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Emergency Planning and Community Right-To-Know Act Section 313 Reporting Guidance for Rubber and Plastics Manufacturing

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ACKNOWLEDGMENT

The U.S. EPA wishes to acknowledge the valuable contributions made by the staff and members of the Rubber Manufacturers Association (RMA), the Society of the Plastics Industry (SPI), and the International Institute of Synthetic Rubber Producers (IISRP). Without the insight provided by those in the industry with actual experience in fulfilling the reporting requirements of EPCRA Section 313, we would not have been able to produce a document that we believe will be of great assistance to those who must prepare future EPCRA Section 313 reports. Special thanks go to Ms. Tracey Norberg, Director, Environmental Affairs, RMA; Ms. Maureen Healey, Director of Environmental and Transportation Issues, SPI; and Mr. Jim McGraw, Deputy Managing Director, IISRP for their hard work.

OVERVIEW

This document supersedes the booklet entitled *Title III Section 313 Release Reporting Guidance, Estimating Chemical Releases From Rubber Production and Compounding*, dated March 1988. It is intended to assist establishments and facilities in the rubber and plastics manufacturing industry in complying with the Emergency Planning and Community Right-To-Know Act (EPCRA) Section 313 and Pollution Prevention Act (PPA) Section 6607 reporting requirements, the preparation of Form R or the alternate certification statement, Form A. The EPCRA Section 313 program is commonly referred to as the Toxic Chemical Release Inventory (TRI).

The principal differences in this new document include:

- More detailed examples;
- New EPCRA Section 313 regulations and guidance developed since 1988;
- PPA Section 6607 reporting requirements;
- U.S. Environmental Protection Agency's (U.S. EPA's) interpretive guidance on various issues specific to rubber and plastics manufacturing; and
- EPCRA Section 313 issues regarding processes not discussed in the earlier documents.

This document is designed to be a supplement to the annual issue of the *Toxic Chemical Release Inventory Reporting Forms and Instructions,* (*TRI Forms and Instructions)*. It is organized to provide a step-by-step guide to compliance with EPCRA Section 313 and PPA Section 6607, starting with how to determine if your facility must report and ending with guidance for estimating release and other waste management activity quantities.

Chapter 1 introduces EPCRA Section 313 and PPA Section 6607 reporting and provides a brief background on Section 313 of EPCRA and Section 6607 of PPA.

Chapter 2 discusses reporting requirements and begins with how to determine if your facility must report. This determination is based on your answers to a series of four questions:

- Is your facility's primary Standard Industry Classification (SIC) Code on the EPCRA Section 313 list?
- Does your facility employ ten or more full-time employees or the equivalent?
- Does your facility manufacture, process, or otherwise use any EPCRA Section 313 chemicals or chemical categories?
- Does your facility exceed any of the activity thresholds for an EPCRA Section 313 chemical or chemical category?

If the answer to ANY ONE of the first three questions is "No" you are not required to submit an EPCRA Section 313 report for any chemicals. If you answer "Yes" to the first three questions and "No" to the fourth, you are not required to submit an EPCRA Section 313 report for that chemical or chemical category. If you answer "Yes" to ALL four questions, the next step is to determine what kind of report you must prepare, a Form R or the alternate certification statement, Form A. Chapter 2 provides detailed information on the requirements for each kind of report. Chapter 2 concludes with a discussion on how to address trade secrets and the records that should be kept to support your reporting.

Chapter 3 discusses how to calculate the activity thresholds (manufacture, process, and otherwise use) for the EPCRA Section 313 chemicals or chemical categories. Information is provided on how to determine which EPCRA Section 313 chemicals or chemical categories your facility manufactures, processes, or otherwise uses and how to calculate the quantities of each. Detailed information is also provided on the various exemptions:

- *De minimis* exemption;
- Article exemption;
- Facility-related exemption; and
- Activity-related exemptions.

Chapter 3 concludes with a discussion of how to determine which EPCRA Section 313 chemicals or chemical categories exceed a reporting threshold.

Chapter 4 discusses how to estimate the release and other waste management activity amounts for those EPCRA Section 313 chemicals and chemical categories for which you must prepare a report. The first part of this chapter provides a step-by-step approach designed to minimize the risk of overlooking an activity involving an EPCRA Section 313 chemical or chemical category and any potential sources or types of release and other waste management activities. This procedure consists of:

- Preparation of a detailed **process flow diagram**;
- Identification of EPCRA Section 313 chemicals and chemical categories and potential **sources** of chemical release and other waste management activities;
- Identification of the potential **types** of release and other waste management activities from each source; and
- Determination of the most appropriate methods for **estimating the quantities** of EPCRA Section 313 chemical and chemical category release and other waste management activities.

The second part of Chapter 4 is organized by the typical processes in rubber and plastics manufacturing: rubber manufacturing, rubber product manufacturing, tire manufacturing, and plastic product manufacturing. The commonly used EPCRA Section 313 chemicals and chemical categories, process descriptions, release and other waste management activity estimates, example calculations, and common problems are presented.

This document includes examples and common errors applicable to rubber and plastics manufacturing. These examples are based on information identified during voluntary site surveys of facilities that have filed EPCRA Section 313 reports in the past, discussion with representatives of the Rubber Manufacturers Association, the Society of the Plastics Industry, and the International Institute of Synthetic Rubber Producers, and on questions received by the EPCRA Hotline.

CHAPTER 1 - INTRODUCTION

1.0 PURPOSE

The purpose of this guidance manual two-fold. The primary purpose is to assist rubber and plastics manufacturing facilities in complying with the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and of Section 6607 of the Pollution Prevention Act of 1990 (PPA). This manual explains the EPCRA Section 313 reporting requirements and discusses specific release and other waste management activities encountered at many rubber and plastics manufacturing facilities. Since each plant is unique, the recommendations presented may have to be modified for your particular facility. The secondary purpose is to provide information to other interested parties (such as management, legal professionals, inspectors, consultants, teachers, students, and the general public) about the processes and some of the toxic chemicals used in this industry.

This manual is intended solely for guidance and does not alter any statutory or regulatory requirements. The document should be used in conjunction with the appropriate statutes and regulations but does not supersede them. Accordingly, the reader should consult other applicable documents (for example, the statute, the Code of Federal Regulations (CFR), relevant preamble language, and the current *Toxic Chemical Release Inventory Reporting Forms and Instructions* (*TRI Forms and Instructions*)).

This document supersedes the 1988 document entitled *Title III Section 313 Release Reporting Guidance, Estimating Chemical Releases from Rubber Production and Compounding*. This new document includes:

- More detailed examples;
- New EPCRA Section 313 regulations and guidance developed since 1988;
- PPA Section 6607 reporting requirements;
- U.S. Environmental Protection Agency's (U.S. EPA's) interpretive guidance on various issues specific to rubber and plastics manufacturing; and
- EPCRA Section 313 issues regarding processes not discussed in the earlier document.

It is intended to supplement the *TRI Forms and Instructions* document that is updated and published annually by U.S. EPA. It is essential that you use the current version of the *TRI Forms and Instructions* to determine if (and how) you should report. Changes or modifications to EPCRA Section 313 reporting requirements are reflected in the annual *TRI Forms and Instructions* and should be reviewed before compiling information for the report.

The objectives of this manual are to:

- Reduce the level of effort expended by those facilities that prepare an EPCRA Section 313 report; and
- Increase the accuracy and completeness of the data being reported.

U.S. EPA cannot anticipate every potential issue or question that may apply to your facility. Therefore, this manual attempts to address those issues most prevalent or common for rubber and plastics manufacturing. Used in conjunction with the most current *TRI Forms and Instructions* and *Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Form (1999 version)*, facilities should be able to provide complete and accurate information for EPCRA Section 313 reporting. Additional discussions on specific issues can be found in U.S. EPA's current edition of *EPCRA Section 313, Questions and Answers* (the 1998 edition is EPA 745-B-98-004), which is available on the U.S. EPA's TRI website (**http://www.epa.gov/tri**) or by contacting the **EPCRA Hotline at 1-800-424-9346**. In the Washington, DC metropolitan area, call 703-412-9810.

1.1 Background on EPCRA Section 313 and PPA Section 6607

The following overview of EPCRA Section 313 and Section 6607 of the PPA, will provide you with a basic understanding of the objectives and requirements of this program, and will help you in completing your forms.

One of the primary goals of EPCRA is to increase the public's knowledge of, and access to, information on both the presence of toxic chemicals in their communities and on releases into the environment and other waste management activities of those chemicals. EPCRA Section 313 requires certain designated businesses (see SIC Code discussion, Chapter 2, Section 2.2) to submit annual reports (commonly referred to as Form R reports and Form A reports) on over 600 EPCRA Section 313 chemicals and chemical categories. Covered facilities report the amounts released or otherwise managed as waste. However, if a facility meets the reporting criteria for listed toxic chemicals, the facility must report even if there are no releases or other waste management quantities associated with these chemicals. Throughout this document, whenever EPCRA Section 313 chemicals are discussed, the discussion includes chemical categories, as appropriate. Chemicals or chemical categories may be added or deleted from the list. Therefore, before completing your annual report, be sure to check the most current list included with the *TRI Forms and Instructions* when evaluating the chemicals and chemical categories present at your facility. Copies of the reporting package can be requested from the EPCRA Hotline, 1-800-424-9346.

All facilities meeting the EPCRA Section 313 reporting criteria must report the annual release and other waste management activity quantities (routine and accidental) of EPCRA Section 313 chemicals and chemical categories to all environmental media. A separate report is required for each EPCRA Section 313 chemical or chemical category that is manufactured (including imported), processed, or otherwise used above the reporting threshold. The reports must be submitted to U.S. EPA and State or Tribal governments, on or before July 1, for activities in the previous calendar year. The owner/operator of the facility on July 1 is primarily responsible for the report, even if the owner/operator did not own the facility during the reporting year. However, property owners with no business interest in the operation of the facility, other than or lesser interest, are exempt from reporting requirements.

EPCRA also mandates U.S. EPA to establish and maintain a publicly available database system consisting of the information reported under Section 313 and under Section 6607 of the PPA. This database, known as the Toxic Chemical Release Inventory (TRI) database, can be accessed through the following sources:

- U.S. EPA Internet site, http://www.epa.gov/tri;
- Envirofacts Warehouse Internet site, http://www.epa.gov/enviro; and
- Right-to-Know network, http://www.rtk.net/trisearch.html.

However, information qualifying as a trade secret, in accordance with the regulatory requirements is protected from public release. In addition to being a resource for the public, TRI data are also used in the research and development of regulations related to EPCRA Section 313 chemicals and chemical categories.

To reduce the reporting burden for small businesses, U.S. EPA established an alternate activity threshold of one million pounds manufactured, processed, or otherwise used for facilities with total annual reportable amounts of 500 pounds or less for each EPCRA Section 313 chemical or chemical category. Provided the facility does not exceed either the reportable amount or the alternate threshold, the facility may file a certification form (Form A) rather than a Form R. By filing the Form A, the facility certifies that they do not exceed the reportable amount of 500 pounds or exceed the alternate threshold of one million pounds for the respective chemical or chemical category.

Note that the annual reportable amount includes the quantity of the EPCRA Section 313 chemical or chemical category in all production-related waste management activities, not just releases (see the discussion in Section 2.8 for more detail). Also note that either a Form A or a Form R, but not both, must be submitted for each EPCRA Section 313 chemical or chemical category above any reporting threshold, even if there are zero release and other waste management activity quantities.

Violation of EPCRA Section 313 reporting provisions may result in federal civil penalties of up to $27,500 per day for each violation (61 FR 69360). State enforcement provisions may also be applicable depending on the state’s EPCRA Section 313 reporting regulations.

Members of the Rubber Manufacturers Association, the Society of the Plastics Industry, and the International Institute of Synthetic Rubber Producers provided input on common problems specific to rubber and plastics manufacturing encountered by those completing the EPCRA Section 313 reports. U.S. EPA has combined this input with questions forwarded to the EPCRA Hotline and those identified during voluntary site surveys of facilities that have filed EPCRA Section 313 reports in the past. Selected issues and guidance addressing these common problems are presented throughout this document as applicable.

The *TRI Forms and Instructions* and *The 1994 and 1995 Toxic Release Inventory Data Quality Report*, EPA 745-R-98-002 also contain discussions of common problems in completing the EPCRA Section 313 reports. You are encouraged to read both documents before filling out the Form R (or Form A) for your facility.

If, after reading this manual, you still have questions about EPCRA Section 313 reporting, please contact the EPCRA Hotline at 1-800-424-9346 or refer to the U.S. EPA's TRI website, http://www.epa.gov/tri. Assistance is also available from the designated EPCRA Section 313 Coordinator in the U.S. EPA regional office and the EPCRA contact in your state (see the *TRI Forms and Instructions* for a current list of these contacts). Additional guidance is also available in the resources listed in Appendix A.

CHAPTER 2 - REPORTING REQUIREMENTS

2.0 PURPOSE

The purpose of this chapter is to help you determine if you must prepare an EPCRA Section 313 report(s) and, if so, what kind of report(s) should be prepared (Form R or the alternate certification statement, the Form A). This chapter presents the EPCRA Section 313 reporting requirements to help you determine if these requirements apply to your facility. It also discusses the reporting of trade secrets and the records that must be kept.

To understand the following discussion you must first understand how EPCRA defines a facility. The term “facility” is defined as, “all buildings, equipment, structures, and other stationary items which are located on a single site or on contiguous or adjacent sites and which are owned or operated by the same person (or by any person who controls, who is controlled by, or who is under common control with such person). A facility may contain more than one “establishment” (40 CFR 372.3). An “establishment” is defined as, “an economic unit, generally at a single physical location, where business is conducted, or where services or industrial operations are performed” (40 CFR 372.3).

U.S. EPA recognizes that for business reasons it may be easier and more appropriate for establishments at one facility to report separately. However, the combined quantities of EPCRA Section 313 chemicals and chemical categories manufactured, processed, or otherwise used in all establishments making up that facility must be considered for threshold determinations. Also, the combined release and other waste management activity quantities reported singly for each establishment must total those for the facility as a whole.

Note that if a facility is comprised of more than one establishment, once an activity threshold is met by the facility, providing the facility meets the SIC Code and employee threshold criteria, release and other waste management activities from all establishments at the facility must be reported.

Example - Multiple Establishments

Your facility has several different establishments, all with SIC Codes covered under EPCRA Section 313. One establishment used 7,000 pounds of toluene, an EPCRA Section 313 chemical, during the year to clean equipment. Another establishment purchased and used 4,000 pounds of toluene during the year as a solvent to separate a component from a mixture, with recovery of the toluene for reuse. Both activities constitute otherwise use of the EPCRA Section 313 chemical (as presented in Section 2.5 and described in detail in Chapter 3) and the total for the facility exceeded the 10,000-pound otherwise use threshold for the year. Thus, if your facility meets the employee threshold, you must file one Form R for toluene from your facility, or two Form Rs, one from each establishment. **Please note that you may be eligible to file one Form A for the facility but you cannot file a separate Form A for each establishment.**

2.1 Must You Report?

How do you determine if your facility must prepare an EPCRA Section 313 report? Your answers to the following four questions will help you decide (illustrated by Figure 2-1):

1) Is the primary SIC Code for your facility included in the list covered by EPCRA Section 313 reporting (see Section 2.2)?

2) Does your facility have 10 or more full-time employees or the equivalent (see Section 2.3)?

3) Does your facility manufacture (which includes importation), process, or otherwise use EPCRA Section 313 chemicals or chemical categories (see Section 2.4)?

4) Does your facility exceed any applicable thresholds of EPCRA Section 313 chemicals or chemical categories (for non-PBT chemicals: 25,000 pounds per year for manufacturing; 25,000 pounds per year for processing; or 10,000 pounds per year for otherwise use - see Section 2.5; for PBT chemicals: see Section 2.6 for applicable thresholds)?

If you answered “No” to any of the first three questions, you are not required to prepare any EPCRA Section 313 reports. If you answered “Yes” to ALL of the first three questions, you must complete a threshold calculation for each EPCRA Section 313 chemical and chemical category at the facility, and submit an EPCRA Section 313 report for each chemical exceeding the applicable threshold.

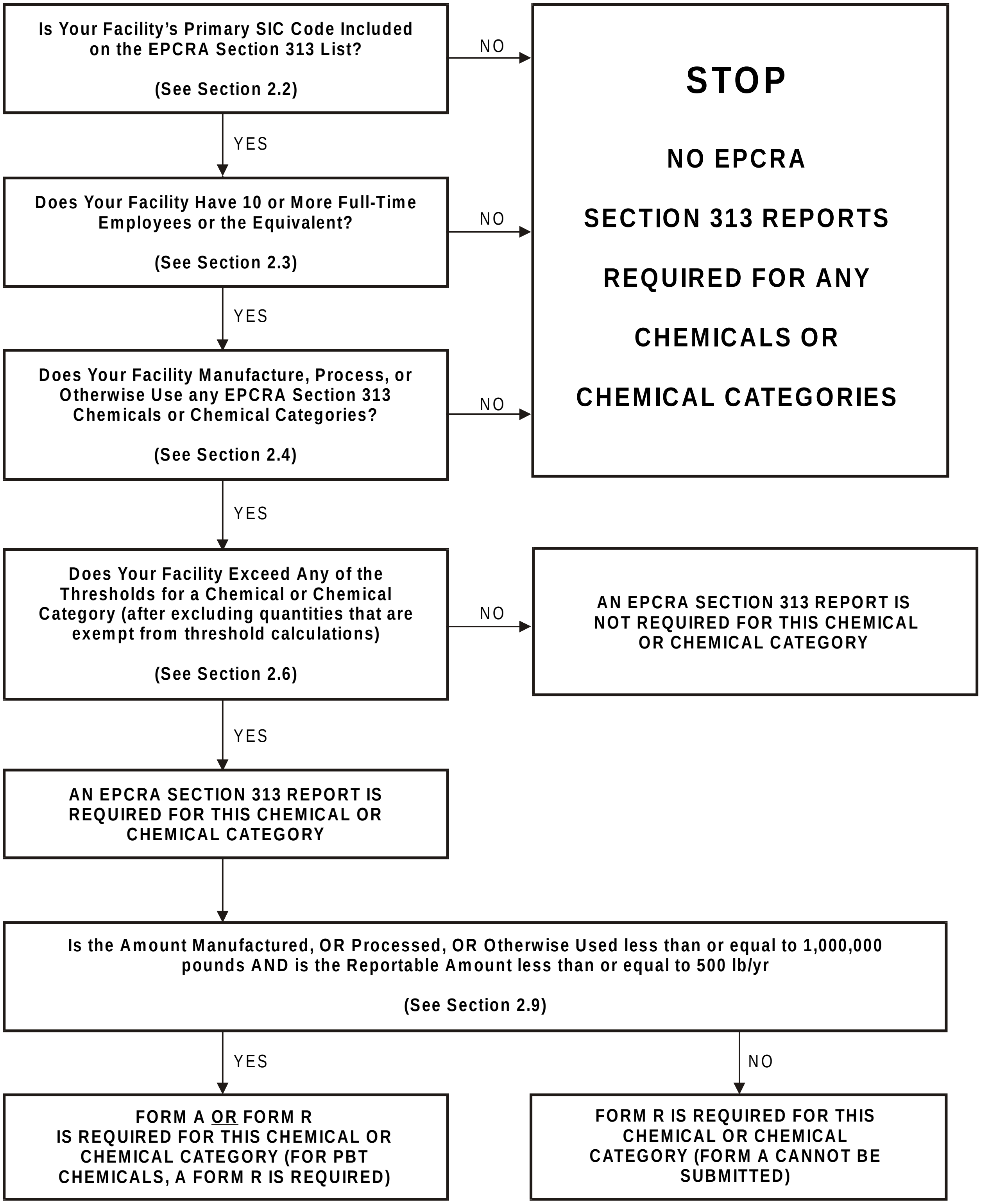

Figure 2-1. EPCRA Section 313 Reporting Decision Diagram

2.2 SIC Code Determination

Facilities with the SIC Codes presented in Table 2-1 are covered by the EPCRA Section 313 reporting requirements.

Table 2-1

SIC Codes Covered by EPCRA Section 313 Reporting

SIC Codes	Industry	Qualifiers
10	Metal Mining	Except SIC Codes 1011, 1081, and 1094
12	Coal Mining	Except SIC Code 1241
20 through 39	Manufacturing	None
4911, 4931, and 4939	Electric and Other Services and Combination Utilities	Limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce
4953	Refuse Systems	Limited to facilities regulated under RCRA Subtitle C
5169	Chemicals and Allied Products	None
5171	Petroleum Bulk Stations and Terminals	None
7389	Business Services	Limited to facilities primarily engaged in solvent recovery services on a contract or fee basis

Table 2-2 presents a listing of each SIC Code for rubber and plastics manufacturing facilities, with brief descriptions. You should determine the SIC Code(s) for your facility, based on the activities on site. For assistance in determining which SIC Code best suits your facility refer to *Standard Industrial Classification Manual, 1987* published by the Office of Management and Budget.

Table 2-2

SIC Codes for Rubber and Plastics Manufacturing Facilities

SIC Code	Description
2822	Synthetic Rubber (vulcanizable elastomers)
3011	Tires and Inner Tubes
3021	Rubber and Plastics Footwear
3052	Rubber and Plastics Hose and Belting
3053	Gaskets, Packing and Sealing Devices
3061	Molded, Extruded, and Lathe-Cut Mechanical Rubber Goods
3069	Fabricated Rubber Products, (not elsewhere classified)
3081	Unsupported Plastics Film and Sheet
3082	Unsupported Plastics Profile Shapes
3083	Laminated Plastics Plate, Sheet, and Profile Shapes
3084	Plastics Pipe
3085	Plastics Bottles
3086	Plastics Foam Products
3087	Custom Compounding of Purchased Plastic Resin
3088	Plastics Plumbing Fixtures
3089	Plastics Products, (not elsewhere classified)

Most rubber and plastics manufacturing facilities are in SIC Major Group 30 and are required to prepare EPCRA Section 313 reports if they meet the employee and chemical activity threshold criteria.

Note that auxiliary facilities can assume the SIC Code of another covered establishment if the primary function is to service the covered establishment's operations. For the purpose of EPCRA Section 313, auxiliary facilities are defined as those that are primarily engaged in performing support services for another covered establishment or multiple establishments of a covered facility, and are in a different physical location from the primary facility. In addition, auxiliary facilities perform an integral role in the primary facility's activities. In general, the auxiliary facility's basic administrative services (e.g., paperwork, payroll, employment) are performed by the primary facility. If an auxiliary facility's primary function is to support/service a facility with a covered SIC Code, the auxiliary facility assumes the covered SIC Code as its primary SIC Code and must consider the other reporting requirements (40 CFR Section 372.22) to determine if it must comply with the EPCRA Section 313 reporting requirements. However, if the SIC Code for the primary facility is not covered by EPCRA Section 313, then neither the primary nor the auxiliary facility is required to submit a report.

If your facility has more than one SIC Code (i.e., several establishments with different SIC Codes are owned or operated by the same entity and are located at your facility), you are subject to reporting requirements if:

- All the establishments have SIC Codes covered by EPCRA Section 313; OR,
- The total value of the products shipped or services provided at establishments with covered SIC Codes is greater than 50% of the value of the entire facility's products and services; OR,
- Any one of the establishments with a covered SIC Code ships and/or produces products or provides services whose value exceeds the value of services provided, products produced, and/or shipped by every other establishment within the facility.

Example - Primary SIC Code

A facility has two establishments. The first, a scrap and waste materials facility, is in SIC Code 5093. SIC Code 5093 is not a covered SIC Code. However, the second establishment, a plastic products not elsewhere classified facility, is in SIC Code 3089, which is a covered SIC Code. The facility also determines the waste plastic product is worth $500/unit as received from the establishment in the non-covered SIC Code and the value of the plastic sheet product is $1,500/unit after processing by the establishment in the covered SIC Code. The value added by the establishment in the covered SIC Code is more than 50% of the product value; therefore, the primary SIC Code is 3089, a covered SIC Code. Thus, the establishment is covered by EPCRA Section 313 reporting and the entire facility is subject to reporting.

A pilot plant within a covered SIC Code is considered a covered facility and is subject to reporting, provided it meets the employee and activity criteria (note that pilot plants are not eligible for the laboratory exemption, which is discussed in Chapter 3). Warehouses on the same site as facilities in a covered SIC Code and warehouses that qualify as auxiliary facilities of covered facilities are also subject to reporting provided all applicable reporting requirements are met.

While you are currently required to determine your facility's reporting eligibility based on the SIC code system described above, it is important to be aware that the SIC code system will be replaced by a new system in the future. On April 9, 1997 (62 FR 17287), the Office of Management and Budget promulgated the North American Industrial Classification System (NAICS). NAICS is a new economic classification system that replaces the SIC code system as a means of classifying economic activities for economic forecasting and statistical purposes. The transition to the new NAICS may require regulatory actions. As a result, the SIC code system is still required to be used as the mechanism to determine your facility's reporting eligibility. EPA will issue notice in the *Federal Register* to inform you and other EPCRA Section 313 facilities of its plans to adopt the NAICS and how facilities should make their NAICS code determination.

2.3 Number of Employees

If your facility meets SIC Code and activity threshold criteria, you are required to prepare an EPCRA Section 313 report if your facility has 10 or more full-time employees or the equivalent. A full-time employee equivalent is defined as a work year of 2,000 hours. If your facility's employees hours total 20,000 or more hours in a calendar year, you meet the 10 or more employee threshold criterion.

The following information should be included in your employee calculations:

- Owners;
- Operations/manufacturing staff;
- Clerical staff;
- Temporary employees;
- Sales personnel;
- Truck drivers (employed by the facility);
- Other non-manufacturing or off-site facility employees directly supporting the facility;
- Paid vacation and sick leave; and

- Contractor employees (maintenance, construction, etc. but excluding contracted truck drivers and minor intermittent service vendors (e.g., trash handlers)).

In general, if an individual is employed or hired to work at the facility, all the hours worked (including paid leave and overtime) by that individual for the facility should be counted in determining if the 20,000-hour criterion has been met.

Example - Employee Equivalent Calculation

Your facility has six full-time employees working 2,000 hours/year. You also employ two full-time sales people and a delivery truck driver (employed by the facility) who are assigned to the plant, each working 2,000 hours/year but predominantly on the road or from their homes. The wastewater treatment system (on site and owned by the facility) is operated by a contractor who spends an average of two hours per day and five days per week at the plant. Finally, you built an addition to the plant warehouse during the year, using four contractor personnel who were on site full time for six months (working on average of 1,000 hours each). You would calculate the number of full-time employee equivalents as follows:

- Hours for your nine full-time employees (six plant personnel, two salespeople, and one delivery truck driver) are:
  (9 employees) × (2,000 hours/year) = 18,000 hours/year;

- Hours for the wastewater treatment system operator are:
  (2 hours/day) × (5 days/week) × (52 weeks/year) = 520 hours/year; and

- Hours for the construction crew are:
  (4 contractors) × (1,000 hours) = 4,000 hours/year.

Your facility has a total of 22,520 hours for the year, which is above the 20,000 hours/year threshold; therefore, you meet the employee criterion.

2.4 Manufacturing, Processing, and Otherwise Use of EPCRA Section 313 Chemicals or Chemical Categories

If you are in a covered SIC Code and have 10 or more full-time employee equivalents, you must determine which EPCRA Section 313 chemicals and chemical categories are manufactured, processed, or otherwise used at your facility. You should prepare a list which includes all chemicals and chemical categories found in mixtures and trade name products at all establishments at the facility. This list should then be compared to the CURRENT list of EPCRA Section 313 chemicals and chemical categories found in the *TRI Forms and Instructions* document for that reporting year (also available from the EPCRA Hotline, 1-800-424-9346). Once you identify the EPCRA Section 313 chemicals and chemical categories at your facility, you must evaluate the activities involving each chemical and chemical category and determine if any activity thresholds have been met.

The original list of chemicals and chemical categories subject to EPCRA Section 313 reporting was a combination of lists from New Jersey and Maryland. Refinements to the list have been made and changes are anticipated to continue. The list can be modified by U.S. EPA initiatives or industry or the public can petition U.S. EPA to modify the list. When evaluating a chemical or chemical category for addition or deletion from the list, U.S. EPA must consider the chemical's potential acute human health effects, chronic human health effects, or its adverse environmental effects. U.S. EPA reviews these petitions and initiates a rulemaking to add or delete the chemical from the list, or publishes an explanation why it denied the petition.

Note that chemicals and chemical categories are periodically added, delisted, or modified. Therefore, it is imperative that you refer to the appropriate reporting year's list. You can refer to the U.S. EPA's TRI website, http://www.epa.gov/tri, for updated guidance. Also, note that a list of synonyms for EPCRA Section 313 chemicals and chemical categories can be found in the U.S. EPA publication *Common Synonyms for Chemicals Listed Under Section 313 of the Emergency Planning and Community Right-To-Know Act* (EPA 745-R-95-008). Table 2-3 lists the EPCRA Section 313 chemicals and chemical categories most frequently reported for rubber and plastics manufacturing. This list is not intended to be all inclusive and should only be used as a guide.

Table 2-3

EPCRA Section 313 Chemicals and Chemical Categories Commonly Encountered in Rubber and Plastics Manufacturing (SIC Codes 2822, 301, 302, 305, 306, and 308)

CASRN	Chemicals	Process
71-55-6	1,1,1-Trichloroethane	Solvent
1717-00-6	1,1-Dichloro-1-fluorethane	Flame Retardant
106-99-00	1,3-Butadiene	Monomer for Rubber Manufacturing
7664-41-7	Ammonia (anhydrous and 10% of aqueous)	Reaction Product, Wastewater Treatment, Catalyst
NA	Antimony compounds	Rubber and Plastic Product Compounding Additive, Flame Retardant
NA	Barium compounds	Compounding Additive, Heat-Stabilizer
75-15-0	Carbon Disulfide	Coincidentally Manufactured
NA	Certain Glycol ethers	Process Oils, Lubricants
7782-50-5	Chlorine	Water treatment, Waste Water Treatment, Surface Glaze
75-45-6	Chlorodifluoromethane	Flame Retardant, Solvent
NA	Chromium compounds	Compounding Additive
NA	Cobalt compounds	Polymerization Chemical Additive, Plastic Finishing Chemical
1163-19-5	Decabromodiphenyl oxide	Flame Retardant
117-81-7	Di (2-Ethylhexyl) phthalate	Compounding Additive
75-09-2	Dichloromethane	Plastic Compounding Additive
111-42-2	Diethanolamine	Vulcanization Accelerator
NA	Diisocyanates	Monomer, Plasticizer
131-11-3	Dimethyl phthalate	Plastic Product Chemical
100-41-4	Ethyl benzene	Plastic Compounding Additive
107-21-1	Ethylene glycol	Monomer or Polymerization Reactant
50-00-0	Formaldehyde	Cord or Yarn Surface Coating Constituent, Fabric Latex Coating, Coincidental Manufacture in Boilers
110-54-3	n-Hexane	Solvent
7647-01-0	Hydrochloric acid (acid aerosols)	Coincidentally Manufactured
NA	Lead compounds	Vulcanizing Agent/Accelerator
7439-92-1	Lead	Heat Stabilizer/Compounding Additive
NA	Manganese compounds	Initiators
67-56-1	Methanol	Typically Present in Solutions of Formaldehyde
80-62-6	Methyl methacrylate	Monomer
78-93-3	Methyl ethyl ketone	Carrier in Primer, Adhesives, and Paints
108-10-1	Methyl isobutyl ketone	Carrier in Primer, Adhesives, and Paints Solvent

Table 2-3 (Continued)

CASRN	Chemicals	Process
NA	Nickel compounds	Rubber Product Compounding Additive, Polymerization Chemical Additive,
7697-37-2	Nitric acid	Wastewater Treatment
108-95-2	Phenol	Finishing Chemical-Protective Agent, Compounding Chemical Additive, Cleaning Agent
100-42-5	Styrene	Monomer used in Rubber & Plastic Industry
7664-93-9	Sulfuric acid (acid aerosols)	Coincidentally Manufactured in Cooling Towers, Storage Tanks, and Boiler Stacks
137-26-8	Thiram (tetramethyl thiuram disulfide)	Accelerator in Rubber Compounding
108-88-3	Toluene	Solution Polymerization Solvent
26471-62-5	Toluene diisocyante (mixed isomers)	Monomer
584-84-9	Toluene-2,4-diisocyanate	Monomer
91-08-7	Toluene-2,6-diisocyanate	Monomer
79-01-6	Trichloroethylene	Monomer
1330-20-7	Xylene (mixed isomers)	Solvent
NA	Zinc compounds	Rubber Product Compounding Additive Vulcanizing Agent/Accelerator

2.5 Activity Categories

EPCRA Section 313 defines three activity categories for the listed chemicals and chemical categories: manufacturing (which includes importing), processing, and otherwise use. The activity thresholds are 25,000 pounds per year for manufacturing, 25,000 pounds per year for processing, and 10,000 pounds per year for otherwise use[1]. These thresholds apply to each chemical or chemical category individually. The quantity of chemicals or chemical categories stored on site or purchased is not relevant for threshold determinations. Rather, the determination is based solely on the annual quantity actually manufactured (including imported), processed, or otherwise used. Therefore, EPCRA Section 313 chemicals and chemical categories that are brought on site and stored, but are not prepared in the reporting year for distribution in that year or subsequent years or are not otherwise used on site during the reporting year, are not considered towards any activity threshold.

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[1] These activity thresholds are for non-PBT chemicals. See Section 2.6 for the activity thresholds applicable to PBT chemicals.

Expanded definitions with examples of each of the three activities are found in Chapter 3, Tables 3-2, 3-3, and 3-4. The terms are briefly defined in Table 2-4.

Table 2-4

Activity Categories

Activity Category	Definition	Threshold[1] (lbs/yr)
Manufacture	To produce, prepare, import, or compound an EPCRA Section 313 chemical or chemical category. Manufacture also applies to an EPCRA Section 313 chemical that is produced coincidentally during the manufacture, processing, otherwise use, or disposal of another chemical or mixture of chemicals as a byproduct, and an EPCRA Section 313 chemical or chemical category that remains in that other chemical or mixture of chemicals as an impurity during the manufacturing, processing, or otherwise use or disposal of any other chemical substance or mixture. An example would be the production of ammonia or nitrate compounds in a wastewater treatment system.	25,000
Process	To prepare a listed EPCRA Section 313 chemical, or a mixture or trade name product containing an EPCRA Section 313 chemical, for distribution in commerce. For example, the addition of EPCRA Section 313 listed pigments to paint should be reported if you exceeded the reporting threshold. Processing includes the preparation for sale to your customers (and transferring between facilities within your company) of a chemical or formulation that you manufacture. For example, if you manufacture an EPCRA Section 313 chemical or chemical category or product, package it, and then distribute it into commerce, this chemical has been manufactured AND processed by your facility.	25,000

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[1] These activity thresholds are for non-PBT chemicals. See Section 2.6 for the activity thresholds applicable to PBT chemicals.

Activity Category	Definition	Threshold[1] (lbs/yr)
Otherwise Use	Generally, use of an EPCRA Section 313 chemical or chemical category that does not fall under the manufacture or process definitions is classified as otherwise use An EPCRA Section 313 chemical or chemical category that is otherwise used does not function by being incorporated into a product that is distributed in commerce, but may be used instead as a manufacturing or processing aid (e.g., catalyst), in waste processing, or as a fuel (including waste fuel). For example, xylene used as a carrier solvent for paint is classified as otherwise used. On May 1, 1997 U.S. EPA revised the interpretation of otherwise use. The following new otherwise use definition became effective with the 1998 reporting year (62 FR 23834, May 1, 1997): Otherwise use means "any use of a toxic chemical contained in a mixture or other trade name product or waste, that is not covered by the terms manufacture or process. Otherwise use of a toxic chemical does not include disposal, stabilization (without subsequent distribution in commerce), or treatment for destruction unless: 1) The toxic chemical that was disposed, stabilized, or treated for destruction was received from off site for the purposes of further waste management; OR 2) The toxic chemical that was disposed, stabilized, or treated for destruction was manufactured as a result of waste management activities on materials received from off site for the purposes of further waste management activities."	10,000

[1] These activity thresholds are for non-PBT chemicals. See Section 2.6 for the activity thresholds applicable to PBT chemicals.

COMMON ERROR - Coincidental Manufacture

The coincidental manufacture of an EPCRA Section 313 chemical or chemical category, outside the primary product process line but in direct support of the process, is frequently overlooked. For example, a tire manufacturer (SIC Code 3011) uses steam heated pressure vessels for the vulcanization process. These vessels use large quantities of steam which is generated on site by a coal-fired steam plant. The burning of coal will potentially result in the coincidental manufacture of several EPCRA Section 313 chemicals including the aerosol forms of sulfuric and hydrochloric acid, metal compounds, and formaldehyde. The amount of each coincidentally manufactured EPCRA Section 313 chemical or chemical category must be included in any threshold determinations and, if a threshold is exceeded, any subsequent release and other waste management activity quantity calculations.

COMMON ERROR - Definition of “Compounding”

Do not include rubber or plastic compounding in the manufacturing threshold determination. The EPCRA Section 313 definition of manufacture includes the term compounding. Compounding is defined, for the purpose of EPCRA Section 313 reporting, as generation of an EPCRA Section 313 chemical, not the mixing of EPCRA Section 313 chemicals to form a new product. This may be different than compounding as typically used in rubber and plastic manufacturing where it is usually a type of mixing operation. The mixing of an EPCRA Section 313 chemical to form a new product is considered processing if the chemical remains as part of the product or otherwise used if the chemical does not intentionally remain as part of the product.

For example, plastic pellets containing the EPCRA Section 313 listed monomer styrene (CAS Registry No. 100-42-5) are compounded with various additives at a plastic product manufacturing facility. Because the styrene remains with the product, it is considered processed. The addition of a cobalt catalyst to the compounding operation would be defined as otherwise use, because the catalyst does not intentionally remain with the product.

Example - Treatment of Wastes from Off Site

A covered facility receives a waste containing 12,000 pounds of Chemical A, an EPCRA Section 313 chemical, from off site. The facility treats the waste, destroying Chemical A and in the treatment process manufactures 10,500 pounds of Chemical B, another EPCRA Section 313 chemical. Chemical B is disposed on site.

Since the waste was received from off site for the purpose of waste management, the amount of Chemical A must be included in the otherwise use threshold determination for Chemical A. The otherwise use threshold is 10,000 pounds and since the amount of Chemical A exceeds this threshold, all release and other waste management activities for Chemical A must be reported.

Chemical B was manufactured in the treatment of a waste received from off site. Accordingly, the quantity of chemical B should be counted towards the manufacturing threshold. However, the facility disposed of Chemical B on site and “otherwise use” of a toxic chemical includes disposal, stabilization (without subsequent distribution in commerce) or treatment for destruction if the toxic chemical that was disposed, stabilized, or treated for destruction was manufactured as a result of waste management activities on materials received from off site for the purposes of further waste management activities. Therefore, the amount of Chemical B must also be considered in the otherwise use threshold determination. Thus, at 10,500 pounds, the otherwise use reporting threshold for Chemical B has been exceeded and all release and other waste management activities for Chemical B must be reported.

Relabeling or redistribution of an EPCRA Section 313 chemical or chemical category where no repackaging occurs does not constitute manufacturing, processing, or otherwise use of that chemical. This type of activity should not be included in threshold determinations.

Example - Relabeling

You buy a mixture in small containers that contains an EPCRA Section 313 chemical. When it arrives you put your own label on each container, put the containers in a larger box with several other items you manufacture, and sell the larger box as a kit. The quantity of the EPCRA Section 313 chemical in the small containers should not be counted toward the processing threshold (because you did not repackage the chemical) or the otherwise use threshold, nor should it be counted toward the manufacturing activity threshold unless the small containers were imported. However, you must consider other EPCRA Section 313 chemicals that you manufactured in the kit toward manufacturing and processing threshold determinations.

Also, note that the threshold determinations for the three activity categories (manufacturing, processing, and otherwise use) are mutually exclusive. That is, you must conduct a separate threshold determination for each activity category and if you exceed any threshold, all release and other waste management activities of that EPCRA Section 313 chemical or chemical category at the facility must be considered for reporting.

2.6 Persistent, Bioaccumulative, and Toxic (PBT) Chemicals

U.S. EPA promulgated the final rule for Persistent, Bioaccumulative, and Toxic (PBT) chemicals in the October 29, 1999 Federal Register (64 FR 209). This rule applies for the reporting year beginning January 1, 2000 (for EPCRA Section 313 reports that must be filed by July 1, 2001).

In this rule, U.S. EPA has added seven chemicals and lowered the reporting thresholds for 18 chemicals and chemical categories that meet the EPCRA Section 313 criteria for persistence and bioaccumulation. The PBT chemicals and their thresholds are listed in Table 2-5.

Table 2-5

Reporting Thresholds for EPCRA Section 313 Listed PBT Chemicals

Chemical Name or Chemical Category	CASRN	Section 313 Reporting Threshold (in pounds unless noted other-wise)
Aldrin	309-00-2	100
Benzo(g,h,i)perylene	191-24-2	10
Chlordane	57-74-9	10
Dioxin and dioxin-like compounds category (manufacturing; and the processing or otherwise use of dioxin and dioxin-like compounds if the dioxin and dioxin-like compounds are present as contaminants in a chemical and if they were created during the manufacturing of that chemical)	NA	0.1 grams
Heptachlor	76-44-8	10
Hexachlorobenzene	118-74-1	10
Isodrin	465-73-6	10
Methoxychlor	72-43-5	100
Octachlorostyrene	29082-74-4	10
Pendimethalin	40487-42-1	100
Pentachlorobenzene	608-93-5	10
Polycyclic aromatic compounds category	NA	100
Polychlorinated biphenyl (PCBs)	1336-36-3	10
Tetrabromobisphenol A	79-94-7	100
Toxaphene	8001-35-2	10
Trifluralin	1582-09-8	100
Mercury	7439-97-6	10
Mercury compounds	NA	10

U.S. EPA also added two chemicals to the polycyclic aromatic compounds (PACs) category that is listed above:

- Benzo(j,k)fluorene (fluoranthene)
- 3-methylchloanthrene

These two chemicals are not to be reported individually; rather, they should be included within the PACs compound category.

U.S. EPA finalized two thresholds based on the chemicals' potential to persist and bioaccumulate in the environment. The two levels include setting Section 313 manufacture, process, and otherwise use thresholds to 100 pounds for PBT chemicals and to 10 pounds for that subset of PBT chemicals that are highly persistent and highly bioaccumulative. One exception is the dioxin and dioxin-like compounds category. EPA set the threshold for the dioxin and dioxin-like compound category at 0.1 gram.

U.S. EPA eliminated the *de minimis* exemption for the PBT chemicals. However, this action does not affect the applicability of the *de minimis* exemption to the supplier notification requirements (40 CFR 372.45(d)(1)). U.S. EPA also excluded all PBT chemicals from eligibility for the alternate threshold of 1 million pounds (see Section 2.9) and eliminated range reporting of PBT chemicals and chemical categories for on-site releases and transfers off-site for further waste management.

Concurrent with the additions and lowered thresholds discussed above, U.S. EPA added "vanadium, except when contained in an alloy" and "vanadium compounds" to the list of toxic chemicals subject to reporting under EPCRA Section 313. The corresponding thresholds for vanadium and vanadium compounds remain 10,000 pounds if otherwise used, 25,000 pounds if processed, and 25,000 pounds if manufactured. Please refer to the discussion on "Qualifiers" in Section 3.1 if vanadium is a concern at your facility.

Note that U.S. EPA is currently developing five guidance documents for chemicals modified by the PBT rule:

- Dioxins and dioxin-like compounds;
- Mercury and mercury compounds;
- Vanadium and vanadium compounds;
- Polycyclic aromatic compounds (PACs) category; and
- Other PBT chemicals.

Please refer to this guidance if applicable to your facility.

2.7 How Do You Report?

You must submit an EPCRA Section 313 report for each EPCRA Section 313 chemical or chemical category that exceeds a threshold for manufacturing, OR processing, OR otherwise use (providing you meet the employee and SIC Code criteria). Provided you do not exceed certain alternate activity thresholds and total annual reportable amounts, you may prepare a Form A (See Section 2.9) rather than a Form R. The *TRI Forms and Instructions* contain detailed directions for the preparation and submittal of EPCRA Section 313 reports for the reporting year. The *TRI Forms and Instructions* are sent to all facilities that submitted EPCRA Section 313 reports the preceding year. However, if you do not receive a courtesy copy, you may request copies of the *TRI Forms and Instructions* from the EPCRA Hotline (1-800-424-9346).

