United States Environmental Protection Agency
Office of Pollution Prevention and Toxics
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TOXICS RELEASE INVENTORY

Guidance for Reporting Mercury and Mercury 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 and recycling 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 mercury and mercury 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. 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

On October 29, 1999, EPA promulgated the final rule on Persistent, Bioaccumulative, and Toxic (PBT) chemicals (64 FR 58666). This rule modified the reporting requirements for mercury and mercury compounds under section 313 of EPCRA beginning with reporting year 2000 (reports due July 1, 2001). The reporting threshold for mercury (Chemical Abstract Service (CAS) Registry Number 7439-97-6) and the mercury compound category was lowered to 10 pounds per year for manufacturing, processing, or otherwise use.

The purpose of this document is to assist facilities in complying with the reporting requirements of EPCRA section 313 for mercury and the mercury compounds category. Facilities that meet the EPCRA section 313 employee threshold and industry code requirements, and that exceed the ten pound reporting threshold for mercury or the mercury compounds category are subject to the EPCRA section 313 annual reporting requirements.

Section 1.1 What are the Reporting Thresholds?

Thresholds are specified amounts of listed toxic chemicals manufactured, processed, or otherwise used during the calendar year that trigger reporting requirements. EPCRA section 313 establishes default reporting thresholds, but authorizes EPA to establish lower thresholds for particular chemicals, classes of chemicals, or categories of facilities, if a different threshold is warranted. EPA has used this authority to establish lower thresholds for Persistent Bioaccumulative Toxic (PBT) chemicals. See 40 CFR 370.28, 64 FR 58666. The thresholds are determined separately for mercury (using the weight of the metal) and for mercury compounds (using the weight of the entire compound). Therefore, provided that the facility meets the industry code and employee threshold criteria, reporting for mercury is required:

- If a facility manufactures more than 10 pounds of mercury during the calendar year.
- If a facility processes more than 10 pounds of mercury during the calendar year.
- If a facility otherwise uses more than 10 pounds of mercury during the calendar year.

Provided that the facility meets the other two reporting requirements, reporting for the mercury compounds category is required:

- If a facility manufactures more than 10 pounds of mercury compounds during the calendar year.
- If a facility processes more than 10 pounds of mercury compounds during the calendar year.
- If a facility otherwise uses more than 10 pounds of mercury compounds during the calendar year.

If a threshold is exceeded for both mercury and the mercury compounds category, only a single Form R needs to be prepared. The terms manufacture, process, and otherwise use are defined in 40 CFR 372.3 as:

> Manufacture means to produce, prepare, import, or compound a toxic chemical. Manufacture also applies to a toxic chemical that is produced coincidentally during the manufacture, processing, otherwise use, or disposal of another chemical or mixture of chemicals, including a toxic chemical that is separated from that other chemical or mixture of chemicals as a byproduct, and a toxic chemical that remains in that other chemical or mixture of chemicals as an impurity.
>
> Process means the preparation of a toxic chemical, after its manufacture, for distribution in commerce:
>
> 1) In the same form or physical state as, or in a different form or physical state from, that in which it was received by the person so preparing such substance, or
>
> 2) As part of an article containing the toxic chemical. Process also applies to the processing of a toxic chemical contained in a mixture or trade name product.

Otherwise use means any use of a toxic chemical, including a toxic chemical contained in a mixture or other trade name product or waste, that is not covered by the terms “manufacture” or “process.” Otherwise use of a toxic chemical does not include disposal, stabilization (without subsequent distribution in commerce), or treatment for destruction unless:

1) The toxic chemical that was disposed, stabilized, or treated for destruction was received from off site for the purposes of further waste management; or

2) The toxic chemical that was disposed, stabilized, or treated for destruction was manufactured as a result of waste management activities on materials received from off site for the purposes of further waste management activities. Relabeling or redistributing of the toxic chemical in which no repackaging of the toxic chemical occurs does not constitute otherwise use or processing of the toxic chemical.

The quantities of mercury and mercury compounds included in threshold determinations are not limited to the amounts released to the environment. All mercury and mercury compounds manufactured, processed, or otherwise used must be counted toward threshold determinations. (EPCRA section 313(a)). This may include mercury compounds that are generated in closed systems. To assist facilities in determining if they may need to report, Table 1–1 below lists potential industry and process sources of mercury and mercury compounds. For more information on threshold determinations, see Section 2.0.

Table 1–1: Industry and Process Sources of Mercury and Mercury Compounds

Industry/Process	EPCRA Section 313 Activity	Mercury or Mercury Compounds	Reference[1]
Metal mining: trace constituent in ore	Processed, manufactured (by-product)	Mercury and mercury compounds	2
Coal mining: trace constituent in ore	Processed	Mercury compounds	2
Paper manufacturing: present in wood and chemicals	Processed	Mercury	2, 3
Chlor-alkali production by mercury cell process	Otherwise used	Mercury	2, 3
Plastic materials and resin manufacture: formulation component	Processed	Mercury compounds	2
Importing of cadmium-mercury pigments (no domestic production)	Manufactured (import), processed	Mercury	16
Special paper coatings: mercury bromide and mercury acetic acid used in paper and film with cathode ray tubes	Processed	Mercury compounds	16
Chemical manufacture: mercury compound production, reactants, pharmaceuticals, and catalysts	Manufactured, processed, otherwise used	Mercury and mercury compounds	2, 16
Carbon black production: trace constituent in crude oil	Processed	Mercury compounds	2, 3
Petroleum refining: trace constituent in petroleum crude	Processed, manufactured (by-product or impurity)	Mercury compounds	2, 3
Cement and clay products: trace constituent in raw materials	Processed	Mercury	2, 3

