

Material Balance Quick Guide

Information updated March 2024

Overview

Material Balance is a method for estimating emissions that is based solely on how much material is used, by mass, during production in order to determine pollutant emissions. This method does not associate emissions with a production activity (i.e. emission factor method), but does account for the amount of material used, wasted, or retained in the product. This method can be used for volatile pollutants and particulate emissions primarily associated with painting and coating operations. Facilities must record Material Balance emissions on Worksheets 4 and 5 of the AQ104B Toxics reporting form and the Air Toxics Emissions Inventory (ATEI) reporting form.

Information to gather

Facilities need the following information to estimate emissions using Material Balance:

- Basic information about the type of activity (e.g. spray application or dip tank) and annual usage (volume or mass).
- Specific material information from safety data sheets (SDSs), including product density, pollutant names and Chemical Abstract System (CAS) numbers, and percent weight for each pollutant in the product.
- Material waste stream, including how much ends up as waste and is shipped off-site or drains as liquid to a collection/treatment system (by material, if available).
- Any control devices such as filter systems or thermal oxidizers, and their removal or destruction efficiencies (by pollutant, if available).
- Transfer efficiencies for spray or coating operations (if available).
- Retention efficiencies for the percentage of material components that react and are retained in the product (if available).

Locate SDS pollutant information

Facilities can find information needed to calculate air emissions in the following sections of an SDS or similar technical data sheet.

Hazardous Ingredients/Composition Section: This section contains a list of the material's hazardous ingredients, their CAS numbers and pollutant name, and their percent by weight or by volume. Sometimes a data sheet will list a range (e.g. Acetone 1-5% wt.) instead of an exact percentage. In such instances, use the mean value of the range (e.g., Acetone 3%).

Physical/ Chemical Properties Section: This section of the SDS typically contains information such as product density (also called 'material density', the product weight per unit volume) and specific gravity (unitless), which are necessary to convert from product volume to weight if density is not provided.



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Product Weight, Product Density, or Material Density: This is how much one unit of the material weighs.

Specific Gravity or Relative Density: This dimensionless number can be used if Product Density is not listed by multiplying it by the density of water, 8.345 lb/gal.

Product Weight 9.75 lb/gal	Specific Gravity 1.17	FLASH POINT 103 °F PMCC				
Hazard Category (for SARA 311.312) Acute Chronic Fire						
Volatile Ingredients						
Chemical / Compound	SARA 302 EHS	CERCLA	SARA 313 TC	HAPS 112	% by Weight	% by Volume
Mineral Spirits 64742-88-7	N	N	N	N	25	39
Ethylbenzene 100-41-4	N	Y	Y	Y	0.1	< 1

CAS Number and Pollutant Name: This will need to be cross-referenced with the DEQ Pollutant List. Use names as they appear on the DEQ Pollutant List.

Percent Composition: This is the percent weight of the given pollutant in the product.



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Enter information on the AQ104B or ATEI reporting form Worksheet 4. Material Balance Activities

Emissions Unit/Product Information					Material Usage [lb/yr]	Material Waste [lb/yr]
Emissions Unit ID	Emission Unit Description	Material Name	Manufacturer	Control Device Type (if applicable)		
EU-Booth	Widget Paint Booth - atomizer spray guns (EX)	Widget Paint-A	Widget Paint Co.	booth filter	13,188	2000
EU-Booth	Epoxy resin (EXAMPLE)	Widget Epoxy	Widget Epoxy Co.	none	950	15
EU ID	Description	MaterialName	Manufacturer	ControlDevice	MaterialUsag	MaterialWast
WAX-EU	wax department - cast release	Cast mold release	Wax-R-US	none	100	
FW	marking paint	red marking paint	Dura Wear	none	52	
BOOTH	Spray coating, HVLP (60% efficiency)	Yellow Epoxy Primer	Match Paints	fabric filter (95%)	138	26

1. List all Emission Unit (EU) IDs and EU/Descriptions with material balance emissions. For example, high volume low pressure (HVLP) spraying or coating operations performed in a spray booth might be captured as, **Emissions Unit ID:** "BOOTH" and **Emission Unit Description:** "HVLP spray coating". If the activities are listed in the source permit, please use the EU IDs and description as found in the permit. A single EU ID and description may be used for multiple materials, but the combination of EU ID and Material Name should be unique for each row (product).

