facility Subsystem (AFS); Comprehensive Environmental Response, Compensation and

Liability (CERCLA) Information System (CERCLIS); the 1990 Census of Population and Housing; Dun & Bradstreet (DUNS); and TRI. IDEA resides on EPA's mainframe computer located at the National Computer Center in Research Triangle Park, NC. Additional information on IDEA can be found on OECA's Web page at <http://es.epa.gov/oeca/idea/>.

Economic Growth Analysis System

The Economic Growth Analysis System (EGAS) is an economic and activity forecasting model that projects growth factors by source classification code (SCC) for nonattainment areas and attainment portions of States for the 48 contiguous States. The system is composed of a national economic tier, a regional economic tier, and a growth factor tier which includes energy consumption models for the residential, commercial, and industrial sectors, modules which forecast industrial physical output and vehicle miles traveled, and a crosswalk which matches the appropriate growth factor with each point, area, and mobile source SCC. Additional information on EGAS can be found at http://www.epa.gov/ttn/chief/ei_data.html#EGAS

Multiple Projections System

The Multiple Projections System (MPS) is a projection model that uses a base year inventory, source-specific growth factors, and projected changes in (source-specific) control efficiency and rule effectiveness to develop inventories for future years. Additional information on MPS can be found at http://www.epa.gov/ttn/chief/ei_data.html#PS

APPENDIX G

**LIST OF EMISSION ESTIMATION MODELS
AND EMISSION FACTOR RESOURCES
(Current as of August 1999)**

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List of Emission Factor Resources

Landfill Gas Emissions Model (Version 2.01)

The Landfill Gas Emissions Model was developed by the Clean Air Technology Center (CATC). The model can be used to estimate emission rates for methane, carbon dioxide, nonmethane organic compounds, and individual toxic air pollutants from landfills. The system allows the user to enter specific information regarding the characteristics and capacity of an individual landfill and to project the emissions of methane, CO, nonmethane organic compounds, and individual HAPs over time using the Scholl Canyon decay model for landfill gas production estimation. The Scholl Canyon Model is a first-order decay equation that uses site-specific characteristics for estimating the gas generation rate. In the absence of site-specific data, the program provides conservative default values. The user also may tailor decay rate characteristics on an individual basis. An integrated decay rate constant calculator is provided for landfills that may be operating a gas recovery system to allow more accurate assessments of decay attributes. Outputs may be reviewed in either tabular or graphical forms. A help system is also provided with information on the model operation as well as details on assumptions and defaults used by the system. For additional information contact the EPA's Air Pollution Prevention and Control Division at (919) 541-2709. The model can be downloaded from the World Wide Web through EPA's TTN Web site at <http://www.epa.gov/ttn/catc/products.html#software>.

TANKS

TANKS is a Windows-based computer software program that computes estimates of VOC emissions from fixed- and floating-roof storage tanks based on the emission estimation procedures from Chapter 7 of AP-42, plus recent updates from the American Petroleum Institute. The TANKS program employs a chemical database of over 100 organic liquids and meteorology data from over 250 cities in the United States. The user may add new chemicals and cities to their version of the database. The tank types addressed in the program include vertical and horizontal fixed roof tanks, and internal and external floating roof tanks. The tank contents can consist of single-component liquid or a multicomponent mixture. TANKS is available through the EPA's TTN Web site at <http://www.epa.gov/ttn/chief/tanks.html>.

WATER8

WATER8 is an analytical model for estimating compound-specific air emissions from wastewater collection & treatment systems including aerated basins, and other units. WATER8 contains useful features such as the ability to link treatment units to form a treatment system, the ability for recycle among units, and the ability to generate and save site-specific compound properties. WATER8 uses some of the same models found in CHEMDAT8, but has a database with compound-specific data for over 950 chemicals. WATER8 is available through the EPA's TTN Web site at <http://www.epa.gov/ttn/chief/software.html#water8>.

CHEMDAT8

CHEMDAT8 is a Lotus 1-2-3 spreadsheet that includes analytical models for estimating emissions from treatment, storage and disposal facility (TSDF) processes. The original models include disposal impoundments, closed landfills, land treatment facilities, and aeration and nonaeration impoundment processes.

The models in CHEMDAT8 can be applied to other types of TSDF processes besides those contained in the original design. The nonaerated impoundment model in CHEMDAT8 can estimate emissions from storage surface impoundments and open-top wastewater treatment tanks. The CHEMDAT8 aerated impoundment model may be used for predicting emissions from surface treatment impoundments and aerated wastewater treatment tanks. The land treatment model in CHEMDAT8 can estimate emissions from land treatment soil, open landfills, and wastepiles. Emissions from an oil film surface in a land treatment facility or an oil film on surface impoundments can be predicted via the oil film model in CHEMDAT8. When a CHEMDAT8 model is not available to predict emissions, the equations shown in the reports that provide the background to the model can be used to perform hand calculations of emissions.

This eighth version of the CHEMDAT spreadsheet contains several major operational modifications. In CHEMDAT8, the user can select a subset of target compounds for investigation. The user can also specify which TSDF processes are to be considered during a session. These two selections improve the efficiency of CHEMDAT8 relative to some of the earlier versions by minimizing storage requirements as well as actual loading and execution time.

Default input parameters in the CHEMDAT8 diskette demonstrate example calculations. However, the input parameters can be changed to reflect different TSDF characteristics and then recalculate emissions under these modified conditions. The list of 60 compounds currently in CHEMDAT8 can be augmented by an additional 700 chemicals. Procedures for introducing data for additional compounds into CHEMDAT8 are described in the supporting documentation report. CHEMDAT8 is available through the EPA's TTN Web site at <http://www.epa.gov/ttn/chief/software.html#water8>.

MECH

MECH is a computer program which estimates particulate emissions from paved roads, unpaved roads, materials handling, agricultural tilling and construction & demolition operations. This program automates the calculation routines contained in the EPA document titled *Control of Open Fugitive Dust Sources* (EPA, 1988). MECH is available through the EPA's TTN Web site at <http://www.epa.gov/ttn/chief/software.html#fugitive>

PM Calc

PM Calc is a computer software developed by EPA to estimate PM_{2.5} emissions. PM Calc is applicable to point sources and requires the user to input uncontrolled emissions (either total particulate or PM₁₀) for each source, the source category classification (SCC) and the type of control device, if any. The program will then calculate controlled emissions for PM_{2.5} and PM₁₀ for each point source. PM Calc is available through the EPA's TTN Web site at <http://www.epa.gov/ttn/chief/software.html#fugitive>

Compilation of Air Pollutant Emission Factors (AP-42)

The primary reference for criteria pollutant emission factors for industrial sources is *AP-42* (EPA, 1998). EPA is continuously updating *AP-42* to include available emission factors for the most common emission source categories.

The extent of completeness and detail of the emission information in *AP-42* is determined by the information available from published references. Emissions from some processes are better documented than others. For example, several emission factors may be listed for the production of one substance: one factor for each of a number of steps in the production process such as neutralization, drying, distillation, and other operations. However, because of less extensive information, only one emission factor may be given for production facility releases for another substance, though emissions are probably produced during several intermediate steps. There may be more than one emission factor for the production of a certain substance because differing production processes may exist, or because different control devices may be used. Therefore, it is necessary to look at more than just the emission factor for a particular application and to observe details in the text and in table footnotes of *AP-42*.

Each *AP-42* emission factor is given a rating from A through E, with A being the best. A factor's rating is a general indication of the reliability, or robustness, of that factor. This rating is assigned based on the estimated reliability of the tests used to develop the factor and on both the amount and the representative characteristics of those data. Because ratings are subjective and only indirectly consider the inherent scatter among the data used to calculate factors, the ratings should be seen only as approximations. A rating should be considered an indicator of the accuracy and precision of a given factor being used to estimate emissions from a large number of sources. This indicator is largely a reflection of the professional judgment of *AP-42* authors and reviewers concerning the reliability of any estimates derived with these factors.

The fact that an emission factor for a pollutant or process is not available from EPA does not imply that the Agency believes the source does not emit that pollutant or that the source should not be inventoried, but it is only that EPA does not have enough data to provide any advice. *AP-42* must be considered work-in-progress. Up-to-date sections of *AP-42* can be downloaded off the World Wide Web through OAQPS' TTN Web site at <http://www.epa.gov/ttn/chief/ap42etc.html>. *AP-42* is also available through *Fax CHIEF*

automated fax document delivery service, through the *Air CHIEF* CD-ROM, and in hard copy from the Government Printing Office (202) 512-1800.

Factor Information Retrieval (FIRE) Data System

FIRE is a database management system containing:

- EPA's recommended emission estimation factors for criteria pollutants and HAPs;
- Information about industries, their emitting processes, and chemicals emitted;
- All EPA point and area SCCs through March 1999;
- Easy access to emission factors obtained from *AP-42*, *L&E* series documents, factors derived from state-reported test data, and factors taken from literature searches;
- Each emission factor entry includes comments about its development, in terms of the calculation methods and/or source conditions, as well as the references where the data were obtained. The emission factor entry also includes a data quality rating;
- Capability for users to browse through records in the database or to select specific emission factors by source category name or source classification code (SCC), by pollutant name or CAS number, or by control device type or code.

FIRE Version 6.2 (released April 1999) is a user-friendly, menu-driven Windows[®] program that can run under Windows[®] Version 3.1, 95 or Windows[®] NT. FIRE can be downloaded off the World Wide Web through OAQPS' TTN Web site at <http://www.epa.gov/ttn/chief/fire.html>. FIRE is also available on the Air CHIEF, a compact disc read-only memory (CD-ROM) and can be obtained by calling the Info CHIEF Help Desk.

