United States Environmental Protection Agency

Office of Pollution Prevention and Toxics
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TOXICS RELEASE INVENTORY

Guidance for Reporting the Lead and Lead Compounds Category

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 the annual quantity of such chemicals entering each environmental medium. Such facilities must also report pollution prevention data for such chemicals, pursuant to section 6607 of the Pollution Prevention Act, 42 U.S.C. 13106. EPCRA section 313 is also known as the Toxics Release Inventory (TRI).

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DISCLAIMER

This guidance document is intended to assist industry with EPCRA section 313 reporting for lead and lead compounds. In addition to providing an overview of aspects of the statutory and regulatory requirements of the EPCRA section 313 program, this document also provides recommendations and emissions factors to assist industry with EPCRA reporting. These recommendations do not supersede any statutory or regulatory requirements, are subject to change, and are not independently binding on either EPA or covered facilities. Additionally, if a conflict exists between guidance on this site and the statutory or regulatory requirements, the conflict must be resolved in favor of the statute or regulation.

Although EPA encourages industry to consider these recommendations and emissions factors, in reviewing this document, industry should be aware that these recommendations and emissions factors were developed to address common circumstances at typical facilities. The circumstances at a specific facility may significantly differ from those contemplated in the development of this document. Thus, individual facilities may find that the recommendations and emissions factors provided in this document are inapplicable to their processes or circumstances, and that alternative approaches or information are more accurate and/or more appropriate for meeting the statutory and regulatory requirements of EPCRA section 313. To that end, industry should use facility specific information and process knowledge, where available, to meet the requirements of EPCRA section 313. EPCRA section 313 also provides that, in the absence of such readily available data, a reporting facility may make reasonable estimates to meet those EPCRA section 313 requirements. Facilities are encouraged to contact the Agency with any additional or clarifying questions about the recommendations and emissions factors in this document, or if the facility believes that EPA has incorrectly characterized a particular process or recommendation.

Additional guidance documents, including industry specific and chemical specific guidance documents, are also available on TRI's GuideME website:
https://ofmpub.epa.gov/apex/guideme_ext/f?p=guideme:gd-list.

SECTION 1.0 INTRODUCTION

Lead and lead compounds were on the original EPCRA section 313 list of toxic chemicals. On January 17, 2001, EPA published a final rule (66 FR 4499) that classified lead and lead compounds as Persistent Bioaccumulative Toxic (PBT) chemicals and lowered the 25,000 pound and 10,000 pound reporting thresholds for lead and lead compounds to 100 pounds, with the exception of lead contained in stainless steel, brass, and bronze alloys (2). For stainless steel, brass, or bronze alloys that contain lead, the quantity of lead contained in these alloys is still applied to the 25,000 pound and 10,000 pound reporting thresholds. These three alloys, when they contain lead, are often referred to in this document as the "qualified alloys." EPA deferred its decision on lowering the 25,000 pound and 10,000 pound reporting thresholds for lead when it is contained in stainless steel, brass, and bronze alloys because the Agency was evaluating a previously submitted petition as well as comments received in response to previous petition denials that requested the Agency revise the EPCRA section 313 reporting requirements for certain metals contained in stainless steel, brass, and bronze alloys. The final lead rule was based on EPA's finding that lead and lead compounds are PBT chemicals. The basis for the 100 pound threshold is discussed in detail in Section VI (page 42232) of the Preamble to the proposed lead rule (7). EPA's responses to public comments pertaining to the 100 pound threshold are discussed on page 4530 of the Preamble to the final lead rule (2). The rule is part of the Agency's effort to expand the public's right to know about release and other waste management quantities of toxic chemicals – particularly PBT chemicals – in their communities. Hence, provided industry code and employee criteria are met, facilities that manufacture, process, or otherwise use more than 100 pounds of lead or any lead compound(s) must now report annually to EPA and state/tribal governments their releases and other waste management quantities.

Up until promulgation of the lead rule, only those facilities that manufactured or processed more than 25,000 pounds (or otherwise used more than 10,000 pounds) of lead or lead compounds were required to report. The primary difference between the lead rule and the previous requirements is that the lead rule requires any affected facility that manufactures, processes, or otherwise uses more than 100 pounds of lead or lead compound(s) annually to report. Under the lead rule additional data pertaining to releases of lead and lead compounds into the environment will be captured. The TRI lead rule does not in any way prevent or restrict any facility from manufacturing, processing, or otherwise using lead or lead compounds, or from releasing lead into the environment.

EPA has developed this guidance document to assist regulated entities in complying with the lead rule. Because each facility is unique, the recommendations presented may have to be adjusted to the specific nature of operations at your facility or industrial activity.

Section 1.1 What Are the Reporting (Activity) Thresholds?

A reporting threshold for a listed chemical is a pre-established quantity pertaining to the manufacture, processing, or otherwise use of the chemical, such that when the quantity is exceeded within a calendar year by a facility, that triggers reporting requirements. Reporting thresholds are also known as activity thresholds, because they are related to manufacturing, processing, or otherwise use activities. EPCRA section 313 establishes two default reporting thresholds. These are: 25,000 pounds per year for manufacture or processing of a listed chemical and 10,000 pounds per year for otherwise using a listed chemical (42 U.S.C. 11023(f)(1)). Thus, unless a different threshold has been established, if a covered facility manufactures more than 25,000 pounds of a listed chemical within a particular calendar year, that facility must report their releases and other waste management quantities to the U.S. EPA and state and tribal governments. The same would hold true if the facility processed more than 25,000 pounds or otherwise used more than 10,000 pounds of the chemical.

EPCRA section 313 authorizes EPA to establish different thresholds for particular chemicals, classes of chemicals, or categories of facilities, if a different threshold is warranted (42 U.S.C.11023(f)(2)). EPA has used this authority to establish lower thresholds for PBT chemicals. (See 40 CFR 370.28, 64 FR 58666 and 66 FR 4500.) The determination of whether a facility needs to report environmental releases and other waste management quantities of a listed chemical is based on a prior determination of whether any of the reporting thresholds have been exceeded within a calendar year (i.e., January 1 through December 31 of a given year).

The thresholds are determined separately for lead (using the weight of the metal) and for lead compounds (using the weight of the entire lead compound and combining the weights of all lead compounds; 40 CFR 372.25(h)). Provided that the facility meets the industry code and employee threshold criteria, reporting for lead is required:

- If a facility manufactures, processes, or otherwise uses more than 100 pounds of lead (not contained in stainless steel, brass, or bronze alloys) during the calendar year, or;
- If a facility manufactures or processes more than 25,000 pounds of lead (regardless of whether it is contained in stainless steel, brass, or bronze alloys) during the calendar year, or;
- If a facility otherwise uses more than 10,000 pounds of lead (regardless of whether it is contained in stainless steel, brass, or bronze alloys) during the calendar year.

Additionally, provided that the facility meets the industry code and employee threshold criteria, reporting for the lead compounds category is required:

- If a facility manufactures, processes, or otherwise uses more than 100 pounds of a lead compound or a combination of lead compounds during the calendar year.

The 25,000 pound (manufacture or processing) and 10,000 pound (otherwise use) reporting thresholds are still in effect for lead contained in stainless steel, brass, or bronze alloys. The reporting of lead in these alloys is described in detail in Section 3.0.

It is important to note that lead is not included in the lead compounds category: lead and lead compounds are listed separately on the EPCRA section 313 list of toxic chemicals. This means that for facilities that manufacture, process, or otherwise both lead and one or more lead compounds, determinations of whether the 100 pound reporting threshold has been exceeded for the manufacturing, processing, or otherwise use of lead must be made separately from the same determinations for the lead compound(s). That is, for purposes of determining whether a threshold has been exceeded, one should not combine the quantities of lead and lead compounds. For purposes of EPCRA section 313 reporting, threshold determinations for chemical categories must be based on the total of all toxic chemicals in the category (see 40 CFR 372.25(d)). For example, a facility that manufactures three lead compounds would count the total amount manufactured of all three lead compounds towards the manufacturing threshold for the category. In the case of lead compounds, the threshold for manufacturing lead compounds is 100 pounds. The manufacture of lead compounds includes lead compounds that are generated but not released (e.g., chemical intermediates). One report is filed for the category and all releases and waste management quantities are reported on one Form R report.

If a reporting threshold is exceeded for both lead and the lead compounds category, only a single EPCRA section 313 report needs to be prepared, and this would be for lead compounds. This is allowed because if a facility exceeds a threshold for lead compounds, the facility must only report the quantity of the parent metal (lead) contained in the compounds that is released or otherwise managed as waste, not the quantity of the lead compound that is released or otherwise managed as waste (40 CFR 372.25(h)). If a facility exceeds the threshold quantity for either the manufacturing, processing, or otherwise use activities for an EPCRA section 313 chemical or chemical category, the facility must file an EPCRA section 313 report for that chemical or chemical category, even if the facility has zero release and other waste management activity quantities. Exceeding the chemical activity (reporting) threshold quantity, not the quantity released or otherwise managed as waste, determines whether the facility must report.

To assist facilities in determining if they may need to report, Table 1-1 lists some common potential industries and process sources of lead and lead compounds. Note that this table is not intended to be all-inclusive (see also Section 4.0). If you manufacture, process, or otherwise use lead or lead compounds in other operations you must consider the lead and lead compounds in threshold determinations. For more information on threshold determinations in general, see Section 2.0, and for information pertaining to threshold determinations when processing or otherwise using lead in stainless steel, brass, or bronze alloys, see Section 3.0.

Table 1-1: Industry and Process Sources of Lead and Lead Compounds

Industry/Process	Lead or Lead Compounds	Reference[1]
Metal mining: constituent in ore	Lead and lead compounds	3, 4
Smelting and refining: constituent in ore	Lead	3, 4
Coal mining: trace constituent in ore	Lead compounds	3, 4
Steel industry: coke production, trace constituent in coal	Lead compounds	3, 4
Fabricated metal products: article component (e.g., ammunition, galvanized products, pipe organs)	Lead and lead compounds	3, 4
Electronic product components (e.g., batteries, electroplating of printed circuit boards, solder)	Lead	3, 4
Other product components (e.g., blown glass, dental amalgam fillings, lead cable coating, lead oxides in pigments and inks)	Lead and lead compounds	3, 4
Paper manufacturing: present in wood and chemicals	Lead	3, 4
Plastic materials and resin manufacture: formulation component	Lead compounds	3, 4
Chemical manufacture: organo-lead compound production, rubber, reactants, and catalysts	Lead and lead compounds	3, 4
Carbon black production: trace constituent in crude oil	Lead compounds	3
Petroleum refining: trace constituent in petroleum crude	Lead compounds	3, 4
Cement: trace constituent in raw materials	Lead	3, 4
Coal, oil, wood combustion (electric utilities, other facility electricity generation): traces in fuels	Lead and lead compounds	3, 4, 5
Waste treatment and solvent recovery: trace constituent in waste stream	Lead and lead compounds	3
Incineration of municipal and various industrial wastes	Lead and lead compounds	3, 4
Wholesale distribution of lead chemicals and compounds	Lead and lead compounds	3
Bulk petroleum stations: trace constituent in petroleum products	Lead compounds	3

[1] Numbers correspond to the references listed in the reference section at the end of this document

Section 1.2 What Other Changes to the EPCRA Section 313 Reporting Requirements Apply to Lead and the Lead Compounds Category?

EPA has also made modifications and/or clarifications to certain reporting exemptions and requirements for the PBT chemicals that are subject to the lower reporting thresholds; this includes lead and lead compounds category. Please note that for lead and lead compounds, like other PBT chemicals, facilities cannot apply the *de minimis* exemption when making threshold determinations and release and other waste management calculations. PBT chemicals are also excluded from using the Alternate Reporting Threshold and Form A Certification Statement, and from using range reporting options when reporting releases or off-site transfers (Part II, Section 5 and 6). More information on reporting PBT chemicals to

TRI, or on the above exemptions and reporting options, can be found in the Reporting Forms and Instructions, available at: https://ofmpub.epa.gov/apex/guideme_ext/f?p=guideme:rfi-home.

SECTION 2.0 GUIDANCE FOR DETERMINING WHETHER REPORTING THRESHOLDS ARE EXCEEDED AND REPORTING ENVIRONMENTAL RELEASES OF LEAD AND LEAD COMPOUNDS

Section 2.1 General Guidance

This chapter provides guidance that facilities should find helpful in determining whether they have exceeded the 100 pound reporting threshold for lead or lead compounds, and, if so, in estimating and reporting annual releases and other waste management quantities for lead and the lead compounds category. Unless otherwise stated, the guidance in this chapter, as it pertains to lead, only deals with situations in which the lead is not contained in stainless steel, brass, or bronze alloys. Guidance pertaining to determining whether a facility has exceeded a reporting threshold for lead when it is contained in stainless steel, brass, or bronze alloys is not presented in this section but is presented in detail in the next section of this document. For those facilities that only manufacture, process, or otherwise use lead compounds or lead not contained in a stainless steel, brass, or bronze alloy only the 100 pound reporting threshold needs to be considered. It is important to emphasize, however, that for those facilities that manufacture, process, or otherwise use lead as well as stainless steel, brass, or bronze alloys that contain lead, the quantities of lead not in stainless steel, brass, or bronze alloys are applied to the 25,000 pound and 10,000 pound reporting thresholds, as well as the 100 pound reporting thresholds. This point is discussed in detail in the next chapter.

Important Points Regarding the Threshold Calculations

Lead and lead compounds are separately listed on the EPCRA section 313 list.

- There is only one listing for lead, but there are three reporting thresholds: 25,000 pounds (lb), 10,000 lb, and 100 lb;
- The 100 lb threshold is applied to lead only when it is NOT contained in stainless steel, brass, or bronze alloy;
- The 25,000 lb manufacturing and processing thresholds and the 10,000 lb otherwise use threshold apply to lead both when it is contained in stainless steel, brass, or bronze alloy and when it is not;
- Quantities of lead not contained in stainless steel, brass, or bronze alloys are STILL applied to the 25,000 lb and 10,000 lb thresholds, in addition to the 100 lb threshold; and
- There is only one listing for lead compounds and only one reporting threshold for lead compounds: 100 lb.

This chapter is not intended to provide complete guidance for all situations involving lead and lead compounds. The reader is advised to consult industry-specific guidance documents applicable to his or her facility for more detailed guidance. This document includes concentration and emissions factor data which may be used as default values in determining whether the reporting thresholds have been exceeded and in calculating releases and other waste management quantities. EPA recommends that facilities complete these determinations and calculations using best readily available information applicable to their operations, even when it differs from the data provided herein. In the absence of such information, EPCRA section 313 permits a reporting facility to make a reasonable estimate. EPA also recommends that facilities maintain documentation of the basis for making these estimates (see 40 CFR 372.10). Facilities are not required to perform additional testing for EPCRA section 313 reporting.

2.1.1 Determining Whether the 100 Pound Reporting Thresholds Have Been Exceeded

As discussed in Section 1.1, EPA lowered the reporting threshold for lead and the lead compounds category to 100 pounds per year for each of the three reporting activities: manufacturing, processing, and otherwise use. The determination of whether the 100 pound reporting threshold is exceeded for any of these activities is made independently. Thus, when determining if a threshold is exceeded for lead, one should calculate separately the amount of lead manufactured, the amount of lead processed, and the amount of lead otherwise used. These calculations must also be conducted separately for lead and for lead compounds. To determine if a threshold is exceeded for the lead compounds category, use the entire weight of the lead compound and include all lead compounds for each threshold determination (40 CFR 372.25(h)). (Some typical quantities required to meet the threshold for fuels and other selected materials may be found in Table 4-7 of Section 4.3.) However, in reporting releases and other waste management quantities, the quantities of lead can be combined on the Form R report, and submission of only one Form R is necessary if reporting for both lead and lead compounds. The first example below illustrates a few key points for determining whether the 100 pound threshold has been exceeded for lead metal (Pb^0) versus the lead compounds category.

Lead is often present as an impurity in fuels such as, for example, coal or oil. Lead present as an impurity in the fuel forms a lead compound that is coincidentally manufactured as a result of the combustion and subsequently released or otherwise managed as waste. Lead may be present in the fuel either in its elemental form (Pb^0) or as a lead compound (PbX). If you burn fuels (e.g., coal or oil) on site you must consider, for purposes of complying with section 313 of EPCRA, the lead present in the fuel and any lead compound(s) that are formed from the combustion. In the absence of any other data, EPA recommends assuming elemental lead is present in the fuel, and that it is converted to lead monoxide (Pb^0), a lead compound, during combustion(s). In this case, you would apply the amount of lead in the fuel to the otherwise use threshold for lead and the amount of lead monoxide formed to the manufacturing threshold for lead compounds. The second example below demonstrates this point.

See Section 4.5 for more information pertaining to combustion of fuels containing lead.

Example 1: Threshold Determinations For Lead Metal Versus Lead Compounds

During the calendar year, your facility manufactures 5 pounds of lead monoxide (PbO), a lead compound; processes 200 pounds of a material containing 55% lead metal (Pb^0) (not contained in stainless steel, brass, or bronze alloys); processes 99 pounds of lead sulfide (PbS), another lead compound; otherwise uses 50 pounds of lead metal; and otherwise uses 8 pounds of lead tetraoxide, (Pb_3O_4), another lead compound. To determine whether you are required to submit a Form R release report, you first need to determine whether you have exceeded the 100 pound threshold for manufacturing, processing, or otherwise use activities for lead metal or the lead compounds. To do this, you must calculate separately the quantities of lead metal and lead compounds that were manufactured, processed, or otherwise used. Thus, a total of six separate calculations must be performed. These are: 1) what quantity of lead was manufactured; 2) what quantity of lead was processed; 3) what quantity of lead was otherwise used; 4) what quantity of lead compounds were manufactured; 5) what quantity of lead compounds were processed; and 6) what quantity of lead compounds were otherwise used. If the answer to *any* of these calculations is greater than 100 pounds, you have tripped the threshold and must file a Form R release report. The calculations are shown below.

Lead Metal (Pb^0)

1. Manufacturing: None specified above.
2. Processing: 200 lb of Pb × 0.55 = 110 lb of Pb.
3. Otherwise Use: Given above as 50 lb of Pb.

Lead Compounds

1. Manufacturing: Given above as 5 lb of PbO.
2. Processing: Given above as 99 lb of PbS.
3. Otherwise Use: Given above as 8 lb of Pb_3O_4.

The only threshold that your facility exceeded was the 100 lb threshold for processing lead (metal). This means you must submit an EPCRA section 313 report for lead, and you must calculate all releases and other non-exempt waste management activity quantities of lead from your facility, including releases from the otherwise use activity for lead metal (40 CFR 372.85(b)(15)(i)).

You do not have to report releases and other waste management quantities of the lead portion of the lead compounds that resulted from the manufacturing, processing, or otherwise use of lead compounds because you did not exceed any thresholds for lead compounds. However, if your facility had processed more than 100 lb of PbS (instead of 99 lb), you would have also exceeded the threshold for processing lead compounds and you would have to report all releases and other non-exempt waste management activity quantities of lead from all lead compounds at your facility.

If your facility exceeds a threshold for both lead and lead compounds, you are allowed to prepare one Form R report that accounts for your releases of lead resulting from all of your non-exempt activities involving both lead and lead compounds. In this case, the lead associated with your activities involving lead compounds include:

1. Manufacturing: 5 lb of PbO × (207.2; mol. wt. Pb/223.2; mol. wt. PbO) = 4.6 lb Pb .
2. Processing: 100 lb PbS × (207.2; mol. wt. Pb/239.26; mol. wt. PbS) = 86.6 lb Pb.
3. Otherwise Use: 8 lb of Pb_3O_4 × (621.6; mol. wt. of 3Pb/685.6; mol. wt. of Pb_3O_4) = 7.3 lb of Pb.

Example 2: Determining the Amount of Lead Combusted and Lead Monoxide Formed

Your facility operates several coal-fired boilers to produce heat, steam, and electricity (coal is not directly processed or used in your production process). The supplier of the coal provided you with a Safety Data Sheet (SDS) stating that the lead content of the coal is 7 ppmw. Using inventory records, you know that 13,600,000 pounds of coal were burned in this boiler during the calendar year. By burning coal that contains lead, you have otherwise used lead, and it can reasonably be assumed that you have coincidentally manufactured PbO during the combustion of the coal. Two threshold calculations, therefore, must be performed: one for the otherwise use of lead, the other for the manufacture of lead oxide, a lead compound.

Otherwise Use of Lead Metal (Pb^0):

$$(7 \text{ lb lead}/1 \times 10^6 \text{ lb coal}) \times 13{,}600{,}000 \text{ lb coal/yr} = 95.2 \text{ lb lead/yr}$$

Manufacturing of Lead Compounds (PbO):

$$95.2 \text{ lb lead/yr} \times (223.2;\ \text{mol. wt. PbO}/207.2;\ \text{mol. wt. Pb}) = 10^3 \text{ lb PbO/yr}$$

While your facility did not exceed the 100 lb/yr threshold for otherwise using lead (in coal), your facility exceeded the 100 lb/yr threshold for manufacturing lead compounds and, therefore, you will have to file an EPCRA section 313 (Form R) report for lead compounds this year.

The concentration of lead or lead compounds may be known as a specific concentration, as an average, as a range, or as an upper or lower boundary. If you know the specific concentration of lead or lead compounds, you must use that value for estimates (40 CFR 372.30(b)(i)). If only an average concentration is provided (e.g., by the supplier), use that value in the threshold calculation. If only the upper-bound concentration is known, you must use that value in the threshold calculation (40 CFR 372.30(b)(3)(ii)). If only the lower-bound concentration is known, or the concentration is given as a range of an upper and lower boundary, EPA has developed the following guidance on the use of this type of information in threshold determinations:

- If the concentration is given as a range or an upper and lower boundary, EPA recommends that you use the mid-point in your calculations;
- If only the lower bound concentration of lead or lead compounds is given and the concentrations of the other components are given, EPA recommends that you subtract the other component total from 100% to calculate the upper bound of the lead or lead compound(s). EPA recommends that you then determine the mid-point for use in your calculations;
- If only the lower-bound concentration of lead or lead compounds is given and the concentration of the other components is not given, EPA recommends that you assume the upper bound for the lead or lead compounds is 100% and use the mid- point. Alternatively, product quality requirements or information available from the most similar process stream may be used to determine the upper bound of the range.

Example 3: Determining the Amount of Lead Processed

Your facility processes a chemical substance that contains lead as an impurity. You have information indicating that the lead content of the chemical substance is 2.2 to 2.6 percent by weight. Using inventory records, you know that 750,000 pounds of the chemical substance was processed at your facility during the calendar year. Using the mid-point of the range of lead concentrations available (2.4% or 0.024 pounds (lb) of lead/100 lb of chemical substance), you can determine whether you have exceeded the processing threshold.

$$(0.024 \text{ lb lead/lb chemical substance}) \times 750{,}000 \text{ lb chemical substance/yr} = 18{,}000 \text{ lb lead/yr}$$

Your facility exceeded the 100 lb/yr processing threshold for lead and, consequently, will have to report for lead this year.

Chemical production facilities may manufacture lead compounds for other industry use. Production records are a good source for determining the amount manufactured. You must also include any importation of lead or lead compounds in your manufacturing threshold determination (EPCRA section 313(b)(1)(C)(i)). You can obtain these amounts from purchasing records.

2.1.2 *De minimis* Exemption

Typically, EPCRA section 313 chemicals or chemical categories that qualify for the *de minimis* exemption may be excluded from threshold determinations and release or other waste management estimations. However, the *de minimis* exemption does not apply to lead, lead compounds, or other PBT chemicals or chemical categories (40 CFR 372.38(a)), except when lead is contained in stainless steel, brass, or bronze alloys (see Table 3-3 in Chapter 3).

Section 2.2 Guidance for Reporting Annual Environmental Releases and Other Waste Management Quantities of Lead

When reporting releases and other waste management quantities for lead or the lead compound category, only the amount of elemental lead should be reported on the Form R (40 CFR 372.25(h)).

EPA recommends that you calculate lead releases and other waste management quantities by following these steps:

1. Identify the processes/operations where lead or lead compounds may be manufactured, processed, or otherwise used;
2. Determine potential sources of releases and other waste management quantities from these processes (e.g., wastewater discharge, emissions from operations);
3. Identify the types of releases and other waste management quantities. These types correspond to sections in the Form R (e.g., stack emissions, quantity sent off site for recycling);
4. Determine the most appropriate estimation method(s) and calculate the estimates for release and other waste management quantities.

During threshold determinations, you should have identified the processes and operations in which lead (and lead compounds) are found. Potential release and other waste management sources of lead include the following:

- Accidental spills and releases;
- Air pollution control devices (e.g., baghouses, electrostatic precipitators, and scrubbers);
- Clean up and housekeeping practices;
- Combustion by-products;
- Container residues;
- Fittings and pumps;
- Process discharge stream;
- Recycling and energy recovery by-products;
- Storage tanks;
- Tower stacks;
- Transfer operations;
- Treatment sludge;
- Volatilization from processes; and
- Waste treatment discharges.

After determining the release and other waste management activity sources of lead and lead compounds, you are ready to determine the types of releases and other waste management quantities. These final destinations of lead (not including incorporation into a final product) correspond to elements of the Form R (https://ofmpub.epa.gov/apex/guideme_ext/f?p=guideme:rfi-home).

Once you have determined that you exceeded a threshold, and after you have identified all of the potential sources for release and other waste management activity types, you must estimate the quantities of lead and the lead portion of lead compounds released and otherwise managed as waste. EPA has identified basic methods that may be used to develop estimates (each method has been assigned a code that must be included when reporting). The basic methods and corresponding codes are:

- Estimate is based on continuous monitoring data or measurements for the EPCRA section 313 chemical (M1);
- Estimate is based on periodic or random monitoring data or measurements for the EPCRA section 313 chemical (M2);
- Estimate is based on mass balance calculations, such as calculation of the amount of the EPCRA section 313 chemical in streams entering and leaving process equipment (C);
- Estimate is based on published emissions factors, such as those relating release quantity to through-put or equipment type (e.g., air emissions factors) (E1);
- Estimate is based on-site specific emissions factors, such as those relating release quantity to through-put or equipment type (e.g., air emissions factors) (E2);
- Estimate is based on other approaches such as engineering calculations (e.g., estimating volatilization using published mathematical formulas) or best engineering judgment. This would include applying estimated removal efficiency to a waste stream, even if the composition of the stream before treatment was fully identified through monitoring data (O).

Descriptions of these basic methods are provided in the U.S. EPA publication, *Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Forms* (6) (https://www.epa.gov/nscep) and in the annual TRI Reporting Forms and Instructions (https://ofmpub.epa.gov/apex/guideme_ext/f?p=guideme:rfi-home). Many data sources exist for these (and other) methods of developing estimates. Figure 2-1 presents potential data sources and the estimation methodology in which each estimation source is most likely to prove useful. 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.

Monitoring Data	Mass Balance	Emissions Factors	Engineering Calculations
• Air permits • Continuous emission monitoring • Effluent limitations • Hazardous waste analysis • Industrial hygiene monitoring data • NPDES[1] water permits • Outfall monitoring data • POTW pretreatment standards • RCRA[2] hazardous waste permit • Stack monitoring data • New Source Performance Standards • Title V Air Permit Data • MACT[3] Air Standards	• Air emissions inventory • Hazardous material inventory • Hazardous waste manifests • SDSs[5] • Pollution prevention reports • Spill event records • Supply and purchasing records	• AP-42[4] chemical specific emissions factors • Facility or trade association derived chemical- specific emissions factors	• NTI[6] database • Facility non-chemical specific emissions factors. • Henry's Law • Raoult's Law • SOCMI[7] or trade association non-chemical specific • Emissions factors • Solubilities • Volatilization rates

[1] National Pollutant Discharge Elimination System.
[2] Resource Conservation Recovery Act.
[3] Maximum Achievable Control Technology.
[4] Compilation of emissions factors, U.S. EPA.
[5] Safety Data Sheets.
[6] National Toxic Inventory.
[7] Synthetic Organic Chemicals Manufacturing Industry.

Figure 2-1: Potential Data Sources for Release and Other Waste Management Calculations

SECTION 3.0 QUALIFICATION FOR STAINLESS STEEL, BRASS, AND BRONZE ALLOYS THAT CONTAIN LEAD

Section 3.1 The Qualified Alloys: Stainless Steel, Brass, and Bronze Alloys that Contain Lead

An alloy is a solid mixture that contains two or more elements, at least one of which being a metal. Examples of alloys are stainless steel, brass, and bronze, which are three of the most commonly used alloys (9). The major metal in stainless steel is iron. However, depending on the type of stainless steel, there can be substantial amounts of chromium, manganese, and/or nickel, which are added to minimize the corrosion of the stainless steel. The major metal in brass and bronze is copper; however, substantial amounts of nickel and/or zinc may also be present. Brass is an alloy of copper and zinc with other metals in varying lesser amounts. Bronze is an alloy of copper and tin with smaller amounts of other metals. The final lead rule[1] lowered the 25,000 pound and 10,000 pound reporting thresholds for lead and lead compounds to 100 pounds, with the exception of lead contained in stainless steel, brass, and bronze alloys. For stainless steel, brass, or bronze alloys that contain lead, the quantity of lead contained in these alloys is still applied to the 25,000 pound and 10,000 pound reporting thresholds.

These three alloys, when they contain lead, are referred to in this document as the “qualified alloys.”

EPA deferred on lowering the 25,000 pound and 10,000 pound reporting thresholds for lead when it is in stainless steel, brass, and bronze alloys because the Agency was evaluating a previously submitted petition as well as comments received in response to previous petition denials that requested the Agency to revise the EPCRA section 313 reporting requirements for certain metals contained in stainless steel, brass, and bronze alloys. It is important to note that stainless steel, brass, and bronze alloys, even when they contain lead, are not listed on the EPCRA section 313 list of toxic chemicals: they are not listed chemicals. Lead, of course, is included on the EPCRA section 313 list of toxic chemicals, and its presence in stainless steel, brass, or bronze alloys does not change its status as a listed or PBT chemical.

As mentioned in Section 1, there is only one reporting threshold for the manufacturing, processing, or otherwise use activities of lead compounds, and that is 100 pounds. Thus, a facility that manufactures, processes, or otherwise uses more than 100 pounds of a single lead compound or combination of lead compounds within a calendar year must report their environmental releases and other waste management quantities of the compound(s). For lead metal (Pb^0) there are three reporting thresholds: 25,000 pounds; 10,000 pounds; and 100 pounds. The 25,000 pound threshold pertains to the manufacture or processing of all lead metal: lead contained in stainless steel, brass or bronze alloys (the qualified alloys), and lead that is not contained in one of the qualified alloys. Similarly, the 10,000 pound threshold pertains to the otherwise use of all lead metal. Thus, a facility that manufactures or processes within a calendar year more than 25,000 pounds of lead, regardless of whether the lead is in a qualified alloy, is required to report their environmental releases and other waste management quantities of lead. The same is true if the facility otherwise uses more than 10,000 pounds of lead. The 100 pound threshold only pertains to the manufacture, processing, or otherwise use of lead when it is not in stainless steel, brass, or bronze alloys. Lead that is in stainless steel, brass, or bronze alloys should not be included in determinations of whether the 100 pound threshold for lead has been exceeded.

[1] Lead and Lead Compounds; Lowering of Reporting Thresholds; Community Right-to-Know Toxic Chemical Release Reporting; Final Rule. Federal Register, 66, 4499-4547 (January 17, 2001).

Those facilities that manufacture, process, or otherwise use within a calendar year more than 100 pounds of lead that is not contained in a qualified alloy must report their environmental releases and other waste management quantities.

The determination of whether a facility has to file a release report for lead must be based on a prior determination of whether that facility has exceeded any of the three reporting thresholds for lead. Ostensibly, those facilities that do not manufacture, process, or otherwise use stainless steel, brass, or bronze alloys that contain lead will not have to determine whether they have exceeded the 25,000 pound or 10,000 pound thresholds. Or, in other words, those facilities that manufacture, process, or otherwise use lead only when it is *not* contained in stainless steel, brass, or bronze alloy will only have to determine whether they have exceeded the 100 pound threshold. Facilities that manufacture, process, or otherwise use lead when it is both in stainless steel, brass, or bronze alloys and when it is not in these alloys must consider all three thresholds. An important point to remember is that when determining whether a facility has exceeded the 25,000 pound or 10,000 pound thresholds, any lead that is **not** in stainless steel, brass, or bronze alloys must also be included in the determination. Figure 3-1 summarizes the basic steps that need to be taken when determining whether a facility has exceeded any of the three reporting thresholds for lead. The remainder of this chapter discusses these steps in greater detail, and provides examples to illustrate how such determinations should be made.

This chapter also provides a general discussion on what stainless steel, brass, and bronze alloys are. A more detailed discussion on the composition of stainless steel, brass, and bronze alloys is provided in Appendix A. A comprehensive discussion on the chemistry, composition, and environmental fate of alloys, including stainless steel, brass, and bronze alloys is available in an EPA document entitled Report on the Corrosion of Certain Alloys (8).

3.1.1 Definition of Stainless Steel Alloy

The American Iron and Steel Institute (AISI) defines alloy steels as follows: "....common custom steel is considered to be alloy steel when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: manganese (Mn), 1.65%; silicon (Si), 0.60%; copper (Cu), 0.60%; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum (Al), boron (B), chromium (Cr) up to 4.00%, cobalt (Co), niobium (Nb), molybdenum (Mo), nickel (Ni), titanium (Ti), tungsten (W), vanadium (V), zirconium (Zr), or any other alloying element added to obtain a desired alloying effect."

Steels that contain 4% or more of chromium are included, by convention, among the special types of alloy steels known as **stainless steels** (8). Trace concentrations of lead may be contained in stainless steel as an impurity. The main reason for the existence of stainless steels is their resistance to corrosion.

Some Important Points about Alloys

- An alloy is a solid mixture that contains two or more elements, at least one of which is a metal;
- With regard to the TRI Lead Rule and this document, the "qualified alloys" are stainless steel, brass, and bronze alloys that contain lead;
- Stainless steels are steels that contain 4% or more of chromium;
- Brass is an alloy that consists chiefly of copper and zinc in variable proportions, and to a lesser extent other elements;
- Bronze is an alloy that consists chiefly of copper and tin in variable proportions, and to a lesser extent other elements.

