PRTR Estimation Manual

29. Switchgear and Controlgear Manufacturing Industry

March 2004

Prepared by the Working Group for Switchboard Industries

Contents

Chapter 1 Outline of the PRTR System

The English description here is omitted.

Chapter 2 Basic Philosophy behind Releases /Transfers Calculation

The English description here is omitted.

Chapter 3 Calculation of Releases/Transfers in Processes for Manufacturing Switchgear/Controlgear

Depending on the method used, switchgear/controlgear manufacturing is roughly comprised of the following processes: cutting and bending, welding, pretreatment, undercoating, finishcoating, and assembly. **Figure 3.1** shows the typical processes.

Releases and transfers are calculated by analyzing and arranging these processes. As is mentioned in **Chapter 1**, it is recommended that the following be confirmed before calculation:

a) Obtaining an Material Safety Data Sheet (MSDS) and calculating the amount handled

If raw materials or resources (stainless steel, paint, solvent, solder, etc.) containing PRTR chemicals are used, obtain an MSDS.

Calculate the content of the PRTR chemicals and check if the content is the minimum amount prescribed by law (PRTR chemicals: 1.0 ton, PRTR specified chemicals: 0.5 tons) or more to determine whether reporting is required or not. (See **Figure 1.2**.)

If reporting is necessary, calculate the releases and transfers of each PRTR chemical accurately. (Detailed in **3.1** and later)

Of the PRTR chemicals, those contained in purchased assembly parts and components used in sealed states (capacitors, etc.) shall be excluded from totaling of the amount handled for reporting if it is obvious the PRTR chemicals are not released to the environment.

b) Classification of releases and transfers

For each PRTR chemical (for reporting), classify releases and transfers by thoroughly examining the contents in and after Section **3.1**. Since volatile and nonvolatile substances are classified differently, clarify the type of releases and transfers by referencing **Attached Forms 4 to 6** in **Reference 2**.