2.8 Form R

Form R is the report in which the information required by EPCRA Section 313 is reported. If you are submitting a Form R, it is essential that you use the *TRI Forms and Instructions* for the appropriate reporting year. U.S. EPA encourages the electronic submittal of the Form R, via the Automated Toxic Chemical Release Inventory Reporting Software (ATRS). Use of the ATRS will save preparation time in data entry and photocopying and will reduce errors via on-line validation routines and use of pick lists. The ATRS can be found on the Internet at:

- **http://www.epa.gov/atrs**

The ATRS is available in both DOS and Windows versions. More information can be found in the *TRI Forms and Instructions* and by calling the ATRS User Support Hotline at (703) 816-4434.

The Form R consists of two parts:

Part I, Facility Identification Information. This part may be photocopied and re-used for each Form R you submit, except for the signature, which must be original for each submission.

Part II, Chemical Specific Information. You must complete this part separately for each EPCRA Section 313 chemical or chemical category; it cannot be reused year to year even if reporting has not changed.

Submission of incomplete EPCRA Section 313 reports may result in issuance of a Notice of Technical Error (NOTE), Notice of Significant Error (NOSE), or Notice of Non-Compliance (NON). See the current *TRI Forms and Instructions* for more detailed information on completing the Form R and submitting the EPCRA Section 313 report.

2.9 Alternate Threshold and Form A

U.S. EPA developed the Form A, also referred to as the "Certification Statement," to reduce the annual reporting burden for facilities with minimal amounts of EPCRA Section 313 chemicals or chemical categories released and otherwise managed as waste (59 FR 61488, November 1994; applicable beginning reporting year 1994 and beyond). On Form A, you certify that you are not required to report the release and other waste management information required by EPCRA Section 313 and PPA Section 6607. A facility must meet the following two criteria to use a Form A:

- First, the total annual reportable amount of the EPCRA Section 313 chemical or chemical category manufactured, processed, OR otherwise used cannot exceed 500 pounds per year. The "reportable amount" is defined as the sum of the on-site amounts released (including disposal), treated, recycled, and combusted for energy recovery, combined with the sum of the amounts transferred off site for recycling, energy recovery, treatment, and/or release (including disposal). This total corresponds to the total of data elements 8.1 through 8.7 on the 1999 version of the Form R.

- Second, the amount of the EPCRA Section 313 chemical cannot exceed one million pounds. It is important to note that the quantities for each activity are mutually exclusive and must be evaluated independently. If the quantity for any one of the activities exceeds 1,000,000 pounds a Form A cannot be used.

Example - Form A Threshold

If the combined annual reportable amounts from all activities does not exceed 500 pounds, a facility that manufactures 900,000 pounds of an EPCRA Section 313 chemical and processes 150,000 pounds of the same chemical is eligible to use the Form A because the facility did not exceed the one million pound threshold for either activity, even though the total activity usage exceeds one million pounds.

The Form A Certification Statement must be submitted for each eligible EPCRA Section 313 chemical or chemical category. The information on the Form A will be included in the publicly accessible TRI database; however, these data are marked to indicate that they represent certification statements rather than Form Rs. Note that separate establishments at a facility cannot submit separate Form As for the same chemical or chemical category; rather, only one Form A per EPCRA Section 313 chemical or chemical category can be submitted per facility.

While Form A requests facility identification and chemical identification information, no release and other waste management quantity estimations to any media are required. You must simply certify that the total annual reportable amount did not exceed 500 pounds and that amounts manufactured, processed, or otherwise used did not exceed one million pounds. Once the facility has completed estimates to justify the submission of a Form A, there is a considerable time savings in using the Form A, especially in subsequent years providing activities involving the chemical or chemical category did not change significantly. It is strongly recommended that you document your initial rationale and refer to it every year to verify you have not modified a part of the process that would invalidate the initial rationale supporting submission of a Form A.

2.10 Trade Secrets

If you submit trade secret information, you must prepare two versions of the substantiation form as prescribed in 40 CFR Part 350 (see 53 FR 28801, July 29, 1988) as well as two versions of the EPCRA Section 313 report. One set of reports should be “sanitized” (i.e., it should provide a generic name for the EPCRA Section 313 chemical or chemical category identity). This version will be made available to the public. The second version, the "unsanitized" version, should provide the actual identity of the EPCRA Section 313 chemical or chemical category and have the trade secret claim clearly marked in Part I, Section 2.1 of the Form R or Form A. The trade secrets provision only applies to the EPCRA Section 313 chemical and chemical category identity. All other parts of the Form R or Form A must be filled out accordingly.

Individual states may have additional criteria for confidential business information and the submittal of both sanitized and unsanitized reports for EPCRA Section 313 chemicals and chemical categories. Facilities may jeopardize the trade secret status of an EPCRA Section 313 chemical or chemical category by submitting an unsanitized version to a state agency or tribal government that does not require an unsanitized version.

More information on trade secret claims, including contacts for individual state's submission requirements, can be found in the *TRI Forms and Instructions*.

2.11 Recordkeeping

Complete and accurate records are absolutely essential to meaningful compliance with EPCRA Section 313 reporting requirements. Compiling and maintaining good records will help you to reduce the effort and cost in preparing future reports, and to document how you arrived at the reported data in the event of U.S. EPA compliance audits. U.S. EPA requires you to maintain records substantiating each EPCRA Section 313 report submission for a minimum of three years. Each facility must keep copies of every EPCRA Section 313 report along with all supporting documents, calculations, work sheets, and other forms that you used to prepare the EPCRA Section 313 report. U.S. EPA may request this supporting documentation during a regulatory audit.

Specifically, U.S. EPA requires the following records be maintained for a period of three years from the date of the submission of a report (summarized from 40 CFR 372.10):

1) A copy of each EPCRA Section 313 report that is submitted.

2) All supporting materials and documentation used to make the compliance determination that the facility or establishment is a covered facility.

3) Documentation supporting the report submitted, including:

   - Claimed allowable exemptions,
   - Threshold determinations,
   - Calculations for each quantity reported as being released, either on or off site, or otherwise managed as waste,
   - Activity determinations, including dates of manufacturing, processing, or use,
   - The basis of all estimates,
   - Receipts or manifests associated with transfers of each EPCRA Section 313 chemical or chemical category in waste to off-site locations, and
   - Waste treatment methods, treatment efficiencies, ranges of influent concentrations to treatment, sequential nature of treatment steps, and operating data to support efficiency claims.

4) For facilities submitting a Form A, all supporting materials used to make the compliance determination that the facility or establishment is eligible to submit a Form A, including:

   - Data supporting the determination the alternate threshold applies,
   - Calculations of annual reportable amounts, and
   - Receipts or manifests associated with the transfer of each EPCRA Section 313 chemical or chemical category in waste to off-site locations, and
   - Waste treatment methods, treatment efficiencies, ranges of influent concentrations to treatment, sequential nature of treatment steps, and operating data to support efficiency claims.

Because EPCRA Section 313 reporting does not require additional testing or monitoring you must determine the best readily available source of information for all estimates. Some facilities may have detailed monitoring data and off-site transfer records that can be used for estimates while others may only have purchase and inventory records. Examples of records that you should keep, if applicable, might include:

- Each EPCRA Section 313 report submitted;
- EPCRA Section 313 Reporting Threshold Worksheets (sample worksheets can be found in Chapter 3 of this document as well as in the *TRI Forms and Instructions)*;

- EPCRA Section 313 Reporting Release and Other Waste Management Quantity Estimation Worksheets (sample worksheets can be found in Chapter 4 of this document);
- Engineering calculations and other notes;
- Formulation sheets;
- Purchase records from suppliers;
- Inventory data;
- Material Safety Data Sheets (MSDS);
- New Source Performance Standards (NSPS);
- National Pollutant Discharge Elimination System (NPDES)/State Pollutant Discharge Elimination System (SPDES) permits and monitoring reports;
- EPCRA Section 312, Tier II reports;
- Monitoring records;
- Air permits;
- Flow measurement data;
- Resource Conservation Recovery Act (RCRA) hazardous waste generator's reports;
- Pretreatment reports filed with local governments;
- Invoices from waste management firms;
- Manufacturer's estimates of treatment efficiencies;
- Comprehensive Environmental Response, Conservation, and Liability Act of 1980 (CERCLA) Reportable Quantity (RQ) reports;
- RCRA manifests; and
- Process flow diagrams (including emissions, releases, and other waste management activities).

CHAPTER 3 - EPCRA SECTION 313 CHEMICAL OR CHEMICAL CATEGORY ACTIVITY THRESHOLD DETERMINATIONS

3.0 PURPOSE

This chapter provides a step-by-step procedure for determining if any EPCRA Section 313 chemicals or chemical categories exceed a reporting threshold. Threshold determinations are essentially a three-step process:

Step 1)	Identify any EPCRA Section 313 chemicals and chemical categories you manufacture/import, process, or otherwise use.
Step 2)	Identify the activity category and any exempt activities for each EPCRA Section 313 chemical or chemical category.
Step 3)	Calculate the quantity of each EPCRA Section 313 chemical or chemical category and determine which ones exceed an activity threshold.

3.1 Step 1 - Identify Which EPCRA Section 313 Chemicals or Chemical Categories are Manufactured (Including Imported), Processed, or Otherwise Used

Compile lists of all chemicals and mixtures at your facility. For facilities with many different chemicals and mixtures it is often helpful to prepare two lists: one with the pure (single ingredient) chemicals (including chemical compounds) and one with the mixtures and trade name products. On the second list, under the name of each mixture/trade name product, write the names of all chemicals in that product. Next, compare the chemicals and chemical categories on both lists to the current EPCRA Section 313 chemicals and chemical categories list found in the *TRI Forms and Instructions* (remember that chemicals and chemical categories may be periodically added and deleted and you should use the current reporting year's instructions). Highlight the EPCRA Section 313 chemicals and chemical categories that are on your lists.

Review the lists to be sure each chemical and chemical category is shown by its correct EPCRA Section 313 name. For example, a common EPCRA Section 313 chemical found in rubber and plastics manufacturing operations is toluene. Toluene (Chemical Abstracts Service (CAS) Registry No. 108-88-3) has several synonyms including methylbenzene, methylbenzol, phenylmethane, and toluol. It must be reported on Form R (or Form A), Item 1.2, by its EPCRA Section 313 chemical name, toluene. Synonyms can be found in the U.S. EPA document *Common Synonyms for Chemicals Listed Under Section 313 of the Emergency Planning and Community Right-to-Know Act* (EPA 745-R-95-008).

While you must consider every chemical on the EPCRA Section 313 chemical and chemical category list, you should be aware of the chemicals and chemical categories typically used in rubber and plastics manufacturing. As a guide, the most frequently reported EPCRA Section 313 chemicals and chemical categories for reporting year 1995 by rubber and plastics manufacturing facilities, SIC Codes 301, 302, 305, 306, and 308, and the processes they are typically used in, are listed in Table 2-3.

COMMON ERROR - Vinyl Chloride

Vinyl chloride (CAS Registry No. 75-01-4) is an EPCRA Section 313 reportable chemical. Polyvinyl chloride is a polymer of vinyl chloride but it is NOT an EPCRA Section 313 reportable chemical. However, any unreacted vinyl chloride monomer mixed with the polymerized material, in excess of the 0.1% *de minimis* concentration, must be included in activity threshold determinations.

A computerized spreadsheet may be helpful in developing your facility's chemical and chemical category list and performing threshold calculations. The spreadsheet could show the chemical, chemical category, or chemical mixture with corresponding component concentrations; the yearly quantity manufactured, processed, or otherwise used; and the CAS Registry number. The spreadsheet could also be designed to identify the total quantity by activity category (amounts manufactured, processed, and otherwise used) for each EPCRA Section 313 chemical or chemical category in every mixture, compound, and trade name product.

An initial investment of time will be required to develop this spreadsheet; however, the time and effort saved in threshold calculations in subsequent years will be significant. Such a system will also reduce the potential of inadvertently overlooking EPCRA

Section 313 chemicals or chemical categories present in mixtures purchased from off-site sources.

To develop the chemical and chemical category list and the associated activity categories you may want to consult the following:

- Material Safety Data Sheets (MSDSs);
- Facility purchasing records;
- New Source Performance Standards (NSPS);
- Inventory records;
- Air and water discharge permits;
- Individual manufacturing/operating functions; and
- Receipts of manifests associated with the transfer of each EPCRA Section 313 chemical and chemical category in waste to off-site locations.

The following is suggested useful information needed to prepare your EPCRA Section 313 reports and should be included for each chemical and chemical category on your spreadsheet:

- The mixture name and associated EPCRA Section 313 chemical and chemical category names;
- The associated Chemical Abstract Service (CAS) Registry numbers;
- The trade name for mixtures and compounds;
- The throughput quantities; and
- Whether the chemical or chemical category is manufactured, processed, or otherwise used at the facility (be sure to include quantities that are coincidentally manufactured and imported, as appropriate).

MSDSs provide important information for the type and composition of chemicals and chemical categories in mixtures, and for determining whether you have purchased raw materials that contain EPCRA Section 313 chemicals and chemical categories. As of 1989, chemical suppliers to facilities in SIC Major Group Codes 20 through 39 are required to notify manufacturing customers of any EPCRA Section 313 chemicals and chemical categories present in mixtures or trade name products distributed to facilities. The notice must be provided to the receiving facility and may be attached or incorporated into that product's MSDS. If no MSDS is required, the notification must be in a letter that accompanies the first shipment of the product to your facility each year. This letter must contain the chemical name, CAS Registry number, and the weight or volume percent (or a range) of the EPCRA Section 313 chemical or chemical category in mixtures or trade name products.

Carefully review the entire MSDS. Although new MSDSs must list whether EPCRA Section 313 chemicals and chemical categories are present, the language and location of this notification is not currently standardized. Depending on the supplier, this information could be found in different sections of the MSDS. The most likely sections of an MSDS to provide information on EPCRA Section 313 chemicals and chemical categories are:

- Physical properties/chemical composition section;
- Regulatory section;
- Hazardous components section;
- Labeling section; and
- Additional information section.

Also, many EPCRA Section 313 chemicals or chemical categories are present as impurities in mixtures. These quantities must also be considered in threshold determinations unless the concentration is below the *de minimis* value (see Section 3.2.2.1).

COMMON ERROR - Mixture Components

Facilities often overlook EPCRA Section 313 chemicals that are present in small quantities of bulk solutions. For example, a common chemical used in rubber and plastics manufacturing is xylene. Xylene is often purchased in large quantities for use as a solvent, among other things. Most facilities correctly report for xylene; however, ethylbenzene is typically present at up to 15% in solutions of xylene commercially available. Many facilities have historically overlooked the ethylbenzene in their bulk xylene purchases.

Qualifiers

Several chemicals on the EPCRA Section 313 chemical and chemical category list include qualifiers related to use or form. Some chemicals are reportable ONLY if manufactured by a specified process or classified in a specified activity category. For example, isopropyl alcohol is only reportable if it is manufactured using the strong acid process and saccharin is reportable only if it is manufactured. Some other chemicals are only reportable if present in certain forms. For example, only yellow or white phosphorus is reportable, while black or red phosphorus is not reportable.

The qualifiers and associated chemicals and chemical categories are presented below. Please make special note of the discussion pertaining to vanadium and vanadium compounds.

- **Aluminum oxide (fibrous)** - Aluminum oxide is only subject to threshold determination and release and other waste management calculations when it is handled in fibrous forms. U.S. EPA has characterized fibrous aluminum oxide for purposes of EPCRA Section 313 reporting as a man-made fiber commonly used in high-temperature insulation applications such as furnace linings, filtration, gaskets, joints, and seals.

- **Ammonia** - (includes anhydrous ammonia and aqueous ammonia from water dissociable ammonium salts and other sources) On June 26, 1995, U.S. EPA qualified the listing for ammonia (CAS Registry No. 7664-41-7) and deleted ammonium sulfate (solution) (CAS Registry No. 7783-20-2) from the EPCRA Section 313 chemical list. Both the qualification and the deletion were effective as of reporting year 1994. The qualifier for ammonia means that anhydrous forms of ammonia are 100% reportable while only 10% of the total aqueous ammonia is reportable. Any evaporation of ammonia from aqueous ammonia solutions is considered anhydrous ammonia. This qualifier applies to both activity threshold determinations and release and other waste management calculations. Note that while ammonium sulfate is no longer an EPCRA Section 313 chemical, 10% of the aqueous ammonia formed from the dissociation of ammonium sulfate (and all other ammonium salts) is reportable, and must be included in both activity threshold determinations and release and other waste management calculations. Additionally, any ammonium nitrate must also be included in the threshold determination and the nitrate portion included in the release and other waste management calculations, for the nitrate compounds category. U.S. EPA has published guidance on reporting for ammonia and ammonium salts in *Emergency Planning and Community Right-to-Know, EPCRA Section 313, Guidance for Reporting Aqueous Ammonia,* EPA 745-R-95-012 (see Appendix D).

- **Asbestos (friable)** - Asbestos only needs to be considered when it is handled in the friable form. Friable refers to the physical characteristics of being able to crumble, pulverize, or reduce to a powder with hand pressure. Please refer to *EPCRA Section 313 Questions and Answers, Revised 1998 Version* (EPA 745-B-98-004) for more information on asbestos, if applicable.

- **Fume or dust** - Two metals (aluminum and zinc) are qualified with “fume or dust.” This definition excludes “wet” forms such as solutions or slurries, but includes powder, particulate, or gaseous forms of these metals. There is no particle size limitation for particulates. For example, use of zinc metal as a paint component is not subject to reporting unless the zinc is in the form of a fume or dust. However, even though elemental zinc is reportable only in the fume or dust form, all forms of zinc compounds are reportable. Note that the entire weight of all zinc compounds should be included in the threshold determination for zinc compounds, while only the metal portion of metal compounds is reported in the release and other waste management amounts. Prior to reporting year 2000, vanadium was also qualified with "fume or dust." As of reporting year 2000 the qualifier has been removed for vanadium such that all physical forms are now reportable unless the vanadium is contained in an alloy. Please see the discussion on vanadium and vanadium compounds below, if applicable.

- **Hydrochloric acid (acid aerosols)** - On July 25, 1996, U.S. EPA promulgated a final rule delisting non-aerosol forms of hydrochloric acid (CAS Registry No. 7647-01-0) from the EPCRA Section 313 chemical list (effective for the 1995 reporting year). Therefore, threshold determinations and release and other waste management estimates now apply only to the aerosol forms. Under EPCRA Section 313, the term aerosol covers any generation of airborne acid (including mists, vapors, gas, or fog) without any particle size limitation. Therefore, any process that sprays hydrochloric acid "manufactures" hydrochloric acid aerosol and should include this quantity in the manufacturing threshold determination.

- **Manufacturing qualifiers** - Two chemicals, saccharin and isopropyl alcohol, contain qualifiers relating to manufacture. The qualifier for saccharin means that only manufacturers of the chemical are subject to the reporting requirement. The qualifier for isopropyl alcohol means that only facilities that manufacture the chemical by the strong acid process are required to report. Facilities that only process or otherwise use these chemicals are not required to report. Thus, a facility that uses isopropyl alcohol as a solvent should not report for isopropyl alcohol.

- **Nitrate Compounds (water dissociable; reportable only in aqueous solution)** - A nitrate compound is covered by this listing only when in water and if water dissociable. Although the complete weight of the nitrate compound must be used for threshold determinations for the nitrate compounds category, only the nitrate portion of the compound must be considered for release and other waste management calculations. One issue recently raised by industry is how to report nitrate compounds in wastewater and sludge that is applied to farms as a nitrogen source (either on site or off site). Although during such use, nitrate compounds may be taken up by plants and cycled back into the ecosystem, U.S. EPA considers the nitrate compounds in wastewater/sludge to be managed as waste. In this scenario, nitrate compounds should be reported as being disposed to land (either on site or off site as appropriate). U.S. EPA has published guidance for these chemicals in *List of Toxic Chemicals Within* *the Water Dissociable Nitrate Compounds Category and Guidance for Reporting*, EPA 745-R-96-004 (see Appendix C).

- **Phosphorus (yellow or white)** - Only manufacturing, processing, or otherwise use of phosphorus in the yellow or white chemical forms require reporting. Black and red phosphorus are not subject to EPCRA Section 313 reporting.

- **Sulfuric acid (acid aerosols)** - On June 26, 1995, U.S. EPA promulgated a final rule delisting non-aerosol forms of sulfuric acid (CAS Registry No. 7664-93-9) from the EPCRA Section 313 toxic chemical list (effective for the 1994 reporting year). Therefore, threshold determinations and release and other waste management estimates now apply only to the aerosol forms. Under EPCRA Section 313, the term aerosol covers any generation of airborne acid (including mists, vapors, gas, or fog) without any particle size limitation. Therefore, any process that sprays sulfuric acid "manufactures" sulfuric acid aerosol and should include this quantity in the manufacturing threshold determination. U.S. EPA has published guidance for acid aerosols in *Guidance for Reporting Sulfuric Acid*, EPA 745-R-97-007.

- **Vanadium and vanadium compounds** - Note that prior to reporting year 2000 (December 31, 1999 for EPCRA Section 313 reports that must be filed by July 1, 2001), the fume or dust qualifier also applied to vanadium. As of December 31, 1999, U.S. EPA removed this qualifier for vanadium for reporting year 2000 and beyond. Concurrently, U.S. EPA exempted all physical forms of metallic vanadium that are present in alloys. Therefore, vanadium that is present in any physical forms of alloys should not be considered for EPCRA Section 313 reporting. However, if vanadium is separated from the alloy, all physical forms of the vanadium are considered to be manufactured and the quantity manufactured should be applied to the 25,000-pound manufacturing threshold. If the vanadium is subsequently processed or otherwise used, the applicable quantity should also be applied to the processing or otherwise use threshold(s). If a threshold is exceeded, all quantities released or otherwise managed as waste must be reported as appropriate.

  Concurrent with this rulemaking, U.S. EPA also added vanadium compounds to the list of toxic chemicals subject to reporting under EPCRA Section 313. U.S. EPA specifically excluded vanadium compounds from the fume or dust qualifier and from the alloy exemption. Therefore, all physical forms of vanadium compounds must be included in threshold determinations and release and other waste management activities estimates.

3.2 Step 2. Identify the Activity Category and Any Exempt Activities for Each EPCRA Section 313 Chemical and Chemical Category

The next step is to determine the activity category (or categories) and any exempt activities for each EPCRA Section 313 chemical and chemical category on your list. Table 3-1 lists the reporting thresholds for each of these activity categories (Tables 3-2 through 3-4 provide detailed definitions of subcategories for each activity category). Each threshold must be individually calculated; they are mutually exclusive and are not additive.

Table 3-1

Reporting Thresholds

Activity Category	Threshold[2]
Manufacturing (including importing)	25,000 pounds per year
Processing	25,000 pounds per year
Otherwise Used	10,000 pounds per year

[2] These reporting thresholds are for non-PBT chemicals. See Section 2.6 for the activity thresholds applicable to PBT chemicals.

Example -Threshold Determination

If your facility manufactures 22,000 pounds of an EPCRA Section 313 chemical and you also otherwise use 8,000 pounds of the same chemical, you have not exceeded either threshold and an EPCRA Section 313 report for that chemical is not required. However, if your facility manufactures 28,000 pounds per year of an EPCRA Section 313 chemical and otherwise uses 8,000 pounds of the same chemical, you have exceeded the manufacturing threshold and ALL release and other waste management quantities (except those specifically exempted) of that chemical must be reported on the Form R, including those from the otherwise use activity.

Each of the activity categories is divided into subcategories. As discussed in the *TRI Forms and Instructions*, you are required to designate EACH category and subcategory that applies to your facility. Detailed definitions, including descriptions of subcategories for each activity and examples, are presented in Tables 3-2, 3-3, and 3-4.

Table 3-2

Definitions and Examples of Manufacturing Subcategories

Manufacturing Activity Subcategory	Definition	Examples in Rubber and Plastics Manufacturing*
Produced or imported for on-site use/processing	A chemical or chemical category that is produced or imported and then further processed or otherwise used at the same facility.	Import of monomers or additives for rubber/plastic manufacturing
Produced or imported for sale/distribution	A chemical or chemical category that is produced or imported specifically for sale or distribution outside the manufacturing facility.	
Produced as a byproduct	A chemical or chemical category that is produced coincidentally during the production, processing, or otherwise use of another chemical substance or a mixture and is separated from that substance or mixture. EPCRA Section 313 chemicals or chemical categories produced and released as a result of waste treatment or disposal are also considered byproducts.	Chemicals coincidentally manufactured during vulcanization (e.g., carbon disulfide) Generation of sulfuric acid and hydrochloric acid aerosols
Produced as an impurity	A chemical or chemical category that is produced coincidentally as a result of the manufacture, processing, or otherwise use of another chemical and remains primarily in the mixture or product with that other chemical.	

* More complete discussions of the industry-specific examples can be found in Chapter 4 of this guidance manual.

COMMON ERROR - Overlooking Coincidental Manufacturing

Twenty-three facilities in SIC Major Group 30 were surveyed for *The 1994 and 1995 Toxic Release Inventory Data Quality Report*, EPA 745-R-98-002. The activity classification for EPCRA Section 313 chemicals by these facilities was almost evenly split between processing and otherwise used with no manufacturing of EPCRA Section 313 chemicals reported. However, facilities that burn large amounts of fossil fuels should be careful to not overlook the coincidental manufacturing of combustion products such as polycyclic aromatic hydrocarbons, sulfuric acid aerosols, and metal compounds that may result from such activities.

Table 3-3

Definitions and Examples of Processing Subcategories

Processing Activity Subcategory	Definition	Examples in Rubber and Plastics Manufacturing*
Reactant	A natural or synthetic chemical or chemical category used in chemical reactions for the manufacture of another chemical substance or product. Examples include feedstocks, raw materials, intermediates, and initiators.	Initiators and Accelerators:
Formulation component	A chemical or chemical category that is added to a product or product mixture prior to further distribution of the product and acts as a performance enhancer during use of the product. Examples include additives, dyes, reaction diluents, initiators, solvents, inhibitors, emulsifiers, surfactants, lubricants, flame retardants, and rheological modifiers.	Initiators: Monomers: styrene, ethylene glycol, 1-3-butadiene Flame Retardants: antimony oxide
Article component	A chemical or chemical category that becomes an integral component of an article distributed for industrial, trade, or consumer use.	Heat Stabilizers: zinc, lead, barium-cadmium compounds
Repackaging only	A chemical or chemical category that is processed or prepared for distribution in commerce in a different form, state, or quantity. May include, but is not limited to, the transfer of material from a bulk container, such as a tank truck, to smaller containers such as cans or bottles.	Preparation of repair kits for conveyor belts

* More complete discussions of the industry-specific examples can be found in Chapter 4 of this guidance manual.

Example - Packing Foam

A manufacturing facility, which meets the SIC Code and equivalent number of employees criteria for EPCRA Section 313 reporting, buys methylene bis(phenylisocyanate) (MDI) (CAS Registry No. 101-68-8), a member of the EPCRA Section 313 diisocyanates chemical category, to use as an ingredient in making packing foam. The MDI is blown into a foam and used as packing material in shipping containers to protect delicate items from damage during transportation from the manufacturing facility to the customers. The amount of MDI used for this purpose must be included in the processing threshold determination as it is incorporated into a product that is distributed in commerce.

Example - Chemical Mixtures

A tennis ball manufacturer, SIC Code 3949, purchases natural and synthetic rubber in slabs and adds chemicals to achieve the desired properties. The purchased rubber is considered to be a mixture for EPCRA Section 313 reporting and any EPCRA Section 313 chemicals in the rubber mixture must be included in the processing threshold determination, providing their concentrations are above the *de minimis* concentration limits. The amount of any such chemicals can be estimated by multiplying the weight percent of the chemical by the total weight of the rubber mixture. Likewise, any EPCRA Section 313 chemicals added on site must be included in the processing activity threshold determination.

Table 3-4

Definitions and Examples of Otherwise Use Subcategories

Otherwise Use Activity Subcategory	Definition	Examples in Rubber and Plastics Manufacturing*
Chemical processing aid	A chemical or chemical category that is added to a reaction mixture to aid in the manufacture or synthesis of another chemical substance but is not intended to remain in or become part of the product or product mixture. Examples include process solvents, catalysts, inhibitors, initiators, reaction terminators, and solution buffers.	Catalysts: cobalt compounds, nickel compounds Solvents: n-hexane, toluene, cyclohexane Product Cleaning Agents: phenol
Manufacturing aid	A chemical or chemical category that aids the manufacturing process but does not become part of the resulting product and is not added to the reaction mixture during the manufacture or synthesis of another chemical substance. Examples include process lubricants, metalworking fluids, coolants, refrigerants, and hydraulic fluids.	Glycol ethers, hexane
Ancillary or other use	A chemical or chemical category that is used for purposes other than aiding chemical processing or manufacturing. Examples include cleaners, degreasers, lubricants, fuels (including waste fuels), and chemicals used for treating wastes.	Glycol ethers

* More complete discussions of the industry-specific examples can be found in Chapter 4 of this guidance manual.

Example - Chemical Processing Aid

A plastics parts manufacturing facility performs spray painting using toluene as the carrier solvent. Ideally all the solvent would evaporate; however, studies have shown 1% of the applied solvent remains on the product. Since the function of the solvent is to improve the application of the paint and is a non-incorporative activity, the entire amount of toluene is considered otherwise used. If the solvent's function was such that it was intended to remain with the product, it would be considered processed, as is the case for pigments, binders, and other paint components intended to remain with the product.

3.2.1 Concentration Ranges for Threshold Determination

You should use the best readily available information or where such data are not available, reasonable estimates, for all calculations in EPCRA Section 313 reporting; however, the exact concentration of an EPCRA Section 313 chemical or chemical category in a mixture or trade name product may not be known. The supplier or MSDS may only list ranges, or upper or lower bound concentrations. U.S. EPA has developed guidance on how to use information in this situation for threshold determinations.

- If the concentration is provided as a lower and upper bound or as a range, you should use the mid-point in your calculations for the threshold determination. For example, the MSDS for the trade name product states methanol is present in a concentration of not less than 20% and not more than 40%, or it may be stated as present at a concentration between 20 to 40%. You should use the mid-point value of 30% methanol in your threshold calculations.

- If only the lower bound concentration of the EPCRA Section 313 chemical or chemical category is specified and the concentration of other components are given, subtract the other component values from 100%. The remainder should be considered the upper bound for the EPCRA Section 313 chemical or chemical category and you should use the given lower bound to calculate the mid-point as discussed above. For example, the MSDS states that a solvent contains at least 50% methyl ethyl ketone (MEK) and 20% non-hazardous surfactants. Subtracting the non-hazardous contents from 100% leaves 80% as the upper bound for MEK. The mid-point between upper (80%) and lower (50%) bounds is 65%, the value you should use in your threshold calculation.

- If only the lower bound is specified and no information on other components is given, you should assume the upper bound is 100% and calculate the mid-point as above.

- If only the upper bound concentration is provided, you should use this value in your threshold calculation.

Special guidance for concentration ranges that straddle the *de minimis* value is presented in Section 3.2.2.1.

3.2.2 Evaluation of Exemptions

When determining thresholds, you can exclude quantities of any EPCRA Section 313 chemicals and chemical categories that are manufactured, processed, or otherwise used in exempt activities. Exemptions are divided into four classes:

1. *De minimis* exemption;
2. Article exemption;
3. Facility-related exemption; and
4. Activity-related exemptions.

COMMON ERROR - Exempt Activities

If an EPCRA Section 313 chemical or chemical category is used in exempt activities, the quantity used in these activities does not need to be included in your threshold determinations or release and other waste management calculations, even if the chemical or chemical category is used in a reportable activity elsewhere in the facility.

3.2.2.1 *De Minimis* Exemption

If the amount of EPCRA Section 313 chemical(s) or chemical categories present in a mixture or trade name product processed or otherwise used is below its *de minimis* concentration level, that amount is considered to be exempt from threshold determinations and release and other waste management calculations. Note that this exemption does not apply to manufacturing, except for importation or as an impurity as discussed below. Also note that the *de minimis* exemption does not apply to the manufacturing, processing, or otherwise use of the PBT chemicals (refer to Section 2.6). The *de minimis* concentration for EPCRA Section 313 chemicals and chemical categories is 1%, except for Occupational Safety and Health Administration (OSHA)-defined carcinogens, which have a 0.1% *de minimis* concentration. Note that if a mixture contains more than one member of an EPCRA Section 313 chemical category, the weight percent of all members must be summed. If the total meets or exceeds the category's *de minimis* level, the *de minimis* exemption does not apply. U.S. EPA has published several detailed questions and answers and a directive in the current edition of *EPCRA Section 313, Questions and Answers* (Appendix A, Directive #2 in 1998 edition (EPA 745-B-98-004)) that may be helpful if you have additional concerns about the *de minimis* exemption. The *TRI*

Forms and Instructions list each EPCRA Section 313 chemical and chemical category with the associated *de minimis* value.

Once the *de minimis* level has been equaled or exceeded, the exemption no longer applies to that process stream, even if the EPCRA Section 313 chemical or chemical category later falls below the *de minimis* concentration. All release and other waste management activities that occur after the *de minimis* concentration has been equaled or exceeded are subject to reporting. The facility does not have to report release and other waste management activities that took place before the *de minimis* concentration was equaled or exceeded.

Example - *De Minimis*

Your facility uses a mixture containing 1.1% nitric acid and 0.6% manganese. The *de minimis* exemption would apply to manganese because the concentration is below 1% which is the *de minimis* level for manganese; however, it would not apply to nitric acid. All of the nitric acid must be included in threshold determinations, release, and other waste management calculations.

The *de minimis* exemption also applies to EPCRA Section 313 chemicals and chemical categories that are coincidentally manufactured below the *de minimis* level only if that chemical is manufactured as an impurity in a mixture that is subsequently distributed in commerce. In addition, the exemption applies to EPCRA Section 313 chemicals and chemical categories below the *de minimis* concentration in an imported mixture or trade name product.

For some mixtures the concentration of EPCRA Section 313 chemicals and chemical categories may be available only as a range. U.S. EPA has developed guidance on how to determine quantities applicable to threshold determinations and release and other waste management calculations when this range straddles the *de minimis* value. In general, only the quantity of the processed or otherwise used EPCRA Section 313 chemical or chemical category whose concentration exceeds the *de minimis* must be considered. Therefore, U.S. EPA allows facilities to estimate the quantity below the *de minimis* and exclude it from further consideration. The following examples illustrate this point.

Examples - *De Minimis* Concentration Ranges

Example 1:

A facility processes 8,000,000 pounds of a mixture containing 0.25 to 1.25% manganese. Manganese is subject to a 1% *de minimis* concentration exemption. The amount of mixture subject to reporting is the quantity containing manganese above the *de minimis* concentration:

$$(8{,}000{,}000) \times (0.0125 - 0.0099) \div (0.0125 - 0.0025)$$

The average concentration of manganese that is not exempt (above the *de minimis)* is:

$$(0.0125 + 0.01) \div (2)$$

Therefore, the amount of manganese that is subject to threshold determination and release and other waste management estimates is:

$$\left[\frac{(8{,}000{,}000)\ \times\ (0.0125 - 0.0099)}{(0.0125 - 0.0025)}\right] \times \left[\frac{(0.0125 + 0.01)}{(2)}\right] = 23{,}400\ \text{pounds}$$

= 23,400 pounds manganese (which is below the processing threshold)

In this example, because the facility's information pertaining to manganese was available to two decimal places, 0.99 was used to determine the amount below the *de minimis* concentrations. If the information was available to one decimal place, 0.9 should be used, as in Example 2 below.

Example 2:

As in Example 1, manganese is present in a mixture, of which 8,000,000 pounds is processed. The MSDS states the mixture contains 0.2% to 1.2% manganese. The amount of mixture subject to reporting (above *de minimis*) is:

$$(8{,}000{,}000) \times (0.012 - 0.009) \div (0.012 - 0.002)$$

The average concentration of manganese that is not exempt (above *de minimis*) is:

$$(0.012 + 0.01) \div (2)$$

Therefore, the amount of manganese that is subject to threshold determinations and release and other waste management estimates is:

$$\left[\frac{(8{,}000{,}000)\ \times\ (0.012 - 0.009)}{(0.012 - 0.002)}\right] \times \left[\frac{(0.012 + 0.01)}{(2)}\right] = 26{,}400\ \text{pounds}$$

= 26,400 pounds manganese (which is above the processing threshold)

The exemption does not apply to EPCRA Section 313 chemicals and chemical categories coincidentally manufactured as byproducts and separated from the product, nor does it apply to EPCRA Section 313 chemicals and chemical categories coincidentally manufactured as a result of waste management activities, from either on site or off site (under EPCRA Section 313, U.S. EPA does not consider waste to be a mixture). For example, facilities that perform biological waste treatment of process wastewaters may be generating ammonia. The ammonia would be considered to be coincidentally manufactured as part of the waste treatment process and the *de minimis* exemption does not apply. Thus, 10% of the aqueous ammonia created should be counted toward the 25,000-pound manufacturing threshold.

3.2.2.2 Articles Exemption

An article is defined as a manufactured item that:

- Is formed to a specific shape or design during manufacture;
- Has end-use functions dependent in whole or in part upon its shape or design; and
- Does not release an EPCRA Section 313 chemical or chemical category under normal conditions of processing or otherwise use of the item at the facility.

If you receive a manufactured article from another facility or you produce the article in your facility and process or otherwise use it without changing the shape or design, and your processing or otherwise use does not result in the release into the environment of more than 0.5 pound of the EPCRA Section 313 chemical or chemical category in a reporting year for all like articles, then the EPCRA Section 313 chemical or chemical category in that article is exempt from threshold determinations and release and other waste management calculations (U.S. EPA allows a release of 0.5 pound or less to be rounded to zero; the 0.5-pound limit does not apply to each individual article, but applies to the sum of all releases from processing or use of all like articles). Section 313 chemicals or chemical categories used to produce an article, however, do not qualify for the article exemption.

The shape and design can be changed somewhat during processing and otherwise use as long as part of the item retains the original dimensions. That is, as a result of processing or otherwise use, if an item retains its initial thickness or diameter, in whole or in part, then it still meets the article definition. If the item's original dimensional characteristics are totally altered during processing or otherwise use, the item would not meet the definition. As an example, items that do not meet the definition would be items that are cold extruded, such as lead ingots formed into wire or rods. However, cutting a manufactured item into pieces that are recognizable as the article would not change the exemption status as long as the diameter and the thickness of the item remain unchanged. For instance, metal wire may be bent and sheet metal may be cut, punched, stamped, or pressed without losing the article status as long as no change is made in the diameter of the wire or tubing or the thickness of the sheet and no releases above 0.5 pound per year occur for all like articles.

Any processing or otherwise use of an article that results in a release above 0.5 pound per year for each EPCRA Section 313 chemical or chemical category for all like articles also negates the exemption. Cutting, grinding, melting, or other processing of a manufactured item could result in a release of an EPCRA Section 313 chemical or chemical category during normal conditions of use and, therefore, could negate the article exemption if the total annual releases from all like articles exceed 0.5 pound in a year. However, if all of the resulting waste is recycled or reused either on site or off site, so that the release of the EPCRA Section 313 chemical or chemical category does not exceed 0.5 pound for the calendar year, then the article's exemption status is maintained. If the processing or otherwise use of similar manufactured items results in a total release of less than or equal to 0.5 pound of any individual EPCRA Section 313 chemical or chemical category to any environmental media in a calendar year, U.S. EPA will allow this quantity to be rounded to zero and the manufactured items maintain their article status. The 0.5-pound limit does not apply to each individual article, but applies to the sum of all releases from processing or otherwise use of like articles for each EPCRA Section 313 chemical or chemical category. The current edition of *EPCRA Section 313 Questions and Answers* (1998 edition is EPA 745-B-98-004) presents several specific question and answers/discussions pertaining to the articles exemption.

COMMON ERROR - Articles Exemption

A covered manufacturer makes plastic bottles by blow molding a mixture of plastic resin and polymer pellets that contain lead chromate, an EPCRA Section 313 listed chemical category for both lead compounds and chromium compounds. After the plastic bottles are made, they are given a quality assurance check. Bottles that do not pass the quality check are discarded in the facility trash for ultimate disposal in the local municipal landfill, a RCRA Subtitle C landfill. The Article Exemption under EPCRA Section 313 does NOT include the manufacture of articles such as these bottles, it only applies to processing or otherwise use of such articles. Thus, the lead chromate sent to the landfill would be considered a release of both a lead compound and a chromate compound, and reported in Part II, Section 5.5.1A, providing the 25,000 pound per year processing activity thresholds for these compounds have been exceeded by the facility.

3.2.2.3 Facility-Related Exemption

Laboratory Activity Exemption

EPCRA Section 313 chemicals or chemical categories that are manufactured, processed, or otherwise used in laboratories under the supervision of a technically qualified individual are exempted from the threshold determination (and subsequent release and other waste management calculations). This exemption may be applicable in circumstances such as laboratory sampling and analysis, research and development, and quality assurance and quality control activities. It does not include pilot plant scale or specialty chemical production.

Example - Laboratory Activity Exemption

A plastic products manufacturing facility has a research laboratory that applies various formulations of organic coatings containing EPCRA Section 313 chemicals and chemical categories to product samples for testing for a toy manufacturer. The testing is under the supervision of a technically qualified individual in the laboratory. The EPCRA Section 313 chemicals and chemical categories used in this activity would be exempt from EPCRA Section 313 reporting and should not be included in any threshold determination or release and other waste management calculations.

3.2.2.4 Activity-Related Exemptions (Otherwise Use Exemptions)

Some exemptions apply to the otherwise use of an EPCRA Section 313 chemical and chemical category. The specific quantities of EPCRA Section 313 chemicals and chemical categories used in these activities do not need to be included in facility threshold determinations (nor the associated release and other waste management calculations). The following otherwise use activities are considered exempt:

- **EPCRA Section 313 chemicals and chemical categories used in routine janitorial or facility grounds maintenance**. Examples are bathroom cleaners, fertilizers, and garden pesticides similar in type or concentration to consumer products. Materials used to clean process equipment do not meet this exemption.

- **Personal use of items**. Examples are foods, drugs, cosmetics, and other personal items including those items within a facility operated cafeteria, store, or infirmary. Office supplies such as correction fluid are also exempt.

- **Structural components of the facility**. Exemptions apply to EPCRA Section 313 chemicals and chemical categories present in materials used to construct, repair, or maintain structural components of a facility. An example common to all facilities would be the solvents and pigments used to paint the buildings. Materials used to construct, repair, or maintain process equipment are not exempt.

- **EPCRA Section 313 chemicals and chemical categories used with facility motor vehicles**. This exemption includes the use of EPCRA Section 313 chemicals and chemical categories for the purpose of maintaining motor vehicles operated by the facility. Common examples include gasoline, radiator coolant, windshield wiper fluid, brake and transmission fluid, oils and lubricants, cleaning solutions, and solvents in paint used to touch up the vehicle. Motor vehicles include, but may not be limited to, cars, trucks, forklifts, locomotives, and aircraft. Note that this exemption applies to the OTHERWISE USE of EPCRA Section 313 chemicals and chemical categories. The coincidental manufacture of EPCRA Section 313 chemicals and chemical categories resulting from combustion of gasoline is not exempt and should be considered toward the manufacturing threshold.

Example - Motor Vehicle Exemption

Methanol is purchased for use as a processing aid and as a windshield washer anti-freeze in company vehicles. Only the amount used as a processing aid would be used in facility threshold calculations. Even if the facility still exceeds the otherwise use threshold, the amount in the anti-freeze is exempt from release and other waste management calculations.

This exemption does NOT apply to stationary process equipment. The use of lubricants and fuels for stationary process equipment (e.g., pumps and compressors) and stationary energy sources (e.g., furnaces, boilers, heaters), are NOT exempt.

Example - Process Equipment Chemical Use

Lubricants containing EPCRA Section 313 chemicals and chemical categories used on facility vehicles or on-site structural maintenance activities that are not integral to the process are exempt activities. However, lubricants used to maintain pumps and compressors that aid facility process operations are not exempt and the amount of the EPCRA Section 313 chemical or chemical category in the lubricant should be applied to the otherwise use threshold.

- **EPCRA Section 313 chemicals and chemical categories in certain air or water drawn from the environment or municipal sources**. Included are an exemption for EPCRA Section 313 chemicals and chemical categories present in process water and non-contact cooling water drawn from the environment or a municipal source, or chemicals and chemical categories present in air used either as compressed air or as an oxygen source for combustion.