Industry/Process	EPCRA Section 313 Activity	Mercury or Mercury Compounds	Reference[1]
Steel industry: coke production, trace constituent in coal	Processed	Mercury compounds	2, 3
Smelting and refining: trace constituent in sulfide ore	Processed, manufactured (by-product)	Mercury	2, 3
Fabricated metal products: article component (e.g., high purity copper foil)	Processed	Mercury and mercury compounds	2, 16
Electronic product component (e.g., bulbs, switches, batteries)	Processed	Mercury	2, 3
Other product components (e.g., thermometers, dental amalgam fillings)	Processed	Mercury	2, 3
Coal, oil, wood combustion (electric utilities, other facility electricity generation): traces in fuels	Otherwise used, manufactured (by-product)	Mercury and mercury compounds	2, 3
Waste treatment and solvent recovery: trace constituent in waste stream	Processed, otherwise used	Mercury and mercury compounds	2
Wholesale distribution of mercury chemicals and compounds	Processed	Mercury and mercury compounds	2
Bulk petroleum stations: trace constituent in petroleum products	Processed	Mercury compounds	2

[1]Numbers correspond to the references listed in Section 5.0.

Section 1.2 What Other Changes to the EPCRA Section 313 Reporting Requirements Apply to Mercury and the Mercury 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 mercury and the mercury compounds category. Please note that for mercury and mercury 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 and other waste management activities. 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 ON THRESHOLD DETERMINATION FOR MERCURY AND MERCURY COMPOUNDS

Section 2.1 Threshold Determination

As mentioned in Section 1.1, EPA lowered the reporting threshold for mercury and the mercury compounds category to 10 pounds per year for each of the reporting activities (manufacturing, processing, and otherwise use). Each activity threshold is determined independently. When determining if a threshold is exceeded for mercury, you should calculate the amount of mercury manufactured, the amount of mercury processed, and the amount of mercury otherwise used. To determine if a threshold is exceeded for the mercury compounds category, use the entire weight of the mercury compounds for each threshold determination. Quantities required to meet the threshold for fuels and other materials may be found in Table 3–1 through Table 3–4. The following example illustrates key points in determining if a threshold has been exceeded for mercury or the mercury compounds category.

Example 1: Threshold Determination

Your facility processes 1,000 pounds of mercury during the calendar year, otherwise uses 8 pounds of mercury, and manufactures 5 pounds of a mercury compound as a by-product. Your facility did not exceed the otherwise use threshold for mercury, nor the manufacturing threshold for mercury compounds. Your facility did exceed the processing threshold for mercury, and must prepare a Form R report for mercury. (Note: if your facility had exceeded an activity threshold for both mercury and mercury compounds, you need only prepare one Form R.)

Since you determined that you must submit an EPCRA section 313 Form R report for mercury, you must calculate all releases and other waste management activity quantities of mercury from your facility, including releases and other waste management quantities of mercury from the otherwise use activity. You are not required to submit a Form R for mercury compounds.

If you do not know in what form mercury is present in a material, EPA recommends in most cases assuming elemental mercury. For fuels, assume that mercury is present as mercury compounds. In the absence of other data, EPA recommends assuming the mercury compound is Hg_2O for threshold calculations. If you burn fuels on site, elemental mercury emissions are coincidentally manufactured. The amount of mercury emissions should be applied to the manufacturing threshold for elemental mercury.

The concentration of mercury or mercury 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 the mercury or mercury compounds in the stream, you must use that value (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 mercury or mercury 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 mercury or mercury compound(s). EPA then recommends that you determine the mid-point for use in your calculations.
- If only the lower bound concentration of mercury or mercury compounds is given and the concentration of the other components is not given, EPA recommends that you assume the upper

bound for the mercury or mercury 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.

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

Example 2: Using a Typical Concentration to Determine Amount Processed During Carbon Black Production

Your facility manufactures carbon black. Using inventory records, you know that 30 million pounds of crude oil was processed through your facility. Using a mercury concentration of 1.5 ppm in the crude oil, you determine if you have exceeded the processing threshold.

$$(1.5 \text{ lb mercury} / 1 \times 10^6 \text{ lb crude oil}) \times (30{,}000{,}000 \text{ lb crude oil}) = 45 \text{ lb/yr}$$

Your facility exceeded the 10 lb/yr threshold and you must prepare a Form R for that year.

SECTION 3.0 SOURCES OF MERCURY AND MERCURY COMPOUNDS

This section provides an overview of where EPA believes mercury and mercury compounds are likely to be found at facilities and what operations may manufacture, process, or otherwise use mercury or mercury compounds. You should determine if these sources apply to your facility.