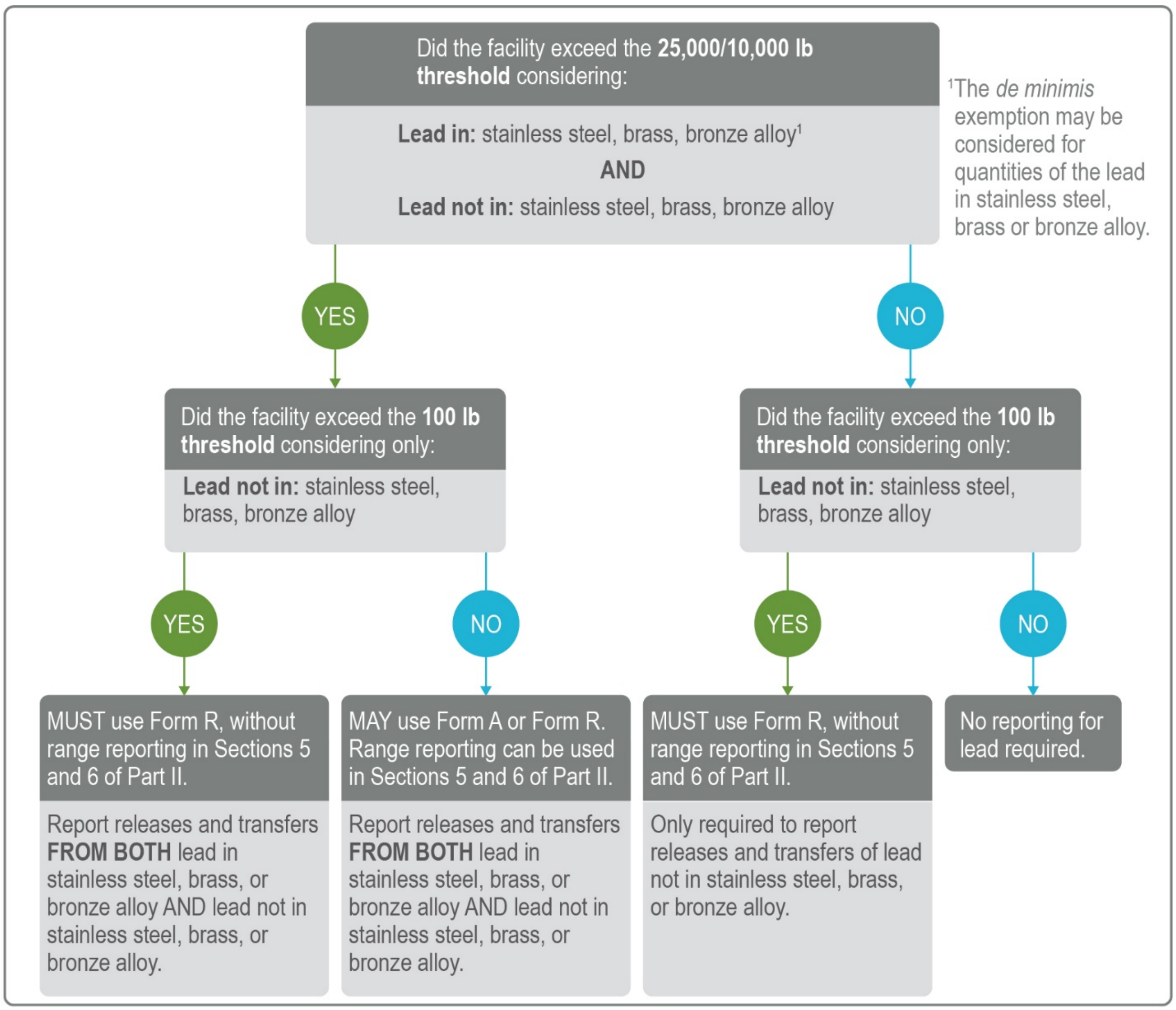

Figure 3-1. Reporting Thresholds and Requirements for Lead

(The flow chart in Figure 3-1 does not apply to lead compounds, which is a separately listed TRI chemical.)

More than 180 different alloys belong to the stainless steel group and each year new ones and modifications of existing ones appear. In some stainless steels the chromium content approaches 30%. Corrosion and oxidation resistance of stainless steels increase as the chromium content is increased. By increasing the amount of the chromium content and by the presence of other elements, such as molybdenum or titanium, the corrosion resistance of stainless steels can be varied over a tremendous range.

3.1.2 Definitions of Brass and Bronze

Brass is an alloy that consists chiefly of copper and zinc in variable proportions, and to a lesser extent other elements. **Bronze** is an alloy that consists chiefly of copper and tin in variable proportions, and to a lesser extent other elements. There are a number of different types of brass and bronze that differ in the concentrations of copper, zinc, tin, or other metals.

Copper and its alloys, including brass and bronze, are classified in the United States by composition according to Copper Development Association (CDA) designations which have been incorporated into the Unified Numbering System (UNS) for metals and alloys. Wrought copper materials are assigned five digit numerical designations which range from C10100 through C79999, but only the first three or sometimes four numerals are frequently used for brevity. Designations that start with 8 or 9 are reserved for cast copper alloys. The designations and principal alloying elements of wrought copper alloys are given in Table 3-1.

Table 3-1: UNS (CDA) Designations for Brass and Bronze Alloys

Alloy Group	UNS (CDA) Designation	Principal Alloy Elements
Brasses	C20500-C28580	Zn
Leaded brasses	C31200-C38590	Zn-Pb
Tin brasses	C40400-C40980	Sn, Zn
Phosphor bronzes	C50100-C52400	Sn-P
Leaded bronzes	C53200-C54800	Sn-P, Pb
Phosphorus-silver	C55180-C55284	Ag-P
Aluminum bronze	C60600-C64400	Al, Fe, Ni, Co, Si
Silicon bronze	C64700-C66100	Si, Sn
Modified brass	C66400-C69950	Zn, Al, Si, Mn

Brass and bronze can be grouped according to how the principal elemental additions affect properties. This grouping depends primarily on whether the additions that dissolve in the liquid copper can form discrete second phases during melting/casting or in-process thermal treatment. Brass and bronze are considered to be solid solution alloys when copper dissolves other elements to varying degrees to produce a single-phase alloy that is strengthened relative to unalloyed copper. The contribution to strengthening from an element depends on the amount of the element in solution and by its particular physical characteristics, such as atom size and valency. Tin, silicon, and aluminum show the highest strengthening efficiency of the common elemental additives, whereas nickel and zinc are the least efficient. The limiting factor in their alloy range is the extent to which the elements, either singly or in combination, remain dissolved in the copper during processing. Table 3-2 gives the designations and compositions of some specific brass and bronze wrought alloys. More details on these specific alloys are provided in Appendix A.

Table 3-2: UNS (CDA) Designation and Compositions of Some Brass and Bronze Wrought Alloys

Alloy Group	UNS Designation	Elemental Composition, wt% [a]
Zinc brass	C260	30 Zn
Leaded brass	C360	35 Zn, 3 Pb
Tin brass	C425	9.5 Zn, 2.0 Sn
Phosphor bronze	C510	5.0 Sn, 0.1 P
Aluminum bronze	C638	2.8 Al, 1.8 Si
Silicon bronze	C654	3.0 Si, 1.5 Sn, 0.1 Cr
Silicon bronze	C655	3.3 Si, 0.9 Mn
Modified Cu-Zn	C688	22.7 Zn, 3.4 Al, 0.4 Co

[a] Remaining percentage is copper.

Section 3.2 Determining When Reporting of Releases and Other Waste Management Quantities for the Qualified Alloys is Required

As discussed above, there is only one reporting threshold for lead compounds, and that is 100 pounds. Hence, a facility that either manufactures, processes, or otherwise uses more than 100 pounds annually of a single lead compound, or more than one lead compound, will have to report releases and other waste management quantities of the lead contained in the lead compound(s). For lead metal (Pb^0), there are three reporting thresholds—25,000 pounds; 10,000 pounds; and 100 pounds—that pertain to the manufacture, processing, or otherwise use of this chemical. A facility must file an EPCRA section 313 report if it manufactures, processes, or otherwise uses more than 100 pounds of lead (not contained in stainless steel, brass, or bronze alloy) during the calendar year. For lead contained in stainless steel, brass, or bronze alloy, the 25,000 pound threshold for manufacturing and processing and the 10,000 pound threshold for otherwise use is applied. As illustrated in Figure 3-1, facilities that manufacture, process, or otherwise use lead and stainless steel, brass, or bronze alloys that contain lead must apply all quantities of lead (regardless of whether they are in an alloy) to the 25,000 pound threshold for manufacturing and processing or the 10,000 pound threshold for otherwise use. When conducting threshold evaluations, a facility must consider the amount of lead not in stainless steel, brass, or bronze alloys toward both the 100 pound threshold AND the 25,000 and 10,000 pound thresholds (see Figure 3-1). Of course, facilities that manufacture, process, or otherwise use lead only when it is not contained in any of the qualified alloys would only have to consider the 100 pound threshold.

Thus, the qualification for lead contained in stainless steel, brass, or bronze alloys creates three potential scenarios for facilities that may manufacture, process, or otherwise use lead as well as stainless steel, brass, or bronze alloys that contain lead: 1) all lead is in forms other than stainless steel, brass, or bronze alloy; 2) all lead is in stainless steel, brass, or bronze alloy; and 3) some lead is in stainless steel, brass, or bronze alloy and some is not; i.e., some lead may be manufactured, processed, or otherwise used elsewhere at the facility. Table 3-3 summarizes what a facility needs to consider in determining whether they need to report releases and other waste management quantities under each of these scenarios and, if reporting is required, what options the facility has in filing reports. Table 3-3 refers to the following three **variables**: 1) Form A Certification Statement; 2) range reporting for Sections 5 and 6 of Part II of the Form R; and 3) *de minimis* exemption. These variables, as well as their applicability, are discussed in Section 1.2. Additional details on these variables can be found in the *Toxic Chemical Release Inventory Reporting Forms and Instructions* package, which is published annually by EPA and can be obtained from the Internet at https://ofmpub.epa.gov/apex/guideme_ext/f?p=guideme:rfi-home.

Table 3-3: Threshold Scenarios and Options Involving Lead and the Qualified Alloys

Scenario	Option
None of the lead at the facility is contained in a qualified alloy. In this scenario all lead quantities are "not in stainless steel, brass, or bronze alloys." In principle the 100 pound, 25,000 pound and 10,000 pound thresholds are applicable. However, since none of the lead is in a qualified alloy, as a practical matter what really determines whether reporting is required in this scenario is whether the 100 pound threshold is "triggered" (i.e., exceeded).	In this scenario, the facility may NOT use ANY of the following variables: *de minimis* exemption, Form A Certification Statement, and range reporting for Sections 5 and 6 of Part II of the Form R.
All of the lead is only in qualified alloys. Thus, all lead quantities to be considered in the threshold determination are only "in stainless steel, brass, or bronze alloys." Therefore, only the 25,000/10,000 pound thresholds need to be considered.	If either the 25,000 or 10,000 pound thresholds are exceeded: • The facility can use the *de minimis* exemption (if otherwise applicable). • The facility may also use the Form A. • Certification Statement and range reporting options for completing Sections 5 and 6 of Part II of the Form R.
Lead is in qualified alloys AND not in qualified alloys. Quantities of lead are "in stainless steel, brass or bronze alloys" and "not in stainless steel, brass, or bronze alloys." Thus, all three reporting thresholds: i.e., the 100 pound, 25,000 pound, and 10,000 pound thresholds need to be considered, and the facility will need to determine whether any of these thresholds have been triggered (exceeded). Those quantities of lead not in qualified alloys are to be applied to all three reporting thresholds. Those quantities of lead that are only in the specified alloys should only be applied to the 25,000 pound and 10,000 pound thresholds.	The facility may take the *de minimis* exemption for those quantities of lead "in stainless steel, brass, or bronze alloys" that meet the *de minimis* exemption requirements (e.g., manufactured as an impurity). The facility may not take the *de minimis* exemption for any of the lead "not in stainless steel, brass, or bronze alloys." If the 100 pound reporting threshold is exceeded, the facility may NOT use the following variables: Form A Certification Statement and range reporting for Sections 5 and 6 of Part II of the Form R, regardless of whether the 25,000/10,000 pound threshold is exceeded. If only the 25,000 or 10,000 pound threshold is exceeded, the facility may use the Form A Certification Statement or range reporting variables even though, in this example, quantities of lead "not in stainless steel, brass, or bronze alloys" were included in the threshold calculation. The reporting variables cannot be used once the 100 pound threshold has been exceeded.

The following example demonstrates some of the points described in the above threshold determination scenarios. Relevant questions and answers on guidance for reporting lead and lead compounds to TRI are included in Appendix B. Additional Q&As for TRI reporting guidance are also published on GuideME: https://ofmpub.epa.gov/apex/f?p=guideme:qa-seach.

Example 3: Threshold Determinations for Various Scenarios Involving Lead Alloys

1) Consider a facility that processes 20,000 pounds of lead in a stainless steel alloy and 275 pounds of lead in another alloy that is not stainless steel, brass, or bronze during the calendar year. Does this facility need to file an EPCRA section 313 report for lead?

Yes, this facility must file an EPCRA section 313 Form R report for lead (a Form A Certification Statement is not an option). While this facility did not exceed the 25,000 pound threshold for processing lead in all forms, it exceeded the 100 pound threshold for processing lead in forms other than in stainless steel, brass, or bronze alloys. This facility is only required to report releases and transfers of lead not contained in stainless steel, brass, or bronze alloys, and it cannot use range reporting in Sections 5 and 6 of Part II of the Form R.

2) Consider a facility that processes 24,950 pounds of lead in a stainless steel alloy and 75 pounds of lead in another alloy that is not stainless steel, brass, or bronze during the calendar year. Does this facility need to file an EPCRA section 313 report for lead?

Yes, this facility must file an EPCRA section 313 report for lead. This facility exceeded the 25,000 pound threshold for processing of lead in all forms (24,950 pounds in a qualified alloy plus 75 pounds in a non-qualified alloy = 25,025 pounds total); therefore, this facility must file a report. Since this facility did not exceed the 100 pound threshold for processing lead in forms other than stainless steel, brass, or bronze alloys, this facility may file a Form A Certification Statement rather than a Form R report if it meets the other requirements (less than 1,000,000 pounds manufactured, processed, or otherwise used and less than 500 pounds for the total annual reportable amount) for completing a Form A Certification Statement. This facility is required to report releases and transfers of all lead (both contained in the stainless steel alloy and not contained in stainless steel, brass, or bronze alloys), and can use range reporting in Sections 5 and 6 of Part II of the Form R.

3) Consider a facility that processes 275 pounds of lead metal that is not in stainless steel, brass, or bronze alloys and that in a separate operation processes 24,900 pounds of lead in a brass alloy during the calendar year. Does this facility have to file an EPCRA section 313 report for lead, and is this facility required to report quantities released and otherwise managed as waste from the lead in all sources?

Yes, this facility must file a Form R report for lead. This facility exceeded both the 25,000 pound processing threshold for lead in all forms (275 pounds of lead in a non-qualified alloy plus 24,900 pounds in a brass alloy = 25,175 pounds total) and the 100 pound threshold for lead not contained in stainless steel, brass, or bronze alloys. Therefore, this facility must complete a Form R (it cannot use a Form A Certification Statement). This facility must consider the amount of lead in both the qualified and non-qualified alloys when estimating its releases and quantities otherwise managed as waste (although the *de minimis* exemption can be used for waste streams that apply to the 24,900 pounds of lead in the brass alloy, if appropriate). This facility cannot use range reporting in Sections 5 and 6 of Part II of the Form R.

4) Consider a facility that processes 90 pounds of a lead compound, 95 pounds of lead metal (i.e., lead that is not contained in stainless steel, brass, or bronze alloys), and 24,910 pounds of lead in a stainless steel alloy during the calendar year. Does this facility have to file an EPCRA section 313 report for lead?

Yes, this facility must file an EPCRA section 313 report for lead. This facility exceeded the 25,000 pound threshold for processing of lead in all forms (95 pounds not in a qualified alloy plus 24,910 pounds in stainless steel = 25,005 pounds total) and must, therefore, file a report.

Since this facility did not exceed the 100 pound threshold for processing of lead not in stainless steel, brass, or bronze alloys, this facility may file a Form A Certification Statement rather than a Form R report if it meets the other requirements (less than 1,000,000 pounds manufactured, processed, or otherwise used and less than 500 pounds for the total annual reportable amount released) for completing a Form A Certification Statement.

This facility is required to report releases and transfers of all lead (both contained in the stainless steel alloy and not contained in stainless steel, brass, or bronze alloys) and can use range reporting in Sections 5 and 6 of Part II of the Form R.

Note, however, that this facility did not exceed the 100 pound processing threshold for lead compounds and, therefore, does not need to report its processing of a lead compound. None of the lead in the lead compound is factored into the above threshold determinations for lead, or toward release or otherwise managed quantity estimates for lead.

Example 3 (continued): Threshold Determinations for Various Scenarios Involving Lead Alloys

5) Consider a facility that processes 26,500,000 pounds of a stainless steel alloy containing 0.0950% lead. Does this facility have to file an EPCRA section 313 report for lead?

The amount of lead in the stainless steel alloy processed is calculated as follows:

(26,500,000 pounds alloy) × (0.0950% lead) = 25,200 pounds lead

While the threshold for processing lead appears to have been exceeded (25,200 pounds is more than the 25,000 pound threshold for processing lead), the lead in the alloy is less than the *de minimis* concentration (0.1%) and therefore does not have to be considered in the threshold calculation (i.e., is exempt from the threshold calculation). Thus, because the *de minimis* concentration for lead is 0.1%, and because this facility processed lead only in the form of the qualified alloy of stainless steel (i.e., the 100 pound threshold was not also exceeded), this facility is not required to file an EPCRA section 313 report.

It is important to note that if a facility exceeds the 100 pound threshold for lead not contained in stainless steel, brass, or bronze alloys, they must complete a Form R. Keep in mind that the *de minimis* exemption may apply when estimating the amounts of release and otherwise managed quantities associated with the lead in the qualified alloys. Clarification on "melting" qualified alloys is presented in Appendix B, Q&A 6.

SECTION 4.0 SOURCES OF LEAD AND LEAD COMPOUNDS

This chapter provides an overview of where EPA believes lead and lead compounds are likely to be found at facilities and which operations may manufacture, process, or otherwise use lead or lead compounds. You should determine if the sources of lead and lead compounds discussed in this chapter apply to your facility. EPA recognizes that this document is not exhaustive and that many additional sources of lead and lead compounds exist. You should carefully consider all potential sources, not just those discussed in this document.

Section 4.1 Physical and Chemical Nature of Lead and Lead Compounds

In pure form, lead metal (Pb^0) is silvery in appearance. Lead metal oxidizes and turns bluish-gray when exposed to air. It is soft enough to be scratched with a fingernail. It is dense, malleable, and readily fusible (10). Its properties include a low melting point; ease of casting; high density; low strength; ease of fabrication; acid resistance; electrochemical reaction with sulfuric acid; chemical stability in air, water, and soils; and the ability to attenuate sound waves, atomic radiation, and mechanical vibration (11). The physical properties of lead are presented in Table 4-1.

Lead in its elemental or pure form rarely occurs in nature. Lead most commonly occurs as the mineral galena (lead sulfide [PbS]), a lead compound, and is sometimes found in other mineral forms, which are of lesser commercial importance, such as anglesite ($PbSO_4$) and cerussite ($PbCO_3$) (10).

Table 4-2 presents properties of these three mineral compounds. Lead is hardened by alloying it with small amounts of arsenic, copper, antimony, or other metals (10). These alloys are frequently used in manufacturing various lead-containing products. A list of typical end uses for lead alloys is given in Table 4-3.

Lead in its compound form also has many uses in manufacturing processes, primarily as pigments. Lead compounds can be classified into the following general categories:

- Organolead compounds;
- Lead oxides;
- Lead sulfides; and
- Lead salts.

Each of these classes of lead compounds is discussed briefly below. Table 4-4 presents a summary of the chemical formulas and end uses of the most commonly used lead compounds.

4.1.1 Organolead Compounds

Organolead compounds are compounds that contain lead and carbon and have at least one lead-carbon bond. Only two types of organolead compounds have found large-scale commercial applications: tetramethyllead (TML) and tetraethyllead (TEL). Both TML and TEL were once manufactured in large quantities in the United States because they were used extensively in automotive gasoline. However, due to strict regulations that have essentially outlawed the use lead as an additive in gasoline, the commercial production or importation of TML and TEL in the United States is now greatly reduced. Special use of lead as an additive in certain types of fuels, such as fuels for certain racing cars and aircraft, is still permitted, however.

Table 4-1: Physical Properties of Lead

Property	Value
Atomic weight	207.2 Da
Melting point	327°C
Boiling point	1770°C
Specific gravity	
20°C	11.35 g/cm^3
327°C (solid)	11.00 g/cm^3
327°C (liquid)	10.67 g/cm^3
Specific heat	130 J/(kg-K)a
Latent heat of fusion	25 J/g
Latent heat of vaporization	860 J/g
Vapor pressure	
980°C	0.133 kPa
1160°C	1.33 kPa
1420°C	13.33 kPa
1500°C	26.7 kPa
1600°C	53.3 kPa
Thermal conductivity	
28°C	34.7 W/(m-K)
100°C	33.0 W/(m-K)
327°C (solid)	30.5 W/(m-K)
327°C (liquid)	24.6 W/(m-K)
Coefficient of linear expansion, at 20°C per °C	29.1×10^{-6}
Surface tension at 360°C	442 mN/m

Source: Reference 12

Table 4-2: Physical Properties of the Principal Lead-Ore Compounds

Parameter	Galena	Cerussite	Anglesite
Formula	PbS	$PbCO_3$	$PbSO_4$
Lead, weight percent	86.6 %	77.5 %	68.3 %
Hardness, Mohs scale	2.5 to 2.75	3 to 3.5	2.5 to 3
Luster	Metallic	Adamantine to vitreous, resinous	Adamantine to vitreous, resinous
Color	Lead gray	Colorless to white	Colorless to white
Density, g/cm3	7.58	6.55	6.38

Source: Reference 13

Table 4-3: Uses of Lead Alloys

Alloy	Uses
Lead - Copper (<0.10% copper by wt.)	• Lead sheet • Lead pipes • Sheathings for electric power cables • Wire and other fabricated lead products • Tank linings • Tubes for acid-mist precipitators • Steam heating pipes for acid-plating baths
60 to 70% copper by wt. (leaded brass or bronze)	• Bearings and bushings
Lead - Antimony	• Lead-acid battery positive grids, posts, and connectors • Flashings and roofing materials • Cable sheathings • Ammunition • Tank linings, pumps, valves, pipes, and heating and cooling coils in chemical operations using sulfuric acid or sulfate solutions at elevated temperatures • Lead sheet • Anodes in metal-plating and metal-electrowinning operations • Collapsible tubes • Wheel-balancing weights for automobiles and trucks • Special weights and castings • Battery cable clamps
Lead - Antimony - Tin	• Printing-type metals • Bushing and sleeve bearings • Journal bearings in freight cars and mobile cranes • Decorative, slush, and special castings (e.g., miniature figures, casket trim, belt buckles, trophies, and holloware)
Lead - Tin	• Solders for sealing and joining metals (e.g., electronic applications including printed circuit boards) • Automobile radiators • High-temperature heat exchangers • Terne-steel sheets for radio and television chassis, roofs, fuel tanks, air filters, oil filters, gaskets, metal furniture, gutters, and downspouts
Lead - Calcium	• Coating of copper sheet used for building flashings • Coating of steel and copper electronic components • Electroplating • Grids for large stationary stand-by power, submarine, and specialty sealed batteries • Original equipment automotive batteries • Negative grids for replacement batteries • Electrowinning anodes • Cable sheathing, sleeving for cable splices, specialty boat keels, and lead-alloy tapes
Lead - Calcium - Aluminum	• Negative battery grids

Alloy	Uses
Lead - Calcium - Tin	• Maintenance-free automotive battery grids • Electrowinning anodes
Lead - Silver	• Insoluble anodes for zinc and manganese electroplating • Anodes in the d-c cathodic protection of steel pipe and structures used in fresh, brackish, or seawater • Solder in high pressure, high temperature cooling systems • Positive grids of lead-acid batteries • Soft solders
Lead - Silver – Antimony	• Production of thin copper foil for electronics
Lead - Silver - Calcium	• Zinc electrowinning
Lead - Strontium - Tin	• Maintenance-free battery grids • Bearings
Lead - Tellurium	• Used in pipes and sheets for chemical installations • Shielding for nuclear reactors • Cable sheathing
Fusible (lead, cadmium, bismuth, and tin in varying compositions)[a]	• Fuses • Low-melting sprinkler systems Foundry patterns • Molds, dies, punches, chucks, cores, mandrels, flexible tubing, and low-temperature solder
Lead – Idium	• Used to solder metals to glass
Lead - Lithium and Lead	• Battery grids
Lithium - Tin	• Bearings

[a] Alloys that melt at very low temperatures (i.e., 32°F to 361.4°F [0°C to 183°C]).
Source: Reference 1

Table 4-4: Lead Compounds

Compound*	CAS Number	Chemical Formula or Description	Uses
Lead acetate	301-04-2	$Pb(C_2H_3O_2)_2 \cdot 3H_2O$	Dyeing of textiles, waterproofing, varnishes, lead driers, chrome pigments, gold cyanidation process, insecticide, anti-fouling paints, analytical reagent, hair dye
Lead alkyl, mixed	—	A mixture containing various methyl and ethyl derivatives of tetraethyl lead and tetramethyl lead	Anti-knock agents in aviation gasoline
Lead antimonate	13510-89-9	$Pb_3(SbO_4)_2$	Staining glass, crockery, and porcelain
Lead arsenate	7645-25-2	$Pb_3(AsO_4)_2$	Insecticide, herbicide
Lead arsenite	10031-13-7	$Pb(AsO_2)_2$	Insecticide
Lead azide	13424-46-9	$Pb(N_3)_2$	Primary detonating compound for high explosives
Lead borate	14720-53-7	$Pb(BO_2)_2 \cdot H_2O$	Varnish and paint drier, waterproofing paints, lead glass, electrically conductive ceramic coatings
Lead borosilicate	—	Composed of a mixture of the borate and silicate of lead	A constituent of optical glass
Lead carbonate, basic	598-63-0	$2PbCO_3 \cdot Pb(OH)_2$	Exterior paint pigments, ceramic glazes
Lead chloride	7758-95-4	$PbCl_2$	Preparation of lead salts, lead chromate pigments, analytical reagent
Lead chromate	7758-97-6	$PbCrO_4$	Pigment in industrial paints, rubber, plastics, ceramic coatings; organic analysis
Lead cyanide	592-05-2	$Pb(CN)_2$	Metallurgy
Lead dimethyl dithiocarbamate	19010-66-3	$Pb[SCSN(CH_3)_2]_2$	Vulcanization accelerator with litharge
Lead dioxide	1309-60-0	PbO_2	Oxidizing agent, electrodes, lead-acid storage batteries, curing agent for polysulfide elastomers, textiles (mordant, discharge in dyeing with indigo), matches, explosives, analytical reagent
Lead fluoborate	13814-96-5	$B_2F_8 \cdot Pb$	Salt for electroplating lead; can be mixed with stannous fluoborate to electroplate any composition of tin and lead as an alloy
Lead fluoride	7783-46-2	PbF_2	Electronic and optical applications, starting materials for growing single-crystal solid-state lasers, high-temperature dry film lubricants in the form of ceramic-bonded coatings
Lead fluosilicate	25808-74-6	$PbSiF_6 \cdot 2H_2O$	Solution for electrorefining lead
Lead formate	811-54-1	$Pb(CHO_2)_2$	Reagent in analytical determinations
Lead hydroxide	19783-14-3	$Pb(OH)_2$	Lead salts, lead dioxide
Lead iodide	10101-63-0	PbI_2	Bronzing, printing, photography, cloud seeding
Lead linoleate	16996-51-3	$Pb(C_{18}H_{31}O_2)_2$	Medicine, drier in paints and varnishes

Compound*	CAS Number	Chemical Formula or Description	Uses
Lead maleate, tribasic	—	$C_4H_6O_5 \cdot Pb$	Vulcanizing agent for chlorosulfonated polyethylene, highly basic stabilizer with high heat stability in vinyls
Lead molybdate	10190-55-3	$PbMoO_4$	Analytical chemistry, pigments
Lead α - naphthalenesulfonate	—	$Pb(C_{10}H_7SO_3)_2$	Organic preparations
Lead naphthenate	61790-14-5	$C_{14}H_{22}O_4Pb$	Paint and varnish drier, wood preservative, insecticide, catalyst for reaction between unsaturated fatty acids and sulfates in the presence of air, lube oil additive
Lead nitrate	10099-74-8	$Pb(NO_3)_2$	Lead salts, mordant in dyeing and printing calico, matches, mordant for staining mother of pearl, oxidizer in the dye industry, sensitizer in photography, explosives, tanning, process engraving, and lithography
Lead oleate	1120-46-3	$[CH_3(CH_2)_7CH{:}CH(CH_2)_7COO]_2Pb$	Varnishes, lacquers, paint drier, high-pressure lubricants
Lead oxide, red	1314-41-6	Pb_3O_4	Storage batteries, glass, pottery, enameling, varnish, purification of alcohol, packing pipe joints, metal-protective paints, fluxes and ceramic glazes
Lead phosphate	7446-27-7	$Pb_3(PO_4)_2$	Stabilizing agent in plastics
Lead phosphate, dibasic	—	$PbHPO_4$	Imparting heat resistance and pearlescence to polystyrene and casein plastics
Lead phosphite, dibasic	15845-52-0	$2PbO{\cdot}PbHPO_3 \bullet 1/2H_2O$	Heat and light stabilizer for vinyl plastics and chlorinated paraffins. As a UV screening and antioxidizing stabilizer for vinyl and other chlorinated resins in paints and plastics
Lead phthalate, dibasic	—	$C_6H_4(COO)_2Pb \bullet PbO$	Heat and light stabilizer for general vinyl use
Lead resinate	9008-26-8	$Pb(C_{20}H_{29}O_2)_2$	Paint and varnish drier, textile waterproofing agent
Lead salicylate	—	$Pb(OOCC_6H_4OH)_2 \bullet H_2O$	Stabilizer or costabilizer for flooring and other vinyl compounds requiring good light stability
Lead sesquioxide	1314-27-8	Pb_2O_3	Ceramics, ceramic cements, metallurgy, varnishes
Lead silicate	11120-22-2	$3PbO \bullet SiO_2$	Ceramics, fireproofing fabrics
Lead silicate, basic	—	A pigment made up of an adherent surface layer of basic lead silicate and basic lead sulfate cemented to silica	Pigment in industrial paints
Lead silicochromate	11113-70-5	A yellow lead-silicon pigment	Normal lead silicon chromate is used as a yellow prime pigment for traffic marking paints. Basic lead silicon chromate is used as a corrosive inhibitive pigment for metal protective coatings, primers, and finishers. Also for industrial enamels requiring a high gloss
Lead sodium thiosulfate	—	$PbS_2O_3 \bullet 2Na_2S_2O_3$	Matches
Lead stannate	12036-31-6	$PbSnO_3 \bullet 2H_2O$	Additive in ceramic capacitors, pyrotechnics
Lead stearate	52652-59-2	$Pb(C_{18}H_{35}O_2)_2$	Varnish and lacquer drier, high-pressure lubricants, lubricant in extrusion processes stabilizer for vinyl polymers, corrosion inhibitor for petroleum, component of greases, waxes, and paints

Compound*	CAS Number	Chemical Formula or Description	Uses
Lead subacetate	1335-32-6	$2Pb(OH)_2 \cdot Pb(C_2H_3O_2)_2$	Decolorizing agent (sugar solutions, etc.)
Lead suboxide	—	Pb_2O	In storage batteries
Lead sulfate	7446-14-2	$PbSO_4$	Storage batteries, paint pigments
Lead sulfate, basic	—	$PbSO_4PbO$	Paints, ceramics, pigments
Lead sulfate, blue basic	—	Composition: Lead sulfate (min) 45%, lead oxide (min) 30%, lead sulfide (max) 12%, lead sulfite (max) 5%, zinc oxide 5%, carbon and undetermined matter (max) 5%	Components of structural-metal priming coat paints, rust-inhibitor in paints, lubricants, vinyl plastics, and rubber products
Lead sulfate, tribasic	—	$3PbO \cdot PbSO_4 \cdot H_2O$	Electrical and other vinyl compounds requiring high heat stability
Lead sulfide	1314-87-0	PbS	Ceramics, infrared radiation detector, semi-conductor, ceramic glaze, source of lead
Lead telluride	1314-91-6	PbTe	Single crystals used as photoconductor and semiconductor in thermocouples
Lead tetraacetate	546-67-8	$Pb(CH_3COO)_4$	Oxidizing agent in organic synthesis, laboratory reagent
Lead thiocyanate	592-87-0	$Pb(SCN)_2$	Ingredient of priming mix for small-arms cartridges, safety matches, dyeing.
Lead titanate	12060-00-3	$PbTiO_3$	Industrial paint pigment
Lead tungstate	7759-01-5	$PbWO_4$	Pigment
Lead vanadate	10099-79-3	$Pb(VO_3)_2$	Preparation of other vanadium compounds, pigment
Lead zirconate titanate	12626-81-2	$PbTiZrO_3$	Element in hi-fi sets and as a transducer for ultrasonic cleaners, ferroelectric materials in computer memory units
Litharge	1317-36-8	PbO	Storage batteries, ceramic cements and fluxes, pottery and glazes, glass, chromium pigments, oil refining, varnishes, paints, enamels, assay of precious metal ores, manufacture of red lead, cement (with glycerol), acid-resisting compositions, match-head compositions, other lead compounds, rubber accelerator

Source: Reference 15

* Some of the lead compounds listed in this table are stated as being used in paints and other coating materials. It should be noted that the use of lead compounds in paints and other coating materials has been restricted by various regulations. Nowadays, the major uses of lead-based paints and other coating materials are as metal primers in automobile refinishing; as anti-corrosive undercoatings in the automobile industry; in public works applications (such as bridges and roads, for example); in traffic paints; in art materials; and in marine applications (such as boats and buoys).