Air Clearinghouse for Inventories and Emission Factors (Air CHIEF) CD-ROM

Air CHIEF CD-ROM format, gives access to air emission data specific to estimating the types and quantities of pollutants that may be emitted from a wide variety of sources. Updated annually, Air CHIEF offers thousands of pages contained in some of EPA's most widely used documents. This most recent version of Air CHIEF contains many enhancements, such as linking between related documents, Web links directly to the CHIEF Web site for easy access to the most recent updates, and enhanced full-CD searching. The Adobe Acrobat[®] software included on the CD allows for easy browsing of all information or locating specific information by conducting keyword searches by pollutant, source category, SCC, or SIC code. Some of the databases included on Air CHIEF version 6.0 are: (1) *AP-42*; (2) *L&E* documents; (3) *EIIP*

documents; (4) *AP-42* background files; and (5) FIRE version 6.1. Also included on Air CHIEF are the installable copies of these MS-DOS software programs: BEIS, Water 8, Chemdat 8, and PMCALC.

Air CHIEF version 6.0 is available for distribution by GPO for \$15.00 (Stock Number: 055-000-00609-1) and can be ordered by calling GPO at (202) 512-1800, or by ordering online through OAQPS' TTN Web site at <http://www.epa.gov/ttn/chief/airchief.html#order>. Version 6.0 will be released in November 1998.

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APPENDIX H

LIST OF *L&E* DOCUMENTS

(<http://www.epa.gov/ttn/chief/ap42etc.html#LE>)

(Current as of August 1999)

List of *L&E* Documents

Substance	EPA Publication Number	Available On Line?
Acrylonitrile	EPA-450/4-84-007a	NO
Arsenic	EPA-454/R-98-013	YES
Benzene	EPA-454/R-98-011	YES
Butadiene	EPA-454/R-96-008	YES
Cadmium	EPA-454/R-93-040	YES
Carbon Tetrachloride	EPA-450/4-84-007b	NO
Chlorobenzene (update)	EPA-454/R-93-044	YES
Chloroform	EPA-450/4-84-007c	NO
Chromium (supplement)	EPA-450/2-89-002	YES
Chromium	EPA-450/4-84-007g	YES
Cyanide Compounds	EPA-454/R-93-041	YES
Dioxins and Furans	EPA-454/R-97-003	YES
Epichlorohydrin	EPA-450/4-84-007j	YES
Ethylene Dichloride	EPA-450/4-84-007d	NO
Ethylene Oxide	EPA-450/4-84-007i	YES
Formaldehyde	EPA-450/4-91-012	YES
Lead	EPA-454/R-98-006	YES
Manganese	EPA-450/4-84-007h	NO
Mercury	EPA-453/R-97-012	YES
Methyl Chloroform	EPA-454/R-93-045	YES
Methyl Ethyl Ketone	EPA-454/R-93-046	YES
Methylene Chloride	EPA-454/R-93-006	YES
Nickel	EPA-450/4-84-007f	NO
Organic Liquid Storage Tanks	EPA-450/4-88-004	NO
Perchloroethylene and Trichloroethylene	EPA-450/2-89-013	NO
Phosgene	EPA-450/4-84-007i	NO
Polychlorinated Biphenyls (PCBs)	EPA-450/4-84-007n	NO
Polycyclic Organic Matter (POM)	EPA-454/R-98-014	YES
Styrene	EPA-454/R-93-011	YES
Toluene	EPA-454/R-93-047	YES
Vinylidene Chloride	EPA-450/4-84-007k	YES
Xylenes	EPA-454/R-93-048	YES

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APPENDIX I
OPTIONS FOR DATA REPORTING

Options for Data Reporting

You can submit your data to EPA using one of several data transfer options. The appropriate data transfer method is identified during the planning stage of the inventory process, based on the end use of the inventory and availability of resources.

At this time the NET Input Format and the AIRS/AFS are equally viable options for submitting the point source data. The NET Input Format is the preferred option for submitting area data. You should keep in mind that information technology is a rapidly changing field, and electronic reporting of inventory data is an evolving issue. Refer to the EPA Data Submission page at <http://www.epa.gov/ttn/chief/ei/eisubmit.html> for updates on emissions reporting.

Four options are available for data reporting:

- **Aerometric Information Retrieval System/Aerometric Information Retrieval Facility Subsystem (AIRS/AFS)** - AIRS is a computer-based system for the storage and retrieval of ambient air quality monitoring data and emissions and compliance data for individual facilities. AFS contains emissions, compliance, and permit data for point sources regulated or tracked by federal, state, and local air pollution agencies.

This is the option that has been used for transferring SIP and annual emission inventory data to EPA. This option may be used to transfer **only point source data**. State and local agencies can upload industrial facility data directly to AIRS/AFS. EPA will extract the point source data submitted to AIRS/AFS and translate it into a format compatible with storage in the EPA National Emissions Trends (NET) database. You can find more information on the use of this option on the World Wide Web at <http://www.epa.gov/airsdata>.

For states that submit point source data via AIRS/AFS, it is necessary to use one of the other data transfer options to submit area, mobile, and biogenic data. Note, However, that the emissions component of AIRS/AFS will be phased out by the end of September, 2000, and the data transferred to the NET format. You should consult the AIRS/AFS Web site at <http://www.epa.gov/ttn/airs/afs/index.html> for the latest memos and information on the plans to migrate the emissions component of AIRS/AFS to the NET database.

- **NET Input Format** - The NET is an Oracle database that contains emission estimates of carbon monoxide, nitrogen oxides, sulfur dioxide, volatile organic compounds, particulate matter, lead, hazardous air pollutants, and ammonia from point, area, nonroad mobile, onroad mobile, and biogenic sources. The Emission Factor and Inventory Group is redesigning its NET database in Oracle using the EIIP Phase I Data Model as one of the primary design criteria.

The NET Input Format creates relational, normalized data sets which conform to the relational standards and structure of the NET Oracle database. The flexibility of the format design enables it to be mapped to a wide variety of alternative database structures (e.g., state/local systems, EPA systems). By avoiding duplication of data, the data set(s) created in this format are optimized in terms of the file space and the time it takes for electronic transfer to EPA.

EFIG will process and load the NET input files into its NET database system.

You should note that point source data submitted to the NET will **not** be transferred to AFS. If you are interested in obtaining the EPA's new NET Oracle database structure, contact the Technical Support Center at 800-334-2405 or 919-541-7862 for additional details.

- **EIIP EDI X12** - The EIIP Data management Committee has developed a data transfer format using existing electronic data interchange (EDI) X12 standards. The EDI data exchange standard is a nonproprietary standard created and maintained by the American National Standards Institute (ANSI) X12 committee. This format is described in EIIP Volume VII, *Data Management*. The EDI data transfer procedure may be available to state/local agencies through EPA assistance. If your agency would like to use this option, contact the Technical Support Center at 800-334-2405 or 919-541-7862 to obtain advice on how to proceed.

Agencies choosing to use this option will need to develop an application interface and procure an EDI translator, or use a translator provided by the EIIP/EDI data transfer demonstration. The standardized format generated by this approach will be loaded by EPA into the NET database system. The EIIP/EDI procedure allows an agency to submit their point, area, mobile, and biogenic information in a single file.

While the EIIP successfully tested the use of EDI through its prototype demonstration, the EPA is determining how to best establish and support EDI data transfer procedures across the Agency. To learn more about the EDI data transfer technique and the results of the EIIP prototype demonstration, see the EIIP Data Management Committee, Procedures Documents page at www.epa.gov/ttn/chief/eiip/.

- **Direct Source Reporting** - Point sources may already be reporting electronic emissions inventory data to EPA as part of Title IV or regional NO_x trading programs. For example, electricity-generating units subject to Title IV Acid Rain monitoring and reporting provisions must report continuous emission monitoring (CEM) data to EPA in a specified electronic data reporting (EDR) format. Submission of this data will not fulfill reporting requirements for ozone, PM, or

regional haze SIP inventory submittal, but EPA recognizes this as a viable data option where reporting requirements overlap.

To avoid duplication of efforts, EPA envisions that the emissions data submitted directly to EPA from the source will be:

- Transferred to EPA's NET database; or
- Made available to the states for incorporation into their emissions inventories, which will then be entered into the NET database.