Section 3.1 Mercury in Raw Materials

Raw materials processed by facilities may contain metal mercury or mercury compounds as a trace constituent in chemicals (e.g., chlorine), metal ores, petroleum products, and coal.

Mercury and mercury compounds are present in metal ores, such as copper, lead, zinc, gold, and silver. Mercury and its compounds are also trace constituents in coal, oil, or wood that is processed or otherwise used by a facility. Table 3–1 lists some common concentrations of mercury in the above mentioned sources, and Table 3–2 lists average mercury concentrations from coal sampled at electric utilities. Note that the concentrations of mercury in metal ores vary from mine to mine.

Table 3–1: Quantity of Raw Materials Required to Meet the Reporting Threshold

Raw Material	Concentration Mercury (ppm)	Reference[1]	Quantity Needed to Meet Threshold (pounds for ores, gallons for oil)[3]
Copper ores	0.5	11	2.00 × 107
Gold ores	9	11	1.11 × 106
No. 2 fuel oil[2]	0.001	13	1.41 × 109
No. 6 fuel oil[2]	0.00067	12	1.89 × 109

[1] Numbers correspond to the references listed in Section 5.0.
[2] Constituents are most likely metal compounds rather than elemental mercury. Mercury 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.
[3] Assumes the following densities: No. 2 Fuel Oil - 7.1 lb/gallon; No. 6 fuel Oil - 7.9 lb/gallon.

Table 3–2: Quantity of Solid Fuels Required to Meet the Reporting Threshold

Coal Type	Average Mercury[1] Content (ppm)	Quantity Needed to Meet Threshold (pounds)
Anthracite	0.16	6.25×10^{7}
Bituminous	0.11	9.09×10^{7}
High Sulfur Bituminous	0.10	1.00×10^{8}
Low Sulfur Bituminous	0.09	1.11×10^{8}
Lignite	0.11	9.09×10^{7}
Petroleum Coke	0.05	2.00×10^{8}
Subbituminous Coal	0.07	1.43×10^{8}
Tires	0.06	1.67×10^{8}
Waste Anthracite	0.19	5.26×10^{7}

Coal Type	Average Mercury[1] Content (ppm)	Quantity Needed to Meet Threshold (pounds)
Waste Bituminous Coal	0.46	2.17×10^7
Waste Subbituminous Coal	0.12	8.33×10^7

Source: USEPA, Electric Utility Steam Generating Units Hazardous Air Pollutant Emission Study: Data-Coal Analysis Results (Mercury Information Collection Request (ICR), 1999). Office of Air Quality Planning and Standards, https://www3.epa.gov/airtoxics/combust/utiltox/utoxpg.html

[1] Mercury is expected to be present in coal as metal compounds, and consequently, are expected to be at higher concentrations than reported in the table.

The scientific literature indicates that the concentration of mercury has been measured in many sources of crude oil. In one recent article, 76 crude samples were measured with an average concentration of 1.5 ppm (12). The actual concentrations varied over four orders of magnitude. EPA recognizes that this is enormous variability, and that many facilities use crude oils with a mercury concentration well below 1.5 ppm. In the absence of site-specific information, EPA recommends that facilities contact their trade association or other facilities to determine whether mercury concentration data is available for the type of crude oil they use. The mean of 1.5 ppm may be used as a default value. In the absence of data about the specific form of mercury, EPA recommends that facilities assume all mercury is in the form of mercurous oxide, or Hg_2O. As always, facilities should use the best readily available information that is applicable to their operations.

Coal and oil are common fuel sources at many facilities covered under EPCRA section 313, and are used especially for electric power generation. Coal is processed at coal mining and coke production facilities. Oil feedstocks (including crude oil, No. 2 fuel oil, and No. 6 fuel oil) are processed through carbon black production facilities, petroleum refining facilities, and bulk stations and terminals.

Portland cement facilities may process mercury or mercury compounds as an impurity in raw materials, and otherwise use mercury compounds during fuel combustion. Some typical concentrations of mercury in cement manufacturing process streams are listed in Table 3–3.

Table 3–3: Quantity of Cement Manufacturing Streams Required to Meet the Reporting Threshold

Process Stream	Mercury Concentration	Quantity Needed to Meet Threshold (pounds)
Raw mix	<0.01 ppm	1.00×10^9
Waste-derived fuels	<1.5 ppm	6.67×10^6
Clinker product	<0.01 ppm	1.00×10^9
Cement kiln dust	< 0.5 ppm	2.00×10^7

Source: Radian Corporation, *Trial Burn Report*. 1995.

Mercury or mercury compound impurities may be present in chemicals used by your facility. For example, chlorine used by a pulp mill may contain a mercury impurity if manufactured by the mercury cell process.

Copper and lead smelting and refining facilities may process mercury or mercury compounds as an impurity in the sulfide ore. At primary lead smelting operations, the amount of mercury present in the ore is approximately 0.0004 pounds per ton of ore concentrate (5, p. 4-60).

Section 3.2 Mercury Recovery Operations

The manufacture and subsequent processing of mercury may result from a facility's mercury recovery activities. A facility may recover liquid mercury from dismantled equipment, or recover mercury from scrap and industrial wastes using a thermal or chemical extractive process. Major sources of recycled or recovered mercury include scrap from instrument and electrical devices (lamps and switches), wastes and sludge from electrolytic refining plants, and mercury batteries. Secondary smelting operations may recover mercury from scrap for reuse or sale, and gold mining facilities may manufacture mercury as a by-product.