4.1.2 Lead Oxides

Lead oxide is a general term and includes lead monoxide or "litharge" (PbO); lead tetraoxide or "red lead" (Pb_3O_4); and black or "gray" oxide, which is a mixture of 70 percent lead monoxide and 30 percent metallic lead. Litharge is used primarily in the manufacture of various ceramic products. Because of its electrical and electronic properties, litharge is also used in capacitors and electrophotographic plates, as well as in ferromagnetic and ferroelectric materials. It is also used as an activator in rubber, a curing agent in elastomers, a sulfur removal agent in the production of thiols and in oil refining, and as an oxidation catalyst in several organic chemical processes. It also has important markets in the production of many lead chemicals, dry colors, soaps (i.e., lead stearate), and driers for paint. Another important use of litharge is the production of lead salts, particularly those used as stabilizers for plastics, notably polyvinyl chloride materials (16).

Lead tetraoxide (Pb_3O_4) or red lead is a brilliant orange-red pigment. It is used as a pigment in anticorrosion paints for steel surfaces. It is also used in lead oxide pastes for tubular storage batteries, in ballistic modifiers for high-energy propellants, in ceramic glazes for porcelain, in lubricants for hot pressing metals, in radiation-shielding foam coatings in clinical x-ray exposure, and in rubber adhesives for roadway joints (14). Black lead is made for specific use in the manufacture of lead acid storage batteries (16). Lead dioxide (PbO_2) is a brownish, black powder. Because of its strong oxidizing properties, it is used in the manufacture of dyes and to control burning in incendiary fires. It is also used as a curing agent for liquid polysulfide polymers and low molecular weight butyl and polyisopropane (17). Lead titanate ($PbTiO_3$) and lead zirconate ($PbZrO_3$) are two lead oxides that are frequently mixed, resulting in highly desirable piezoelectric properties that are used in high-power acoustic radiating transducers, hydrophones, and specialty instruments (18).

4.1.3 Lead Sulfides

Lead sulfide (PbS) or galena is one of the most common lead minerals, appearing black and opaque. It is an efficient heat conductor and has semiconductor properties, making it desirable for use in photoelectric cells. Lead sulfide is used in ceramics, infrared radiation detectors, and ceramic glaze (18,19).

4.1.4 Lead Salts

Many lead salts are colored and, therefore, are used commercially as pigments. Basic lead carbonate ($Pb(OH)_2 \cdot 2PbCO_3$), basic lead sulfate ($Pb(SO_4) \cdot PbO$), and basic lead silicates ($3PbO \cdot SiO_2$) are well known white pigments. Basic lead carbonate is used as a component of ceramic glazes, as a curing agent with peroxides to form improved polyethylene wire insulation, as a color-changing component of temperature-sensitive inks, as a component of lubricating greases, and as a component of weighted nylon-reinforced fish nets made of polyvinylchloride (PVC) fibers (14). Basic lead sulfate helps provide efficient, long-term, economic heat stability to flexible and rigid PVC. In neat form lead sulfate can be dispersed easily and has excellent electrical insulation properties. It is also an effective activator for azodicarbonamide blowing agents for vinyl foams (14). Basic lead silicates are used by the glass, ceramic, paint, rubber, and plastics industries. Lead monosilicate ($3PbO \cdot 3SiO_2$) is used in formulating lead-bearing glazes for the ceramics industry and as a source of PbO in the glass industry. Lead bisilicate ($PbO \cdot O \cdot O_3Al_2O_3 \cdot 1.95SiO_2$) was developed as a low solubility source of lead in ceramic glazes for foodware. Tribasic lead silicate ($3PbO \cdot SiO_2$) is used primarily by glass and frit producers (14).

Lead chromates (e.g., $PbCrO_4$), are orange or yellow in color and, as such, are used frequently as orange and yellow pigments (15). Lead borates [$Pb(BO_2)_2H_2O$], germanates ($PbO \cdot GeO_2$), and silicates ($PbO \cdot SiO_2$) are glass-forming compounds that impart unique properties to glasses, enamels, glazes, and other ceramics. Other salts are used as stabilizers for plastics and rubbers, explosives, and in electroplating (14, 15).

Section 4.2 Overview of Production and Use

Lead is obtained in one of two ways: either by primary production through mining of ores or secondary production through recycling. According to the U.S. Bureau of Mines, the 2016 domestic production of recoverable lead from lead ores was 346,000 tons, or 26 percent of the total lead produced domestically. The 2016 quantity of domestic refined lead recovered from lead scrap was 1,000,000 tons, or 74 percent of the total lead produced domestically (33). In 2016, domestic lead ore mining in the United States accounted for about 7 percent of the total amount of the world mined production of lead for that year. China accounted for about 50 percent of the world's mined production of lead in 2016. Other major lead ore producing countries include Australia, Peru, Russia, Mexico, India, Sweden, Bolivia, and Turkey (33).

Most of the lead ore mined in the United States comes from Alaska and the “lead-belt” in southeast Missouri. The recoverable lead mine production from Alaska and Missouri was about 92 percent of the total lead mine production in the United States in 1999. Lead is also mined in Idaho, Montana, New York, and Tennessee. In these states, lead is recovered from lead, zinc, lead-zinc, and silver ore deposits (20). Lead ore is mined underground except when it is mined with copper ores, which are typically mined in open pits. The lead content of ores typically ranges from 3 to 8 percent, and the lead is usually in the form of a lead compound. The ores are extracted and beneficiated to produce a lead ore concentrate of 55 to 70 percent lead. Once dried, the lead-ore concentrates are shipped to primary lead smelter/refinery plants for further processing. Lead ore concentrates are processed at primary lead smelter/refinery plants to produce lead metal or alloys. Primary lead has not been produced in the United States since 2013. Of the 346 tons of concentrate produced in 2015, 341 tons were exported outside the U.S. (34).

Lead is among the most recycled nonferrous metals in the world. Secondary production (from recycled materials) accounts for 100 percent of domestic lead production (34). Secondary lead smelters and refineries recover and refine metal from lead-bearing scrap materials and residues to produce lead and lead alloy ingots, lead oxide, and lead pigments. In 2015, about 93 percent of recycled scrap was from lead-acid batteries (34). Secondary lead smelting and refining generally falls under NAICS code 331492 (SIC code 3341). In 2016, 1,490,000 tons of lead were consumed by product manufacturing sectors in the United States. Figure 4-1 shows the various manufacturing sectors consuming lead in 1999 (34).

As shown in Figure 4-1, the manufacture of storage batteries (SIC code 3691 [NAICS code 335911]) is the major end use of lead (accounting for 86 percent of domestic lead use). About 50 percent of the total storage battery consumption is for manufacturing battery posts and grids, and 50 percent was for manufacturing lead oxides used in battery paste (34). The manufacture of ammunition (SIC code 3482 [NAICS code 332992]) is the next largest use of lead, accounting for about 6 percent of the total domestic lead consumption in 2015. Ammunition and ordnance detonation may be sources of lead being otherwise used at facilities and air emissions. The manufacture of casting materials accounted for 1 percent of total lead consumption in 2015. Numerous other product types accounted for less than 1 percent of total lead consumption (34).

Table 4-5 and Table 4-6 provide summaries of the facilities filing EPCRA section 313 reports for lead and lead compounds, respectively, in reporting year 2017.

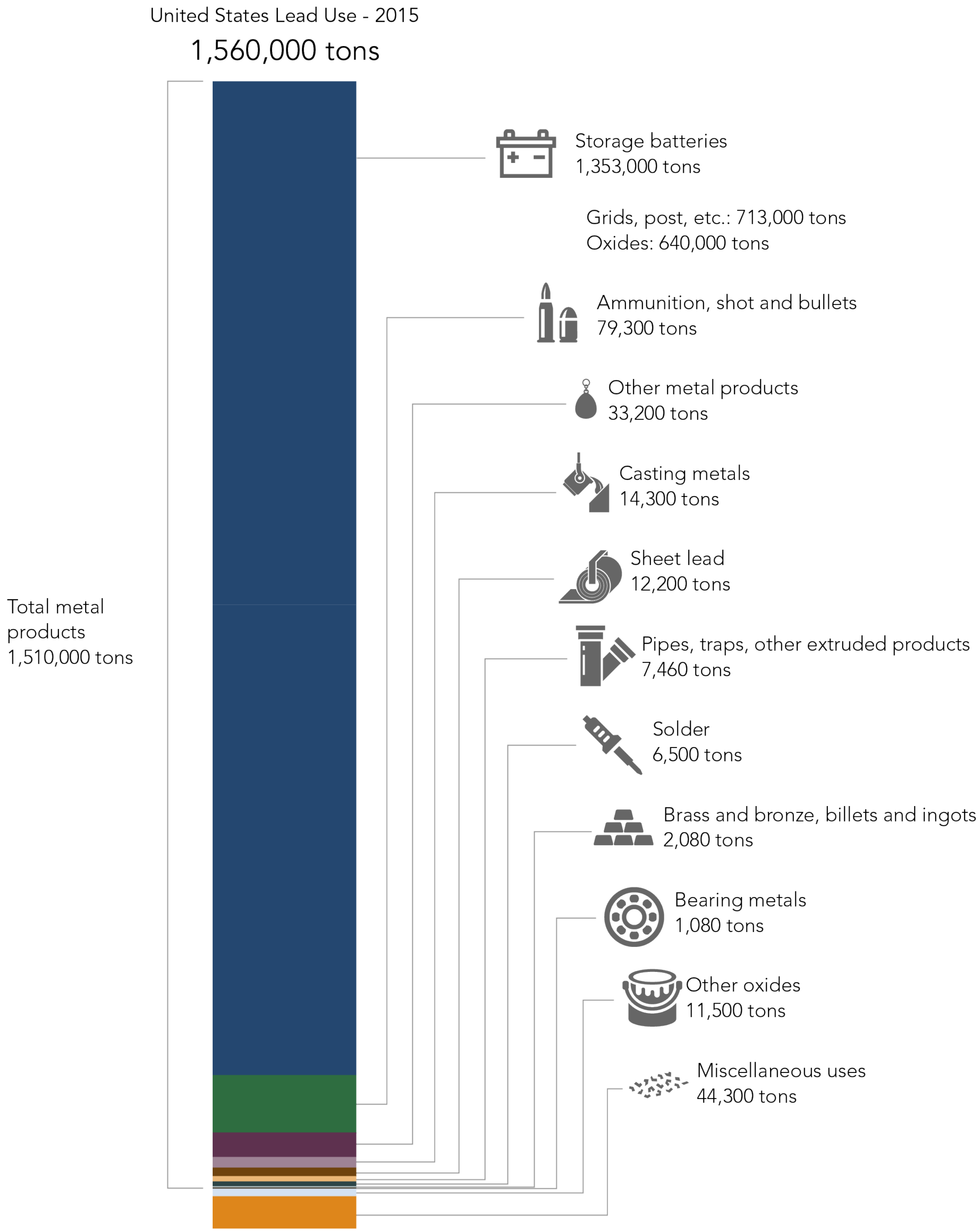

Figure 4-1: Usage of Lead in the United States in 2015

Source: Reference 34.

Table 4-5: Summary of TRI Reporting for Lead, 2017

Industry	Number of Facilities	Number of Form R Reports	Number of Form A Reports	Total Releases (Section 8.1) in pounds[1]	Total Production-Related Waste Managed (Sections 8.1-8.7) in pounds[2]
2121 Coal Mining	14	14	0	513,677	514,846
2122 Metal Mining	1	1	0	8	8
2211 Electric Utilities	14	14	0	95,022	101,214
311 Food	10	10	0	1,250	1,250
3122 Tobacco	1	1	0	—	28,000
313 Textiles	1	1	0	393	393
314 Textile Product	3	3	0	8,059	291,098
316 Leather	1	1	0	—	—
321 Wood Products	99	99	0	9,123	98,586
322 Paper	55	55	0	13,156	17,278
323 Printing	6	6	0	2,544	4,263
324 Petroleum	80	80	0	8,454	20,594
325 Chemicals	88	86	2	35,738	71,859
326 Plastics and Rubber	34	34	0	956	571,190
327 Nonmetallic Mineral Product	906	890	17	72,215	87,229
331 Primary Metals	472	472	1	2,084,524	72,152,755
332 Fabricated Metals	776	774	6	193,480	16,430,759
333 Machinery	281	279	2	8,292	772,101
334 Computers and Electronic Products	353	351	2	10,923	446,611
335 Electrical Equipment	150	150	0	562,838	54,301,275
336 Transportation Equipment	303	305	0	23,041	2,272,200
337 Furniture	34	34	0	2,390	40,783
339 Miscellaneous Manufacturing	55	56	0	6,896	758,560
4246 Chemical Wholesalers	4	4	0	221	221
4247 Petroleum Bulk Terminals	30	30	0	91	573
511 Publishing	1	1	0	0	68,802
562 Hazardous Waste	67	67	0	6,962,109	7,910,819
Other	321	375	1	2,651,705	3,943,505
Total	**4,160**	**4,193**	**31**	**13,267,107**	**160,906,772**

Source: TRI 2017 data

[1] Section 8.1 Releases represents the quantity of the toxic chemical released due to production-related events by the facility to all environmental media both on and off site during the calendar year.

[2] Total Production-Related Waste represents the sum of total waste managed (i.e., recycled on and off site, energy recovery on and off site, treated on and off site, and quantities released on and off site in sections 8.1-8.7). Given metals and metal compounds cannot be managed as waste via treatment for destruction or energy recovery, this total reflects only Section 8.1 releases and Sections 8.4 and 8.5 recycling.

Table 4-6: Summary of TRI Reporting for Lead Compounds, 2017

Industry	Number of Facilities	Number of Form R Reports	Number of Form A Reports	Total Releases (Section 8.1) in pounds[1]	Total Production Related Waste Managed (Sections 8.1-8.7) in pounds[2]
2121 Coal Mining	10	10	0	325,910	325,910
2122 Metal Mining	76	77	0	913,882,346	916,650,419
2211 Electric Utilities	319	320	0	4,063,769	4,093,536
311 Food	37	41	0	32,415	32,681
3121 Beverages	1	1	0	2	2
3122 Tobacco	1	1	0	—	—
313 Textiles	11	11	0	2,416	2,495
314 Textile Product	4	4	0	222	520
321 Wood Products	160	163	0	18,034	22,705
322 Paper	150	151	0	299,050	312,108
323 Printing	3	3	0	15	2,619
324 Petroleum	184	188	0	180,794	263,974
325 Chemicals	249	250	0	1,945,721	2,145,382
326 Plastics and Rubber	115	115	0	24,045	2,749,742
327 Nonmetallic Mineral Product	1,042	1,048	0	348,029	5,803,180
331 Primary Metals	384	384	0	24,187,912	168,161,391
332 Fabricated Metals	309	309	0	631,971	20,488,265
333 Machinery	45	45	0	38,307	1,486,466
334 Computers and Electronic Products	168	168	0	286,533	465,072
335 Electrical Equipment	94	94	0	608,501	140,746,651
336 Transportation Equipment	73	73	0	338,624	837,645
337 Furniture	8	8	0	861	1,115
339 Miscellaneous Manufacturing	15	15	0	2,102	126,130
4246 Chemical Wholesalers	6	6	0	8	8
4247 Petroleum Bulk Terminals	174	176	0	5,103	5,110
562 Hazardous Waste	79	80	0	9,714,785	36,286,634
Other	108	122	0	2,868,176	20,172,446
Total	**3,825**	**3,863**	**0**	**959,805,652**	**1,321,182,207**

Source: TRI 2017 data

[1] Section 8.1 Releases represents the quantity of the toxic chemical released due to production-related events by the facility to all environmental media both on and off site during the calendar year.

[2] Total Production-Related Waste represents the sum of total waste managed (i.e., recycled on and off site, energy recovery on and off site, treated on and off site, and quantities released on and off site in sections 8.1-8.7). Given metals and metal compounds cannot be managed as waste via treatment for destruction or energy recovery, this total reflects only Section 8.1 releases and Sections 8.4 and 8.5 recycling.

Section 4.3 Lead in Raw Materials

Raw materials involved in activities at a wide variety of facilities may contain metallic lead or lead compounds. Lead is present as a trace constituent in many metal ores, including zinc, copper, gold, silver, and molybdenum ores. Lead is also a trace constituent in fuels such as coal, oil, or wood that is processed or otherwise used by many facilities. Because lead is present as a trace constituent in crude oil, it can also be found in many products derived from oil such as heating oils and gasolines.

Table 4-7 lists some typical concentrations of lead in these types of raw materials and the corresponding quantity of material needed to meet the 100 pound threshold. Note that lead concentrations in metal ores vary from mine to mine and in oil-based products by the source of the crude oil and the specific manufacturer of the products. Note also that Table 4-7 is not comprehensive—lead and lead compounds may be contained in many other raw materials for many other processes.

Facilities should use the best readily available information that is applicable to their operations. For purposes of TRI reporting, the lead concentration in the raw materials used at a particular site should be used in threshold and release and other waste management calculations when such concentrations are known, rather than the common lead concentrations shown in Table 4-7. In the absence of site-specific information, EPA recommends that you contact your supplier or an applicable trade association to determine whether lead concentration data is available for the raw materials you use. In the absence of such data, EPCRA section 313 allows a reporting facility to make a reasonable estimate (42 U.S.C. 11023(g)(2)).

Table 4-7: Typical Concentration of Lead in Raw Materials and Quantity Required to Meet the 100 Pound Reporting Threshold

Raw Material	Concentration Lead (ppmw)	Reference[1]	Quantity Needed to Meet the 100 Pound Lead Threshold
Copper ores	11,000	3	9,090 lb
Lead and zinc ores	24,000	3	4,170 lb
Gold ores	6.60	3	1.52×10^7 lb
Bituminous coal[2]	3 to 111	23	3.33×10^7 to 9.01×10^5 lb
Subbituminous coal[2]	2.07 to 31	23	4.83×10^7 to 3.23×10^6 lb
Lignite coal[2]	3.73 to 9.8	23	2.68×10^7 to 1.02×10^7 lb
Wood	20	4	5.00×10^6 lb
Crude oil	0.31	3	4.30×10^7 gallons[4]
No. 2 fuel oil[3]	0.50	3	2.82×10^7 gallons[4]
No. 6 fuel oil[3]	1	3	1.27×10^7 gallons[4]
Gasoline	0.079	3	2.10×10^8 gallons[4]
Aviation gas	1,750	3	9.25×10^3 gallons[4]
JP-4	<3	24	$>5.12 \times 10^6$ gallons[4]
Natural gas	<0.05 mg/m^3	25	$>9.08 \times 10^8$ m^3

[1] Numbers correspond to the references listed in Section 6.0.
[2] These ranges were obtained from the EPCRA section 313 Industry Guidance for Electric Generating Facilities (https://ofmpub.epa.gov/apex/guideme_ext/f?p=guideme:gd-list) which should be consulted to obtain the appropriate concentration for a particular coal type from a particular state.
[3] Constituents are most likely metal compounds rather than elemental lead. Lead is listed in this table because concentration data are for only the metal occurring in the fuel. Concentrations for metal compounds would be somewhat higher depending on the metal compound.
[4] Assumes the following densities: Crude Oil - 7.5 lb/gallon; No. 2 Fuel Oil - 7.1 lb/gallon; No. 6 Fuel Oil - 7.9 lb/gallon; Gasoline - 6.0 lb/gallon; Aviation Gas - 6.2 lb/gallon; JP-4 - 6.5 lb/gallon.

Coal and oil are common fuel sources at many facilities covered under EPCRA section 313, and are used especially for electric power generation. Section 4.5 discusses combustion of lead- containing fuels in more detail. Oil feedstocks (including No. 2 fuel oil and No. 6 fuel oil) are processed through carbon black production facilities and petroleum bulk stations and terminals.

Section 4.4 Recovery, Recycle, and Reuse of Lead and Lead Compounds

The manufacture and subsequent processing of lead may result from a facility's lead recovery activities. A facility may recover lead from batteries, dismantled equipment, or from scrap and industrial wastes using a thermal or chemical extractive process. Major sources of recycled or recovered lead include scrap batteries and wastes and sludges from electrolytic refining plants.

Secondary smelting operations recover lead for reuse or sale. For EPCRA section 313 reporting, it is important to note that the process of melting metals releases metals to the environment and that EPA has not yet promulgated regulations defining waste management activities such as recycling. The following paragraphs provide some guidance on these topics.

Melting of a metal can cause it to be released into the environment. When in a molten state the most common forms in which the metal can be released are vapors and particulates from handling and heating raw materials, and refining operations. Lead and lead compounds may be present in a raw material and may be found in fumes and dust that evolve from heating and refining operations that involve the raw material. EPA does not have a regulatory definition of a fume or a dust, but considers dusts, for the purposes of reporting, to consist of solid particles generated by any mechanical processing of materials including crushing, grinding, rapid impact, handling, detonation, and decrepitation of organic and inorganic materials such as rock, ore, and metal. Dusts do not tend to flocculate except under electrostatic forces. A fume is an airborne dispersion consisting of small solid particles created by condensation from the gaseous state, in distinction to a gas or vapor. Fume arises from the heating of solids. The condensation is often accompanied by a chemical reaction, such as oxidation. Fumes flocculate and coalesce. [Q&A 302 in Reference 1 provides more detail on fumes and vapors.]

In the past, there has been some difficulty in determining the difference between recycling and reuse. According to EPA's document *Interpretations of Waste Management Activities: Recycling, Combustion for Energy Recovery, Treatment for Destruction, Waste Stabilization and Release (August 1999)*, recycling is defined as: (1) the recovery for reuse of a toxic chemical from a gaseous, aerosol, aqueous, liquid, or solid stream; or (2) the reuse, or the recovery for reuse of a toxic chemical that is a RCRA hazardous waste or is a constituent of a RCRA hazardous waste as defined in 40 CFR 261. EPA considers the direct recirculation of a toxic chemical within a process or between processes without any reclamation to be "reuse" of the toxic chemical rather than recycling. The direct use, direct further use, or direct reuse of the toxic chemical is not recycling provided that there is no reclamation of the chemical prior to that continued use or reuse (26).

Pursuant to the Pollution Prevention Act (PPA) of 1990, facilities must report the quantities of toxic chemicals released, treated for destruction, combusted for energy recovery and recycled (42 U.S.C. 13106(b)). EPA has not yet promulgated regulations defining these waste management activities. EPA considers toxic chemicals "recycled" when the toxic chemicals are recovered for reuse. If toxic chemicals are directly reused, without any intervening reclamation or recovery steps, the toxic chemicals are not considered recycled for Form R reporting purposes. That is, direct reuse is not a reportable activity. Reclamation or recovery would not include simple phase changing of the toxic chemical before further reuse (e.g., simple remelting of scrap metal). A reclamation and recovery step, however, would include changing the relative amounts of the chemicals in an alloy. A recovery step would include removing toxic chemicals from a pollution control device or removing contaminants from the toxic chemical after it has been used and can no longer be used for its intended purpose.

Accordingly, if the scrap metal is not mixed with other scrap and can be remelted and directly reused, without any recovery steps, then the toxic chemicals in the scrap metal are being directly reused.

Facilities should use their best available information in determining if the scrap sent off site is being directly reused or, instead, is recycled because of an intervening reclamation or recovery step prior to reuse.[2] In the absence of such readily available data, EPCRA section 313 permits a reporting facility to make a reasonable estimate. For documentation requirements facilities should refer to 40 CFR section 372.10, which addresses the EPCRA section 313 recordkeeping requirements.

Section 4.5 Combustion of Fuels Containing Lead

As mentioned in Section 2.1.1 of this document, fuels (e.g., coal or oil) contain trace quantities of some EPCRA section 313 chemicals, including lead and lead compounds, as impurities.

All EPCRA section 313 chemicals contained in fuels combusted for energy production are considered otherwise used (40 CFR 372.3). Thus, the amount of lead and lead compounds present in the fuel must be included in the otherwise use threshold. Lead may be present in the fuel either in its elemental form [i.e., lead metal (Pb^0)] or as a lead compound. In the absence of any other data, EPA recommends assuming elemental lead (Pb^0) is present in the fuel.

Additionally, during combustion processes it is expected that lead is converted to various lead compounds (e.g., lead oxides). EPA considers this to be "coincidental manufacture" of lead compounds. Therefore, the amount of lead compounds generated from fuel combustion must be applied to the 100 pound manufacturing threshold (40 CFR 372.3). Recall that lead and lead compounds are separately listed substances, and threshold calculations should be made for them separately. Unless facilities have information to indicate otherwise, EPA recommends they assume that they manufacture lead monoxide (PbO) during combustion, and that 100% of the lead portion of the lead or lead compounds in the fuel is converted to PbO (e.g., the lowest molecular weight lead oxide). The amount of metal compound manufactured is determined by the total weight of the compound, not by the parent metal (40 CFR 372.25(h)). To summarize the EPCRA considerations for lead and lead compounds when combusting fuels, if you burn fuels (e.g., coal or oil) on site you must consider, for purposes of complying with section 313 of EPCRA: 1) the otherwise use of the lead present in the fuel; and 2) the manufacture of any lead compound(s) that are formed from the combustion. These considerations are illustrated in the example on combusting fuels in Section 2.1.1.

[2] Memorandum dated June 21, 2001, from John Dombrowski, US EPA, Toxics Release Inventory Program Division, Washington DC, to Mr. Stephen J. Axtell of Thompson Hine & Flory, LLP, Dayton, Ohio.

SECTION 5.0 RELEASE AND OTHER WASTE MANAGEMENT CALCULATIONS

The release and other waste management calculations provided in this section demonstrate some available techniques you can use to calculate your facility's releases and other waste management quantities of lead and the lead portion of lead compounds. You should determine the best information available for your operation and decide which calculation method works best for you.

Section 5.1 Lead and Lead Compound Air Emissions

In lieu of actual test data, the use of process-specific air emissions factors is the most common way to estimate the amount of lead released to air. If your process uses an air pollution control device, you can use its capture and control efficiency to determine the quantity of point source emissions.

Depending on the type of device, the controlled lead air emissions may become part of a wastewater stream (e.g., lead collected in scrubber wastewater) or baghouse dust. Sources of air emissions factors include U.S. EPA's Compilation of Air emissions factors, AP-42 (27) and Web Factor Information Retrieval (WebFIRE) Data System (28), the California Air Resources Board's Air Toxics Database (29), and chemical- and industry-specific factors determined by trade associations, and other factors published in the literature. In your consideration of air emissions, keep in mind the activity use exemption (40 CFR 372.38(c)) that makes an allowance for chemicals contained in intake air.

One example of industry-specific air emissions factors determined by a trade association can be found in the *Ferrous Foundry Air Emissions Study - Final Report* (30). This report describes the development of an industry-specific database that can be downloaded from the Internet to assist facilities in estimating air emissions of Hazardous Air Pollutants, many of which are reportable as EPCRA section 313 chemicals or chemical categories. As always, for purposes of TRI reporting, if you have other means of estimating air emissions that are more applicable to your operations, they should be used in place of generally-available air emissions factors.

In May 1998, the U.S. EPA Office of Air Quality Planning and Standards published *Locating and Estimating Air Emissions From Lead and Lead Compounds* (EPA-454/R-98-006) (2). This document (referred to as the L&E document below) identifies most of the major industrial process sources of lead air emissions (for all processes listed in Table 5-1), and provides descriptions of these processes and the associated lead emissions factors. Facilities that must report lead air emissions under the TRI Program are encouraged to use the L&E document. This document is similar to the *Compilation of Air Emissions Factors* (AP-42) but focuses only on lead air emissions.

Emissions factors discussed in AP-42 and the L&E document are also contained in U.S. EPA's WebFIRE Data System (28). The WebFIRE Data System is a database of EPA-developed emissions factors; it lists only the emissions factors whereas the *Compilation of Air Emissions Factors* (AP-42) and the L&E document provide written descriptions of the processes for which each emissions factor was developed, in addition to presenting the emissions factors. To prepare this TRI guidance document, the WebFIRE Data System was searched and all emissions factors for lead were extracted. These emissions factors are shown in Appendix C. Readers already familiar with the use of emissions factors may find the factors they need in Appendix C, while readers not as familiar with emissions factors should consult AP-42 and/or the L&E document (rather than Appendix C alone) to read the process descriptions and basis of each emissions factor. Appendix C also contains lead emissions factors contained in the California Air Resources Board's Air Toxics Database (29). Note that EPA periodically updates AP-42 and the WebFIRE Data System as additional data become available. You should refer to EPA's Internet site for the Clearinghouse for Inventories and Emission Factors (CHIEF) for updates to these documents and development of new air emission source materials (https://www.epa.gov/chief).

The following example shows how to calculate lead air emissions using an emissions factor.

Example 4: Point Source Emission Estimate Using an Emission Factor

Your facility uses 100 million gallons of No. 6 fuel oil to generate electricity during the reporting year. You have determined that you exceeded the 100 pound reporting threshold for lead and must calculate all releases and other waste management activity quantities.

After evaluating your options, you decide to use a WebFIRE Data System emissions factor for your calculation for uncontrolled lead air emissions from your boiler (0.00151 lb lead/1,000 gal No. 6 fuel oil).

Amount of lead air emissions:

100,000,000 gal No. 6 fuel oil/yr × (0.00151 lb lead emitted/1,000 gal No. 6 fuel oil)

= 151 lb lead emitted/yr

If you do not have any controls on the boiler, you should report this amount in Part II, Sections 5.2 (Stack or Point Air Emissions) and 8.1 (Quantity Released) of the Form R. If you have emissions controls on your boiler, the amount controlled (if known) should be subtracted from this amount and reported as appropriate depending on the ultimate disposition of the collected waste material. Note that emissions control activities should be reflected in Section 7A of the Form R.

Fuel combustion activities and other heated processes that process or otherwise use lead can generate lead or lead compound emissions. Emissions of lead originate from lead or lead compounds contained in fuels and are emitted during combustion. The lead or lead compounds contained in fuels, and quantities coincidentally manufactured, must be applied toward threshold calculations, and any emissions of lead resulting from combustion of fuels must be included in the release report. During combustion, metals such as lead only change physical state or are converted into a metal compound of the same metal. The metal itself (or metal portion of a metal compound) is never destroyed during combustion. Thus, the amount of lead in the original fuel or waste will be equal to the amount of lead found in the ash and/or emitted in the effluent gas. The type of air emissions control device(s) used at your facility may govern the final destination of the controlled lead (e.g., dust in a baghouse or part of scrubber wastewater).

Table 5-1: Sources of Lead Emissions

Facility/Process Type	Operation Sources of Lead Emissions
Primary and secondary lead smelting	All unit operations
Primary and secondary copper production	Most heated and ore-handling unit operations
Primary zinc smelting	Sintering
Secondary aluminum operations	All unit operations
Coke production	Coal preparation and handling, Fugitive emissions from oven
Iron and steel foundries	Most heated and casting unit operations
Ore mining, crushing, and grinding	Drilling, blasting, loading, conveying, screening, unloading, crushing, and grinding operations
Brass and bronze manufacturing	Most heated unit operations
Combustion of coal, natural gas, oil, or wood	Boiler exhaust gas and bottom and fly ash handling
Municipal waste, industrial, sewage sludge, medical waste, and hazardous waste incinerators	Exhaust stack and bottom and fly ash handling
Other forms of incineration: drum and barrel reclamation, scrap tire incineration and open burning of scrap tires, and crematories	Exhaust stack and bottom and fly ash handling
Pulp and paper industry	Chemical recovery unit operations
Portland cement manufacturing	Raw material handling and kiln exhaust gases

Facility/Process Type	Operation Sources of Lead Emissions
Pressed and blown glass	Raw material blending and transport, melting, and forming and finishing
Lead-acid battery production	Grid casting, lead reclamation, slitting, small parts casting, and three-process operation
Lead oxides in pigments	Exhaust gas
Lead cable coating	Melting kettle
Frit manufacturing	Frit smelting operation
Ceramics and glazes	Glaze firing and spraying phases
Miscellaneous lead products: ammunition, type metal, bearing metals, pipe and sheet lead, and abrasive grain manufacturers	Heated unit operations and dust-handling operations
Solder manufacturing	Lead melting and solder paste production
Electroplating (including printed circuit boards)	Plating process
Stabilizers in resins	Materials (powder) handling
Asphalt concrete (hot mix asphalt)	Drying process (combustion)
Application of paints	Spraying, brushing, dipping, blending, drying, curing
Shooting ranges and explosive ordnance disposal sites	Firing of small arms ammunition with lead projectiles and/or lead primers
Rubber products	Material handling
Fuel production	While being phased out, some fuels still contain lead

Source: U.S. EPA. *Locating and Estimating Air Emissions from Sources of Lead and Lead Compounds*. EPA-454/R-98-006. Office of Air Quality Planning and Standards (OAQPS). May 1998.

U.S. EPA's WebFIRE Data System (28) includes emissions factors for fuel oil and wood combustion. Lead emissions from distillate oil (diesel) combustion can be calculated using an emissions factor of 0.000014 lb/10^{12} BTU (uncontrolled). The average lead emissions factor from No. 6 fuel oil combustion is 0.00151 lb/1,000 gal (uncontrolled). Lead emissions factors for wood and/or bark combustion operations include: 0.0029 lb/ton (uncontrolled); 0.00032 lb/ton (using a mechanical collector as the control device); 0.00035 lb/ton (using a wet scrubber as the control device); and 0.000016 lb/ton (using an electrostatic precipitator as the control device). After determining the quantity of lead released to the air, facilities must also determine the quantity of lead in the bottom ash and collected by the control device (see Section 5.3 for an example).

U.S. EPA's AP-42 (Chapter 15) includes emissions factors related to ordnance detonation. The lead emissions factors for all ammunition are summarized in Table C-3 in Appendix C of this document.

Example 5: Air Emissions from Ordnance Detonation

Your facility has fired 1,000,000 rounds of the M855 5.56-mm ball cartridge ammunition (DODIC A059) during the reporting year. You have determined that you exceeded the 100 pound reporting threshold for lead and must calculate all releases and other waste management activity quantities.

After evaluating your options, you decide to use the AP-42 emissions factor associated with M855 ammunition (see Table C-3) for your calculation for uncontrolled lead air emissions from ordnance detonation.

Amount of lead air emissions:

1,000,000 M855 rounds × (5.1 × 10^{-6} lb lead emitted per round)
= 5.1 lb lead emitted/yr

You should report this amount in Part II, Sections 5.1 (Fugitive or Non-Point Air Emissions) and 8.1 (Quantity Released) of the Form R.