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APPENDIX J

**1997 CRITERIA POLLUTANTS EMISSIONS
BY SOURCE CATEGORY**

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**Table 1. 1997 National Carbon Monoxide (CO) Emissions Estimates
from Stationary Sources (1,000 Short Tons)**

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	4,817	24%
<i>Electric Utilities</i>	406	8%
Coal	254	63%
Other Fuels	152	37%
<i>Industrial</i>	1,110	23%
Gas	362	33%
Other Fuels	748	67%
<i>Other Sources</i>	3,310	69%
Residential	3,042	92%
Commercial/Institutional	268	8%
Industrial Processes	6,052	30%
<i>Chemical and Allied Processing</i>	1,287	21%
Carbon Black	889	69%
Other Chemical Processing	398	31%
<i>Metals Processing</i>	2,465	41%
Ferrous Metals Processing	1,999	81%
Other Metal Processing	466	19%
<i>Petroleum and Related Industries</i>	364	6%
Petroleum Refineries	323	89%
Other Petroleum Industries	41	11%
<i>Other Industrial Processes</i>	663	11%
Wood, Pulp and Paper	515	78%
Other Processes	148	22%
<i>Solvent Utilization</i>	6	0.1%
<i>Storage and Transport</i>	26	0.4%
<i>Waste Disposal and Recycling</i>	1,242	21%
Open Burning	772	62%
Other Disposal	470	38%
Miscellaneous Sources	9,568	47%
<i>Slash/Prescribed Burning</i>	5,033	53%
<i>Forest Wildfires</i>	3,863	40%
<i>Other</i>	672	7%
Total Emissions	20,437	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

**Table 2. 1997 National Lead (Pb) Emissions Estimates
from Stationary Sources (1,000 Short Tons)**

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	496	15%
<i>Electric Utilities</i>	64	13%
Coal	53	83%
Other Fuels	11	17%
<i>Industrial</i>	17	3%
<i>Other Sources</i>	415	84%
Industrial Processes	2,897	85%
<i>Chemical and Allied Processing</i>	159	5%
Lead Oxide and Pigment Manufacturing	159	100%
<i>Metals Processing</i>	2,038	70%
Nonferrous Metals Processing	1,320	65%
Other Metals Processing	718	35%
<i>Other Industrial Processes</i>	54	2%
<i>Waste Disposal and Recycling</i>	646	22%
Total Emissions	3,393	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

**Table 3. 1997 National Nitrogen Oxides (NO_x) Emissions Estimates
from Stationary Sources (1,000 Short Tons)**

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	10,724	89%
<i>Electric Utilities</i>	6,178	58%
Coal	5,599	91%
Other Fuels	579	9%
<i>Industrial</i>	3,270	30%
Gas	1,385	42%
Other Fuels	1,885	58%
<i>Other Sources</i>	1,276	12%
Residential	859	67%
Commercial/Institutional	417	33%
Industrial Processes	917	8%
<i>Chemical and Allied Processing</i>	167	18%
Agricultural Chemical Manufacturing	78	47%
Other Chemical Manufacturing	89	53%
<i>Metals Processing</i>	102	11%
Ferrous Metals Processing	86	84%
Other Metals Processing	16	16%
<i>Petroleum and Related Industries</i>	115	13%
Oil and Gas Production	60	52%
Other Petroleum Industries	55	48%
<i>Other Industrial Processes</i>	421	46%
Mineral Products	303	72%
Other Processes	118	28%
<i>Solvent Utilization</i>	3	0.3%
<i>Storage and Transport</i>	6	1%
<i>Waste Disposal and Recycling</i>	103	11%
Incineration	56	54%
Open Burning	46	45%
Other Disposal and Recycling	2	1%
Miscellaneous Sources	346	3%
<i>Other Combustion</i>	344	99%
<i>Fugitive Dust</i>	1	0.3%
Total Emissions	11,987	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

Table 4. 1997 National PM_{2.5} Emissions Estimates from Stationary Sources (1,000 Short Tons)

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	847	11%
<i>Electric Utilities</i>	158	19%
Coal	134	85%
Other Fuels	24	15%
<i>Industrial</i>	213	25%
Internal Combustion	51	24%
Other Industrial	162	76%
<i>Other Sources</i>	476	56%
Residential Fuels	384	81%
Other (Including Commercial/Institutional)	92	19%
Industrial Processes	777	10%
<i>Chemical and Allied Products</i>	44	6%
Organic Chemical Manufacturing	12	27%
Other Chemical Manufacturing	32	73%
<i>Metals Processing</i>	139	18%
Ferrous Metals Processing	96	69%
Other Metals Processing	43	31%
<i>Petroleum and Related Industries</i>	23	3%
<i>Other Industrial Processes</i>	267	34%
Mineral Products	138	52%
Other Processes	129	48%
<i>Solvent Utilization</i>	6	0.8%
<i>Storage and Transport</i>	44	6%
Bulk Material Storage	43	98%
Other Storage and Transport	1	2%
<i>Waste Disposal and Recycling</i>	254	33%
Open Burning	200	79%
Other Disposal and Recycling	54	21%
Miscellaneous Sources	5,272	69%
<i>Agriculture and Forestry</i>	925	18%
<i>Fugitive Dust</i>	3,461	66%
<i>Other Sources</i>	886	17%
Natural Sources	797	10%
Total Emissions	7,693	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

Table 5. 1997 National PM₁₀ Emissions Estimates from Stationary Sources (1,000 Short Tons)

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	1,101	3%
<i>Electric Utilities</i>	290	26%
Coal	265	91%
Other Fuels	25	9%
<i>Industrial</i>	314	29%
Coal	72	23%
Internal Combustion	68	22%
Other Industrial	174	55%
<i>Other Sources</i>	497	45%
Residential Fuels	388	78%
Other (Including Commercial/Institutional)	109	22%
Industrial Processes	1,277	4%
<i>Chemical and Allied Products</i>	70	5%
<i>Metals Processing</i>	220	17%
Ferrous Metals Processing	155	70%
Other Metals Processing	65	30%
<i>Petroleum and Related Industries</i>	41	3%
<i>Other Industrial Processes</i>	530	42%
Mineral Products	326	62%
Other Processes	204	38%
<i>Solvent Utilization</i>	6	0.5%
<i>Storage and Transport</i>	114	9%
Bulk Material Storage	112	98%
Other Storage and Transport	2	2%
<i>Waste Disposal and Recycling</i>	296	23%
Open Burning	220	74%
Other Disposal and Recycling	76	26%
Miscellaneous Sources	25,153	77%
Agriculture and Forestry	4,707	19%
Fugitive Dust	19,429	77%
Other Sources	1,017	4%
Natural Sources	5,316	16%
Total Emissions	32,847	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

**Table 6. 1997 National Sulfur Oxides (SO_x) Emissions Estimates
from Stationary Sources (1,000 Short Tons)**

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	17,260	91%
<i>Electric Utilities</i>	13,082	76%
Coal	12,531	96%
Other Fuels	551	4%
<i>Industrial</i>	3,365	19%
Gas	1,769	53%
Other Fuel	1,596	47%
<i>Other Sources</i>	813	5%
Commercial/Institutional	620	76%
Other (Including Residential)	193	24%
Industrial Processes	1,718	9%
<i>Chemical and Allied Processing</i>	301	18%
Inorganic Chemical Manufacturing	208	69%
Other Chemical Manufacturing	93	31%
<i>Metals Processing</i>	552	32%
Nonferrous Metals Processing	378	68%
Other Metals Processing	174	32%
<i>Petroleum and Related Industries</i>	385	22%
Petroleum Refineries	283	74%
Other Petroleum	102	26%
<i>Other Industrial Processes</i>	427	25%
Mineral Products	297	70%
Other Industrial Processes	130	30%
<i>Solvent Utilization</i>	1	0.1%
<i>Storage and Transport</i>	2	0.1%
<i>Waste Disposal and Recycling</i>	50	3%
Miscellaneous Sources	13	0.1%
Total Emissions	18,991	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

**Table 7. 1997 National Volatile Organic Compound (VOC) Emissions
Estimates from Stationary Sources (1,000 Short Tons)**

Source Category	1997 Emissions	Percent Contribution
Fuel Combustion	861	7%
<i>Electric Utilities</i>	51	6%
<i>Industrial</i>	217	25%
Gas	77	35%
Other Fuels	140	65%
<i>Other Sources</i>	593	69%
Residential Wood (Fireplaces)	527	89%
Other (including commercial/institutional fuel and other residential)	66	11%
Industrial Processes	9,836	85%
<i>Chemical and Allied Products</i>	458	5%
Polymer and Resins Manufacturing	142	31%
Other Chemical Processing	316	69%
<i>Metals Processing</i>	73	1%
<i>Petroleum and Related Industries</i>	538	5%
Oil and Gas Production	282	52%
Petroleum Refineries and Related Processes	252	47%
Other Petroleum Industries	4	1%
<i>Other Industrial Processes</i>	458	5%
Agriculture, Food, and Kindred Products	141	31%
Wood, Pulp and Paper	129	28%
Other Industrial Processes	188	41%
<i>Solvent Utilization</i>	6,483	66%
Degreasing	692	11%
Graphic Arts	412	6%
Industrial Adhesives	475	7%
Architectural Coating	558	9%
Pesticide Application	382	6%
Non-industrial Adhesives	406	6%
Consumer Solvents	1,219	19%
Other Solvent Utilization	2,339	36%
<i>Storage and Transport</i>	1,377	14%
Bulk Terminals and Plants	255	19%
Service Stations: Stage I	359	26%

Table 7. 1997 National Volatile Organic Compound (VOC) Emissions Estimates from Stationary Sources (1,000 Short Tons) (Continued)

Source Category	1997 Emissions	Percent Contribution
Service Stations: Stage II	427	31%
Other Storage and Transport	336	24%
<i>Waste Disposal and Recycling</i>	449	5%
Miscellaneous Sources	858	7%
<i>Slash/Prescribed Burning</i>	262	31%
<i>Forest Wildfires</i>	421	49%
<i>Other</i>	175	20%
Total Emissions	11,555	100%

Source: National Air Pollutant Emission Trends Update: 1970-1997 (December 1998), EPA-454/E-98-007.