2. List all materials (e.g. paints, coating materials, thinners, solvents, etc.) containing pollutants from the provided DEQ Pollutant List - include the specific **Material Name** and **Manufacturer** for each. Although uncommon, materials with *identical* SDS ingredient information, % weights, and physical properties may be combined for total volume and not listed individually.

3. Identify the **Control Device Type**, if present, e.g. fabric filter or RTO. If no control devices are present, enter "none."

4. Record **Material Usage** quantities in pounds for annual activity/production/process rates for each EU and material. Below are variations of material information and how to calculate material usage:

- Where product weight or density is provided on the SDS, convert from product volume (e.g., gallons/yr) using the SDS-listed product density (e.g., lb/gal).
- Where product weight or density is *not* provided on SDS, convert from Specific Gravity by multiplying by the density of water, or 8.345 lb/gal to get product density (lb/gal), then multiply by product volume (gal/yr).

Air Toxics Emissions Reporting

5. Record **Material Waste** as the amount of product that should be excluded from emissions calculation, in quantities of pounds per year.

Worksheet 5. Pollutant Emissions – MB



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Emissions Unit ID	Material Name	Pollutant Information		Emissions Data			Calculated Annual Emissions
		CAS or DEQ ID	Pollutant Name	Control Efficiency	Percent Composition	Reference/Notes	
EU-BOOTH	Widget Paint-A	67-56-1	Methanol	0.00%	35.00%		3915.8
EU-BOOTH	Widget Paint-A	100-40-3	4-Vinylcyclohexene	0.00%	48.00%		5370.24
EU-BOOTH	Widget Paint-A	18540-29-9	Chromium VI, chromate and dichromate particulate	99.72%	5.00%	Includes Transfer Efficiency (72%) and Filter R	1.56632
EU-BOOTH	Widget Epoxy	100-41-4	Ethyl benzene	0.00%	5.00%		46.75
EU-BOOTH	Widget Epoxy	108-88-3	Toluene	0.00%	3.00%		28.05
EU-BOOTH	Widget Epoxy	1330-20-7	Xylene (mixture, including m-xylene, o-xylene, p-xylene)	0.00%	1.00%		9.35
EU ID	MaterialName	CAS	PollutantName	ControlEfficien	PercentCompos	Notes	Emissions
WAX-EU	Cast mold release	611-97-2	1,1,1,2-Tetrafluoroethane	0.00%	45.00%	gas, no control	45
FW	red marking paint	67-56-1	Methanol	0.00%	7.50%		3.9
FW	red marking paint	67-64-1	Acetone	0.00%	15.00%		7.8
FW	red marking paint	108-65-6	Propylene glycol monomethyl ether acetate	0.00%	2.00%		1.04
FW	red marking paint	108-10-1	Methyl isobutyl ketone (MIBK, hexone)	0.00%	2.00%		1.04
BOOTH	Yellow Epoxy Primer	227	Epoxy resins	98.00%	22.50%	60% transfer efficiency, 95% filter efficiency	0.504
BOOTH	Yellow Epoxy Primer	111-76-2	Ethylene glycol monobutyl ether	0.00%	7.50%		8.4
BOOTH	Yellow Epoxy Primer	7789-06-2	Strontium Chromate	98.00%	7.50%	60% transfer efficiency, 95% filter efficiency	0.168
BOOTH	Yellow Epoxy Primer	78-93-3	2-Butanone (methyl ethyl ketone)	0.00%	3.00%		3.36
BOOTH	Yellow Epoxy Primer	67-64-1	Acetone	0.00%	3.00%		3.36
BOOTH	Yellow Epoxy Primer	67-63-0	Isopropyl alcohol	0.00%	3.00%		3.36

1. Locate pollutant information on the material or product SDS and use one row for each air toxic pollutant contained in a specified material. The pollutant CAS and name may be completed by either entering a **CAS or DEQ ID** (and the **Pollutant Name** will auto populate) or copy and paste both from the DEQ Pollutant List tab. Note that the **Emissions Unit ID** and **Material Name** should be completed on each row and match exactly how they appear on Worksheet 4. If they do not match, the **Calculated Annual Emissions** column will return an error.

2. If a control device was identified on Worksheet 4 under **Control Device Type**, provide the **Control Efficiency** for each pollutant contained in a specified material, and note that this value may differ for pollutants within a given material. For example, a fabric filter may be effective at removing particulates, but not volatile compounds. Likewise, a thermal oxidizer breaks down VOCs but does not remove particulates. In each case, the control efficiency would only be applied to some of the pollutants but not others, as appropriate.