A mass balance calculation using the total amount of lead in the fuel may be used to determine these quantities if you do not have site-specific data. The release, including disposal, of lead in bottom ash or from the control device (e.g., effluent from a wet scrubber) must be reported on the Form R. The following example shows how you can use Table 4-7 and Appendix C to estimate lead emissions from coal combustion.

Example 6: Fugitive Emission Estimate Using a Mass Balance

Your facility manufactures a lead-containing product. Based on purchase and import records, the amount of lead brought on-site totals 200,000 pounds per year. The amount of lead in the final product is calculated to be 198,500 pounds per year.

Your facility wastewater from washdowns, tank cleanings, and scrubber operations is discharged to a POTW. You monitor the wastewater to comply with the POTW pretreatment permit. The concentration of lead in the water is 34.0 mg/L. The volume of water discharged to the POTW during the reporting year is 250,000 gallons.

The amount of lead discharged to the POTW is calculated below:

$$(34.0 \text{ mg/L lead}) \times (250{,}000 \text{ gal water}) \times (3.785 \text{ L/gal}) \times (1 \text{ lb}/453{,}592 \text{ mg}) = 70.9 \text{ lb lead}$$

This quantity should be reported in Part II, Section 6.1 (Discharges to POTWs) and Section 8.1 (Quantity released) of the Form R.

No solid waste sources of lead were identified at your facility; therefore, you assume the remaining quantity of lead is released as fugitive emissions. The lead fugitive emissions are calculated using the following mass balance:

$$[200{,}000 \text{ lb}]_{in} = [198{,}500 \text{ lb} + 70.9 \text{ lb} + \text{fugitive emissions lb}]_{out}$$

$$\text{Fugitive lead emissions} = [200{,}000 - 198{,}500 - 70.9] \text{ lb} = 1{,}429.1 \text{ lb/yr}$$

This quantity should be reported in Part II, Section 5.1 (Fugitive or non-point air emissions) and Section 8.1 (Quantity released) of the Form R. Note that the data precision discussion in Section 1.4.4 states that lead releases should be reported to one-tenth of a pound. In this example, 1,429.1 or 1,429 or 1,430 pounds could all be reported based on the precision of the data available for this calculation.

Lead emissions may also be calculated using monitoring data. For instance, your facility might continuously monitor stack emissions, or data might be available from short-term testing performed at the facility. Engineering calculations, for example Raoult's law, may also be used for calculations.

Mass balances are not typically used to calculate emissions, but can be used if all other quantities (e.g., lead in the final product, released with wastewater, disposed with solid waste) are known, as demonstrated in the above example.

While the preceding discussion focused on the use of emissions factors to calculate estimates of air emissions, emissions factors may not be available for all processes. Emissions factors are generally available for large industrial processes subject to air emission standards. The following example illustrates another way to calculate air emissions using industrial hygiene data.

Example 7: Point Source Emission Estimate Using Industrial Hygiene Data

Your electronic component manufacturing facility applies well over 200 pounds of a 50:50 lead-tin solder to your product, and you have determined that you exceeded the 100 pound reporting threshold for processing lead. You must now calculate all releases and other waste management activity quantities (which likely includes air, water, and solid waste releases, but this example discusses only air emissions). While you do not have an emissions factor available to you for the release of lead from your operation, you have worker exposure data. The OSHA Permissible Exposure Limit (PEL) for lead is 0.05 mg/m^3 on an 8-hour time-weighted average (TWA) basis, and you know from testing performed at your facility that the workers performing the soldering were exposed to lead at a concentration of no more than 0.025 mg/m^3 (TWA basis). From this value, your number of soldering work stations (assume 5 separate work stations for this example), your soldering room ventilation rate (assume an air flow of 28.3 m^3/min [1,000 ft^3/min] through a dedicated but uncontrolled exhaust system at each work station for this example) and your soldering process hours of operation (assume 24 hours/day, 7 days/week, and 50 weeks/year for this example), your lead emissions from this soldering process can be calculated.

Time of operation: 60 minutes/hour × 24 hours/day × 7 days/week × 50 weeks/year = 504,000 minutes/year
Amount of lead air emissions:

> 0.025 mg lead/m^3 air × 28.3 m^3 air/min × 504,000 min/year × 1 gram/1,000 mg × 1 lb/454 grams × 5 work stations =
>
> 3.9 lb lead emitted/yr

You should report this amount in Part II, Sections 5.2 (Stack or Point Air Emissions) and 8.1 (Quantity Released) of the Form R.

Note: A study by the School of Public Health at the University of Illinois measured an average of 86 mg/hour for uncontrolled lead emissions from three wave soldering lines. Using the other data provided in the example above (i.e., the same hours of operation and 5 work stations or “lines”), 8.0 lb/yr of lead would be emitted.

Section 5.2 Lead in Wastewater

Wastewater sources of lead include process wastewater and area washdowns and tank clean outs from processes in which lead or lead compounds are manufactured, processed, or otherwise used. If a wet air pollution control device (e.g., scrubber) is used in a process generating lead emissions, lead can be transferred from the air stream to the water stream. This wastewater may be treated on site, discharged to surface water or a POTW, or transferred off site for other waste management activities. In addition to the sources listed above, spills and one-time events may also generate a lead-containing wastewater stream. In your consideration of water releases, keep in mind the otherwise use exemption (40 CFR 372.38(c)) that makes an allowance for chemicals contained in intake water.

If your facility discharges to surface water, you most likely have a NPDES or state discharge permit. This permit may require you to monitor for lead. You can use this information to calculate the amount of lead discharged to surface water. Discharges to POTWs may also require lead monitoring. Table 5-2 shows the industries required to monitor their effluents for lead due to EPA effluent limitations guidelines for lead (31). Monitoring data that are collected to comply with permits or effluent limitations guidelines may be useful for estimating water discharges. Alternatively, if you have not conducted monitoring but a regulatory limit for lead discharges exists, it may be appropriate to use the regulatory limit as a reasonable “worst-case” scenario to estimate your yearly discharges of lead.

Table 5-2: Industries with Effluent Limitations for Lead

The Regulations Are Described at 40 CFR Part	Point Source Category
414	Organic Chemicals, Plastics and Synthetic Fibers
415	Inorganic Chemicals Manufacturing
420	Iron and Steel
421	Non-Ferrous Metals Manufacturing
426	Glass Manufacturing
428	Rubber Manufacturing
433	Metal Finish
437	Centralized Waste Treatment
440	Ore Mining and Dressing
442	Transportation Equipment Cleaning
444	Waste Combustors
455	Pesticide Chemicals
461	Battery Manufacturing
464	Metal Molding and Casting
466	Porcelain Enameling
468	Copper Forming
469	Electrical and Electrical Components
471	Non-Ferrous Metals Forming and Metal Powders

The example below shows an approach to calculating lead discharges using monitoring information.

Example 8: Lead Discharged to a POTW Using Monitoring Information

Your facility exceeds a lead reporting threshold. Additionally, you are required to perform monitoring for wastewater that is discharged to your local POTW for certain chemicals, including lead, two times each year. The results of the monitoring were:

April 4: 2.0 ppm lead (representative of the six-month period for January through June) October 5: 2.4 ppm lead (representative of the six-month period for July through December)

For the reporting year, the following water volumes were discharged to the POTW:

January through March: 425,000 gal
April through June: 555,000 gal
July through September: 345,000 gal
October through December: 390,000 gal

First, convert the water flows to pounds, using the standard density for water of 8.345 lb/gal:

425,000 gal × (8.345 lb/gal) = 3,546,625 lb for January through March
555,000 gal × (8.345 lb/gal) = 4,631,475 lb for April through June
45,000 gal × (8.345 lb/gal) = 2,879,025 lb for July through September
390,000 gal × (8.345 lb/gal) = 3,254,550 lb for October through December

Using the appropriate lead concentrations measured during the monitoring periods, the amount of lead discharged to the POTW is:

$$[(2 \text{ lb lead} / 1\times 10^6 \text{ lb water}) \times (3{,}546{,}625 + 4{,}631{,}475) \text{ lb water}]_{\text{Jan - June}}$$
$$+ [(2.4 \text{ lb lead} / 1 \times 10^6 \text{ lb water}) \times (2{,}879{,}025 + 3{,}254{,}550) \text{ lb water}]_{\text{Jul – Dec}}$$
$$= 31.1 \text{ lb/yr lead}$$

This quantity should be reported in Part II, Section 6.1 (Discharge to POTW) and included in Part II, Section 8.1 (Quantity Released) of the Form R. Note that the data precision discussion in Section 1.4.4 states that lead releases should be reported to one-tenth of a pound. In this example, 31.1 or 31 lb/yr could be reported based on the precision of the data available for this calculation.

Mass balances and engineering calculations can also be used to determine the amount of lead in the wastewater. If your facility treats wastewater on site, you may need to perform engineering calculations to determine how much lead becomes part of the waste sludge and how much is discharged. In this case, Part II, Section 7 (on-site treatment, energy recovery, and recycling) of the Form R should be completed as appropriate.

Section 5.3 Lead Solid Waste Calculations

Solid wastes that contain lead and lead compounds include dust or solid raw materials spilled during transfer or process operations. Lead contained in a solution, such as petroleum products, may also be splashed or spilled on the ground and, after evaporation or if cleaned with absorbent materials, may result in solid waste generation. Other solid waste sources include sludge from on-site treatment, spent bags or filters from air pollution control devices, and ash from combustion operations. Solid material spills and ash may also contribute to fugitive emissions of particulate matter. The amount of lead in solids is commonly calculated using mass balances from records (such as spill reports and hazardous waste manifests). Monitoring data on sludge may be available, but as mentioned in the previous wastewater section, engineering calculations can be performed to determine the lead content in the sludge.

Facility-specific information, such as waste analyses and process knowledge, can be used to estimate amounts of lead in combustion wastes. In the absence of site-specific data, facilities can use the default values for concentrations of lead in ash presented in Table 5-3.

Table 5-3: Lead Concentration in Ash Combustion Residuals

Combustion Residual	Concentration (ppm)	Reference[1]
Coal Fly Ash	2,120	32
Coal Bottom Ash	1,082	32
Oil Ash	100,000	32

[1] Number corresponds to the references listed in the reference section at the end of this document.

If your facility produces lead-containing wastes, you can use a mass balance to determine the quantity of lead released or otherwise managed as waste. Using facility concentrations, or literature concentrations if facility-specific concentrations are not available, you can determine the quantity of lead processed at your facility from the amount in the raw material. From process and engineering knowledge, the destination of the lead releases and other waste management activity quantities can be determined. The mass balance approach can also be applied to a combustion process where, after determining the quantity of lead released to the air, facilities must also determine the quantity of lead in the bottom ash and collected by the control device(s). A mass balance calculation using the total amount of lead in the fuel may be used to determine these quantities if you do not have site-specific data. The release or waste management of lead in bottom ash or from the control device(s) (e.g., effluent from a wet scrubber) must be reported on the Form R. The following example shows how you can use Table 4-7 and Appendix C to estimate lead emissions from coal combustion.

Example 9: Lead Release and Other Waste Management Calculations from Coal Combustion

Your facility combusts lignite coal in a boiler with a Source Classification Code #10300305, and you have installed an electrostatic precipitator as the air pollution control device for this boiler. You fed 0.5 million tons of lignite coal into the boiler during the reporting year and collected 1.0 million pounds of bottom ash for disposal (note that this example assumes lead is released only to air through a stack, to bottom ash, or to ESP dust whereas other releases such as to wastewater may occur at your site). The task is to determine if a threshold has been exceeded and to estimate the reportable amounts of lead for the applicable sections of the Form R. Assuming you do not have site-specific test data, it may be appropriate to use default values from Table 4-7 to determine the amount of lead in the coal and Table 5-3 to estimate the amount of lead in the bottom ash, and an emissions factor from Appendix C to estimate air releases.

<u>Threshold Determination:</u>
First, you must determine if you exceed a threshold for lead or lead compounds. Any TRI chemical or chemical compounds that are present in fuel are considered to be otherwise used. Table 4-7 lists the average lead concentration in lignite coal as 7 ppm. Therefore:

$$(0.5 \times 10^6 \text{ tons coal}) \times (2{,}000 \text{ lb/ton}) \times (7 \text{ lb lead/ } 1 \times 10^6 \text{ lb coal}) = 7{,}000 \text{ lb lead}$$

This is the amount of elemental lead in the coal. The mass of lead in the coal exceeds 100 lb; therefore, your facility exceeds the otherwise use reporting threshold for lead and you must file a Form R.

<u>Stack Air Release:</u>
EPA's WebFIRE system contains an emissions factor for lead from combustion of lignite coal in a boiler with SCC #10300305 and an ESP (Appendix C): 4.2×10^{-4} pounds of lead are emitted per ton lignite coal burned.

$$(0.5 \times 10^6 \text{ tons coal}) \times (4.2 \times 10^{-4} \text{ lb of lead/ton coal}) = 210 \text{ lb lead}$$

This quantity should be reported in Part II, Section 5.2 (Stack or Point Air Emissions) and included in Section 8.1 (Quantity Released) of the Form R.

<u>Quantities Otherwise Managed as Waste:</u>
The lead that is not emitted is either collected in the ESP dust or contained in bottom ash. You should estimate the amount of lead to each of these waste streams and report the quantities in the applicable sections of the Form R. At your site, you may also collect some or all of these wastes for on-site recycle (Part II Sections 7C and 8.4), or you may transfer them off site (in which case Part II, Section 6.2 and applicable sections of Part II, Section 8 should be completed). Additionally, since the flue gases have been sent through an on-site air pollution control system, Sections 7A and 8.6 (Quantity Treated On Site) should be completed as appropriate.

Based on the default concentration listed in Table 5-3 (1,082 ppm), the quantity of lead in the bottom ash is:

$$(1.0 \times 10^6 \text{ lb bottom ash}) \times (1{,}082 \text{ lb lead/}1 \times 10^6 \text{ pound bottom ash}) = 1{,}082 \text{ lb lead}$$

A mass balance around the boiler can now be used to estimate the amount of lead collected in the ESP dust: (lead in coal) = (lead released to air) + (lead in bottom ash) + (lead in control devices)

$$(7{,}000 \text{ lb lead in coal}) - (210 \text{ lb to air}) - (1{,}082 \text{ lb in bottom ash}) = 5{,}708 \text{ lb lead is ESP}$$

SECTION 6.0 REFERENCES

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APPENDIX A. Additional Information about Stainless Steel, Brass, and Bronze Alloys

The discussions below were excerpted from the EPA document "Report on the Corrosion of Certain Alloys" [EPA report # EPA-260-R-01-002 (July 2001)], which was made available to the public in July 2001. The interested reader should consult this report for additional and more detailed discussions on alloys and for references pertaining to alloys.

A.1 Stainless Steel Alloys

Identification of Stainless Steel Alloys

Stainless steels produced in the United States can be identified in three general ways: (1) by the Unified Numbering System (UNS) numbers developed by the American Society for Testing and Materials (ASTM) and the Society of Automotive Engineers (SAE) for all commercial metals and alloys; (2) by the American Iron and Steel Institute (AISI) numbering system; and (3) by the names based on compositional abbreviations, proprietary designations, and trademarks. The UNS number comprises six symbols (i.e., a letter followed by five numbers) that are difficult to recognize instantly and memorize for the 180 stainless steels. Therefore, technical journals allow each alloy to be initially identified by the lengthy UNS number and then subsequently the better-known AISI or another designation may be used. The AISI number designates the wrought standard grades of stainless steels by three-digit numbers. Three groups of wrought stainless steels, series 200, 300, and 400, have composition limits standardized by the AISI. Steels in the AISI 400 series contain a minimum of 11.5% chromium and usually not more than 2.5% of any other alloying element. Steels in the AISI 300 series contain a minimum of 16% chromium and 6% nickel; the relative amounts of these elements are balanced to give an austenitic structure. Austenitic structures have face-centered cubic lattices, while ferritic structures have body-centered cubic lattices, and martensitic structures have body-centered tetragonal or cubic lattices. Stainless steels containing both austenite and ferrite, usually in roughly equal amounts, are known as duplex. Duplex stainless steels, precipitation-hardening stainless steels, and higher alloys containing less than 50% iron (Fe) do not have AISI designations and are generally known by names based on compositional abbreviations and trademarks as well as UNS numbers.

The many grades of stainless steel are due to the crystal structure of the iron-rich matrix. The austenite field in iron exists over an increasingly small temperature range as chromium is added and disappears at about 12% chromium. To make the martensitic grades, it is important to be able to form 100% austenite first. Fortunately, carbon extends the austenite range so it is possible to have all austenite prior to quenching in a 12% chromium carbon steel, or if the carbon content is high enough, even in a 17% chromium steel. Adding several percent of nickel to an iron-chromium alloy can allow austenite to exist as metastable or stable forms down to ambient temperature. A body-centered cubic phase, or sometimes a hexagonal close-packed phase, can then form martensitically, and can give very high strengths to the stainless steel. For the ferrite grades, it is necessary to have at least 12% chromium and only very small amounts of elements that stabilize austenite. For these materials, the structure is body-centered cubic from room temperature to the melting point. Some elements, such as molybdenum, niobium, titanium, and aluminum, which encourage the body-centered cubic structure, may also be in these steels.

Compositions of some stainless steels are listed in the following table, Table A-1.

Table A-1:Typical Composition of Some Stainless Steels, wt%

(Sulfur (S) and Phosphorus (P) are held below 0.03 and 0.04% max, respectively, balance is Fe)

AISI #	C	Mn	Si	Cr	Ni	Mo	N	Ti	Nb
201	0.15	6.50	0.75	17.0	4.50		0.20		
202	0.15	8.75	0.75	18.0	5.00		0.20		
205	0.12	15.0	0.50	17.0	1.75		0.35		
304	0.06	1.50	0.75	19.0	10.0				
309	0.16	1.50	0.75	23.0	13.5				
310	0.20	1.50	1.00	25.0	20.5				
316	0.06	1.50	0.75	17.0	12.0	2.50			
321	0.06	1.50	0.75	18.0	10.5			0.50	
330	0.08	2.00	1.00	18.0	35.0				
347	0.06	1.50	0.75	18.0	11.0				1.00
410	0.12	0.75	0.75	12.5					
430	0.10	0.75	0.50	16.0	0.30				
446	0.30	1.00	0.75	25.0			0.20		

Classes of Stainless Steel Alloys

There are four major classes of stainless steel: 1) austenitic; 2) martensitic; 3) ferritic; and 4) age-hardened or precipitation-hardening steels. A brief description of each is provided below.

1. ***Austenitic stainless steels***, these are essentially non-magnetic and cannot be hardened by heat treatment. They are hardenable only by cold-working. As a group, these stainless steels have greater corrosion resistance than the other three groups. At the same time, there is a wide range in the corrosion resistance among the austenitic types. Most of these steels contain nickel as the principal austenite former, and some contain substantial amounts, 2-4%, of manganese and less nickel. These steels possess better corrosion resistance than the straight chromium steels. Chromium content is generally between 16-26%, with the nickel content generally between 4-22%. The 300 series represents by far the largest category of stainless steels produced in the United States. For the sake of discussion, the austenitic alloys can be divided into four subclasses.

    Class A: AISI types 301, 302, 303, 304, 304L, 304N, 321, 347, and 348 are all contained within class A. Each of the types in this group can be considered an 18-8 stainless steel (i.e., 18% chromium content and 8% nickel content). Within this class, there is no great difference in the general corrosion resistance of the individual types. Those that have a higher alloy content are slightly more corrosion resistant than those with a lower alloy content. Types 321, 347, and 348 are carbide stabilized with titanium and/or niobium. Although their general corrosion resistance may be no higher than types 302 or 304, they are essentially immune to sensitization and the possible attendant intergranular corrosion under specific conditions.

    Class B: Only types 305 and 384 are contained within class B. These have relatively high nickel contents (12.0% and 15.0%) nominally and respectively. While they both have greater corrosion resistance than the 18-8 steels, they were principally designed for extra-deep drawing and cold heading operations, as allowed by the higher nickel content

Class C: AISI types 302B, 308, 309, 309S, 310, 310S, and 314 are examples of the class C group. Type 302B is a modified 18-8 and has a silicon addition (2.5%) that increases oxidation resistance at elevated temperatures. Type 314 represents a higher alloy version (25% chromium-20% nickel) of an 18-8 steel. It has a silicon addition that is more corrosion resistant, especially to sulfuric acid, than type 302B and also has a high resistance to scaling at elevated temperatures. Types 308, 309, 309S, 310, and 310S are all higher in chromium and nickel and are commonly called 20-11 (20% chromium-11% nickel, type 308), 24-12 (24% chromium-12% nickel, types 309 and 309S) and 25-20 (25% chromium-20% nickel, types 310 and 310S). They have a very high resistance to corrosion and oxidation at elevated temperatures.

Class D: AISI types 316, 316L, 316F, 316N, 317 and 317L are part of this class. They contain at a minimum 16% chromium and at least 2% molybdenum. The ferrite-forming influence of the molybdenum requires an increase in nickel, as an austenite former, to at least 10%. The presence of molybdenum specifically enhances corrosion resistance to chloride pitting and crevice corrosion and also increases general resistance to specific chemicals (e.g., organic acids, amines, phosphoric acid, dilute sulfuric acid).

2. ***Martensitic stainless steels***, these are iron-chromium alloys which are hardened by heat treatment. Heat treatment results in higher strength, with a corresponding proportional diminution of ductility with increasing hardness. Corrosion resistance is less than in the other two groups. In the hardened condition, there may be a greater resistance to general corrosion but there is increasingly less resistance to hydrogen-induced cracking. Martensitic steels can be heat-treated to obtain high tensile strengths. The heat treatment results in higher strengths, with a corresponding proportional diminution of ductility with increasing hardness. Corrosion resistance is less than in the other two groups. In the hardened condition, there may be a greater resistance to general corrosion, but there is increasingly less resistance to hydrogen-induced cracking. Chromium content is generally between 11.5-18% with carefully controlled carbon content. Some of the AISI types that make up this group are 403, 410, 414, 416, 420, 420F, 431, 440A, 440B, and 440C.

   Types 403, 410, and 416 are known as “turbine quality.” Type 403 is virtually identical to type 410, except that it is made from specially processed and rigorously inspected ingots, as is required for steam turbine blades. Both types contain just enough chromium to maintain “stainlessness” (nominally 12.5%), but there are no significant amounts of other alloying elements. Type 416 is simply 410 with the addition of free-machining additives. Although offering improved machining characteristics, there is a sacrifice in corrosion resistance.

   Types 414 and 431 provide better corrosion resistance than type 410, largely because they contain a nominal amount (2.0%) of nickel. These steels have been commonly known as 12-2 (12% chromium-2% nickel) and 16-2 (16% chromium-2% nickel), respectively.

   Types 420 and 420F, despite having a higher chromium content than type 410, do not have an appreciably higher corrosion resistance level. Type 420F is almost identical to type 420, except that there is an addition of sulfur to improve machinability. This results in a slight sacrifice of corrosion resistance.

   Types 440A, 440B, and 440C are all high-carbon stainless steels and are sometimes called “stainless tool steels.” These types have the highest chromium range of any of the martensitic types, yet their corrosion resistance levels are among the lowest because of their higher carbon content. There is a gradual decrease in corrosion resistance from the A to C subtypes. This is due to the increase in carbon content.

3. ***Ferritic stainless steels***, these are nonhardenable steels so designated because they cannot be hardened by heat treatment. They are hardenable only by cold-working. Chromium content is generally between 11.5-27% with low carbon content. Examples of AISI types that make up this group are 405, 409, 429, 430, 430F, 434, 436, 442, and 446. As a group the ferritic stainless steels do not closely approach the austenitic types with respect to corrosion resistance. There are, however, some ferritic types that may nearly equal the corrosion resistance levels of the austenitics in some environments, but these are exceptions. One of the most interesting aspects of this group of stainless steels is their resistance to stress corrosion.

   Type 405, while meeting the minimum requirements for a stainless steel, is actually relatively low in its resistance to corrosion. The carbon level is 0.08% maximum and it has a nominal chromium content of 12.5%. An addition of 0.10 to 0.30% aluminum (a powerful ferritizer) prevents the formation of any appreciable amount of austenite at any temperature. It is thus the ideal grade for welding. Of all the stainless steels, type 409 is generally considered to have the lowest degree of corrosion resistance. It contains very nearly the minimum amount of chromium to qualify as a stainless steel (10.5-11.75%) and is stabilized with titanium.

   Types 430, 430F, 434, and 436 represent the old and well-known 17-chrome stainless steel grade, which is the original type 430. Type 430 shows a high resistance against attack by practically all types of atmospheres and also by many types of chemicals, notably oxidizing acids. At times, type 430 replaces the more expensive 18-8 austenitic types. Type 430F is a machinable grade of type 430. The additives contained in it reduce the corrosion resistance of the basic type 430. Type 434 has the same chromium content as type 430, but it has a nominal 1.0% molybdenum content, which adds greatly to its resistance to certain types of corrosion, notably pitting corrosion. Type 436 is essentially type 434, but it contains up to 0.70% niobium plus tantalum for carbide stabilization. Therefore, it is suited for elevated temperature applications as well as for room-temperature corrosion resistance. Types 442 and 446 are frequently called "chrome-irons." They differ in composition only in chromium content 18.0-20.0% for type 442 and 23.0-27.0% for type 446. Neither is used to any great extent for corrosion resistance at room temperatures. Their principal uses are in heat processing equipment where resistance to scaling is important. Types 442 and 446 are capable of sustained operation at temperatures of 980°C and 1095°C respectively, without experiencing destructive scaling. A need for a higher degree of weldability than that provided by type 430 resulted in the development of type 429. Both alloys have the same carbon content; however, 429 has a lower chromium content (14.0-16.0%). This carbon-chromium ratio allows type 429 to retain its ferritic status.

4. The fourth group consists of the age-hardened or precipitation-hardening steels. They are hardened and strengthened by solution-quenching followed by heating for substantial times at temperatures in the range of 800-1000 degrees Fahrenheit. Precipitation-hardened stainless steels can have a microstructure consisting of ferrite, martensite, or austenite depending on the heat treatment performed. The precipitation hardening process is thought to involve the formation of very fine intermetallics that impede dislocation motion during deformation, producing higher strength. Prolonged aging cause these intermetallics to coarsen, enabling dislocations to bypass them during deformation, and their strength to begin to decline. In this condition, the material is said to be overaged. AISI types that make up this group include 630, 631, 632, 633, 634, and 660. It is generally considered that the average corrosion resistance of this group approaches that of the 18-8 austenitic grades and that it is usually superior to the corrosion resistance of the martensitic and ferritic types.

   Copper is the principal hardening agent in type 630. Its corrosion resistance approaches that of types 302 and 304. In the heat-treated condition, type 631 has a duplex structure. Stainless steels that have a duplex structure have a two-phase microstructure that exhibits improved strength and high resistance to stress corrosion cracking. With the exception of an addition of molybdenum, type 632 is very much like type 630. There is an improvement in strength and resistance to pitting corrosion due to the addition of molybdenum.

Type 633 is also a duplex-structure grade, but has a slightly higher alloy content than types 631 and 632. Thus, its corrosion resistance is better than types 631 or 632. Type 634 is semi-austenitic (duplex), but it has an alloy content slightly less than type 633. The duplex stainless steels are currently popular for withstanding high chloride environments. These alloys have a two-phase microstructure that exhibits improved strength and high resistance to stress corrosion. Most duplex stainless steels contain high chromium (usually about 25%), low nickel (generally about 8% maximum), and 2-4% molybdenum for enhanced resistance to chloride induced phenomena and to promote general corrosion resistance, specifically pitting corrosion.

The super-austenitic stainless steels include such alloys as 904L and 254MO. These alloys have increased resistance over the austenitic stainless steels due to the addition of 6% molybdenum or other elements.

A.2 Brass and Bronze Alloys

Brass, bronze, and other copper alloys have been widely used for centuries in many applications because of their excellent corrosion resistance. Despite the formation of the common green patina in natural environments, copper and its alloys corrode at negligible rates in unpolluted water or air and in deaerated nonoxidizing acids. Copper roofing in rural atmospheres, where there is little if any pollution, has been found to corrode at rates of less than 0.4 mm (15 mils) in 200 years. Some copper alloy artifacts have been found in nearly perfect condition, with only small amounts of corrosion on the surface, after having been buried in the earth for thousands of years.

Although classed as corrosion resistant, neither copper nor its alloys form the truly passive corrosion-resistant film that characterizes most true corrosion-resistant alloys. In aqueous environments at ambient temperatures, cuprous oxide or cupric carbonate forms the protective scale on copper and copper alloys. The film is adherent and follows parabolic growth kinetics. For the corrosion reaction to proceed, copper ions and electrons must migrate through the cuprous oxide or cupric carbonate layer. Consequently, reducing the ionic or electronic conductivity of the film by doping with divalent or trivalent cations should improve corrosion resistance. In practice alloying additions of aluminum, zinc, tin (Sn), iron, and nickel are used to dope the corrosion product films, resulting in a significant reduction in corrosion rate.

Copper alloys can be quite susceptible to stress-corrosion cracking. While high-zinc yellow brasses are the most susceptible to stress-corrosion cracking, small amounts of phosphorus, arsenic (As), antimony (Sb), silicon, aluminum, or nickel as constituents in other copper-base alloys render them also susceptible to stress-corrosion cracking in ammoniacal environments. Other nitrogenous environments, such as nitrite or nitrate solutions, as well as nitric acid vapors, can also cause stress-corrosion cracking. As for other elements, the corrosion-resistant behavior of copper is best revealed by considering its alloy systems. The basic systems for copper are copper-tin (bronze), copper-zinc (brass), copper-nickel (cupro-nickels), and variations of these, including aluminum-bronzes, phosphor-bronzes, and nickel-silvers.

Copper and its alloys are classified in the United States by composition according to Copper Development Association (CDA) designations which have been incorporated into the Unified Numbering System (UNS) for metals and alloys. Wrought copper materials are assigned five digit numerical designations which range from C10100 through C79999, but only the first three or sometimes four numerals are frequently used for brevity. Designations that start with 8 or 9 are reserved for cast copper alloys.

Most wrought alloys are provided in conditions that have been strengthened by various amounts of cold work or heat treatment. Cold worked alloys are the result of cold rolling or drawing by prescribed amounts of plastic deformations from the annealed condition. Alloys that respond to strengthening by heat treatment are referred to as precipitation or age hardenable. The designations and principal alloying elements of wrought copper alloys are given in Table A-2.

Table A-2: UNS (CDA) Designations for Brass and Bronze Alloys

Alloy Group	UNS (CDA) Designation	Principal Alloy Elements
Brasses	C20500-C28580	Zn
Leaded brasses	C31200-C38590	Zn-Pb
Tin brasses	C40400-C40980	Sn, Zn
Phosphor bronzes	C50100-C52400	Sn-P
Leaded bronzes	C53200-C54800	Sn-P, Pb
Phosphorus-silver	C55180-C55284	Ag-P
Aluminum bronze	C60600-C64400	Al, Fe, Ni, Co, Si
Silicon bronze	C64700-C66100	Si, Sn
Modified brass	C66400-C69950	Zn, Al, Si, Mn

Nickel and copper are mutually soluble or miscible. In commercial alloys known as copper-nickels or cupronickels, where copper is the dominant element, the copper content ranges from about 54% to over 90%. Nickel provides the best general resistance to aqueous corrosion of all the commercially important alloy elements. It promotes resistance to impingement or erosion corrosion and to stress corrosion cracking. The addition of 10-25 wt% nickel to copper-zinc alloys produces alloys called nickel-silvers. Most commonly these have about 18% nickel and 55-65% copper. Such alloy additions promote good resistance to corrosion in both fresh and salt waters. The nickel inhibits dezincification. Nickel-silvers are much more corrosion resistant in saline solutions than brasses of similar copper content.

Elements are added to copper alloys in varying amounts to enhance corrosion resistance. For example, the addition of arsenic, antimony, or phosphorus improves resistance of Admiralty Metals (72% copper, 26% zinc, 1% tin) to dezincification. Also, 2% aluminum is added to 76% copper-22% zinc solutions to produce aluminum brass, and a small amount of arsenic (less than 0.10%) is added to the alloy to inhibit dezincification.

Brass and bronze can be grouped according to how the principal elemental additions affect properties. This grouping depends primarily on whether the additions that dissolve in the liquid copper can form discrete second phases during melting/casting or in-process thermal treatment.

Brass and bronze are considered to be solid solution alloys when copper dissolves other elements to varying degrees to produce a single-phase alloy that is strengthened relative to unalloyed copper. The contribution to strengthening from an element depends on the amount of the element in solution and by its particular physical characteristics, such as atom size and valency. Tin, silicon, and aluminum show the highest strengthening efficiency of the common elemental additives, whereas nickel and zinc are the least efficient. The limiting factor in their alloy range is the extent to which the elements, either singly or in combination, remain dissolved in the copper during processing. Table A-3 gives the designations and compositions of some specific brass and bronze wrought alloys. More details on these specific alloys are provided below.

Table A-3: UNS (CDA) Designation and Compositions of some Brass and Bronze Wrought Alloys

Alloy Group	UNS Designation	Elemental Composition, wt%[a]
Zinc brass	C260	30 Zn
Leaded brass	C360	35 Zn, 3 Pb
Tin brass	C425	9.5 Zn, 2.0 Sn
Phosphor bronze	C510	5.0 Sn, 0.1 P
Aluminum bronze	C638	2.8 Al, 1.8 Si
Silicon bronze	C654	3.0 Si, 1.5 Sn, 0.1 Cr
Silicon bronze	C655	3.3 Si, 0.9 Mn
Modified Cu-Zn	C688	22.7 Zn, 3.4 Al, 0.4 Co

[a] Remaining percentage is copper.

The presence of finely dispersed second-phase particles in copper alloys contributes to strength, through refined grain size and increased response to hardening from cold working. A dispersion of fine particles can be incorporated into the alloy through thermomechanical processing where the alloy content is above the solid state solubility limit. Precipitation and coarsening of the excess solute by an in-process anneal is used in high copper alloys, such as C194 and C195, to form iron or iron-cobalt dispersions.