Example - Chemicals in Process Water

A facility uses river water for one of its processes. This water contains approximately 100 pounds of an EPCRA Section 313 chemical or chemical category. The facility ultimately returns the water that contains the entire 100 pounds of the EPCRA Section 313 chemical or chemical category to the river. The EPCRA Section 313 chemical or chemical category in the water can be considered exempt because the EPCRA Section 313 chemical or chemical category was present as it was drawn from the environment. The facility does not need to consider the EPCRA Section 313 chemical or chemical category drawn with river water for threshold determinations or release and other waste management calculations.

3.2.3 Additional Guidance on Threshold Calculations for Certain Activities

This section covers three specific situations in which the threshold determination may vary from normal facility operations: reuse, remediation, and recycling activities of EPCRA Section 313 chemicals and chemical categories.

3.2.3.1 Reuse Activities

Threshold determinations of EPCRA Section 313 chemicals or chemical categories that are reused at the facility are based only on the amount of the EPCRA Section 313 chemical or chemical category that is added to the system during the year, not the total volume in the system. For example, a facility operates a refrigeration unit that contains 15,000 pounds of anhydrous ammonia at the beginning of the year. The system is charged with 2,000 pounds of anhydrous ammonia during the year. The facility has therefore otherwise used only 2,000 pounds of the EPCRA Section 313 chemical or chemical category and is not required to report (unless the facility has additional otherwise use activities of ammonia that, when taken together, exceed the reporting threshold). If, however, the whole refrigeration unit was recharged with 15,000 pounds of anhydrous ammonia during the year, the facility would exceed the otherwise use threshold, and be required to report.

COMMON ERROR - Threshold Determination, Recirculation

Facilities often incorrectly base threshold calculations on the amount of EPCRA Section 313 chemicals in a recirculation system rather than the amount actually used in the reporting year. The amount of the EPCRA Section 313 chemical that is actually manufactured (including the quantity imported), processed, or otherwise used, not the amount in storage or in the system, should be the amount applied to the threshold determination. For example, a solvent containing an EPCRA Section 313 chemical is used, recirculated on site, and reused as a solvent. The amount of EPCRA Section 313 chemical recirculated in the on-site recycling process is not considered in the threshold determination because it is considered a direct reuse and is not reportable. Only the amount of new chemical added to the system should be included in the otherwise used threshold calculation. However, if you send a solvent containing an EPCRA Section 313 chemical off site for distillation and subsequent recycling, it should be reported as a transfer to an off-site location for recycling (Form R, Part II, Section 6.2 and 8.5) because the distillation is considered a waste management activity. The amount of solvent returned to you and subsequently used in the same reporting year must be included in the threshold determination. If the reporting threshold is exceeded, the total quantity recycled should be reported in Section 8.4; i.e., the amount recycled must be reported in Section 8.4 each time it is recycled.

3.2.3.2 Remediation Activities

EPCRA Section 313 chemicals and chemical categories undergoing remediation (e.g., Superfund remediation) are not being manufactured, processed, or otherwise used. Therefore, they are not included in the threshold determinations.

However, if you are conducting remediation of an EPCRA Section 313 chemical or chemical category that is also being manufactured, processed, or otherwise used by the facility above an activity threshold level, you must consider this activity for release and other waste management calculations. You must report any release or other waste management quantities of an EPCRA Section 313 chemical or chemical category due to remediation in Part II, Sections 5 through 8, accordingly, of the 1999 Form R. Those quantities would also be considered as part of the amount for determining Form A eligibility. EPCRA Section 313 chemicals and chemical categories used for remediation should be considered toward threshold determinations. If an EPCRA Section 313 chemical or chemical category exceeds one of the reporting thresholds elsewhere at the facility, all release and other waste management activity quantities of that chemical or chemical category must be reported, including release and other waste management activity quantities resulting from remediation.

Excavation (that is considered part of the remedial action) of material already landfilled does not constitute a manufacturing, processing, or otherwise use activity. However, routine activities (e.g., dredging a lagoon), even if not performed every year, are not considered to be remedial actions and are always subject to reporting.

3.2.3.3 Recycling Activities

For on-site recycling and reuse systems where the same EPCRA Section 313 chemical or chemical category is recycled and reused multiple times, the quantity recycled or reused should be counted only once (at the time it is introduced into the system) for threshold calculations. (Please note that for reporting on-site waste management activities the quantity of the EPCRA Section 313 chemical or chemical category should be counted every time it exits the recycling unit in Section 8 of the Form R) EPCRA Section 313 chemicals and chemical categories recycled off site and returned to the facility should be treated as newly purchased materials for purposes of EPCRA Section 313 threshold determinations.

3.3 Step 3. Calculate the Quantity of Each EPCRA Section 313 Chemical and Chemical Category and Determine Which Ones Exceed an Activity Threshold

The final step is to determine the quantity and which EPCRA Section 313 chemicals and chemical categories exceed an activity threshold. At this point you should have:

1. Identified each EPCRA Section 313 chemical and chemical category at your facility.
2. Determined the activity category for each EPCRA Section 313 chemical and chemical category (manufactured, processed, or otherwise used).

Now, you must sum the amount for each EPCRA Section 313 chemical and chemical category by activity category, subtract all exempt quantities, and compare the totals to the applicable thresholds. Each EPCRA Section 313 chemical and chemical category exceeding **any one** of the activity thresholds requires the submission of an EPCRA Section 313 report. Provided you meet certain criteria you may prepare a Form A rather than a Form R (see Section 2.8).

COMMON ERROR - Assuming a Threshold is Exceeded.

U.S. EPA recently published a report, *The 1994 and 1995 Toxic Release Inventory Data Quality Report*, EPA 745-R-98-002, with the site survey results of over 100 facilities (including rubber and plastic manufacturing facilities) to evaluate EPCRA Section 313 reporting quality. One of the findings of this survey was that facilities which simply assumed that chemical activity thresholds were exceeded were often in error. This resulted in many of these facilities filing EPCRA Section 313 reports when thresholds were actually not exceeded. Unless the facility has strong grounds to support such an assumption, the time spent in explicitly calculating the activity threshold is well spent.

COMMON ERROR - Zero Release and Other Waste Management Quantities

If you meet all reporting criteria and exceed any activity threshold for an EPCRA Section 313 chemical, you must file an EPCRA Section 313 report for that chemical, even if you have zero release and other waste management activity quantities. Exceeding the chemical activity threshold, not the quantity released and otherwise managed as waste determines whether you must report. Note that if the release and other waste management activity quantity is 500 pounds or less for each chemical or chemical category you may be eligible to use the alternate certification statement, Form A, rather than a Form R (see Section 2.9).

To determine if an EPCRA Section 313 chemical or chemical category exceeds a reporting threshold, you must calculate the annual activity amount of that chemical or chemical category. Start with the amount of chemical at the facility as of January 1, add any amounts brought on site during the year and the amount manufactured (including imported), and subtract the amount left in the inventory on December 31. If necessary, adjust the total to account for exempt activities (see Section 3.2.2 for a discussion of exemptions). You should then compare the result to the appropriate threshold to determine if you are required to submit an EPCRA Section 313 report for that chemical or chemical category. Keep in mind that the threshold calculations are independent for each activity category: manufactured, processed, and otherwise used. If more than one activity category applies, the amount associated with each category is determined separately.

Example - Xylene Isomers

Rubber and plastics manufacturers use large amounts of xylene, with the mixed isomers, CAS Registry No. 1330-20-7, being the most frequently reported type. Xylene is listed on the EPCRA Section 313 chemicals list in three isomeric forms and a mixture of these, namely ortho-, meta-, para-, and mixed. The mixed isomer classification can be used when a mixture contains any combination of two or three of the isomers. The threshold determination for xylene should be calculated for each form individually. For example, a covered facility annually uses 8,000 pounds of para-xylene, 6,000 pounds of ortho-xylene, and 8,000 pounds of mixed isomers as carrier solvents in three separate processing lines. All three activities of xylene are classified as otherwise use as the carrier is intended to evaporate and not remain with the product. There are no other uses of any form of xylene in the facility. The otherwise use activity threshold of 10,000 pounds/year has not been reached for any of the xylenes and an EPCRA Section 313 report need not be prepared for any of the xylenes. However, if any two streams mix, the otherwise use activity threshold would be exceeded for mixed isomers and an EPCRA Section 313 would have to be prepared for the mixed isomers.

Table 3-5 presents a work sheet that may be helpful when conducting your threshold determinations. Table 3-6 illustrates how the work sheet can be used for the following example:

Example - Threshold Worksheet

Assume your facility purchases two mixtures that contain xylene (mixed isomers) in the applicable reporting year. You purchased 25,000 pounds of Mixture A (which is 50% xylene, by weight, according to the MSDS) and 110,000 pounds of Mixture B (which contains 20% xylene, by weight). Further, you determine that you process the entire quantity of Mixture A, while you process only half of Mixture B and otherwise use the other half. You do not qualify for any exempt activities.

In this example, you would have processed a total of 23,500 pounds of xylene (12,500 pounds from activities associated with Mixture A and 11,000 pounds from activities associated with Mixture B). You would also have otherwise used a total of 11,000 pounds (all from Mixture B). Therefore, you would not have exceeded the 25,000 pound threshold for processing; however, you would have exceeded the 10,000 pound threshold for otherwise use and would be required to submit an EPCRA Section 313 report that includes releases and other waste management quantities from all activities (including processing).

Table 3-5. EPCRA Section 313 Reporting Threshold Worksheet

Facility Name: ____

EPCRA Section 313 Chemical or Chemical Category: ______________________________

CAS Registry Number: ____

Reporting Year: ____

Date Worksheet Prepared: ____________________

Prepared By: ______________________________

Amounts of chemical manufactured, processed, or otherwise used.

Mixture Name or Other Identifier	Information Source	Total Weight (lb)	Percent EPCRA Section 313 Chemical by Weight	EPCRA Section 313 Chemical Weight (lb)	Amount of the EPCRA Section 313 Chemical by Activity (lb):		
					Manufactured	Processed	Otherwise Used
1.							
2.							
3.							
4.							
Subtotal:					(A)________lb.	(B)________lb.	(C)________lb.

Exempt quantity of chemical that should be excluded.

Mixture Name as Listed Above	Applicable Exemption (de minimis, article, facility, activity)	Fraction or Percent Exempt (if Applicable)	Amount of the EPCRA Section 313 Chemical Exempt from Above (lb):		
			Manufactured	Processed	Otherwise Used
1.					
2.					
3.					
4.					
Subtotal:			(A_1)________lb.	(B_1)________lb.	(C_1)________lb.

	Amount subject to threshold:	($A-A_1$)_____ lb.	($B-B_1$)_____ lb.	($C-C_1$)_____ lb.
Compare to threshold for EPCRA Section 313 reporting.	**Activity threshold quantities[3]:**	**25,000 lb.**	**25,000 lb.**	**10,000 lb.**

If any one of the thresholds is exceeded, reporting is required for all activities. [Do not submit this worksheet with Form R, retain it for your records.]

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[3] These activity thresholds are for non-PBT chemicals. See Section 2.6 for the activity thresholds applicable to PBT chemicals.

Table 3-6. Sample EPCRA Section 313 Reporting Threshold Worksheet

Facility Name: ABC Rubber Corporation
EPCRA Section 313 Chemical or Chemical Category: Xylene (mixed isomers)
CAS Registry Number: 1330-20-7
Reporting Year: 1999

Date Worksheet Prepared: March 1, 2000
Prepared By: A.B. Calloway

Amounts of chemical manufactured, processed, or otherwise used.

Mixture Name or Other Identifier	Information Source	Total Weight (lb)	Percent EPCRA Section 313 Chemical by Weight	EPCRA Section 313 Chemical Weight (lb)	Amount of the EPCRA Section 313 Chemical by Activity (lb):		
					Manufactured	Processed	Otherwise Used
1. Mixture A	MSDS	25,000	50%	12,500	---	12,500	---
2. Mixture B	MSDS	110,000	20%	22,000	---	11,000	11,000
3.							
4.							
Subtotal:					(A) 0 lb.	(B) 23,500 lb.	(C) 11,000 lb.

Exempt quantity of chemical that should be excluded.

Mixture Name as Listed Above	Applicable Exemption (de minimis, article, facility, activity)	Fraction or Percent Exempt (if Applicable)	Amount of the EPCRA Section 313 Chemical Exempt from Above (lb):		
			Manufactured	Processed	Otherwise Used
1. Mixture A	none				
2. Mixture B	none				
3.					
4.					
Subtotal:			(A_1) 0 lb.	(B_1) 0 lb.	(C_1) 0 lb.

	Amount subject to threshold:	$(A-A_1)$ 0 lb.	$(B-B_1)$ 23,500 lb.	$(C-C_1)$ 11,000 lb.
Compare to threshold for EPCRA Section 313 reporting.	Activity threshold quantities[3]:	25,000 lb.	25,000 lb.	10,000 lb.

If any one of three thresholds is exceeded, reporting is required for all activities. [Do not submit this worksheet with Form R, retain it for your records.]

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[3] These activity thresholds are for non-PBT chemicals. See Section 2.6 for the activity thresholds applicable to PBT chemicals.

CHAPTER 4 - ESTIMATING RELEASES AND OTHER WASTE MANAGEMENT QUANTITIES

4.0 PURPOSE

This chapter is intended to guide the user in developing a systematic approach for estimating release and other waste management quantities of EPCRA Section 313 chemicals and chemical categories from rubber and plastics manufacturing processes. Figure 4-1 diagrams a recommended approach for estimating quantities of reportable EPCRA Section 313 chemicals or chemical categories.

This chapter also includes common EPCRA Section 313 reporting and compliance issues as they apply to rubber and plastics manufacturers. The general discussion (Section 4.1) is followed by a presentation of specific examples and issues (Section 4.2).

4.1 General Steps for Determining Release and Other Waste Management Activity Quantities

Release and other waste management activity quantities can be determined by completing the following four steps, described in detail in the following sections.

Step 1)	Prepare a **process flow diagram**.
Step 2)	Identify EPCRA Section 313 chemicals and chemical categories and potential **sources** of chemical release and other waste management activities.
Step 3)	Identify release and other waste management activity **types**.
Step 4)	Determine the most appropriate method(s) and **calculate the estimates** for release and other waste management activity quantities.

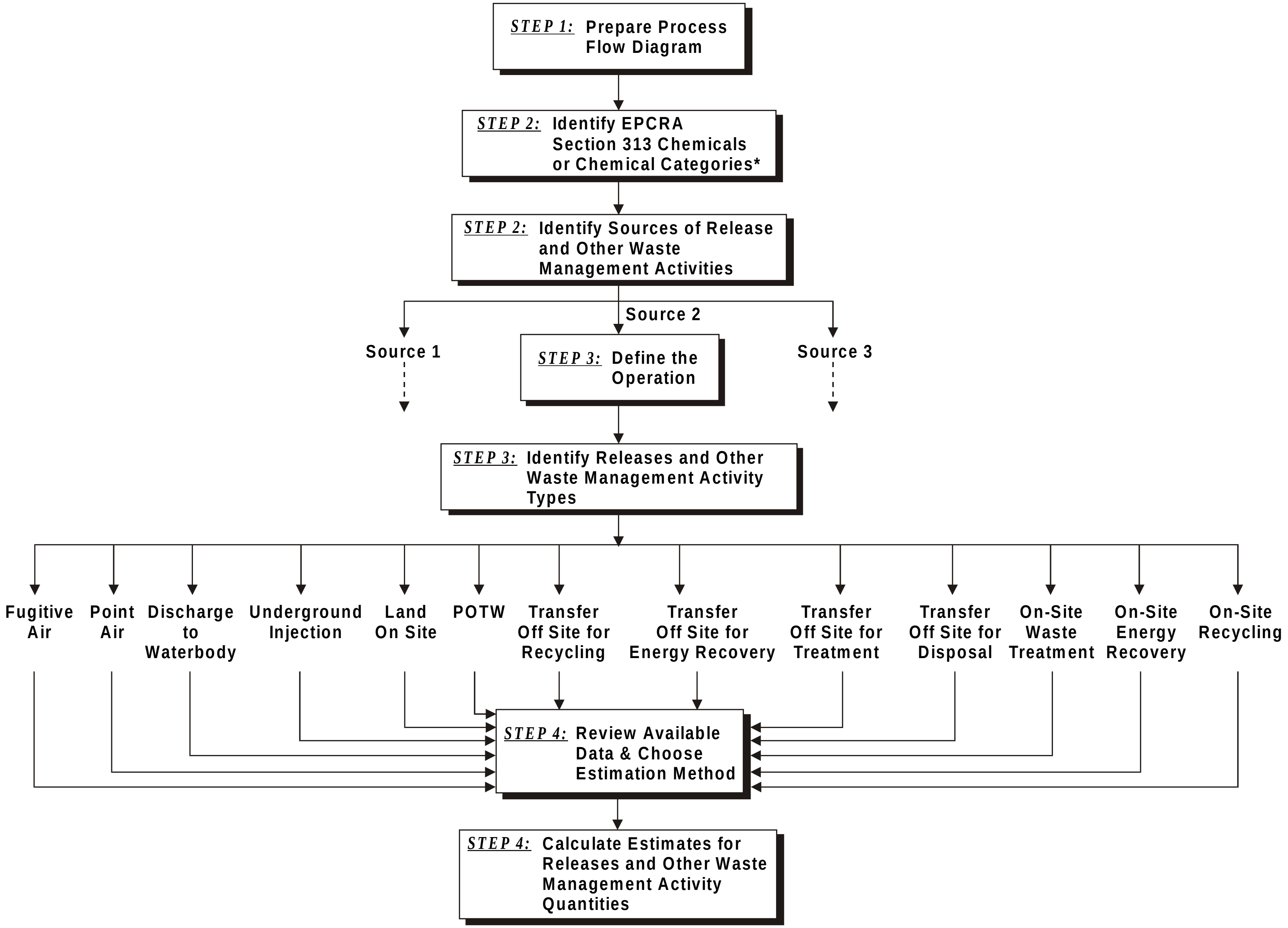

Figure 4-1. Releases and Other Waste Management Activity Calculation Approach

For EPCRA Section 313 purposes, “sources” means the streams or units that generate the release and other waste management activity (such as process vents, container residue, or spills) and “types” means the environmental media corresponding to elements in Sections 5 through 8 of the 1999 Form R (for example, releases to fugitive air, releases to stack air, discharges to receiving streams or POTWs, or releases to land).

4.1.1 Step 1: Prepare a Process Flow Diagram

Preparing a process flow diagram will help you to identify potential sources and types of EPCRA Section 313 chemicals and chemical categories released and otherwise managed as waste at your facility. Depending on the complexity of your facility, you may want to diagram individual processes or operations rather than the entire facility. The diagrams should show how materials flow through the processes and identify material input, generation, and output points. Looking at each operation separately, you can determine where EPCRA Section 313 chemicals and chemical categories are used and the medium to which they may be released or otherwise managed as waste.

4.1.2 Step 2: Identify EPCRA Section 313 Chemicals and Chemical Categories and Potential Sources of Chemical Release and Other Waste Management Activities

Once a process flow diagram has been developed, you must determine the potential sources and the EPCRA Section 313 chemicals and chemical categories may be released and otherwise managed as waste from each unit operation and process. Remember to include upsets and routine maintenance activities. Potential sources include:

- Accidental spills and releases;
- Air pollution control devices (e.g., baghouses, electrostatic precipitators, and scrubbers);
- Clean up and housekeeping practices;
- Combustion byproducts.
- Container residues;
- Fittings;
- Flanges;
- Process discharge streams;
- Process vents;
- Pumps;
- Recycling and energy recovery byproducts;
- Relief valves;
- Stock pile losses;

- Storage tanks;
- Storm water runoff;
- Tower stacks;
- Transfer operations;
- Treatment sludge;
- Volatilization from process or treatment areas; and
- Waste treatment discharges.

Next, you must identify the EPCRA Section 313 chemicals and chemical categories that may be released or otherwise managed as waste from each source. A thorough knowledge of the facility operations and processes is required for this determination. You should also consider whether any of the EPCRA Section 313 chemicals and chemical categories are coincidentally manufactured at your facility. Table 2-3 identifies EPCRA Section 313 chemicals and chemical categories typically used in rubber and plastics manufacturing. This table can be used as an aid in identifying which chemicals and chemical categories are found in your process. The list may not include all the EPCRA Section 313 chemicals and chemical categories your facility uses, and it may include many chemicals and chemical categories that you do not use.

4.1.3 Step 3: Identify Release and Other Waste Management Activity Types

For each identified source of an EPCRA Section 313 chemical or chemical category, you should examine all possible release and other waste management activity types. Figure 4-2 schematically represents the possible release and other waste management activity types as they correspond to individual data elements of the Form R. Remember to include both routine operations and accidents when identifying types. This diagram along with the following descriptions can be used as a checklist to make sure all possible types of release and other waste management activities have been considered.

a. **Fugitive or Non-Point Air Emissions (Part II, Section 5.1 of Form R) -** Includes all emissions to the air that are not released through stacks, vents, ducts, pipes, or any confined air stream. Examples include:

- Equipment leaks from valves, pump seals, flanges, compressors, sampling connections, open-ended lines, etc.;
- Releases from building ventilation systems, such as a roof fan in an open room;
- Evaporative losses from solvent cleaning tanks, surface impoundments, and spills; and
- Emissions from any other fugitive or non-point source.

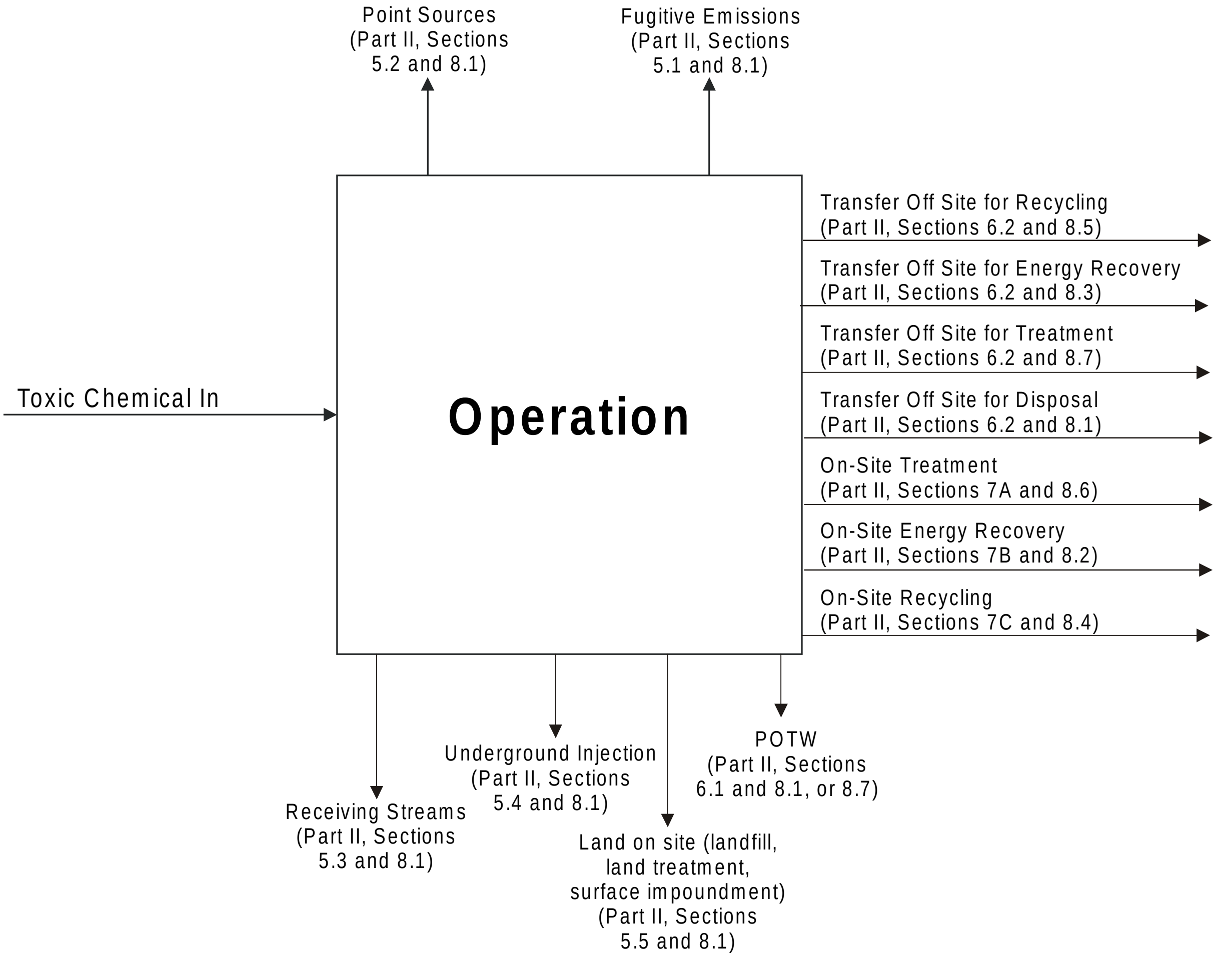

Figure 4-2. Possible Release and Other Waste Management Activity Types[4] for EPCRA Section 313 Chemicals and Chemical Categories

b. **Stack or Point Air Emissions (Part II, Section 5.2 of Form R)** - Includes all emissions to the air that occur through stacks, vents, ducts, pipes, or any confined air stream, including the emissions from storage tanks and air pollution control equipment. Air emissions from paint booths are often channeled through vapor recovery systems and/or air pollution control devices. These are considered stack emissions. Note that emissions released from general room air through a ventilation system are not considered stack or point releases for the purpose of EPCRA Section 313 reporting unless they are channeled through an air pollution control device. Instead, they are considered fugitive releases. However, you should note that for certain state reporting requirements not associated with EPCRA Section 313 reporting, some state air quality agencies consider ventilation systems to be a stack or point source.

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[4] Sections refer to 1999 Form R - Quantities released to the environment as a result of remedial actions, catastrophic events, or one-time events should be reported in Part II, Section 8 as Subsection 8.8

c. **Discharges to Receiving Streams or Water Bodies (Part II, Section 5.3 of Form R)** - Includes direct wastewater discharges to a receiving stream or surface water body. Discharges usually occur under a NPDES or SPDES permit.

d. **Underground Injection On-Site to Class I Wells (Part II, Section 5.4.1 of Form R) and to Class II through V Wells (Part II, Section 5.4.2 of Form R)** - Includes releases into an underground well at the facility. These wells may be monitored under an Underground Injection Control (UIC) Program permit. RCRA Hazardous Waste Generator Reports may be a good source of information for wastes injected into a Class I well. Injection rate meters may provide information for all the well classes.

e. **Disposal to Land On-Site (Part II, Section 5.5 of Form R)** - Includes all releases to land on site, both planned (i.e., disposal) and unplanned (i.e., accidental release or spill). The four predefined subcategories for reporting quantities released to land within the boundaries of the facility are:

(1) **Landfill** - The landfill may be either a RCRA-permitted (Part II, Section 5.5.1A of Form R) or a non-hazardous waste landfill (Part II, Section 5.5.1B of Form R). Both types are included if they are located on site. Leaks from landfills in the years subsequent to the disposal of the EPCRA Section 313 chemicals or chemical categories in the landfill do not need to be reported as a release.

(2) **Land treatment/application farming** - Land treatment is a disposal method in which a waste containing an EPCRA Section 313 chemical or chemical category is applied to or incorporated into soil. Volatilization of an EPCRA Section 313 chemical or chemical category due to the disposal operation must be included in the total fugitive air releases and should be excluded from land treatment/application farming to avoid double counting.

Sludge and/or aqueous solutions that contain biomass and other organic materials are often collected and applied to farm land. This procedure supplies a nitrogen source for plants and supplies metabolites for microorganisms. U.S. EPA considers this operation to be land treatment/farming if it occurs on site. If a facility sends this material off site for the same purpose, it is considered to be a “transfer to an off-site location, disposal” and should be reported under Sections 6.2 and 8.1 of the Form R.

The ultimate disposition of the chemical or chemical category after application to the land does not change the required reporting. For example, even if the chemical or chemical category is eventually biodegraded by microorganisms or plants, it is not considered recycled, reused, or treated.

(3) **Surface impoundment** - A surface impoundment is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials that is designed to hold an accumulation of wastes containing free liquids. Examples include: holding, settling, storage, and elevation pits; ponds; and lagoons. Quantities of the toxic chemical released to surface impoundments that are used merely as part of a wastewater treatment process generally must not be reported in this section. However, if the sludge from the surface impoundment contains the EPCRA Section 313 chemical or chemical category, then the EPCRA Section 313 chemicals or chemical categories in the sludge must be estimated in this section unless the sludge is removed and subjected to another waste management activity.

(4) **Other disposal** - Releases to land that do not fit the categories of landfills, land treatment, or surface impoundment are classified as other disposal. This disposal may include any spills or leaks of the EPCRA Section 313 chemical or chemical category to land.

f. **Discharges to Publicly Owned Treatment Works (POTW) (Part II, Section 6.1 of Form R)** - Includes the amount of EPCRA Section 313 chemical or chemical category in water transferred to an off-site POTW. Note that metals and metal compounds transferred to a POTW must also be reported in Section 8.1.

g. **Transfers to Other Off-Site Locations (Part II, Section 6.2 of Form R**) - Includes all off-site transfers containing the EPCRA Section 313 chemical or chemical category for the purposes of waste treatment, disposal, recycling, or energy recovery. Off-site transfer for disposal includes underground injection, landfill/surface impoundment, other land disposal, and transfer to a waste broker for disposal. The amount transferred off site for disposal must also be reported in Section 8.1.

Also reported in Section 6.2 would be any residual EPCRA Section 313 chemicals in “empty” containers transferred off site. U.S. EPA expects that all containers (bags, totes, drums, tank trucks, etc.) will have a small amount of residual solids and/or liquid. On-site cleaning of containers must be considered for EPCRA Section 313 reporting. If the cleaning occurs with a solvent (organic or aqueous), you must report the disposition of the waste solvent as appropriate. If the containers are sent off site for disposal or reclamation, you should report the EPCRA Section 313 chemical or chemical category in this section.

COMMON ERROR - Shipping Container Residue

Do not overlook residual chemicals or chemical categories in containers. U.S. EPA recently published *The 1994 and 1995 Toxic Release Inventory Data Quality Report*, EPA 745-R-98-002, presenting the site survey results of over 100 facilities to evaluate EPCRA Section 313 reporting quality. This survey found the largest source of overlooked release and other waste management activities was from container residue. So-called “empty” drums may contain an inch or more of liquid after draining and similarly “empty” bags may contain residues of dust and powder. Even though each individual drum or bag may only contain a small amount of an EPCRA Section 313 chemical or chemical category, for facilities that receive hundreds or thousands of drums or bags each year the annual cumulative amount of an EPCRA Section 313 chemical or chemical category can be substantial. The quantities should typically be reported in Section 6.2 (see Table 4-1 for estimates of liquid drum residual and the text of this section for estimates of residual from solids). Please note that unlike RCRA, EPCRA Section 313 does not define what constitutes an “empty” container. EPCRA Section 313 is merely trying to account for all the quantities of toxic chemicals released and otherwise managed as waste.

Table 4-1

Summary of Liquid Residue Quantities From Pilot-Scale Experimental Study[a,b] (weight percent of drum capacity)

Unloading Method	Vessel Type	Value	Material			
			Kerosene[c]	Water[d]	Motor Oil[e]	Surfactant Solution[f]
Pumping	Steel drum	Range Mean	1.93 - 3.08 2.48	1.84 - 2.61 2.29	1.97 - 2.23 2.06	3.06 3.06
Pumping	Plastic drum	Range Mean	1.69 - 4.08 2.61	2.54 - 4.67 3.28	1.70 - 3.48 2.30	Not Available
Pouring	Bung-top steel drum	Range Mean	0.244 - 0.472 0.404	0.266 - 0.458 0.403	0.677 - 0.787 0.737	0.485 0.485
Pouring	Open-top steel drum	Range Mean	0.032 - 0.080 0.054	0.026 - 0.039 0.034	0.328 - 0.368 0.350	0.089 0.089
Gravity Drain	Slope-bottom steel tank	Range Mean	0.020 - 0.039 0.033	0.016 - 0.024 0.019	0.100 - 0.121 0.111	0.048 0.048
Gravity Drain	Dish-bottom steel tank	Range Mean	0.031 - 0.042 0.038	0.033 - 0.034 0.034	0.133 - 0.191 0.161	0.058 0.058
Gravity Drain	Dish-bottom glass-lined tank	Range Mean	0.024 - 0.049 0.040	0.020 - 0.040 0.033	0.112 - 0.134 0.127	0.040 0.040

[a] From "Releases During Cleaning of Equipment." Prepared by PEI Associates, Inc., for the U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, Washington DC Contract No. 68-02-4248. June 30, 1986.

[b] The values listed in this table should only be applied to similar vessel types, unloading methods, and bulk fluid materials. At viscosities greater than 200 centipoise, the residue quantities can rise dramatically and the information on this table is not applicable.

[c] For kerosene, viscosity = 5 centipoise, surface tension = 29.3 dynes/cm^2

[d] For water, viscosity = 4 centipoise, surface tension = 77.3 dynes/cm^2

[e] For motor oil, viscosity = 97 centipoise, surface tension = 34.5 dynes/cm^2

[f] For surfactant solution viscosity = 3 centipoise, surface tension = 31.4 dynes/cm^2

Actual data and a knowledge of the unloading methods at your facility can be used to estimate the quantity of residual EPCRA Section 313 chemicals or chemical categories in containers. However, U.S. EPA has developed guidance to assist facilities if no site-specific information is available. Table 4-1 provides results from a study of liquid residue quantities left in drums and tanks when emptied. These results are presented as the mass percent of the vessel capacity, and are categorized based on unloading method, vessel material, and bulk fluid material properties such as viscosity and surface tension. No testing was conducted for residual solids in this study. If data or on-site specific knowledge is available to estimate the quantity of solid residual in containers, it should be considered. If no data are available, U.S. EPA believes an estimate of 1% residual solid is reasonable.

The following example describes how the information in the table can be used to estimate the quantity of an EPCRA Section 313 chemical or chemical category in water that was used to clean drums on site.

Example - Container Residue

You have determined that a Form R for an EPCRA Section 313 chemical must be submitted. The facility purchases and uses one thousand 55-gallon steel drums that contain a 10% aqueous solution of the chemical. Further, it is assumed that the physical properties of the solution are similar to water. The solution is pumped from the drums directly into a mixing vessel and the “empty” drums are triple-rinsed with water. The rinse water is indirectly discharged to a POTW and the cleaned drums are sent to a drum reclaimer.

From Table 4-1, the average drum residue quantity for this scenario is 2.29%. In this example, it can be assumed that all of the residual solution in the drums was transferred to the rinse water. Therefore, the quantity of the EPCRA Section 313 chemical transferred to the drum reclaimer should be reported as “zero.”

The annual quantity of residual solution that is transferred to the rinse water can be estimated by multiplying the mean weight percent of residual solution remaining in a pumped steel drum by the total annual weight of solution in the drums. If the density is not known, it may be appropriate to use the density of water (8.34 pounds per gallon):

$$(0.0229) \times (55 \text{ gal/drum}) \times (1{,}000 \text{ drums}) \times (8.34 \text{ lb/gal}) = 10{,}504 \text{ pounds solution}$$

The concentration of the EPCRA Section 313 chemical in the solution is only 10%.

$$(10{,}504 \text{ lb solution}) \times (0.1) = 1{,}050 \text{ pounds of the EPCRA Section 313 chemical}$$

Therefore, 1,050 pounds of the EPCRA Section 313 chemical are transferred to the POTW, and should be reported in Part II, Sections 6.1 and 8.7 of the 1999 Form R. Because they cannot be destroyed, metals cannot be reported as being treated, and metals and metal portions of metal compounds should be reported in Part II, Section 6.1 and 8.1 of the 1999 Form R.

h. **On-Site Waste Treatment (Part II, Section 7A of Form R)** - Includes all on-site waste treatment of EPCRA Section 313 chemicals or chemical categories. The information reported in Section 7A focuses on the treatment of the entire waste stream, not the specific EPCRA Section 313 chemical or chemical category. The information includes type of waste stream (gaseous, aqueous or non-aqueous liquid, or solid); treatment methods or sequence; influent concentrations of the EPCRA Section 313 chemical or chemical category; treatment efficiency (combined removal and destruction) of the entire method or sequence; and whether efficiency data are based on actual operating data. Metals and metal portions of metal compounds treated in a combustion process are not destroyed but should still be reported as going through the treatment process, with a treatment efficiency of zero. Note that only the metal portion of metal compounds should be reported in the Form R. The following example illustrates how Section 7A should be completed for on-site treatment of a wastewater stream containing three EPCRA Section 313 chemicals or chemical categories.

Example - On-Site Waste Treatment

A process at the facility generates a wastewater stream containing an EPCRA Section 313 chemical (chemical A). A second process generates a wastewater stream containing two EPCRA Section 313 chemicals, a metal (chemical B) and a mineral acid (chemical C). Thresholds for all three chemicals have been exceeded and you are in the process of completing separate Form Rs for each chemical.

The two wastewater streams are combined and sent to an on-site wastewater treatment system before being released to a POTW. This system consists of an oil/water separator that removes 99% of chemical A; a neutralization tank in which the pH is adjusted to 7.5, thereby destroying 100% of the mineral acid (chemical C); and a settling tank where 95% of the metal (chemical B) is removed from the water (and eventually land filled off site).

Section 7A should be completed slightly differently when you file the Form R for each of the chemicals or chemical categories. The table accompanying this example shows how Section 7A should be completed for each chemical or chemical category. First, on each Form R you should identify the type of waste stream in Section 7A.1a as wastewater (aqueous waste, code W). Next, on each Form R you should list the code for each of the treatment steps that is applied to the entire waste stream, regardless of whether the operation affects the chemical or chemical category for which you are completing the Form R (for instance, the first four blocks of Section 7A.1b of all three Form Rs should show: P19 (liquid phase separation), C11 (neutralization), P11 (settling/clarification), and N/A (to signify the end of the treatment system). Note that Section 7A.1b is the only section of the Form R that is not chemical or chemical category specific. It applies to the entire waste stream being treated. Section 7A.1c of each Form R should show the concentration of the specific chemical or chemical category in the influent to the first step of the process (oil/water separation). For this example, assume chemicals or chemical categories A, B, and C are all present at concentrations greater than 1%. Therefore, code “1” should be entered. Section 7A.1d is also chemical specific. It applies to the efficiency of the entire system in destroying and/or removing the chemical or chemical category for which you are preparing the Form R. You should enter 99% when filing for chemical A, 95% for chemical B, and 100% for chemical C. Finally, you should report whether the influent concentration and efficiency estimates are based on operating data for each chemical or chemical category, as appropriate.

Chemical A						
7A.1a	7A.1b	1. P19	2. C11	7A.1c	7A.1d	7A.1e
W	3. P11	4. N/A	5. ______	1	99 %	Yes No
	6. ______	7. ______	8. ______			X ____
Chemical B						
7A.1a	7A.1b	1. P19	2. C11	7A.1c	7A.1d	7A.1e
W	3. P11	4. N/A	5. ______	1	95 %	Yes No
	6. ______	7. ______	8. ______			X ____
Chemical C						
7A.1a	7A.1b	1. P19	2. C11	7A.1c	7A.1d	7A.1e
W	3. P11	4. N/A	5. ______	1	100 %	Yes No
	6. ______	7. ______	8. ______			X ____

Note that the quantity removed and/or destroyed is not reported in Section 7 and that the efficiency reported in Section 7A.1d refers to the amount of EPCRA Section 313 chemical or chemical category destroyed and/or removed from the applicable waste stream. The amount actually destroyed should be reported in Section 8.6 (quantity treated on site). For example, when completing the Form R for chemical B you should report "0" pounds in Section 8.6 because the metal has been removed from the wastewater stream, but not actually destroyed. The quantity of chemical B that is ultimately land filled off site should be reported in Section 6.2 and 8.1. However, when completing the Form R for chemical C you should report the entire quantity in Section 8.6 because raising the pH to 7.5 will completely destroy the mineral acid.

i. **On-Site Energy Recovery (Part II, Section 7B of Form R)** - Includes all on-site energy recovery of reported EPCRA Section 313 chemicals and chemical categories. U.S. EPA's view is that EPCRA Section 313 chemicals or chemical categories that do not contribute significant heat energy during combustion processes should not be considered for energy recovery. Therefore, only EPCRA Section 313 chemicals or chemical categories with a significant heating value that are combusted in an energy recovery unit, such as an industrial furnace, kiln, or boiler can be reported for energy recovery. If an EPCRA Section 313 chemical or chemical category is incinerated on site but does not significantly contribute energy to the process, (e.g., chlorofluorocarbons (CFCs)) it must be considered on-site waste treatment (see 4.1.3, h. above). Metals and metal portions of metal compounds will never be combusted for energy recovery. Note that only the metal portion of metal compounds should be reported in the Form R.

j. **On-Site Recycling (Part II, Section 7C of Form R)** - Includes all on-site recycling methods used on EPCRA Section 313 chemicals or chemical categories.

k. **Source Reduction and Recycling Activities (Part II, Section 8 of Form R)**[1] - Provide information about source reduction and recycling activities related to the EPCRA Section 313 chemical or chemical category for which release and other waste management activities are being reported. Section 8 uses some data collected to complete Part II, Sections 5 through 7. For this reason, Section 8 should be completed last. The relationship between Sections 5, 6, and 8.8 to Sections 8.1, 8.3, 8.5, and 8.7 are provided in equation forms below.

(1) **Quantity Released (Part II, Section 8.1 of Form R)** - The quantity reported in Section 8.1 is the quantity reported in all of Section 5 plus the quantity of metals and metal compounds reported as discharged off site to POTWs in Section 6.1 plus the quantity reported as sent off site for disposal in Section 6.2 minus the quantity reported in Section 8.8 that was released on site or sent off site for disposal:

§8.1 = §5 + §6.1 (metals and metal compounds) + §6.2 (disposal) - §8.8 (on-site release or off-site disposal only)

(2) **Quantity Used for Energy Recovery On-Site (Part II, Section 8.2 of Form R)** - Estimate the quantity of the EPCRA Section 313 chemical or chemical category in wastes combusted for energy recovery on site. This estimate should be the quantity of the chemical or chemical category combusted in the process for which codes were reported in Section 7B. Test data from trial burns or other monitoring data may be used to estimate the quantity of the EPCRA Section 313 chemical or chemical category combusted for energy recovery purposes. If monitoring data are not available, vendor specifications regarding combustion efficiency may be used as they relate to the EPCRA Section 313 chemical or chemical category. A quantity must be reported in Section 8.2 when a method of on-site energy recovery is reported in Section 7B and vice versa.

Two conditions need to be met to report the combustion of an EPCRA Section 313 chemical or chemical category in waste as energy recovery: the chemical (1) must have a significant heating value and (2) must be combusted in an energy recovery unit, such as a waste heat boiler, an industrial furnace, or a kiln. If an EPCRA Section 313 chemical or chemical category that does not have a significant heating value (except metals and metal compounds) is combusted for energy recovery on site, it must be considered on-site waste treatment (see 4.1.3.h). However, this

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[1] The Subsection 8.1 through 8.8 designations are for the 1999 Form R. Please refer to the current reporting year *TRI Forms and Instructions* for any changes.

does not apply to metals and metal compounds. Metals and metal compounds in a waste that are combusted on site will never be combusted for energy recovery or treated for destruction and are therefore normally disposed. Note that "NA" should be reported for EPCRA Section 313 chemicals or chemical categories that do not have a significant heating value. This includes metals, metal portions of metal compounds, halogens, hydrochlorofluorocarbons (HCFCs), and CFCs.

(3) **Quantity Used for Energy Recovery Off-Site (Part II, Section 8.3 of Form R)** - The quantity reported in Section 8.3 is the quantity reported in Section 6.2 for which energy recovery codes are reported. If a quantity is reported in Section 8.8, subtract any associated off-site transfers for energy recovery:

§8.3 = §6.2 (energy recovery) - §8.8 (off-site energy recovery)

Two conditions need to be met to report the combustion of an EPCRA Section 313 chemical or chemical category in waste as energy recovery: the chemical or chemical category (1) must have a significant heating value and (2) must be combusted in an energy recovery unit, such as a waste heat boiler, an industrial furnace, or a kiln. If an EPCRA Section 313 chemical or chemical category that does not have a significant heating value (except metals and metal compounds) is sent off site for energy recovery, it must be considered off-site waste treatment (see 4.1.3.g). However, this does not apply to metals and metal compounds. Metals and metal compounds sent off site for combustion in energy recovery units must be considered as sent off site for disposal because typically they will ultimately be disposed. Metals and metal portions of metal compounds will never be treated or combusted for energy recovery. Note that only the metal portion of metal compounds should be reported in the Form R. Also note that "NA" should be reported for EPCRA Section 313 chemicals or chemical categories that do not have a significant heating value. This includes metals, metal portions of metal compounds, halogens, HCFCs, and CFCs.