APPENDIX K

**LIST OF POTENTIAL POINT SOURCE
CATEGORIES BY POLLUTANT**

List of Potential Point Source Categories by Pollutant

Category	SO ₂	PM	VOC	NO _x	CO
Fuel Combustion - Electric Utility					
Coal	H	H	L	H	L
Gas	L	✓	L	M	L
Internal Combustion	L	M	L	M	L
Oil	M	L	L	L	L
Other	✓	✓	✓	✓	✓
Fuel Combustion - Industrial					
Coal	H	M	L	M	L
Gas	H	M	M	M	L
Internal Combustion	L	M	M	H	L
Oil	M	M	L	M	L
Other	L	H	L	L	L
Fuel Combustion - Other					
Commercial/Institutional Coal	M	L	✓	L	L
Commercial/Institutional Gas	L	L	L	L	L
Commercial/Institutional Oil	L	L	L	L	L
Residential Wood	✓	✓	✓	✓	✓
Residential Other	✓	✓	✓	✓	✓
Miscellaneous Fuel Combustion except Residential	L	L	L	L	L
Chemical and Allied Products Manufacturing					
Agricultural Chemicals	L	L	L	L	L
Inorganic Chemicals	M	L	L	L	L
Organic Chemicals	L	M	M	L	L
Paints, Varnishes, Lacquers, Enamels	✓	✓	L	✓	✓
Pharmaceuticals	✓	✓	L	✓	✓
Polymers and Resins	✓	L	M	L	L
Other Chemicals	L	M	M	L	M
Metal Processing					
Ferrous Metals	M	H	L	L	M
Nonferrous Metals	M	M	L	L	L
Metals Processing NEC	L	M	L	L	L
Petroleum and Related Industries					
Asphalt Manufacturing	L	L	L	L	L
Oil and Gas Production	L	✓	M	L	L

**List of Potential Point Source
Categories by Pollutant (Continued)**

Category	SO ₂	PM	VOC	NO _x	CO
Petroleum Refineries and Related Industries	M	M	M	L	L
Other Industrial Processes					
Agricultural, Food, and Kindred Products	L	M	M	L	L
Construction		✓			
Electronic Equipment	✓	✓	L	✓	L
Machinery Products	✓	L	L	L	✓
Mineral Products	M	H	L	M	L
Rubber and Miscellaneous Plastic Products	✓	L	M	✓	✓
Textiles, Leather, and Apparel Products	✓	✓	L	✓	✓
Transportation Equipment	✓	✓	L	✓	✓
Wood, Pulp and Paper, and Publishing Products	M	H	M	L	L
Miscellaneous Industrial Processes	L	✓	L	L	L
Solvent Utilization					
Degreasing	✓	✓	L	✓	✓
Dry Cleaning	✓	✓	L	✓	✓
Graphic Arts	✓	✓	M	✓	✓
Other Industrial			L		L
Surface Coating	L		H	L	
Storage and Transport					
Bulk Materials Storage	✓	M	✓	✓	L
Bulk Materials Transport		✓			
Bulk Terminals and Plants	✓	✓	M	✓	L
Inorganic Chemical Storage	✓	✓	✓	✓	✓
Inorganic Chemical Transport	✓	✓		✓	
Organic Chemical Storage	✓	✓	L	L	L
Organic Chemical Transport	✓	✓	L	✓	✓
Petroleum and Petroleum Product Storage	✓	✓	M	✓	✓
Petroleum and Petroleum Product Transport	✓	✓	M	✓	✓
Service Stations: Stage I			L		
Service Stations: Stage II	✓	✓	L	✓	✓
Waste Disposal and Recycling					
Incineration	L	M	L	L	L
Industrial Waste Water	✓	✓	L	✓	✓
Landfills	✓	✓	L	✓	L

List of Potential Point Source Categories by Pollutant (Continued)

Category	SO ₂	PM	VOC	NO _x	CO
POTWs	✓	✓	L	✓	✓
TSDFs		✓	L	✓	✓
Other	✓	✓	L	✓	✓
Miscellaneous					
Cooling Towers		L	L	✓	✓
Health Services			✓		

Source: 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.

Notes: The H (high), M (medium), and L (low) designations indicate the level of significance of a source category's emissions to the overall emissions of that pollutant.

A "✓" indicates that emissions of that pollutant may occur from that source category, but they are not considered significant.

A blank cell indicates that no emissions of that pollutant are emitted from that source category based on the data in EPA's NET inventory.

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APPENDIX L

**LIST OF POTENTIAL AREA SOURCE
CATEGORIES BY POLLUTANT**

List of Potential Area Source Categories By Pollutant

Category	SO ₂	PM	VOC	NO _x	CO
Fuel Combustion - Electric Utility					
Internal Combustion			✓	L	L
Fuel Combustion - Industrial					
Coal	H	L	L	L	L
Gas	L	L	L	M	L
Internal Combustion	✓	✓	L	L	L
Oil	H	L	L	L	L
Other	L	L	L	L	L
Fuel Combustion - Other					
Commercial/Institutional Coal	L	L	✓	L	L
Commercial/Institutional Gas	L	L	L	M	L
Commercial/Institutional Oil	M	L	L	L	L
Residential Wood	L	H	H	L	M
Residential Other	M	M	L	H	L
Miscellaneous Fuel Combustion except Residential	L	H	L	L	L
Chemical and Allied Products Manufacturing					
Inorganic Chemicals				✓	
Organic Chemicals				L	✓
Pharmaceuticals				L	
Polymers and Resins			M		
Metal Processing					
Ferrous Metals				✓	✓
Nonferrous Metals			✓	✓	
Metals Processing NEC		✓	✓	✓	✓
Petroleum and Related Industries					
Asphalt Manufacturing			✓	✓	✓
Oil and Gas Production	L	L	M	L	L
Petroleum Refineries and Related Industries			M		
Other Industrial Processes					
Agricultural, Food, and Kindred Products		L	M	✓	✓
Machinery Products			✓	✓	
Mineral Products	✓	✓	✓	L	✓
Rubber and Miscellaneous Plastic Products		✓	L		

List of Potential Area Source Categories By Pollutant (Continued)

Category	SO ₂	PM	VOC	NO _x	CO
Wood, Pulp and Paper, and Publishing Products		L	✓	✓	✓
Miscellaneous Industrial Processes	L	M	L	L	✓
Solvent Utilization					
Degreasing			H		
Dry Cleaning			M		
Graphic Arts			M		
Nonindustrial			H	✓	✓
Other Industrial			L		
Surface Coating			H	✓	✓
Solvent Utilization NEC					
Storage and Transport					
Bulk Materials Storage					
Bulk Terminals and Plants			M		
Organic Chemical Storage			L		
Petroleum and Petroleum Product Storage			L	✓	
Petroleum and Petroleum Product Transport			L		
Service Stations: Breathing and Emptying			L		
Service Stations: Stage I			H		
Service Stations: Stage II			H		
Waste Disposal and Recycling					
Incineration	L	M	L	L	L
Industrial Waste Water			L		
Landfills			L	✓	✓
Open Burning	L	H	M	L	L
POTWs			L		
TSDFs			L	✓	✓
Other			L		
Miscellaneous					
Agriculture and Forestry		L	M		
Catastrophic/Accidental Releases			L		
Health Services			✓		
Other Combustion (Structure Fires, Forest Fires, Slash Burning, Prescribed Burning, Managed Burning)	L	H	H	M	H

List of Potential Area Source Categories By Pollutant (Continued)

Category	SO ₂	PM	VOC	NO _x	CO
Natural Sources					
Geogenic, Wind Erosion		M			
Miscellaneous					
Agricultural Crops (Tillage)		M			
Construction		M			
Paved Roads		M			
Unpaved Roads		H			
Other Fugitive Dust (e.g., Mining and Quarrying)		M			

Source: 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.

Notes: The H (high), M (medium), and L (low) designations indicate the level of significance of a source category's emissions to the overall emissions of that pollutant.

A "✓" indicates that emissions of that pollutant may occur from that source category, but they are not considered significant.

A blank cell indicates that no emissions of that pollutant are emitted from that source category based on the data in EPA's NET inventory.

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APPENDIX M

GUIDANCE ON HOW TO CONDUCT SCREENING STUDIES

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ELEMENTS

An emission inventory questionnaire mail-out has three basic elements: the cover letter, the questionnaire instructions, and the questionnaire itself. The questionnaire format and content depends on the detail of the inventory and the ultimate use of the data. All of these components, when considered together, make up the questionnaire package.

Cover Letter

The cover letter is a key to the emission inventory, because it introduces the purpose of the questionnaire and is the initial contact with the recipient. If the cover letter does not command attention, the attached questionnaire may be discarded or filed away and not considered a top priority. This could make the number of companies requiring recontact by agency personnel increase dramatically.

The cover letter should include the following:

- Applicable regulations, if any, that require the recipient to respond;
- Confidentiality provisions, if applicable;
- The purpose of the questionnaire;
- A respectful request for cooperation in filling out the questionnaire;
- Due date for the return of completed questionnaires;
- A state or local agency contact name and telephone number to answer questions; and
- Rationale for asking for what may appear to the source to be redundant information.

The cover letter should be as short and direct as possible. The most successful return rates for questionnaires have been the ones having the strongest legal statements. Therefore, states/local agencies requiring source registration to obtain construction or operating permits may obtain better source cooperation.

A strong statement about existing and applicable regulations which require a recipient to respond to the questionnaire is the agency's most powerful tool for maximizing the return rate. The statement should be placed prominently in the beginning or at the top of the cover letter. It should cite any applicable regulations or proposed regulations and specify penalties for noncompliance.