Copper-Zinc (Cu-Zn) Brasses

Copper-zinc alloys have been the most widely used of the copper alloys during the 1990s. Brass alloys fall within the designation C205 to C280 and cover the entire solid solution range up to 35 wt% zinc in the Cu-Zn alloy system. Zinc, which is generally less expensive than copper, does not impair conductivity and ductility to any appreciable extent. The alloys have a yellow "brass" color at zinc levels above 20 wt%. By far the best known and most used composition is the 30 wt% zinc alloy, called Cartridge brass, which is best known for its applications as door knobs and bullet cartridges.

The series of brasses, C312 to C385, contain from 0.25-5.0 wt% lead (Pb) for the purpose of improving machinability. C360, having the composition of 61.5 wt% copper, 35.4 wt% zinc, and 3.1 wt% lead, has become the industry standard for machinability performance.

Tin Brasses

The tin brass series of alloys consists of various copper-zinc (2.5-35 wt%) alloys to which up to about 4 wt% tin has been added. These are the C40000 series of alloys. Tin provides better general corrosion resistance and strength without greatly reducing electrical conductivity. Several tin brasses have lead additions to enhance machinability. Naval Brass C485 contains 60.5 wt% copper, 37 wt% zinc, 0.7 wt% tin, and 1.8 wt% lead. Resistance to dezincification is increased with the addition of tin. In brasses that contain a high zinc content, it is common to use other alloying additives to enhance corrosion resistance. C443 contains 0.02-0.10 wt% arsenic, C444 contains 0.02-0.10 wt% antimony, and C445 contains 0.02-0.10 wt% phosphorus, which is added to control dezincification. When any of these elements are used, the alloy is referred as being "inhibited."

Tin Bronzes

Tin bronzes may be the most familiar of copper alloys with roots going back into ancient times. They are essentially solid solutions of tin in copper. Phosphorus at 0.03-0.35 wt% is commonly used as a deoxidizer, and the residual phosphorus content gives rise to the term "phosphor bronze." The addition of tin to copper promotes good resistance to fresh and sea water. Under some conditions, when more than

5% tin is present, the corrosion resistance in marine applications is enhanced. Strength, corrosion resistance, and stress relaxation resistance increases with tin content. Where the water velocity is high, the tin content in copper alloys for marine applications should exceed 5%. Alloys containing between 8-10% tin have high resistance to impingement or erosion attack. Tin bronzes tend to have intermediate pitting resistance. One of the most highly used specialty tin bronzes is C544, containing 88 wt% copper-4 wt% tin-4 wt% zinc-4 wt% lead. Zinc provides increased strength to this tin bronze, whereas the lead addition provides good machinability.

Aluminum Bronzes

Aluminum bronze alloys comprise a series of alloys (C606 to C644) based on the copper-aluminum (2-15 wt%) binary system, to which iron, nickel, and/or manganese are added to increase strength. Corrosion resistance results from the formation of an adherent aluminum oxide layer that protects the surface from further oxidation. Mechanical damage to the surface is readily healed by the redevelopment of this oxide. The aluminum bronzes are resistant to sulfuric or hydrochloric acids, but not nitric acid. These alloys must be properly heat treated to be resistant to dealloying and general corrosion.

Two single-phase, binary alloys are used commercially: C606, containing 5 wt% aluminum and C610, containing 8 wt% aluminum. Most of the available aluminum bronzes contain additional alloy elements. C608 contains 5 wt% aluminum to which 0.02-0.35 wt% arsenic has been added to improve corrosion resistance. Alloy C614, in addition to having 7 wt% aluminum and 2.5 wt% iron, also has a 0.3 wt% tin addition for improved resistance to stress corrosion.

Most of the aluminum bronzes contain substantial iron, nickel, or manganese additions. These alloying elements increase strength by forming second phases during heat treatment. Iron, the most commonly added element, separates as an iron-rich particle that controls grain size while it enhances strength. Nickel also reacts with aluminum to form NiAl precipitate during heat treatment with the same result as the iron addition.

Silicon Bronzes

Silicon bronzes have long been available for use in electrical connectors, heat exchange tubes, and marine and pole line hardware because of their high solution hardened strength and resistance to general and stress corrosion. Their compositions are limited to below 4.0 wt% silicon because above this level, an extremely brittle phase is developed that prevents cold processing. The three most popular alloys in this series are C651, C654, and C655.

Modified Copper-Zinc Alloys

The series of brass alloys C664 to C698 have been modified by additions of manganese (manganese brasses and manganese bronzes), aluminum, silicon, nickel, and cobalt. Each of the modifying additions provides some property improvement to the already workable, formable, and inexpensive Cu-Zn brass base alloy. Aluminum and silicon additions improve strength and corrosion resistance. Nickel and cobalt form aluminide precipitates for grain size control and dispersion strengthening by the presence of finely dispersed second-phase particles in the copper alloy.

A.3 Specific Properties of Cast Brass and Bronze Alloys

Cast copper alloys can be classified into two main groups: single-phase alloys, characterized by moderate strength, high ductility (except for leaded varieties), moderate hardness and good impact strength; and polyphase alloys, having high strength, moderate ductility, and moderate impact strength. The tolerance for impurities is normally greater in cast copper alloys than in wrought copper alloy because the cast alloys are not mechanically formed. However, in those cast alloys likely to be repaired or joined by welding, some impurities can be very detrimental. On the basis of consumption, red brass alloys, C83600

(85 wt% copper, 5 wt% tin, 5 wt% lead, and 5 wt% zinc), C84400 (81 wt% copper, 3 wt% tin, 7 wt% lead, and 9 wt% zinc), and C93200 (83 wt% copper, 7 wt% tin, 7 wt% lead, and 3 wt% zinc) are the most important of the cast copper alloys.

The mechanical properties of cast copper alloys (e.g., brass, bronze) are a function of alloying elements and their concentrations. The nominal chemical composition and identification of some copper casting alloys are listed in Table A-4.

Table A-4: Nominal Composition by wt% of Some Casting Brass and Bronze Alloys

Common Name	UNS (CDA) Designation	Cu	Sn	Pb	Zn	Fe	Al	Others
High strength yellow brass	C86300	63.0			25.0	3.0	6.0	3.0 Mn
Gun metal	C 90500	88.0	10.0		2.0			
Tin bronze 84:16	C 91100	84.0	16.0					
High leaded tin bronze	C 93700	80.0	10.0	10.0				
Steam bronze	C 92200	88.0	6.0	1.5	4.5			
Phosphorus bronze	C 94400	81.0	8.0	11.0				0.35 P
High leaded tin bronze	C 93800	78.0	7.0	15.0				
Journal bronze	C 94100	70.0	5.5	18.0	3.0			
Aluminum bronze 9D	C 95500	81.0				4.0	11.0	4.0 Ni
Al-Silicon bronze	C 95600	91.0					7.0	2.0 Si
Mn-Al bronze	C 95700	75.0				3.0	8.0	12.0 Mn, 2.0 Ni
Ni-Al bronze	C 95800	81.0				4.0	9.0	1.0 MN, 5.0 Ni
Die-casting yellow brass	C 85800	58.0	1.0	1.0	40.0			
Die-cast silicon brass	C 87800	82.0			14.0			4.0 Si
Commercial no. 1 yellow brass	C 85400	67.0	1.0	3.0	29.0			
Yellow brass	C 85700	63.0	1.0	1.0	34.7		0.3	
High strength yellow brass	C 86200	64.0			26.0	3.0	4.0	3.0 Mn
Leaded high strength yellow brass	C 86400	59.0		1.0	40.0	2.0	1.5	1.5 Mn
Silicon bronze	C 87200	89.0	1.0	0.5	5.0	2.5	1.5	1.5 Mn, 4.0 Si
Silicon brass	C 87400	83.0			14.0			3.0 Si
Silicon brass	C 87500	82.0			14.0			4.0 Si
Tin bronze	C 90300	88.0	8.0		4.0			

Common Name	UNS (CDA) Designation	Cu	Sn	Pb	Zn	Fe	Al	Others
Leaded tin bronze	C 92300	87.0	8.0	1.0	4.0			
High leaded tin bronze	C 93200	83.0	7.0	7.0	3.0			
Nickel-tin bronze	C 94700	88.0	5.0		2.0			5.0 Ni
Leaded nickel-tin bronze	C 94800	87.0	5.0	1.0	2.5			5.0 Ni

APPENDIX B. Questions and Answers

B.1 Part I: Relevant Questions and Answers Extracted from the *EPCRA Section 313 Questions & Answers 2019 Consolidation Document*

Article Exemption – Lead

476. A covered manufacturing facility produces neon signs by bending leaded glass tubing. The facility uses enough tubing annually to process in excess of 100 pounds of lead, an EPCRA section 313 toxic chemical. When signs are formed from glass tubing, the diameter of the tubes remains unchanged and lead is not released during the heating or bending process, qualifying the tubes for the article exemption. If a discrete number of glass tubes are broken and discarded during the year, under what circumstances would disposal of the broken tubes constitute a release that negates the article exemption, and how would the facility calculate the amount of lead used in their operation?

Disposal of the glass does not necessarily constitute a release which automatically negates the article exemption. For the tubing to meet the definition of an article when discarded, the diameter of the tubing must remain intact and unchanged. As a result, shards of glass no longer qualify as articles. If more than 0.5 pounds of lead is released and not recycled, then the article exemption would not apply to this glass tubing.

Article Exemption – Lead Bricks

470. A ship building facility incorporates lead bricks as ballast into the ships it distributes in commerce. The lead bricks remain permanently with the ship. They could be considered articles and therefore be exempt from reporting. However, the facility infrequently cuts some of the bricks, generating lead dust, which it collects and sends to an off-site lead reprocessor. How should the facility report? What should be counted towards the threshold if the lead bricks are not considered articles?

If all of the lead is recycled or reused then the lead dust does not have to be counted as a release. Therefore, the cut bricks retain their article status. If while cutting the bricks, there are releases which are not recycled and that exceed 0.5 pounds for a year, then the cut bricks would not be considered articles. In this case, count only the lead in bricks actually processed toward the threshold determination. Any amounts of toxic chemicals sent off-site for recycling would be reported appropriately on the Form R.

Lead and Lead Compounds

183. For Section 313 reporting requirements and threshold determinations, if a covered facility uses lead, lead chromate, and other chromium compounds, can they be considered separately or must they be combined into categories? When reporting releases and other waste management activities, must quantities of categories be determined as well?

Threshold determinations for metal containing compounds are made separately from parent-metal threshold determinations because they are listed separately under Section 313. In the scenario presented in the question, the facility would apply the quantity of the lead metal manufactured, processed, or otherwise used to the appropriate threshold for lead. The facility would apply the quantities of the lead chromate manufactured, processed, or otherwise used to the appropriate threshold for lead compounds and would apply the quantities of the lead chromate and other chromium compounds manufactured, processed, or otherwise used to the appropriate threshold for chromium compounds. However, a facility may, once a threshold has been met individually, combine the parent metal and its metal compounds for reporting. In completing the Form R, only the weight of the parent metal (not the entire compound weight) is to be considered.

515. A covered facility has determined that it needs to report under EPCRA section 313 for both elemental lead and lead compounds. Can this facility file one Form R that takes into account both the releases and other waste management activities of lead and lead compounds, or is it required to report separately?

If a covered facility exceeds thresholds for both the parent metal and compounds of that same metal, it is allowed to file one joint Form R (e.g., one report for both lead compounds and elemental lead). EPA allows this because the release and other waste management information reported in connection with metal compounds will be the total pounds of the parent metal released and otherwise managed as a waste.

516. A covered facility processes both elemental lead and lead compounds. The facility exceeds the 100 pounds per year processing threshold for lead compounds, but not for elemental lead, and must submit a report for lead compounds only. When calculating releases and other waste management activities from the lead compounds, the owner/operator is only required to account for the weight of the parent metal released (40 CFR Section 372.25(h)). Should the facility account for both releases of lead from activities involving lead compounds and releases of lead from activities involving elemental lead?

No. In the case when an activity threshold is exceeded only for lead compounds, the report is only required to be based on the releases and other waste management estimates of lead, the parent metal, from lead compounds only. Releases and other waste management estimates of lead resulting from activities involving elemental lead need not be included in the release and other waste management calculations. Conversely, if the facility were to exceed an activity threshold for only elemental lead, the report would only have to be based on releases and other waste management estimates from activities involving elemental lead only.

Lead Deposits

255. A re-manufacturer of auto engines cleans the engine parts and thereby produces a lead-containing waste (from gasoline lead deposits) which it sends off-site for disposal. Does the facility manufacture, process, or otherwise use lead compounds?

None of the EPCRA section 313 activities apply. Neither lead nor lead compounds are manufactured. Lead is not incorporated into products for distribution in commerce nor is it a manufacturing aid or a processing aid as those terms are defined. Lead in the waste would not be included for a threshold determination. The facility does not manufacture, process, or otherwise use lead compounds.

Metal Alloys

260. How does a facility determine the threshold for reporting of a listed toxic chemical (such as chromium) in a solid piece of steel which it processes?

Since steel is a mixture (and not a compound), the processing threshold determination is made based on the total amount of each toxic chemical present in the steel. If the toxic chemical is present in a known concentration, the amount present can be calculated by multiplying the weight of the steel by the weight percent of the listed toxic chemical (see 40 CFR Section 372.30(b)(3)). The threshold for processing chromium is 25,000 pounds.

262. Regarding non-PBT metals in mixtures, such as chromium in an alloy (stainless steel), how are thresholds and releases and other waste management activities accounted for in a foundry type operation where all of the metals are melted down? Could the *de minimis* and article exemptions be applied?

For threshold purposes, if the listed toxic chemicals in the metals are processed, otherwise used, manufactured as an impurity (that remains with the product), or imported below the *de minimis* levels, then the *de minimis* exemption may be taken for that metal in the alloy. However, the article exemption cannot be taken for this type of foundry operation since in founding, a metal is melted down and poured into a mold. Consequently, the resulting metal is not recognizable as its original form. Note that the *de minimis* exemption may apply for lead in stainless steel, brass, or bronze alloys.

565. How is galvanized sheet metal considered for EPCRA section 313 reporting? Are metals in alloys subject to Section 313 reporting?

Galvanized sheet metal is an alloy of several different metals. An alloy is considered a mixture for Form R reporting because the individual metals in the alloy retain their chemical identities. Like all other listed toxic chemicals in mixtures, alloys are subject to Form R reporting. When determining whether a facility meets an activity threshold, the owner/operator should only consider the weight percent of the listed chemical in the alloy.

Metal Compounds

7. How are toxic chemical categories handled under Section 313 threshold determinations and release and other waste management calculations?

All toxic chemicals in the category that are manufactured, processed, or otherwise used at a covered facility must be totaled and compared to the appropriate thresholds (40 CFR Section 372.25(d)). A threshold determination for toxic chemical categories is based on the total weight of the compound. Except for metal compound categories and nitrate compounds, the total weight of the compound released or otherwise managed as waste must be reported. Releases and other waste management quantities of metal compounds are reported as the parent metal portion of the compounds (40 CFR Section 372.25(h)). If the metal and corresponding metal compounds exceed thresholds, a joint report for metal compounds, including the parent metal, can cover both reporting requirements. Similarly, releases and other waste management quantities of nitrate compounds are reported as the nitrate portion of the compound.

180. How are threshold determinations made for metal-containing compounds?

Threshold quantities for metal compounds are based on the total weight of the metal compound, not just the metal portion of the metal compound. The threshold quantities are determined by adding up the total weight of all metal compounds containing the same parent metal. However, release and other waste management calculations are based solely on the weight of the parent metal portion of the metal compounds. Note that there are a few metal compounds that are separately listed and are not counted in the metal compounds categories. For example, maneb (CAS number 12427-38-2) is a manganese compound that is a separately listed chemical and is not reportable under the manganese compounds category.

181. Is the conversion from one metal compound to another metal compound within the same metal compound category considered manufacturing for purposes of threshold determinations and release and other waste management calculations?

Yes. The conversion of one metal compound to another metal compound within the same metal compound category is considered the manufacture of a metal compound, which must be considered toward threshold determinations. This is identical to how threshold calculations are derived for listed toxic chemicals in non-metal compound categories. The unique aspect for metal compounds, as compared to non-metal compounds within a listed compound category, is how amounts released and otherwise managed as waste are reported. As stated in the final rule (62 FR 23850; May 1, 1997), “if a metal is converted to a metal compound or if a metal compound is converted to another metal compound..., a metal compound has been manufactured as defined under EPCRA section 313." However, provided that thresholds are exceeded, covered facilities are instructed to report only the amount of the parent metal contained in the metal compound for amounts released or otherwise managed as waste. If thresholds for both the elemental metal and its metal compounds have been exceeded, covered facilities have the option to submit one Form R that includes on their report the amounts of the elemental metal from the parent metal along with amounts of the metal portion from the metal compounds.

187. A covered facility manufactures specialty glass products. The starting materials are primarily metal silicates which are ground into a powder, mixed, and heated. The resulting mixture, the specialty glass, has all the metal silicates melted together in a non-crystalline structure. Since the metal silicates do not exist by themselves in the mixture, how should a threshold determination be made?

The metal silicates are processed since they become incorporated into a product (the specialty glass) that is distributed in commerce. If the metal silicates still exist as the original metal silicates but just mixed together then each metal silicate that belongs to a particular metal compound category is included in the processing threshold calculations for that category. If the metal silicates have been reacted to produce another compound (i.e., if the specialty glass is not just a mixture of individual metal silicates but is another new metal compound) then the metal silicates have still been processed, but a new metal compound has also been manufactured and its weight (i.e., the whole weight of the glass) must be included in the manufacturing threshold calculations.

201. We manufacture and use copper wire. We also use copper compounds in various parts of our processes. The Section 313 list contains both copper and copper compounds. Should we combine these categories for our determination of thresholds and reporting? Do we report the release and other waste management of copper compounds as copper metal?

Copper and copper compounds are separate entries on the Section 313 list, and therefore threshold determinations should be made separately. Copper compounds are a listed category and will include the aggregate of all copper compounds (other than the free metal). For copper compounds, report releases and other waste management activities as copper (e.g., as the copper ion in wastewater), not as the total mass of copper compounds. If a facility exceeds thresholds for both the parent metal and compounds of the same metal, EPA allows the facility to file a combined report (e.g., one report for copper compounds and copper metal).

202. Do we count the nonmetal portion of metal compounds?

The nonmetal portion of metal compounds is included in threshold determinations but not in release and other waste management calculations.

203. An electroplating facility uses metal cyanide compounds in their electroplating operations. Are they processing or otherwise using those cyanide compounds? How do they determine whether they meet the threshold, and which threshold applies?

The parent metal is plated onto a substance electrochemically. The metal compounds are processed, and the cyanide compounds are processed because the metal cyanide is the source of the metal that is plated and subsequently distributed in commerce. Metal cyanides are reportable as both cyanide compounds and metal cyanides. The total compound weight is applied for threshold determinations for both categories.

204. An oxidation/reduction reaction that occurs as part of a waste treatment operation results in the formation of 2,500 pounds of lead chromate. How must a threshold determination be made for this compound?

Lead chromate meets the criteria for both a lead compound and a chromium compound. In such cases, the total amount of the compound manufactured, processed, or otherwise used must be applied to the threshold determination for both metal compound categories. The weight of the entire compound, not the weight of the parent metal, is applied for the threshold determination of each metal compound category.

233. In an electroplating operation, a facility uses an elemental copper anode and an electrolyte solution containing a copper compound. During the electrolytic process, elemental copper is deposited at the cathode (the item being plated). As elemental copper is plated out at the cathode, copper goes into solution at the anode forming a copper compound. For purposes of EPCRA section 313, how would the facility make threshold determinations for copper and copper compounds?

The electroplating of copper is a two-step process in which the elemental copper from the anode is converted into a copper compound in solution and the copper compound in solution is converted to elemental copper.

A constant concentration of copper compounds is thus maintained in the electrolytic solution surrounding the electrodes. In such an electrolytic cell, four separate thresholds are applicable for purposes of EPCRA section 313:

a) The amount of copper anode consumed counts towards a processing threshold for elemental copper (since its purpose is to provide copper to the cathode, via the bath).

b) The amount of copper compound generated in the electrolytic solution (as a result of oxidation of elemental copper at the anode) would count towards a manufacturing threshold for copper compounds.

c) The amount of copper compound converted to elemental copper in the electrolytic solution counts toward a processing threshold for copper compounds (since it is available for reduction at the cathode).

d) Finally, the amount of copper deposited at the cathode would count towards a manufacturing threshold for elemental copper (since elemental copper is being produced from a copper compound).

For example, a facility uses up 15,000 pounds of copper anode per year (the anode is composed of elemental copper). The elemental copper is processed by manufacturing 37,000 pounds of copper sulfate (copper sulfate (CuSO4) is 40 percent copper by weight and, in this example, is the form in which copper exists in the electroplating bath). The copper sulfate is then processed by manufacturing 15,000 pounds of elemental copper. The following quantities would apply to TRI reporting thresholds:

Chemical or Chemical Category	Manufacture	Process
Elemental copper	15,000 pounds	15,000 pounds
Copper compounds	37,000 pounds	37,000 pounds ($CuSO_4$)

The facility would file a Form R for “Copper Compounds” because it exceeds the manufacturing and processing thresholds for a copper compound.

234. A covered electroplating facility uses copper cyanide as its source of copper in plating baths in their electroplating operation. Are they manufacturing, processing, or otherwise using this compound? How do they determine whether they meet the activity threshold and how are releases and other waste management activities reported for this chemical?

In this process, the copper cyanide is both manufactured and processed. The copper cyanide is created in the plating solution, and the amount created should be counted towards the 25,000 pound manufacturing threshold. The copper cyanide is also being processed since the copper from the copper cyanide is plated onto an object that is to be distributed in commerce. Thus, the copper cyanide used in this process should be counted towards the processing threshold for both copper and cyanide compounds.

The copper cyanide is both a copper compound and a cyanide compound and is reportable under both the copper compounds category and the cyanide compounds category. The total weight of the copper cyanide is to be counted towards the thresholds for both categories. However, for reporting releases and other waste management activities, the total weight of the copper cyanide is to be reported under the cyanide compounds category, but only the weight of the copper is to be reported under the copper compounds category.

250. Do covered facilities need to consider the inadvertent conversion of one metal compound to another as manufacturing? For example, a pulp and paper mill inadvertently converts metal carbonates and oxides in wood to metal sulfides during pulping. Is this a covered manufacturing activity?

Yes. Manufacturing is not limited to intentional manufacturing; it also includes coincidental manufacture or, inadvertent manufacture. In general, anytime one metal compound has been converted to another metal compound, the facility must count the new metal compound towards the manufacturing threshold. The fact that the parent metal is the same in both compounds does not negate the fact that a new metal compound has been manufactured.

264. A glass manufacturer uses a brick in its refractory kiln that contains chromium (III) compounds. During the manufacturing process, the chromium reacts to generate chromium (VI) compounds. The chromium compounds, while being used in the kiln, become part of the glass being manufactured. All the brick in the kiln is replaced every four to five years. What activity thresholds apply to chromium in this situation?

The brick, and thus the chromium (III) compounds in the brick, are being otherwise used based on the quantity of the bricks installed within a reporting year. The chromium compounds in the bricks are also considered processed, because the chromium compounds in the brick are incorporated as an impurity into the final product (the glass) which is distributed in commerce. However, for this processing step, the *de minimis* exemption may be taken. The chromium (VI) compounds generated from the chromium (III) compounds are considered manufactured. Thus, threshold calculations should be made for all three EPCRA section 313 activity thresholds. The thresholds would be calculated based on the total weight of the chromium compounds being manufactured, processed, or otherwise used. However, only the weight of the chromium in the chromium compounds are used in release and other waste management calculations. Any releases that go up the stack or are sent off site for waste management must be included. When the brick is replaced and disposed of, the amount of chromium that remains in the brick would also need to be included in release and other waste management calculations.

507. A covered facility has a coal-fired boiler. The combustion of the coal generates aerosol forms of hydrochloric acid as a byproduct. Should the aerosol forms of the HCl emissions be reported under EPCRA section 313?

Yes. In the combustion of coal, the facility will be coincidentally manufacturing aerosol forms of hydrochloric acid, as well as hydrofluoric acid and sulfuric acid. The combustion of coal will also result in the coincidental manufacture of new metal compounds. The facility must submit a Form R if it manufactures more than a threshold amount of any of these listed toxic chemicals.

512. For Section 313 reporting, a catalyst contains 61 percent total nickel, which includes 26 percent nickel metal and 35 percent nickel contained in compounds. Should the threshold determination be based on the 61 percent total nickel?

No. The 61 percent total nickel cannot be used in the threshold determinations. Nickel compounds are a listed toxic chemical category; therefore, the full weight of nickel compounds (not just the 35 percent nickel contained in the compounds) must be used in the threshold determination for nickel compounds. A separate threshold determination is required for the nickel metal since nickel is a separately listed toxic chemical under Section 313.

513. A covered facility uses chromium compounds in its electroplating operation, and as a result, a hexavalent chromate compound is generated. Are the hexavalent chromate compounds reportable under Section 313?

The hexavalent chromate compounds are members of a reportable toxic chemical category, chromium compounds, and have been manufactured by the oxidation/reduction reaction that occurred in the electroplating operation. As a result, the total amount of the hexavalent chromate compounds produced must be included in the manufacturing threshold for chromium compounds.

514. Are chromium compounds (e.g., chromic acid CAS number 11115- 74-5 or chromic acetate CAS number 1066-30-4) reportable under Section 313?

All chromium compounds are reportable. They must be aggregated together for purposes of threshold and maximum amount on-site calculations. However, release and other waste management amounts should be for the chromium metal portion only (see 40 CFR Section 372.25(h)).

694. In Part II, Section 7A of the Form R, should covered facilities report the influent concentration to a treatment system for metal compounds in a waste stream for the parent metal only? How do I consider treatment efficiencies for metal compounds?

For metal compounds, the calculation of the reportable concentration and waste treatment efficiency must be based on the weight of the parent metal, not on the weight of the metal compounds. Metals are not destroyed, only physically removed or chemically converted from one form to another. The waste treatment efficiency reported must represent only the physical removal from the waste stream (except for incineration), not the percent conversion from one form to another. If a listed waste treatment method converts but does not remove a metal (e.g., chrome reduction), the method must be reported with a waste treatment efficiency of zero.

Metals

483. Are there recommended methods for determining if the 0.5 lb release limit is exceeded from a metal stamping operation?

EPA recommends that facilities use one or more of the following for performing release and other waste management calculations of EPCRA Section 313 chemicals: monitoring data, mass balance, emissions factors, and engineering calculations. If all wastes generated from stamping operations (including fume, dust, sludge, and scrap pieces) are recycled or reused and the facility's total releases will be equal to or less than 0.5 lb limit for each toxic chemical per year, the article exemption may apply. If releases (including disposal) of a toxic chemical are more than 0.5 lb, the article exemption is negated for that chemical and all quantities of that chemical in the metal sheets should be included in threshold determinations and release and other waste management calculations.

606. Why does EPA not allow covered facilities to use the efficiency of a combustion unit (e.g., incinerator, industrial furnace, or boiler) to calculate releases of metals from the unit?

Metals cannot be destroyed by combustion. Therefore, the efficiency of a combustion unit has no relation to the releases of metals from the unit.

688. A covered facility sends a toxic chemical in a paint thinner waste to a firm for fuel blending purposes. Should the amount of toluene and xylene in the waste be reported on the Form R, Part II, Section 6 as a transfer off site?

A toxic chemical in a waste stream sent off site for waste fuel blending is considered combusted for energy recovery if the listed toxic chemical has a significant heat value and is combusted in an energy recovery device. EPA believes that waste blended into fuel will be combusted in an integrated energy recovery device. Where both elements are met, the quantity of the toxic chemical must be reported as an off-site transfer for purposes of energy recovery on the Form R. However, other reportable toxic chemicals in the waste (e.g., metal pigments) that are incombustible or that do not add significant heat value to energy recovery upon combustion must be reported as off-site transfers for purposes of waste treatment or disposal, as appropriate. Please note that metals cannot be treated or combusted for energy recovery purposes and, therefore, should be reported as disposed in Section 8 of the Form R, unless the facility has knowledge the metals are being recycled.

706. If a covered facility sends metal scraps containing chromium offsite to be remelted and subsequently reused, does it report the amount of toxic chemical in the metal as recycled off site?

Assuming no contaminants are removed during the melting process, the chromium in the metal scraps is not actually being recovered but merely melted and reused. Therefore, the amount of the toxic chemical in the metal scraps would not be reportable in Part II, Sections 6.2 or 8 of the Form R. However, because the facility is repackaging and distributing the toxic chemicals in commerce, it should consider these amounts of the toxic chemical towards the facility's processing threshold. If the covered facility exceeds a chemical activity threshold, it is required to file a TRI Report for that chemical.

708. If I send 10 pounds of chromium (or any metal) to a POTW or other wastewater treatment facility, where should I report the ten pounds in Section 8 of the Form R?

Because metals cannot be destroyed, they should not be reported as treated in Part II, Section 8.6 or 8.7 of the Form R. If you do not know what the POTW does with the metal constituents they receive, you should assume they are released and report the ten pounds sent to a POTW in Part II, Section 8.1 on the Form R.

Welding

444. A covered facility uses sheet metal to manufacture metal desks. When manufacturing the desks, the operator welds and solders some of the sheet metal together. Must the facility include the toxic chemicals in the welding rods, solders, and the metals being joined for its threshold determination? Does the metal desk meet the article exemption?

If 0.5 pounds or less of the toxic chemical is released from all like articles in the reporting year and the overall thickness or diameter of the sheet metal is not changed when processed into the desk, the sheet metal would retain its article status. The desk itself would not meet the criteria for the article exemption because the exemption does not apply to the manufacture of articles. Also, because air emissions are generated from the welding and soldering rods when they are used, the owner/operator must assess the entire amount of the toxic chemical in the rods for processing threshold purposes.

473. During the construction and repair of ships, small quantities of a listed toxic chemical are emitted in the form of fumes when steel plates are being welded together. The steel plates are formed to a specific shape during manufacture, and their end use function is dependent upon their shape. Are these steel plates articles and should the amount of toxic chemical (fumes from the steel

plates) emitted from the steel plates during the welding process be included in determining the threshold?

If the processing or otherwise use of all like manufactured items results in the release of 0.5 pounds or less of a toxic chemical, EPA will allow this quantity to be rounded to zero and the steel plates may be exempt as articles. If the listed toxic chemical that is released exceeds 0.5 pounds over a calendar year and is completely recycled or reused, on site or off site, then these steel plates may also be exempt as articles. Any amount that is not recycled or reused will count toward the 0.5 pound per year cut-off value.

Firing Ranges, Fugitive Releases, Lead Bullets

588. DOE sites have firing ranges for their security personnel. The bullets used by the security personnel are made out of lead. During firing, they release trace amounts of lead, and often disintegrate upon impact with the target. How would lead released from the use of bullets in a firing range be reported on the Form R?

Releases from the firing of the bullets would be reported as fugitive releases to air—Part II, Section 5.1 of Form R. Lead in unrecovered bullets would be reported as releases to land: other disposal—Part II, Section 5.5.4 of Form R. Lead in bullets that are recovered and sent off site for disposal or recycling would be reported in the appropriate sections of the Form R. U.S. EPA's AP-42 (Chapter 15) includes emissions factors related to ordnance detonation. The lead emissions factors for all ammunition are summarized in Table C-3 in Appendix C of this document.

B.2 Part II: Selected Questions (with Answers) Received Since Promulgation of the Lead Rule

Question 1: Is the lead in computer screens' reportable to TRI after the computers are disposed of by a company from a typical office environment? If the company receives the computers intact and simply uses them as computers, as opposed to manufacturing computers, and then disposes of the computers, would this "use" of lead be considered exempt from the regulation for the normal user of computers/screens? Also, would the solder used on the computer circuit cards be exempt for the user of computers and hence not reportable, after proper disposal by the user?

Answer: In the scenario described in this question the computers may qualify as articles eligible for the articles exemption. That is, chemicals included on the TRI list of toxic chemicals that are contained in articles (e.g., computers, pipes) are exempt from both threshold determinations and release and other waste management calculations (i.e., exempt from inclusion on a Form R report) provided that the item meets the criteria of the articles exemption. However, if a facility were to take the computers and modify them in a way such that they are no longer articles (e.g., crush them), the facility may be subject to TRI reporting requirements (40 CFR Section 372.38(b)).

Question 2: Is the lead within plumbing that is being removed from service in a building during renovations or modifications reportable to TRI?

Answer: In this scenario, the pipes may qualify as articles eligible for the articles exemption. That is, chemicals included on the TRI list of toxic chemicals that are contained in articles (e.g., computers, pipes) are exempt from both threshold determinations and release and other waste management calculations (i.e., exempt from inclusion on a Form R report) provided that the items meet the criteria of the articles exemption. However, if a facility were to take the pipes and modify them in a way such that they are no longer articles (e.g., melt them), the facility may be subject to TRI reporting requirements (40 CFR Section 372.38(b)).

Question 3: A pharmaceutical manufacturing facility manufactures radioactive materials that are used in medical treatments. Lead shields are used to protect workers from the radioactive materials. No lead is released from the use of the shields. Would this qualify for the "personal use" exemption?

Answer: It appears that the lead shields may meet the definition of an article and could qualify for the articles exemption (40 CFR Section 372.38(b)). These shields, however, would not qualify for the personal use exemption because the shields are process related (40 CFR Section 372.38(c)(3)).

Question 4: A facility uses lead bricks as a barrier to protect workers and other people from radioactivity. The bricks are permanent; they are never removed or replaced, but they are not built into the facility (i.e., they are not part of the facility). No lead is released from the bricks. Does this qualify for any exemptions, such as the structural components exemption or articles exemption?

Answer: If in fact no lead is released from the bricks, then the articles exemption may apply (40 CFR Section 372.38(b)). The structural component exemption would not apply because these bricks are facility process related (40 CFR Section 372.38(c)(1)).

Question 5: Does the lead and lead compounds qualifier "except in stainless steel, bronze, or brass alloys" mean that these alloys do not have a 25,000 or 10,000 pound threshold for lead?