(4) **Quantity Recycled On-Site (Part II, Section 8.4 of Form R) -** Estimate the quantity of the EPCRA Section 313 chemical or chemical category recycled in wastes on site. This estimate should be the quantity of the chemical or chemical category recycled in the process for which codes were reported in Section 7C. A quantity should be reported in Section 8.4 when a method of on-site recycling is reported in Section 7C and vice versa. To estimate this quantity, you should determine if operating data exist that indicate a recovery efficiency and use that efficiency value combined with

throughput data to calculate an estimate. If operating data are unavailable, available vendor specifications may be appropriate.

(5) **Quantity Recycled Off-Site (Part II, Section 8.5 of Form R)** - The quantity reported in Section 8.5 must be the same as the quantity reported in Section 6.2 for which recycling codes are reported. If a quantity is reported in Section 8.8, subtract any associated off-site transfers for recycling:

If the facility has knowledge about metals being recovered, this quantity should be reported in Section 8.5.

§8.5 = §6.2 (recycling) - §8.8 (off-site recycling)

COMMON ERROR - Direct Reuse vs. Recycling

The direct reuse of an EPCRA Section 313 chemical does not need to be included in the amount reported in Part II, Section 8 of Form R. However, recycling of the chemical should be included.

(6) **Quantity Treated On-Site (Part II, Section 8.6 of Form R)** - Waste treatment in Section 8 is limited to the destruction or chemical conversion of the EPCRA Section 313 chemical or chemical category in wastes. The quantities reported in Section 8.6 will be those that have undergone processes that are a subset of the processes for which codes were reported in Section 7A, where treatment includes physical removal from a waste stream. To estimate the quantity treated, you should determine if operating data exist that indicate a treatment efficiency (e.g., destruction or chemical conversion of the EPCRA Section 313 chemical or chemical category) and use that efficiency value combined with throughput data to calculate an estimate. Because metals cannot be destroyed or chemically converted into something other than the metal or metal compound, metals cannot be reported as treated in Section 8.6. Note that conversion of a metal from one oxidation state to another (e.g., Cr(VI) to Cr(III)) is not considered treatment for Section 8.6. If operating data are unavailable, available vendor specifications may be appropriate. Section 7A must be completed if a quantity is entered in Section 8.6.

(7) **Quantity Treated Off-Site (Part II, Section 8.7 of Form R)** - The quantity reported in Section 8.7 must be the same as the quantity reported in Section 6.2 for which treatment codes are reported plus quantities sent to a POTW as reported in Section 6.1 except for metals and metal compounds. If a quantity is reported in Section 8.8, subtract any associated off-site transfers for treatment:

§8.7 = §6.1 (except metals and metal compounds) + §6.2 (treatment) - §8.8 (off-site treatment)

Because metals cannot be destroyed or chemically converted into something other than the metal or metal compound, metals cannot be reported as treated in Section 8.7. Quantities of metals reported in Section 6.1 and 6.2 should be reported in Section 8.1 (Quantity Released) unless the facility has knowledge that the metal is being recovered.

(8) **Quantity Released to the Environment as a Result of Remedial Actions, Catastrophic Events, or One-Time Events Not Associated with Production Processes (Part II, Section 8.8 of Form R)** - The purpose of this section is to separate quantities recycled off site, used for energy recovery off site, treated off site, or released (including disposed) that are associated with normal or routine production from those quantities that are not. The quantity reported in Section 8.8 is the quantity of the EPCRA Section 313 chemical or chemical category released directly into the environment or sent off site for recycling, waste treatment, energy recovery, or disposal during the reporting year due to any of the following events:

- Remedial actions;
- Catastrophic events such as earthquakes, fires, or floods; or
- One-time events not associated with normal or routine production processes.

The quantity reported in Section 8.8 should not be included with quantities reported in Part II, Sections 8.1 through 8.7 of Form R, but should be included in Part II, Sections 5 and 6 of Form R as appropriate.

Spills that occur as a routine part of production operations and could be reduced or eliminated by improved handling, loading, or unloading procedures are included in the quantities reported in Section 8.1 through 8.7 as appropriate. This includes small drippings and spills that often occur during transfer operations and loading/unloading operations.

On-site releases and off-site transfers for further waste management from remediation of an EPCRA Section 313 chemical or chemical category or an unpreventable accident unrelated to production (such as a hurricane) are reportable in Section 8.8.

On-site treatment, energy recovery, or recycling of EPCRA Section 313 chemicals or chemical categories in wastes generated as a result of remedial actions, catastrophic events, or one-time events not associated with production processes are not reported in Part II, Section 8.8, nor in Sections 8.1 through 8.7 of Form R.

COMMON ERROR - Double Counting

Release and other waste management activities should not be"double counted." A single wastewater discharge should not be listed as both a release to water (on site) and a discharge to POTW (off site). Similarly, a release to land should not be listed as both a release to land (on site) and a transfer to an off-site landfill. Estimates of releases and other waste management activities should be prepared for Sections 5 through 7 of the Form R. For the most part, Section 8 relies on the data collected to complete these previous sections. Therefore, Section 8 should be completed last. However, the data elements of Section 8 (8.1 through 8.7) are mutually exclusive and care should be taken to avoid double counting.

4.1.4 Step 4: Determine the Most Appropriate Method(s) and Calculate the Estimates for Release and Other Waste Management Activity Quantities

After you have identified all of the potential sources for release and other waste management activity types, you must estimate the quantities of each EPCRA Section 313 chemical and chemical category released and otherwise managed as waste. U.S. EPA has identified four basic methods that may be used to develop estimates (each method has been assigned a code that must be included when reporting). The methods and corresponding codes are:

- Monitoring Data or Direct Measurement (M);
- Mass Balance (C);
- Emission Factors (E); and,
- Engineering Calculations (O).

Descriptions of these techniques are provided in the U.S. EPA publication, *Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Forms*. They are also briefly described below. A more detailed discussion including examples of selected calculation techniques is presented in Appendix B. U.S. EPA does not require you to conduct additional sampling or testing for EPCRA Section 313 reporting; however, you are required to use the best, readily available information to determine the method that will result in the most accurate estimate. For example, it may not be appropriate to use emission factors or engineering calculations if more accurate data, such as stack testing results, are available. You are required to identify the primary method used for each estimation.

Many potential sources of data exist for these (and other) methods of developing estimates. Table 4-2 presents potential data sources and the estimation methodology in which they are most likely to be used. Based on site-specific knowledge and potential data sources available, you should be able to determine the best method for calculating each release and other waste management activity quantity.

Once all potential release and other waste management activity sources, types, and estimation methods have been determined, an estimate for each EPCRA Section 313 chemical and chemical category can be developed corresponding to the elements on Form R.

Table 4-2

Potential Data Sources for Release and Other Waste Management Calculations

DATA SOURCES

Monitoring Data

- Air permits
- Continuous emission monitoring
- Effluent limitations
- Hazardous waste analysis
- Industrial hygiene monitoring data
- NPDES permits
- Outfall monitoring data
- pH for acids and bases
- POTW pretreatment standards
- RCRA permit
- Stack monitoring data
- New Source Performance Standards
- Title V permit data

Mass Balance

- Air emissions inventory
- Hazardous material inventory
- Hazardous waste manifests
- MSDSs
- Pollution prevention reports
- Spill event records
- Supply and purchasing records

Emission Factors

- AP-42 chemical specific emission factors
- Facility or trade association derived chemical-specific emission factors

Engineering Calculations

- Facility non-chemical specific emission factors.
- Henry’s Law
- Raoult’s Law
- SOCMI* or trade association non-chemical specific emission factors
- Solubilities
- Volatilization rates

*Synthetic Organic Chemicals Manufacturing Industry.

4.1.4.1 Monitoring Data or Direct Measurement (code M)

Using monitoring data or direct measurements is usually the best method for developing chemical release and other waste management activity quantity estimates. Your facility may be required to perform monitoring under provisions of the Clean Air Act (CAA), Clean Water Act (CWA), RCRA, or other statutory or regulatory requirements. If so, data should be available for developing estimates. Data may have also been collected for your facility through an occupational health and safety assessment. If only a small amount of direct measurement data is available or if you believe the monitoring data are not representative, you must decide if another estimation method would give a more accurate result.

Example - Monitoring Data

Data from the on-site wastewater treatment facility indicate that the annual average concentration of copper in the discharge is 2 mg/L. The wastewater treatment facility processed 1.5 million gallons of water during the year. The treated wastewater is discharged to an off-site POTW. The amount of copper transferred off site to the POTW (for Sections 6.1 and 8.1 of the Form R) is estimated as follows:

Amount of copper transferred

$$= (2\ \text{mg/L}) \times \left(\frac{\text{g}}{1{,}000\ \text{mg}}\right) \times \left(\frac{\text{lb}}{453.59\ \text{g}}\right) \times \left(\frac{\text{L}}{0.2642\ \text{gal}}\right) \times (1{,}500{,}000\ \text{gal/yr})$$

$$= 25\ \text{lb/yr}$$

This quantity should be reported in Part II, Sections 6.1 and 8.1 of the 1999 Form R since the discharged chemical is a metal. Had the discharged EPCRA Section 313 chemical not been a metal it should be reported in Part II, Section 6.1 and 8.7 of the 1999 Form R.

COMMON ERROR - Treatment Efficiencies

Vendor data on treatment efficiencies often represent ideal operating conditions. You should adjust such data to account for downtime and process upsets during the year that would result in lower efficiencies. Remember that efficiencies reported by vendors are often general and may not apply to specific chemicals. For example, an incinerator or flare may be 99.99% efficient in destroying certain organic chemicals, but will have a 0% efficiency in destroying metals.

4.1.4.2 Mass Balance (code C)

A mass balance involves determining the amount of an EPCRA Section 313 chemical or chemical category entering and leaving an operation. The mass balance is written as follows:

$$\boxed{\text{Input} + \text{Generation} = \text{Output} + \text{Consumption}}$$

where:

- <u>Input</u> refers to the materials (chemicals) entering an operation. For example, chlorine added to process water as a disinfectant would be considered an input to the water treatment operation.

- <u>Generation</u> identifies those chemicals created during an operation (manufactured, including coincidental manufacturing). For example, when nitrogen sources are used in biological wastewater treatment systems, nitrate compounds and additional ammonia may be coincidentally manufactured.

- <u>Output</u> refers to the materials (chemicals) leaving an operation by various avenues. Output (avenues) may include on-site release and other on-site waste management activities; transfers off site for recycling, energy recovery, treatment, storage, or disposal; or the amount of chemical that leaves with the final product.

- <u>Consumption</u> refers to the amount of chemical converted to another substance during the operation (i.e., reacted). For example, nitric acid would be consumed by neutralization during wastewater treatment.

The mass balance technique may be used for manufactured, processed, or otherwise used EPCRA Section 313 chemicals or chemical categories. It is typically most useful for otherwise used chemicals that do not become part of the final product, such as catalysts, solvents, acids, and bases. For large input and output streams, a mass balance may not be the best estimation method because slight uncertainties in mass calculations can yield significant errors in the release and other waste management quantity estimates.

Example - Mass Balance

A facility otherwise uses a volatile EPCRA Section 313 chemical as a refrigerant and adds 20,000 pounds to the refrigeration system (to make up for system losses). The chemical is released to the air from relief vents during system filling operations and from leaks in valves and fittings. During system maintenance, the lines are bled directly into water and the system is vented to the air. Monitoring data of the wastewater, including chemical concentrations and wastewater throughput, indicate that 1,200 pounds of the chemical were discharged to the wastewater. The remaining losses are assumed to be fugitive air releases and are estimated as follows:

Fugitive air releases of the EPCRA Section 313 chemical

= Amount input (lb/yr) - Amount released to wastewater (lb/yr)

= 20,000 lb/yr - 1,200 lb/yr

= 18,800 lb/yr

COMMON ERROR - Mass Balances for Otherwise Used Chemicals

Facilities often do not account for the entire quantity of EPCRA Section 313 chemicals or chemical categories that are otherwise used. Many EPCRA Section 313 chemicals and chemical categories in rubber and plastics manufacturing are classified as otherwise used. Such chemicals and chemical categories may or may not leave the facility with the product. For those instances where the EPCRA Section 313 chemical or chemical category does not leave the facility in the product, all throughput may be lost during processing through on-site releases to air, water, or land, or it may be shipped off site for further waste management activities. Thus, the entire throughput is often reportable on Form R as release and other waste management activities to various media. Be sure to consider the entire throughput in these circumstances and partition it as appropriate. A mass balance may be the best starting point to estimate the release and other waste management quantities.

4.1.4.3 Emission Factors (code E)

An emission factor is a representative value that attempts to relate the quantity of a chemical or chemical category released with an associated activity. These factors are usually expressed as the weight of chemical or chemical category released divided by a unit weight, volume, distance, or duration of the activity releasing the chemical (e.g., pounds of chemical released per pounds of product produced). Emission factors, commonly used to estimate air emissions, have been developed for many different industries and activities. You should carefully evaluate the source of the emission factor and the conditions for its use to determine if it is applicable to the situation at your facility. If there are more than one EPA published emission factors, you should determine which is the most appropriate for your operations and document your rationale.

The most widely known and used source for emission factors is U.S. EPA's publication *Compilation of Air Pollutant Emission Factors (AP-42)*. Volume I of AP-42 contains information on over 200 stationary source categories, including process descriptions and potential sources of air emissions from these processes. Methodologies for estimating the quantity of air pollutant emissions from these sources are presented as Emission Factors. For EPCRA Section 313 purposes only CHEMICAL-SPECIFIC emission factors can be reported as Code "E" - Emission Factor in Part II, Section 5, Column B, Basis for estimate, of the Form R. AP-42 contains emission factors for individual chemicals and for the chemical group Volatile Organic Compounds (VOCs). The VOC emission factors are NOT chemical specific and when used must be reported in Column B as Code "O" - Engineering Calculations. Each chapter in Volume I covers a major industry or source category. Of special interest to rubber and plastic manufacturing facilities would be Chapter 4: Evaporation Loss Sources, in particular Sections 4.2.2.14: Surface Coating of Plastic Parts for Business Machines; 4.4: Polyester Resin Plastic Product Fabrication; and 4.12: Manufacture of Rubber Products (Section 4.12 is currently in draft status), Chapter 6: Organic Chemical Process Industry, in particular Sections 6.6: Plastics and 6.10: Synthetic Rubber, and Chapter 7: Liquid Storage Tanks.

AP-42 can be accessed at the following Internet site:

- **http://www.epa.gov/ttn/chief/ap42.html**

In an effort to provide current emissions data in an easy-to-access format, U.S. EPA has prepared a CD-ROM entitled Air CHIEF (Air ClearingHouse for Inventories and Emission Factors). The Air CHIEF CD-ROM is updated annually and is available from the Government Printing Office and can be ordered from their Web site. In addition to AP-42, the Air CHIEF CD-ROM contains the Factor Information Retrieval (FIRE) data system, a database management system containing U.S. EPA's recommended emission estimation factors for criteria and hazardous air pollutants. The CD-ROM also contains installable copies of software programs for air emission estimation models such as "TANKS" for VOC emission from storage tanks; "WATER8" for air emissions from wastewater systems; and "CHEMDAT8" for VOC emissions from Treatment, Storage, and Disposal Facility (TSDF) processes. Additional information on Air CHIEF and the CD-ROM is available at:

- **http://www.epa.gov/ttn/chief/airchief.html**

Your facility may have developed non-chemical-specific emission factors for fugitive or stack emissions based on stack tests for various air permits. Be sure to consider these emission factors if appropriate. However, if such factors are used, they are considered "engineering calculations" for the purposes of EPCRA Section 313 reporting.

Example - Emission Factors

Emission factors have been developed for air releases of fuel constituents and combustion products from boiler operations. AP-42 lists a range of formaldehyde emission factors when No. 6 fuel oil is consumed:

0.024 to 0.061 lb formaldehyde generated/10^3 gal No. 6 fuel oil fired.

Assuming a facility met reporting requirements for formaldehyde, the facility operating a boiler using No. 6 fuel oil could use the above emission factor to determine the amount of formaldehyde generated and subsequently released to the air. If 1,000,000 gallons of No. 6 fuel oil is used during a reporting year, the amount of formaldehyde generated would be between:

$$(0.024 \text{ lb}/10^3 \text{ gal}) \times (1{,}000{,}000 \text{ gal}) \text{ and } (0.061 \text{ lb}/10^3 \text{ gal}) \times (1{,}000{,}000 \text{ gal})$$

$$= 24 \text{ and } 61 \text{ lb of formaldehyde generated}$$

If there are no engineering controls or air pollution control devices that would destroy or remove the formaldehyde, this quantity should be reported in Part II, Sections 5.2 and 8.1 of the 1999 Form R.

NOTE: No. 6 fuel oil contains other EPCRA Section 313 chemicals and chemical categories and EPCRA Section 313 chemicals and chemical categories may also be coincidentally manufactured during combustion. All should be considered for EPCRA Section 313 reporting.

4.1.4.4 Engineering Calculations (code O)

Engineering calculations are assumptions and/or judgments used to estimate quantities of EPCRA Section 313 chemicals and chemical categories released or otherwise managed as waste. The quantities are estimated by using physical and chemical properties and relationships (e.g., Ideal Gas law, Raoult's law) or by modifying an emission factor to reflect the chemical properties of the chemical in question. Engineering calculations rely on the process parameters; you must have a thorough knowledge of your facility operations to complete these calculations.

Engineering calculations can also include computer models. Several computer models are available for estimating emissions from storage tanks, landfills, water and wastewater treatment, and other processes. See discussion in Section 4.1.4.3 for details on these models and how they may be accessed.

Non-chemical-specific emission factors, Synthetic Organic Chemicals Manufacturing Industry (SOCMI) emission factors, industry-determined emission factors for processes or equipment, and site-specific emission factors also can be used, but must be classified as “Engineering Calculations” for EPCRA Section 313 reporting.

Examples - Engineering Calculations

Stack monitoring data are available for xylene but you are required to report for toluene. Toluene is used in the same application as xylene at your facility and the concentrations of the chemicals in the liquid feedstock are approximately the same. You can estimate the emissions of toluene by adjusting the monitoring data of xylene by a ratio of the vapor pressure for xylene to toluene. This example is an engineering calculation based on physical properties and process operation information:

From facility stack monitoring data, you determine that an estimated 200 lb of xylene are released as air emissions during the reporting year. Toluene is also present in the air emissions, but not monitored. The stack operates at approximately 20°C. Based on literature data, the vapor pressure at 20°C for toluene is 22 millimeters of mercury (mmHg) atmospheres and for xylene is 6 mmHg. Using a ratio of the vapor pressures, the amount of toluene released as air emissions from the stack can be calculated:

$$\frac{\text{X lb/yr toluene}}{\text{200 lb/yr xylene}} = \frac{\text{22 mmHg (vapor pressure of toluene)}}{\text{6 mmHg (vapor pressure of xylene)}}$$

$$\text{X lb/yr toluene} = \frac{\text{(22 mmHg) (1.44 atm toluene)}}{\text{(6 mmHg xylene)}}$$

Completing the calculation, you determine the facility determines that 730 lbs of toluene were released as stack air emissions during the reporting year. The quantity of toluene released should be reported in Section 5.2 of the 1999 Form R.

4.1.4.5 Estimating Release and Other Waste Management Quantities

Once all sources, types, and appropriate estimation methodologies have been identified, you can estimate the release and other waste management activity quantities of EPCRA Section 313 chemicals or chemical categories for each element of the Form R. The recommended approach is that you estimate amounts from all sources at your facility to each type as identified by the elements of Form R. Table 4-3 presents a work sheet that may be helpful in compiling this information.

If you prepare a Form R, you must also enter on-site treatment information in Section 7A, including the code for each treatment method used, the destruction and removal efficiency for the EPCRA Section 313 chemical or chemical category in the treated waste stream, and the concentration of the EPCRA Section 313 chemical or chemical category in the influent to treatment. You should report treatment methods that do not actually destroy or remove the chemical or chemical category by entering “zero (0)” for removal efficiency. Similarly, on-site energy recovery methods and on-site recycling methods must be reported in Sections 7B and 7C, respectively.

Table 4-3

Release and Other Waste Management Quantity Estimation Worksheet

Facility Name: ____________________
EPCRA Section 313 Chemical or Chemical Category: ____________________
CAS Registry Number: ____________________
Reporting Year: ____________________

Date Worksheet Prepared: __________
Prepared by: ____________________

ON SITE			
Release or Other Waste Management Activity Type	**Amount (lb)**	**Basis of Estimate**	**Form R Element* (1999 version)**
FUGITIVE AIR			
Equipment Leaks			5.1 and 8.1 or 8.8
Process Areas			5.1 and 8.1 or 8.8
Evaporative Losses, Spills, Surface Impoundments			5.1 and 8.1 or 8.8
Total =			5.1 and 8.1 or 8.8
STACK AIR			
Process Vents			5.2 and 8.1 or 8.8
Storage Tanks			5.2 and 8.1 or 8.8
Control Device Stacks			5.2 and 8.1 or 8.8
Other			5.2 and 8.1 or 8.8
Total =			5.2 and 8.1 or 8.8
RECEIVING STREAM/WATER BODY DISCHARGE			
Stormwater Discharge			5.3 and 8.1 or 8.8
On-Site Treatment Plant Discharge			5.3 and 8.1 or 8.8
Total =			5.3 and 8.1 or 8.8
ON-SITE UNDERGROUND INJECTION			
Underground Injection to Class I Wells			5.4 and 8.1 or 8.8
Underground Injection to Class II - V Wells			5.4 and 8.1 or 8.8
Total =			5.4 and 8.1 or 8.8

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*Entries for Section 8.8 only if release is result of remedial action, catastrophic event, or one-time event not associated with production process.

Table 4-3 (Continued)

ON SITE			
Release or Other Waste Management Activity Type	**Amount (lb)**	**Basis of Estimate**	**Form R Element* (1999 version)**
ON-SITE LAND			
RCRA Subtitle C Landfill			5.5 and 8.1 or 8.8
Other Landfill			5.5 and 8.1 or 8.8
Land Treatment/Application Farming			5.5 and 8.1 or 8.8
Surface Impoundment			5.5 and 8.1 or 8.8
Other Disposal			5.5 and 8.1 or 8.8
Total =			5.5 and 8.1 or 8.8
ON-SITE ENERGY RECOVERY			
Industrial Kiln			8.2
Industrial Furnace			8.2
Industrial Boiler			8.2
Other Energy Recovery Methods			8.2
Total =			8.2
ON-SITE RECYCLING			
Solvents/Organics Recovery			8.4
Metals Recovery			8.4
Acid Regeneration			8.4
Other Reuse or Recovery			8.4
Total =			8.4
ON-SITE TREATMENT			
Air Emissions Treatment			8.6
Biological Treatment			8.6
Chemical Treatment			8.6
Incineration/Thermal Treatment			8.6
Physical Treatment			8.6
Solidification/Stabilization			8.6
Total =			8.6

*Entries for Section 8.8 only if release is result of remedial action, catastrophic event, or one-time event not associated with production process.

Table 4-3 (Continued)

OFF SITE				
Release or Other Waste Management Activity Type	**Amount (lb)**	**Basis of Estimate**	**Form R Element* (1999 version)**	**Off-Site Location (name)**
OFF-SITE DISPOSAL				
Solidification/Stabilization (metals and metal compounds only)			6.2 and 8.1 or 8.8	
Amount of metal and metal compounds to POTW			6.1 and 8.1 or 8.8	
Wastewater Treatment (excluding POTWs) metals and metal compounds only			6.2 and 8.1 or 8.8	
Underground Injection			6.2 and 8.1 or 8.8	
Landfill/Surface Impoundment			6.2 and 8.1 or 8.8	
Land Treatment			6.2 and 8.1 or 8.8	
Other Land Disposal			6.2 and 8.1 or 8.8	
Other Off-Site Management			6.2 and 8.1 or 8.8	
Total =			6.2 and 8.1 or 8.8	
OTHER AMOUNTS SENT OFF SITE				
Amounts sent for storage			6.2 and 8.1 or 8.8	
Amounts sent for unknown waste management practice			6.2 and 8.1 or 8.8	
Total =			6.2 and 8.1 or 8.8	
OFF-SITE TREATMENT				
Solidification/Stabilization			6.2 and 8.7 or 8.8	
Incineration/Thermal Treatment			6.2 and 8.7 or 8.8	
Incineration/Insignificant Fuel Value			6.2 and 8.7 or 8.8	
Wastewater Treatment (to POTW excluding metals and metal compounds)			6.1 and 8.7 or 8.8	
Wastewater Treatment (excluding POTW and metal and metal compounds)			6.2 and 8.7 or 8.8	
Sent to Waste Treatment Broker			6.2 and 8.7 or 8.8	
Total =			6.2 and 8.7 or 8.8	

*Entries for Section 8.8 only if release is result of remedial action, catastrophic event, or one-time event not associated with production process.

Table 4-3 (Continued)

OFF SITE				
Release or Other Waste Management Activity Type	**Amount (lb)**	**Basis of Estimate**	**Form R Element* (1999 version)**	**Off-Site Location (name)**
OFF-SITE ENERGY RECOVERY				
Off-Site Energy Recovery			6.2 and 8.3 or 8.8	
Sent to Energy Recovery Broker			6.2 and 8.3 or 8.8	
Total =			6.2 and 8.3 or 8.8	
OFF-SITE RECYCLING				
Solvents/Organics Recovery			6.2 and 8.5 or 8.8	
Metals Recovery			6.2 and 8.5 or 8.8	
Other Reuse or Recovery			6.2 and 8.5 or 8.8	
Acid Regeneration			6.2 and 8.5 or 8.8	
Sent to Recycling Waste Broker			6.2 and 8.5 or 8.8	
Total =			6.2 and 8.5 or 8.8	

*Entries for Section 8.8 only if release is result of remedial action, catastrophic event, or one-time event not associated with production process.

4.2 Determination of Release and Other Waste Management Activity Quantities from Rubber and Plastic Manufacturing Processes

Rubber and plastics manufacturing is comprised of various processes and activities. This section will present specific information on processes, release and other waste management types and sources, and sample calculations for estimating quantities released and otherwise managed as waste, from these activities. Four processes, and their corresponding use of typical EPCRA Section 313 chemicals, will be discussed:

- Synthetic rubber manufacturing and rubber processing (Section 4.2.1);
- Rubber product manufacturing (Section 4.2.2);
- Tire manufacturing (Section 4.2.3); and
- Plastic product manufacturing (Section 4.2.4).

Each of the above processes has multiple unit operations many of which include EPCRA Section 313 chemicals. For instance: synthetic rubber manufacturing activities include polymerization during which chemicals such as catalysts, activators, and initiators are processed or otherwise used in the reactors; rubber processing chemical activities include coagulation and cleaning operations; at rubber product and tire manufacturing sites, operations such as building, vulcanizing, and finishing operations include chemical activities using reinforcing materials and adhesives, vulcanizing agents and accelerators, and finishing chemicals, which may contain EPCRA Section 313 chemicals; compounding and mixing operations at plastic product manufacturing facilities may include the use of EPCRA Section 313 chemicals in foaming agents, catalysts, lubricants and plasticizers; finally, finishing operations may include chemical activities such as coating, dyeing, and/or spraying.

Historical data show that the primary EPCRA Section 313 chemicals reported from the manufacture of rubber and plastic products are solvents. The most commonly encountered solvents include acetone, toluene, methyl ethyl ketone (MEK), 1,1,1 -trichloroethane, and dichloromethane. Large quantities of metals including copper, lead and lead compounds and zinc compounds are also commonly reported.

4.2.1 Synthetic Rubber Manufacturing and Rubber Processing

Rubber manufacturing and processing facilities produce synthetic rubber and process natural and synthetic rubber into material for use in the manufacturing of rubber products. The major synthetic rubber manufacturing operations are monomer inhibitor removal, polymerization, distillation, steam stripping, and monomer separation/recycling. Synthetic rubber manufacturing facilities may use an emulsion polymerization process or a solution polymerization process. The major difference is that solution polymerization uses organic solvents, such as cyclohexane, toluene, and n-hexane and has an additional solvent recovery step. Therefore it does not generate wastewater. Emulsion polymerization uses a soap and water solution to add activators, catalysts, modifiers, and imitators to the monomer mix. This results in the generation of wastewater from this process. Synthetic and natural rubber processing steps may include coagulation and screening, rinsing and dewatering, cutting and rolling, and drying steps. The final product is a strong elastic material that can be used to manufacture items such as tires, belts, hoses, and a myriad of other rubber products.

Step 1: Prepare a Process Flow Diagram

Figure 4-3 shows a typical synthetic rubber manufacturing emulsion process and Figure 4-4 depicts the differences between the emulsion polymerization process and the solution polymerization process. Figure 4-5 shows a basic process flow diagram for processing the natural and synthetic rubber to prepare it for the manufacturing of rubber products.

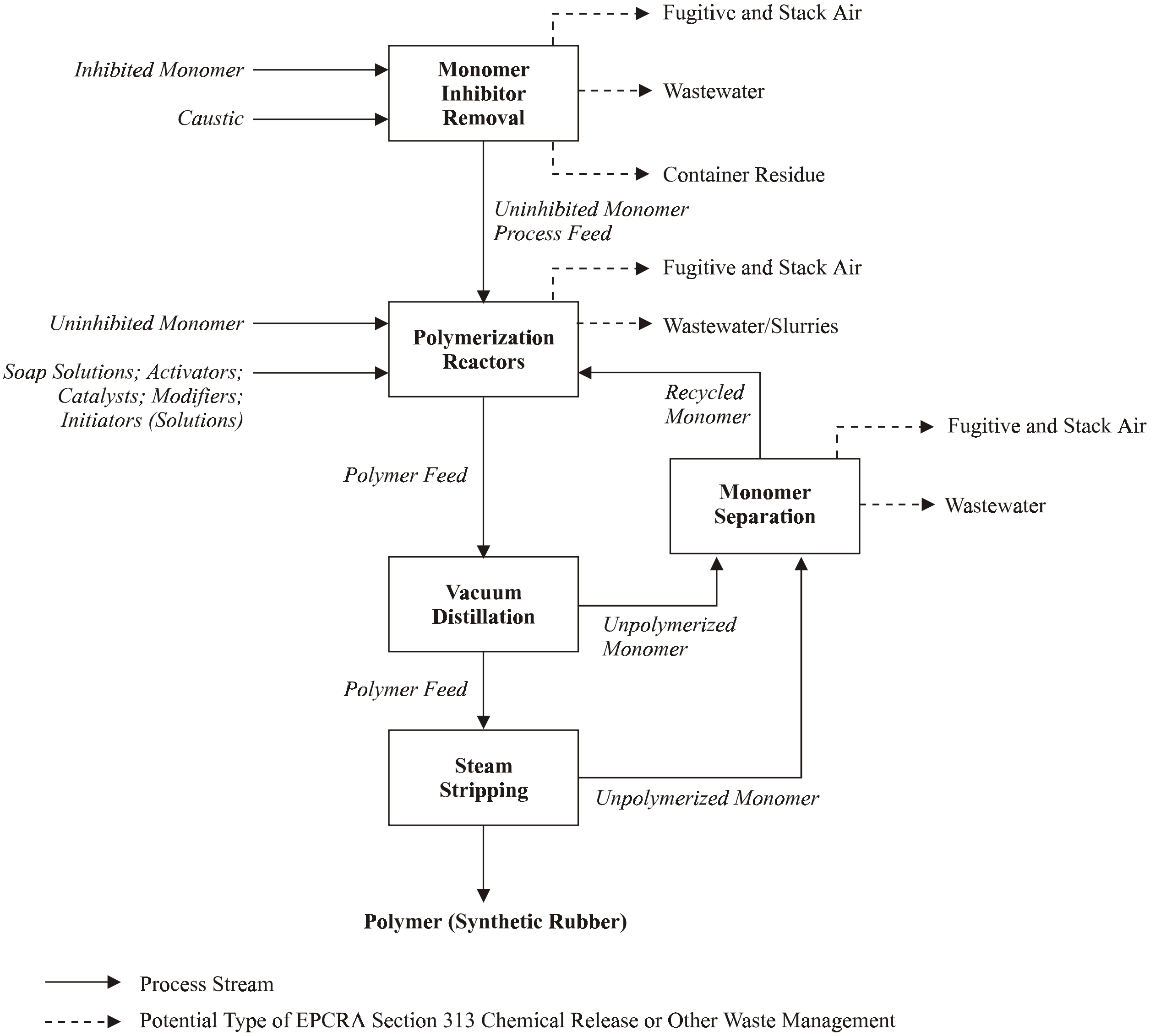

Figure 4-3. Typical Emulsion Process for Manufacturing Synthetic Rubber

(Ref: U.S. EPA, Title III Section 313 Release Reporting Guidance, *Estimating Chemical Releases from Rubber Production and Compounding* (EPA 560/4-88-004q). March 1988.)

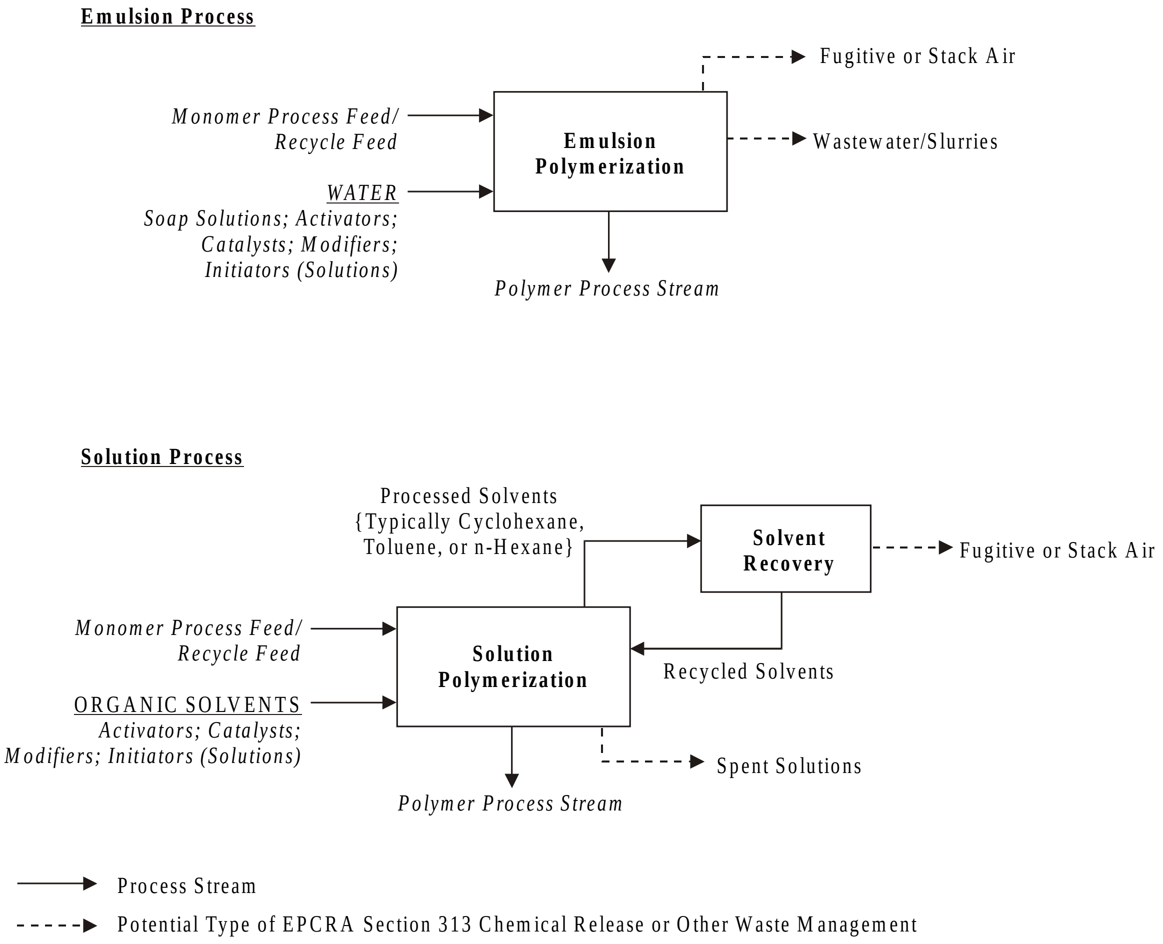

Figure 4-4. Comparison Between Emulsion and Solution Polymerization Process

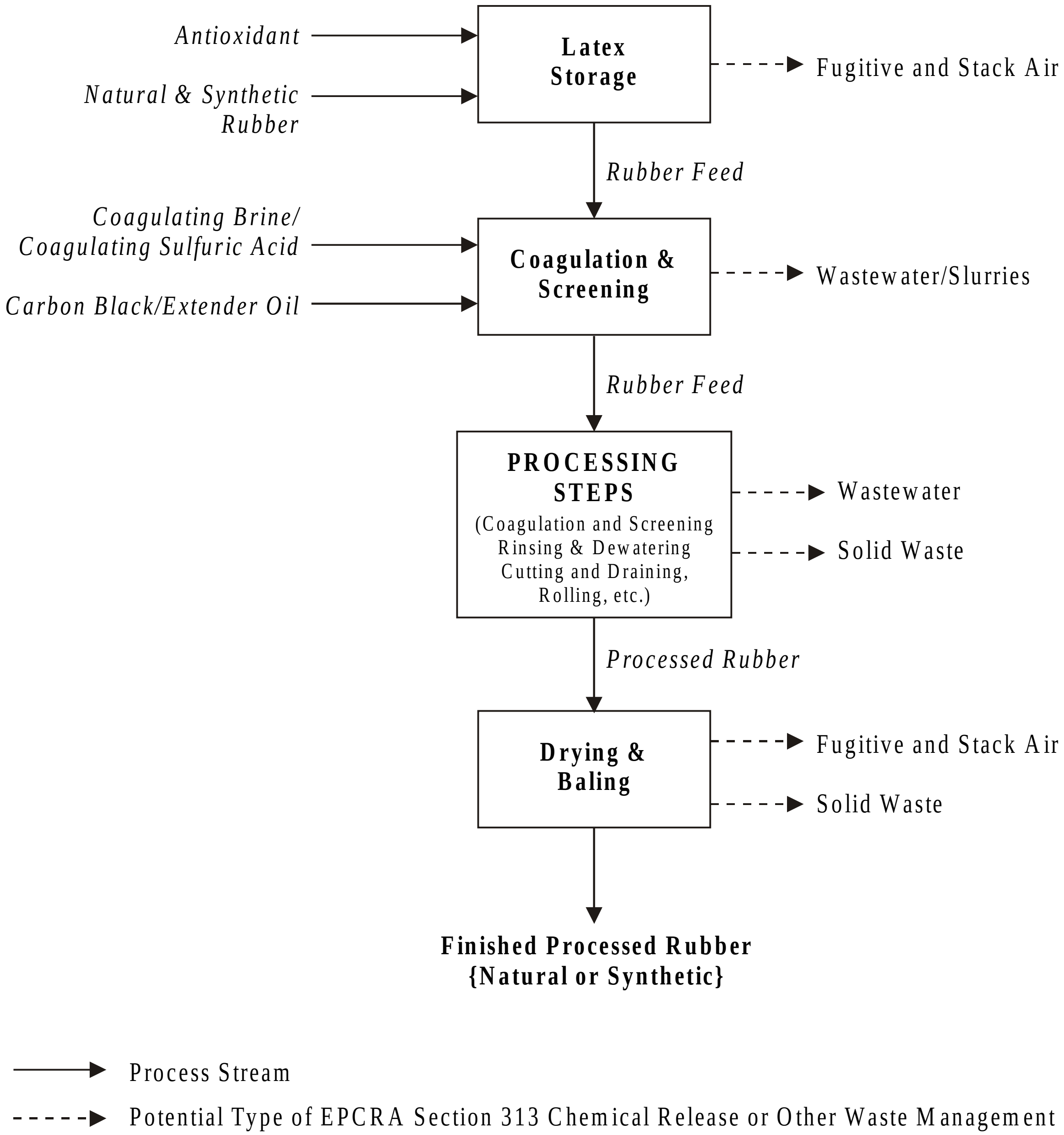

Figure 4-5. Processing Rubber to Prepare for Product Manufacture

(Ref: U.S. EPA, Title III Section 313 Release Reporting Guidance, *Estimating Chemical Releases from Rubber Production and Compounding* (EPA 560/4-88-004q). March 1988.)

Step 2: Identify EPCRA Section 313 Chemicals and Chemical Categories and Potential Sources of Chemical Release and Other Waste Management Activities

EPCRA Section 313 chemicals in air may come from sources such as absorber vents, pumps, relief valves, and fittings located throughout the facility. Loading/unloading and transfer operations are sources of fugitive air releases. Fugitive emissions most likely occur during inhibitor removal and during the addition of any volatile EPCRA Section 313 chemical from storage tanks. Major unit operations that are potential sources of EPCRA Section 313 chemicals to air include monomer recovery, solvent recovery for solution polymerization, and drying operations. Sources such as storage tank and reactor vents may generate stack air emissions of EPCRA Section 313 chemicals. Air pollution control devices located on equipment vents, such as solvent recovery units, monomer separators, and polymerization reactors may also be a source of stack air emissions.

AP-42 devotes an entire chapter, Chapter 7: Liquid Storage Tanks, to estimating emissions from storage tanks. The equations are presented for various tank types including: fixed roof; external and internal floating roof; covered floating roof; variable vapor space; and low and high pressure. In addition to physical parameters of the tank, the equations consider properties of the liquid including: vapor pressure; molecular weight; temperature (daily maximum and minimum and average); meteorological conditions including temperature; and solar absorbance. The equations can be complex and labor intensive; therefore, U.S. EPA has developed a software program called "TANKS" that computes estimates of volatile organic compound emissions from fixed and floating roof storage tanks. For purposes of EPCRA Section 313 reporting all emission estimates calculated using the TANKS program are considered stack emissions and reported in Part II, Section 5.2 of the Form R. TANKS can be downloaded from the U.S. EPA web page:

- **http://www.epa.gov/ttn/chief/tanks.html**.

Potential liquid sources of EPCRA Section 313 chemicals include equipment leaks and process operations during monomer inhibitor removal, polymerization, steam stripping, monomer separation, rubber rinsing and draining, coagulation and screening and final cleaning and finishing. Spent solutions such as polymer reactor slurries may contain EPCRA Section 313 chemicals. Wastewater or liquid slurries may also come from wastewater treatment operations, rinsing of shipping containers, utility operations, or equipment cleaning (e.g., reactor cleaning). You should also consider spill clean-ups and housekeeping practices when determining liquid sources of EPCRA Section 313 chemicals.

Solid sources of EPCRA Section 313 chemicals include disposal or cleaning of "empty" shipping containers; residue in shipping containers can be estimated using values listed in Table 4-1. Materials from processing (e.g., cutting), drying and baling operations may contain EPCRA Section 313 chemicals. Reactor cleaning may also generate solid or slurry materials containing EPCRA Section 313 chemicals. Off-specification materials and suspended solids in process wastewater are two other sources of solid wastes that may contain EPCRA Section 313 chemicals.

COMMON ERROR - Direct Reuse vs. Recycling

The direct reuse of an EPCRA Section 313 chemical does not need to be included in the amount reported in Part II, Section 8 of Form R. However, recycling of the chemical should be included.

Step 3: Identify Release and Other Waste Management Activity Types

EPCRA Section 313 chemicals may be released or otherwise managed as waste on site or transferred off site through wastewater, fugitive and stack air, sludges and slurries, and other materials. Fugitive and stack air emissions could include volatile compounds (e.g., solvents) and particulates (e.g., dust) from process or transfer operations.

EPCRA Section 313 chemicals such as monomers may become airborne during unloading and transfer at the inhibitor removal step. Volatile chemicals may be emitted or collected at process vents and control devices; solvents such as toluene, cyclohexane, and/or n-hexane are typically used during solution polymerization and may be vented during solvent recovery.

Wastewater types could include off-site transfer to a POTW, on-site treatment and/or underground injection.

Solid wastes can be transferred off site for recycling or reuse and/or treatment and disposal.

Table 4-4 summarizes the typical release and other waste management activity sources and types and lists the typical EPCRA Section 313 chemicals associated with each for rubber manufacturing and processing operations.

