

## Material Balance Quick Guide

Information updated February 2023



State of Oregon  
Department of  
Environmental  
Quality

### Air Quality Division

700 NE Multnomah St.  
Suite 600  
Portland, OR 97232  
Phone: 503-229-5696  
800-452-4011  
Fax: 503-229-6124

Contact: Clara Funk  
503-229-5661  
Clara.Funk@  
deq.oregon.gov

[www.oregon.gov/DEQ](http://www.oregon.gov/DEQ)

*DEQ is a leader in  
restoring, maintaining  
and enhancing the  
quality of Oregon's air,  
land and water.*

### 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 the AQ104B Toxics Reporting form Worksheets 4 and 5.

### 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.
- 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).
- Material waste stream, including how much is projected to end up as waste and shipped off-site or will drain as liquid to a collection/treatment system (by material, 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 average 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.

# Air Toxics Emissions Reporting

**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.

<b>Product Weight</b> 9.75 lb/gal	<b>Specific Gravity</b> 1.17	<b>FLASH POINT</b> 103 °F PMCC				
<b>Hazard Category (for SARA 311.312)</b>   Acute   Chronic   Fire						
<b>Volatile Ingredients</b>						
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.



State of Oregon  
Department of  
Environmental  
Quality

**Air Quality Division**  
700 NE Multnomah St.  
Suite 600  
Portland, OR 97232  
Phone: 503-229-5696  
800-452-4011  
Fax: 503-229-6124

Contact: Clara Funk  
503-229-5661  
Clara.Funk@  
deq.oregon.gov

[www.oregon.gov/DEQ](http://www.oregon.gov/DEQ)

*DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.*

## Enter information on the AQ104B Toxics Reporting form Worksheet 4. Material Balance Activities

Material Information					Max Daily Material Usage [lb/day]	Annual Material Usage [lb/yr]
Emissions Unit ID	Emission Unit Description	Material Name	Manufacturer	Control Device Type (if applicable)		
EU-Booth	Widget Paint Booth - atomizer spray guns (E)	Widget Paint-A	Widget Paint Co.	booth filter	150	13,188
EU-Booth	Epoxy resin (EXAMPLE)	Widget Epoxy	Widget Epoxy Co.	none	98	950
EU ID	Description	MaterialName	Manufacturer	ControlDevice	DailyUsage	AnnualUsage
EU-HOPS	Retrofitting and Rebuilding	Adhesion Promoter 8643M	3M	None		14
EU- Fuel Shop	Fuel Control System Assembly	Edge Sealer 4150S	3M	None		1
EU-HOPS	Retrofitting and Rebuilding	High performance rubb	3M	None	15	16.03
EU-HOPS	Electrical Control Systems Manufacturing	Neoprene Rubber and	3M	None		2

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 maximum daily activity (batch) and 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

Note: The Material Waste column was removed from the AQI04B Toxics reporting form. If this is critical for capturing emissions estimates at your facility, the calculation can be performed manually based on the equation at the bottom of page 4 and noted in the Reference/Notes column of the spreadsheet.



State of Oregon  
Department of  
Environmental  
Quality

Air Quality Division  
700 NE Multnomah St.  
Suite 600  
Portland, OR 97232  
Phone: 503-229-5696  
800-452-4011  
Fax: 503-229-6124

Contact: Clara Funk  
503-229-5661  
Clara.Funk@  
deq.oregon.gov

[www.oregon.gov/DEQ](http://www.oregon.gov/DEQ)

*DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.*

## Worksheet 5. Pollutant Emissions – MB

Emissions Unit ID	Material Name	Pollutant Information			Emissions Data		Calculated Max Daily Emissions [lb/day]	Calculated Annual Emissions [lb/yr]
		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%		52.5	4615.8
EU-BOOTH	Widget Paint-A	100-40-3	4-Vinylcyclohexene	0.00%	48.00%		72	6330.24
EU-BOOTH	Widget Paint-A	18540-29-9	Chromium VI, chromate and dichromate parti	99.72%	0.50%	Includes Transfer Efficiency (72%) and Filter	0.0021	0.184632
EU-BOOTH	Widget Epoxy	100-41-4	Ethyl benzene	0.00%	5.00%		4.9	47.5
EU-BOOTH	Widget Epoxy	108-88-3	Toluene	0.00%	3.00%		2.94	29.5
EU-BOOTH	Widget Epoxy	1330-20-7	Xylene (mixture) including m-xylene, o-xylene	0.00%	1.00%		0.98	9.5
EU ID	Material Name	CAS	Pollutant Name	Control Efficiency	Percent Compos	Notes	Daily Usage Emissions	Annual Usage Emissi
EU-HOPS	Adhesion Promoter 88	67-63-0	Isopropyl alcohol	0.00%	3.00%		0	0.42
EU-Fuel Shop	Edge Sealer 4150S	100-41-4	Ethyl benzene	0.00%	10.00%		0	0.1
EU-Fuel Shop	Edge Sealer 4150S	108-65-6	Propylene glycol monomethyl ether acetate	0.00%	30.00%		0	0.3
EU-Fuel Shop	Edge Sealer 4150S	71-43-2	Benzene	0.00%	0.05%		0	0.0005
EU-HOPS	High performance rubb	108-88-3	Toluene	0.00%	13.00%		1.95	2.0639
EU-HOPS	High performance rubb	110-54-3	Hexane	0.00%	15.00%		2.25	2.4045
EU-HOPS	High performance rubb	110-82-7	Cyclohexane	0.00%	5.00%		0.75	0.8015
EU-HOPS	High performance rubb	1314-13-2	Zinc oxide	0.00%	1.00%		0.15	0.1603
EU-HOPS	High performance rubb	78-93-3	2-Butanone (methyl ethyl ketone)	0.00%	30.00%		4.5	4.809

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 appears 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:

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

### 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.

**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:

# Air Toxics Emissions Reporting

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

**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 median value,  $(\text{low end} + \text{high end})/2 = \text{median}$
- Where “ $\leq$ ” is given, use the provided value
- Where “ $<$ ” is given, use the median 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 Max Daily and Annual Emissions.** The form includes embedded formulas 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.
- 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.



State of Oregon  
Department of  
Environmental  
Quality

**Air Quality Division**  
700 NE Multnomah St.  
Suite 600  
Portland, OR 97232  
Phone: 503-229-5696  
800-452-4011  
Fax: 503-229-6124

Contact: Clara Funk  
503-229-5661  
Clara.Funk@  
deq.oregon.gov

[www.oregon.gov/DEQ](http://www.oregon.gov/DEQ)

*DEQ is a leader in  
restoring, maintaining  
and enhancing the  
quality of Oregon's air,  
land and water.*

# Air Toxics Emissions Reporting

- 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](mailto:deqinfo@deq.state.or.us).



State of Oregon  
Department of  
Environmental  
Quality

**Air Quality Division**  
700 NE Multnomah St.  
Suite 600  
Portland, OR 97232  
Phone: 503-229-5696  
800-452-4011  
Fax: 503-229-6124

Contact: Clara Funk  
503-229-5661  
Clara.Funk@  
deq.oregon.gov

[www.oregon.gov/DEQ](http://www.oregon.gov/DEQ)

*DEQ is a leader in  
restoring, maintaining  
and enhancing the  
quality of Oregon's air,  
land and water.*