Answer: There is no "exemption" for lead contained in stainless steel, brass, and bronze alloys: lead in these alloys are still subject to the manufacture and process thresholds of 25,000 pounds, and an otherwise use threshold of 10,000 pounds (66 FR 4500). Furthermore, the higher reporting thresholds for the alloys only apply while lead is literally a component of the alloy. If a facility uses lead or a lead compound in the manufacture of a stainless steel alloy, bronze alloy, or brass alloy that contains lead, the 100 pound threshold applies to the lead or lead compound(s) used in the manufacture of the alloy. Additionally, if a facility is otherwise using a stainless steel, bronze or brass alloy that contains lead, the 10,000 pound threshold applies to the entire amount of lead in the alloy. If any lead is removed/released from the alloys during the otherwise use activity, the 100 pound threshold also applies to that amount of lead that was removed/released.

Question 6: Are alloys of stainless steel, brass, and bronze that contain lead exempt from the 100 pound reporting threshold for lead, regardless of the alloy's form (solid or molten)?

Answer: If a facility is processing a lead-containing stainless steel, bronze, or brass alloy in such a way that lead is removed or released from the alloy, the 100 pound threshold applies to that amount of lead that has been removed or released. For example, a facility obtains a stainless steel alloy that contains lead. The stainless steel alloy is melted, and while in a molten state some lead fumes are generated. Some of these fumes are released into the environment via stacks. The facility must apply the 100 pound threshold to that amount of lead that volatilized from the molten, stainless steel alloy, and report if a threshold is exceeded that amount of lead that has been released through a stack in section 5.2 of Form R. In addition, because the stainless steel alloy is being processed, the lead contained in the alloy must be applied to the 25,000 pound processing threshold. Thus, in this scenario, there are two thresholds that need to be applied: the 100 pound threshold for that quantity of the lead that has been removed or released from the alloy, and the 25,000 pound processing threshold for lead in the alloy itself. The 100 pound threshold also applies to fumes of lead that are generated from welding of stainless steel, bronze or brass alloys that contain lead.

Question 7: If a facility uses lead or a lead compound in the manufacture of a stainless steel, bronze, or brass alloy, does the 100 pound threshold apply to the lead or lead compound(s) used in the manufacture of the alloy?

Answer: Yes, in this scenario, the facility is using lead to manufacture the alloy, and the 100 pound threshold also applies to that amount of lead being used in the manufacture of the alloy.

Question 8: If a facility is processing a lead-containing stainless steel, bronze, or brass alloy in such a way that the lead is not removed/released from the alloy, would the lower 100 pound threshold apply to that lead being processed?

Answer: If a facility is processing a lead-containing stainless steel, bronze, or brass alloy in such a way that the lead is not removed/released from the alloy, the 100 pound threshold does not apply. For example, a facility obtains 100,000 pounds of a stainless steel alloy that contains lead. The stainless steel alloy is processed in such a way that no lead is removed/released from the alloy. The facility need only apply the 25,000 pound threshold to the processing of stainless steel alloy. However, if any lead is removed or released from the alloys during processing, the 100 pound threshold would also apply to that amount of lead that was removed or released. Quantities of lead not in stainless steel, brass, or bronze alloys are applied to both the 100 pound threshold and the 25,000/10,000 pound thresholds.

Question 9: Can the *de minimis* exemption be applied towards lead in stainless steel, brass, or bronze alloys?

Answer: A facility may take the *de minimis* exemption (i.e., threshold variable) for those quantities of lead in stainless steel, brass, or bronze alloys that meet the *de minimis* exemption requirements (e.g., manufactured as an impurity). However, the *de minimis* exemption does not include listed substances that are manufactured as byproducts. Accordingly, EPA will allow the *de minimis* exemption to be considered for all quantities of lead in stainless steel, brass, or bronze alloy even though this exemption will not be applied to lead not in stainless steel, brass, or bronze alloy.

Question 10: Can facilities use the Form A certification statement to report on lead and lead compounds? If a facility uses the Form R, can they use range reporting for Sections 5 and 6 for lead and lead compounds?

Answer: The Form A certification statement and range reporting for Sections 5 and 6 of Part II of the Form R cannot be applied to lead reporting if the 100 pound threshold has been exceeded for lead not contained within a stainless steel, brass, or bronze alloy—even if the facility would also be reporting lead and/or lead compounds in those alloys if the 25,000/10,000 pound threshold is exceeded. However, if a facility exceeds the 25,000/10,000 pound threshold but does not exceed the 100 pound threshold, the facility may consider the reporting variables.

Question 11: A facility processed 200 pounds of lead in alloys other than stainless steel, brass, or bronze. In doing so the facility has exceeded the 100 pound reporting threshold for lead and, therefore, must file a Form R for lead. In the same calendar year, the facility processed 24,000 pounds of lead in stainless steel, brass, or bronze alloy. Does the facility need to include releases and waste management quantities of the lead in stainless steel, brass, or bronze alloy on the Form R?

Answer: No, because the 25,000 pound processing threshold is not exceeded in this scenario. There are two thresholds to consider in this scenario: the 100 pound threshold for lead not in stainless steel, brass or bronze alloys, and the 25,000 pound processing threshold for all lead, including lead in stainless steel, brass, and bronze alloys (i.e., the qualified alloys). In this scenario, the 100 pound reporting threshold is exceeded, but the 25,000 pound activity threshold is not exceeded. The 100 pound threshold is exceeded because of the processing of 200 pounds of lead in alloys other than stainless steel, brass, or bronze. The 25,000 pound threshold is not exceeded because the combined weight of lead in the qualified alloys and non-qualified alloys does not meet or exceed 25,000 pounds (24,000 pounds + 200 pounds = 24,200 pounds). If, however, in this scenario the amount of processed lead in stainless steel, brass, or bronze were 24,850 pounds, then both the 100 pound threshold and the 25,000 pounds thresholds are exceeded, and all releases and waste management quantities from all forms of lead would be reported on the Form R.

Question 12: If a facility processes 95 pounds of lead in alloys other than stainless steel, brass, or bronze, and processes 24,910 pounds of lead in stainless steel, brass, or bronze alloy, does the facility need to report to TRI?

Answer: Yes, because the 25,000 pound threshold for lead in stainless steel, brass, or bronze has been exceeded. The 100 pound threshold for lead has not been exceeded. In this scenario, the facility may consider the *de minimis* exemption for quantities of lead in stainless steel, brass, or bronze alloy and the facility may consider the use of the Form A certification statement and range reporting.

Question 13: A facility exceeds a reporting threshold for lead metal. The facility also has lead piping in its operations. The natural degradation of the lead piping causes lead to be released in wastewater. Does the facility need to report this lead as released to water on the Form R required to be submitted?

Answer: Yes. While the release of lead from the pipes is not related to a threshold activity (i.e., a release activity by itself does not constitute the manufacture, processing, or otherwise use of lead or a lead compound), if the threshold for lead has been exceeded as result of manufacturing, processing, or otherwise use of lead elsewhere at the facility all other non-exempt releases and other waste management quantities of lead must be included on the Form R. Such releases are not considered, however, in determining whether an activity threshold has been exceeded. For example, in the above scenario the release of lead from degradation of the pipes would not be added to the quantity that is being applied to the threshold determination. Pipes used in a non-process related activity may qualify for the structural component exemption (40 CFR Section 372.38(c)(1)). It is important to note that the answer provided here is based on the scenario provided in the question that the lead is being released from the pipe as lead itself (i.e., Pb^0), not as a lead compound, such as lead oxide. If in this example, the lead released from the pipe were in the form of a lead compound, the release of the lead from the piping would not have to be included on the Form R, unless the lead compounds category reporting threshold has also been exceeded.

Question 14: A company is a decorator of decorative plates. A lead-bearing ceramic decal is sent to the facility by customers, which is applied on porcelain and kiln fired. We apply hundreds of different decals per year; accordingly, it is almost impossible to get an SDS for each decal. How does the facility determine the quantities of lead being processed and its waste stream? Is it necessary to measure lead in the air above the stack? Is it necessary to measure lead in water in which the decal is soaked?

Answer: The total quantity of a TRI chemical going into or through a facility's operations and that becomes incorporated into the product to be distributed in commerce is counted toward the processing activity threshold, even though a portion of that TRI chemical may not become part of the product and would be released into the environment or be managed as a waste via recycling, energy recovery, or treatment. Any small amounts of lead in a raw material (either as an impurity or as a necessary ingredient) must be counted toward the processing activity threshold. TRI does not impose any monitoring burden for determining the quantities. Some facilities are required to measure or monitor emission or other waste management quantities due to regulations unrelated to the TRI Program, or due to company policies. These existing, readily available data must be used by facilities for TRI reporting purposes if it is the most accurate information available to the facility. When measured (e.g., monitoring) data are not "readily available," or are known to be non-representative for TRI reporting purposes, the TRI regulations require that facilities determine release and other waste management quantities of TRI-listed chemicals by making "reasonable estimates." For example, information available on decals processed could be used to estimate quantities of lead in decals for which the company lacks data.

Metallic decals applied to glass via heat could remain articles if they do not change totally in thickness or diameter and if less than 0.5 pounds of the TRI chemical from all like items is released into the environment over the calendar year. The separation of the decal from its backing does not change its article status.

APPENDIX C. Emissions Factors Compiled from Various Sources

Appendix C contains emissions factors compiled from various sources including version 6.25 of EPA's Web Factor Information Retrieval (WebFIRE) Data System, and the California Air Resource Board's (CARB) California Air Toxic Emission Factors for Lead. The FIRE database can be accessed through the Technology Transfer Network Clearinghouse for Inventories and Emissions Factors website for WebFIRE at https://cfpub.epa.gov/webfire/. Select "Search for emissions factors," then select "Detailed Search" to access information on the WebFIRE database.

The data fields shown in Table C-1 in this appendix are as follows:

1. Material - The substance being manufactured, processed, or combusted.
2. Source Classification Code - A numeric code related to the material and controls.
3. Primary Control - The primary air pollution control device used on the tested source if applicable.
4. Secondary Control - The secondary air pollution control device used on the tested source if applicable.
5. Emissions Factor - The numerical result of the source test, usually an average of many tests.
6. Unit - The measurement of the air emissions, usually in pounds of lead.
7. Measure - The measurement of the amount of material manufactured, processed, or combusted.
8. Action - Whether the material was manufactured, processed, or combusted.
9. Notes - Any qualifications that must be reported regarding the use or interpretation of the emissions factor.
10. Formula - Any equation that must be reported regarding the use or interpretation of the emissions factor.
11. Reference - The document describing the development of the emissions factor.
12. Quality - A data quality rating (e.g., A, B, C, D, E, or U) as defined below.

Data quality ratings for the source tests and the number of source tests available for a given emission point were used to create the emissions factor quality ratings shown in the WebFIRE database. Because of the difficult task of assigning a meaningful confidence limit to industry-specific variables (e.g., sample size vs. sample population, industry and facility variability, method of measurement), the use of a statistical confidence interval for establishing a representative emissions factor for each source category was not practical. Therefore, some subjective quality rating was necessary. The following quality ratings were used in the emissions factor tables in the WebFIRE Data System:

A. *Excellent.* Emissions factor is developed primarily from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category population is sufficiently specific to minimize variability.
B. *Above average*. Emissions factor is developed primarily from A- or B-rated test data from a moderate number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category population is sufficiently specific to minimize variability.
C. *Average*. Emissions factor is developed primarily from A-, B-, and C-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category population is sufficiently specific to minimize variability.
D. *Below average*. Emissions factor is developed primarily from A-, B-, and C-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source population.

E. *Poor*. Factor is developed from C- rated and D-rated test data from a very few number of facilities, and there may be reasons to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population.
F. *Unrated* (Only used in the *Locating and Estimating Air Toxic Emissions* report series - Reference 4). Emissions factor is developed from source tests that have not been thoroughly evaluated, research papers, modeling data, or other sources that may lack supporting documentation. The data are not necessarily "poor," but there is not enough information to rate the factors according to the rating protocol.

Table C-1: Lead Emissions Factors Compiled from Version 6.25 of the Factor Information Retrieval (FIRE) Data System

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Air-Dried Unbleached Pulp[1]	30700106	Industrial Processes	Pulp and Paper and Wood Products	Sulfate (Kraft) Pulping	Lime Kiln	Uncontrolled	0.0001088	lb per tons produced	Detection limits used for non-detects.	U
Anthracite[2]	10100101	External Combustion Boilers	Electric Generation	Anthracite Coal	Pulverized Coal	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10100102	External Combustion Boilers	Electric Generation	Anthracite Coal	Traveling Grate (Overfeed) Stoker	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10200101	External Combustion Boilers	Industrial	Anthracite Coal	Pulverized Coal	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10200104	External Combustion Boilers	Industrial	Anthracite Coal	Traveling Grate (Overfeed) Stoker	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10200107	External Combustion Boilers	Industrial	Anthracite Coal	Hand-fired	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10300101	External Combustion Boilers	Commercial/ Institutional	Anthracite Coal	Pulverized Coal	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10300102	External Combustion Boilers	Commercial/ Institutional	Anthracite Coal	Traveling Grate (Overfeed) Stoker	Uncontrolled	0.0089	lb per tons burned		E
Anthracite[2]	10300103	External Combustion Boilers	Commercial/ Institutional	Anthracite Coal	Hand-fired	Uncontrolled	0.0089	lb per tons burned		E
Bark[3]	10200904	External Combustion Boilers	Industrial	Wood/Bark Waste	Bark-fired Boiler (< 50,000 Lb Steam) **	Uncontrolled	0.0029	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value.	D
Bark[3]	10200904	External Combustion Boilers	Industrial	Wood/Bark Waste	Bark-fired Boiler (< 50,000 Lb Steam) **	Miscellaneous Control Devices	0.000445	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value. Emission factor represents measurements from wood waste combustors equipped with PM controls (i.e., fabric filters, multi-cyclones, ESP, and wet scrubbers).	B

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Batteries	30400501	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Overall Process **	Uncontrolled	1.177	lb per tons produced		U
Batteries	30400502	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Casting Furnace **	Uncontrolled	0.059	lb per tons produced		U
Batteries	30400503	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Paste Mixer **	Uncontrolled	0.192	lb per tons produced		U
Batteries	30400504	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Three Process Operation **	Uncontrolled	0.815	lb per tons produced		U
Batteries[4]	30400506	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Grid Casting	Uncontrolled	7.700E-1 - 9.000E-1	lb per 1000 produced		B
Batteries[5]	30400506	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Grid Casting	Rotoclone	0.0673	lb per 1000 produced	Lack of Supporting Documentation.	U
Batteries[4]	30400507	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Paste Mixing	Uncontrolled	1.100E0 - 2.490E0	lb per 1000 produced		B
Batteries[6]	30400508	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Lead Oxide Mill (Baghouse Outlet)	Uncontrolled	0.11	lb per 1000 produced		U
Batteries[4]	30400508	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Lead Oxide Mill (Baghouse Outlet)	Baghouse	1.100E-1 - 1.200E-1	lb per 1000 produced		C
Batteries[4]	30400509	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Three Process Operation	Uncontrolled	1.060E1 - 1.460E1	lb per 1000 produced		B
Batteries[5]	30400509	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Three Process Operation	Fabric Filter	0.377	lb per 1000 produced	Baghouse average efficiency of 97.5% - 98.5%. Lack of Supporting Documentation.	U
Batteries[4]	30400510	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Lead Reclaiming Furnace	Uncontrolled	7.700E-1 - 1.380E0	lb per 1000 produced		B
Batteries[4]	30400511	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Small Parts Casting	Uncontrolled	0.1	lb per 1000 produced		C
Bituminous Coal[7]	10100202	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Bituminous Coal)	Miscellaneous Control Devices	0.00042	lb per 1000 burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10100203	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Cyclone Furnace (Bituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10100212	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Tangential) (Bituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Bituminous Coal[7]	10100218	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Atmospheric Fluidized Bed Combustion: Circulating Bed (Bitum. Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10200202	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10200203	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Cyclone Furnace	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal	10200210	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Overfeed Stoker **	Uncontrolled	0.0133	lb per tons burned		U
Bituminous Coal[7]	10200212	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Tangential)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10200218	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Atmospheric Fluidized Bed Combustion: Circulating Bed (Bitum. Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10300203	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Cyclone Furnace (Bituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[7]	10300206	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Bituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Bituminous Coal[8]	10300208	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Underfeed Stoker (Bituminous Coal)	Multiple Cyclone W/O Fly Ash Reinjection	0.00121	lb per tons burned	CEM, flue gas O2 averaged 7%, CO2 12% (dry). Lack of Supporting Documentation.	U
Bituminous Coal[8]	10300208	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Underfeed Stoker (Bituminous Coal)	Multiple Cyclone W/O Fly Ash Reinjection	0.0393	lb per tons burned	CEM, flue gas O2 averaged 5.2%, CO2 12.9% (dry), 16% by weight mixed fuel. Lack of Supporting Documentation.	U
Bituminous Coal[7]	10300216	External Combustion Boilers	Commercial/Instituti onal	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Tangential) (Bituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Bituminous Coal[7]	10300218	External Combustion Boilers	Commercial/Institutional	Bituminous/ Subbituminous Coal	Atmospheric Fluidized Bed Combustion: Circulating Bed (Bitum. Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Body[9]	31502101	Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Health Care - Crematoriums	Crematory Stack	Uncontrolled	0.0000662	lb per 1000 burned	Wrapping material = 4 lb of cardboard and 2 lb of wood.	U
Brick[10]	30500310	Industrial Processes	Mineral Products	Brick Manufacture	Curing and Firing: Sawdust Fired Tunnel Kilns	Uncontrolled	0.00015	lb per tons produced		D
Brick[10]	30500311	Industrial Processes	Mineral Products	Brick Manufacture	Curing and Firing: Gas-fired Tunnel Kilns	Uncontrolled	0.00015	lb per tons produced		D
Brick	30500313	Industrial Processes	Mineral Products	Brick Manufacture	Curing and Firing: Coal-fired Tunnel Kilns	Uncontrolled	0.00015	lb per tons produced		D
Brick	30500361	Industrial Processes	Mineral Products	Brick Manufacture	Sawdust Dryer: Heated With Exhaust From Sawdust-fired Kiln	Uncontrolled	0.00012	lb per tons produced		E
Bullion[11]	30301002	Industrial Processes	Primary Metal Production	Lead Production	Blast Furnace Operation	Baghouse	0.067	lb per tons processed	This includes emissions from dross kettles.	E
Cans[12]	30400109	Industrial Processes	Secondary Metal Production	Aluminum	Burning/Drying	Venture Scrubber	0.00000218	lb per pounds processed	Cans are 95% aluminum by weight.	U
Cans[12]	30400109	Industrial Processes	Secondary Metal Production	Aluminum	Burning/Drying	Baghouse	5.18E-09	lb per pounds processed	Cans are 95% aluminum by weight.	U
Cans[13]	30400109	Industrial Processes	Secondary Metal Production	Aluminum	Burning/Drying	Multiple Cyclones	0.0000108	lb per pounds processed		U
Cement[6]	30500613	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Raw Material Grinding and Drying	Uncontrolled	0.04	lb per tons produced		U
Cement[6]	30500606	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Kilns	Uncontrolled	0.12	lb per tons produced		U

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Cement[6]	30500617	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Clinker Grinding	Uncontrolled	0.04	lb per tons produced		U
Cement[6]	30500706	Industrial Processes	Mineral Products	Cement Manufacturing (Wet Process)	Kilns	Uncontrolled	0.1	lb per tons produced		U
Cement[6]	30500717	Industrial Processes	Mineral Products	Cement Manufacturing (Wet Process)	Clinker Grinding	Uncontrolled	0.02	lb per tons produced		U
Clinker[14]	30500606	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Kilns	Fabric Filter	0.000075	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500606	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Kilns	Electrostatic Precipitator	0.00071	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500622	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Preheater Kiln	Fabric Filter	0.000075	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500622	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Preheater Kiln	Electrostatic Precipitator	0.00071	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500623	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Preheater/ Precalciner Kiln	Fabric Filter	0.000075	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500623	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Preheater/ Precalciner Kiln	Electrostatic Precipitator	0.00071	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500706	Industrial Processes	Mineral Products	Cement Manufacturing (Wet Process)	Kilns	Fabric Filter	0.000075	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Clinker[14]	30500706	Industrial Processes	Mineral Products	Cement Manufacturing (Wet Process)	Kilns	Electrostatic Precipitator	0.00071	lb per tons produced	This entry has 4 SCC's: 30500606, 30500706, 30500622, and 30500623.	D
Concentrated Ore[15]	30300502	Industrial Processes	Primary Metal Production	Primary Copper Smelting	Multiple Hearth Roaster	Uncontrolled	0.15	l lb per tons processed	The emission factor is used to determine total process and fugitive emissions.	C
Concentrated Ore[15]	30300503	Industrial Processes	Primary Metal Production	Primary Copper Smelting	Reverberatory Smelting Furnace after Roaster	Uncontrolled	0.072	lb per tons processed	The emission factor is used to determine total process and fugitive emissions.	C
Concentrated Ore[15]	30300504	Industrial Processes	Primary Metal Production	Primary Copper Smelting	Converter (All Configurations)	Uncontrolled	0.27	lb per tons processed	The emission factor is used to determine total process and fugitive emissions.	C

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Concentrated Ore	30301001	Industrial Processes	Primary Metal Production	Lead Production	Sintering: Single Stream	Uncontrolled	105	lb per tons processed		U
Concentrated Ore	30301003	Industrial Processes	Primary Metal Production	Lead Production	Dross Reverberatory Furnace	Uncontrolled	2.9	lb per tons processed		U
Concentrated Ore[6]	30301006	Industrial Processes	Primary Metal Production	Lead Production	Sintering: Dual Stream Feed End	Uncontrolled	174	lb per tons processed		U
Distillate Oil (Diesel)[16]	20100101	Internal Combustion Engines	Electric Generation	Distillate Oil (Diesel)	Turbine	Uncontrolled	0.000014	lb per million Btus input	Emission factors based on an average distillate oil heating value of 139 MMBtu/1000 gallons. To convert from (lb/MMBtu) to (lb/1000 gallons), multiply by 139.	C
Distillate Oil (Diesel)[16]	20200101	Internal Combustion Engines	Industrial	Distillate Oil (Diesel)	Turbine	Uncontrolled	0.000014	lb per million Btus input	Emission factors based on an average distillate oil heating value of 139 MMBtu/1000 gallons. To convert from (lb/MMBtu) to (lb/1000 gallons), multiply by 139.	C
Distillate Oil (Diesel)[16]	20200103	Internal Combustion Engines	Industrial	Distillate Oil (Diesel)	Turbine: Cogeneration	Uncontrolled	0.000014	lb per million Btus input	Emission factors based on an average distillate oil heating value of 139 MMBtu/1000 gallons. To convert from (lb/MMBtu) to (lb/1000 gallons), multiply by 139.	C
Distillate Oil (Diesel)[16]	20300102	Internal Combustion Engines	Commercial/Instituti onal	Distillate Oil (Diesel)	Turbine	Uncontrolled	0.000014	lb per million Btus input	Emission factors based on an average distillate oil heating value of 139 MMBtu/1000 gallons. To convert from (lb/MMBtu) to (lb/1000 gallons), multiply by 139.	C
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Uncontrolled	0.1	lb per tons fed		B
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Venture Scrubber	0.0018	lb per tons fed		E
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Venture Scrubber Secondary: Impingement Type Wet Scrubber	0.06	lb per tons fed		B
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Venture Scrubber Secondary: Wet Electrostatic Precipitator	0.00018	lb per tons fed		E
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Single Cyclone	0.06	lb per tons fed		E
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Venture Scrubber Secondary: Single Cyclone	0.006	lb per tons fed		E
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Miscellaneous Control Devices	0.1	lb per tons fed	Control devices are venturi scrubber, impingement type wet scrubber, and afterburner.	E
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Miscellaneous Control Devices	0.022	lb per tons fed	Control devices are single cyclone, venturi scrubber, and impingement scrubber.	E

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Impingement Type Wet Scrubber	0.04	lb per tons fed		E
Dried Sludge[17]	50100515	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Multiple Hearth	Electrostatic Precipitator	0.002	lb per tons fed		E
Dried Sludge[17]	50100516	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Fluidized Bed	Uncontrolled	0.04	lb per tons fed		E
Dried Sludge[17]	50100516	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Fluidized Bed	Venture Scrubber Secondary: Impingement Type Wet Scubber	0.16	lb per tons fed		E
Dried Sludge[17]	50100516	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Fluidized Bed	Miscellaneous Control Devices	0.000002	lb per tons fed	Control devices are venturi scrubber, impingement type wet scrubber, and ESP.	E
Dried Sludge[17]	50100516	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Fluidized Bed	Impingement Type Wet Scrubber	0.006	lb per tons fed		E
Dried Sludge[17]	50100516	Waste Disposal	Solid Waste Disposal - Government	Other Incineration	Sludge: Fluidized Bed	Fabric Filter	0.00001	lb per tons fed		E
Electrode[18]	30905116	Industrial Processes	Fabricated Metal Products	Shielded Metal Arc Welding (SMAW)	E310 Electrode	Uncontrolled	0.024	lb per 1000 pounds consumed	Current = 102 to 225 A; voltage = 21 to 34 V. Includes E310-15.	C
Electrode[18]	30905152	Industrial Processes	Fabricated Metal Products	Shielded Metal Arc Welding (SMAW)	E7028 Electrode	Uncontrolled	0.162	lb per 1000 pounds consumed	Current = 102 to 225 A; voltage = 21 to 34 V.	C
Energy[19]	30300702	Industrial Processes	Primary Metal Production	Ferroalloy, Semi-covered Furnace	Electric Arc Furnace: Other Alloys/Specify	Venture Scrubber	6.06	lb per Megawatt-Hour consumed	Lack of Supporting Documentation.	U
Glaze[20]	30500845	Industrial Processes	Mineral Products	Ceramic Clay/Tile Manufacture	Ceramic Glaze Spray Booth	Uncontrolled	3	lb per tons used	Glaze being applied contained about 24% lead oxide.	E
Gray Iron[21]	30400301	Industrial Processes	Secondary Metal Production	Grey Iron Foundries	Cupola	Uncontrolled	1.000E-1 - 1.100E0	lb per tons produced		B
Heat[22]	10100201	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Wet Bottom (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100202	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Heat[22]	10100203	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Cyclone Furnace (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100204	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Spreader Stoker (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100205	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Traveling Grate (Overfeed) Stoker (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100221	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Wet Bottom (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100222	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100223	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Cyclone Furnace (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100224	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Spreader Stoker (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10100225	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Traveling Grate (Overfeed) Stoker (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[23]	10100501	External Combustion Boilers	Electric Generation	Distillate Oil	Grades 1 and 2 Oil	Uncontrolled	0.000009	lb per million Btus input		E
Heat[24]	10100901	External Combustion Boilers	Electric Generation	Wood/Bark Waste	Bark-fired Boiler	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[24]	10100902	External Combustion Boilers	Electric Generation	Wood/Bark Waste	Wood/Bark Fired Boiler	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Heat[24]	10100903	External Combustion Boilers	Electric Generation	Wood/Bark Waste	Wood-fired Boiler - Wet Wood (>=20% moisture)	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[24]	10100908	External Combustion Boilers	Electric Generation	Wood/Bark Waste	Wood-fired Boiler - Dry Wood (<20% moisture)	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[25]	10101201	External Combustion Boilers	Electric Generation	Solid Waste	Specify Waste Material in Comments	Electrostatic Precipitator	0.000124	lb per million Btus input		U
Heat[22]	10200201	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Wet Bottom	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200203	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Cyclone Furnace	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200204	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Spreader Stoker	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200205	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Overfeed Stoker	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200206	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Underfeed Stoker	Uncontrolled	0.000507	lb per million Btus input		E
Heat[26]	10200799	External Combustion Boilers	Industrial	Process Gas	Other: Specify in Comments	Uncontrolled	0.00000666	lb per million Btus input		U
Heat[22]	10200221	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Wet Bottom (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200222	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200223	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Cyclone Furnace (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Heat[22]	10200224	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Spreader Stoker (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10200225	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Traveling Grate (Overfeed) Stoker (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[23]	10200501	External Combustion Boilers	Industrial	Distillate Oil	Grades 1 and 2 Oil	Uncontrolled	0.000009	lb per million Btus input		E
Heat[24]	10200901	External Combustion Boilers	Industrial	Wood/Bark Waste	Bark-fired Boiler	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[27]	10200901	External Combustion Boilers	Industrial	Wood/Bark Waste	Bark-fired Boiler	Electrostatic Precipitator- Medium Efficiency	0.0000015	lb per million Btus input	F-factor 9,600 dscf/MMBtu. Emission factor developed from metal to PM ratio in front-half sample.	U
Heat[24]	10200902	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood/Bark-fired Boiler	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[24]	10200903	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler - Wet Wood (>=20% moisture)	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[27]	10200903	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler - Wet Wood (>=20% moisture)	Wet Scrubber - Medium Efficiency	0.000016	lb per million Btus input	F-factor 9,420 dscf/MMBtu. Emission factor developed from metal to PM ratio in front-half sample.	U
Heat[27]	10200903	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler - Wet Wood (>=20% moisture)	Multiple Cyclone W/O Fly Ash Reinjection Secondary: Wet Scrubber - Medium Efficiency	0.00004	lb per million Btus input	F-factor, 9,240 dscf/MMBtu. Emission factor developed from metal to PM ratio in front-half sample.	U

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Heat[5]	10200903	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler - Wet Wood (>=20% moisture)	Multiple Cyclone W/O Fly Ash Reinjection Secondary: Electrostatic Precipitator- Medium Efficiency	0.00000225	lb per million Btus input	F factor 9,240 dscf/MMBtu. Emission factor developed from metal to PM ratio in front-half sample.	U
Heat[28]	10200906	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler (< 50,000 Lb Steam) **	Scrubber	0.0000114	lb per million Btus input	Factors calculated using an F-factor for wood of 9240 dscf/MMBtu.	U
Heat[24]	10200908	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler - Dry Wood (<20% moisture)	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[23]	10300501	External Combustion Boilers	Commercial/ Institutional	Distillate Oil	Grades 1 and 2 Oil	Uncontrolled	0.000009	lb per million Btus input		E
Heat[22]	10300203	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Cyclone Furnace (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300205	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Wet Bottom (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300206	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300207	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Overfeed Stoker (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300209	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Spreader Stoker (Bituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300221	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Wet Bottom (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Heat[22]	10300222	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300223	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Cyclone Furnace (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300224	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Spreader Stoker (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[22]	10300225	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Traveling Grate (Overfeed) Stoker (Subbituminous Coal)	Uncontrolled	0.000507	lb per million Btus input		E
Heat[24]	10300901	External Combustion Boilers	Commercial/ Institutional	Wood/Bark Waste	Bark-fired Boiler	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[24]	10300902	External Combustion Boilers	Commercial/ Institutional	Wood/Bark Waste	Wood/Bark-fired Boiler	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[24]	10300903	External Combustion Boilers	Commercial/ Institutional	Wood/Bark Waste	Wood-fired Boiler - Wet Wood (>=20% moisture)	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[24]	10300908	External Combustion Boilers	Commercial/Institutional	Wood/Bark Waste	Wood-fired Boiler - Dry Wood (<20% moisture)	Uncontrolled	0.000048	lb per million Btus input	To convert the emission factor from Lb/MMBtu to Lb/ton, multiply the emission factor by (HHV * 2000) where "HHV" is the higher heating value of the fuel (MMBtu/lb). Factors are for boilers with no controls or with particulate matter controls.	A
Heat[29]	30600101	Industrial Processes	Petroleum Industry	Process Heaters	Oil-fired **	Uncontrolled	0.0000021	lb per million Btus input	CARB2588 data.	U
Heat[5]	31000413	Industrial Processes	Oil and Gas Production	Process Heaters	Crude Oil: Steam Generators	Low Nox Burners	0.00000194	lb per million Btus input		U

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Hot Mix Asphalt[30]	30500245	Industrial Processes	Mineral Products	Asphalt Concrete	Batch Mix Plant: Hot Elevators, Screens, Bins, Mixer & NG Rot Dryer	Fabric Filter	0.00000089	lb per tons produced		D
Hot Mix Asphalt[30]	30500246	Industrial Processes	Mineral Products	Asphalt Concrete	Batch Mix Plant: Hot Elevators, Screens, Bins, Mixer& #2 Oil Rot Dryer	Fabric Filter	0.00000089	lb per tons produced		D
Hot Mix Asphalt[30]	30500247	Industrial Processes	Mineral Products	Asphalt Concrete	Batch Mix Plant: Hot Elevs, Scrns, Bins, Mixer& Waste/Drain/#6 Oil Rot	Fabric Filter	0.00001	lb per tons produced		E
Hot Mix Asphalt[30]	30500255	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, Natural Gas-Fired	Fabric Filter	0.00000062	lb per tons produced		E
Hot Mix Asphalt[30]	30500256	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, Natural Gas, Parallel Flow	Fabric Filter	0.00000062	lb per tons produced		E
Hot Mix Asphalt[30]	30500257	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, Natural Gas, Counterflow	Fabric Filter	0.00000062	lb per tons produced		E
Hot Mix Asphalt[30]	30500258	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, #2 Oil-Fired	Uncontrolled	0.00054	lb per tons produced		E
Hot Mix Asphalt[30]	30500258	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, #2 Oil-Fired	Fabric Filter	0.000015	lb per tons produced		C

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Hot Mix Asphalt[30]	30500259	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, #2 Oil-Fired, Parallel Flow	Uncontrolled	0.00054	lb per tons produced		E
Hot Mix Asphalt[30]	30500259	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, #2 Oil-Fired, Parallel Flow	Fabric Filter	0.000015	lb per tons produced		C
Hot Mix Asphalt[30]	30500260	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, #2 Oil-Fired, Counterflow	Uncontrolled	0.00054	lb per tons produced		E
Hot Mix Asphalt[30]	30500260	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer / Mixer, #2 Oil-Fired, Counterflow	Fabric Filter	0.000015	lb per tons produced		C
Hot Mix Asphalt[30]	30500261	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Plant: Rotary Drum Dryer/Mixer, Waste/Drain/#6 Oil-Fired	Fabric Filter	0.000015	lb per tons produced		C
Hot Mix Asphalt[30]	30500262	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Pl: Rotary Drum Dryer/Mixer, Waste/Drain/#6 Oil, Parallel Flo	Fabric Filter	0.000015	lb per tons produced		C
Hot Mix Asphalt[30]	30500263	Industrial Processes	Mineral Products	Asphalt Concrete	Drum Mix Pl: Rotary Drum Dryer/Mixer, Waste/Drain/#6 Oil, Counterflow	Fabric Filter	0.000015	lb per tons produced		C
Lead[31]	30400409	Industrial Processes	Secondary Metal Production	Lead	Casting	Uncontrolled	0.01	lb per tons cast	Lead content of casting emissions is 36%.	C
Lead[31]	30400413	Industrial Processes	Secondary Metal Production	Lead	Smelting Furnace: Fugitive Emissions	Uncontrolled	2.000E-1 - 6.000E-1	lb per tons produced		E