Table 4-4

Sources and Types of EPCRA Section 313 Chemicals for Rubber Manufacturing and Processing

Unit Operation/ Source Activity	Release and Other Waste Management Types	Typical EPCRA Section 313 Chemicals
Monomer Inhibitor Removal	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Monomers: 1,3-Butadiene, acrylic acid, acrylonitrile, butyl acrylate, chloroprene, epichlorohydrin, ethyl acrylate, methyl methacrylate, ethylene, ethylene glycol, ethylene oxide, propylene, styrene
Emulsion Polymerization	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Cobalt compounds, nickel compounds, titanium tetrachloride, hydroquinone
Solution Polymerization	Fugitive and Stack Air On-site land or off-site disposal	Solvents: n-Hexane, cyclohexane, toluene Catalysts, Modifiers, Initiators and Activators
Monomer Separation (Includes Distillation and Steam Stripping)	Fugitive and Stack Air Receiving stream or POTW	Unpolymerized monomers (see monomer list above)
Latex Storage	Fugitive and Stack Air	Remaining solvents, monomers, antioxidants; phenylenediamine
Coagulation and Screening	Receiving stream or POTW On-site land or off-site disposal	Spent slurries and solutions
Rinsing and Dewatering	Receiving stream or POTW	Chemicals rinsed from rubber
Cutting, Rolling and Draining	Receiving stream or POTW On-site land or off-site disposal	Any EPCRA Section 313 chemicals incorporated into products that are also present in rubber material scraps
Drying and Baling	Fugitive and Stack Air On-site land or off-site disposal	Monomers (see list above) Off-specification product

Step 4: Determine the Most Appropriate Method(s) and Calculate the Estimates for Release and Other Waste Management Activity Quantities

Due to the complex process of rubber manufacturing and processing, calculating release and other waste management activity quantities often entails the use of multiple methods. If direct monitoring data are not available, you may use a combination of emission factors, mass balances, and engineering calculations to determine the reportable amount of an EPCRA Section 313 chemical.

Fugitive air emissions may occur during loading and unloading operations. The amount of an EPCRA Section 313 chemical emitted can be calculated using emission factors such as those in U.S. EPA's *Compilation of Air Pollutant Emission Factors* (AP-42), using EPA's TANKS program, or using other engineering calculations. Emissions of EPCRA Section 313 solvents used as processing aids can be determined by mass balance calculations; it may be appropriate to assume all solvents are emitted to the air if they are not expected to remain with the product. You should then partition the air emissions between fugitive and stack. If an air pollution control device is used, the efficiency of the system should be considered to determine the quantity treated on site, and the quantity actually released. Emissions from these control device systems should be considered stack emissions.

Air emission data may be available from process monitoring information (vent flows and concentrations), air operating permits, or the technical literature. Available information may be in the form of total Volatile Organic Compounds (VOC) and particulate emissions. Engineering calculations and assumptions can be used with monitoring data or emission factors to convert available information into chemical-specific estimates, as shown in the following example.

Example - VOC Emissions
(AP-42 emission factor for VOC and subsequent on-site treatment)

A monomer plant produces 40,000 tons of crumb emulsion latex annually. Measurement data are unavailable and an accurate mass balance is difficult to perform because of the large input and output streams. The facility air from the monomer plant is sent to a flare before release to the atmosphere. Based on vendor information and facility test data, the flare destruction efficiency is assumed to be 90%. According to AP-42 emission factors, total volatile organic emissions are approximately 5.2 pounds per ton of latex produced. Note that this is "non-chemical-specific." Therefore, it is not considered an emission factor for EPCRA Section 313 purposes. Rather, it should be reported as an engineering calculation. An occupational monitoring program at this plant indicated that 1,3-butadiene concentrations in the ambient air were typically nine times greater than styrene concentrations. Styrene and 1,3-butadiene make up the majority of the VOC emissions at this plant; therefore, you can assume that the total amount of 1,3-butadiene and styrene in the air is 5.2 pounds per ton of latex. Based on the 9-to-1 ratio, the amount of 1,3-butadiene and styrene in the air can be calculated as follows:

Amount of 1,3-butadiene in air:
(40,000 tons latex) × (5.2 lb VOC/ ton latex) × (90%) = 187,200 lb

Amount of styrene in air:
(40,000 tons latex) × (5.2 lb VOC/ ton latex) × (10%) = 20,800 lb

Amount of 1,3-butadiene in stack emissions (Part II, Sections 5.2 and 8.1 of 1999 Form R):
(187,200 lb) × (10%) = 18,720 lb

Amount of styrene in stack emissions (Part II, Sections 5.2 and 8.1 of 1999 Form R):
(20,800 lb) × (10%) = 2,080 lb

Amount of 1,3-butadiene treated on site (Part II, Section 8.6 of 1999 Form R):
(187,200 lb) × (90%) = 168,480 lb

Amount of styrene treated on site (Part II, Section 8.6 of 1999 Form R):
(20,800 lb) × (90%) = 18,720 lb

The on-site waste treatment should be noted on the Form R as follows: in Part II, Section 7A.1a, enter "A," in Section 7A.1b, enter "A01," in Section 7A.1b, 2, enter "N/A;" in Section 7A.1c, enter "1," in Section 7A.1d, enter "90%," and in Section 7A.1e, check the "yes" box.

Mass balance estimations are applicable to rubber manufacturing operations because of the precision required when weighing out additives for the rubber recipe. Given detailed information on chemical inputs and the quantity of a chemical retained in the product, a facility can calculate the amount released and otherwise managed as waste. The following example shows how a mass balance may be used to estimate EPCRA Section 313 chemicals incorporated into the manufactured or processed rubber. Mass balances are also effective in calculating quantities of otherwise used chemicals, such as catalysts, solvents, acids, and bases. Because these chemicals are not incorporated into the final product, the quantity used will often equal the quantity released and otherwise managed as waste. Engineering assumptions may then be applied to determine the fate of these chemicals.

Example - Use of Mass Balance in Synthetic Rubber Production

A synthetic rubber manufacturing facility produced 80,000 tons of polybutadiene during the reporting year. Cobalt chloride, $CoCl_2$, was used as a catalyst in the reaction process, and is the only use of a cobalt compound at the facility. Purchasing and inventory records show 64,000 pounds of $CoCl_2$ were processed during the year. Analysis of the polybutadiene showed it contained an average of 170 ppm of cobalt.

Threshold estimates for metal compounds should be based on the weight of the entire compound while release and other waste management quantity estimates should be based on the weight of the parent metal. Thus, for the threshold determination, the amount of the cobalt compound, 64,000 pounds per year, exceeds the 25,000 pounds per year processing threshold; therefore, an EPCRA Section 313 report must be submitted. For the release and other waste management quantity estimation only the amount of the parent metal, cobalt, is considered.

Assuming the only two discharges of cobalt are as a component of the polybutadiene and in the equipment cleaning wastewater, the amount in each stream can be estimated using a mass balance (code C) as follows: [Atomic weight of Co = 59; molecular weight of $CoCl_2$ = 130]

Amount of cobalt entering the process:

$$(64{,}000 \text{ lb } CoCl_2) \times (59 \text{ lb Co}/ 130 \text{ lb } CoCl_2) = 29{,}046 \text{ lb Co}$$

Amount of cobalt in the polybutadiene:

$$(80{,}000 \text{ tons}) \times (2{,}000 \text{ lb/ton}) \times (170 \text{ lb Co} / 10^6 \text{ lb polybutadiene}) = 27{,}200 \text{ lb Co}$$

Amount of cobalt in wastewater:

$$(29{,}046) - (27{,}200) = 1{,}846 \text{ lb Co}$$

Since the reportable amount of cobalt is greater than 500 pounds per year, a Form R must be prepared. If untreated wastewater from the facility was discharged directly to a POTW, the facility would report 1,846 pounds of cobalt in Section 6.1 of the Form R and include in Section 8.1. If pretreatment was provided on site and a sludge was generated, the amount of cobalt released or otherwise managed as a solid waste would have to be estimated as appropriate.

4.2.2 Rubber Product Manufacturing

Rubber product manufacturing is defined as the compounding and processing of natural and/or synthetic rubber into a product. The unit operations involved may include compounding of the raw material into the desired formulation, extrusion, calendering, injection molding, building, vulcanization, and finishing operations. The compounding step mixes natural and/or synthetic rubber with carbon black, oils, and other chemicals to produce a rubber with product-specific qualities. EPCRA Section 313 chemicals may be introduced into the process as processing aids, vulcanizing agents, activators, accelerators, age resistors, and fillers.

Step 1: Prepare a Process Flow Diagram

Figure 4-6 shows a typical process flow diagram for rubber product manufacturing. Depending on the product, forming steps may include calendering, extruding, or injection molding operations.

Step 2: Identify EPCRA Section 313 Chemicals and Chemical Categories and Potential Sources of Chemical Release and Other Waste Management Activities

Vents or dust collection control devices used during compounding and mixing operations are sources of EPCRA Section 313 chemicals in air. Fugitive dust emissions or spills may be generated by storage of dry chemicals in open bins and weighing of chemicals before mixing. Volatile solvent evaporation can occur via sources such as equipment cleaning and molding operations. During vulcanization processes, EPCRA Section 313 chemicals can be coincidentally manufactured and emitted to the air. Operations such as coating, grinding, and cutting are also potential sources of releases and other waste management activities.

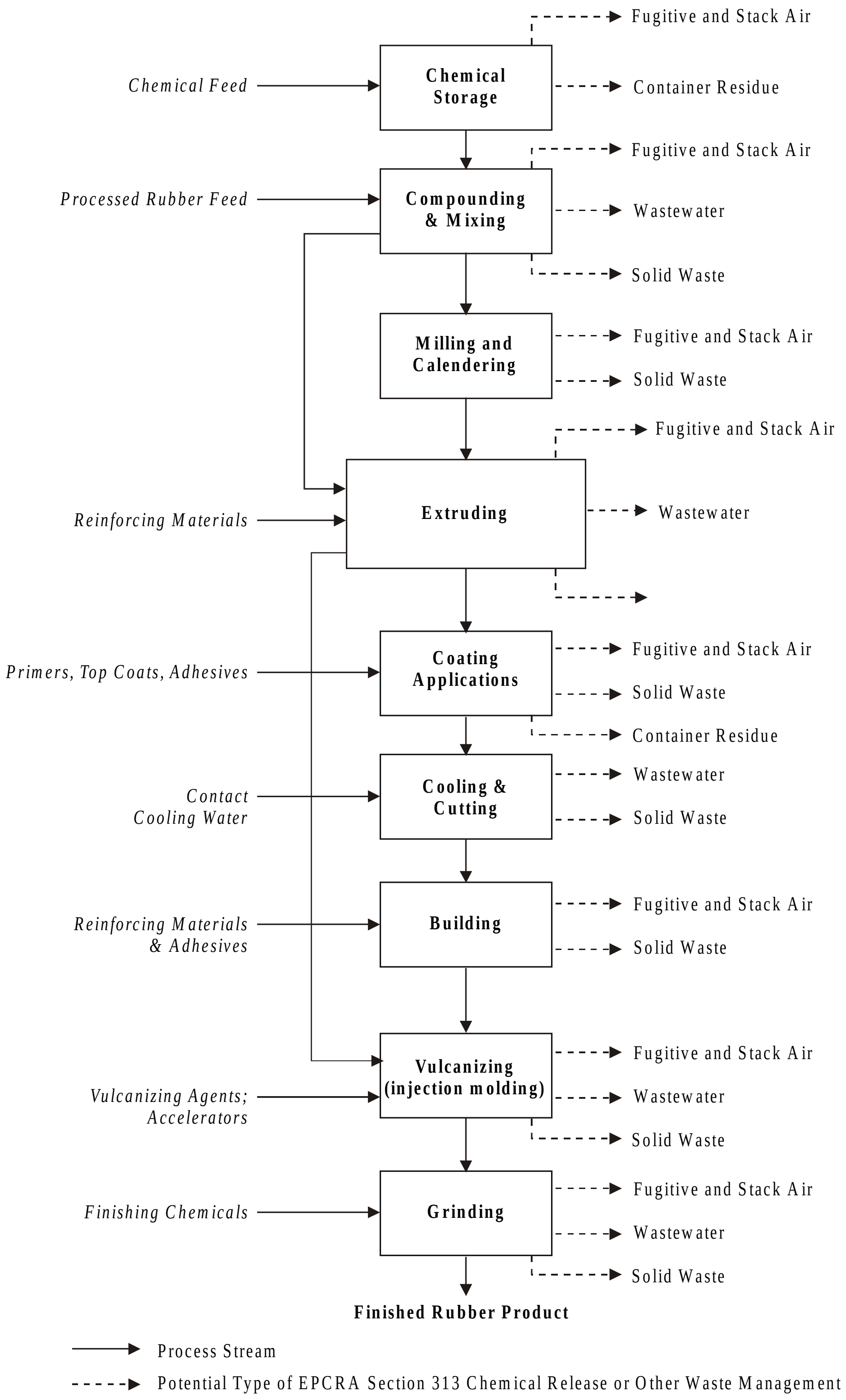

Figure 4-6. Typical Rubber Product Manufacturing

(Ref: U.S. EPA, Sector Notebook Project, *Profile of the Rubber and Plastics Industry* (EPA 310-R-95-016), September 1995.)

COMMON ERROR - Coincidental Manufacturing

Coincidentally manufactured chemicals are often overlooked when determining sources of EPCRA Section 313 chemicals. AP-42 lists Rubber Manufacturers Association emission factors for various process steps. These factors can be used to calculate the amount of EPCRA Section 313 chemicals coincidentally manufactured. The *de minimis* exemption only applies to coincidentally manufactured impurities present in products if it they remain in the product for distribution into commerce. *De minimis* exemption, however, does not apply to EPCRA Section 313 chemicals manufactured as byproducts, regardless of whether the byproduct is a result of waste treatment.

Please note not all of the chemicals listed in AP-42 for various rubber processing steps may be introduced to the process as raw materials in various mixtures. The facility must determine which reportable chemicals, if any, are coincidentally manufactured.

Water discharges may be generated by direct contact heating and/or cooling, vulcanizing, and equipment cleaning operations. Process water may include spent solutions or rinsing water from various operations. Water used for spill clean-up or general housekeeping such as equipment and area washdowns are potential sources of EPCRA Section 313 chemical releases or other waste management activities. Wastewater may contain carbon black or additives rinsed from the processing operations. Equipment sources include extruder cooling conveyors and vulcanization equipment. Residual material from container cleaning operations is also a source of water discharges.

Solid and other wastes or materials may be released or otherwise managed as waste throughout the facility during compounding, forming, building, and finishing operations. Equipment cleaning, collection of dust on dry filters (fabric filters and/or bag houses), and residual material in “empty” shipping container disposal or cleaning may result in solid waste generation. Residues in “empty” shipping containers can be estimated using the values in Table 4-1. Operations such as surface grinding generate dust that may then be controlled in a baghouse, cyclone, or electrostatic precipitator; this collected material may then be disposed or treated. Scorched or waste rubber sources can occur throughout the facility from mixing, milling, calendering, molding, etc.

Step 3: Identify Release and Other Waste Management Activity Types

Rubber product manufacturing releases and other waste management activity types include stack and fugitive air emissions, water discharges, and solid wastes that are managed on site or transferred off site. Table 4-5 summarizes the release and other waste management activity sources and types and lists the typical EPCRA Section 313 chemicals associated with each for rubber product manufacturing operations.

Table 4-5

Source and Types of EPCRA Section 313 Chemicals for Rubber Product Manufacturing

Unit Operation/ Source Activity	Release and Other Waste Management Activity Type	Typical EPCRA Section 313 Chemicals
Chemical Storage	Fugitive and Stack Air On-site land or off-site disposal	Solvents in tanks and drums; empty bag residue for zinc oxide and TMTD
Compounding and Mixing	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Antimony compounds, carbon disulfide, dibutyl phthalate, nickel compounds, zinc compounds
Milling and Calendering	Fugitive and Stack Air On-site land or off-site disposal	Coincidentally manufactured chemicals such as hexane; zinc compounds in wastewater and scrap rubber
Extruding	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Coincidentally manufactured chemicals such as hexane; zinc compounds in wastewater and scrap rubber
Building	Fugitive and Stack Air On-site land or off-site disposal	Toluene, MEK, and xylene
Vulcanizing	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Vulcanizing agents: Lead compounds, selenium compounds, zinc compounds Accelerators: Diethanolamine, ethylene thiourea, zinc compounds, lead compounds Retardants: n-Nitrosodiphenylamine Reaction products: Ammonia, carbon disulfide
Grinding	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Protective agents: Phenol, p-phenylenediamine, zinc compounds
Coating Application	Fugitive and stack air, on-site or off-site waste management	MEK, xylene, toluene, container residue

Volatile chemicals (e.g., solvents) are often released to the atmosphere, but may be controlled (e.g., by a scrubber) prior to release. Fugitive air particulates such as dusts from the mixing and compounding area may be collected in a baghouse or other air pollution control device; the collected dust is typically either disposed, reused or recycled. Dusts released to the atmosphere such as zinc may also be washed away with storm water into a facility's discharge point or wastewater treatment system.

The process wastewater generated at the facility may be treated on site, discharged to surface waters, or transferred off site for treatment. Lubrication, hydraulic, and process oils are typically transferred to an off-site location for waste management activities.

Solid and other wastes or material types include scrap and scorched rubber, off-specification products, collected dust, rubber trimmings, and residue in shipping containers. Solids and slurries may also be collected and subsequently disposed or waste managed from equipment cleaning. Uncured rubber waste is often recycled on site, cured rubber waste may be recycled or sold off site, and off-specification rubber may either be disposed of on or off site or sold to other companies.

Step 4: Determine the Most Appropriate Method(s) and Calculate the Estimates for Release and Other Waste Management Activity Quantities

In lieu of site-specific data, air emission factors may be appropriate to determine the amount of an EPCRA Section 313 chemical emitted to the air or generated during operations. Section 4-12 of AP-42 lists chemical-specific emission factors for rubber product manufacturing operations. Please note VOC emission factors are not chemical specific and their use must be classified as engineering calculations (Code O) for EPCRA Section 313 reporting purposes.

Mass balances are also often appropriate for use in determining the amount of EPCRA Section 313 chemical released or otherwise managed as waste. Compounded rubber mixtures typically have set concentrations for the chemicals added. The total amount of chemical processed during the year can be determined by knowing the annual throughput of the rubber mixture, along with its corresponding chemical compound recipe. The quantities used but not incorporated into the final product can be similarly calculated. Engineering assumptions and calculations can then be used to determine the release or other waste management activity quantity and medium type for each EPCRA Section 313 chemical.

A potential for double counting of VOC emissions exists when compiling air emission data for a rubber manufacturing facility using a combination of mass balance and emission factor calculations. It arises in the use of solvents for the application of cements, solvent tackifiers, and release agents in the manufacture of rubber products, including tires. The mass balance calculation often assumes 100% loss of the solvent at the time of application to the rubber substrate. Anecdotal evidence suggests that as much as 5% of the solvent applied to the surface of the rubber may migrate into the rubber and show up later in the process as a volatile emission. Caution should therefore be exercised when compiling a facility wide solvent emission inventory that combines the use of mass balance and emission factor calculations. (From: Draft of Chapter 4.12 "Manufacture of Rubber Products" of AP-42 currently under review).

The following example shows a mass balance calculation for a metal compound processed as part of a rubber mixture.

Example - Estimating Quantities of Metal and Metal Compounds Using Mass Balance

A rubber product manufacturing facility prepares a mixture by adding chemicals to the synthetic rubber received from a rubber processing plant. One of the chemicals, zinc oxide (ZnO), is added such that the final concentration is 2.5% by weight. A careful review of the MSDS information for all the other additives indicates no other EPCRA Section 313 chemicals or compounds are present. Production records show 2,000 tons of the rubber mixture was processed during the reporting year. Inventory and purchasing records reveal the facility had 10,000 pounds of ZnO on hand at the beginning of the year, 100,000 pounds were purchased during the year, and 5,000 pounds remained at the end of the year. The threshold determination for this processed chemical is based on the entire weight of the zinc compound.

Amount of ZnO processed:
Beginning inventory + Purchased amount - Final inventory = Amount processed
10,000 pounds + 100,000 pounds - 5,000 pounds = 105,000 pounds

This amount exceeds the processing threshold of 25,000 pounds and an EPCRA Section 313 report must be prepared.

Only the amount of the parent metal, zinc (Zn), should be included in the release and other waste management amount estimation. The following mass balance can be used for this determination:
[Atomic weight of Zn = 65.4; molecular weight of ZnO = 81.4]

(Zn released or otherwise managed as waste) = (amount of Zn processed) -
(amount of Zn in product)

Amount of ZnO in product =
(2,000 tons product) × (2,000 lb/ton) × (2.5% ZnO)
= 100,000 pounds ZnO

Amount of ZnO released or otherwise managed =
105,000 pounds processed - 100,000 pounds in product = 5,000 pounds ZnO

Amount of Zn released or otherwise managed =
(5,000 pounds ZnO) × (65.4 pounds Zn/81.4 pounds ZnO) = 4,000 pounds Zn

This quantity of zinc should be partitioned to the applicable sections of the Form R (Part II, Sections 5, 6 and 8 of 1999 Form R) for zinc compounds as appropriate.

Note that, since the combined annual reportable amount exceeds 500 pounds, the facility is not eligible for the Form A and a Form R must be submitted.

COMMON ERROR - Consumed Chemicals

Be sure to consider a consumption term in your mass balance. Chemicals added for rubber product manufacturing may be consumed or reacted during the process. For example, an accelerator added to the rubber mixture may react during vulcanization. Some or all of the accelerator may be consumed during the process. Knowledge of the chemical reactivity and facility operations can help you determine the extent that an EPCRA Section 313 chemical has been consumed.

Monitoring data and engineering calculations may also be used to determine the amount of an EPCRA Section 313 chemical released or otherwise waste managed. Typical examples of monitoring data may be from stack test results for compliance with air permits or from testing wastewater discharge or transfer points for NPDES permits. Knowledge of facility operations may be used with monitoring data to perform engineering calculations. For example, sulfuric acid aerosols may be coincidentally manufactured in facility cooling towers, storage tanks, or boiler stacks. Monitoring of sulfuric acid or sulfur trioxide (SO_3), which reacts with water to form sulfuric acid, would allow a facility to determine how much of the acid aerosol is generated. The following example demonstrates the calculation for the coincidental manufacture of sulfuric acid aerosols.

Example - Coincidental Manufacture of Sulfuric Acid Aerosols

Detailed information on reporting for sulfuric acid aerosols can be found in U.S. EPA's *EPCRA Section 313, Guidance for Reporting Sulfuric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size*), EPA-745-R-97-007, November 1997, Updated March 3, 1998 (see Appendix C). The example below shows how a facility may determine the amount of sulfuric acid aerosol coincidentally manufactured and the subsequent release and other waste management activity quantity. All sulfuric acid produced within the stack, including the gas and the mist, falls under the EPCRA Section 313 definition of a sulfuric acid aerosol.

A rubber products plant has oil-fired boilers on site, which burn approximately 3,000,000 gallons of No. 6 fuel oil annually. All boiler stack emissions are controlled by scrubbers that are 95% efficient for removal of sulfuric acid (H_2SO_4). Section 3.1.7 of the above referenced document provides data on the typical sulfur content of various types of fuel oil, and an emission factor to determine the amount of H_2SO_4 generated by the combustion of each gallon of oil.

Fuel oil No. 6 typically contains 3.97% sulfur (Appendix C). The H_2SO_4 emission factor for industrial boilers for uncontrolled combustion of fuel oil is:

$$(0.00245) \times (\text{weight percent of sulfur}) = \text{pound of } H_2SO_4/\text{gallons of fuel oil burned}$$

Thus, for this facility, the amount of H_2SO_4 coincidentally manufactured is:

$$= (0.00245) \times (3.97;\ \text{weight \% sulfur}) \times (3{,}000{,}000\ \text{gal/year; fuel oil burned})$$

$$= 29{,}180\ \text{pounds/year}$$

The amount of sulfuric acid aerosol generated on site exceeds the manufacturing threshold of 25,000 pounds per year; therefore an EPCRA Section 313 report must be submitted. The quantity of sulfuric acid aerosol that should be reported includes any release or other waste management activity quantities. The amount of sulfuric acid aerosol treated by the scrubber is:

H_2SO_4 treated:

$$= (29{,}180\ \text{pounds}) \times (95\%\ \text{scrubber efficiency})$$
$$= 27{,}721\ \text{pounds}$$

H_2SO_4 released as stack air emissions:

$$= (29{,}180\ \text{pounds}) \times (5\%\ \text{scrubber inefficiency})$$
$$= 1{,}459\ \text{pounds}$$

The 27,721 pounds removed by the scrubber is converted to a non-aerosol form and is therefore considered to be treated. Part II, Section 7 should be completed as appropriate and the quantity treated for destruction should be reported in Part II, Section 8.6. The quantity of stack air emissions and H_2SO_4 aerosols should be reported in Sections 5.2 and 8.1

4.2.3 Tire Manufacturing

Tire manufacturing is considered a special segment of rubber product manufacturing. It has many of the same processing steps as other rubber products, with the major variations in the extrusion and building steps. Many rubber components are used during building operations to form tires.

Step 1: Prepare a Process Flow Diagram

Figure 4-7 shows a typical process flow diagram for tire manufacturing. Operations for tire manufacturing that are not included in other rubber product manufacturing are the rubber coating of bead wires in an extruding process, rubber coating of fabrics in a calendering process, assembly of the final product on a tire-building machine, lubrication of the tires (known as green tire spraying), cementing processes, and scrap tire disposal.

Step 2: Identify EPCRA Section 313 Chemicals and Chemical Categories and Potential Sources of Chemical Release and Other Waste Management Activities

All of the sources listed in rubber product manufacturing also apply to tire production (see Section 4.2.2). Additional consideration should be taken for sources of VOC emissions from processes unique to tire manufacturing and the generation of scrap tires. EPCRA Section 313 chemicals, specifically solvents, may be emitted during building, cementing, and green tire spraying operations. Sources may include process equipment vents, control devices, valves, or general room air vents. Operations such as coating, grinding, and cutting can also result in releases and other waste management activities of dusts and excess rubber material containing EPCRA Section 313 materials. Off-specification rubber or tires and scrap materials may be generated during extruding, calendering, cutting, building, and vulcanization operations.

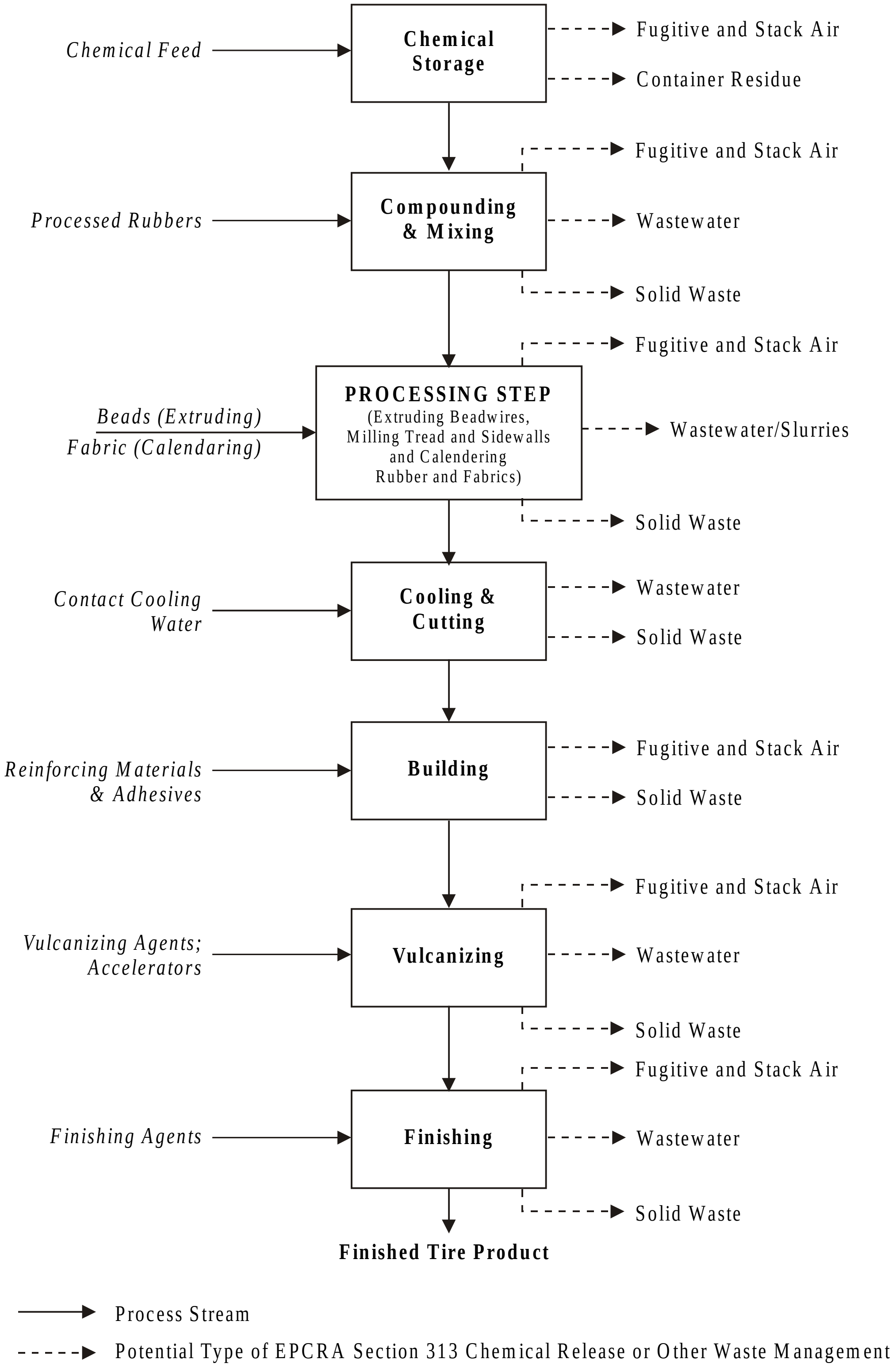

Figure 4-7. Typical Tire Manufacturing

(Ref. U.S. EPA Sector Notebook Project, *Profile of the Rubber and Plastics Industry* (EPA 310-R-95-016) September 1995.)

Step 3: Identify Release and Other Waste Management Activity Types

Tire manufacturing release and other waste management activity types typically include stack and fugitive air emissions, water discharges, and solid wastes that are managed on site or transferred off site. The release and waste management types described in Section 4.2.2 for rubber product manufacturing also apply to tire manufacturing. Additionally, solvents applied to tire components during building operations typically result in air emissions. Cementing operations may also result in the volatilization of EPCRA Section 313 chemicals. Control devices may be located on equipment, such as scrubbers that may transfer the chemicals to a water medium where the chemicals may be treated on site, transferred off site, or discharged to water. Scrap tires may be disposed, recycled, or transferred off site.

Table 4-6 summarizes the release and other waste management activity sources and types and lists the typical EPCRA Section 313 chemicals associated with each for tire manufacturing operations.

Table 4-6

Sources and Types of EPCRA Section 313 Chemicals for Tire Manufacturing

Unit Operation/ Source Activity	Release and Other Waste Management Activity Type	Typical EPCRA Section 313 Chemicals
Chemical Storage	Fugitive and Stack Air On-site land or off-site disposal	Empty bag residue for ZnO and TMTD adhesives in drums and tanks
Compounding and Mixing	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Antimony compounds, phenol, zinc compounds
Extruding	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	
Calendering	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Formaldehyde and styrene from fabric dripping
Cooling and Cutting	Receiving stream or POTW On-site land or off-site disposal	Zinc and cobalt compounds
Building	Fugitive and Stack Air On-site land or off-site disposal	Adhesives and adhesive solvents:

Table 4-6 (Continued)

Unit Operation/ Source Activity	Release and Other Waste Management Activity Type	Typical EPCRA Section 313 Chemicals
Vulcanizing	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Vulcanizing agents: lead compounds, selenium compounds, zinc compounds Accelerators: diethanolamine, ethylene thiourea, zinc compounds, lead compounds Retardants: n-nitrosodiphenylamine Reaction products: ammonia, carbon disulfide
Finishing	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Protective Agents: phenol, p-phenylenediamine, zinc compounds, solvents

Step 4: Determine the Most Appropriate Method(s) and Calculate the Estimates for Release and Other Waste Management Activity Quantities

As with rubber product manufacturing, emission factors may be used to determine the amount of a volatile EPCRA Section 313 chemical, such as a solvent, that is emitted to the air and subsequently released or managed as waste. AP-42 lists chemical emission factors for various unit operations. See discussion on potential for double counting of solvent emissions in Section 4.2.2., Step 4.

Emission factors associated with processes but not chemical specific may be used to determine reportable quantities; these factors are considered to be engineering calculations. Engineering calculations may be used to determine reportable quantities by using non-chemical-specific emission factors.

Mass balances are also often appropriate for estimating chemical releases and quantities otherwise managed. Formulations for rubber mixes and the final tire chemical concentration can be used in conjunction with production data and purchase and inventory records to determine the amount of a chemical leaving with the product and the amount sent off site or recycled with scrap tires and other waste streams.

Example - Use of Emission Factor to Estimate Air Emissions of Methyl Ethyl Ketone

A rubber tire manufacturing facility has determined it must file an EPCRA Section 313 report for methyl ethyl ketone (MEK). The following rubber products, along with their corresponding production amounts (P), are compounded and mixed on site:

Compound 1: Tire Inner Liner -- 1,500,000 pounds per year;
Compound 2: Tire Ply Coat -- 1,020,000 pounds per year;
Compound 3: Tire Belt Coat -- 1,020,000 pounds per year;
Compound 4: Tire Base/Sidewall -- 1,800,000 pounds per year;
Compound 5: Tire Apex -- 500,000 pounds per year;
Compound 6: Tire Tread -- 1,550,000 pounds per year; and
Compound 7: Tire Bladder -- 700,000 pounds per year.

The following MEK (or 2-butanone) emission factors (EF) apply to internal mixing and milling of each tire component [Ref: Draft of Chapter 4.12 "Manufacture of Rubber Products" of AP-42 currently under review].

Compound 1: 5.91 lb MEK / 10^6 lb rubber;
Compound 2: 1.59 lb MEK / 10^6 lb rubber;
Compound 3: 0.90 lb MEK / 10^6 lb rubber;
Compound 4: 2.74 lb MEK / 10^6 lb rubber;
Compound 5: 1.53 lb MEK / 10^6 lb rubber;
Compound 6: 0.44 lb MEK / 10^6 lb rubber; and
Compound 7: 1.40 lb MEK / 10^6 lb rubber.

The MEK air emissions from compound 1 are calculated as shown below:

MEK emissions = (EF) × (P)
MEK emissions (Compound 1) = (5.91 lb MEK/ 10^6 lb rubber) × (1,500,000 lb/yr)
= 8.9 pounds per year

The MEK emissions for the remaining compounds are calculated in the same manner and the resulting annual emissions are listed below

Compound 1: 8.9 lb MEK
Compound 2: 1.6 lb MEK
Compound 3: 0.92 lb MEK
Compound 4: 4.9 lb MEK
Compound 5: 0.77 lb MEK
Compound 6: 0.68 lb MEK
Compound 7: 0.98 lb MEK

The emissions resulting from the mixing and milling of all seven tire rubber components are calculated to total 19 pounds. If appropriate, you should consider the removal and destruction by air pollution control devices when determining the stack releases and quantities treated on site.

Air emissions should be reported in Sections 5 and 8.1

COMMON ERROR - Off-Specification Tires

Neither the article exemption nor the motor vehicle activity exemption applies to off-specification cured tires that are sent off site for disposal, recycling, or other waste management. EPCRA Section 313 chemicals present in the tires sent off site for disposal or recycling must be considered in threshold determinations and release and other waste management activity estimates. However, EPCRA Section 313 chemicals in tires that a facility purchases and uses for on-site vehicles are exempt.

4.2.4 Plastic Product Manufacturing

Plastic product manufacturing facilities make a variety of plastic products from plastic pellets, resins, etc. Depending on the product, which ranges from toys and footwear to industrial tower packing, various additives may be used to impart the desired properties to the finished product.

Step 1: Prepare a Process Flow Diagram

Figure 4-8 shows a typical process flow diagram for plastic product manufacturing. Various unit operations may be used in the manufacture of plastic products. The major steps are compounding, forming or molding, cooling, trimming, and finishing. Forming processes used in plastic product manufacture include casting and encapsulation, heating, injection systems, extrusion, thermoforming, and calendering. Types of molding operations include injection, rotational, transfer and compression, reaction, and blow molding.

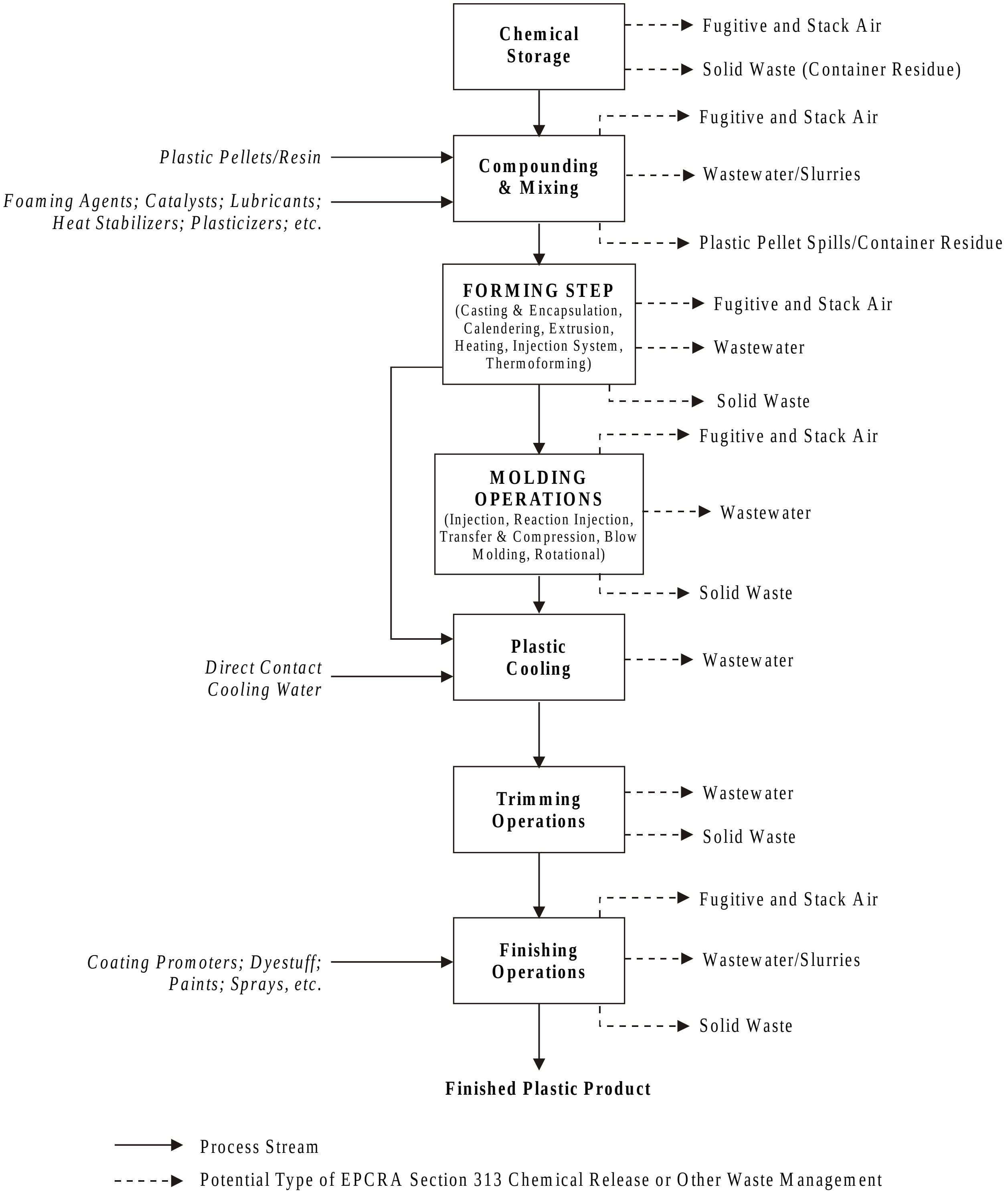

Figure 4-8. Typical Plastic Product Manufacturing

(Ref: U.S. EPA, Sector Notebook Project, *Profile of the Rubber and Plastics Industry* (EPA 310-R-95-016), September 1995.)

Step 2: Identify EPCRA Section 313 Chemicals and Chemical Categories and Potential Sources of Chemical Release and Other Waste Management Activities

The main sources of air emissions are typically the molding and extruding processes, during which chemicals are processed under high heat and pressure and emitted. Chemical storage, compounding equipment, and finishing operations are also sources of air emissions. Fugitive air sources are typically fittings, valves, pumps, etc. Unloading, storage, and transferring of additives may result in fugitives of volatile components or particulates. Stack air sources include equipment vents and air pollution control devices employed at the facility.

During forming and molding operations, water is used to cool or heat the plastic products or to clean the surface of the products and equipment. Water may also be used during finishing operations. The water may contact and retain EPCRA Section 313 chemicals during these operations. Spill clean-ups and housekeeping practices such as area and equipment washdowns are also sources of EPCRA Section 313 chemicals. Note that small spills that are "routinely observed," such as polymer pellets falling on the floor, are not considered to be a result of one-time events and should not be included in Part II, Section 8.8 (of the 1999 Form R) calculations.

The trimming and cutting process generates solid plastic waste, which may contain EPCRA Section 313 chemicals. Finishing operations such as coating and cleaning may also be sources for the release and other waste management of EPCRA Section 313 chemicals. Solid wastes potentially containing EPCRA Section 313 chemicals may include unreacted pellets and resins in wastewater or floor sweepings, off-specification plastic products, and dusts captured in air pollution control systems (baghouses, dry filters, etc.). Residual chemicals from equipment cleaning and waste management of "empty" shipping containers should also be considered when determining liquid and solid waste or other material sources; estimates can be calculated using the values listed in Table 4-1.

Step 3: Identify Release and Other Waste Management Activity Types

Fugitive emissions are the most common air releases. Fugitive dust emissions that contain EPCRA Section 313 chemicals can occur during the handling of raw materials. Typical metals in particulate matter, including cadmium and zinc, may be collected in a baghouse or other air pollution control device or released through equipment or general room air vents. Collected dust that is otherwise managed should be included in the calculations for the appropriate release type.

Wastewater containing EPCRA Section 313 chemicals may be generated from contact water used during the cooling or heating of plastic parts, process equipment cleaning, spills, leaks, and finishing water. During cleaning operations, organics such as phenol, and metals such as zinc may be transferred to the water. Facilities may treat this wastewater on site, discharge the wastewater to a surface water, or transfer the wastewater to a POTW or other off-site facility.

Solid from plastics manufacturing may be reused or recycled on site or sent off site for treatment, recycling, or disposal. High heat value plastics may be combusted for energy recovery, or on or off site.

Table 4-7 summarizes the release and other waste management activity sources and types and lists the typical EPCRA Section 313 chemicals associated with each for plastic product manufacturing operations.

Table 4-7

Sources and Types of EPCRA Section 313 Chemicals for Plastic Product Manufacturing

Unit Operation/ Source	Release and Other Waste Management Activity Type	Typical EPCRA Section 313 Chemicals
Chemical Storage	Fugitive and Stack Air On-site land or off-site disposal Recycling	
Compounding and Mixing	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Chloroform, dichloromethane, ethylbenzene, phenol Thermoplastics & Monomers (such as 1,3-butadiene, ethylene, propylene, styrene, styrene-acrylonitrile, vinyl chloride) Heat Stabilizers: lead, zinc, barium, and cadmium compounds Impact Resistor: acrylic acid, acrylamide Flame Retardants: antimony compounds
Forming	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Chemicals from compounding and mixing: Cleaning Agents: phenol, zinc
Molding	Fugitive and Stack Air Receiving stream or POTW On-site land or off-site disposal	Chemicals from compounding and mixing: Cleaning Agents: phenol, zinc
Cooling and Trimming	Receiving stream or POTW On-site land or off-site disposal	Dimethyl phthalate, di-n-butyl phthalate
Finishing	Fugitive and Stack Air Receiving stream or POTW/ Slurries On-site land or off-site disposal	Dimethyl phthalate, cobalt compounds, phenol Dyestuff/ Paints: phenol, selenium Sprays: vinyl chloride (monomer)

Step 4: Determine the Most Appropriate Method(s) and Calculate the Estimates for Release and Other Waste Management Activity Quantities

Emission factors or engineering calculations may be used to determine the amount of an EPCRA Section 313 chemical emitted to the air. Chemical specific emission factors for unit operations are available from AP-42. Process operation emission factors or other engineering calculations may be used to determine the release and other waste management activity quantities of volatile chemicals. The following example uses AP-42 information to determine the reportable quantities of an EPCRA Section 313 solvent.