Section 3.3 Mercury Components

Mercury may be incorporated into final products such as lamps, switches, and batteries. Although the use of mercury has declined, facilities may still exceed the 10-pound processing or otherwise use threshold.

Electrical apparatus manufacturing facilities may process mercury as an article component in products such as electrical switches, thermal-sensing devices, fluorescent lamps, and copper foil. The electrical apparatus manufacturing industry primarily uses mercury as an electrical contact in electric switch production. High-purity copper foil production also uses mercury as an electrical contact. Mercury may be a component in thermal sensing devices, in which it expands upon heating, activating the controls. Fluorescent lamp manufacturers inject mercury vapor into lamps.

In addition, mercury and mercury compounds may be processed by facilities as a component in thermometers, dental amalgams, and batteries. Mercury is a component in mercuric oxide, silver oxide, zinc-air, carbon-zinc, and alkaline batteries. As of 1996, mercury is legally prohibited from being added as a corrosion inhibitor in most alkaline batteries (8). However, it is present in alkaline battery casings still in use as a side reaction inhibitor and corrosion inhibitor. Table 3–4 lists the concentration of mercury in common articles.

Table 3–4: Quantity of Common Articles Containing Mercury Required to Meet the Reporting Threshold

Article Type	Mercury Content (per article)	Reference	Number of Articles Required to Meet Threshold
Mercuric oxide battery	30 - 40%	5, p. 4-20	[a]
Silver oxide battery	7.7×10^{-6} lb	15	1.30×10^{6}
Zinc - Air battery	1.99×10^{-5} lb	15	5.03×10^{5}
Carbon - Zinc	0.01%	30	[a]
Alkaline manganese button battery	2.4×10^{-5} lb	15	4.17×10^{5}
4' Fluorescent Lamp	2.56×10^{-5} lb	14	3.91×10^{5}
Ampoules [b]	6.2×10^{-3} lb	17	1.61×10^{3}
Thermostats [b]	8.8×10^{-3} lb	17	1.14×10^{3}

[a] No information on the weight of mercuric oxide or carbon-zinc batteries is available.
[b] Thermostats may contain multiple ampoules. The mercury content provided is an average value.

Although mercuric oxide batteries are the only batteries currently manufactured with mercury and mercury compounds as main components, mercury may be recovered from the other battery types.

Section 3.4 Mercury and Mercury Compounds in the Chemical Industry

Facilities covered by EPCRA section 313 reporting requirements include chemical facilities that manufacture, process, or otherwise use mercury or mercury compounds. Some industries include chlor-alkali manufacturing, inorganic or organic mercury compound production, and custom compound resins manufacture.

Chlor-alkali production using the mercury cell process accounts for the largest percentage of commercial consumption of mercury. However, the amount of chlorine produced using the mercury cell process has declined significantly over the last 20 years. The chlor-alkali industry now favors a membrane cell process that uses no mercury, is more energy-efficient, and produces mercury- free products.

Inorganic chemical and industrial chemical production plants may manufacture mercury compounds. The amount of mercury used as a raw material should be included in the processing threshold determination. The amount of mercury compounds produced should be included in the manufacturing threshold.

In addition to facilities manufacturing mercury compound products, other facilities may import, process, or otherwise use mercury reagents or catalysts. If a reaction occurs, mercury compounds may be manufactured. Mercury may also be present in industrial or commercial grade sulfuric acid.

Mercury and mercury compounds may be contained in waste streams received by facilities covered under EPCRA section 313. A facility must consider the treatment or combustion of these waste streams containing mercury or mercury compounds during threshold determinations. The concentration in the waste stream will vary.

Section 3.5 Combustion of Fuels Containing Mercury

All EPCRA section 313 chemicals contained in fuels combusted for energy production are considered otherwise used. The amount of mercury and mercury compounds present in the fuel (e.g., coal, fuel oil) should be included in the otherwise use threshold. If you do not know the mercury compound present in the fuel, EPA recommends using Hg_2O for threshold calculations of otherwise use. Recall that mercury and mercury compounds are separately listed substances, and threshold calculations should be made for them separately.

Current information indicates that elemental mercury and mercury compounds found in coal may be either converted to other mercury compounds or to elemental mercury during the combustion process. The percent conversion is likely a function of several variables. (Study of Hazardous Air Pollutant Emissions from Electricity Generating Units - Final Report to Congress, February 1998). In the absence of better information, EPA recommends that facilities assume that the form of mercury in the coal is mercurous oxide (Hg_2O). The estimated quantity of mercurous oxide is then applied towards the ten pound otherwise use threshold determination. EPA also recommends that facilities assume that all releases and other waste management quantities of mercury from the combustion of coal are in the form of elemental mercury. These estimates of elemental mercury are then used toward ten pound manufacturing threshold determinations.

For fuels other than coal, EPA recommends using the same assumptions. Unless facilities have information to indicate otherwise, EPA recommends they assume that they manufacture elemental mercury during combustion, and that 100% of the mercury compounds in the fuel are converted to elemental mercury. As with coal, apply the weight of the metal, rather than the metal compound toward the manufacturing threshold for mercury.