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Lead[32]	30400413	Industrial Processes	Secondary Metal Production	Lead	Smelting Furnace: Fugitive Emissions	Baghouse	0.012	lb per tons produced		U
Lead[33]	30301002	Industrial Processes	Primary Metal Production	Lead Production	Blast Furnace Operation	Uncontrolled	0.0001	lb per tons produced	Lack of Supporting Documentation.	U
Lead[33]	30301002	Industrial Processes	Primary Metal Production	Lead Production	Blast Furnace Operation	Spray Tower Secondary: Fabric Filter	0.017	lb per tons produced	Lack of Supporting Documentation.	U
Lead[31]	30400414	Industrial Processes	Secondary Metal Production	Lead	Kettle Refining: Fugitive Emissions	Uncontrolled	0.0006	lb per tons produced		E
Lead[33]	30400414	Industrial Processes	Secondary Metal Production	Lead	Kettle Refining: Fugitive Emissions	Miscellaneous Control Devices	2.4	lb per tons produced	Control devices are afterburner, fabric filter, venturi scrubber, and demister. Lack of Supporting Documentation.	U
Lead[31]	30400425	Industrial Processes	Secondary Metal Production	Lead	Casting: Fugitive Emissions	Uncontrolled	0.0007	lb per tons produced		E
Lead[31]	30400426	Industrial Processes	Secondary Metal Production	Lead	Kettle Refining	Uncontrolled	0.01	lb per tons produced	Lead content of kettle refining emissions is 40%.	C
Lead[33]	30400507	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Paste Mixing	Wet Scrubber - Medium Efficiency	0.0004	lb per tons produced	Uncontrolled emissions = 3.3E-4 lb/ton. Lack of Supporting Documentation.	U
Lead[34]	30400510	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Lead Reclaiming Furnace	Scrubber	0.101	lb per tons processed	Controlled by cascade scrubber at average efficiency of 98.3%, lead acid batteries. Lack of Supporting Documentation.	U
Lead[35]	30405103	Industrial Processes	Secondary Metal Production	Metallic Lead Products	Other Sources of Lead	Uncontrolled	1.5	lb per tons processed		C
Lead in Ore[36]	30301004	Industrial Processes	Primary Metal Production	Lead Production	Ore Crushing	Baghouse	0.002	lb per tons crushed		E
Lead Oxide	30400408	Industrial Processes	Secondary Metal Production	Lead	Barton Process Reactor (Oxidation Kettle)	Uncontrolled	0.44	lb per tons produced		U
Lignite[37]	10100301	External Combustion Boilers	Electric Generation	Lignite	Pulverized Coal: Dry Bottom, Wall Fired	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Lignite[37]	10100302	External Combustion Boilers	Electric Generation	Lignite	Pulverized Coal: Dry Bottom, Tangential Fired	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Lignite[37]	10100303	External Combustion Boilers	Electric Generation	Lignite	Cyclone Furnace	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Lignite[37]	10100318	External Combustion Boilers	Electric Generation	Lignite	Atmospheric Fluidized Bed Combustion - Circulating Bed	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Lignite[37]	10200301	External Combustion Boilers	Industrial	Lignite	Pulverized Coal: Dry Bottom, Wall Fired	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Lignite[37]	10200302	External Combustion Boilers	Industrial	Lignite	Pulverized Coal: Dry Bottom, Tangential Fired	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Lignite[37]	10200303	External Combustion Boilers	Industrial	Lignite	Cyclone Furnace	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Lignite[37]	10300305	External Combustion Boilers	Commercial/ Institutional	Lignite	Pulverized Coal: Dry Bottom, Wall Fired	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Lignite[37]	10300306	External Combustion Boilers	Commercial/ Institutional	Lignite	Pulverized Coal: Dry Bottom, Tangential Fired	Miscellaneous Control Devices	0.00042	lb per tons burned	The factor applies to boilers utilizing either venturi scrubbers, spray dryer absorbers, or wet limestone scrubbers with an electrostatic precipitator (ESP) or fabric filter (FF). In addition, the factor applies to boilers using only an ESP, FF, or venturi scrubber. Emission factor equations are available in AP42 Table 1.7-12 for this pollutant for all typical firing configurations and control scenarios	A
Material[38]	30103506	Industrial Processes	Chemical Manufacturing	Inorganic Pigments	Lead Oxide: Barton Pot	Uncontrolled	0.44	lb per tons produced		E
Material[38]	30103507	Industrial Processes	Chemical Manufacturing	Inorganic Pigments	Lead Oxide: Calciner	Uncontrolled	14	lb per tons produced		E
Material[38]	30103507	Industrial Processes	Chemical Manufacturing	Inorganic Pigments	Lead Oxide: Calciner	Baghouse	0.05	lb per tons produced		E
Material[38]	30103510	Industrial Processes	Chemical Manufacturing	Inorganic Pigments	Red Lead	Uncontrolled	0.9	lb per tons produced		B
Material[38]	30103515	Industrial Processes	Chemical Manufacturing	Inorganic Pigments	White Lead	Uncontrolled	0.55	lb per tons produced		B
Material[38]	30103520	Industrial Processes	Chemical Manufacturing	Inorganic Pigments	Lead Chromate	Uncontrolled	0.13	lb per tons produced		B
Material[39]	30104201	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Recovery Furnace	Uncontrolled	55	lb per tons produced		U

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Material	30104201	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Recovery Furnace	Fabric Filter Secondary: Wet Scrubber	55	lb per tons produced		B
Material[39]	30104202	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Process Vents: Tetraethyl Lead	Uncontrolled	4	lb per tons produced		U
Material[40]	30104202	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Process Vents: Tetraethyl Lead	Miscellaneous Control Devices	4	lb per tons produced	Controls are incinerator and fabric filter or wet scrubber and incinerator.	B
Material[39]	30104203	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Process Vents: Tetramethyl Lead	Uncontrolled	150	lb per tons produced		U
Material[40]	30104203	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Process Vents: Tetramethyl Lead	Miscellaneous Control Devices	150	lb per tons produced	Controls are incinerator and fabric filter, or wet scrubber and incinerator.	B
Material[40]	30104204	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Sodium/Lead Alloy Process)	Sludge Pits	Uncontrolled	1.2	lb per tons produced	Emissions are fugitive.	B
Material[39]	30104301	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Electrolytic Process)	General	Uncontrolled	1	lb per tons produced		U
Material[40]	30104301	Industrial Processes	Chemical Manufacturing	Lead Alkyl Manufacturing (Electrolytic Process)	General	Miscellaneous Control Devices	1	lb per tons produced	Controls are an elevated flare and a liquid incinerator, while a scrubber w/toluene as medium controls the blending and tank car loading/unloading systems.	B
Material[39]	30300601	Industrial Processes	Primary Metal Production	Ferroalloy, Open Furnace	50% FeSi: Electric Smelting Furnace	Uncontrolled	0.29	lb per tons produced		U
Material[39]	30300604	Industrial Processes	Primary Metal Production	Ferroalloy, Open Furnace	Silicon Metal: Electric Smelting Furnace	Uncontrolled	0.0031	lb per tons produced		U
Material[41]	30300605	Industrial Processes	Primary Metal Production	Ferroalloy, Open Furnace	Silicomanaganese : Electric Smelting Furnace	Uncontrolled	0.0057	lb per tons produced		U

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Material[39]	30300701	Industrial Processes	Primary Metal Production	Ferroalloy, Semi-covered Furnace	Ferromanganese: Electric Arc Furnace	Uncontrolled	0.11	lb per tons produced		U
Material[42]	30400242	Industrial Processes	Secondary Metal Production	Copper	Charge with Other Alloy (7%): Reverberatory Furnace	Uncontrolled	5	lb per tons produced		B
Material[42]	30400243	Industrial Processes	Secondary Metal Production	Copper	Charge with High Lead Alloy (58%): Reverberatory Furnace	Uncontrolled	50	lb per tons produced		B
Material[42]	30400244	Industrial Processes	Secondary Metal Production	Copper	Charge with Red/Yellow Brass: Reverberatory Furnace	Uncontrolled	13.2	lb per tons produced		B
Material[44]	30400522	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Grid Casting	Uncontrolled	0.139	lb per tons processed	Lack of Supporting Documentation.	U
Material[45]	30400523	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Paste Mixing	Uncontrolled	1.72	lb per tons processed	Lead acid batteries. Lack of Supporting Documentation.	U
Material[44]	30400526	Industrial Processes	Secondary Metal Production	Lead Battery Manufacture	Lead Reclaiming Furnace	Uncontrolled	5.9	lb per tons processed	Lack of Supporting Documentation.	U
Material[35]	30404001	Industrial Processes	Secondary Metal Production	Lead Cable Coating	General	Uncontrolled	0.5	lb per tons processed		C
Material	30501107	Industrial Processes	Mineral Products	Concrete Batching	Cement Unloading to Elevated Storage Silo	Uncontrolled	0.000000736	lb per tons processed	From one emission test of pneumatic unloading cement to elevated storage silo.	E
Material[46]	30501107	Industrial Processes	Mineral Products	Concrete Batching	Cement Unloading to Elevated Storage Silo	Fabric Filter	1.09E-08	lb per tons processed	From one emission test of pneumatic unloading cement to elevated storage silo.	E
Material[46]	30501109	Industrial Processes	Mineral Products	Concrete Batching	Mixer Loading of Cement/Sand/Aggregate	Uncontrolled	0.000000382	lb per tons processed	Material processed includes only cement and cement supplement. From one emission test of central mix production facility. The average estimated capture efficiency of the enclosure was 94%.	E
Material[46]	30501109	Industrial Processes	Mineral Products	Concrete Batching	Mixer Loading of Cement/Sand/Aggregate	Fabric Filter	3.66E-08	lb per tons processed	Material processed includes only cement and cement supplement. From one emission test of central mix production facility. The average estimated capture efficiency of the enclosure was 94%.	E

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Material[46]	30501110	Industrial Processes	Mineral Products	Concrete Batching	Loading of Transit Mix Truck	Uncontrolled	0.00000362	lb per tons processed	Material processed includes only cement and cement supplement. From two emission tests of truck mix production facility. The average estimated capture efficiency of the enclosure was 71%.	E
Material[46]	30501110	Industrial Processes	Mineral Products	Concrete Batching	Loading of Transit Mix Truck	Fabric Filter	0.00000153	lb per tons processed	Material processed includes only cement and cement supplement. From two emission tests of truck mix production facility. The average estimated capture efficiency of the enclosure was 71%.	E
Material[46]	30501117	Industrial Processes	Mineral Products	Concrete Batching	Cement Supplement Unloading to Elevated Storage Silo	Fabric Filter	0.00000052	lb per tons processed	From one emission test of pneumatic unloading cement to elevated storage silo.	E
Material[47]	30501305	Industrial Processes	Mineral Products	Frit Manufacture	Rotary Smelting Furnace	Fabric Filter	0.00001	lb per tons fed		E
Material[47]	30501306	Industrial Processes	Mineral Products	Frit Manufacture	Continuous Smelting Furnace	Fabric Filter	0.00001	lb per tons fed		E
Material[48]	30503505	Industrial Processes	Mineral Products	Abrasive Grain Processing	Washing/Drying	Wet Scrubber	0.0044	lb per tons processed		E
Material[35]	36000101	Industrial Processes	Printing and Publishing	Typesetting (Lead Remelting)	Remelting (Lead Emissions Only)	Uncontrolled	0.25	lb per tons melted		C
Material[49]	50300203	Waste Disposal	Solid Waste Disposal - Industrial	Open Burning	Auto Body Components	Uncontrolled	0.0002	lb per tons burned		C
Material[49]	50300203	Waste Disposal	Solid Waste Disposal - Industrial	Open Burning	Auto Body Components	Uncontrolled	0.00067	lb per tons burned		C
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Uncontrolled	0.0728	lb per tons burned		B
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Wet Scrubber - High Efficiency	0.0698	lb per tons burned		E
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Wet Scrubber - Medium Efficiency (Fabric Filter)	0.0016	lb per tons burned		E

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Wet Scrubber - Low Efficiency	0.0794	lb per tons burned		E
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Fabric Filter	0.0000992	lb per tons burned		E
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Baghouse Secondary: Dry Sorbent Injection	0.0000517	lb per tons burned	Control devices are dry sorbent injection, Baghouse, and scrubber.	E
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Fabric Filter Secondary: Dry Sorben Injection	0.0000625	lb per tons burned		E
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0047	lb per tons burned		E
Medical Waste[50]	50200501	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Med Waste Controlled Air Incin-aka Starved air, 2-stg, or Modular comb	Dry Sorbent Injection Secondary: Carbon Injection	0.0000927	lb per tons burned	Control devices used were dry sorbent injection, carbon injection, and fabric filter.	E
Medical Waste[50]	50200503	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Medical Waste Rotary Kiln Incinerator	Uncontrolled	0.124	lb per tons burned		E
Medical Waste[50]	50200503	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Medical Waste Rotary Kiln Incinerator	Miscellaneous Control Devices Secondary: Spray Dryer	0.0000738	lb per tons burned	Control devices used were spray dryer, carbon injection, and fabric filter.	E

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Medical Waste[50]	50200503	Waste Disposal	Solid Waste Disposal - Commercial/ Institutional	Incineration: Special Purpose	Medical Waste Rotary Kiln Incinerator	Fabric Filter Secondary: Spray Dryer	0.000189	lb per tons burned		E
Metal[43]	30400301	Industrial Processes	Secondary Metal Production	Grey Iron Foundries	Cupola	Baghouse	0.002672	lb per tons charged	Iron melting stack data exceeded the standards specified by the permit for all pollutants, except sulfur dioxide.	U
Metal[31]	30400402	Industrial Processes	Secondary Metal Production	Lead	Reverberatory Furnace	Uncontrolled	65	lb per tons produced		C
Metal[31]	30400403	Industrial Processes	Secondary Metal Production	Lead	Blast Furnace (Cupola)	Uncontrolled	104	lb per tons produced		C
Metal[31]	30400403	Industrial Processes	Secondary Metal Production	Lead	Blast Furnace (Cupola)	Miscellaneous Control Devices	0.29	lb per tons produced	The controlled emission factor was estimated from tests using several control devices such as Baghouse, wet scrubber, cyclone, fabric filter, settling chamber and demister.	C
Natural Gas[51]	10100601	External Combustion Boilers	Electric Generation	Natural Gas	Boilers > 100 Million Btu/hr except Tangential	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	10100602	External Combustion Boilers	Electric Generation	Natural Gas	Boilers < 100 Million Btu/hr except Tangential	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	10100604	External Combustion Boilers	Electric Generation	Natural Gas	Tangentially Fired Units	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	10200601	External Combustion Boilers	Industrial	Natural Gas	> 100 Million Btu/hr	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	10200602	External Combustion Boilers	Industrial	Natural Gas	10-100 Million Btu/hr	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	10300602	External Combustion Boilers	Commercial/ Institutional	Natural Gas	10-100 Million Btu/hr	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Natural Gas[51]	10300601	External Combustion Boilers	Commercial/ Institutional	Natural Gas	> 100 Million Btu/hr	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	10300603	External Combustion Boilers	Commercial/ Institutional	Natural Gas	< 10 Million Btu/hr	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Natural Gas[51]	2104006010	Stationary Source Fuel Combustion	Residential	Natural Gas	Residential Furnaces	Uncontrolled	0.0005	lb per million cubic feet burned	Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act. HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.	D
Ore[39]	30301004	Industrial Processes	Primary Metal Production	Lead Production	Ore Crushing	Uncontrolled	0.3	lb per tons crushed		U
Ore[36]	30301028	Industrial Processes	Primary Metal Production	Lead Production	Tetrahedrite Dryer	Baghouse	0.0006	lb per tons processed		E
Ore[36]	30301032	Industrial Processes	Primary Metal Production	Lead Production	Ore Screening	Baghouse	0.002	lb per tons processed		E
Ore[52]	30303101	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Lead Ore w/ 5.1% Lead Content	Uncontrolled	0.3	lb per tons processed		B
Ore[52]	30303102	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Zinc Ore w/ 0.2% Lead Content	Uncontrolled	0.012	lb per tons processed		B
Ore[52]	30303103	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Copper Ore w/ 0.2% Lead Content	Uncontrolled	0.012	lb per tons processed		B
Ore[52]	30303104	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Lead-Zinc Ore w/ 2% Lead Content	Uncontrolled	0.12	lb per tons processed		B
Ore[52]	30303105	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Copper-Lead Ore w/ 2% Lead Content	Uncontrolled	0.12	lb per tons processed		B
Ore[52]	30303106	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Copper-Zinc Ore w/ 0.2% Lead Content	Uncontrolled	0.012	lb per tons processed		B
Ore[52]	30303107	Industrial Processes	Primary Metal Production	Leadbearing Ore Crushing and Grinding	Copper-Lead-Zinc w/ 2% Lead Content	Uncontrolled	0.12	lb per tons processed		B

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Pellets[53]	30302351	Industrial Processes	Primary Metal Production	Taconite Iron Ore Processing	Induration: Grate/Kiln, Gas-fired, Acid Pellets	Multiple Cyclones	0.0005	lb per tons produced		E
Pellets[53]	30302352	Industrial Processes	Primary Metal Production	Taconite Iron Ore Processing	Induration: Grate/Kiln, Gas-fired, Flux Pellets	Multiple Cyclones	0.0005	lb per tons produced		E
Pellets[53]	30302381	Industrial Processes	Primary Metal Production	Taconite Iron Ore Processing	Induration: Straight Grate, Gas-fired, Acid Pellets	Multiple Cyclones Secondary: Wet Scrubber	0.000068	lb per tons produced		E
Pellets[53]	30302382	Industrial Processes	Primary Metal Production	Taconite Iron Ore Processing	Induration: Straight Grate, Gas-fired, Flux Pellets	Multiple Cyclones Secondary: Wet Scrubber	0.000068	lb per tons produced		E
Pellets[53]	30302387	Industrial Processes	Primary Metal Production	Taconite Iron Ore Processing	Induration: Straight Grate, Coke & Gas-fired, Acid Pellets	Multiple Cyclones Secondary: Wet Scrubber	0.000076	lb per tons produced		E
Pellets[53]	30302388	Industrial Processes	Primary Metal Production	Taconite Iron Ore Processing	Induration: Straight Grate, Coke & Gas-fired, Flux Pellets	Multiple Cyclones Secondary: Wet Scrubber	0.000076	lb per tons produced		E
Raw Material	30303012	Industrial Processes	Primary Metal Production	Zinc Production	Raw Material Unloading	Uncontrolled	0.13	lb per tons processed		U
Refuse Derived Fuel[39]	10301202	External Combustion Boilers	Commercial/Institutional	Solid Waste	Refuse Derived Fuel	Uncontrolled	0.13	lb per tons burned	Edited 05/19/92	U
Refuse Derived Fuel[39]	10201202	External Combustion Boilers	Industrial	Solid Waste	Refuse Derived Fuel	Uncontrolled	0.13	lb per tons burned	Edited 05/19/92	U
Refuse Derived Fuel[54]	50100103	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Refuse Derived Fuel	Uncontrolled	0.201	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 5500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2, NOx, CO).	C
Refuse Derived Fuel[54]	50100103	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Refuse Derived Fuel	Electrostatic Precipitator	0.00366	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 5500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2, NOx, CO).	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Refuse Derived Fuel[54]	50100103	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Refuse Derived Fuel	Fabric Filter Secondary: Spray Dryer	0.00104	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 5500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2, NOx, CO).	D
Refuse Derived Fuel[54]	50100103	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Refuse Derived Fuel	Electrostatic Precipitator Secondary: Spray Dryer	0.00116	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 5500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2, NOx, CO).	B
Residual Oil[55]	31000402	Industrial Processes	Oil and Gas Production	Process Heaters	Residual Oil	Uncontrolled	0.00224	lb per 1000 gallons burned	F-factor, residual oil (calculated) = 9,103 dscf/MMBtu.	U
Residual Oil (No. 5)[56]	10100405	External Combustion Boilers	Electric Generation	Residual Oil	Grade 5 Oil: Normal Firing	Uncontrolled	0.0024	lb per 1000 gallons burned	CARB2588 data.	U
Residual Oil (No. 6)[23]	10100401	External Combustion Boilers	Electric Generation	Residual Oil	Grade 6 Oil: Normal Firing	Uncontrolled	0.00151	lb per 1000 gallons burned		C
Residual Oil (No. 6)[23]	10100404	External Combustion Boilers	Electric Generation	Residual Oil	Grade 6 Oil: Tangential Firing	Uncontrolled	0.00151	lb per 1000 gallons burned		C
Sinter[11]	30301025	Industrial Processes	Primary Metal Production	Lead Production	Sinter Machine Leakage	Electrostatic Precipitator Secondary: Scrubber	0.032	lb per tons processed	This includes fugitive emissions from sinter building.	E
Sinter[11]	30301029	Industrial Processes	Primary Metal Production	Lead Production	Sinter Machine (Weak Gas)	Electrostatic Precipitator Secondary: Scrubber	0.019	lb per tons produced		E
Solid Waste[25]	10101201	External Combustion Boilers	Electric Generation	Solid Waste	Specify Waste Material in Comments	Uncontrolled	0.265	lb per tons burned		U
Solid Waste[57]	10101201	External Combustion Boilers	Electric Generation	Solid Waste	Specify Waste Material in Comments	Miscellaneous Control Devices	< 2.660E-4	lb per tons burned	Control devices are spray dryer, absorber, and electrostatic precipitator. Two detection limit values were used to calculate the emission factor averages.	U
Solid Waste[39]	50100101	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Starved Air: Multiple Chamber	Uncontrolled	0.12	lb per tons burned		U

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50100101	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Starved Air: Multiple Chamber	Electrostatic Precipitator	0.00282	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., CO, NOx).	C
Solid Waste[39]	50100102	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn: Single Chamber	Uncontrolled	0.18	lb per tons burned		U
Solid Waste[54]	50100104	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Refractory Wall Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100104	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Refractory Wall Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100104	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Refractory Wall Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100104	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Refractory Wall Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100104	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Refractory Wall Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50100104	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Refractory Wall Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[54]	50100105	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Waterwall Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50100105	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Waterwall Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100105	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Waterwall Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100105	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Waterwall Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100105	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Waterwall Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50100105	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Waterwall Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[54]	50100106	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Rotary Waterwall Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100106	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Rotary Waterwall Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100106	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Rotary Waterwall Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50100106	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Rotary Waterwall Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100106	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Rotary Waterwall Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50100106	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Mass Burn Rotary Waterwall Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[54]	50100107	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Modular Excess Air Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100107	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Modular Excess Air Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100107	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Modular Excess Air Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100107	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Modular Excess Air Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50100107	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Modular Excess Air Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50100107	Waste Disposal	Solid Waste Disposal - Government	Municipal Incineration	Modular Excess Air Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[58]	50300102	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Single Chamber	Uncontrolled	0.00181	lb per tons burned		U
Solid Waste[54]	50300111	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Refractory Wall Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300111	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Refractory Wall Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300111	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Refractory Wall Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300111	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Refractory Wall Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300111	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Refractory Wall Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50300111	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Refractory Wall Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[54]	50300112	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Waterwall Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50300112	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Waterwall Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300112	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Waterwall Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300112	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Waterwall Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300112	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Waterwall Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50300112	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Waterwall Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[54]	50300113	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Rotary Waterwall Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300113	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Rotary Waterwall Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300113	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Rotary Waterwall Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50300113	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Rotary Waterwall Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300113	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Rotary Waterwall Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50300113	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Mass Burn Rotary Waterwall Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Solid Waste[54]	50300114	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Starved-air Combustor	Electrostatic Precipitator	0.00282	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., CO, NOx).	C
Solid Waste[54]	50300115	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Excess-air Combustor	Uncontrolled	0.213	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300115	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Excess-air Combustor	Electrostatic Precipitator	0.003	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300115	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Excess-air Combustor	Fabric Filter Secondary: Spray Dryer	0.000261	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A
Solid Waste[54]	50300115	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Excess-air Combustor	Electrostatic Precipitator Secondary: Spray Dryer	0.000915	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Solid Waste[54]	50300115	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Excess-air Combustor	Fabric Filter Secondary: Dry Sorbent Injection	0.000297	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	C
Solid Waste[54]	50300115	Waste Disposal	Solid Waste Disposal - Industrial	Incineration	Modular Excess-air Combustor	Electrostatic Precipitator Secondary: Dry Sorbent Injection	0.0029	lb per tons burned	EF calculated from F-factor of 9570 dscf/MBtu and heating value of 4500 Btu/lb EF should be used for estimating long-term emission levels. This particularly applies to pollutants measured w/ continuous emission monitoring system (e.g., SO2).	E
Sprayed Metal	30904001	Industrial Processes	Fabricated Metal Products	Metal Deposition Processes	Metallizing: Wire Atomization and Spraying	Uncontrolled	0.5	lb per tons consumed		U
Steel[59]	30900198	Industrial Processes	Fabricated Metal Products	General Processes	Other Not Classified	Baghouse	0.00294	lb per tons produced	Emission factors are based on the sum of the results of the front and back half sample analysis.	U
Subbituminous Coal[22]	10100222	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10100223	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Cyclone Furnace (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10100226	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom Tangential (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10100238	External Combustion Boilers	Electric Generation	Bituminous/ Subbituminous Coal	Atmospheric Fluidized Bed Combustion - Circulating Bed (Subbitum Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10200222	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10200223	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Cyclone Furnace (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A

Material	Source Classification Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Subbituminous Coal[22]	10200226	External Combustion Boilers	Industrial	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom Tangential (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10300222	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10300223	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Cyclone Furnace (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Subbituminous Coal[22]	10300226	External Combustion Boilers	Commercial/ Institutional	Bituminous/ Subbituminous Coal	Pulverized Coal: Dry Bottom Tangential (Subbituminous Coal)	Miscellaneous Control Devices	0.00042	lb per tons burned	ESP or FABRIC FILTER only & WET LIMESTONE SCRUBBER or SPRAY DRYER w/ESP or FABRIC FILTER	A
Waste Oil[60]	10101302	External Combustion Boilers	Electric Generation	Liquid Waste	Waste Oil	Uncontrolled	2.2	lb per tons burned		D
Waste Oil[60]	10201302	External Combustion Boilers	Industrial	Liquid Waste	Waste Oil	Uncontrolled	2.2	lb per tons burned		D
Waste Oil[61]	10301302	External Combustion Boilers	Commercial/ Institutional	Liquid Waste	Waste Oil	Uncontrolled	2.2	lb per tons burned	Formula for this factor is 55L where "L"= weight% lead in fuel. Multiply numeric value by L to obtain emission factor. For example, if lead content is 5%, then L=5. std factor based on assumed 0.04 weight % lead.	D
Waste Oil[61]	10500113	External Combustion Boilers	Space Heaters	Industrial	Waste Oil: Air Atomized Burner	Uncontrolled	2	lb per tons burned	Formula for this factor is 50L where "L"= weight% lead in fuel. Multiply numeric value by L to obtain emission factor. For example, if lead content is 5%, then L=5. std factor based on assumed 0.04 weight % lead.	D
Waste Oil[61]	10500114	External Combustion Boilers	Space Heaters	Industrial	Waste Oil: Vaporizing Burner	Uncontrolled	0.0164	lb per tons burned	Formula for this factor is 0.41L where "L"= weight% lead in fuel. Multiply numeric value by L to obtain emission factor. For example, if lead content is 5%, then L=5. std factor based on assumed 0.04 weight % lead.	D
Waste Oil[61]	10500213	External Combustion Boilers	Space Heaters	Commercial/ Institutional	Waste Oil: Air Atomized Burner	Uncontrolled	2	lb per tons burned	Formula for this factor is 50L where "L"= weight% lead in fuel. Multiply numeric value by L to obtain emission factor. For example, if lead content is 5%, then L=5. std factor based on assumed 0.04 weight % lead.	D

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Waste Oil[61]	10500214	External Combustion Boilers	Space Heaters	Commercial/ Institutional	Waste Oil: Vaporizing Burner	Uncontrolled	0.0164	lb per tons burned	Formula for this factor is 0.41L where "L"= weight% lead in fuel. Multiply numeric value by L to obtain emission factor. For example, if lead content is 5%, then L=5. std factor based on assumed 0.04 weight % lead.	D
Wood[3]	10200906	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler (< 50,000 Lb Steam) **	Miscellaneous Control Devices	0.000445	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value. Emission factor represents measurements from wood waste combustors equipped with PM controls (i.e., fabric filters, multi-cyclones, ESP, and wet scrubbers).	B
Wood[3]	10200906	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood-fired Boiler (< 50,000 Lb Steam) **	Electrostatic Precipitator	0.0011	lb per tons burned	Emission factors are based on wet, as-fired wood waste with average properties of 50 weight percent moisture and 2,500 kcal/kg (4,500 Btu/lb) higher heating value.	D
Wood[3]	10200907	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood Cogeneration	Miscellaneous Control Devices	0.000445	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value. Emission factor represents measurements from wood waste combustors equipped with PM controls (i.e., fabric filters, multi-cyclones, ESP, and wet scrubbers).	B
Wood/Bark[3]	10200905	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood/Bark-fired Boiler (< 50,000 Lb Steam) **	Multiple Cyclone W/O Fly Ash Reinjection	0.00032	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value. Due to lead's relative volatility, it is assumed that flyash reinjection does not have a significant effect on lead emissions following mechanical collectors.	D
Wood/Bark[3]	10200905	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood/Bark-fired Boiler (< 50,000 Lb Steam) **	Multiple Cyclone W/ Fly Ash Reinjection	0.00032	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value. Due to lead's relative volatility, it is assumed that flyash reinjection does not have a significant effect on lead emissions following mechanical collectors.	D
Wood/Bark[3]	10200905	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood/Bark-fired Boiler (< 50,000 Lb Steam) **	Miscellaneous Control Devices	0.000445	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value. Emission factor represents measurements from wood waste combustors equipped with PM controls (i.e., fabric filters, multi-cyclones, ESP, and wet scrubbers).	B
Wood/Bark[3]	10200905	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood/Bark-fired Boiler (< 50,000 Lb Steam) **	Electrostatic Precipitator	0.000016	lb per tons burned	Emission factors are based on wet, as-fired wood waste with average properties of 50 weight percent moisture and 2,500 kcal/kg (4,500 Btu/lb) higher heating value.	D

Material	Source Classifica-tion Code	Level 1	Level 2	Level 3	Level 4	Primary Control (Secondary Control, if applicable)	Emissions Factor Quantity	Emissions Factor Units and Actions	Notes	Quality
Wood/Bark[3]	10200905	External Combustion Boilers	Industrial	Wood/Bark Waste	Wood/Bark-fired Boiler (< 50,000 Lb Steam) **	Wet Scrubber	0.00035	lb per tons burned	Units are lb of pollutant/ton of wood waste burned. Emission factors are based on wet, as-fired wood waste with average properties of 50 weight% moisture and 4500 Btu/lb higher heating value.	D

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Table C-2: California Air Resources Board's California Air Toxic Emissions Factors for Lead

Source Classification Code (SCC)	System Type	Material Type	Air Pollution Control Device	Other Description	Maximum Emissions Factor	Mean Emissions Factor	Median Emissions Factor	Units
N/A	Abrasive Blasting	Dust	None	None	4.97E+01	5.75E+02	5.75E+02	mg/kg
30500211	Asphalt Production	Diesel/Aggregate	C/FF	None	2.77E-06	2.17E-06	2.17E-06	lb/ton
30500205	Asphalt Production	Diesel/Aggregate	FF	None	4.04E-06	1.45E-06	1.45E-06	lb/ton
30500205	Asphalt Production	Diesel/Aggregate	WS	None	2.19E-03	2.19E-03	2.19E-03	lb/ton
N/A	Asphalt Production	Dust	None	None	1.40E+01	1.40E+01	1.40E+01	mg/kg
N/A	Asphalt Production	Rock plant mine feed	None	None	1.40E+01	1.40E+01	1.40E+01	mg/kg
N/A	Asphalt Production	Specialty mine feed	None	None	1.40E+01	1.40E+01	1.40E+01	mg/kg
30500211	Asphalt Production	Natural gas/Aggregate	C/FF	None	2.10E-05	1.52E-06	1.52E-06	lb/ton
30500211	Asphalt Production	Natural gas/Aggregate	C/WS	None	2.10E-05	1.52E-06	1.52E-06	lb/ton
30500211	Asphalt Production	Back-up oil/Aggregate	C/BH	None	7.41E-06	2.11E-06	2.11E-06	lb/ton
30500211	Asphalt Production	Process oil 70/Aggregate	C/WS	None	7.41E-06	2.11E-06	2.11E-06	lb/ton
30400522	Battery Production	Grids	None	None	7.98E-03	6.46E-03	6.46E-03	lb/ton
30400505	Battery Production	Batteries	None	None	1.77E-02	4.77E-03	4.77E-03	lb/MBat
30400505	Battery Production	Batteries	None	None	2.39E-02	8.43E-03	8.43E-03	lb/MBat
10100222	Boiler	Coal/Natural gas	None	None	3.14E-04	2.70E-04	2.70E-04	lb/ton
10200802	Boiler	Coke/Coal	LI/AI/B	None	4.41E-06	4.32E-06	4.32E-06	lb/ton
10100401	Boiler	No. 6 Fuel oil	None	None	3.79E-03	1.04E-03	1.04E-03	lb/Mgal
10200401	Boiler	No. 6 Fuel oil	None	None	3.62E-02	6.41E-04	6.41E-04	lb/Mgal
10200402	Boiler	No. 6 Fuel oil	None	None	3.62E-02	6.41E-04	6.41E-04	lb/Mgal
10200403	Boiler	No. 6 Fuel oil	None	None	3.62E-02	6.41E-04	6.41E-04	lb/Mgal
10200401	Boiler	Residual oil	None	None	3.62E-02	6.41E-04	6.41E-04	lb/Mgal
10300811	Boiler	Landfill gas	None	None	6.85E-03	5.71E-03	5.71E-03	lb/MMcf
10200701	Boiler	Refinery gas	None	EA<100%	2.49E-03	2.42E-03	2.42E-03	lb/MMcf
10200701	Boiler	Refinery gas	SCR	EA<100%	2.49E-03	2.42E-03	2.42E-03	lb/MMcf
10200701	Boiler	Refinery gas	None	EA>100%	7.73E-03	7.51E-04	7.51E-04	lb/MMcf
30500606	Cement Kiln	Coal/Raw materials	FF	None	3.06E-04	1.96E-05	1.96E-05	lb/ton
30500606	Cement Kiln	Coal/Coke/Raw materials	FF	None	2.34E-06	8.91E-07	8.91E-07	lb/ton
30601401	Coke Calcining	Natural gas/Coke	SD/FF	None	9.27E-05	4.92E-05	4.92E-05	lb/ton
N/A	Composition	Crude oil	None	None	2.97E+02	2.97E+02	2.97E+02	µg/L