Another important item to include in a cover letter to ensure a high return rate is the due date. The final due date should be included in the cover letter to that it will not be overlooked by those who do not read instructions. The due date may be specified either as a stated date or as a period of time after the recipient receives the questionnaire. The first approach is more specific, and gives the recipient a definite deadline. With the latter approach however, the questionnaire mailing can be staggered without having to reprint the due dates listed on the cover letter. The agency should record each due date so it will be clear when follow-up letters or phone calls may need to begin for tardy respondents.

Questionnaire Instructions

General information that affects the whole questionnaire may be included first on the instruction page. For example, if the questionnaire is “open-ended” (i.e., asks the recipient to list every toxic compound from every emission source) , it should be clear that the respondent should use chemical compound names or preferably CAS numbers and not just industrial trade names. Also, it may be helpful to point out that not all questions, sections, or pages may apply to every industry, as in a source category specific directed questionnaire. If the questions are designed for direct coding to computer input, the general instructions should explain how to enter numbers properly. In addition to explaining how to complete the questionnaire, the general instructions should indicate the specific year, or other appropriate period of time, for which all data are required.

Some agencies have utilized production/use questionnaires which basically just ask sources to identify whether each substance is purchased, used, or produced, followed by a more detailed questionnaire targeted to specific industries. Some agencies include minimum usage or emissions levels specified on an attached list as part of the instructions.

Questionnaire Design

There are several ways to design a questionnaire. Of utmost importance when designing a questionnaire is that the format suits the needs of the agency and attains correct responses and maintains a good agency-industry working relationship.

Several approaches can be taken in designing the questionnaire which, in turn, will effect the format of the questionnaire. The approaches that can be used include: open vs. closed-ended, emission-based vs. chemical use, permit related, and general vs. industry-specific. In order for an agency to decide which approach to use, it needs to be familiar with some of the impacts of each approach.

Each agency should tailor their inventory package according to their agency’s individual needs. Many times, the examples are a combination of approaches. For instance, in one case a general design questionnaire was sent to various manufacturers and process industries, and later, industry specific questionnaires were sent to a small subset of the original recipients. In still another case

a screening study was first done to narrow down the number of sources to be inventoried and indicated the design needs of the final questionnaire to be sent out. Later, a second questionnaire was sent.

The following sections explain the advantages and disadvantages of various type questionnaire designs. These are not necessarily mutually exclusive.

Open-Ended Approach

The open-ended approach does not target specific source types or a limited group of compounds. The open-ended approach asks the respondent to list any compound that they emit. It does not provide a checklist of compounds. Therefore, with an open-minded approach a much larger number of contacts will be necessary. This approach has several similarities to a screening study:

- Less time and effort in questionnaire design;
- Responses may be less detailed;
- More responses may be inaccurate or trade names (not chemical compound names) may be listed; and
- Some sources may report no air toxic emissions.

Closed-Ended Approach

The closed-ended approach is a more direct approach, which usually provides a limited list of compounds with the questionnaire. Some agencies' list lists of toxic compounds are becoming rather extensive and use of CAS numbers is widespread. This approach requires more design time up from (e.g. screening studies, modeling analyses). However, the benefits are that the resulting number of sources contacted can be greatly reduced and the quality and detail of the data received are usually better.

Emissions-Based Approach

Emissions-based questionnaires request information often included in annual volatile organic compound (VOC) or particulate matter emissions inventories.

The agency may request permitted or potential emissions per source and/or actual emissions, average emissions, or emissions per day. They may also specify emissions per hour (or time interval) for specific compounds. In many cases some of this information can be collected for the majority of sources from the established criteria emission inventory records. The agency may also ask for emergency episode emissions, fugitive emissions, and information from excluded criteria emission inventory sources.

Chemical Use Approach

Chemical use questionnaires are directed toward lists of specific compounds and ask for process input information and Material Safety Data Sheets (MSDS). The Material Safety Data Sheets include the needed species composition data and should be requested where available, for any approach used. The agency can require the source to contact the suppliers of chemicals they use, if MSDS are not available. The agency can use these data to make emissions estimates if information is also provided on daily use, process operating parameters, and efficiency of the control equipment.

General Approach

This type of questionnaire may be used as input to simple screening models to determine if a particular source is a potential problem and if further, more detailed source, emissions, and modeling data are required. A list of chemicals is provided and the sources must access it if it emits any of the listed compounds. These questionnaires may list minimum levels for each compound addressed. Such questionnaires may also be used in conjunction with several source specific questionnaires. The general questionnaire may also be sent to a variety of manufacturing or industrial process facilities not covered by the source specific questionnaires.

Industry-Specific Approach

These are very detailed questionnaires that may include emissions information from process vents, fugitive equipment leaks, equipment openings, raw material/product storage and handling, secondary waste treatment, and liquid spills. Questionnaires of this type are usually focused on a handful of very large, singularly important point sources. A great deal of pre-screening effort would be required for industry-specific questionnaires, and a great deal of effort would also be required of the recipient in filling out the questionnaire. More effort would be required per source for the agency to properly interpret the response. However, this level of detail is probably the next best thing to actual source testing in estimating emissions. This technique may also prove useful in targeting particular sources the agency determines may or may not need to conduct source tests.

Tiered Approach

In the tiered or staggered mail-out approach, a cover letter and screening study type questionnaire are used, followed later by more detailed questionnaires sent to a select number or type of sources. A phone survey may be conducted by the agency prior to the screening study to narrow the number of facilities to send the screening study questionnaire or the detailed questionnaire. Whether the phone survey is conducted before or after the screening study questionnaire is sent depends on the number and type of facilities in the inventory area.

A good example would be dry cleaning establishments. The state manufacturing guide may list 100 dry cleaners in a certain city. However, after a phone survey the agency found that 75 percent of these locations are only drop-off and pick service centers. By conducting the phone screening, it was obvious that no questionnaires were necessary for those service centers. A more detailed questionnaire was sent to the remaining 25 dry cleaners. This benefitted both the agency by not having to review unnecessary forms, and the excluded service centers by not wasting their time completing unnecessary forms. Phone screening may not always be an efficient use of agency time, depending on the individual agency needs or types of industries included.

Another approach is to first send an open-ended questionnaire or general questionnaire, followed by later designed industry specific (by source type) questionnaire, followed-up by phone calls to clarify data and/or source tests or inspections.

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OTHER CONSIDERATIONS

Other considerations when developing a questionnaire are more related to strategy for maximizing accuracy and minimizing cost and time involved to conduct an inventory. These include discussions of the importance of the following:

- Asking the right questions;
- Maximizing return rates;
- Providing for facility confidentiality of trade secrets;
- Outlining what questions are applicable for particular source categories;
- Designing question/answer style and format to decrease confusion or misrepresentation;
- Providing written instructions for answers (especially units of measurement) with computer coding format instructions if necessary; and
- Developing a data quality assurance procedure.

Some of these considerations are clearly technical in nature, but they need to be incorporated with administrative and procedural considerations for the whole effort to be the most efficient.

The Right Questions

A successful questionnaire obtains the right answers to the right questions for the particular agency while maintaining a good working relationship with the recipients. Duplication of information already available through permit files may not be needed if the number of sources included in the survey is few and the information is easily extracted from other sources. However, for large survey efforts, it may be too time consuming for agency personnel to extract needed available information and thus, some duplication of effort on the part of the sources cannot be avoided. If the sources being sent questionnaires are the same as included in the criteria pollutant inventory, all information which the agency already has about the recipient's facility, such as mailing address, SIC number, UTM coordinates, emission point numbers, etc., should be preprinted on the questionnaire. The agency could use a window envelope to expose the facility name and address and avoid making additional mailing labels.

The Return Rate

The return rate of a questionnaire depends on several factors. The first impression of the recipient, the simplicity of the questionnaire, and conveying the importance of returning the questionnaire are all important factors affecting the return rate.

Minimize Questionnaire Length

The recipient's first impression will be based on the size of the questionnaire. It should be as brief as possible. Unfortunately, it may be impossible for the forms and accompanying instructions for a large listing of toxic compounds or source categories to be brief. So, the next best approach may be to design the forms in such a way to make the pages as uncluttered and readable as possible leaving ample room for answers.

Maximizing Return Rates

Staggered mailing is particularly important for very large inventories, because 1000 or more questionnaires returned simultaneously may be too difficult to process at one time. Staggered return uses the agency's limited manpower and resources more economically. Questionnaires can easily become lost or damaged if they are not processed expediently by the agency, and this may be less likely to occur if the staggered mailing approach is used.

Each respondent should have an equal amount of time to respond to questionnaires when using the same format and approach especially if there is a penalty for late responses. But this must depend on equal complexity of the information required by questionnaires. Obviously more time will be needed for a large source to complete a source specific questionnaire than a simple screening survey or a general information questionnaire with, for example 20 compounds versus 200 compounds. Therefore, the time period allowed for completion of emission inventories require more planning than criteria pollutant inventories. The time period should be long enough so that the respondent is not overly rushed and short enough that the respondent does not procrastinate in responding.

Another good approach for a large inventory is to classify the mailings according to priority chemicals, source type, source size, county locations, or simply a source name (alphabetical) staggered approach. In this way, all of the questionnaires will not be returned at the same time. Each questionnaire should be reviewed as soon as possible after it is received. When this approach is used for a selected small number of sources at the beginning of the update, the agency can predict the manpower and resources it will take to complete the full-blown inventory effort. They may find they do not in fact have the manpower to conduct the type of inventory they want. They can instead rethink and replan their approach or request additional manpower to complete the inventory.