Monitoring information may be available to determine the amount of an EPCRA Section 313 chemical emitted to the air, discharged to water, transferred off site, or treated on site. For permit applications or worker exposure data, facilities may have monitored for dusts generated during compounding and mixing operations. Facilities may also have to monitor their wastewater discharges.

Using production, purchase, and inventory records, mass balance calculations can be performed for EPCRA Section 313 chemicals incorporated into the product or otherwise used, e.g., a catalyst, during plastic product manufacturing.

Example - Estimates from Surface Coating of Plastic Parts

A plastic parts facility performs surface coating during its finishing operations and uses approximately 15,000 gallons of the coating mixture during the year. According to the MSDS, the coating contains 10% xylene by volume, and the density of xylene is approximately 7.2 pounds per gallon. The coating is applied in a paint booth using an air atomized spray and the particles from spraying are controlled by a scrubber. According to AP-42, an air atomized spray has a 25% transfer efficiency for prime, color, texture, touch up, and fog coatings. Vendor and facility testing information show the scrubber as having a 95% capture efficiency (i.e., the amount of particles captured by the control device) and 95% control efficiency (i.e., the amount of particles removed from the captured air); the scrubber water is then sent to a POTW for treatment.

The amount of xylene in the spray coating is calculated as shown below:

(15,000 gal) × (10%) × (7.2 lb/gal) = 10,800 lb xylene

Assume 25% of the xylene in the spray coating will remain on the plastic product:

(10,800 lb xylene) × (25% on product) = 2,700 lb xylene on product

Therefore, 8,100 pounds of xylene do not remain on the product. Fugitive air emissions of xylene equals the 5% not captured by the scrubber, calculated as shown below:

Fugitive Air Emissions of Xylene: (5%) × (8,100 lb) = 405 lb
Xylene Captured by Scrubber: 8,100 - 405 = 7,695 lb

Stack air emissions equal the 5% of the captured xylene which is not controlled by the scrubber:

Stack Air Emissions of Xylene: (5%) × (7,695 lb) = 385 lb

The remaining quantity of xylene captured by the scrubber becomes part of the scrubber water and is discharged to the POTW for treatment.

Xylene Transferred to the POTW: 7,695 - 385 = 7,310 lb

The xylene remaining on the plastic part , 2,700 pounds, will most likely volatilize during drying operations. The dryer stack gas is not controlled; therefore, 100% of the volatilized xylene is assumed to be released as stack emissions through the dryer vent. The total stack air emissions from the spraying and drying operations is 3,085 pounds:

Total Xylene Stack Air Emissions: 2,700 + 385 = 3,085 lb

Assuming these operations are the only sources of reportable xylene quantities, the facility would report, 405 pounds fugitive air emissions (Section 5.1), 3,085 pounds stack air emissions (Section 5.2) and 7,310 pounds discharged to a POTW (Section 6.1) on its Form R for xylene. A Form A cannot be completed for xylene because the total reportable quantity exceeds 500 pounds per year.

Appendix A

TRI GUIDANCE RESOURCES

Appendix A

TRI GUIDANCE RESOURCES

A.1 EPCRA Section 313 RELATED REFERENCES

40 CFR 372, Toxic Chemical Release Reporting; Community Right-to-Know; Final Rule
See 53 FR 4500, February 16, 1988.

Toxic Chemical Release Inventory Reporting Forms and Instructions for the Current Reporting Year - See also Automated Toxic Chemical Release Inventory Reporting Software (ATRS) under Section A.2, Internet Sites.
U.S. EPA publishes this document each year to provide current guidance for preparing the Form R and Form A reports. This document contains the most up-to-date list of chemicals for which reports are required. It includes a blank Form R and Form A and provides step-by-step instructions for completing each report. It also has a list of U.S. EPA regional and state contacts for EPCRA Section 313 reporting. The current version of this document should always be consulted in preparing the EPCRA Section 313 report.

Common Synonyms for Chemicals Listed Under EPCRA Section 313 of the Emergency Planning and Community Right-to-Know Act (EPA 745-R-95-008)
This glossary contains chemical names and their synonyms for substances covered by the reporting requirements of EPCRA Section 313. The glossary was developed to aid in determining whether a facility manufactures, processes, or uses a chemical subject to EPCRA Section 313 reporting.

Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112(r) of the Clean Air Act (as amended) (EPA 740-R-95-001)
List of chemicals covered by EPCRA Sections 302 and 313, CERCLA Hazardous Substances, and CAA 112(r). The list contains the chemical name, CAS Registry Number, and reporting requirement(s) to which the chemical is subject.

The Emergency Planning and Community Right-to-Know Act: EPCRA Section 313 Release Reporting Requirements, August, 1995 (EPA 745/K-95-052)
This brochure alerts businesses to their reporting obligations under EPCRA Section 313 and assists in determining whether their facility is required to report. The brochure contains U.S. EPA Regional contacts, the list of EPCRA Section 313 toxic chemicals and a description of the Standard Industrial Classification (SIC) codes subject to EPCRA Section 313.

EPCRA Section 313 Questions and Answers: 1998 Version, (EPA 745-B-97-004).

Executive Order 12856 - Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements: Questions and Answers (EPA 745-R-95-011)
This document assists federal facilities in complying with Executive Order 12856. This information has been compiled by U.S. EPA from questions received from federal facilities. This document is intended for the exclusive use of federal facilities in complying with Sections 302,

303, 304, 311, 312, and 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 and the Pollution Prevention Act of 1990, as directed by the Executive Order.

Supplier Notification Requirements (EPA 560/4-91-006)
This pamphlet assists chemical suppliers who may be subject to the supplier notification requirements under EPCRA Section 313. The pamphlet explains the supplier notification requirements, gives examples of situations which require notification, describes the trade secret provision, and contains a sample notification.

Toxic Chemical Release Inventory - Data Quality Checks to Prevent Common Reporting Errors on Form R/Form A (EPA 745-R-98-012)
This is a compilation of Notices of Data Change, Significant Error, Noncompliance, or Technical Error. It provides a listing of common errors found on the Form R reports submitted to U.S. EPA. It also provides a discussion of the types of errors which result in each of the above Notices as well as a list of Notice of Technical Error codes and descriptions.

Trade Secrets Rule and Form
See 53 FR 28772, July 29, 1988. This rule implements the trade secrets provision of the EPCRA (Section 322) and includes a copy of the trade secret substantiation form.

A.2 INFORMATION SOURCES

Most of the materials included as reference in this manual are available from the following sources:

National Center for Environmental Publications and Information (NCEPI)
P.O. Box 42419
Cincinnati, OH 45242-2419
(800) 490-9198
Fax: (513)489-8695
Internet: *http://www.epa.gov/ncepihom/index.html*

Emergency Planning and Community Right-to-Know (EPCRA) Information Hotline
U.S. Environmental Protection Agency
(800) 424-9346 or (703) 412-9810 (for the Washington, D.C. metropolitan area)
TDD: (800) 553-7672

Internet Sites

- TRI homepage: *http://www.epa.gov/tri*
  This site contains information on the Toxic Release Inventory and provides links to a variety of data and documents related to the TRI program.

- Automated Toxic Chemical Release Inventory Reporting Software (ATRS): *http://www.epa.gov/atrs*
  This site provides access to the automated EPCRA Section 313 reporting forms for electronic submittal of required data to U.S. EPA.

- Air CHIEF CD-ROM
  http://www.epa.gov/ttn/chief/airchief.html
  This site provides information on the Air CHIEF CD-ROM, contents, ordering information, system requirements, and sources for additional information.

- Clearinghouse for Inventories and Emission Factors (CHIEF):
  http://www.epa.gov/ttn/chief/
  This site provides access to the latest information and tools for estimating emissions of air pollutants and performing emission inventories.

- Code of Federal Regulations, 40 CFR: *http://www.epa.gov/epacfr40*
  This site was created by U.S. EPA to expand access to Title 40 - Environmental Protections of the Code of Federal Regulations.

- Compilation of Air Pollutant Emission Factors (AP-42):
  http://www.epa.gov/ttn/chief/ap42etc.html
  This site provides access to files containing guidance for estimating emissions from specific sources and emission factors.

- Federal Register Notice: *http://www.epa.gov/EPA-TRI*
  This site provides access to all Federal Register notices related to the TRI program from 1994 to current.

- Material Safety Data Sheets (MSDSs):
  http://msds.pdc.cornell.edu/issearch/msdssrch.htm
  A key word searchable database of 325,000 MSDSs.

- TANKS: *http://www.epa.gov/ttn/chief/tanks.html*
  This site contains information on TANKS, a DOS-based computer software program that computes estimates of VOC emissions from fixed and floating-roof storage tanks.

- WATER8/CHEMDAT8: *http://www.epa.gov/ttn/chief/software.html#water8*
  WATER8 is an analytical model for estimating compound-specific air emissions from wastewater collection and treatment systems. CHEMDAT8 is a Lotus 1-2-3 spreadsheet for estimating VOC emissions from TSDF processes.

A.3 INDUSTRY-SPECIFIC TECHNICAL GUIDANCE DOCUMENTS

In 1988 and 1990, U.S. EPA developed a group of individual guidance documents for industries or activities in industries who primarily manufacture, process, or otherwise use EPCRA Section 313 chemicals. See list of industries/activities below. U.S. EPA is currently revising some of these documents and preparing additional documents. The newer versions will be available beginning in the Fall of 1998.

Chemical Distribution Facilities, January 1999 (EPA 745-B-99-005)

Coal Mining Facilities, January 1999 (EPA 745-B-99-002)

Coincidental Manufacture/By-Products (EPA 745-B-00-014)

Electricity Generating Facilities, January 1999 (EPA-745-B-99-003)

Estimating Releases and Waste Treatment Efficiencies

Food Processors, September 1998 (EPA 745-R-98-011)

Formulation of Aqueous Solutions

Foundry Operations (EPA 745-B-00-016)

Leather Tanning and Finishing Industry, April 2000 (EPA 745-B-00-012)

Metal Mining Facilities, January 1999 (EPA 745-B-99-001)

Metal Working and Electroplating Operations, April 2000 (EPA 745-B-00-015)

Monofilament Fiber Manufacture (EPA 745-B-00-013)

Petroleum Terminals and Bulk Storage Facilities, January 1999 (EPA 745-B-99-006)

Pulp, Paper, and Paperboard Production (EPA 745-B-00-010)

Presswood & Laminated Wood Products Manufacturing

Printing Industry, April 2000 (EPA 745-B-00-005)

RCRA Subtitle C TSD Facilities and Solvent Recovery Facilities, January 1999 (EPA 745-B-99-004)

Rubber and Plastics Manufacturing, April 2000 (EPA 745-B-00-017)

Semiconductor Manufacture (EPA 745-R-99-007)

Smelting Operations (EPA 745-B-00-009)

Spray Application and Electrodeposition of Organic Coatings, December 1998 (EPA 745-B-99-014)

Textile Processing Industry, April 2000 (EPA 745-B-00-008)

Welding Operations (EPA 745-B-00-011)

Wood Preserving Operations (EPA 745-B-00-007)

U.S. EPA, Office of Compliance, published a series of documents in 1995 called Sector Notebooks. These documents provide information of general interest regarding environmental issues associated with specific industrial sectors. The Document Control Numbers (DCN) range from EPA/310-R-95-001 through EPA/310-R-95-018.

A.4 CHEMICAL-SPECIFIC GUIDANCE DOCUMENTS

U.S. EPA has also developed a group of guidance documents specific to individual chemicals and chemical categories. These are presented below.

Emergency Planning and Community Right-to-Know EPCRA Section 313: Guidance for Reporting Aqueous Ammonia, July 1995 (EPA 745-R-95-012)

Emergency Planning and Community Right-to-Know EPCRA Section 313: List of Toxic Chemicals within the Chlorophenols Category, November 1995 (EPA 745-B-95-004)

Estimating Releases for Mineral Acid Discharges Using pH Measurements, U.S. Environmental Protection Agency, June 1991.

Guidance for Reporting Sulfuric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size), November 1997 (EPA-745-R-97-007)

Toxic Release Inventory List of Toxic Chemicals within the Glycol Ethers Category and Guidance for Reporting, May 1995 (EPA 745-R-95-006)

Toxic Release Inventory List of Toxic Chemicals within the Nicotine and Salts Category and Guidance for Reporting, February 1995 (EPA 745-R-95-004)

Toxic Release Inventory List of Toxic Chemicals within the Polychlorinated Alkanes Category and Guidance for Reporting, February 1995 (EPA 745-R-95-001)

Toxic Release Inventory List of Toxic Chemicals within the Polycyclic Aromatic Compounds Category, February 1995 (EPA 745-R-95-003)

Toxic Release Inventory List of Toxic Chemicals within the Strychnine and Salts Category and Guidance for Reporting, February 1995 (EPA 745-R-95-005)

Toxic Release Inventory List of Toxic Chemicals within the Water Dissociable Nitrate Compounds Category and Guidance for Reporting, May, 1996 (EPA 745-R-96-004)

Toxics Release Inventory - List of Toxic Chemicals Within Ethylenebisdithiocarbamic Acid Category, November 1994 (EPA 745-B-94-003).

Toxics Release Inventory - Copper Phthalocyanine Compounds Excluded for the Reporting Requirements Under the Copper Compounds Category on the EPCRA Section 313 List, April 1995 (EPA 745-R-95-007).

Toxics Release Inventory - List of Toxic Chemicals Within Warfarin Category, November 1994 (EPA 745-B-94-004).

A.5 OTHER USEFUL REFERENCES

Burgess, W.A. Recognition of Health Hazards in Industry. Harvard School of Public Health. Boston, Massachusetts, John-Wiley & Sons.

CRC Handbook of Chemistry and Physics. Latest Edition, Robert C. Weast, Editor, CRC Press, Inc., Florida.

Donofrio, J., “Zinc Phosphating;” Organic Finishing Guidebook and Directory, May 1996, pages 68-85.

Locating and Estimating Air Emissions from Various Sources. Available from: National Technical Information Services (NTIS), (703) 487-4650.

The Merck Index. Latest Edition, Merck & Co., Inc., New Jersey.

Perry, R.H. and C.H. Chilton, Chemical Engineer's Handbook. Latest Edition, McGraw-Hill Book Company, New York.

Sax, N.I. and R.J. Lewis, Sr., Hawley's Condensed Chemical Dictionary. Latest Edition, Van Nostrand Reinhold Company, New York.

Appendix B

BASIC CALCULATION TECHNIQUES

Appendix B

BASIC CALCULATION TECHNIQUES

This section will provide the basic techniques needed to use specific types of data or engineering calculations. Examples are provided for:

(1) Stack monitoring data;

(2) Industrial hygiene data;

(3) Raoult's Law;

(4) Air emission factors;

(5) RCRA hazardous waste analysis data;

(6) NPDES monitoring data.

(1) Stack Monitoring Data

The following is an example of a release calculation using monitoring data.

Example: Stack monitoring data are available for a paint booth. The measured average concentration of toluene is 0.1 ppmv (dry gas basis). The moisture content in the stack is typically 10%, and stack conditions are maintained at 80^{o}C and atmospheric pressure. The stack gas velocity is 8 m/s. The diameter of the stack is 0.3 m. Calculate the point air release of toluene.

Step 1. Calculate volumetric flow of stack gas stream.

$$\text{Volumetric flow} = (\text{gas velocity}) \times [(\pi) \times (\text{internal stack diameter})^2/4)]$$

$$\text{Volumetric flow} = (8.0\ \text{m/s}) \times [(\pi) \times (0.3\ \text{m})^2/4] = 0.6\ \text{m}^3/\text{s}$$

Step 2. Correct for moisture content in stack gas stream.

Stack exhausts may contain large amounts of water vapor. The concentration of the chemical in the exhaust is often presented on a dry basis. For an accurate release rate, correct the vent gas flow rate for the moisture content by multiplying by the term (1 - fraction water vapor). The dry gas rate can then by multiplied by the chemical concentration.

(Note: If the toluene concentration is on a wet gas basis, no correction is necessary for moisture content.)

$$\boxed{\text{Dry volumetric flow} = (\text{Volumetric flow}) \times (1\text{-fraction water vapor})}$$

Dry volumetric flow = (0.6 m^3/s) × (1-0.10) = 0.5 m^3/s

Step 3. Convert ppmv to mg/m^3.

- ppmv is defined as one part of a chemical in 10^6 parts of gas (1.0 m^3/10^6 m^3).
- Use the molar volume of a gas, corrected for stack temperature and pressure conditions, calculated by the ideal gas law (PV = nRT). Note that the molar volume of an ideal gas at 237 K and 1 atm is 22.4 L/mole.
- Molecular weight of toluene (MW) = 92.14 g/mole.
- R = the Ideal Gas Constant (0.082057 L - atm per mole-Kelvin)

To calculate the molar volume of stack gas, use the ideal gas equation.

$$\boxed{\text{Molar volume} = \frac{V}{n} = \frac{RT}{P}}$$

For the example, the stack conditions are 80° C (353 K) and atmospheric pressure (1 atm).

$$\text{Molar volume} = \left(0.082057\ \frac{\text{L}-\text{atm}}{\text{mole}-\text{K}}\right) \times (353\ \text{K})/(1\text{atm})$$

= 29.0 L/mole

The conversion of ppmv to mg/m^3 can now be calculated.

$$\boxed{\left(\frac{\text{mg}}{\text{m}^3}\right) = (\text{concentration of chemical, ppmv}) \times \left(\frac{1}{\text{molar volume of gas}}\right) \times (\text{MW})}$$

Using the example, the concentration of toluene is calculated as follows:

$$\left(\frac{0.1\ \text{m}^3}{10^6\ \text{m}^3}\right) \times \left(\frac{\text{mole}}{29.0\ \text{L}}\right) \times \left(\frac{92.14\ \text{g}}{\text{mole}}\right) \times \left(\frac{\text{L}}{10^{-3}\ \text{m}^3}\right) \times \left(\frac{1{,}000\ \text{mg}}{1\ \text{g}}\right) = 0.3\ \text{mg/m}^3$$

Step 4. Calculate air releases.

Air releases are calculated as follows:

$$\boxed{\text{Air Release}=(\text{volumetric flow, m}^3\text{/s}) \times (\text{concentration, mg/m}^3) \times (\text{operating time, s/yr})}$$

The paint booth is used 8 hours per day, 5 days per week, 52 weeks per year.

$$\text{Operating time} = \left(8\ \frac{\text{hr}}{\text{day}}\right) \times \left(5\ \frac{\text{day}}{\text{week}}\right) \times \left(52\ \frac{\text{week}}{\text{yr}}\right) = 2{,}080\ \text{hr/yr}$$

$$\text{Air Release} = (0.5\ \text{m}^3\text{/s}) \times (0.3\ \text{mg/m}^3) \times \left(\frac{3{,}600\ \text{s}}{\text{hr}}\right) \times \left(\frac{2{,}080\ \text{hr}}{\text{yr}}\right) \times \left(\frac{\text{lb}}{454\ \text{g}}\right) \times \left(\frac{\text{g}}{1{,}000\ \text{mg}}\right)$$

$$= 2.5\ \text{lb/yr of toluene}$$

It is important to note that this calculation assumes the measured emissions are representative of actual emissions at all times; however, this is not always the case. Ideally, a continuous emissions monitor provides the most representative data.

Also note that monitoring and stack data may have units that are different than those used in the example. Modify conversion factors and constants to reflect your data when calculating air releases.

(2) Industrial Hygiene Data

The following is an example of a release calculation using industrial hygiene data.

Example: Occupational industrial hygiene data shows that workers are exposed to an average of 0.1 ppmv benzene (wet gas basis). The density of benzene vapor is 0.2 lb/ft^3. The ventilation system exhausts 20,000 acfm of room air at 70°F. The plant operates 24 hours per day, 330 days per year.

The benzene concentration is on a wet gas basis, therefore a moisture correction of the ventilation flow rate is not necessary. The industrial hygiene data is collected at the same ambient conditions as the ventilation system, therefore no adjustment for temperature or pressure needs to be performed. A conservative estimation of benzene fugitive releases could be calculated as follows:

Air Release = (ventilation flow rate, ft^3/min) × (operating time, min/yr) × (concentration of chemical, ppmv) × (vapor density of chemical, lb/ft^3)

Benzene releases per year would be calculated as follows:

$$\left(\frac{20{,}000\ \text{ft}^3}{\text{min}}\right) \times \left(\frac{60\ \text{min}}{\text{hr}}\right) \times \left(\frac{24\ \text{hr}}{\text{day}}\right) \times \left(\frac{330\ \text{day}}{\text{yr}}\right) \times \left(\frac{0.1\ \text{ft}^3\ \text{benzene}}{10^6\ \text{ft}^3\ \text{air}}\right) \times \left(\frac{0.2\ \text{lb}}{\text{ft}^3}\right)$$

$$= 190\ \text{lb/yr of benzene}$$

(3) Raoult's Law

The following is an example of a release calculation using Raoult's Law. Raoult's Law states that the partial pressure of a compound in the vapor phase over a solution may be estimated by multiplying its mole fraction in the liquid solution by the vapor pressure of the pure chemical.

$$P_A = X_{A,L}P^o = X_{A,G}P_T$$

where:

P° = Vapor pressure of pure liquid chemical A;
$X_{A,L}$ = Mole fraction of chemical A in solution;
$X_{A,G}$ = Mole fraction of chemical A in the gas phase;
P_A = Partial pressure of chemical A in the gas phase; and
P_T = Total pressure.

Example: A wash tank holds a solution containing 10% by weight of o-xylene (A) and 90% by weight of toluene (B). The tank is vented to the atmosphere; the process vent flow rate is estimated as 100 acfm (2.83m^3/min) based on a minimum fresh air ventilation rate. The molecular weight of o-xylene is 106.17 g/mole and toluene is 92.14 g/mole. The vapor pressure of o-xylene is 10 mm of Hg (0.19 psia). The total pressure of the system is 14.7 psia (atmospheric conditions). The process tank is in service 250 days/yr. Calculate the air release of o-xylene.

Step 1: Calculate the mole fraction of o-xylene in the liquid solution.

$$X_{A,L} = \frac{\dfrac{\text{wt fraction A}}{MW_A}}{\dfrac{\text{wt fraction A}}{MW_A} + \dfrac{\text{wt fraction B}}{MW_B}}$$

Where:

$X_{A,L}$ = Mole fraction of chemical A in liquid solution;
MW = Molecular weight of chemical, g/mole; and
wt fraction = Weight fraction of chemical in material.

$$X_{A,L} = \frac{\left[\dfrac{0.1}{106.17}\right]}{\left[\dfrac{0.1}{106.17} + \dfrac{0.9}{92.14}\right]}$$

$$X_{A,L} = 0.09$$

Step 2: Calculate the mole fraction of o-xylene in the gas phase.

$$X_{A,G} = \frac{X_{A,L}P^{\circ}}{P_T}$$

where:

$X_{A,G}$ = Mole fraction of chemical A in gas phase;
$X_{A,L}$ = Mole fraction of chemical A in liquid solution;
P° = Vapor pressure of pure liquid chemical A, psia; and
P_T = Total pressure of system, psia.

$$X_{A,G} = [0.09] \times \left[\frac{0.19 \text{ psia}}{14.7 \text{ psia}}\right] = 0.001$$

Step 3: Calculate releases using Raoult's Law.

$$\boxed{\text{Emissions} = (X_{A,G}) \times (\text{AFR}) \times (t) \times (\text{MW}_A) \times \left(\frac{1}{\text{MV}}\right)}$$

where:

Emissions = Air release of pollutant A, g-A/yr;
$X_{A,G}$ = Mole fraction of chemical A in gas phase;
AFR = Air flow rate of room, m^3/min;
t = Operating time of wash tank, min/yr;
MW = Molecular weight of chemical, g/g-mole; and
MV = Gas molar volume (22.4 L/mole at standard temperature and pressure).

If conditions vary from standard temperature and pressure the gas molar volume can be calculated using the ideal gas law and tank conditions as presented in Example 1.

Emissions = (0.001) ×

$$\left(\frac{2.83\,\text{m}^3}{\text{min}}\right) \times \left(\frac{250\ \text{day}}{\text{yr}}\right) \times \left(\frac{24\ \text{hr}}{\text{day}}\right) \times \left(\frac{60\ \text{min}}{\text{hr}}\right) \times \left(\frac{\text{mole}}{22.4\,\text{L}}\right) \times \left(\frac{106.17\,\text{g}}{\text{mole}}\right) \times \left(\frac{\text{L}}{10^{-3}\,\text{m}^3}\right)$$

$= 4.8 \times 10^6$ g/yr

The emission of o-xylene is calculated as shown below.

$$\text{Emissions} = \left(4.8 \times 10^6\ \text{g/yr}\right) \times \left(\frac{\text{lb}}{454\ \text{g}}\right) = 10{,}570\ \text{lb/yr of o-xylene}$$

Air releases for toluene can be calculated in a similar manner.

(4) Air Emission Factor

The following is an example of a release calculation using air emission factors.

Example: An industrial boiler uses 300 gallons per hour of No. 2 fuel oil. The boiler operates 2,000 hours per year. Calculate emissions of formaldehyde using the AP-42 emission factors.

$$\boxed{\text{AE} = (\text{EF}) \times (\text{AU}) \times (\text{OT})}$$

where:

AE = Annual emissions of pollutant, lb/yr
EF = Emission factor of pollutant, lb/10^3 gallon of fuel. EF for formaldehyde for an industrial boiler burning No. 2 fuel oil is 0.035 to 0.061 lb/10^3 gallons.
AU = Quantity of fuel used, gal/yr.
OT = Operating time, hr/yr.

Using an emission factor of 0.061 pounds of formaldehyde per gallon of fuel, the air releases are calculated as follows:

$$\text{AE} = \left(\frac{0.061\ \text{lb}}{10^3\ \text{gal}}\right) \times \left(\frac{300\ \text{gal}}{\text{hr}}\right) \times \left(\frac{2{,}000\ \text{hr}}{\text{yr}}\right) = 36.6\ \text{lb/yr of formaldehyde}$$

(5) RCRA Waste Analysis

The following is an example of a calculation using RCRA waste analysis data.

Example: Spent paint wastes were disposed at an off-site waste treatment facility. The quantity of paint waste shipped was five 55-gallon drums per year. Analysis of the waste showed 5% cadmium by weight. Estimating the density of the paint waste to be 9.5 lb/gallon, the amount of cadmium to off-site disposal is calculated as follows:

Amount of cadmium = (amount of paint waste disposed, gal/yr) × (concentration of cadmium, lb/lb) × (density of paint waste, lb/gal)

$$\left(\frac{5\ \text{drums}}{\text{yr}}\right) \times \left(\frac{55\ \text{gal}}{\text{drum}}\right) \times \left(\frac{9.5\ \text{lb}}{\text{gal}}\right) \times \left(\frac{5\,\text{lb Cd}}{100\,\text{lb waste}}\right) = 131\ \text{lb/yr of cadmium}$$

(6) NPDES Data

The following is an example of a calculation using NPDES data.

NPDES permits require periodic monitoring of the effluent stream. In this example, quarterly samples were taken to be analyzed for silver content. Each sample was an hourly, flowrate-based composite taken for one day to be representative of the discharge for that day. The total effluent volume for that day was also recorded. The following data were collected on each sample day.

Yearly Quarter Sample Number	Discharge Flow Rate (10^6 gal/day)	Total Silver (µg/L)
1	0.5	10
2	0.6	10
3	0.4	6
4	0.2	<3

To calculate the amount of silver in pounds discharged on each sample day, the concentration of silver in the discharge is multiplied by the discharge flow rate for that day, as shown below for the first quarter sample.

$$\boxed{\text{Amount of silver} = (\text{daily flow rate}) \times (\text{silver concentration})}$$

$$\text{First Quarter: } \left(\frac{10\,\mu\text{g}}{\text{L}}\right) \times \left(\frac{1\,\text{g}}{10^6\,\mu\text{g}}\right) \times \left(\frac{1\,\text{lb}}{454\,\text{g}}\right) \times \left(\frac{3.785\,\text{L}}{\text{gal}}\right) \left(\frac{0.5 \times 10^6\,\text{gal}}{\text{day}}\right)$$

$$= 0.04 \text{ lb/day of silver}$$

The amount of silver discharged during each of the other three monitoring events was similarly determined to be:

0.05 lb/day; 0.02 lb/day, and 0.005 lb/day.

For the last data point the concentration of silver was reported by the laboratory to be less than the detection limit of 3 µg/L. For this calculation the detection limit was used to calculate the daily discharge, a conservative assumption.

The average daily discharge was calculated to be:

$$\left(\frac{0.04 + 0.05 + 0.02 + 0.005}{4}\right) \text{lb/day} = 0.03\,\text{lb/day}$$

The plant operates 350 days/year (plant shuts down for two weeks in July).

The estimated annual discharge of silver is calculated as follows:

Annual discharge = (350 day/yr) (0.03 lb/day) = 10.5 lb of silver/yr

Appendix C

EPCRA SECTION 313 GUIDANCE FOR REPORTING SULFURIC ACID

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW
EPCRA Section 313
Guidance for Reporting Sulfuric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)

Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) requires certain facilities manufacturing, processing, or otherwise using listed toxic chemicals to report their environmental releases of such chemicals annually. Beginning with the 1991 reporting year, such facilities also must report pollution prevention and recycling data for such chemicals, pursuant to section 6607 of the Pollution Prevention Act, 42 U.S.C. 13106. When enacted, EPCRA Section 313 established an initial list of toxic chemicals that was comprised of more than 300 chemicals and 20 chemical categories. EPCRA section 313(d) authorizes EPA to add chemicals to or delete chemicals from the list, and sets forth criteria for these actions.

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Section 1.0. Introduction

On June 30, 1995 (60 FR 34182), EPA modified the listing for sulfuric acid (Chemical Abstracts Service Number 7664-93-9) on the list of toxic chemicals subject to the reporting requirements under section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (5). EPA modified the listing by deleting non-aerosol forms of sulfuric acid from the section 313 list based on the conclusion that they cannot reasonably be anticipated to cause adverse effects on human health or the environment. EPA added a modifier to the listing for sulfuric acid to exclude the non-aerosol forms. The listing now reads "Sulfuric acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)." Therefore, beginning with the 1994 reporting year, facilities are no longer required to include non-aerosol forms of sulfuric acid in threshold and release determinations. In this document we will use the term "sulfuric acid aerosols" to indicate airborne forms of sulfuric acid as listed in section 313 of EPCRA.

The purpose of this document is to assist facilities in determining the sources and amounts of sulfuric acid aerosols that are to be included in threshold and release determinations under EPCRA section 313. This document is not meant to be exhaustive, but rather provide some guidance to help facilities in their determination of threshold and release quantities. Threshold and release determinations for sulfuric acid aerosols are highly dependent on site specific conditions and equipment. Therefore, this document can only provide general information concerning the possible formation and release of sulfuric acid aerosols.

Section 1.1. Who Must Report

A plant, factory, or other facility is subject to the provisions of EPCRA section 313, if it meets <u>all</u> three of the following criteria:

- It is included in the primary Standard Industrial Classification (SIC) codes 20 through 39 and beginning January 1, 1998, it is in one of the following industries: Metal Mining, SIC code 10 (except SIC codes 1011, 1081, and 1094); Coal Mining, SIC code 12 (except SIC code 1241); Electric Utilities, SIC codes 4911, 4931, or 4939 (each limited to facilities that combust coal and/or oil for the purpose of generating power for distribution in commerce); Commercial Hazardous Waste Treatment, SIC code 4953 (limited to facilities regulated under the Resource Conservation and Recovery Act, subtitle C, 42 U.S.C. section 6921 *et seq.*); Chemicals and Allied Products-Wholesale, SIC code 5169; Petroleum Bulk Terminals and Plants, SIC code 5171; and, Solvent Recovery Services, SIC code 7389 (limited to facilities primarily engaged in solvent recovery services on a contract or fee basis); <u>and</u>

- It has 10 or more full-time employees (or the equivalent of 20,000 hours per year); <u>and</u>

- It manufactures (includes imports), processes or otherwise uses any of the toxic chemicals listed on the EPCRA section 313 list in amounts greater than the threshold quantities specified below.

In addition, pursuant to Executive Order 12856 entitled “Federal Compliance with Right-to-Know Laws and Pollutant Prevention Requirements,” federal facilities are required to comply with the reporting requirements of EPCRA Section 313 beginning with calendar year 1994. This requirement is mandated regardless of the facility’s SIC code.

Section 1.2. Thresholds

Thresholds are specified amounts of toxic chemicals manufactured, processed, or otherwise used during the calendar year that trigger reporting requirements. Reporting is required for sulfuric acid aerosols if the following thresholds are exceeded.

- If a facility *manufactures* or *imports* 25,000 pounds of sulfuric acid aerosols over the calendar year.
- If a facility *processes* 25,000 pounds of sulfuric acid aerosols over the calendar year.
- If a facility *otherwise uses* 10,000 pounds of sulfuric acid aerosols over the calendar year.

The quantities of sulfuric acid aerosols included in threshold determinations are not limited to the amounts of sulfuric acid aerosols released to the environment. All sulfuric acid aerosols manufactured, processed, or otherwise used are to be counted toward threshold determinations. This includes any amount of sulfuric acid aerosols that may be generated in closed systems or that are generated in stacks prior to or after being treated by scrubbers.

Section 1.3. What Constitutes Aerosol Forms of Sulfuric Acid and Their Manufacture, Processing, or Otherwise Use

For the purposes of the reporting requirements under EPCRA section 313, sulfuric acid aerosols include mists, vapors, gas, fog, and other airborne forms of any particle size. Note that there is no size limit for particles that must be included under the EPCRA section 313 sulfuric acid aerosols listing. Although the qualifier includes the terms mists, vapors, gas, and fog these terms are not specifically defined for EPCRA section 313 since the last part of the qualifier “other airborne forms of any particle size” makes it clear that any airborne form is covered by the listing. The specific terms mists, vapors, gas, and fog are included to make it clear that sulfuric acid that is identified as being in one of these forms would be covered by the sulfuric acid aerosols listing.

If sulfuric acid is present in the form of a gas, fog, vapor, or mist or any other airborne formthen sulfuric acid is considered to be in the aerosol form and is covered by the EPCRA section 313 sulfuric acid aerosols listing. Solutions of sulfuric acid which do not become airborne are not covered by the EPCRA section 313 sulfuric acid aerosols listing but such solutions may generate sulfuric acid aerosols during their manufacture, processing or otherwise use. In general, sulfuric acid aerosols are manufactured any time a solution of sulfuric acid is made to become airborne such as when it is sprayed or distilled. If the generation of sulfuric acid aerosols through spraying or other means is intentional (i.e., it is intended that the sulfuric acid aerosol be generated for a particular use activity) then, in addition to manufacturing the sulfuric acid aerosol, such aerosols are also being otherwise used. Thus, spraying of sulfuric acid aerosols on to an item for cleaning, etching, or other purposes constitutes the manufacture and otherwise use of sulfuric acid aerosols. If sulfuric acid aerosols are used in a process in which any part of the sulfuric acid becomes incorporated into a product which is then distributed in commerce then, under EPCRA section 313, the sulfuric acid aerosols are considered to have been processed.

Section 2.0. Guidance On Sulfuric Acid Aerosols For Certain Specific Activities That Generate Aerosols Forms

EPA has provided the following guidance for specific activities that generated sulfuric acid aerosols. The guidance in sections 2.1, 2.2, and 2.3 is intended to apply only to the specific situations discussed in these sections. If you are not sure whether this guidance applies to the situation at your facility, then EPA should be consulted before using this guidance.

Section 2.1. Sulfuric Acid Aerosols Generated In Acid Reuse Systems

When solutions of sulfuric acid are aerosolized the “manufacture” of a listed chemical (sulfuric acid aerosols) has occurred. This is a result of the qualifier to the sulfuric acid listing, which excludes non-aerosol forms and limits the reporting to aerosol forms only. The addition of the acid aerosol qualifier has an impact on certain processes that, prior to the addition of the qualifier, would not have been considered to be “manufacturing” a listed chemical. Acid reuse systems that use aqueous solutions of sulfuric acid to generate acid aerosols, use the acid aerosols, condense them back into solution, and then reuse the acid solution again and again are impacted by the addition of the acid aerosol qualifier. In such processes, the continuous reuse of the acid solutions generates very large quantities of acid aerosols that technically should be counted towards the “manufacture” [the generation of the acid aerosol is the “manufacture” of sulfuric acid (acid aerosol)] and “otherwise use” thresholds. This may result in many facilities greatly exceeding the “manufacture” and “otherwise use” reporting thresholds that, prior to the addition of the qualifier, would not have exceeded thresholds.

While it is technically correct to apply all of the quantities of acid aerosols generated in such systems towards the “manufacture” and “otherwise use” reporting thresholds, EPA did not intend to increase the reporting burden as a result of addition of the sulfuric acid aerosol qualifier. In addition, under EPA’s general approach to reuse systems, a toxic chemical is not counted toward thresholds each time it is reused but only once per reporting period, and that approach would apply to sulfuric acid reuse systems were it not for the aerosol qualifier. Therefore, EPA is providing the following guidance to reduce the reporting burden for facilities that operate such processes and to bring the treatment of such systems into alignment with EPA’s general approach to reuse.

Rather than having facilities count all quantities of acid aerosol generated in such systems towards the “manufacture” and “otherwise use” thresholds, EPA will allow facilities to apply the total volume of acid in these systems only once to these thresholds. For example, if an acid reuse system starts the year with 2000 pounds of acid and 500 pounds is added during the year then the total amount applied towards acid aerosol thresholds would be 2500 pounds. This reflects a one time per year counting of all of the acid molecules as being in the acid aerosol form rather than counting them over and over again each time the acid aerosol form is generated and subsequently used. Since in these acid reuse systems the acid aerosols are “manufactured” and then **“otherwise used”** the 10,000 pound “otherwise use” threshold would be the threshold that would first trigger reporting from such systems.

This guidance applies only to acid reuse systems and the reporting of sulfuric acid aerosols under EPCRA section 313. This guidance does not apply to any other types of processes or to any other listed chemical.

2.2. Sulfuric Acid Aerosols Removed By Scrubbers

When a scrubber is used to remove sulfuric acid aerosols prior to or in a stack, the acid aerosols are usually converted to the non-aerosol form. The non-aerosol forms of sulfuric acid are not reportable under EPCRA section 313 because the qualifier to the sulfuric acid listing includes only acid aerosol forms. Sulfuric acid as a discrete chemical has not actually been destroyed by the scrubber, but the form of sulfuric acid reportable under EPCRA section 313 has been destroyed. Therefore, since sulfuric acid aerosols removed by scrubbers are converted to a non-reportable form, the quantity removed by the scrubber can be reported as having been treated for destruction.

2.3. Sulfuric Acid Aerosols Generated In Storage Tanks

Sulfuric acid aerosols are generated in the empty space (head space) above sulfuric acid solutions contained in storage tanks. The amounts of acid aerosols generated in such storage tanks are to be applied towards the “manufacture” threshold for sulfuric acid aerosols. In such storage tanks the sulfuric acid molecules are constantly moving between the atmosphere and the solution. EPA does not intend for facilities to count such movement of the acid molecules in and out of the stored acid solution as continuous “manufacture” of sulfuric acid aerosols. For such storage tanks the amount of acid aerosol to be applied towards the “manufacture” threshold is the average amount that existed in the atmosphere above the acid solution during the year.

Each facility should determine the average conditions for their specific storage tank (i.e., the capacity of the tank, the average amount in the tank, the average head space in the tank, the concentration of the acid solution stored, the temperature, and other information that may have an impact on aerosol calculations) and make the appropriate calculation of the amount of acid aerosol to apply towards the “manufacture” threshold. Any amounts of sulfuric acid aerosols that may be released from the storage tank through venting or fugitive releases must also be included in the threshold determination. If the storage tank is refilled and drawn down several times during the year then the calculations should be based on all of the acid that was stored in the tank. For example, if a 10,000 pound capacity tank is refilled and drawn down 6 times during the year (such that 60,000 pounds of acid were stored in the tank during the year) then the tank calculations, based on the average condition for one 10,000 pound tank of acid, should be multiplied by 6.

Section 3.0. Sulfuric Acid And Its Formation In Air

Sulfuric acid (H_2SO_4) is miscible in water in all proportions and has a strong attraction for water. The anhydrous chemical boils at 279.6EC (1). Commercial sulfuric acid normally contains 93 to 98% sulfuric acid with the remainder being water. A boiling point-composition diagram (Figure 1, Appendix 1) for aqueous sulfuric acid, indicates that below 75% H_2SO_4, the vapor evaporating from a solution of the acid is essentially water. This fact is illustrated in Table 1a of Appendix 1, which contains the partial pressure of sulfuric acid and total vapor pressure of the solution over aqueous sulfuric acid solutions at various concentrations

(1). Since the partial pressure of concentrated sulfuric acid is very low, little sulfuric acid is expected to volatilize from sulfuric acid solutions such as may be present in storage tanks. However, as discussed above, the amount of acid aerosols generated is dependent on the quantity of acid in the tank(s) during the year, the concentration, temperature, and other factors. The information in Appendix 1 and the guidance in section 2.3 can be used to assist in determining if significant amounts of sulfuric acid aerosols are present in storage tanks.

Sulfuric acid containing dissolved sulfur trioxide (SO_3) is known as oleum, fuming sulfuric acid or disulfuric acid. The vapor pressure of sulfuric acid over oleum containing 10% to 30% of free SO_3 by weight is shown in Table 2a of Appendix 1 (2). Since the vapor pressure of sulfur trioxide over oleum is high, sulfuric acid aerosols also form when oleum is exposed to air containing moisture.

Sulfuric acid is generally formed by the oxidation of sulfur dioxide (SO_2) and the reaction of the resulting sulfur trioxide (SO_3) with water.

$$SO_2 + \tfrac{1}{2}O_2 \rightarrow SO_3$$
$$SO_3 + H_2O \rightarrow H_2SO_4$$

While thermodynamically, SO_2 has a strong tendency to react with oxygen to form SO_3; under normal tropospheric (lower atmosphere) conditions the reaction rate is very slow in the gas phase (3, 17, 18, 19). Other than within a reaction chamber, SO_2 is unlikely to generate SO_3 and then sulfuric acid. However, once SO_3 is formed, it is converted to H_2SO_4 so rapidly (within milliseconds) at normal humidities, that any reaction in which SO is formed in moist air is equivalent to forming H_2SO_4 (3,18). In stacks from combustion processes, moisture in the **stack** would be expected to convert any SO_3 present into sulfuric acid aerosols. This being the case, the quantity of SO generated in such stacks (multiplied by 98.08/80.07, the molecular weight of sulfuric acid divided by the molecular weight of sulfur trioxide) should be included with those of H_2SO_4. If SO_3 is produced within a stack or unit of the plant without moisture present, sulfuric acid aerosols would not be produced. Although the SO_3 releases may be converted to H_2SO_4 in the environment, facilities are not responsible for conversions that may take place in the environment after a chemical that is not listed under EPCRA section 313, such as SO_3, has been released. Therefore, if SO_3 is the chemical that is released from the facility, the facility is not required to include it, or any H_2SO_4 produced in the environment from the released SO_3, in any EPCRA section 313 calculations of thresholds or releases.

Section 3.1. Industrial Sources Of Sulfuric Acid Aerosols

It is clear that industries required to report *sulfuric acid aerosol* releases will be among those that had previously reported *sulfuric acid* releases to air under EPCRA section 313. Facilities that previously reported over 25,000 pounds of sulfuric acid releases to air have exceeded the manufacturing threshold quantity of sulfuric acid aerosols necessary for reporting under the new listing. Additional facilities may be required to report because releases of sulfuric acid to air would not have included, for example, amounts of sulfuric acid aerosols that were produced in the stack and subsequently removed by scrubbers or produced internally during sulfuric acid manufacturing, processing, or use and that were removed by scrubbers prior to the stack. Since these amounts of sulfuric acid aerosols do count towards the EPCRA section 313 threshold determinations, facilities with less than 25,000 pounds of air releases are not excluded from reporting. In addition, some facilities may be using sulfuric acid aerosols in excess of

10,000 pounds and would also be required to report. According to the 1993 Toxics Release Inventory (TRI), there were 191 facilities reporting releases of 25,000 pounds or more of sulfuric acid to air. The number of these facilities in each of 2-digit standard industrial categories (SIC) is shown in Table 1, as well as the prominent types of industries within the category that have reported sulfuric acid emissions to air. The industries shown in italics include 34 facilities that are in the 80th percentile (over 178,000 pounds per year) for sulfuric acid releases to air. These 34 facilities' air emissions are almost entirely from point sources, suggesting that either sulfuric acid is formed in the stack from sulfur trioxide or sulfuric acid is aerosolized in a process that leads to its release in the stack. Thirty two of these sites reported producing the sulfuric acid; the copper smelters and phosphate fertilizer plants produced sulfuric acid for sale or distribution.