SECTION 4.0 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 mercury and metal portions of mercury compounds. You should determine the best information available for your operation and decide which calculation method works best for you.

Section 4.1 Mercury and Mercury Compound Emissions

Fuel combustion activities and other heated processes that process or otherwise use mercury and mercury compounds can generate mercury emissions. Following air treatment, mercury emissions may still be released from the stack. The type of air pollution devices used at your facility may dictate the final destination of the controlled mercury (e.g., dust in a baghouse or part of scrubber wastewater). Table 4–1 presents some common operation sources of mercury emissions.

Table 4–1: Sources of Mercury Emissions

Facility/Process Type	Operation Sources of Mercury Emissions
Gold mining	Pretreatment roaster, Retort
Secondary mercury recovery: thermal treatment	Retort or furnace operations, Distillation, After charcoal filters
Mercury compound production	Reactor, Drier, Filter, Grinder, Transfer operations
Chlorine production using the mercury cell process	By-product hydrogen stream, End box and cell room ventilation
Mercuric oxide battery manufacturing	Grinding, Mixing, Sieving, Pelleting, Consolidating
Electrical switch manufacturing	Welding, Filling, Transfer operations, Testing, Spills or breaks
Tungsten bar sintering	Sintering, Final density measurement
Copper foil production	Drum room, Treating room
Fluorescent lamp manufacturing	Mercury purification and transfer, Parts repair, Mercury injection, Broken lamps, and Spills
Fluorescent lamp recycling	Collection, Crushing
Thermometer manufacturing	Mercury purification and transfer, Filling, Heating-out process
Coal and oil combustion	Utility boiler exhaust, Bottom and fly ash handling
Waste combustion	Exhaust stack, Bottom and fly ash handling
Coke production	Coal preparation and handling, Fugitive emissions from oven
Primary lead smelting	Sintering, Blast furnace
Copper smelting	Roasting, Smelting furnace
Petroleum refining	Distillation, Cracking, Conversion steps
Pulp and paper production	Chemical recovery

While using emissions factors is the most common way to determine the amount of mercury released to air, it provides a less accurate estimate than direct measurement, which is required for many source categories, including but not limited to steam generated electric utility units; sewage sludge incinerators, municipal waste combustors; Portland cement plants; gold mines; commercial, industrial, and solid waste incinerators; and major source boilers. If your facility uses an air pollution control device, you can use the capture and control efficiency to determine the quantity of fugitive and stack emissions. Depending on the type of device, the controlled mercury air emissions may become part of a wastewater stream or baghouse dust. Sources of emissions factors include U.S. EPA's Compilation of Emission Factors (AP-42) (9), trade association chemical-specific factors, and other literature values.

The Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units -- Final Report to Congress (https://www.epa.gov/mats/study-hazardous-air-pollutant-emissions-electric-utility-steam-generating-units-final-report) provides speciated mercury testing data for coal combustion collected for the 1999 Information Collection Request (ICR). Although the data were collected from utility boilers, they may be used for non-utility boilers. Table 4–2 provides the mercury emissions factor for coal based on coal type, boiler type, and air pollution control scheme. When determining mercury emissions to air and site-specific data are unavailable, EPA recommends using data with the same (or most similar) fuel type, boiler type, and control devices. For more details on the data provided, refer to the website.

Table 4–2: Mercury Emissions Factors from Coal for the Mercury and Air Toxics Standards

Coal Type	Boiler Type	Air Pollution Control Scheme	Mercury Emissions Factor (lb/MMBtu)
Bituminous	Conventional	Activated Carbon Injection	1.94E-06
Lignite	Conventional	Activated Carbon Injection	3.90E-06
Subbituminous	Conventional	Activated Carbon Injection	1.30E-06
Lignite	Fluidized Bed	Activated Carbon Injection	4.67E-06
Bituminous	Conventional	Cold-side ESP	5.64E-06
No. 6 Fuel Oil	Conventional	Cold-Side ESP	6.23E-08
Subbituminous	Conventional	Cold-side ESP	3.28E-06
Bituminous	Fluidized Bed	Cold-side ESP	1.73E-06
Bituminous	Conventional	Dry FGD + Fabric Filter	1.14E-07
Subbituminous	Conventional	Dry FGD + Fabric Filter	4.69E-06
Bituminous	Fluidized Bed	Dry FGD + Fabric Filter	5.80E-08
Coal Refuse	Fluidized Bed	Dry FGD + Fabric Filter	3.78E-07
Petroleum Coke	Fluidized Bed	Dry FGD + Fabric Filter	5.96E-08
Bituminous	Conventional	ESP + Wet FGD	1.25E-06
Bituminous	Conventional	Fabric Filter	4.37E-08
Subbituminous	Conventional	Fabric Filter	3.03E-06
Bituminous	Fluidized Bed	Fabric Filter	1.15E-08
Coal Refuse	Fluidized Bed	Fabric Filter	1.63E-07
Lignite	Fluidized Bed	Fabric Filter	1.08E-05
Petroleum Coke	Fluidized Bed	Fabric Filter	9.63E-07
Bituminous	Conventional	Fabric Filter + Wet FGD	8.03E-07
Subbituminous	Conventional	Fabric Filter + Wet FGD	1.47E-07
No. 2 Fuel Oil	Conventional	No Hg Control	1.14E-07
IGCC	IGCC	No Hg Control	8.18E-07