The **Control Efficiency** column is also the opportunity to apply a product transfer or retention efficiency as if it were a secondary control. Transfer and retention efficiencies should be considered in addition to the effect of actual control devices such as filters (for particulates) or an oxidizer (for volatiles), as mentioned above. Use the **Reference/Notes** column to document that the control efficiency value includes transfer or retention efficiency and the percentages used. If no control device is present, a transfer or retention efficiency may still be applied.

When two or more efficiencies are combined, use the following equation to input a single efficiency into the **Control Efficiency** column:

$$\text{Total Control Efficiency} = 1 - [(1 - \text{CE}) * (1 - \text{TE or RE})]$$

Where:

- CE = Control Efficiency includes removal and destruction efficiency
- TE = Transfer Efficiency is the percentage of material that is successfully applied to the product
- RE = Retention Efficiency is the percentage of the material compound(s) that is retained in the product once reacted.

Air Toxics Emissions Reporting

Example 1 – Transfer Efficiency: If a spray coating application booth uses an assembly with a 60% transfer efficiency, and the booth's fabric filter has 95% control efficiency. The total control efficiency should be calculated as:

$$\text{Total CE} = 1 - [(1 - 0.95) * (1 - 0.6)] = 0.98, \text{ or } 98\%$$

Example 2 – Retention Efficiency: Toluene diisocyanate (TDI) is used to manufacture a specific product but reacts during the process and a portion of the chemical is retained in the product. A reference material indicates that 0.4 lb TDI are emitted for every 10 lbs used, or 96% is retained in the product. Emissions from this process are then routed through a thermal oxidizer unit with a control efficiency for TDI of 92%. The total control efficiency should be calculated as:

$$\text{Total CE} = 1 - [(1 - 0.92) * (1 - 0.96)] = 0.997, \text{ or } 99.7\%$$

3. Provide the **Percent Composition** for the Air Toxic in the specified material as supplied by the SDS and using the below pointers:

- Where a range is given, use the mean value, (low end + high end)/2 = mean
- Where “≤” is given, use the provided value
- Where “<” is given, use the mean of the given value and zero
- Double check percentage decimal points to confirm they appear as intended.

4. Provide any **References/ Notes** relevant to the pollutant emissions - e.g. technical references, details of control efficiencies, etc. Utilize the ‘Facility Note’ tab on the reporting form if more space or explanation is required.

5. **Calculate Annual Emissions.** The form includes an embedded formula for calculating emissions based on the below equation. This formula may be overwritten as necessary; however, explanation should be provided if a different calculation method is employed (e.g. in the **References/Notes** column, or a longer statement in the ‘Facility Note’ tab).

Equation

The following material balance equation is used to estimate emissions. Note that Control Efficiency, Transfer Efficiency and Retention Efficiency are discussed above in the Worksheet 5 Instructions section.

$$E_a = [(C_X - W_X) * K_a] * (1 - CE_a)$$

Where:

- E = Annual air toxic emissions [**Pounds/(Year)**]
- a = Subscript ‘a’ represents a specific pollutant within the material
- X = Subscript ‘X’ represents a specific material
- C = Material usage [**Pounds/(Year)**]
- W = Material waste [**Pounds/(Year)**]
- K = Percent weight of pollutant in material ‘X’ expressed as a decimal (from SDS)
- CE = Total Control Efficiency expressed as decimal, including Transfer or Retention efficiencies

Other Considerations

- Retain all product SDSs but do not send them with the reporting form submission. DEQ may contact the individual listed on the Facility Info worksheet of the reporting form if review of the SDS information is required.



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- Some chemicals or pollutants may appear on SDS sheets under a different name than the DEQ Pollutant List - search by the CAS number to locate the version DEQ uses.
- A yellow cell background signifies a pollutant that does not appear on the DEQ Pollutant List. This does not indicate an error; it simply helps identify new compounds.
- Some SDS sheets contain a section for SARA 313 reporting, for which the compounds may appear differently, and with different ranges, than in the Hazardous Ingredient section. For consistency, default to using the primary hazardous ingredient section.

Alternative formats

DEQ can provide documents in an alternate format or in a language other than English upon request. Call DEQ at 800-452-4011 or email deqinfo@deq.state.or.us.



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