Source Classification Code (SCC)	System Type	Material Type	Air Pollution Control Device	Other Description	Maximum Emissions Factor	Mean Emissions Factor	Median Emissions Factor	Units
N/A	Composition	Diesel	None	None	2.58E+02	4.17E+02	4.17E+02	µg/L
N/A	Composition	Jp-4	None	None	1.64E+03	1.64E+03	1.64E+03	µg/L
N/A	Composition	Jp-5	None	None	2.05E+02	2.05E+02	2.05E+02	µg/L
N/A	Composition	Lube oil	None	None	1.98E+02	2.97E+02	2.97E+02	µg/L
31502101	Crematory	Propane/Bodies	None	None	6.29E-05	6.27E-05	6.27E-05	lb/body
50100506	Dehydrator	Natural gas/Sludge	C	None	4.93E-07	4.93E-07	4.93E-07	lb/ton
30400101	Delacquering	Aluminum	None	None	2.25E-02	2.12E-02	2.12E-02	lb/ton
30902501	Drum Burning Furnace	Drums	AB	None	4.98E-04	3.98E-04	3.98E-04	lb/drum
30502201	Dryer	Potash	S	None	6.76E-05	6.62E-05	6.62E-05	lb/ton
30502201	Dryer	Sulfate of potash	BH	None	1.86E-03	1.71E-03	1.71E-03	lb/ton
10100903	Fluidized Bed Combustor	Agricultural waste	AI/C/FF	None	6.77E-05	6.71E-05	6.71E-05	lb/ton
10100903	Fluidized Bed Combustor	Agricultural/Urban wood waste	LI/SNCR/C/FF	None	1.32E-04	1.28E-04	1.28E-04	lb/ton
10100903	Fluidized Bed Combustor	Urban wood waste	LI/SNCR/C/FF	None	5.99E-05	5.94E-05	5.94E-05	lb/ton
10100217	Fluidized Bed Combustor	Coal	LI/AI/C/FF	None	2.11E-04	3.30E-05	3.30E-05	lb/ton
10100217	Fluidized Bed Combustor	Coal	LI/AI/FF/ESP	None	2.11E-04	3.30E-05	3.30E-05	lb/ton
10100801	Fluidized Bed Combustor	Coke	LI/AI/C/FF	None	4.12E-04	8.49E-05	8.49E-05	lb/ton
30600201	Fluid Catalytic Cracking Unit	Refinery gas/Oils	ESP/COB	None	5.76E-04	3.43E-04	3.43E-04	lb/MBar
N/A	Fugitives	Casing gas/Natural gas	None	None	1.10E-03	2.00E-03	2.00E-03	ppbv
30300926	Furnace	Alloy stock	None	Electric Induction	8.64E-03	8.55E-03	8.55E-03	lb/ton
30400107	Furnace	Aluminum	FF	Dross	5.28E-04	4.16E-04	4.16E-04	lb/ton
30400199	Furnace	Aluminum	None	Melting Pot	1.60E-06	1.20E-06	1.20E-06	lb/ton
30400103	Furnace	Aluminum	FF	Reverberatory	3.87E-04	3.36E-04	3.36E-04	lb/ton
30400103	Furnace	Aluminum	None	Reverberatory	1.87E-03	2.98E-04	2.98E-04	lb/ton
30400224	Furnace	Brass/Bronze ingot	FF	Electric Induction	1.32E-03	1.02E-03	1.02E-03	lb/ton
30501402	Furnace	Raw materials	None	None	5.21E-04	5.13E-04	5.13E-04	lb/ton
30501403	Furnace	Raw materials	None	None	5.21E-04	5.13E-04	5.13E-04	lb/ton
30400401	Furnace	Lead	FF	Melting Pot	4.57E-03	2.77E-03	2.77E-03	lb/ton
30400401	Furnace	Lead	FF	Melting Pot	4.57E-03	2.77E-03	2.77E-03	lb/ton
30400408	Furnace	Lead	FF	Melting Pot	2.05E-03	1.16E-03	1.16E-03	lb/ton
30400408	Furnace	Lead	FF	Melting Pot	2.05E-03	1.16E-03	1.16E-03	lb/ton

Source Classification Code (SCC)	System Type	Material Type	Air Pollution Control Device	Other Description	Maximum Emissions Factor	Mean Emissions Factor	Median Emissions Factor	Units
N/A	Gas Processing	Fuel gas	None	None	2.36E-01	3.56E+00	3.56E+00	ppbv
31000403	Heater	Pipeline oil	None	None	5.48E-04	1.79E-04	1.79E-04	lb/Mgal
30600106	Heater	Refinery gas	DeNOx	EA<100%	8.43E-03	1.50E-03	1.50E-03	lb/MMcf
30600106	Heater	Refinery gas	DeNOx	EA<100%	8.43E-03	1.50E-03	1.50E-03	lb/MMcf
30600106	Heater	Refinery gas	None	EA<100%	8.43E-03	1.50E-03	1.50E-03	lb/MMcf
30600106	Heater	Refinery gas	None	EA<100%	8.43E-03	1.50E-03	1.50E-03	lb/MMcf
30600106	Heater	Refinery gas	SCR	EA<100%	8.43E-03	1.50E-03	1.50E-03	lb/MMcf
30600106	Heater	Refinery gas	SCR	EA<100%	8.43E-03	1.50E-03	1.50E-03	lb/MMcf
30600106	Heater	Refinery gas	None	EA>100%	9.28E-04	9.19E-04	9.19E-04	lb/MMcf
30600106	Heater	Refinery gas	None	EA>100%	9.28E-04	9.19E-04	9.19E-04	lb/MMcf
30600106	Heater	Refinery gas	SCR	EA>100%	9.28E-04	9.19E-04	9.19E-04	lb/MMcf
30600106	Heater	Refinery gas	SCR	EA>100%	9.28E-04	9.19E-04	9.19E-04	lb/MMcf
50300205	Incinerator	Diesel/Waste explosives	None	None	2.47E-02	7.42E-03	7.42E-03	lb/ton
31307001	Oven	Coatings of electric motor winding wires	None	None	1.78E-02	1.51E-02	1.51E-02	lb/ton
30901006	Plating	Chromic acid	PBS	None	1.53E+02	1.29E+02	1.29E+02	mg/amp-h
30501622	Preheater Kiln	Coal/Raw materials	C/FF	None	5.89E-05	3.92E-05	3.92E-05	lb/ton
31000413	Steam Generator	Crude oil	None	None	4.90E-04	2.60E-04	2.60E-04	lb/Mgal
31000413	Steam Generator	Crude oil	SO2 Scrub	None	4.90E-04	2.60E-04	2.60E-04	lb/Mgal
30400101	Shredding and Delacquering	Aluminum	BH	None	4.97E-05	3.19E-05	3.19E-05	lb/ton
30400108	Shredding and Delacquering	Aluminum	BH	None	4.97E-05	3.19E-05	3.19E-05	lb/ton
N/A	Tank	Produced water	None	None	7.00E-04	7.00E-04	7.00E-04	ppbv
20200103	Turbine	No. 2 Distillate oil	None	None	7.18E-04	7.04E-04	7.04E-04	lb/Mgal
20200203	Turbine	Natural gas/Refinery gas	COC/SCR	None	1.90E-03	1.81E-03	1.81E-03	lb/MMcf
20200705	Turbine	Natural gas/Refinery gas	COC/SCR	None	1.90E-03	1.81E-03	1.81E-03	lb/MMcf
20200203	Turbine	Natural gas/Refinery gas	SCR/AI/COC	None	1.90E-03	1.81E-03	1.81E-03	lb/MMcf
20200705	Turbine	Natural gas/Refinery gas	SCR/AI/COC	None	1.90E-03	1.81E-03	1.81E-03	lb/MMcf
20200203	Turbine	Natural/Refinery/Liquid petroleum gas	COC/SCR	None	7.16E-02	6.85E-02	6.85E-02	lb/MMcf
20200705	Turbine	Natural/Refinery/Liquid petroleum gas	COC/SCR	None	7.16E-02	6.85E-02	6.85E-02	lb/MMcf

Source Classification Code (SCC)	System Type	Material Type	Air Pollution Control Device	Other Description	Maximum Emissions Factor	Mean Emissions Factor	Median Emissions Factor	Units
20201013	Turbine	Natural/Refinery/Liquid petroleum gas	COC/SCR	None	7.16E-02	6.85E-02	6.85E-02	lb/MMcf
20200701	Turbine	Refinery gas	COC	None	4.18E-02	4.15E-02	4.15E-02	lb/MMcf

Table C-3: AP-42 Lead Emissions Factors for Ordnance Detonation

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
A010, M220 10 Gage Blank/Subcaliber Salute Cartridge	7.8 E-06	2.4 E-04	15.1: Small Cartridges < 30 mm
A011, 12 Gage#00 Shot Cartridge	2.0 E-05	6.2 E-03	15.1: Small Cartridges < 30 mm
A017, 12 Gage #9 Shot Cartridge	7.4 E-06	2.8 E-03	15.1: Small Cartridges < 30 mm
A059, M855 5.56-mm Ball Cartridge	5.1 E-06	1.3 E-03	15.1: Small Cartridges < 30 mm
A063, M856 5.56-mm Tracer Cartridge	2.7 E-06	6.8 E-04	15.1: Small Cartridges < 30 mm
A065, 5.56-mm Practice Ball Cartridge	3.1 E-06	2.4 E-03	15.1: Small Cartridges < 30 mm
A066, M193 5.56-mm Ball Cartridge	1.3 E-05	3.2 E-03	15.1: Small Cartridges < 30 mm
A068, M196 5.56-mm Tracer Cartridge	2.8 E-06	7.2 E-04	15.1: Small Cartridges < 30 mm
A080, M200 5.56-mm Blank Cartridge	9.7 E-07	1.1 E-03	15.1: Small Cartridges < 30 mm
A086, .22 Caliber Long Rifle Ball Cartridge	1.9 E-06	4.6 E-03	15.1: Small Cartridges < 30 mm
A106, .22 Caliber Standard Velocity Long Rifle Ball Cartridge	1.8 E-06	4.5 E-03	15.1: Small Cartridges < 30 mm
A111, M82 7.62-mm Blank Cartridge	2.6 E-06	9.7 E-04	15.1: Small Cartridges < 30 mm
A131, M62 7.62-mm Tracer Cartridge	7.8 E-06	1.1 E-03	15.1: Small Cartridges < 30 mm
A136, M118 7.62-mm Ball Match Cartridge	6.2 E-06	9.8 E-04	15.1: Small Cartridges < 30 mm
A143, M80 7.62-mm Ball Cartridge	4.9 E-06	7.8 E-04	15.1: Small Cartridges < 30 mm
A171, M852 7.62-mm Ball Match Cartridge	5.0 E-06	8.3 E-04	15.1: Small Cartridges < 30 mm
A182, M1 .30 Caliber Ball Cartridge	3.9 E-06	2.1 E-03	15.1: Small Cartridges < 30 mm
A212, M2 .30 Caliber Ball Cartridge	1.8 E-05	2.5 E-03	15.1: Small Cartridges < 30 mm
A218, M25 .30 Caliber Tracer Cartridge	6.0 E-06	8.0 E-04	15.1: Small Cartridges < 30 mm
A247, M72 .30 Caliber Ball Match Cartridge	1.4 E-05	2.0 E-03	15.1: Small Cartridges < 30 mm
A363, M882 9-mm Ball Cartridge	6.8 E-06	8.6 E-03	15.1: Small Cartridges < 30 mm
A365, M181A1 14.5-mm Artillery Training Cartridge	1.3 E-03	8.1 E-02	15.1: Small Cartridges < 30 mm
A400, M41 .38 Caliber Special Ball Cartridge	1.8 E-05	2.4 E-02	15.1: Small Cartridges < 30 mm
A403, .38 Caliber Special Blank Cartridge	3.9 E-06	6.5 E-03	15.1: Small Cartridges < 30 mm
A475, M1911 .45 Caliber Ball Cartridge	1.2 E-05	1.6 E-02	15.1: Small Cartridges < 30 mm
A518, M903 .50 Caliber SLAP Ball Cartridge	2.0 E-05	2.0 E-05	15.1: Small Cartridges < 30 mm
A518, M962 .50 Caliber SLAP Tracer Cartridge	1.7 E-04	4.1 E-03	15.1: Small Cartridges < 30 mm
A525, M2 .50 Caliber Armor Piercing Cartridge	2.1 E-05	6.3 E-04	15.1: Small Cartridges < 30 mm
A557, M33 .50 Caliber Ball Cartridge	1.3 E-05	4.0 E-04	15.1: Small Cartridges < 30 mm
A557, M17 .50 Caliber Tracer Cartridge	1.4 E-05	4.0 E-04	15.1: Small Cartridges < 30 mm

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
A598, M1A1 .50 Caliber Blank Cartridge	1.2 E-05	1.7 E-03	15.1: Small Cartridges < 30 mm
A652, M220 20-mm Target Practice Tracer Cartridge	2.3 E-05	2.6 E-04	15.1: Small Cartridges < 30 mm
A940, M910 25-mm Target Practice Discarding Sabot Tracer Cartridge	5.5 E-05	2.6 E-04	15.1: Small Cartridges < 30 mm
A976, M793 25-mm Target Practice Tracer Cartridge	4.9 E-05	2.4 E-04	15.1: Small Cartridges < 30 mm
B129, M789 30-mm High Explosive Dual Purpose (HEDP) Cartridge	1.1 E-05	3.7 E-04	15.2: Medium Cartridges 30-75 mm
B519, M781 40-mm Practice Cartridge	6.7 E-06	8.3 E-03	15.2: Medium Cartridges 30-75 mm
B535, M583A1 40-mm White Star Parachute Cartridge	1.6 E-04	7.9 E-04	15.2: Medium Cartridges 30-75 mm
B536, M585 40-mm White Star Cluster Cartridge	N/A	N/A	15.2: Medium Cartridges 30-75 mm
B542, M430 40-mm High Explosive Dual Purpose (HEDP) Cartridge	8.0 E-05	9.6 E-04	15.2: Medium Cartridges 30-75 mm
B571, M383 40-mm High Explosive Cartridge	7.3 E-05	6.2 E-04	15.2: Medium Cartridges 30-75 mm
B584, M918 40-mm Practice Cartridge	1.1 E-05	1.1 E-03	15.2: Medium Cartridges 30-75 mm
B627, M83A3 60-mm Illuminating Cartridge (Propelling Charge)	N/A	8.0 E-04	15.2: Medium Cartridges 30-75 mm
B627, M83A3 60-mm Illuminating Cartridge (Projectile)	2.4 E-04	4.4 E-04	15.2: Medium Cartridges 30-75 mm
B627, M83A3 60-mm Illuminating Cartridge (Total)	N/A	4.5 E-04	15.2: Medium Cartridges 30-75 mm
B632, M49A4 60-mm High Explosive Cartridge (Projectile)	2.3 E-04	5.1 E-04	15.2: Medium Cartridges 30-75 mm
B642, M720 60-mm High Explosive Cartridge (Propelling Charge)	N/A	1.0 E-04	15.2: Medium Cartridges 30-75 mm
B642, M720 60-mm High Explosive Cartridge (Projectile)	4.4 E-04	5.5 E-04	15.2: Medium Cartridges 30-75 mm
B642, M720 60-mm High Explosive Cartridge (Total)	N/A	5.2 E-04	15.2: Medium Cartridges 30-75 mm
B645, M766 60-mm Short Range Practice Mortar Cartridge	1.3 E-05	2.0 E-03	15.2: Medium Cartridges 30-75 mm
B643, M888 60-mm High Explosive (HE) Cartridge	6.1 E-04	7.4 E-04	15.2: Medium Cartridges 30-75 mm
BA11, M1001 40-mm High Velocity Canister Cartridge	1.2 E-05	9.9 E-04	15.2: Medium Cartridges 30-75 mm
BA15, M769 60-mm Full Range Practice Cartridge	3.2 E-05	1.3 E-03	15.2: Medium Cartridges 30-75 mm
B505, M662 40-mm Red Star Parachute Cartridge	1.6 E-05	8.7 E-05	15.2: Medium Cartridges 30-75 mm
C226, M301A3 81-mm Illuminating Cartridge	N/A	1.7 E-05	15.3: Large Cartridges > 75 mm
C256, M374A2 81-mm High Explosive Cartridge	6.9 E-04	3.3 E-04	15.3: Large Cartridges > 75 mm
C329, M934 120-mm High Explosive Cartridge	N/A	4.2 E-05	15.3: Large Cartridges > 75 mm
C445, M1 105-mm High Explosive Cartridge	1.0 E-03	2.0 E-04	15.3: Large Cartridges > 75 mm
C511, M490 105-mm Target Practice Tracer Cartridge (Propelling Charge)	6.8 E-04	5.7 E-05	15.3: Large Cartridges > 75 mm
C511, M490 105-mm Target Practice Tracer Cartridge (Total)	6.8 E-04	5.6 E-05	15.3: Large Cartridges > 75 mm
C784, M831 120-mm Target Practice Tracer Cartridge (Propelling Charge)	1.6 E-02	1.2 E-03	15.3: Large Cartridges > 75 mm
C784, M831 120-mm Target Practice Tracer Cartridge (Tracer)	6.3 E-07	1.9 E-05	15.3: Large Cartridges > 75 mm

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
C784, M831 120-mm Target Practice Tracer Cartridge (Total)	1.6 E-02	1.2 E-03	15.3: Large Cartridges > 75 mm
C785, M865 120-mm Target Practice Cone Stabilized Discarding Sabot-Tracer (TPCSDS-T) (Propelling Charge)	1.4 E-03	7.8 E-05	15.3: Large Cartridges > 75 mm
C785, M865 120-mm Target Practice Cone Stabilized Discarding Sabot-Tracer (TPCSDS-T) (Tracer)	1.1 E-06	3.2 E-05	15.3: Large Cartridges > 75 mm
C785, M865 120-mm Target Practice Cone Stabilized Discarding Sabot-Tracer (TPCSDS-T) (Total)	1.4 E-03	7.8 E-05	15.3: Large Cartridges > 75 mm
C787, M830 120-mm High Explosive Anti-Tank Cartridge	7.6 E-04	1.8 E-04	15.3: Large Cartridges > 75 mm
C788, M57 120-mm High Explosive Cartridge	5.2 E-04	1.1 E-04	15.3: Large Cartridges > 75 mm
C868, M821 81-mm High Explosive Cartridge	N/A	5.7 E-05	15.3: Large Cartridges > 75 mm
C876, M880 81-mm Target Practice Short Range Cartridge	1.3 E-05	1.1 E-03	15.3: Large Cartridges > 75 mm
C995, M136 AT4 Recoilless Rifle	4.4 E-05	3.2 E-05	15.3: Large Cartridges > 75 mm
CA03, XM929 120-mm White Phosphorus (WP) Smoke Cartridge	6.0 E-04	4.1 E-04	15.3: Large Cartridges > 75 mm
CA09, M931 120-mm Full Range Practice Cartridge	N/A	2.5 E-05	15.3: Large Cartridges > 75 mm
C449, M314 105-mm Illumination Cartridge	8.0 E-07	3.6 E-07	15.3: Large Cartridges > 75 mm
C484, M816 81-mm Infrared (IR) Illumination Cartridge	N/A	N/A	15.3: Large Cartridges > 75 mm
C623, M933 120-mm High-Explosive Cartridge	9.7 E-04	1.5 E-04	15.3: Large Cartridges > 75 mm
C790, M91 120-mm Illumination Cartridge	7.3 E-06	1.9 E-06	15.3: Large Cartridges > 75 mm
C870, M819 81-mm Red Phosphorus Smoke Cartridge	8.5 E-05	2.8 E-05	15.3: Large Cartridges > 75 mm
D505, M485A2 155-mm Illumination Round	5.8 E-05	9.5 E-06	15.4: Projectiles, Canisters, and Charges
D533, M119A2 155-mm Propelling Charge, Zone 7	2.9 E-02	1.3 E-03	15.4: Projectiles, Canisters, and Charges
D540, M3 and M3A1 155-mm Propelling Charges	N/A	9.9 E-05	15.4: Projectiles, Canisters, and Charges
D541, M4A2 155-mm Propelling Charge, Zone 7	3.6 E-03	2.7 E-04	15.4: Projectiles, Canisters, and Charges
G878, M228 Practice Hand Grenade Fuse	N/A	N/A	15.5: Grenades
G881, M67 Fragmentation Hand Grenade	5.0 E-04	1.2 E-03	15.5: Grenades
G900, Thermite (TH3) AN-M14 Incendiary Hand Grenade	1.1 E-02	7.0 E-03	15.5: Grenades
G911, MK3A2 Offensive Hand Grenade	3.3 E-04	6.7 E-04	15.5: Grenades
G930, AN-M8 Hexachloroethane (HC) Smoke Hand Grenade	4.7 E-04	4.2 E-04	15.5: Grenades
G940, M18 Green Smoke Hand Grenade	3.4 E-05	4.7 E-05	15.5: Grenades
G945, M18 Yellow Smoke Hand Grenade	1.5 E-05	2.0 E-05	15.5: Grenades
G950, M18 Red Smoke Hand Grenade	1.9 E-05	2.6 E-05	15.5: Grenades
G955, M18 Violet Smoke Hand Grenade	1.6 E-05	2.2 E-05	15.5: Grenades
G963, M7A3 CS Riot Control Agent Hand Grenade	9.1 E-02	1.1 E-01	15.5: Grenades

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
G978, M82 Simulant Screening Smoke Launcher Grenade	3.6 E-05	2.2 E-05	15.5: Grenades
G982, M83 Terephthalic Acid (TA) Smoke Practice Hand Grenade	5.8 E-05	8.3 E-05	15.5: Grenades
GG09, M84 Non-lethal Stun Hand Grenade	9.0 E-07	1.2 E-04	15.5: Grenades
G815, L8A3 Red Phosphorus Screening Smoke Launcher Grenade	3.0 E-06	3.6 E-06	15.5: Grenades
H459, 2.75-inch Flechette, MK40 Mod 3 Motor	5.1 E-02	8.5 E-03	15.6: Rockets, Rocket Motors, And Igniters
H557, M72A3 66-mm High Explosive Antitank Rocket (Propelling Rocket)	1.8 E-05	1.3 E-04	15.6: Rockets, Rocket Motors, And Igniters
H557, M72A3 66-mm High Explosive Antitank Rocket (Warhead)	1.2 E-03	1.7 E-03	15.6: Rockets, Rocket Motors, And Igniters
H557, M72A3 66-mm High Explosive Antitank Rocket (Total)	1.2 E-03	1.5 E-03	15.6: Rockets, Rocket Motors, And Igniters
H708, M73 35-mm Subcaliber Practice Rocket (Propelling Rocket)	6.2 E-06	2.3 E-04	15.6: Rockets, Rocket Motors, And Igniters
H708, M73 35-mm Subcaliber Practice Rocket (Warhead)	N/A	N/A	15.6: Rockets, Rocket Motors, And Igniters
H708, M73 35-mm Subcaliber Practice Rocket (Total)	6.2 E-06	2.1 E-04	15.6: Rockets, Rocket Motors, And Igniters
H708, M73 35-mm Subcaliber Practice Rocket (Propelling Rocket)	6.2 E-06	2.3 E-04	15.6: Rockets, Rocket Motors, And Igniters
H974, 2.75-inch M267 Practice Warhead, MK66 Mod 3 Motor	7.0 E-02	9.7 E-03	15.6: Rockets, Rocket Motors, And Igniters
H163, 2.75-inch Rocket with M151 High Explosive Warhead	6.0 E-04	2.6 E-04	15.6: Rockets, Rocket Motors, And Igniters
K010, M4 Field Incendiary Burster	N/A	N/A	15.7: Mines And Smoke Pots
K051, M604 Anti-Tank Practice Mine Fuse	1.5 E-05	3.9 E-04	15.7: Mines And Smoke Pots
K145, M18A1 Antipersonnel Mine	5.7 E-05	3.8 E-05	15.7: Mines And Smoke Pots
K765, CS Riot Control Agent Capsule	N/A	N/A	15.7: Mines And Smoke Pots
K866, ABC-M5 30-Pound HC Smoke Pot	2.4 E-02	7.9 E-04	15.7: Mines And Smoke Pots
K867, M4A2 Floating Type HC Smoke Pot	1.6 E-02	5.9 E-04	15.7: Mines And Smoke Pots
K042, M88 Practice Canister Mine (Volcano)	7.6 E-06	5.5 E-04	15.7: Mines And Smoke Pots
L305, M195 Green Star Parachute Signal Flare	4.7 E-07	1.5 E-06	15.8: Signals And Simulators
L306, M158 Red Star Cluster Signal Flare	1.7 E-06	6.1 E-06	15.8: Signals And Simulators
L307, M159 White Star Cluster Signal Flare	3.8 E-06	1.2 E-05	15.8: Signals And Simulators
L311, M126A1 Red Star Parachute Signal Flare	2.3 E-06	8.0 E-06	15.8: Signals And Simulators
L312, M127A1 White Star Parachute Signal Flare	5.5 E-06	1.9 E-05	15.8: Signals And Simulators
L314, M125A1 Green Star Cluster Signal Flare	2.0 E-06	1.2 E-06	15.8: Signals And Simulators
L366, M74A1 Air Burst Projectile Simulator	1.4 E-03	1.5 E-02	15.8: Signals And Simulators
L367, M22 Anti-Tank Guided Missile and Rocket Launching Simulator	N/A	N/A	15.8: Signals And Simulators
L495, M49A1 Surface Trip Flare	9.9 E-06	9.2 E-06	15.8: Signals And Simulators
L594, M115A2 Ground Burst Simulator	4.1 E-06	2.9 E-05	15.8: Signals And Simulators

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
L596, M110 Flash Artillery Simulator	1.1 E-05	5.8 E-05	15.8: Signals And Simulators
L598, M117 Flash Booby Trap Simulator	2.3 E-06	3.0 E-04	15.8: Signals And Simulators
L599, M118 Illuminating Booby Trap Simulator	5.5 E-08	4.2 E-06	15.8: Signals And Simulators
L600, M119 Whistling Booby Trap Simulator	N/A	N/A	15.8: Signals And Simulators
L601, M116A1 Hand Grenade Simulator	1.4 E-06	1.7 E-05	15.8: Signals And Simulators
L410, M206 Aircraft Countermeasure Flare	N/A	N/A	15.8: Signals And Simulators
L592, TOW Blast Simulator	1.6 E-05	2.9 E-03	15.8: Signals And Simulators
L602, M21 Artillery Flash Simulator	2.0 E-03	2.1 E-02	15.8: Signals And Simulators
L709, M25 Target Hit Simulator	2.1 E-05	3.8 E-04	15.8: Signals And Simulators
L720, M26 Target Kill Simulator	N/A	N/A	15.8: Signals And Simulators
L508, M72 Red Railroad Warning Fuse	N/A	N/A	15.8: Signals And Simulators
L595, M9 Liquid Projectile Air Burst Simulator	4.2 E-06	3.0 E-05	15.8: Signals And Simulators
M023, M112 Demolition Block Charge	1.7 E-04	1.4 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M030, 1/4-Pound Demolition Block Charge	1.4 E-04	5.6 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M031, 1/2-Pound Demolition Block Charge	1.1 E-04	2.2 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M032, 1-Pound Demolition Block Charge	2.0 E-04	2.0 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M130, M6 Electric Blasting Cap	1.5 E-04	5.1 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M131, M7 Non-Electric Blasting Cap	2.6 E-04	9.5 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M174, .50 Caliber Blank Cartridge	1.9 E-06	8.3 E-05	15.9: Blasting Caps, Demolition Charges, And Detonators
M241, M10 High Explosive Universal Destructor	3.3 E-02	1.2 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
M327, Firing Device Coupling Base	6.7 E-06	1.2 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
M420, M2A4 15-Pound Demolition Shaped Charge	3.8 E-02	3.7 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
L599, M118 Illuminating Booby Trap Simulator	5.5 E-08	4.2 E-06	15.8: Signals And Simulators
L600, M119 Whistling Booby Trap Simulator	N/A	N/A	15.8: Signals And Simulators
L601, M116A1 Hand Grenade Simulator	1.4 E-06	1.7 E-05	15.8: Signals And Simulators
L410, M206 Aircraft Countermeasure Flare	N/A	N/A	15.8: Signals And Simulators
L592, TOW Blast Simulator	1.6 E-05	2.9 E-03	15.8: Signals And Simulators
L602, M21 Artillery Flash Simulator	2.0 E-03	2.1 E-02	15.8: Signals And Simulators
L709, M25 Target Hit Simulator	2.1 E-05	3.8 E-04	15.8: Signals And Simulators
L720, M26 Target Kill Simulator	N/A	N/A	15.8: Signals And Simulators
L508, M72 Red Railroad Warning Fuse	N/A	N/A	15.8: Signals And Simulators

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
L595, M9 Liquid Projectile Air Burst Simulator	4.2 E-06	3.0 E-05	15.8: Signals And Simulators
M023, M112 Demolition Block Charge	1.7 E-04	1.4 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M030, 1/4-Pound Demolition Block Charge	1.4 E-04	5.6 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M031, 1/2-Pound Demolition Block Charge	1.1 E-04	2.2 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M032, 1-Pound Demolition Block Charge	2.0 E-04	2.0 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M130, M6 Electric Blasting Cap	1.5 E-04	5.1 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M131, M7 Non-Electric Blasting Cap	2.6 E-04	9.5 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M174, .50 Caliber Blank Cartridge	1.9 E-06	8.3 E-05	15.9: Blasting Caps, Demolition Charges, And Detonators
M241, M10 High Explosive Universal Destructor	3.3 E-02	1.2 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
M327, Firing Device Coupling Base	6.7 E-06	1.2 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
M420, M2A4 15-Pound Demolition Shaped Charge	3.8 E-02	3.7 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
M448, M2A1 8-Second Delay Percussion Detonator	2.4 E-04	3.9 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M456, PETN Type 1 Detonating Cord	N/A	7.3 E-05	15.9: Blasting Caps, Demolition Charges, And Detonators
M500, M21 Cartridge Actuated Cutter	N/A	N/A	15.9: Blasting Caps, Demolition Charges, And Detonators
M591, M1 Military Dynamite Demolition Block Charge	1.5 E-04	4.1 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
M626, M1 Pressure Type Firing Device	4.3 E-06	7.5 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M630, M1 Pull Type Demolition Firing Device	6.9 E-06	1.2 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
M670, M700 Time Blasting Fuse	N/A	N/A	15.9: Blasting Caps, Demolition Charges, And Detonators
M766, M60 Time Blasting Fuse Igniter	2.6 E-06	4.5 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
M913, M58A3 Linear Demolition Charge	N/A	3.4 E-05	15.9: Blasting Caps, Demolition Charges, And Detonators
MD73, M796 Impulse Cartridge	3.6 E-09	4.6 E-06	15.9: Blasting Caps, Demolition Charges, And Detonators
ML03, M142 Multipurpose Demolition Firing Device	5.0 E-06	1.1 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
ML05, MK24 Powder Actuated Cutter	1.1 E-03	8.5 E-04	15.9: Blasting Caps, Demolition Charges, And Detonators
ML09, Linear Shaped Demolition Charge, 20 gr/ft	N/A	3.4 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
ML15, Linear Shaped Demolition Charge, 225 gr/ft	N/A	8.5 E-01	15.9: Blasting Caps, Demolition Charges, And Detonators
ML47, M11 Non-Electric Blasting Cap with 30-foot Shock Tube	1.3 E-04	4.8 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
MM50, M221 Clipped Shaped Demolition Charge	1.9 E-04	2.9 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
MN02, M12 Non-Electric Blasting Cap with 500-foot Shock Tube	5.3 E-05	8.6 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
MN03, M13 Non-Electric Blasting Cap with 1,000-foot Shock Tube	5.5 E-05	5.0 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
MN06, M14 Non-Electric Time Delay Blasting Cap	3.8 E-05	1.5 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
MN07, M15 Non-Electric Time Delay Blasting Cap	1.8 E-04	4.3 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators

Department of Defense Identification Code, Type	Lb Emitted per Item	Lb per lb Net Explosive Weight	AP-42 Section
MN08, M81 Time Blasting Fuse Igniter	4.4 E-06	9.0 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
MN60, M79 Electric Match Igniter	1.4 E-05	1.1 E-03	15.9: Blasting Caps, Demolition Charges, And Detonators
MN68, M151 Booster Demolition Charge	1.1 E-04	1.2 E-02	15.9: Blasting Caps, Demolition Charges, And Detonators
N278, M564 MTSQ Fuse	5.1 E-04	8.1 E-03	15.10: Fuses and Primers
N285, M577A1 Mechanical Time and Super Quick (MTSQ) Fuse	4.0 E-06	4.3 E-03	15.10: Fuses and Primers
N286, M582 Mechanical Time and Super Quick (MTSQ) Fuse	5.0 E-04	9.4 E-03	15.10: Fuses and Primers
N335, M557 Point Detonating Fuse	3.0 E-04	5.7 E-03	15.10: Fuses and Primers
N340, M739A1 Point Detonating Fuse	1.0 E-04	2.2 E-03	15.10: Fuses and Primers
N464, M732 Proximity Fuse	1.5 E-05	1.1 E-03	15.10: Fuses and Primers

Source: https://www3.epa.gov/ttn/chief/ap42/ch15/index.html