Coal Type	Boiler Type	Air Pollution Control Scheme	Mercury Emissions Factor (lb/MMBtu)
Bituminous	Conventional	No Hg Control (includes hot-side ESP's)	1.10E-05
No. 6 Fuel Oil	Conventional	No Hg Control (includes hot-side ESP's)	1.12E-07
Subbituminous	Conventional	No Hg Control (includes hot-side ESP's)	5.25E-06
Petroleum Coke	Conventional	Wet FGD	6.48E-08
Subbituminous	Conventional	Wet FGD	3.32E-06

ESP: Electrostatic precipitator
FGD: Flue gas desulfurization
Source: U.S. EPA. *Emission Factor Supporting Documentation for the Final Mercury and Air Toxics Standards.* Office of Air Quality Planning and Standards. November 2011.
https://www3.epa.gov/airtoxics/utility/mats_efs_casestudies_currentbaseei.pdf

The data provided in Table 4–2 is based on an analysis conducted at the time of the final Mercury and Air Toxics Standards (MATS) rule. As always, if a facility has other means of estimating emissions which are more applicable to that site, they may be used.

After determining the quantity of mercury released to the air, facilities must also determine the quantity of mercury in the bottom ash and collected by the control device. A mass balance calculation using the total amount of mercury in coal (see Table 3–2) may be used to determine these quantities. The release or waste management of the mercury in bottom ash or from the control device (e.g., effluent from a wet scrubber) must be reported on the Form R.

If the data in Table 4–2 do not apply to your boiler, you may use an uncontrolled emissions factor for coal combustion of 16 lb/10^{12} Btu, as provided on page 1.13-8 in Table 1.1-17 of AP-42[(9)].

Pulp and paper mill mercury emissions occur primarily at chemical recovery operations. Table 4–3 lists emission factors for the combustion sources.

Table 4–3: Mercury Emission for Kraft Combustion Sources

Kraft Combustion Source	Average Mercury Emissions Factor (lb/ton)
Recovery furnace, NDCE[1]	2.2 × 10-6
Recovery furnace, DCE[1]	ND (1.0 × 10-5)
Smelt dissolving tank[1]	3.3 × 10-7
Lime kiln, with ESP[2]	4.7 × 10-6
Lime kiln, with scrubbers[2]	ND (9.0 × 10-5)

ND = non-detect
ESP = Electrostatic Precipitator
[1] Emissions factors are per ton of black liquor solids fired in the recovery furnace.
[2] Emissions factors are per ton of lime produced in lime kiln.
Source: Letter from R.C. Kaufmann, National Council of the Paper Industry for Air and Stream Improvement, to Jeff Telander, U.S. EPA. Data provided to EPA's Office of Air Quality Planning and Standards in connection with the MACT II rulemaking activity for pulp and paper combustion sources. February 10, 1999.

Portland cement kiln emissions factors listed in AP-42 (Reference 9, Table 11.6-9) are based on the type of control. The average emissions factor for mercury with an electrostatic precipitator air pollution control device is 0.00022 lb/ton. If a fabric filter (e.g., baghouse) is used, the average emissions factor for mercury is 0.000024 lb/ton. Table 4–4 lists the AP-42 mercury emissions factors from brick manufacturing operations.

Table 4–4: Mercury Emissions Factors from Brick Manufacturing

Source	Mercury Emissions Factor (lb/ton)[1]
Coal-fired kiln (SCC 3-05-003-13)	9.6×10^{-5}
Natural gas-fired kiln (SCC 3-05-003-11)	7.5×10^{-6}
Sawdust-fired kiln (SCC 3-05-003-10)	7.5×10^{-6}
Sawdust-fired kiln and sawdust dryer (SCC 3-05-003-61)	1.1×10^{-5}

SCC = Source Classification Code
[1] Per ton of fired brick produced.
Source: US EPA, *Compilation of Air Pollutant Emission Factors, AP-42. Table 11.3-7,* Fifth Edition, OAQPS.