Table 1. Industrial Categories of Facilities Emitting over 25,000 lbs/yr of Sulfuric Acid Aerosols in 1993

Category (SIC Code)	No. Sites*	Major Industries**
Paper and Allied Products (26)	185	*Pulp, paper and paperboard mills.*
Chemicals and Allied Products (28)	53	*Phosphate fertilizers*; Industrial inorganic chemicals.
Primary metal industries (33)	23	*Copper smelting; Blast furnaces and steel mills*
Food and Kindred Products (20)	11	*Wet corn milling; fats and oils; liquors*; malt beverages.
Lumber, Wood Products (24)	8	Sawmills; Reconstituted wood products
Stone, clay, glass, concrete (32)	6	*Glass*
Petroleum refining (29)	4	*Petroleum refining*
Metal Products, except machinery (34)	4	Metal coatings
Tobacco Manufacturers (21)	1	Tobacco stemming and redrying

*A site may list more that one SIC code.
** The industries shown in italics include facilities that are in the 80th percentile for sulfuric acid releases to air.

The industrial breakdown does not necessarily indicate that emissions result from processes unique to the industry. For example, phosphate fertilizer manufacturers, which use sulfuric acid to make phosphoric acid and normal superphosphate, may produce their own sulfuric acid from elemental sulfur and may also use it captively. Sulfuric acid emissions from phosphate fertilizer manufacturing may therefore be primarily from sulfuric acid manufacturing. Similarly, sulfuric acid is a known component in flue gas from fossil fuel combustion and waste incineration. The SO_3/H_2SO_4 (SO_3, as stated previously is immediately transformed into sulfuric acid in the presence of water) produced from combustion sources is between 1 and 3% of the SO_x emitted by these sources (the rest being SO_2). It is not clear why sulfuric acid is emitted from combustion sources. A possible explanation is that there are substances in the flue gas or on the stack walls that catalyze the oxidation of sulfur dioxide to sulfur trioxide, similar to the heterogeneous reactions that can occur in the atmosphere (17-19). Sulfuric acid is also formed in some flue desulfurization processes (7).

Section 3.1.1 Pulp and Paper Mills

The kraft pulping process involves the digesting of wood chips at elevated temperature in “white liquor”, an aqueous solution of sodium sulfide and sodium hydroxide, to dissolve the lignin that binds the cellulose fibers of the wood together. The spent liquor used to digest wood chips, called “black liquor”, is combusted in recovery furnaces to recover heat and cooking chemicals. Sulfuric acid is present in flue gas from kraft recovery furnaces and has been cited as being one of the five most prevalent air toxics released from recovery furnaces of the direct contact evaporator (DCE) and non-direct contact evaporator (NDCE) types (21). In a DCE, the flue gas comes in contact with the black liquor, whereas in a NDCE, it does not. Field tests on five Kraft recovery furnaces showed SO_3/H_2SO_4 levels ranging from 0 to 3 ppm in the flue gas, with an average level of 0.81 ppm, or about 10% of that found in fossil fuel plants burning fuel containing 1-3% sulfur (4). In these tests, no correlation was found between SO_2 and SO_3/H_2SO_4 levels. Therefore, one cannot estimate emission factors for SO_3/H_2SO_4 based on those for SO_2. While EPA has compiled emission factors for pollutants from kraft, acid sulfite, and neutral sulfite semichemical (NSSC) pulping (9), no emissions factors have been presented for SO_3/H_2SO_4. However, industry tests of Kraft recovery furnaces have been performed between 1989 and 1993 and the results are presented in Table 2 (20).

Table 2. Emission Factors from Kraft Recovery Furnaces *

Mill Code (date built/rebuilt)**: Control device/ Type evaporator	Type	BLS MPPD	H_2SO_4 Emissions in lb/ton BLS	
			Range	Average
A: WB, Cascade	DCE	3.12	ND to 4.7E-02	1.6E-02
B: ESP	DCE	16.56	ND to 1.5E-02	8.4E-03
RFI (1973): WB ESP, Cascade	DCE		4.60 ND to 2.5E-02	1.4E-02
RFRIG1 (1991):WB ESP, Cyclone	DCE	0.85		ND(2.0E-02)
RFRIG2 (1991): WB ESP, Cyclone	DCE	2.63	ND to 1.9E-02	8.2E-03
SUMMARY	DCE		ND to 1.9E-02	8.4E-03 (Median)
C: DB	NDCE	9.84	0.21 to 0.91 ppm	3.3E-02
D: DB ESP	NDCE	18.60	0.17 to 2.98 ppm	7.1E-02
E: ESP	NDCE	12.00	0.49 to 1.71 ppm	5.1E-02
RFO (1986): DB ESP	NDCE	1.90		ND(1.3E-02)
SUMMARY	NDCE		ND to 1.6E-01	4.2E-02 (Median)

*Abbreviations: BLS = black liquor solids; ND = not detected; DCE = direct contact evaporator; NDCE = non-direct contact evaporator; ESP = electrostatic precipitator; WB = wet bottom; DB = dry bottom; MPPD = million pounds per day. Type evaporator given for DCE types only.

** Mills with codes not preceded by “RF “ are from a 1980 study (4). Dates when these mills were built or rebuilt are not available.

The median sulfuric acid emissions from the direct contact (DCE) and non-direct contact (NDCE) evaporator recovery furnaces, 8.4E-03 pounds per ton black liquor solids (BLS) and 4.2E-02 pounds per ton BLS, respectively, can be used to estimate sulfuric acid emissions.

For example, if a kraft mill using 1100 air dry tons of unbleached pulp per day (ADTUBPD) generates 3300 pounds BLS per ADTUBPD and operates two DCE furnaces 365 days per year, the pounds of H_2SO_4, H, emitted during the year will be:

H = 1100 ADTUBPD × 365 days/year × (3300 lbs. BLS/ADTUBPD × ton BLS/2000 lbs BLS) × 8.4E-03 lbs. H SO /ton BLS = 5,565 lbs. of H_2SO_4

The pounds of sulfuric acid aerosols produced in recovery furnaces on site should be combined with that produced from fuel oil and coal combustion. Should the total equal or exceed 25,000 pounds per year, reporting would be required under EPCRA Section 313. It should be noted that sulfuric acid used at the site for such purposes as ClO_2 generation, pH control, and ion exchange generation no longer must be reported since aerosol forms of H_2SO_4 are not involved.

Section 3.1.2 Acid Aerosols from Sulfuric Acid Manufacture

Sulfuric acid may be manufactured commercially by either the lead chamber process or the contact process. However, sulfuric acid is usually produced by the contact process (1, 2, 10, 22). In the contact process, sulfur is oxidized to SO_2 which is subsequently fed into a converter where it is catalytically oxidized to SO_3. Finally, the sulfur trioxide is absorbed in a strong sulfuric acid solution or oleum. Sulfuric acid plants are further classified by feedstock: elemental sulfur burning, spent sulfuric acid and hydrogen sulfide burning, and metal sulfide ores and smelter gas burning. Contact sulfuric acid plants vary in design depending on the raw material used to produce SO_2. Oleum is also produced in contact plants, where SO_3-containing gases are passed through a special oleum tower. Regeneration of spent sulfuric acid is another form of sulfuric acid manufacture, often performed in order to comply with antipollution regulations (1).

Sulfuric Acid Manufacture

The amount of sulfuric acid aerosols produced in sulfuric acid manufacture is a function of the type of sulfur feedstock, the concentration of the absorbing acid, and the conditions in the absorber (1, 2, 22). Elemental sulfur produces little acid mist when burned because there is little water present. However the hydrocarbons in other feedstock (such as spent acid) produce water vapor during combustion. The affect of acid strength on mist production is illustrated by results showing 0.5 to 5.0 kilograms (kg) of uncontrolled acid aerosol emissions per Megagram (Mg) of acid produced (1.0 to 10.0 pounds (lb) of acid emissions per ton of acid produced) from oleum plants burning spent acid compared with 0.2 to 2.0 kg/Mg (0.4 to 4.0 lb/ton) of emissions from 98% sulfuric acid plants burning elemental sulfur. In addition, the aerosol particle size from oleum plants is finer than that from the 98% sulfuric acid plants. The operating temperature of the absorption tower affects SO_3 absorption and, accordingly, acid mist formed in the exit gas. In an elemental sulfur burning plant, after the sulfur is burned to SO_2 and catalytically converted to SO_3, the gas enters one or multiple absorption towers (packed columns), usually operated in countercurrent, in which the sulfur trioxide is absorbed in sulfuric acid of 98-99% concentration to form more sulfuric acid (1, 2, 22). The optimal operating temperature of the absorption tower depends on the strength of the acid produced, throughput rate, inlet sulfur trioxide concentrations and other factors peculiar to a particular plant. The optimal concentration of the absorbing acid is the azeotrope (see Appendix 1), 98.3%, where the combined vapor pressures of H_2SO_4, SO_3, and water are at a minimum. At lower concentrations, the water vapor partial pressure is higher and there is a greater risk of sulfuric acid mist formation. At higher concentrations the tail gas will contain increased amounts of H_2SO_4 and SO_3 because of their higher partial pressures. Both sulfuric acid mist formed within the system and gaseous sulfuric acid vaporized from the concentrated acid in the absorption towers and carried along with the predominant sulfur trioxide gas, constitute sulfuric acid aerosols that are being manufactured and therefore contributing to the manufacturing threshold of sulfuric acid aerosols for reporting under section 313 of EPCRA. Sulfuric acid mists entrained in tail gas are separated by special filters and determined by measurement of the acid content.

Regeneration of Spent Sulfuric Acid

The regeneration of spent sulfuric acid normally comprises two major steps, concentration to the highest feasible level and decomposition of the spent acid (1). Water is essentially the only substance evaporated (other than volatile organic impurities) in concentrating the acid to <75% H_2SO_4. Vapors evolved during the concentration of spent sulfuric acid to a more highly concentrated state (93-98% H_2SO_4) contain significant quantities of gaseous sulfuric acid (1). The formation of this gaseous sulfuric acid contributes to the manufacturing threshold of sulfuric acid aerosols for reporting under section 313 of EPCRA. Spent sulfuric acid may be concentrated in either vacuum or drum concentrators. While vacuum concentrators yield negligible emissions, those from drum concentrators contain acid mist. Exit gas is passed through scrubbers before being vented to the atmosphere. Emissions from acid drum concentrators operating at 55, 73, and 100% of capacity are reported to be 7034, 2401, and 2334 metric ton/day (12).

Acid Aerosol Emissions

Nearly all the sulfuric acid aerosols emitted from sulfuric acid manufacturing plants come from the absorber exit gases. The exit gas contains small amounts of SO_2, even smaller amounts of SO_3, and sulfuric acid vapor and mist. Even with efficient gas drying, mist formation is impossible to eliminate completely. Once formed, these aerosols are of such a fine particle size and so stable that only a small amount can be removed in the absorber. Sulfuric acid is normally combined with SO_3 in determining an emission factor because SO_3 reacts so rapidly with water vapor. The emission factor for SO_3 is calculated as 100% H SO and added to the H_2SO_4 value.

Sulfuric acid mists are always formed when sulfur trioxide combines with water vapor at temperatures below the dew point of sulfur trioxide. The dew point is a function of gas composition and pressure and is generally around 140-170EC. Equations are available that predict the dewpoint for different concentrations of H_2O and H_2SO_4 (4). Examples are given in Section 3.1.5 in Tables 6 and 8 for coal and fuel oil combustion.

Use of Sulfuric Acid Emission Monitoring Data

Some sulfuric acid manufacturing facilities may have sulfuric acid emission monitoring data available that can be used to estimate emissions for sulfuric acid mist under the Clean Air Act New Source Performance Standards (NSPS). Sulfuric acid plants constructed or modified after August 17, 1971, are subject to a sulfuric acid mist emissions limit of 0.15 pounds of sulfuric acid per ton of 100% sulfuric acid produced (see Part 60 Subpart H of Title 40 of the Code of Federal Regulations). If such information is available, it is preferable to use such data for estimating uncontrolled emissions of sulfuric acid, rather than published emission factors since monitoring data should be the best available data. If the measured data available is for controlled emissions, then the amount of sulfuric acid generated prior to emission controls should be calculated based on the average actual control efficiency for the acid mist.

$$\text{Uncontrolled } H_2SO_4 \text{ emissions} = \text{actual emissions to air}/(1\text{-efficiency})$$

(Efficiency expressed as a fraction)

Emission factors for sulfuric acid plants have been compiled by EPA (10). Uncontrolled emission factors for various sulfuric acid plants are shown in Table 3. Table 4 contains emission factors for plants using three of the most commonly used fiber mist eliminator control devices, vertical tube, vertical panel, and horizontal duel pad types.

Table 3. Uncontrolled Emission Factors for Sulfuric Acid Plants

Raw material	* Oleum produced % Total output	Emissions of H_2SO_4 aerosol per unit product	
		kg/Mg	**lb/ton**
Recovered sulfur	0-43	0.174-0.4	0.348-0.8
Bright virgin sulfur	0	0.85	1.7
Dark virgin sulfur	0-100	0.16-3.14	0.32-6.28
Spent acid	0-77	1.1-1.2	2.2-2.4

*Sulfuric acid containing dissolved sulfur trioxide. Also known as fuming sulfuric acid or disulfuric acid.

Table 4. Controlled Emission Factors for Sulfuric Acid Plants

Raw material	* Oleum produced % Total output	Emissions of H_2SO_4 aerosol per unit product	
		kg/Mg	**lb/ton**
Elemental sulfur	---	0.064	0.128
Dark virgin sulfur	0-13	0.26-1.8	0.52-3.6
Spent acid	0-56	0.014-0.20	0.28-0.40

*Sulfuric acid containing dissolved sulfur trioxide. Also known as fuming sulfuric acid or disulfuric acid.

Section 3.1.3. Smelters

Sulfuric acid is a byproduct of metals production, notably copper, and is accordingly sometimes referred to as smelter acid. Smelters produce sulfuric acid by the contact process with the raw material being classified as ‘metal sulfide ores and smelter gas burning’ (see Section 3.1.2). The smelter gas (SO_2 from the smelter furnace) is passed through cyclone dust collectors, electrostatic dust and mist precipitators, and scrubbing and gas cooling towers to remove dust, acid, mist and other impurities. The gas is then converted to SO_3 and then H_2SO_4 in processes similar to those used in sulfuric acid plants using elemental sulfur as a raw material (Section 3.1.2). Therefore, the potential for sulfuric acid aerosols formation is similar to the described above in the third paragraph of Section 3.1.2.

Section 3.1.4. Petroleum Refining

Crude oil contains a small amount of sulfur as an impurity. As a result, sulfur oxides are emitted from petroleum refineries. EPA has compiled emission factors of sulfur oxides, SO_x, for petroleum refining, but factors for sulfuric acid are not provided (11). However, according to information provided by the American Petroleum Institute (API), the staff in API's Health and Environmental Sciences Department uses the following EPA reference for sulfuric acid emission factors: EPA. 1995. Compilation of Air Pollutant Emission Factors. Vol. 1: Stationary Point and Area Sources. Section 8.10, AP-42, 5th ed. (January 1995). Research Triangle Park, NC: U.S. EPA, OAQPS.

Section 3.1.5. Sulfuric Acid Aerosol Formation In Stacks From Combustion Processes

Sulfuric acid aerosols are often formed in flue gas in a stack during combustion of fuel oil, coal, or other sulfur-containing fuels. Both water and sulfur trioxide are combustion products and they have great affinity for each other; as discussed they react quickly to form sulfuric acid. When flue gas is cooled to temperatures at or below the dew point, a sulfuric acid mist will form from any sulfuric acid gas present (16). The dew point is the temperature at which the air becomes saturated and produces dew; sulfuric acid mists are always formed when sulfur trioxide combines with water vapor at temperatures below the dew point of sulfur trioxide. Because of the enormous attraction between sulfur trioxide and water "only a very small amount of sulfur trioxide in combustion gas is required to draw water from the gas and form a fairly concentrated acid" (16). In fact, flue gas containing 1% sulfuric acid has the corrosive properties of 85% sulfuric acid solution. All sulfuric acid produced within the stack, including the gas not just the mist, falls under the EPCRA section 313 definition of a sulfuric acid aerosol. The information on dew points can be used to determine if any of the sulfuric acid present as gas will form a mist that could potentially condense inside the stack.

Tables 5 and 7 below contain expected sulfur trioxide levels in flue gas resulting from the combustion of fuel oil and coal, respectively, as a function of the sulfur content of the fuel and the percent of excess air available (16). If water is present in the stack, Tables 5 and 7 can be used to estimate the amount of sulfuric acid gas that can be formed. Tables 6 and 8 contain empirically-derived dew points of SO_3 for different concentrations of SO_3 in stack gas of oil- and coal-fired units, respectively. These tables can be used to determine whether the stack temperature is below the dew point of SO_3 and sulfuric acid mists are being formed in the stack in flue gas. Examples of how to use these tables to determine the dew point of SO_3 are given below.

Assume a typical oil-fired unit is burning fuel oil containing 2% sulfur and that 17% excess air is present. From Table 5, we see that 15 ppm of SO_3 will be present in the flue gas and available to form sulfuric acid gas. From Table 6, we find that the dew point of SO_3 should be 139°C. Therefore, if the temperature in the stack is at or below 139°C, sulfuric acid mists will very likely form in the stack.

As an example dealing with coal combustion, assume a typical unit is burning coal containing 3% sulfur in the presence of 25% excess air. From Table 7, we see that between 20 and 40 ppm of SO_3 will be present in the flue gas and available to form sulfuric acid gas. From Table 8, we find that the dew point should be between 136°C and 143°C . Therefore, if the temperature in the stack is at or below 136°C to 143°C, sulfuric acid mists will very likely form in the stack.

Table 5. SO_3 Production in Oil Fired Units

Excess air (%)	SO_3 Concentration in Flue Gas (ppm)					
Sulfur in fuel (%)	*0.5*	*1.0*	*2.0*	*3.0*	*4.0*	*5.0*
5	2	3	3	4	5	6
11	6	7	8	10	12	14
17	10	13	15	19	22	25
25	12	15	18	22	26	30

Table 6. Dew Point of SO_3 in Stacks of Oil Fired Units*

SO in gas (ppm)	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Dew point (°C)	130	135	139	141	143	145	147	148	149	150	151	152	153	154

*Using typical value of 10% water in oil

Table 7. SO_3 Production in Coal Fired Units

Excess air (%)	SO_3 Concentration in Flue Gas (ppm)					
Sulfur in fuel (%)	*0.5*	*1.0*	*2.0*	*3.0*	*4.0*	*5.0*
25	3-7	7-14	14-28	20-40	27-54	33-66

Table 8. Dew Point of SO_3 in Stacks of Coal Fired Units*

SO in gas (ppm)	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Dew point (°C)	125	130	134	136	138	140	142	143	144	145	146	147	148	149

*Using typical value of 6% water in coal

Steel stacks are generally designed and operated so that a temperature between 135°C (275°F) and 149°C (300°F) is maintained throughout the stack (16). These stack temperatures are such that they may be below the dew point for SO_3 in the flue gas, leading to the formation of sulfuric acid mists in the stacks.

Section 3.1.6. Coal Combustion

Sulfuric acid aerosols are produced as a byproduct from boilers during coal combustion. U.S. coals contain from 0.2% to 7% sulfur by weight (13). On average, about 95% of sulfur present inbituminous coal will be emitted as gaseous sulfur oxides (SO_x) when burned, whereas somewhat less will be emitted when subbituminous coal is burned (15). In general, boiler size, firing configuration, and boiler operations have little effect on the percent conversion of sulfur in fuel to sulfur oxides. About 0.7% of fuel sulfur is emitted as SO_3/H_2SO_4 (15). This information can be expressed as an uncontrolled emission factor (EF) of 0.43 × S pounds H_2SO_4 per ton of coal burned, where S is the weight percent sulfur in coal. The uncontrolled emission factor also represents the amount of sulfuric acid produced in the stack, as well as that released to the atmosphere in the absence of scrubbers or other emission control devices. The emission factor for sulfur oxides (SO_x) for bituminous coal combustion should not be used to estimate sulfuric acid emissions since the factor includes sulfur dioxide. If C is the tons of coal burned, the pounds of H_2SO_4 generated (H), would be:

$$H = 0.43 \times S \times C$$

For example, if 9,000 tons of coal were burned and the coal contained 3% sulfur, then:

$$H = 0.43 \times 3 \times 9{,}000 = 11{,}610 \text{ pounds of } H_2SO_4$$

Note that the values for the variables C and S have been chosen as an illustration. Values must be chosen that are appropriate for the particular operations at each facility.

Section 3.1.7. Fuel Oil Combustion

Sulfuric acid aerosols are produced during fuel oil combustion from the oxidation of sulfur contained in the fuel. There are various types of fuel oil combustion operations; the type of operation depends on the type of fuel oil burned. There are mainly five types of fuel oil used for commercial, industrial, and residential use in the U.S. The No. 1 and No. 2 fuel oils are known as distillate oils. They have high volatility, low viscosity, and <0.3% sulfur by weight. They are primarily used in domestic and small commercial operations. The No. 5 (also called low sulfur No. 6) and No. 6 fuel oils are known as residual oils. They have low volatility, high viscosity, and high sulfur content. They are mainly used in industrial operations. The No. 4 fuel oil is a mixture of distillate and residual oils and can be used for both types of operations. Typical sulfur contents of fuel oil are (13):

Fuel Oil Grade	Sulfur Content (wt %)
No. 1	0.09
No. 2	0.22
No. 4	1.35
No. 5	0.84
No. 6	3.97

Uncontrolled SO_x emissions are almost entirely dependent on the sulfur content of the fuel and are not affected by boiler size and design or the grade of fuel being burned. On the average, over 95% of the sulfur in fuel oil is converted to SO_2 on combustion; about 1 to 5 percent is further oxidized to sulfur trioxide where it readily reacts with water vapor in flue gas to form sulfuric acid aerosols. The emission factor (°F) for uncontrolled fuel oil combustion from industrial boilers is 0.002 × S pounds SO_3 per gallon of fuel oil burned (14) or 0.00245 × S pounds H_2SO_4 per gallon of fuel oil burned, where S is the weight percent sulfur in the fuel oil. The uncontrolled emission factor also represents the amount of sulfuric acid produced in the stack, as well as that released to the atmosphere in the absence of scrubbers or other emission control devices. An example of the use of the emission factor (°F) to calculate the pounds of sulfuric acid generated is shown below. If F is the number of gallons of fuel oil burned, the pounds of H_2SO_4 generated (H), would be:

$$H = 0.00245 \times S \times F$$

For example, if 4,500,000 gallons of fuel oil were burned and the fuel oil contained 3.97% sulfur, then:

$$H = 0.00245 \times 3.97 \times 4{,}500{,}000 = 43{,}769 \text{ pounds of } H_2SO_4$$

Note that the values for the variables F and S have been chosen as an illustration. Values must be chosen that are appropriate for the particular operations at each facility.

Section. 4.0. Measurement Methods

For source sampling, EPA has specified extractive sampling trains and analytical procedures for SO_3 and sulfuric acid aerosols (7, 8). Separation of particles containing Na_2SO_4 may present problems in cases such as Kraft paper mills (4). If sodium sulfate is present, analytical results for sulfuric acid would be high.

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APPENDIX 1

Figure 1a. Boiling curves for sulfuric acid at 1013 mbar a) Vapor; b) Liquid (reference 1).

Information in the above figure shows that if the vapor above a solution of 85% sulfuric acid, boiling at 223°C, were to be completely condensed it would contain approximately 7 percent H_2SO_4. At concentrations below approximately 75% H_2SO_4, the vapor that evaporates from the solution is essentially water.

Table 1a. Sulfuric Acid Partial Pressure and Total Vapor Pressure (bar) over Aqueous Sulfuric Acid*

	Weight Percent Sulfuric Acid					
°F	**20.0**	**40.0**	**60.0**	**80.0**	**98.0**	**0.0**
32	.843E-20 (.534E-02)	.344E-17 (.326E-02)	.438E-14 (.836E-03)	.161E-10 (.197E-04)	.187E-08 (.117E-07)	.228E-08 (.323E-08)
68	.769E-18 (.205E-01)	.193E-15 (.130E-01)	.149E-12 (.367E-02)	.305E-09 (.115E-03)	.224E-07 (.121E-06)	.273E-07 (.435E-07)
104	.389E-16 (.649E-01)	.649E-14 (.427E-01)	.317E-11 (.131E-01)	.379E-08 (.531E-03)	.191E-06 (.914E-06)	.230E-06 (.425E-06)
140	.121E-14 (.175)	.144E-12 (.119)	.462E-10 (.395E-01)	.334E-07 (.204E-02)	.122E-05 (.538E-05)	.147E-05 (.319E-05)
176	.254E-13 (.417)	.225E-11 (.290)	.492E-09 (.104)	.222E-06 (.668E-02)	.622E-05 (.257E-04)	.743E-05 (.193E-04)
212	.381E-12 (.891)	.264E-10 (.634)	.402E-08 (.244)	.117E-05 (.192E-01)	.261E-04 (.103E-03)	.310E-04 (.966E-04)
302	.106E-09 (4.132)	.460E-08 (3.090)	.316E-06 (1.392)	.343E-04 (.170)	.493E-03 (.180E-02)	.574E-03 (.287E-02)
392	.883E-08 (13.107)	.278E-06 (10.245)	.975E-05 (5.312)	.457E-03 (.913)	.470E-02 (.166E-01)	.538E-02 (.427E-01)
482	.312E-06 (31.939)	.793E-05 (26.056)	.156E-03 (15.351)	.358E-02 (3.439)	.278E-01 (.985E-01)	.314E-01 (.389)
572	.591E-05 (64.407)	.130E-03 (54.869)	.156E-02 (36.361)	.266E-01 (9.916)	.117E-00 (.425)	.130E-00 (2.476)

* Total pressure is in parentheses. Conversion Factors: 1 bar = 0.98677 atmospheres = 14.7 psia = 760 mm Hg = 0.1 MPa

The above table contains the partial pressure of sulfuric acid and total vapor pressure of the solution (in parentheses) over aqueous sulfuric acid solutions in the concentration range of 20 to 100 weight percent sulfuric acid (1). From Table 1a we see that the partial pressure of sulfuric acid above a sulfuric acid solution is very low compared to the total vapor pressure for sulfuric acid solutions below 80% sulfuric acid; the bulk of the vapor being composed of water. Consequently when a solution of sulfuric acid boils, more water than sulfuric acid is volatilized, so that the concentration of the remaining acid increases and the boiling point of the solution rises. This process continues until the acid concentration reaches 98.3 weight % H_2SO_4, when an azeotrope (a mixture of two liquids that boils at constant composition; i.e., the composition of the vapor is the same as that of the liquid) is formed and the concentration of sulfuric acid in the vapor is the same as that of the solution. The vapor above sulfuric acid solutions containing more than 98.3 weight % H_2SO_4 also includes considerable amounts of SO_3, thus the difference between the partial pressure and total pressure of 100% sulfuric acid is the partial pressure of sulfur trioxide. Since the partial pressure of concentrated sulfuric acid is very low, little sulfuric acid is expected to volatilize from sulfuric acid solutions such as may be present in storage tanks. No experimental data are available on sulfuric acid aerosol emissions from storage tanks.

Above 340°C, H_2SO_4 decomposes into sulfur trioxide and water. The vapor-phase reaction of sulfur trioxide and water results in aerosols of sulfuric acid. The $H_2SO_4/H_2O/SO_3$ system is important in the production of sulfuric acid by the contact process as well as in the prevention of corrosionfrom condensing sulfuric acid in stack emissions from the combustion of sulfur-containing fuels. Sulfuric acid containing dissolved sulfur trioxide is known as oleum, fuming sulfuric acid or disulfuric acid. The vapor pressure of sulfuric acid over oleum containing 10% to 30% of free SO_3 by weight is shown in Table 2a (2). Since the vapor pressure of sulfur trioxide over oleum is high, sulfuric acid aerosols also form when oleum is exposed to air containing moisture.

Table 2a. Sulfuric Acid Partial Pressure (bar) over Oleum *

	Free SO_3 in oleum, %		
°C	**10**	**20**	**30**
20	.227 E-08	.120 E-08	.40 E-09
40	.1467 E-07	.667 E	-08 .267 E-08
60	.7333 E-07	.400 E-07	.1333 E-07
80	.3066 E-06	.1600 E-06	.600 E-07
100	.1067 E-05	.5333 E-06	.2133 E-06

Conversion Factors: 1 bar = 0.98677 atmospheres = 14.7 psia = 760 mm Hg = 0.1 Mpa;
°F = 1.8 (°C) + 32.

Appendix D

GUIDANCE FOR REPORTING AQUEOUS AMMONIA

United States Environmental Protection Agency
Office of Pollution Prevention and Toxics
Washington, DC 20460
July 1995
EPA 745-R-95-012

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW

EPCRA Section 313

Guidance for Reporting Aqueous Ammonia

EPCRA Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) requires certain facilities manufacturing, processing, or otherwise using listed toxic chemicals to report their environmental releases of such chemicals annually. Beginning with the 1991 reporting year, such facilities also must report pollution prevention and recycling data for such chemicals, pursuant to section 6607 of the Pollution Prevention Act, 42 U.S.C. 13106. When enacted, EPCRA Section 313 established an initial list of toxic chemicals that was comprised of more than 300 chemicals and 20 chemical categories. EPCRA Section 313(d) authorizes EPA to add chemicals to or delete chemicals from the list, and sets forth criteria for these actions.

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Section 1. Introduction

On June 30, 1995 EPA finalized four actions in response to a petition received in 1989 to delete ammonium sulfate (solution) from the list of toxic chemicals subject to reporting under EPCRA Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), 42 U.S.C. 11001. The four actions taken are summarized as follows: (1) deleted ammonium sulfate (solution) from the EPCRA Section 313 list of toxic chemicals, (2) required that threshold and release determinations for aqueous ammonia be based on 10 percent of the total aqueous ammonia present in aqueous solutions of ammonia, (3) modified the ammonia listing by adding the following qualifier: ammonia (includes anhydrous ammonia and aqueous ammonia from water dissociable ammonium salts and other sources; 10 percent of total aqueous ammonia is reportable under this listing), and (4) deleted ammonium nitrate (solution) as a separately listed chemical on the EPCRA Section 313 list of toxic chemicals. All actions are effective for the 1994 reporting year for reports due July 1, 1995, with the exception of the deletion of ammonium nitrate (solution) as a separately listed chemical, which is effective for the 1995 reporting year for reports due July 1, 1996. At the time that these actions were finalized, EPA indicated that the Agency would develop, as appropriate, interpretations and guidance that the Agency determines are necessary to facilitate accurate reporting for aqueous ammonia. This document constitutes such guidance for reporting under the ammonia listing.

Section 1.1 Who Must Report

A plant, factory, or other facility is subject to the provisions of EPCRA Section 313, if it meets <u>all</u> three of the following criteria:

- It conducts manufacturing operations (is included in Standard Industrial Classification (SIC) codes 20 through 39); <u>and</u>
- It has 10 or more full-time employees (or the equivalent 20,000 hours per year); <u>and</u>
- It manufactures, imports, processes, or otherwise uses any of the toxic chemicals listed on the EPCRA Section 313 list in amounts greater than the “threshold” quantities specified below.

Section 1.2 Thresholds

Thresholds are specified amounts of toxic chemicals used during the calendar year that trigger reporting requirements.

If a facility *manufactures* or *imports* any of the listed toxic chemicals, the threshold quantity will be:

- 25,000 pounds per toxic chemical or category over the calendar year.

If a facility *processes* any of the listed toxic chemicals, the threshold quantity will be:

- 25,000 pounds per toxic chemical or category over the calendar year.

If a facility *otherwise uses* any of the listed toxic chemicals (without incorporating it into any product or producing it at the facility), the threshold quantity is:

- 10,000 pounds per toxic chemical or category over the calendar year.

Section 1.3 Chemical Sources of Aqueous Ammonia

If a facility manufactures, processes, or otherwise uses anhydrous ammonia or aqueous ammonia, they must report under the ammonia listing. EPA is providing a table of Chemical Abstract Service (CAS) numbers and chemical names to aid the regulated community in determining whether they need to report under the ammonia listing for aqueous ammonia. This table includes a list of water dissociable ammonium salts which, when placed in water, are a source of aqueous ammonia. The table contains only commonly used ammonium salts and therefore is not exhaustive. If a facility manufactures, processes, or otherwise uses aqueous ammonia, regardless of its source, it must report under the ammonia listing, even if the source of the aqueous ammonia is not listed in the table provided in this document.

Section 1.4 *De Minimis* Concentrations

The ammonia listing is subject to the one percent *de minimis* concentration. Thus, solutions containing aqueous ammonia at a concentration in excess of *one percent of the 10 percent reportable under this listing* should be factored into threshold and release determinations.

Section 2. Guidance for Reporting Aqueous Ammonia

Note: for the purposes of reporting under the ammonia listing for aqueous ammonia, water dissociable ammonium salts means that the ammonium ion dissociates from its counterion when in solution.

Section 2.1 Determining Threshold and Release Quantities for Ammonia

If a facility manufactures, processes, or otherwise uses *anhydrous ammonia*, the quantity applied towards threshold determinations for the ammonia listing is the total quantity of the anhydrous ammonia manufactured, processed, or otherwise used. The quantity reported when calculating the amount of ammonia that is released, transferred, or otherwise managed is the total quantity of *anhydrous ammonia* released or transferred.

If the facility manufactures, processes, or otherwise uses *anhydrous ammonia* in quantities that exceed the appropriate threshold and subsequently dissolves some or all of the *anhydrous ammonia* in *water*, then the following applies: 1) threshold determinations are based on 100 percent of the *anhydrous ammonia* (simply 10 percent of *aqueous ammonia*); 2) release, transfer, and other waste management quantities for the *aqueous ammonia* are calculated as 10 percent of total ammonia; 3) release, transfer, and other waste management quantities for the *anhydrous ammonia* are calculated as 100 percent of the *anhydrous ammonia*.

If a facility manufactures, processes, or otherwise uses *aqueous ammonia*, the quantity applied toward threshold determinations for the ammonia listing is 10 percent of the total quantity of the *aqueous ammonia* manufactured, processed, or otherwise used. The quantity reported when calculating the amount of ammonia that is released, transferred, or otherwise managed is 10 percent of the total quantity of *aqueous ammonia* released or transferred.

If a facility dissolves a water dissociable ammonium salt in water that facility has manufactured *aqueous ammonia* and 10 percent of the total *aqueous ammonia* manufactured from these salts is to be included in manufacturing threshold determinations under the ammonia listing.

If *aqueous ammonia* from water dissociable ammonium salts is processed or otherwise used, then 10 percent of the total *aqueous ammonia* is to be included in all processing and otherwise use threshold determinations under the ammonia listing.

<u>Example 1</u>: In a calendar year, a facility places 25,000 lbs of anhydrous ammonia in water for processing and processes 25,000 lbs of aqueous ammonia from an ammonium salt. The facility must include all of the 25,000 lbs of anhydrous ammonia in the determination of the processing threshold, but only 10 percent (or 2,500 lbs) of the aqueous ammonia from the ammonium salt in the processing threshold determination.

Total aqueous ammonia is the sum of the two forms of ammonia (un-ionized, NH_3, and ionized, NH_4^+) present in aqueous solutions. A precise calculation of the weight of total aqueous ammonia would require determining the ratio of the two forms of ammonia present using the pH and temperature of the solution. The weight of total aqueous ammonia can be more easily calculated by assuming that aqueous ammonia is comprised entirely of the NH_4^+ form or the NH_3 form. For the purpose of determining threshold and release quantities under EPCRA Section 313, EPA recommends that total aqueous ammonia be calculated in terms of NH_3 equivalents (i.e., for determining weights, assume total ammonia is comprised entirely of the NH_3 form). This method is simpler than using pH and temperature data to determine the ratio of the two forms present and is consistent with the presentation of total ammonia toxicity in a separate EPA document, *Ambient Water Quality Criteria for Ammonia* (EPA document #440/5-85-001, January 1985).

Section 2.2 Chemical Sources of Aqueous Ammonia

Aqueous ammonia may be generated in solution from a variety of sources that include the release of anhydrous ammonia to water and the dissociation of ammonium salts in water. Water dissociable ammonium salts are not reportable in their entirety under the ammonia listing; these salts are reportable to the extent that they dissociate in water, and only 10 percent of the total aqueous ammonia that results when these salts dissociate is reportable. If these salts are not placed in water, they are not reportable.

If these salts are purchased neat or as solids by a facility, then placed in water by that facility, the facility is *manufacturing* aqueous ammonia.

Section 2.2.1 Reporting Aqueous Ammonia Generated from Anhydrous Ammonia in Water

If the source of aqueous ammonia is anhydrous ammonia in water, total aqueous ammonia (calculated in terms of NH_3 equivalents) is equal to the quantity of anhydrous ammonia manufactured, processed, or otherwise used. A hypothetical scenario demonstrating the calculations involved in reporting aqueous ammonia generated from anhydrous ammonia in water is given in Example 2.

Example 2: In a calendar year, a facility uses 30,000 pounds of anhydrous ammonia to neutralize acids in a wastewater stream. The neutralized waste stream (containing aqueous ammonia from dissociated ammonium salts) is then transferred to a POTW. The quantity to be applied toward threshold determinations is the total quantity of anhydrous ammonia used in the waste stream neutralization, or 30,000 pounds. The quantity of ammonia reported as transferred is 10 percent of the total quantity of aqueous ammonia transferred, or 3,000 pounds.

Section 2.2.2 Reporting Aqueous Ammonia Generated from the Dissociation of Ammonium Salts (Other Than Ammonium Nitrate)

If the source of aqueous ammonia is the dissociation of ammonium salts in water, total aqueous ammonia (calculated in terms of NH_3 equivalents) is calculated from the weight percent (wt%) of the NH_3 equivalents of the ammonium salt. The NH_3 equivalent wt% of an ammonium salt is calculated using the following equation:

$$NH_3 \text{ equivalent wt\%} = (NH_3 \text{ equivalent weight})/(\text{MW ammonium salt}) \times 100$$

If the source of aqueous ammonia is a monovalent compound (such as ammonium chloride, NH_4Cl, ammonium nitrate, NH_4NO_3, or ammonium bicarbonate (NH_4HCO_3), the NH_3 equivalent weight is equal to the MW of NH_3 (17.03 kg/kmol). If divalent compounds are involved (such as ammonium carbonate, $(NH_4)_2CO_3$), then the NH_3 equivalent weight is equal to the MW of NH_3 multiplied by two. Similarly, if trivalent compound are involved, then the NH_3 equivalent weight is equal to the MW of NH_3 multiplied by three.

Example 3:

The NH_3 equivalent wt% of ammonium chloride is calculated as follows:

NH_3 equivalent wt% = (NH_3 equivalent weight)/(MW ammonium chloride) × 100
NH_3 equivalent wt% = (17.03)/(53.49) × 100
NH_3 equivalent wt% = 31.84%

The NH_3 equivalent wt% of ammonium carbonate is calculated as follows:

NH_3 equivalent wt% = 2 × (NH_3 equivalent weight)/(MW ammonium chloride) × 100
NH_3 equivalent wt% = 2 × (17.03)/(96.09) × 100
NH_3 equivalent wt% = 35.45%

To aid the regulated community in reporting under the ammonia listing for aqueous ammonia, the table of chemical sources of aqueous ammonium provided in Section 3 of this document includes, in addition to CAS number, chemical name, and molecular weight, the NH_3 equivalent wt% of the commonly used, water dissociable ammonium salts listed in this table.

Example 4: In a calendar year, a facility uses 100,000 pounds of ammonium chloride, NH_4Cl, *in aqueous solution* which is released to wastewater streams, then transferred to a POTW. The NH_3 equivalent wt% of ammonium chloride is 31.84% (taken from Table 1 in Section 3 below or calculated as in Example 3 above). The total quantity of aqueous ammonia present in solution is 31.84% of the 100,000 pounds of ammonia chloride used, or 31,840 pounds. The quantity applied towards threshold determinations for the ammonia listing is 10 percent of the total quantity of aqueous ammonia present in solution, or 3,184 pounds. The quantity of ammonia reported as released or transferred is 10 percent of the total quantity of aqueous ammonia released or transferred, or 3,184 pounds.

Example 5: In a calendar year, a facility uses 500,000 pounds of ammonium carbonate, $(NH_4)_2CO_3$, and 400,000 pounds of ammonium bicarbonate, NH_4HCO_3, *in aqueous solution* which is released to wastewater streams, then transferred to a POTW. The NH_3 equivalent wt% of ammonium carbonate is 35.45%, and the NH_3 equivalent wt% of ammonium bicarbonate is 21.54% (taken from Table 1 in Section 3 below or calculated as in Example 3 above). The quantity of aqueous ammonia present in solution from ammonium carbonate is 35.45% of the 500,000 pounds of ammonia carbonate used, or 177,250 pounds. The quantity of aqueous ammonia present in solution from ammonium bicarbonate is 21.54% of the 400,000 pounds of ammonia bicarbonate used or 86,160 pounds. The total quantity of aqueous ammonia present in solution is 263,410 pounds. The quantity applied towards threshold determinations for the ammonia listing is 10 percent of the total quantity of aqueous ammonia present in solution, or 26,341 pounds. The quantity of ammonia reported as released or transferred is 10 percent of the total quantity of aqueous ammonia released or transferred, or 26,341 pounds.

Section 2.2.3 Reporting Aqueous Ammonia Generated from the Dissociation of Ammonium Nitrate

Some sources of aqueous ammonia may be reportable under other EPCRA Section 313 category listings. Ammonium nitrate (solution) is relevant to reporting under the ammonia listing to the extent that 10 percent of the total aqueous ammonia that results when ammonium nitrate dissociates is reported when determining thresholds and calculating releases. However, under the nitrate compound category listing, ammonium nitrate (and other mixed salts containing ammonium and nitrate) must be reported in its entirety. When reporting ammonium nitrate under this category listing, the total nitrate compound, including both the nitrate ion portion and the ammonium counterion, is included when determining threshold quantities. However, only the nitrate ion portion is included when determining the amount of ammonium nitrate that is released, transferred, or otherwise managed in wastes. The calculations involved in determining threshold and release quantities for reporting under the nitrate compound category listing are described in a separate directive, *List of Toxic Chemicals within the Water Dissociable Nitrate Compounds Category and Guidance for Reporting* (EPA document #745-R-95-002, February 1995). Note: reporting ammonium nitrate under the ammonia listing and nitrate compounds category listing is effective for the 1995 reporting year for reports due July 1, 1996.

Example 6: In a calendar year, a facility uses 1,250,000 pounds of ammonium nitrate, NH_4NO_3, *in aqueous solution* which is released to wastewater streams, then transferred to a POTW. The NH_3 equivalent wt% of ammonium nitrate is 21.28% (taken from Table 1 in Section 3 below or calculated as in Example 3 above). The total quantity of aqueous ammonia present in solution is 21.28% of the 1,250,000 pounds of ammonia chloride used, or 266,000 pounds. The quantity applied towards threshold determinations for the ammonia listing is 10 percent of the total quantity of aqueous ammonia present in solution, or 26,600 pounds. The quantity of ammonia reported as released or transferred is 10 percent of the total quantity of aqueous ammonia released or transferred, or 26,600 pounds. For determining thresholds and calculating releases under the nitrate compound category listing, see the separate directive, *List of Toxic Chemicals within the Water Dissociable Nitrate Compounds Category and Guidance for Reporting* (EPA document #745-R-95-002, February, 1995).