Confidentiality

Confidentiality can be established in one of several ways. The simplest is a box to be checked to request confidentiality for all information other than emissions data given in the questionnaire. Justification for the request would be given by the recipient on a separate sheet. In this way each piece of confidential information can be keyed as such.

Another approach would be for the industry to submit one full questionnaire and one "sanitized" questionnaire that would be available for public review.

The main advantage to this approach is that it clearly indicates the request to the agency. It also alerts the agency to look for supplementary supporting information. If the questionnaire is converted to computer input, a check in the confidentiality box can be programmed as a command to store all information in a limited access data file.

The disadvantages of this approach are that it does not provide confidentiality for only specific pieces of information and that it may be too easy to use. It should be used only for recipients who are anticipated to be deeply concerned about confidentiality. This judgment is best handled by the appropriate agency officials. A better method may be to require the industry to highlight each and every answer it deems confidential.

A more complex method for establishing confidentiality involves the assignment of a survey number to each questionnaire; this number would also be printed on the general information page. The agency director would detach the general information page from the returned questionnaire and store it in a locked file. Since all identification is presented on the general information page, no one would be able to associate the information on the question pages with a specific facility. If necessary, a facility could be identified by locating the survey number in the locked file of general information pages. This consideration is especially important if the agency subcontracts to a private consultant for the interpretation and transcription of the information. If the information is computerized, the identification information could be entered into a separate limited access file.

Each agency should be versed in their local laws to ascertain that the concealment of identification is not forbidden (the public access to records varies among states).

A system which allows for partial confidentiality could be established in the cover letter using a paragraph similar to the following:

Any proprietary information, which you believe is of a confidential nature, should be identified in a supplementary letter with applicable data in the questionnaire marked with the word CONFIDENTIAL. A brief explanation in your letter for the desired confidentiality should be included.

This system indicates clearly to the agency which information is confidential and which is not. It also alerts the agency to look for supplementary supporting information with each returned questionnaire that is marked anywhere with the word "CONFIDENTIAL." However, unless the marking is very clear, this system can become tedious and inefficient.

Applicability and Clarity of Questions

Several factors in the design of the question section can determine the efficiency of the mailing and affect the return rate as well. First, there should be a clear statement from which the respondent can determine whether the questionnaire is applicable to his facility. Second, the questions should be well-arranged and easy to answer.

A clear statement of applicability serves several purposes. If the questionnaire is applicable, the statement reinforces the necessity of compliance. If the questionnaire is not applicable and recipient can easily determine it as such, he may be more cooperative in the future when the questionnaire does apply to him. A maximum return rate for non-applicable respondents is important because the agency will not have to waste time and money for follow-up and know up front which facilities are not being inventoried.

The use of a check box for applicability will help the agency distinguish between questionnaires that are not applicable and the ones that are returned without any response. Examples of statements of applicability are provided below.

- If this equipment was used at least five (5) days last year, check this box and complete the questionnaire.
- If this equipment was not used at least five (5) days last year, check this box and return this form.
- If this equipment has been removed, check this box and return this form.
- If any compound used on the attached table is less than the minimum level listed, check this box and return this form.

Statements of non-applicability at the beginning of each page or section can be used as an alternative or supplement to a general statement of applicability. Colored pages may be used to designate different sections of the questionnaire. By supplying a check box, the agency can discriminate between pages that were forgotten and pages that were not applicable.

Complexity and Questionnaire Format

As mentioned earlier, the questions must be well-arranged and easy to answer. Brevity enhances the rate of return. The agency can usually reduce the bulk of the question section by designing

industry-specific questionnaires instead of general questionnaires. Industry-specific questionnaires are designed specifically for one particular type of industry, as opposed to general questionnaires applicable to a whole group of industries. For example, it may be better to send an industry-specific questionnaire to a dry cleaning establishment and a multipage, general questionnaire to an organic solvent user.

The consideration of questionnaire format, however, must be balanced against the level of resources available to the agency conducting the inventory. It takes more money and manpower to design, mail out, and interpret industry-specific questionnaires than it does general questionnaires. Processing of industry-specific questionnaires is also more complex because the format of each questionnaire will vary. Furthermore, it is possible to send an inappropriate industry-specific questionnaire to a facility. On the other hand, general questions may be preferable if the agency's resources are limited or if the agency is unfamiliar with many of the sources. Inventories for specific pollutants may be most advantageously conducted with general questionnaires. Furthermore, general questionnaires may be more appropriate for large or complex facilities that are difficult to characterize. Most of these facilities will have engineers available to translate their process and emission information onto the forms.

If a general questionnaire must be used, it is important to provide a statement of applicability for each page. In addition, questionnaires that are organized so that all information about each emission point can be provided on one page are usually easier to fill out than questionnaires that have separate pages for process, emissions, control equipment, and stack information (subject-by-subject). For this reason, source-by-source questionnaires are usually considered the better format. However, if the questions are arranged by subject, industry-specific questionnaires can be designed by simply selecting the subject pages that apply to each industry. Then only a few supplementary pages of questions that are unique to an industry must then be formulated.

Another method that can minimize the level of effort required from the recipient, and therefore enhance the return rate, concerns the format of the questions. Multiple choice questions are the easiest type for recipients to answer. Many questions can easily be formatted as multiple choice. For example, a question that asks the recipient to describe or name the type of control device used can be improved by supplying a list of conceivable control devices and asking the recipient to put a check next to the appropriate answer. When needed, multiple choice questions can include the choice "other" with a blank beside it for entering out-of-the-ordinary controls. Other questions, such as those that require exact numerical answers, can only be answered appropriately with a written response. If there are repetitive questions, the recipient could be asked to make a copy of a questionnaire for each point source or substance being inventoried.

Clarity of Instructions

To be considered accurate, questionnaire responses must provide both the descriptive information desired and the correct numerical data. Every effort must be made not to confuse the recipient. Therefore, it is important to provide clear, complete instructions to decrease the

chances of error in the responses. Instructions should be as concise as necessary. Units of measurement, method of calculations and conversions, and code number instructions should be put on the questionnaire itself and not explained in the instructions. This enables the recipient to read through instructions expediently without becoming caught up in too much detail.

In conclusion, general instructions should be as precise as possible. Some of the most effective questionnaire instructions are those which explain in detail how to answer each question. If a particular question requires special clarification, it is best to note special instructions on the same page as the question rather than print them on a separate instruction page.

The following types of information should be included when asking detailed questions:

- Specific Responses--printing the type of units wanted for an answer right next to the answer space. Using the multiple choice format;
- Samples--providing completed samples with the instructions for process flow, schematic and plant layout diagrams. Sample diagrams help the recipient to visualize what is expected; they are easiest to interpret if they are adjacent to the instructions;
- Standardized Forms--providing standardized forms when periodic inventory updates are performed. Regular recipients will eventually learn how to provide the correct responses. This is one condition under which a single generalized form for all facilities is efficient;
- Emissions Estimates--instructions for the inclusion of estimation methods used. Examples of estimation methods include: material balance, emission factors, source test results, models, and engineering judgments.

Final Considerations

After a questionnaire is designed, it is good quality assurance procedure to check its effectiveness. This can be accomplished using a limited pilot mailing followed by site visits. This procedure provides a check on the effectiveness of the particular questionnaire package and its applicability to different sources. A final possibility that may improve industry-agency relations would be to include a few questions at the end of the questionnaire or on a separate page for industry suggestions for future questionnaires or questions such as the following:

- Were the questions clear?
- Approximately how long did it take to complete the form?
- Were the questions applicable to your company?

- If you called for help and/or agency clarification, did we adequately respond?
- Was the time allowed after receiving the questionnaire adequate? If not, why?
- Please provide additional comments, if any.

This type of addition may indicate to the recipients a true concern to minimize industry paperwork, or at least the desire to work with industry to improve future questionnaires.

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FOLLOW-UP PROCEDURES

Follow-up can be as important or more important than the planning and effort expended in questionnaire design. The accuracy and completeness of responses must be checked and tabulated, and entered into a computer. Depending on how thorough the questionnaire instructions were explained with the mail-out, and whether deadlines were identified in the cover letter, a second major effort may be required to contact recipients who are delinquent in responding or to clarify items such as emissions units or estimates of control efficiencies. Some second effort can be expected, either for clarification of answers or for non-response. The following sections discuss the importance of such follow-up procedures such as data quality checks, the use of on-site inspections, and recontacting sources. Questionnaire revisions are also discussed.

Quality Control of Data

All the questionnaires should be checked by engineers, chemists, or experienced environmental scientists to determine if the data provided are reasonable. It is helpful to ask for process flow and plant layout diagrams to aid in the interpretation of data. In addition, the best quality check would be performed by engineers or scientists who have worked in or are familiar with the industry. Finally, for similar processes and chemicals, total emissions can be compared against each other or checked against appropriate emissions factors to determine reasonableness. The extent that detailed checks can be done depends on the resources available to the agency, the number of sources included in the inventory, and the use of the data. It is suggested to recontact a higher percentage of respondents that considered their usage lower than specified yearly amount, or as having no toxic emissions when their SIC code would suggest otherwise. Perhaps they only misunderstood the way the instructions were worded, or know their chemicals by a trade name instead of chemical composition. In any event, a follow-up call may increase the accuracy of the inventory.

On-Site Inspections

For certain sources, it may be appropriate to consider plant visits if more specific information needs to be obtained for a particular program purpose, although this approach can become resource intensive and time consuming. Another approach is to do a preliminary screening and visit a very small percentage of facilities as part of a data quality control procedure. Also, it may be wise to visit a representative sample of respondents that checked the "not applicable" box, especially if the agency determines from cross referencing SIC codes, that the source has a potential to emit air toxic compounds.