Table 4–5: Mercury Emissions Factors

Process and Emission Control Type	Average Mercury Emissions Factor	Reference[1]
Chlor-alkali mercury cell process - hydrogen vent (uncontrolled)	3.3×10^{-3} lb/ton Chlorine (Cl) produced	(9)
Chlor-alkali mercury cell process - hydrogen vent (controlled)	1.2×10^{-3} lb/ton Cl produced	(9)
Chlor-alkali mercury cell process - end box	1.0×10^{-2} lb/ton Cl produced	(9)
Electrical switch manufacturing (uncontrolled)	8 lb/ton mercury	(3)
Fluorescent lamp manufacturing (uncontrolled)	8 lb/ton mercury	(3)
Fluorescent lamp recycling (fabric filter, carbon absorber)	1.9×10^{-9} lb/lamp	(3)
Instrument manufacturing (uncontrolled)	18 lb/ton mercury	(3)
By-product Coke production (fabric filter, ESP)	6.0×10^{-5} lb/ton coke[2]	(3)
Primary copper smelting, acid plant or wet scrubber controls	7.8×10^{-5} lb/ton metal*	(10)
Petroleum refining - process heaters, uncontrolled	2.73×10^{-6} lb/MMBtu	(28)
Petroleum refining - asphalt blowing, uncontrolled	8.3×10^{-6} lb/MMBtu	(29)
Lime manufacture, coal-fired rotary kilns	1.5×10^{-5} lb/ton lime	(3)
Lime manufacture (fabric filter), natural-gas fired vertical kilns	3.0×10^{-6} lb/ton lime	(3)
Batch mix hot mix asphalt plants - dryer, hot screens, and mixer (fabric filter)	4.1×10^{-7} lb/ton hot mix asphalt (HMA) produced	(9)
Drum mix hot mix asphalt plants - natural gas or propane-fired dryer (fabric filter)	2.4×10^{-7} lb/ton HMA produced	(9)
Drum mix hot mix asphalt plants - oil-fired dryer (fabric filter)	2.6×10^{-6} lb/ton HMA produced	(9)
Hot mix asphalt - rotary dryer (wet scrubber)	3.9×10^{-6} lb/ton HMA produced	(24)
Hot mix asphalt - rotary dryer (multiple cyclone)	5.7×10^{-6} lb/ton HMA produced	(24)

Process and Emission Control Type	Average Mercury Emissions Factor	Reference[1]
Hot mix asphalt - rotary dryer (knock out box, baghouse)	4.73×10^{-7} lb/ton HMA produced	(24)
Hot mix asphalt - rotary dryer (single cyclone, wet scrubber)	1.63×10^{-6} lb/ton HMA produced	(25)
Hot mix asphalt - rotary dryer (single cyclone, baghouse)	$<4.0 \times 10^{-8}$ lb/ton HMA produced	(26)
Hot mix asphalt - rotary dryer (knock out box, venturi scrubber)	7.4×10^{-6} lb/ton HMA produced	(23)
Hot mix asphalt - drum dryer (uncontrolled)	7.4×10^{-9} lb/ton HMA produced	(27)
Portland cement kiln (ESP)	2.2×10^{-4} lb/ton clinker produced	(9)
Portland cement kiln (fabric filter)	2.4×10^{-5} lb/ton clinker produced	(9)
Carbon black manufacture (fabric filter)	3.0×10^{-4} lb/ton carbon black	(3)
Dental alloy production (uncontrolled)	40 lb/ton mercury	(3)
Steel mill - Electric arc furnace (EAF)	7.2×10^{-5} lb/ton scrap feed*	(10)
Grey Iron foundries - cupola (uncontrolled)	3.48×10^{-4} lb/ton cast pipe produced	(21)
Grey Iron foundries - cupola (baghouse)	1.587×10^{-4} lb/ton cast pipe produced	(21)
Ferroalloy (FeSi alloy) production - open EAF (uncontrolled)	3.8×10^{-5} lb/ton alloy*	(10)
Ferroalloy (SiMn alloy) production - closed EAF (uncontrolled)	5.6×10^{-4} lb/ton alloy*	(10)
Ferroalloy (FeMn alloy) production - closed EAF (uncontrolled)	1.68×10^{-6} lb/ton alloy*	(10)
Ferroalloy (FeMn alloy) production - semi-covered EAF (venturi scrubber)	9.3×10^{-5} lb/MWh	(20)
Ferroalloy (FeMn alloy) production - semi-covered EAF (uncontrolled)	2.7×10^{-3} lb/MWh	(20)
Ferroalloy (other alloy) production - semi-covered EAF (uncontrolled)	8.36×10^{-6} lb/MWh	(20)
Secondary aluminum production - burning/drying (venturi scrubber)	2.0×10^{-8} lb/lb cans processed	(22)
Secondary aluminum production - burning/drying (baghouse)	2.8×10^{-9} lb/lb cans processed	(22)
Secondary lead production - blast furnace (controlled)	2.2 lb/ton lead produced	(23)
Secondary lead production - kettle refining fugitive emissions (controlled)	4.7×10^{-6} lb/ton lead produced	(23)
Glass manufacture (particulate control)	1.0×10^{-4} lb/ton silica*	(10)
Brick manufacture	See Table 4-4	(9)
Pulp and paper - kraft combustion sources	See Table 4-3	(4)
Battery manufacturing - button cell process	See Reference 3, page 5-10, for individual unit operations	(3)
Distillate fuel oil combustion (uncontrolled)	3.0 lb/10^{12} Btu	(9)
No. 6 fuel oil combustion (uncontrolled)	1.13×10^{-4} lb/1,000 gallons	(9)
Electric utilities (power generation) - residual oil (controlled)	0.057 lb/ 1×10^{6} gallons residual oil burned*	(10)

Process and Emission Control Type	Average Mercury Emissions Factor	Reference[1]
Industrial wood waste combustion (controlled)	5.15×10^{-6} lb/ton wood waste burned (wet, 50% moisture)	(9)
Industrial wood waste combustion (uncontrolled)	6.9×10^{-6} lb/ton wood waste burned (dry)	(19)
Coal combustion (uncontrolled)[3]	16 lb/10^{12} Btu	(9)

ESP = Electrostatic precipitator MMBtu = Million BTUs
[1]Numbers correspond to the references listed in SECTION 5.0.
[2]Emissions factor based on German coke ovens. If no other data available, assume coal cleaning reduces emissions by 20% (3).
[3]Facilities with industrial coal-fired boilers may refer to the Technical Air Pollution Resources Website, https://www.epa.gov/technical-air-pollution-resources, for concentrations of mercury in various types of coal.
*Emissions factor converted from metric units.