Example 7: In a calendar year, a facility transfers 100,000 pounds of nitric acid (HNO_3) to an on-site treatment facility. The nitric acid is neutralized with anhydrous ammonia, and treatment efficiency is 95 percent (the nitrate compound formed as a result of the treatment is ammonium nitrate, NH_4NO_3). The neutralized waste stream (containing aqueous ammonia from dissociated ammonium nitrate) is then transferred to a POTW. The quantity of nitric acid neutralized is 95 percent of 100,000 pounds or 95,000 pounds. The quantity of nitric acid neutralized is converted first to kilograms then to kilomoles using the following equations:

Kilograms HNO_3 neutralized = (lbs HNO_3 neutralized) × (0.4536 kg/lb)
Kilomoles HNO_3 neutralized = (kg HNO_3) ÷ (MW of HNO_3 in kg/kmol)

Substituting the appropriate values into the above equations yields:

Kilograms HNO_3 neutralized = 95,000 lbs × 0.4536 kg/lb = 43,092 kg
Kilomoles HNO_3 neutralized = 43,092 kg ÷ 63.01 kg/kmol = 683.9 kmol

The quantity of anhydrous ammonia used in kilomoles in the acid neutralization and the quantity of ammonium nitrate generated in kilomoles from the neutralization are equal to the quantity of nitric acid neutralized (683.9 kmol). The quantity of anhydrous ammonia used in kilograms and pounds in the acid neutralization is calculated as follows:

Kilograms NH_3 used = (kmol NH_3) × (MW of NH_3 in kg/kmol)
Pounds NH_3 used = (kg NH_3) × (2.205 lbs/kg)

Substituting the appropriate values into the above equation yields:

Kilograms NH_3 used = (683.9 kmol) × (17.03 kg/kmol) = 11,647 kmol
Pounds NH_3 used = (11,647 NH_3) × (2,205 lbs/kg) = 25,682 pounds

The quantity reported applied towards threshold determinations for the ammonia listing is the total quantity of anhydrous ammonia used in the acid neutralization, or 25,682 pounds. The quantity of ammonia reported as released or transferred is 10 percent of the total quantity of aqueous ammonia released or transferred, or 2,568 pounds. For determining thresholds and calculating releases under the nitrate compound category listing, see the separate directive, *List of Toxic Chemicals within the Water Dissociable Nitrate Compounds Category and Guidance for Reporting* (EPA document #745-R-95-002, February 1995).

Section 3. CAS Number and List of Some Chemical Sources of Aqueous Ammonia

EPA is providing the following table of CAS numbers and chemical names to aid the regulated community in determining whether they need to report under the ammonia listing for aqueous ammonia. If a facility manufactures, processes, or otherwise uses, *in aqueous solution*, a chemical which is listed below, they must report 10 percent of the total aqueous ammonia that is the result of the dissociation of this chemical. However, this list is not exhaustive. If a facility manufactures, processes, or otherwise uses, *in aqueous solution*, a water dissociable ammonium compound, they must report 10 percent of the total aqueous ammonia that is the result of the dissociation of the compound, even if the compound does not appear in the following table.

Table D-1
Listing by CAS Number and Molecular Weight of Some Chemical Sources of Aqueous Ammonia

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium acetate	77.08	22.09	631-61-8
Ammonium aluminum sulfate (Ammonium aluminum disulfate)	237.14	7.181	7784-25-0
Ammonium antimony fluoride (Diammonium pentafluoroantimonate)	252.82	13.47	32516-50-0
Ammonium arsenate (Ammonium arsenate, hydrogen) (Ammonium arsenate, dihydrogen)	158.97	10.71	13462-93-6
Ammonium arsenate (Diammonium arsenate) (Diammonium arsenate, hydrogen) (Diammonium arsenate, monohydrogen)	176.00	19.35	7784-44-3
Ammonium arsenite	124.96	13.63	13462-94-7
Ammonium azide	60.06	28.35	12164-94-2
Ammonium benzenesulfonate	175.20	9.720	19402-64-3
Ammonium benzoate	139.15	12.24	1863-63-4
Ammonium bromate	145.94	11.67	13843-59-9
Ammonium bromide	97.94	17.39	12124-97-9
Ammonium cadmium chloride (Ammonium cadmium trichloride)	236.81	7.191	18532-52-0
Ammonium carbamate	78.07	21.81	1111-78-0
Ammonium carbonate carbamate	157.13	21.68	8000-73-5
Ammonium carbonate (Diammonium carbonate)	96.09	35.45	506-87-3

Table D-1 (Continued)

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium carbonate, hydrogen (Ammonium bicarbonate)	79.06	21.54	1066-33-7
Ammonium cerium nitrate (Ammonium hexanitratocerate) (Ammonium hexanitratocerate (IV)) (Diammonium cerium hexanitrate)	548.23	6.213	16774-21-3
Ammonium cerous nitrate (Ammonium cerous nitrate, tetrahydrate)	486.22	7.005	13083-04-0
Ammonium chlorate	101.49	16.78	10192-29-7
Ammonium perchlorate	117.49	14.49	7790-98-9
Ammonium chloride	53.49	31.84	12125-02-9
Ammonium chromate (Ammonium chromate (VI)) (Diammonium chromate)	152.07	22.40	7788-98-9
Ammonium chromate (Ammonium dichromate) (Ammonium dichromate (VI)) (Ammonium bichromate) (Diammonium dichromate)	252.06	13.51	7789-09-5
Ammonium chromium sulfate (Ammonium chromic sulfate)	265.17	6.422	13548-43-1
Ammonium citrate (Ammonium citrate, monohydrogen) (Ammonium citrate, dibasic) (Diammonium citrate) (Diammonium citrate, hydrogen)	226.19	15.06	3012-65-5
Ammonium citrate (Ammonium citrate, tribasic) (Triammonium citrate)	243.22	21.01	3458-72-8
Ammonium cobalt sulfate (Ammonium cobaltous sulfate)	289.14	11.78	13596-46-8
Ammonium cupric chloride (Ammonium chlorocuprate (II)) (Diammonium copper tetrachloride) (Diammonium tetrachlorocuprate)	241.43	14.11	15610-76-1
Ammonium cyanate (Ammonium isocyanate)	60.06	28.35	22981-32-4
Ammonium cyanide	44.06	38.65	12211-52-8
Ammonium cyanoaurate, monohydrate (Ammonium tetracyanoaurate, monohydrate)	319.07	5.337	14323-26-3

Table D-1 (Continued)

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium cyanoaurate (Ammonium dicyanoaurate)	267.04	6.377	31096-40-9
Ammonium ferricyanide (Ammonium hexacyanoferrate (III)) (Triammonium hexacyanoferrate)	266.07	19.20	14221-48-8
Ammonium ferrocyanide (Ammonium hexacyanoferrate (II)) (Tetraammonium ferrocyanide) (Tetraammonium hexacyanoferrate)	284.11	23.98	14481-29-9
Ammonium fluoride	37.04	45.98	12125-01-8
Ammonium fluoride (Ammonium difluoride) (Ammonium bifluoride) (Ammonium fluoride, hydrogen) (Ammonium difluoride, hydrogen) (Ammonium bifluoride, hydrogen)	57.04	29.86	1341-49-7
Ammonium fluoroborate (Ammonium tetrafluoroborate)	104.84	16.24	13826-83-0
Ammonium fluorogermanate (IV) (Ammonium hexafluorogermanate (IV)) (Diammonium hexafluorogermanate)	222.66	15.30	16962-47-3
Ammonium fluorophosphate (Ammonium hexafluorophosphate)	163.00	10.45	16941-11-0
Ammonium fluorosulfate (Ammonium fluorosulfonate)	117.10	14.54	13446-08-7
Ammonium formate	63.06	27.01	540-69-2
Ammonium gallium sulfate	282.90	6.020	15335-98-5
Ammonium hydroxide	35.05	48.59	1336-21-6
Ammonium iodide	144.94	11.75	12027-06-4
Ammonium iridium chloride (Ammonium chloroiridate (III)) (Ammonium hexachloroiridate) (Triammonium hexachloroiridate)	459.05	11.13	15752-05-3
Ammonium iron sulfate (Ammonium ferric sulfate) (Ammonium iron disulfate)	269.02	6.330	10138-04-2
Ammonium iron sulfate (Ammonium ferrous sulfate) (Diammonium iron disulfate) (Diammonium ferrous disulfate)	286.05	11.91	10045-89-3

Table D-1 (Continued)

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium lactate (Ammonium 2-hydroxypropionate)	107.11	15.90	515-98-0
Ammonium laurate (Ammonium dodecanoate)	217.35	7.835	2437-23-2
Ammonium magnesium sulfate	252.50	13.49	14727-95-8
Ammonium malate	168.15	20.26	6283-27-8
Ammonium malate, hydrogen (Ammonium bimalate)	151.12	11.27	5972-71-4
Ammonium molybdate (Diammonium molybdate)	196.01	17.38	13106-76-8
Ammonium molybdate (Ammonium heptamolybdate) (Ammonium molybdate, hydrate) (Ammonium molybdate, tetrahydrate) (Ammonium *para*molybdate, tetrahydrate)	1,163.8	8.780	12054-85-2
Ammonium nickel chloride, hexahydrate	183.09	9.301	16122-03-5
Ammonium nickel sulfate (Ammonium nickel sulfate, hexahydrate) (Ammonium nickel disulfate, hexahydrate) (Diammonium nickel disulfate, hexahydrate)	286.88	11.87	7785-20-8
Ammonium nitrate	80.04	21.28	6484-52-2
Ammonium nitrate sulfate	212.18	24.08	12436-94-1
Ammonium nitrite	64.04	26.59	13446-48-5
Ammonium oleate	299.50	5.686	544-60-5
Ammonium oxalate	124.10	27.45	1113-38-8
Ammonium palladium chloride (Ammonium chloropalladate (II)) (Ammonium tetrachloropalladte (II)) (Diammonium tetrachloropalladate)	284.31	11.98	13820-40-1
Ammonium phosphate (Ammonium orthophosphate)	149.09	34.27	10124-31-9
Ammonium phosphate (Ammonium biphosphate) (Ammonium phosphate, hydrogen) (Ammonium phosphate, dihydrogen) (Ammonium orthophosphate, dihydrogen) (Ammonium phosphate, monobasic)	115.03	14.80	7722-76-1

Table D-1 (Continued)

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium phosphate (Ammonium phosphate, hydrogen) (Ammonium orthophosphate, monohydrogen) (Ammonium phosphate, dibasic) (Ammonium orthophosphate, dibasic) (Diammonium phosphate) (Diammonium orthophosphate) (Diammonium phosphate, hydrogen) (Diammonium phosphate, monohydrogen) (Diammonium orthophosphate, hydrogen)	132.06	25.79	7783-28-0
Ammonium phosphinate (Ammonium hypophosphite)	83.03	20.51	7803-65-8
Ammonium phosphite (Ammonium biphosphite) (Ammonium phosphite, dihydrogen)	99.03	17.20	13446-12-3
Ammonium picramate	216.15	7.879	1134-85-6
Ammonium propionate	91.11	18.69	17496-08-1
Ammonium rhodium chloride (Ammonium chlororhodate (III)) (Ammonium hexachlororhodate (III)) (Triammonium rhodium hexachloride) (Triammonium hexachlororhodate)	369.74	13.82	15336-18-2
Ammonium salicylate (Ammonium 2-hydroxybenzoate)	155.15	10.98	528-94-9
Ammonium selenide	115.04	29.61	66455-76-3
Ammonium silicon fluoride (Ammonium fluorosilicate) (Ammonium hexafluorosilicate) (Diammonium silicon hexafluoride) (Diammonium fluorosilicate) (Diammonium hexafluorosilicate)	178.15	19.12	16919-19-0
Ammonium stearate (Ammonium octadecanoate)	301.51	5.648	1002-89-7
Ammonium succinate (Diammonium succinate)	152.15	22.39	2226-88-2
Ammonium sulfamate (Ammonium amidosulfate) (Ammonium amidosulfonate)	114.12	14.92	7773-06-0
Ammonium sulfate (Diammonium sulfate)	132.13	25.78	7783-20-2

Table D-1 (Continued)

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium sulfate (Ammonium bisulfate) (Ammonium sulfate, hydrogen) (Ammonium sulfate, monohydrogen)	115.10	14.80	7803-63-6
Ammonium *per*sulfate (Ammonium peroxysulfate) (Ammonium peroxydisulfate) (Diammonium persulfate) (Diammonium peroxydifulsite)	228.19	14.93	7727-54-0
Ammonium sulfide (Ammonium bisulfide) (Ammonium sulfide, hydrogen)	51.11	33.32	12124-99-1
Ammonium sulfide (Ammonium monosulfide) (Diammonium sulfide)	68.14	49.99	12135-76-1
Ammonium sulfide (Diammonium pentasulfide)	196.39	17.34	12135-77-2
Ammonium sulfite, monohydrate (Diammonium sulfite, monohydrate)	116.13	29.33	7783-11-1
Ammonium sulfite (Ammonium bisulfite) (Ammonium sulfite, hydrogen)	99.10	17.18	10192-30-0
Ammonium tetrachloroaurate (III), hydrate	356.82	4.772	13874-04-9
Ammonium thiocarbamate	94.13	18.09	16687-42-6
Ammonium thiocarbonate (Diammonium trithiocarbonate)	144.27	23.61	13453-08-2
Ammonium thiocyanate (Ammonium isothiocyanate) (Ammonium sulfocyanate) (Ammonium rhodanate) (Rhodanid)	76.12	22.37	1762-95-4
Ammonium dithionate	196.19	17.36	60816-52-6
Ammonium thiosulfate (Ammonium hyposulfite) (Diammonium thiosulfate)	148.20	22.98	7783-18-8
Ammonium tin bromide (Ammonium bromostannate (IV)) (Ammonium hexabromostannate (IV)) (Diammonium hexabromostannate)	634.19	5.371	16925-34-1

Table D-1 (Continued)

Chemical Name	Molecular Weight*	NH_3 Equivalent Wt%	CAS Number
Ammonium tin chloride (Ammonium chlorostannate (IV)) (Ammonium hexachlorostannate (IV)) (Diammonium tin hexachloride) (Diammonium hexachlorostannate)	367.48	9.269	16960-53-5
Ammonium titanium fluoride (Ammonium fluorotitanate (IV)) (Ammonium hexafluorotitanate (IV)) (Diammonium titanium hexafluoride) (Diammonium hexafluorotitanate)	197.95	17.21	16962-40-6
Ammonium titanium oxalate, monohydrate (Diammonium dioxalatooxotitanate, monohydrate)	276.00	12.34	10580-03-7
Ammonium tungstate (Ammonium tungstate (VI)) (Ammonium *para*tungstate) (Hexaammonium tungstate)	1,779.2	5.743	12028-06-7
Ammonium tungstate (Ammonium tungstate (VI)) (Ammonium *para*tungstate) (Decaammonium tungstate)	3,058.6	5.568	11120-25-5
Ammonium valerate (Ammonium pentoate)	119.16	14.29	42739-38-8
Ammonium zinc chloride (Ammonium chlorozincate) (Ammonium tetrachlorozincate) (Diammonium tetrachlorozincate)	243.27	14.00	14639-97-5

*For hydrated compounds, e.g., ammonium sulfite, monohydrate, the molecular weight <u>excludes</u> the weight of the hydrate portion.

Appendix E

LIST OF TOXIC CHEMICALS WITHIN THE WATER DISSOCIABLE NITRATE COMPOUNDS CATEGORY AND GUIDANCE FOR REPORTING

United States
Environmental Protection
Agency

Office of Pollution Prevention and
Toxics
Washington, DC 20460

Revised May 1996
EPA 745-R-96-004

TOXICS RELEASE INVENTORY

List of Toxic Chemicals Within the Water Dissociable Nitrate Compounds Category and Guidance for Reporting

EPCRA Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) requires certain facilities manufacturing, processing, or otherwise using listed toxic chemicals to report their environmental releases of such chemicals annually. Beginning with the 1991 reporting year, such facilities also must report pollution prevention and recycling data for such chemicals, pursuant to section 6607 of the Pollution Prevention Act, 42 U.S.C. 13106. When enacted, EPCRA Section 313 established an initial list of toxic chemicals that was comprised of more than 300 chemicals and 20 chemical categories. EPCRA Section 313(d) authorizes EPA to add chemicals to or delete chemicals from the list, and sets forth criteria for these actions.

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Section 1. Introduction

On November 30, 1994 EPA added 286 chemicals and chemical categories, which include 39 chemicals as part of two delineated categories, to the list of toxic chemicals subject to reporting under EPCRA Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), 42 U.S.C. 11001. These additions are described at 59 FR 61432, and are effective January 1, 1995 for reports due July 1, 1996. Six chemical categories (nicotine and salts, strychnine and salts, polycyclic aromatic compounds, water dissociable nitrate compounds, diisocyanates, and polychlorinated alkanes) are included in these additions. At the time of the addition, EPA indicated that the Agency would develop, as appropriate, interpretations and guidance that the Agency determines are necessary to facilitate accurate reporting for these categories. This document constitutes such guidance for the water dissociable nitrate compounds category.

Section 1.1 Who Must Report

A plant, factory, or other facility is subject to the provisions of EPCRA Section 313, if it meets all three of the following criteria:

- It conducts manufacturing operations (is included in Standard Industrial Classification (SIC) codes 20 through 39); and
- It has 10 or more full-time employees (or the equivalent 20,000 hours per year); and
- It manufactures, imports, processes, or otherwise uses any of the toxic chemicals listed on the EPCRA Section 313 list in amounts greater than the “threshold” quantities specified below.

Section 1.2 Thresholds

Thresholds are specified amounts of toxic chemicals used during the calendar year that trigger reporting requirements.

If a facility *manufactures* or *imports* any of the listed toxic chemicals, the thresholds quantity will be:

- 25,000 pounds per toxic chemical or category over the calendar year.

If a facility *processes* any of the listed toxic chemicals, the threshold quantity will be:

- 25,000 pounds per toxic chemical or category over the calendar year.

If a facility *otherwise uses* any of the listed toxic chemicals (without incorporating it into any product or producing it at the facility), the threshold quantity is:

- 10,000 pounds per toxic chemical or category over the calendar year.

EPCRA Section 313 requires threshold determinations for chemical categories to be based on the total of all chemicals in the category manufactured, processed or otherwise used. For example, a facility that manufactures three members of a chemical category would count the total amount of all three chemicals manufactured towards the manufacturing threshold for that category. When filing reports for chemical categories, the releases are determined in the same manner as the thresholds. One report is filed for the category and all releases are reported on this form.

Section 1.3 Chemicals Within the Water Dissociable Nitrate Compounds Category

EPA is providing a list of CAS numbers and chemical names to aid the regulated community in determining whether they need to report for the water dissociable nitrate compounds category. The list includes individual chemicals within the water dissociable nitrate compounds category. If a facility is manufacturing, processing, or otherwise using a chemical which is on this list, they must report this chemical. However, this list is not exhaustive. If a facility is manufacturing, processing, or otherwise using a water dissociable nitrate compound, they must report the chemical, even if it does not appear on the list.

Section 1.4 *De Minimis* Concentrations

The water dissociable nitrate compounds category is subject to the one percent *de minimis* concentration. Thus, mixtures that contain members of this category in excess of the *de minimis* should be factored into threshold and release determinations.

Section 2. Guidance for Reporting Chemicals within the Water Dissociable Nitrate Compounds Category

Note: for the purposes of reporting under the nitrate compounds category, water dissociable means that the nitrate ion dissociates from its counterion when in solution.

Section 2.1 Chemicals within the Water Dissociable Nitrate Compounds Category

Chemicals within the nitrate compounds category are only reportable when in aqueous solution. All water dissociable nitrate compounds are included in the nitrate compounds category, including ammonium nitrate. Specifically listed EPCRA Section 313 chemicals *are not* included in threshold determinations for chemical categories such as the water dissociable nitrate compounds category. Specifically listed toxic chemicals are subject to their own individual threshold determinations. As of December 1, 1994, ammonium nitrate (solution) is not an individually listed chemical on the EPCRA Section 313 list. However, ammonium nitrate is still subject to reporting under the nitrate compounds category. In addition, the aqueous ammonia from the dissociation of ammonium nitrate when in aqueous solution is subject to reporting under the ammonia listing.

Section 2.2 Determining Threshold and Release Quantities for Nitrate Compounds

The total nitrate compound, including both the nitrate ion portion and the counterion, is included in the nitrate compounds category. When determining threshold amounts, the total weight of the nitrate compound is to be included in all calculations. However, only the nitrate ion portion is to be included when determining the amount of the chemicals within the nitrate compounds category that is released, transferred, or otherwise managed in wastes.

<u>Example 1</u>: In a calendar year, a facility processes 100,000 pounds of ammonium nitrate (NH_4NO_3), *in aqueous solution*, which is released to wastewater streams then transferred to a POTW. The quantity applied towards threshold calculations for the nitrate compounds category is the total quantity of the nitrate compound or 100,000 pounds. Since this quantity exceeds the 25,000 pound processing threshold, the facility is required to report for the nitrate compounds category. Under the nitrate compounds category, only the weight of the nitrate ion portion of ammonium nitrate is included in release transfer calculations. The molecular weight of the ammonium nitrate is 80.04 and the weight of the nitrate ion portion is 62.01 or 77.47 percent of the molecular weight of ammonium nitrate. Therefore, the amount of nitrate ion reported as transferred to the POTW is 77.47 percent of 100,000 pounds or 77,470 pounds (reported as 77,000 pounds). The aqueous ammonia from ammonium nitrate is reportable under the EPCRA Section 313 listing for ammonia. For determining thresholds and calculating releases under the ammonia listing, see the separate directive, *Guidance for Reporting Aqueous Ammonia* (EPA document #745-R-95-0003, July 1995).

Example 2: In a calendar year, a facility manufactures as by-products 20,000 pounds of sodium nitrate ($NaNO_3$) and 10,000 pounds of calcium nitrate ($Ca(NO_3)_2$), both in aqueous solutions, and releases these solutions to wastewater streams. The total quantity of nitrate compounds manufactured by the facility is the sum of the two chemicals, or 30,000 pounds, which exceeds the manufacturing threshold quantity of 25,000 pounds. The facility therefore is required to report for the nitrate compounds category. By weight, the nitrate ion portion is 72.96 percent of sodium nitrate and is 75.57 percent of calcium nitrate. Of the 20,000 pounds of the sodium nitrate in solution, 72.96 percent or 14,592 pounds is nitrate ion, and similarly, of the 10,000 pounds of the calcium nitrate in solution, 75.57 percent or 7,557 pounds is nitrate ion. The total nitrate ion in aqueous solution released by the facility is the sum of the nitrate ion in the two solutions or 22,149 pounds (reported as 22,000 pounds).

Section 2.3 Reporting Nitrate Compounds Generated from the Partial or Complete Neutralization of Nitric Acid

Nitric acid is an individually listed chemical on the original EPCRA Section 313 list and is reported as a separate chemical if the manufacture, process, or otherwise use thresholds are exceeded. The partial or complete neutralization of nitric acid results in the formation of nitrate compounds which are reported as chemicals within the nitrate compounds category if their manufacture, process, or otherwise use thresholds are exceeded.

Mineral acids such as nitric acid may be present in aqueous waste streams that are sent to on-site neutralization or are discharged to a publicly owned treatment works (POTW) or other off-site treatment facility. As stated in the *Toxic Chemical Release Inventory Reporting Form R and Instructions* document (revised 1993 version, EPA 745-K-94-001), on-site acid neutralization and its efficiency must be reported in Part II, section 7A of Form R (waste treatment methods and efficiency section). For purposes of reporting on Form R, EPA considers a waste mineral acid at a pH 6 or higher to be 100 percent neutralized (water discharges to receiving streams or POTWs are reported as zero). The nitrate compounds produced from the complete neutralization (pH 6.0 or above) of nitric acid are reportable under the nitrate compounds category and should be included in all threshold and release calculations. Two Form R reports would be required if the manufacture, process or otherwise use thresholds are exceeded for nitric acid and for the nitrate compounds category.

If the nitric acid treatment efficiency is not equal to 100 percent (pH is less than 6), the amount of the acid remaining in the waste stream which is released to the environment on-site or off-site must be reported in Part II of Form R. The nitrate compounds produced from the partial neutralization of nitric acid are reportable under the nitrate compounds category and should be included in all threshold and release calculations. Two reports would again be required if the manufacture, process or otherwise use thresholds are exceeded for nitric acid and for the nitrate compounds category.

Section 2.3.1 Estimating Nitric Acid Releases

The pH of the waste stream can be used to calculate the amount of nitric acid in the stream and the efficiency of neutralization. The pH is a measure of the acidity or alkalinity of a waste stream and can be obtained readily using a pH meter or pH sensitive paper. The pH scale itself varies from 0 to 14.

The total nitric acid concentration (ionized and un-ionized) in pounds per gallon can be calculated by using the pH value of the solution, the molecular weight and ionization constant of the acid, and appropriate conversion factors. The total acid concentration for nitric acid for different pH values is listed in Table 1. The calculation of mineral acid concentrations and the derivation of Table 1 are discussed in a separate directive, *Estimating Releases for Mineral Acid Discharges Using pH Measurements*, and an addendum to this directive.

The procedure outlined in this guidance document for calculating the quantity of nitrate compounds formed from the complete or partial neutralization of nitric acid can be used if nitric acid is the only mineral acid in a solution. In addition, the calculation of nitric acid releases using only pH measurements is a rough estimate. The subsequent calculation of nitrate compound releases is therefore also only a rough estimate. The estimates can be made for a waste stream with a steady pH below 6 or for one whose pH temporarily drops to below pH 6. Facilities should use their best engineering judgement and knowledge of the solution to evaluate how reasonable the estimates are.

<u>Example 3</u>: In a calendar year, a facility transfers 1.0 million gallons of a solution containing nitric acid (HNO_3), at pH 4, to a POTW. Using Table 1 (next page), a pH of 4 corresponds to a concentration of 0.0000520 lbs HNO_3/gallon of solution. The weight of HNO_3 transferred can be estimated using the equation:

$$\text{Transfer of } HNO_3 = (\text{Concentration of } HNO_3) \times (\text{effluent flow rate})$$

Substituting the example values into the above equation yields:

$$\text{Transfer of } HNO_3 = 0.0000520 \text{ lbs/gal } HNO_3 \times 1{,}000{,}000 \text{ gal solution/year} = 52 \text{ lbs/year}$$

<u>Example 4</u>: A facility had an episodic release of nitric acid (HNO_3) in which the waste stream was temporarily below pH 6. During the episode, the wastewater (pH 2.0) was discharged to a river for 20 minutes at a rate of 100 gallons per minute. Using Table 1, a pH of 2.0 for HNO_3 represents a concentration of 0.0052000 lbs HNO_3/gallon of solution. The amount of the HNO_3 released can be estimated using the following equation:

$$\text{Release of } HNO_3 = (\text{concentration of } HNO_3) \times (\text{effluent flow rate})$$

Substituting the example values in the above equation:

$$\begin{aligned}\text{Release of } HNO_3 &= 0.0052000 \text{ lbs/gal} \times 100 \text{ gal/min} \times 20 \text{ min}\\ &= 10 \text{ lbs}\end{aligned}$$

Table E-1
Nitric Acid Concentration Versus pH

pH	Nitric Acid Concentration (lbs/gallon)	pH	Nitric Acid Concentration (lbs/gallon)
0.0	0.5200000	3.0	0.0005200
0.2	0.3300000	3.2	0.0003300
0.4	0.2100000	3.4	0.0002100
0.6	0.1300000	3.6	0.0001300
0.8	0.0830000	3.8	0.0000830
1.0	0.0520000	4.0	0.0000520
1.2	0.0330000	4.2	0.0000330
1.4	0.0210000	4.4	0.0000210
1.6	0.0130000	4.6	0.0000130
1.8	0.0083000	4.8	0.0000083
2.0	0.0052000	5.0	0.0000052
2.2	0.0033000	5.2	0.0000033
2.4	0.0021000	5.4	0.0000021
2.6	0.0013000	5.6	0.0000013
2.8	0.0008300	5.8	0.0000008
		6.0	0.0000005

Section 2.3.2 Estimating Treatment Efficiencies for Nitric Acid Neutralization

Nitric acid solutions that are neutralized to a pH of 6 or above have a treatment efficiency of 100 percent. If nitric acid is neutralized to a pH less than 6, then the reportable treatment efficiency is somewhere between 0 and 100 percent. It is possible to estimate the neutralization treatment efficiency using nitric acid concentration values directly from Table 1 in the equation given below. The concentrations correspond to the pH values before and after treatment.

$$\text{Treatment efficiency} = \frac{(I - E)}{I} \times 100$$

where:

I = Acid concentration before treatment; and
E = Acid concentration after treatment.

Example 5: A nitric acid (HNO_3) waste stream of pH 2.4 is neutralized to pH 4.6. Using Table 1, the initial nitric acid concentration is 0.0021000 mol/liter and the final concentration is 0.0000130 mol/liter. Substituting these values into the equation for treatment efficiency:

$$\text{Treatment Efficiency} = \frac{(0.0021000 - 0.0000130)}{0.0021000} \times 100$$

= 99.4 percent

For strong acids only (including nitric acid), the net difference in pH before and after treatment can be used to estimate the treatment efficiency since pH is directly proportional to the acid concentration. For example, a pH change of one unit results in a treatment efficiency of 90 percent, whether the pH change is from pH 1 to pH 2 or from pH 4 to pH 5. Table 2 summarizes treatment efficiencies for various pH changes (the pH change is the difference between the initial pH and the pH after neutralization). In the table, some pH changes result in the same treatment efficiency values due to rounding to one decimal place.

Table E-2
Nitric Acid Treatment Efficiencies for Various pH Changes

pH Unit Change	Treatment Efficiency (%)	pH Unit Change	Treatment Efficiency (%)
1.0	90.0	2.0	99.0
1.1	92.1	2.1	99.2
1.2	93.7	2.2	99.4
1.3	95.0	2.3	99.5
1.4	96.0	2.4	99.6
1.5	96.8	2.5	99.7
1.6	97.5	2.6	99.8
1.7	98.0	2.7	99.8
1.8	98.4	2.8	99.8
1.9	98.7	2.9	99.9
		3.0	99.9

Example 6: If a nitric acid (HNO_3) waste stream of pH 2 is treated to pH 4, the pH change is 2 units. Using Table 2 above, the treatment efficiency is given as 99.0 percent.

Section 2.3.3 Estimating Releases of Nitrate Compounds Generated from the Neutralization of Nitric Acid

The nitrate compounds produced from the complete neutralization (pH 6.0 or above) or partial neutralization (pH less than 6) or nitric acid are reportable under the nitrate compounds category if the appropriate threshold is met and should be included in all threshold and release calculations. In order to determine the quantity of a nitrate compound generated and released, the quantity of nitric acid released must be known (or calculated from the equations used in Examples 3 and 4 above) as well as the nitric acid treatment efficiency (calculated from the equations used in Examples 5 and 6 above).

The neutralization of nitric acid will most likely result in the generation of monovalent nitrate compounds (such as sodium nitrate and potassium nitrate). The quantity of these compounds formed in kilomoles will be equal to the quantity of the nitric acid neutralized in kilomoles. If divalent nitrate compounds are formed (such as calcium nitrate), the quantity of these compounds formed in kilomoles will be equal to one-half the quantity of the nitric acid neutralized in kilomoles. Similarly, if trivalent nitrate compounds are formed (such as iron (III) nitrate), the quantity formed of these compounds in kilomoles will be equal to one-third the quantity of the nitric acid neutralized in kilomoles. Note: to calculate the releases of nitrate compounds generated from the neutralization of nitric acid, the molecular weight of the nitrate compound formed must be used. Molecular weights of some of the individual chemicals within the water dissociable nitrate compounds category are given in Table 3.

Example 7: In a calendar year, a facility transfers 50,000 pounds of nitric acid (HNO_3) to an on-site treatment facility. The nitric acid treatment efficiency is 95 percent, and the nitrate compound formed as a result of the treatment is sodium nitrate ($NaNO_3$). The quantity of nitric acid transferred that is neutralized (generating sodium nitrate) is 95 percent of 50,000 pounds or 47,500 pounds. The molecular weight of nitric acid is 63.01 kg/kmol, and the molecular weight of sodium nitrate is 84.99 kg/kmol. The quantity of nitric acid neutralized is converted first to kilograms then to kilomoles using the following equations:

Kilograms HNO_3 neutralized = (lbs HNO_3 neutralized) × (0.4536 kg/lb)
Kilomoles HNO_3 neutralized = (kg HNO_3) ÷ (MW of HNO_3 in kg/kmol)

Substituting the example values into the above equation yields:

Kilograms HNO_3 neutralized = 47,500 lbs × 0.4536 kg/lb = 21.546 kg

Kilomoles HNO_3 neutralized = 21,546 kg ÷ 63.01 kg/kmol = 341.9 kmol

The quantity of sodium nitrate generated in kilomoles is equal to the quantity of nitric acid neutralized (341.9 kmol). The quantity of sodium nitrate generated in kilomoles is converted first to kilograms then to pounds using the following equations:

Kilograms $NaNO_3$ generated = (kmol $NaNO_3$) × (MW of $NaNO_3$ in kg/kmol)
Pounds $NaNO_3$ generated = (kg $NaNO_3$) × (2.205 lbs/kg)

Substituting the values into the above equation yields:

Kilograms $NaNO_3$ generated = 341.9 kmol × 84.99 kg/kmol = 29,058 kg
Pounds $NaNO_3$ generated = 29,058 kg × 2.205 lbs/kg = 64,073 pounds
(reported as 64,000 pounds)

The 64,000 pounds of sodium nitrate generated is the quantity used to determine whether thresholds have been met or exceeded. The quantity of nitrate ion released is calculated as in Example 1 above.

Section 2.4 Generation of Nitrate Compounds from Biological Wastewater Treatment

If a facility treats wastewater on-site biologically, using the activated sludge process, for example, the facility may be generating nitrate compounds as by-products of this biological process. The nitrate ion generated from this process will be associated with various counterions (e.g., sodium ion, potassium ion). In the absence of information on the identity of the counterion, a facility should assume for the purposes of EPCRA Section 313 threshold determinations that the counterion is sodium ion.

Section 3. CAS Number List of Some of the Individual Chemicals within the Water Dissociable Nitrate Compounds Category

EPA is providing the following table of CAS numbers and chemical names to aid the regulated community in determining whether they need to report for the water dissociable nitrate compounds category. If a facility is manufacturing, processing, or otherwise using a chemical which is listed below, they must report this chemical. However, this list is not exhaustive. If a facility is manufacturing, processing, or otherwise using a water dissociable nitrate compound, they must report this chemical, even if it does not appear on the following list.

Table E-3
Listing by CAS Number and Molecular Weight of Some of the Individual Chemicals within the Water Dissociable Nitrate Compounds Category

Chemical Name	Molecular Weight*	CAS Number
Aluminum nitrate, nonahydrate	213.00	7784-27-2
Ammonium nitrate	80.04	6484-52-2
Cerium (III) ammonium nitrate, tetrahydrate	486.22	13083-04-0
Cerium (IV) ammonium nitrate	548.23	10139-51-2
Barium nitrate	261.34	10022-31-8
Beryllium nitrate, trihydrate	133.02	7787-55-5
Cadmium nitrate	236.42	10325-94-7
Cadmium nitrate, tetrahydrate	236.42	10022-68-1
Calcium nitrate	164.09	10124-37-5
Calcium nitrate, tetrahydrate	164.09	13477-34-4
Cerium (III) nitrate, hexahydrate	326.13	10294-41-4
Cesium nitrate	194.91	7789-18-6
Chromium (III) nitrate, nonahydrate	238.01	7789-02-8
Cobalt (II) nitrate, hexahydrate	182.94	10026-22-9
Copper (II) nitrate, trihydrate	187.56	10031-43-3
Copper (II) nitrate, hexahydrate	187.56	13478-38-1
Dysprosium (III) nitrate, pentahydrate	348.51	10031-49-9
Erbium (III) nitrate, pentahydrate	353.27	10031-51-3
Gadolinium (III) nitrate, hexahydrate	343.26	19598-90-4
Gallium nitrate, hydrate	255.73	69365-72-6
Iron (III) nitrate, hexahydrate	241.86	13476-08-9
Iron (III) nitrate, nonahydrate	241.86	7782-61-8
Lanthanum (III) nitrate, hexahydrate	324.92	10277-43-7
Lead (II) nitrate	331.21	10099-74-8

Table E-3 (Continued)

Chemical Name	Molecular Weight*	CAS Number
Lithium nitrate	68.95	7790-69-4
Lithium nitrate, trihydrate	68.95	13453-76-4
Magnesium nitrate, dihydrate	148.31	15750-45-5
Magnesium nitrate, hexahydrate	148.31	13446-18-9
Manganese (II) nitrate, tetrahydrate	178.95	20694-39-7
Neodymium (III) nitrate, hexahydrate	330.25	16454-60-7
Nickel (II) nitrate, hexahydrate	182.70	13478-00-7
Potassium nitrate	101.10	7757-79-1
Rhodium (III) nitrate, dihydrate	288.92	13465-43-5
Rubidium nitrate	147.47	13126-12-0
Samarium (III) nitrate, hexahydrate	336.37	13759-83-6
Scandium (III) nitrate	230.97	13465-60-6
Scandium (III) nitrate, tetrahydrate	230.97	16999-44-3
Silver nitrate	169.87	7761-88-8
Sodium nitrate	84.99	7631-99-4
Strontium nitrate	211.63	10042-76-9
Strontium nitrate, tetrahydrate	211.63	13470-05-8
Terbium (III) nitrate, hexahydrate	344.94	13451-19-9
Thorium (IV) nitrate	480.06	13823-29-5
Thorium (IV) nitrate, tetrahydrate	480.06	13470-07-0
Yttrium (III) nitrate, hexahydrate	274.92	13494-98-9
Yttrium (III) nitrate, tetrahydrate	274.92	13773-69-8
Zinc nitrate, trihydrate	189.39	131446-84-9
Zinc nitrate, hexahydrate	189.39	10196-18-6
Zirconium (IV) nitrate, pentahydrate	339.24	13986-27-1

*For hydrated compounds, e.g., aluminum nitrate, nonahydrate, the molecular weight excludes the weight of the hydrate portion. For example, the same molecular weight is provided for aluminum nitrate, nonahydrate and aluminum nitrate.

Appendix F

UNIT CONVERSION FACTORS

(From U.S. Coast Guard Commandant Instruction M.16465.12A)

CONVERSION FACTORS

To Convert	To	Multiply By
Length		
inches	millimeters	25.4
inches	feet	0.0833
feet	inches	12
feet	meters	0.3048
feet	yards	0.3333
feet	miles (U.S. statute)	0.0001894
yards	feet	3
yards	miles (U.S. statute)	0.0005682
miles (U.S. statute)	feet	5280
miles (U.S. statute)	yards	1760
miles (U.S. statute)	meters	1609
miles (U.S. statute)	nautical miles	0.868
meters	feet	3.271
meters	yards	1.094
meters	miles (U.S. statute)	0.0006214
nautical miles	miles (U.S. statute)	1.152
Area		
square inches	square centimeters	6.452
square inches	square feet	0.006944
square feet	square inches	144
square feet	square meters	0.09290
square meters	square feet	10.76
square miles	square yards	3,097,600
square yards	square feet	9
Volume		
cubic inches	cubic centimeters	16.39
cubic inches	cubic feet	0.0005787
cubic feet	cubic inches	1728
cubic feet	cubic meters	0.02832
cubic feet	U.S. gallons	7.481
cubic meters	cubic feet	35.31
liters	quarts (U.S. liquid)	1.057
quarts (U.S. liquid)	liters	0.9463
U.S. gallons	barrels (petroleum)	0.02381
U.S. gallons	cubic feet	0.1337
U.S. gallons	Imperial gallons	0.8327
barrels (petroleum)	U.S. gallons	42
Imperial gallons	U.S. gallons	1.201
milliliters	cubic centimeters	1

CONVERSION FACTORS (Continued)

To Convert	To	Multiply By
Time		
seconds	minutes	0.01667
seconds	hours	0.0002778
seconds	days	0.00001157
minutes	seconds	60
minutes	hours	0.01667
minutes	days	0.0006944
hours	seconds	3600
hours	minutes	60
hours	days	0.04167
Mass or Weight		
pounds	kilograms	0.4536
pounds	short tons	0.0005
pounds	long tons	0.000464
pounds	metric tons	0.0004536
tons (short)	pounds	2000
tons (metric)	pounds	2205
tons (long)	pounds	2240
kilograms	pounds	2.205
tonnes (metric tons)	kilograms	1000
Energy		
calories	Btu	0.003968
calories	joules	4.187
Btu (British thermal units)	calories	252.0
Btu	joules	1055
joules	calories	0.2388
joules	Btu	0.0009479
Velocity		
feet per second	meters per second	0.3048
feet per second	miles per hour	0.6818
feet per second	knots	0.5921
meters per second	feet per second	3.281
meters per second	miles per hour	2.237
miles per hour	meters per second	0.4470
miles per hour	feet per second	1.467
knots	meters per second	0.5148
knots	miles per hour	1.151
knots	feet per second	1.689
pounds per cubic foot	grams per cubic centimeter	0.01602
grams per cubic centimeter	pounds per cubic foot	62.42
grams er cubic centimeter	kilograms per cubic meter	1000
kilograms per cubic meter	grams per cubic centimeter	0.001

CONVERSION FACTORS (Continued)

To Convert	To	Multiply By
Pressure		
ponds per square inch (absolute) (psia)	kilonewtons per square meter (kN/m^2)	6.895
psia	atmospheres	0.0680
psia	inches of water	27.67
psia	millimeters of mercury (torr)	51.72
pounds per square inch (gauge) (psig)	psia	add 14.70
millimeters of mercury (torr)	psia	0.01934
millimeters of mercury (torr)	kN/m^2	0.1333
inches of water	psia	0.03614
kilograms per square centimeter	millimeters of mercury (torr)	735.6
inches of water	kN/m^2	0.2491
kilograms per square centimeter	atmospheres	0.9678
atmospheres	kN/m^2	101.3
kilograms per square centimeter	psia	14.22
atmospheres	psia	14.70
bars	kN/m^2	100
kilonewtons per square meter (kN/m^2)	psia	0.1450
bars	atmospheres	0.9869
kilonewtons per square meter (kN/m^2)	atmospheres	0.009869
bars	kilograms per square centimeter	1.020
Viscosity		
centipoises	pounds per foot per second	0.0006720
pounds per foot per second	centipoises	1488
centipoises	poises	0.01
centipoises	Newton seconds per square meter	0.001
poises	grams per centimeter per second	1
grams per centimeter per second	poises	1
Newton seconds per square meter	centipoises	1000
Thermal Conductivity		
Btu per hour per foot per °F	watts per meter-kelvin	1.731
Btu per hour per foot per °F	kilocalories per hour per meter per °C	1.488
watts per meter-kelvin	Btu per hour per foot per °F	0.5778
kilocalories per hour per meter per °C	watts per meter-kelvin	1.163
kilocalories per hour per meter per °C	Btu per hour per foot per °F	0.6720
Heat Capacity		
Btu per pound per °F	calories per gram per °C	1
Btu per pound per °F	joules per kilogram-kelvin	4187
joules per kilogram-kelvin	Btu per pound per °F	0.0002388
calories per gram per °C	Btu per pound per °F	1
Concentration (in water solution)		
parts per million (ppm)	milligrams per liter	1
milligrams per liter	ppm	1
milligrams per cubic meter	grams per cubic centimeter	1×10^{-9}
grams per cubic centimeter	milligrams per cubic meter	1×10^{9}
grams per cubic centimeter	pounds per cubic foot	62.42

CONVERSION FACTORS (Continued)

To Convert	To	Multiply By
Temperature		
degrees Kelvin (°K)	degrees Rankine (°R)	1.8
degrees Rankine (°R)	degrees Kelvin (°K)	0.5556
degrees centigrade (°C)	degrees Fahrenheit (°F)	first multiply by 1.8, then add 32
degrees Fahrenheit (°F)	degrees centigrade (°C)	first subtract 32, then multiply by 0.5556
degrees centigrade (°C)	degrees Kelvin (°K)	add 273.2
degrees Fahrenheit (°F)	degrees Kelvin (°K)	add 459.7
Flow		
cubic feet per second	U.S. gallons per minute	448.9
U.S. gallons per minute	cubic feet per second	0.002228

Universal Gas Constant (R)

8.314 joules per gram mole-kelvin
1.987 calories per gram mole-kelvin
1.987 Btu per pound mole per °F
10.73 psia-cubic feet per pound mole per °F
82.057 atm-cubic centimeters per gram mole-kelvin
62.361 millimeters mercury liter per gram mole-kelvin

INDEX

The pages listed in bold text in the index correspond to the primary uses or definitions of the associated term. Additionally, this index includes a list of primary purposes for examples and common errors that are presented throughout the document.