Another less resource intensive approach may be to inspect the facility to check emission responses during the next regularly scheduled air compliance inspection. Most agencies periodically inspect major facilities within their jurisdiction. The problems that can be encountered using this approach is that air inspectors may need additional training before such

inspections, because most regular air inspections involve criteria pollutants, or at the most select pollutants associated with NESHAPs or NSPS.

Recontacting Sources

The return rate for the questionnaires can be increased by recontacting recipients that are delinquent in responding either by letter or by phone. This recontact reminds them that they will not be forgotten and may be subject to fine, and that a response is necessary. For other companies that may be confused by some of the questions, recontact provides them with a less embarrassing way to ask questions. This interaction is the most effective while the questionnaire is being initially completed, rather than having to return questionnaires to the industries for corrections. Using a pilot mailing will help get an idea of the average time recipients take to respond and how many recipients will need to be recontacted. In addition, a pilot mailing can provide an overview of the effectiveness of the questionnaire before the final mailing is done. Unnecessary recontacts should be minimized to avoid the possibility of some firms becoming uncooperative. Inventory efforts, after all, are not a one-time need. Yearly updates may be necessary.

Revising the Questionnaire

The process of revising the questionnaire should be an evolving process. With each mail-out or updating of the inventory, the questionnaire or instructions for completing the questionnaire can be fine tuned or redirected to meet the developing program needs. But, as mentioned before, industry will become familiar with questionnaire format that is not changed drastically from mailing to mailing. So, a carefully considered initial design is the best approach, and will reduce time needed for follow-up.

Some changes can be expected, such as:

- Promulgation of new regulations, stricter source registration requirements, or changes in reporting requirements;
- More EPA approved emission factors or more available stack test data;
- Increases in the number and types of compounds included;
- Changes in format of questions when agency installs or changes its data handling system; and
- Changes in control technology and/or control equipment efficiency.

Other changes may be made because of the widespread occurrence of wrong responses to a particular question. Still another kind of revision, but one that has much impact, are changes in various aspects of the inventory process, such as:

- Addition or deletion of the use of screening questionnaires;
- Changes in the cover letter, instructions or confidentiality provisions;
- Changes in the type of questionnaire, such as a change from open-ended to industry-specific questionnaires;
- Changes in the ways that the agency intends to use the data; and
- Changes in agency budgets and/or resources and manpower available for inventory efforts.

Perhaps the best way to proceed is not to plan in terms of needed emission inventory questionnaire revisions, but to continually focus on needed improvements, whatever the reasons turn out to be.

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Name of Facility: _____

Street Address: _____

City/State: _____

Contact Person: _____

Telephone Number: _____

Please check the appropriate box describing your operation.

1. Solvent Used	Amount Purchased Annually (gallons)
<input type="checkbox"/> PERC (Perchloroethylene)	_____
<input type="checkbox"/> Petroleum (Stoddard Solvent)	_____
<input type="checkbox"/> Other Petroleum Solvents	_____
<input type="checkbox"/> CFC-113 (Trichlorofluoroethane)	_____
<input type="checkbox"/> TCA (1,1,1-Trichloroethane)	_____
<input type="checkbox"/> Other	_____

Sample Survey Forms for the Dry Cleaning Industry

For each machine at your facility, please provide the following information:

Machine Type	Load Capacity (pounds of garments)	Estimated Solvent Use Per Load (gallons of solvent)	Controls in Place
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

For your entire facility, please estimate the amount of solvent sent for off-site disposal or recycling:

Solvent Type	Estimated (gallons/year)
PERC (Perchloroethylene)	_____
Petroleum Solvents:	_____
_____	_____
_____	_____
TCA (1,1,1 -Trichloroethane)	_____
CFC-113 (Trichlorofluoroethane)	_____
Other (please specify):	_____
_____	_____
_____	_____

For your facility, please estimate the average days per week and hours per day that dry cleaning equipment is operating:

_____ days per week _____ hours per day

Please list the number of employees at this facility:

_____ employees

Sample Survey Forms for the Dry Cleaning Industry (Continued)

APPENDIX N

SAMPLE QC CHECKLIST

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

Emissions calculations checked? _____	Yes	No
checked by	date	
Are equations explicitly shown? [ref] _____	Yes	No

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APPENDIX O

PROCEDURES FOR DEVELOPING, DOCUMENTING, AND EVALUATING THE ACCURACY OF SPREADSHEET DATA

Procedures for Developing, Documenting, and Evaluating the Accuracy of Spreadsheet Data

Procedure

To maintain acceptable data quality, it is important to practice adequate QC measures during the development and review of spreadsheets. The information presented in a spreadsheet should be evaluated to determine if input data are transcribed correctly, calculated results are technically sound, and the final results are reported in a manner that will allow the data to be evaluated.

The procedures to follow when developing, documenting, and evaluating the accuracy of spreadsheets are described in this appendix. These procedures describe the minimum standards to be maintained to help ensure data quality and reproducibility. An example spreadsheet (with facility identification removed) is presented at the end of this appendix.

Definitions

Spreadsheet - An electronic table that is used to process or present data. A spreadsheet can be used to store and manipulate data, as well as present data in report-quality, tabular format.

Spreadsheet Developer (Developer) - The person responsible for the overall accuracy and quality of a spreadsheet. The Developer ensures that data are entered correctly and that mathematical functions are accurately executed.

Technical Reviewer - The person not associated with the development of the spreadsheet that is technically qualified and responsible for verifying the accuracy, completeness, and reasonableness of the data in the spreadsheet.

Quality Assurance Coordinator(QAC) - The person that ensures that QC checks and technical review are performed on the spreadsheet.

Summary of Responsibilities

The Spreadsheet Developer:

- Describes the development of the spreadsheet in the project notebook or in a memorandum to the project file.
- Ensures that all original data are transcribed (entered) to the spreadsheet correctly.

- Ensures that all equations used to generate results are entered correctly; ensures that all equations are used appropriately.
- Ensures that all conversion factors and constants used in equations are described.
- Ensures that all sources of original data are referenced in the spreadsheet.
- Ensures that all variables within equations are defined.
- Ensures that all supporting documentation for the information provided in the spreadsheet is obtained and submitted to the project file; ensures that memoranda summarizing procedures, activities, etc., are also maintained in the project file.
- Keeps a log of spreadsheet revisions. If different versions of a spreadsheet are created, the Developer maintains a log that describes the changes made to the different versions and maintains a historical file of the spreadsheet(s).
- Locks and protects the spreadsheet when giving the electronic file to reviewers. If the spreadsheet is being given to someone who will make revisions or enter data, data cells that should not be changed should be locked. Locking data cells in this manner will help prevent inadvertent changes to the spreadsheet.

The Team Manager or Leader:

- Determines when the use of spreadsheets (rather than database technology) are appropriate.
- Determines if a specific format must be used and specifies what information should be included in each spreadsheet.
- Reviews and approves the procedure for spreadsheet development.
- Ensures that these procedures are followed.
- Ensures that methods and technical approaches used to produce a desired result are technically sound.
- Assigns adequately trained staff to develop and review the spreadsheet.
- Specifies the level of detail to follow in reviewing the spreadsheet.
- Determines the level of QC necessary. For example, the Team Manager or Leader must decide if all data points and all calculations should be checked, or if only a

percentage should be checked. It may be appropriate to initially check a percentage and, based on the number of discrepancies identified, decide if additional QC is required.

- Considers the data quality objectives of the work (how will the data be used?), the complexity of the calculations, and experience level of the data generator.
- Specifies the level of detail to be included in the spreadsheet documentation.
- Ensures that spreadsheet documentation is included in the project file.
- Assigns a project assistant to organize and maintain a project file.
- Provides guidance on how to present data in the spreadsheet.

The Technical Reviewer:

- Verifies that the Developer's technical approach is reasonable and logical.
- Verifies that documentation is complete and clear.
- Ensures that assumptions and procedures used are reasonable.
- Provides timely, constructive, and direct comments to the Developer.
- Verifies (manually recalculates) at least one result at both low and high extremes as well as a result around the mid-point of the two.
- Verifies at least one calculation for each equation or combination of equations used.
- Verifies the accuracy of total values, means, and statistical evaluations of the data.
- With the Team Manager or Leader, determines the amount of data to check; the number of errors found will dictate the amount of data evaluated for accuracy. The higher the error rate, the more data points to be checked. If numerous errors are found, the spreadsheet should be returned to the data generator with a note that includes a description of the review procedure and percentage of errors found. The error rate is a good indicator of the accuracy of all of the information in the spreadsheet. If needed, the QA Coordinator should be consulted for guidance in determining the most effective way to determine which and how many values to recalculate.

- Verifies that original data were input correctly.
- Evaluates the technical soundness of methods and approaches used.
- Ensures that equations in the spreadsheet produce the correct result and that equations were entered into the spreadsheet accurately.
- Ensures that adequate documentation is included in the spreadsheet and that the documentation supports the data in the spreadsheet.
- Verifies that the source of all original data is referenced and all equations are explained.
- Notes all discrepancies identified during their QC review.
- Discusses all discrepancies with the Developer and Team Manager or Leader, as appropriate. Actual spreadsheet errors identified by the Reviewer should be corrected by the Developer.
- Summarizes the review (provides a written summary of the data checked, the errors or problems found, and the recommendations for revisions). The summary should also include the reviewer's name, date of QC review (month/day/year), name of file, type of data reviewed, and the percentage of each type reviewed.
- Keeps a copy of the written summary along with an electronic copy of the spreadsheet that was reviewed.