Mercury 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., leaving with the product, released with wastewater, disposed with solid waste) are known, as demonstrated in the following example.

Example 3: Calculating Mercury Quantities using Mass Balances

The amount of gold ore mined by your facility is 1.5 million pounds during the year. The mercury content in your ore is approximately 9 ppm. The quantity of mercury processed through the facility may be calculated as follows:

$$1{,}500{,}000 \text{ lb ore} \times (9 \text{ lb mercury}/1 \times 10^6 \text{ lb ore}) = 13.5 \text{ lb mercury}$$

Your production records show 10 pounds of mercury is sold as a by-product. The remaining 3.5 lb/yr is assumed to be contained in discarded dusts swept up during area cleaning. The dust is then sent to an off-site landfill.

You should report the 3.5 lb/yr in Part II, Section 6.2 and Section 8.1 of the Form R.

Section 4.2 Mercury in Wastewater

Wastewater sources of mercury include area washdowns and tank clean outs of processes in which mercury or mercury compounds are manufactured, processed, or otherwise used. If a wet air pollution control device (e.g., scrubber) is used at a process generating mercury emissions, mercury 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 activities. In addition to the sources listed above, spills and one-time events may also generate a mercury-containing waste stream.

If your facility discharges to surface water, you most likely have a NPDES or state discharging permit. This permit may require you to monitor for mercury. You can use this information to calculate the amount of mercury discharged to surface water. Discharges to POTWs may also require mercury monitoring. The example below shows an approach to calculating mercury amounts using monitoring information.

Example 4: Mercury Discharged to a POTW - Monitoring Information Calculations

Your facility processes mercury in quantities greater than 10 pounds per year. Your facility is required to perform monitoring for certain chemicals, including mercury, two times each year. The results of the monitoring were:

April 4: 2 ppm mercury (Jan - Jun)
October 5: 2.4 ppm mercury (Jul - Dec)

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

Convert the water flows to pounds, using a density of 8.345 lb/gal:

425,000 gal × (8.345 lb/gal) = 3,550,000 lb
555,000 gal × (8.345 lb/gal) = 4,630,000 lb
345,000 gal × (8.345 lb/gal) = 2,880,000 lb
390,000 gal × (8.345 lb/gal) = 3,250,000 lb

Using the corresponding mercury concentrations, the amount of mercury discharged to the POTW is:

(2 lb mercury / 1× 10^6 lb water) × (3,550,000 + 4,630,000 lb) +

(2.4 lb mercury / 1 × 10^6 lb water) × (2,880,000 + 3,250,000) lb

= 31 lb/yr mercury

This quantity should be reported in Part II, Section 6.1 and Section 8.1 of the 2000 Form R.

Mass balances and engineering calculations can also be used to determine the amount of mercury in the wastewater. If your facility treats wastewater on site, you may need to perform engineering calculations to determine how much mercury becomes part of the waste sludge and how much is discharged.

Section 4.3 Mercury Spills and Solid Waste Calculations

Mercury spills can include dust or solid raw materials being spilled during transfer or process operations. Mercury or mercury compounds contained in solution, such as petroleum products, may also be splashed or spilled. Other solid waste sources include sludge from on-site treatment, bags or filters from air pollution control devices, and ash from combustion operations. Solid material spills and ash may also contribute to fugitive emissions. The amount of mercury in solids is commonly calculated using mass balances from records (such as spill reports). Monitoring data on sludge may be available, but as mentioned in the previous wastewater section, engineering calculations can be performed to determine the mercury content in the sludge.

Facility specific information, such as waste analyses and process knowledge, can be used to estimate amounts of mercury in combustion wastes. In the absence of data determined to be better, facilities can use default values for concentrations of mercury in ash, presented in Table 4–6.

Table 4–6: Mercury Concentration in Combustion Residuals

Combustion Residual	Concentration (ppm)
Coal Fly Ash	12
Coal Bottom Ash	4.2
Oil Ash	1

Source: Inorganic and Organic Constituents in Fossil Fuel Combustion Residues, Volume I, Critical Review, Batelle Pacific Northwest Laboratory for EPRI, EA5176, August 1987.

If your facility manufactures a mercury-containing by-product (e.g., at a gold mining facility), you can use a mass balance to determine the quantity of mercury released or otherwise managed as waste. Using facility concentrations, or literature concentrations if facility-specific ones are not available, you can determine the quantity of mercury or mercury compounds processed at your facility from the raw material. Mercury production records indicate how much mercury-containing by- product is manufactured. From process and engineering knowledge, the destination of the mercury releases and other waste management activity quantities can be determined.

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