The Quality Assurance Coordinator:

- Ensures that an appropriate Technical Reviewer has been assigned to review the spreadsheet.
- Reviews the Developer's quality control (QC) plan.
- Ensures that the procedures described here are followed.

Spreadsheet Identification

- Include a title in the spreadsheet, at the beginning. Make the title descriptive enough to clearly identify the data presented and the project.

- Identify the Developer and the actual date (month/day/year) the spreadsheet was developed. (Distinguish between the “print” date and the “actual” date the spreadsheet was finalized.)
- Identify the reviewer and the date (month/day/year) the spreadsheet was reviewed.
- Include headers or footers that identify the name of the electronic spreadsheet file, the page number, and total number of pages (e.g., Page 1 of 2), and the date the spreadsheet was last revised. The name of the disk or drive on which the file is stored may also be included with the file name. An exception to this procedure is a report-quality table for inclusion in a report.
- Assign a unique name and number to the revised version of the spreadsheet. Add comments as a footnote to explain what was revised, the date the revision was made, and by whom.

Spreadsheet Development

- Keep the spreadsheet as simple as possible. Clarity is important. Avoid numerous calculations in one equation.
- Identify any constants or conversion factors used.
- Identify the source of all information and data. Include as much detail as possible (e.g., table and page number along with the title of the document, where appropriate).
- Describe all equations, using footnotes or a comments field, where appropriate. (e.g., if gram/kilogram are being converted to pound/ton, the equation performing the calculation should be explained as: “Convert g/kg to lb/ton: $1 \text{ g/kg} \times 1 \text{ lb}/453.59 \text{ g} \times 1 \text{ kg}/1,000 \text{ g} \times 453.59 \text{ g/lb} \times 2,000 \text{ lb/ton}$, which is equivalent to multiplying by 2”). If detailed descriptions exist in project notebooks, then a reference to that notebook (e.g., notebook and page number) should be made in the comments field.
- Describe spreadsheet functions (e.g., average, conditional operators [IF statements]).
- Avoid using specific values in equations, except for easily recognizable conversion factors or constants.
- Enter values within a cell. Equations that use the value should reference the cell.

- When a single equation is used numerous times, it may be desirable to enter the equation in a cell and reference the cell when the equation is used. (e.g., If 20 data elements are being converted from g/kg to lb/ton, enter the conversion equation in one cell and reference the cell 20 times, rather than entering the conversion equation 20 times.)
- Hand (manually) verify equation cells.
- Protect verified equation cell regions of spreadsheets to avoid accidentally over writing.

Supporting Data Requirements

The original raw data used in the spreadsheet should be retained in the project file and in the project archive. Reference all information and published documents used for spreadsheet development. Where applicable, photocopy the cover/title page and specific pages of the reference document.

Describe the development of the spreadsheets in the project notebook or in a memorandum or calculation sheet addressed to the project file. Include the following information:

- Project name/reference number;
- Purpose/task;
- Data references;
- Problems that may have occurred during the development of the spreadsheet and how they were eliminated;
- Justification for the technical approach; and
- A description of the data review process and the written comments from the technical reviewer (signed/dated).

Project Data File Requirements

Include all of the data required to reconstruct the development of the spreadsheet and determine the accuracy of the information reported. Include the electronic version of the spreadsheet in the project data file. Maintain an electronic backup copy at an identified location and in hard copy in the project file.

Project: Identification of Emission Factors for CO₂/Coal-Fired Boilers

Developed by: JLJ 06/21/98

Reviewed by: RFD 07/02/98

File name: s:/criteria/cfb_6.xls

TEST REPORT TITLE: RESULTS OF THE NOVEMBER 7, 1991 AIR TOXIC EMISSION
STUDY ON THE NOS. 3, 4, 5 & 6 BOILERS AT THE @@@@ PLANT

FACILITY: @@@@
UNIT NO.: 3, 4, 5 & 6
LOCATION: @@@@
COAL EF DATABASE REFERENCE NO 5

PROCESS DATA

	Run 1	Run 2	Run 3	
Oxygen (% v/v) a	7.70	7.60	7.80	
Vol. Flow Rate (dscf/m) b	804,786	788,668	815,076	
Vol. Flow Rate (dscf/hr)	48,287,160	47,320,080	48,904,560	
F-factor (dscf/MMBtu) c	9,780	9,780	9,780	
Heat input (MMBtu/hr)	3,118	3,079	3,134	
HHV Bituminous Coal (Btu/lb) d	8,498	8,498	8,498	
HHV Bituminous Coal (Btu/ton)	16,996,000	16,996,000	16,996,000	
Coal Feed Rate (ton/hr)	183	181	184	
Coal type e	Subbituminous			
Boiler configuration e	Pulverized, dry bottom			
Coal source e	Rochelle			
SCC	10100222			
Control device 1 e	ESPC			
Control device 2 e	None			
Data Quality	B			
Process Parameters e	Watertube boilers with economizers and air preheaters			
Test methods f	MM 5 metals, PM, PM10, Method 3 for CO2, Method 18 for BTEX			
Number of test runs g	3			

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c 40 CFR Pt 60, App A, Meth. 19

d Page 42

e Page 1.

f Page 1.

g Various pages.

CO2 EMISSION FACTORS

	Run 1	Run 2	Run 3	Avg
CO2 concentration (%v/v) a	11.9	11.9	11.60	
CO2 concentration (ppm) b	0.00119	0.00119	0.00116	
CO2 molecular weight	44	44	44	
CO2 concentration (lb/dscf) c	1.36E-10	1.36E-10	1.32E-10	
CO2 emission rate (lb/hr) d	0.007	0.006	0.006	
CO2 emission factor (lb/ton) e	3.57E-05	3.55E-05	3.51E-05	#N/A

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b convert 1/100 to 1/1,000,000

c (concentration, ppm * molecular weight)/385,500,000

d concentration, lb/dscf * Volumetric flow rate * 60 min/hr

e emission rate/coal feed rate

Date developed: 06/21/98

Date revised: Not applicable

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APPENDIX P

LIST OF RELEVANT WEB SITES

List of Relevant Web Sites

Aerometric Information Retrieval System (AIRS) - Main Menu:

Air ClearingHouse For Inventories And Emission Factors (Air CHIEF) CD-ROM:

<http://www.epa.gov/ttn/chief/airchief.html#order>

AIRS/AFS:

<http://www.epa.gov/ttn/airs/afs/index.html>

AIRSWeb:

<http://www.epa.gov/airswweb/sources.htm>

Ambient Monitoring Technology Information Center (AMTIC):

<http://www.epa.gov/ttn/amtic/>

Basic emission inventory preparation procedures:

<http://www.epa.gov/ttn/chief/>

California Air Resource Board:

<http://www.arb.ca.gov/homepage.htm>

Clean Air Technology Center (CATC):

<http://www.epa.gov/ttn/catc/>

Compilation of Air Pollutant Emission Factors (AP-42):

<http://www.epa.gov/ttn/chief/ap42etc.html>

Dun and Bradstreet Million Dollar Directory:

<http://www.dnb.com/>

EIIP documents:

<http://www.epa.gov/ttn/chief/eiip/>

Emission Measurement Technical Information Center (EMTIC) guidance on emission testing:

Emission Measurement Technical Information Center (EMTIC):

<http://www.epa.gov/ttn/emt看ic/>

Envirofact Warehouse

http://www.epa.gov/enviro/index_java.html

EPA Office of Mobile Sources

<http://www.epa.gov/oms>

EPA's EFIG

<http://www.epa.gov/ttn/chief/efig/>

Factor Information Retrieval (FIRE) Data System:

<http://www.epa.gov/ttn/chief/fire.html>

Locating and Estimating (L&E) documents:

<http://www.epa.gov/ttn/chief/ap42etc.html#LE>

OAQPS Emission Inventory (EI) Public Forum:

<http://www.epa.gov/cgi-bin/netforum/nei/a/1>

Office of Air Quality Planning and Standards (OAQPS):

<http://www.epa.gov/oar/oaqps/>

Office of Air & Radiation:

<http://www.epa.gov/oar/>

Office of Research and Development (ORD):

<http://www.epa.gov/ord/>

Office of Pollution Prevention and Toxics (OPPT):

<http://www.epa.gov/opptintr/>

STAPPA/ALAPCO:

<http://www.4cleanair.org/about.html>

TANKS

<http://www.epa.gov/ttn/chief/tanks.html>

Technology Transfer Network (TTN):

<http://www.epa.gov/ttn/>

The Great Lakes Commission:

<http://www.glc.org/>

The Aerometric Information Retrieval System (AIRS):
<http://www.epa.gov/airs/>

The PM Calc and the MECH Models:
<http://www.epa.gov/ttn/catc/products.html#software>

The TTN CHIEF Forum:
<http://www.epa.gov/cgi-bin/netforum/chief/a/1>

The Landfill Air Emissions Estimation Model:
<http://www.epa.gov/ttn/catc/products.html#software>

Toxic Release Inventory (TRI) data:
<http://www.epa.gov/opptintr/tri/access.htm>

U.S. Department of Agriculture
<http://www.usda.gov/>

U.S. Department Of Energy:
<http://home.doe.gov/>

WATER8 and CHEMDAT8:
<http://www.epa.gov/ttn/chief/software.html#water8>

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