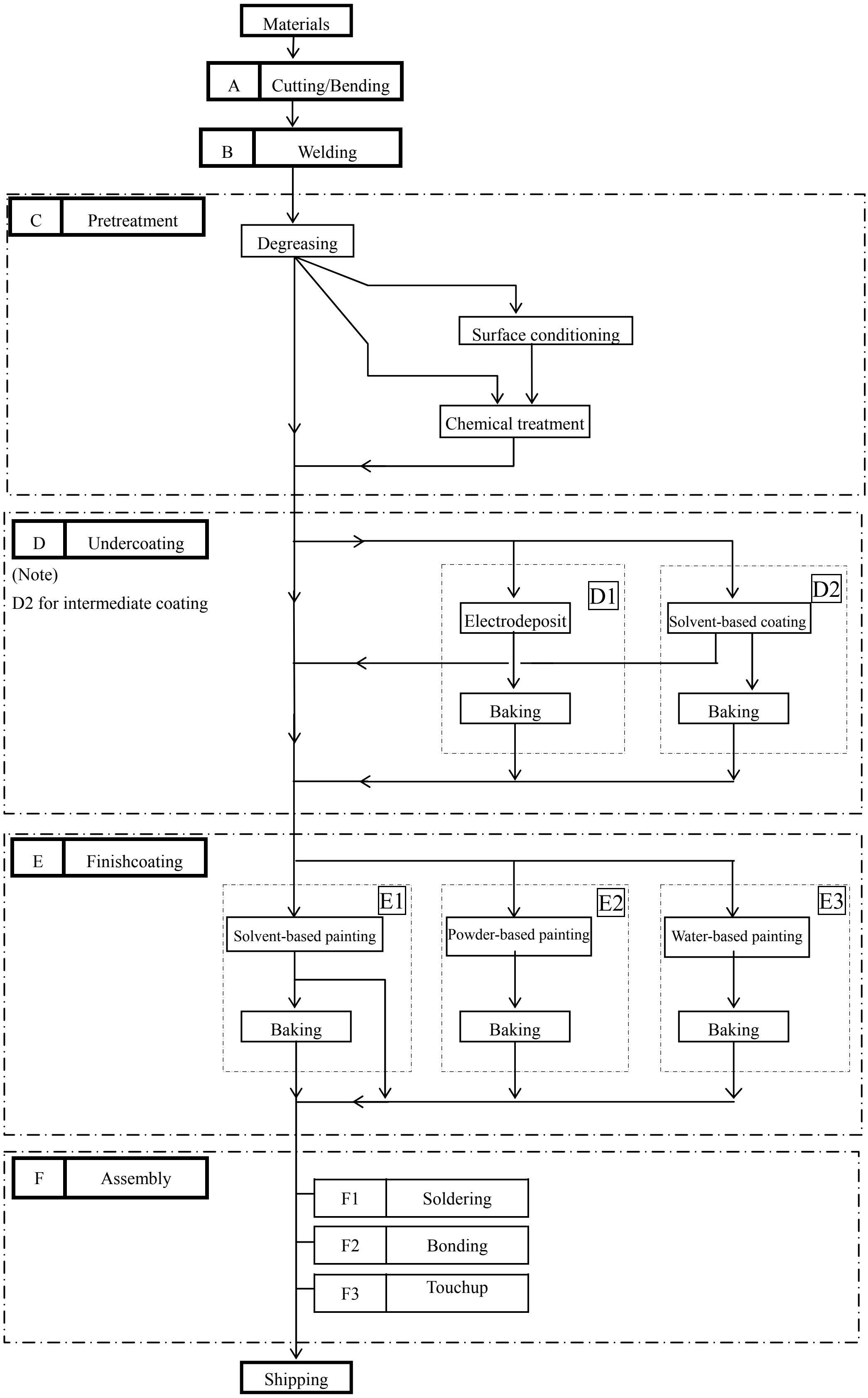


Figure 3.1 Switchgear/controlgear manufacturing processes

3.1 Cutting and Bending Process

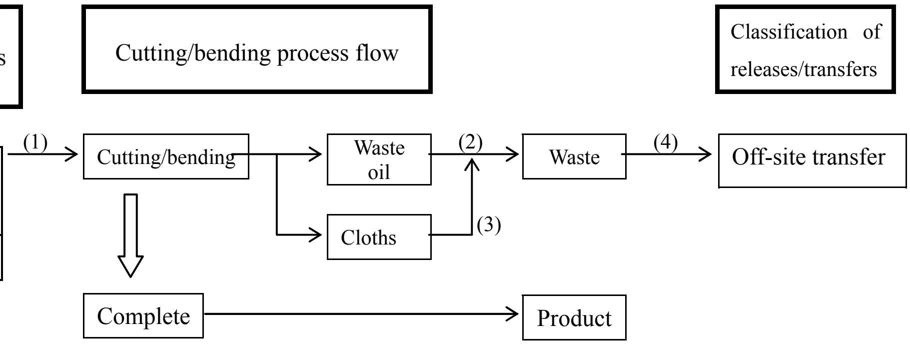
The cutting and bending process is the first process of switchgear/controlgear manufacturing.
Releases to the environment include the transfer of PRTR chemicals contained in the cutting oil, grease, and other lubricants used in cutting and bending equipment.

A. Cutting and bending process

[Example of PRTR chemicals and process flow diagram]

Lubricant

Cabinet Order No.	Examples of PRTR chemicals
309	Poly(oxyethylene) = Nonyl phenyl ether
346	Molybdenum and its compounds



[Calculation flow]

(1) Calculate the annually handled amount of PRTR chemical contained in lubricant ⇐ Annual amount of lubricant handled × Content of PRTR chemical in lubricant

⇩

(2) Calculate the amount of PRTR chemical in waste oil ⇐ Annual amount of waste lubricant × Content in waste oil

⇩

(3) Calculate the amount of PRTR chemical released with cloths ⇐ (1) - (2)

⇩

(4) Calculate the amount contained in waste ⇐ (2) + (3) = (1)

(Note) The content in waste oil shall be equal to the content in the lubricant if it is unknown.
If there is no evaporation (release to the air), amount sent out as value, or substance shipped out as product, the amount handled will be equal to the transfers.

[Calculation example]

This example shows how to calculate the annual releases and transfers of poly(oxyethylene) = nonyl phenyl ether [hereinafter, poly(oxyethylene)] when facilities and conditions are as follows:

(Facilities and conditions)

- Process: Cutting switchgear/controlgear enclosure material
- Processing method: Cutting with a cutter using a cutting oil
- Lubricating material used: Cutting oil [Content of poly(oxyethylene): 1.25%]

• Material to be processed: Soft steel (SS400)
• Annual consumption of cutting oil: 100 kg/year
• Annual amount of waste cutting oil: 90 kg/year

Calculating the releases and transfers of poly(oxyethylene)

Based on the aforementioned calculation flow, the releases and transfers are calculated as explained below. Since the cutting oil does not evaporate in this case, the annual amount handled becomes equal to the annual transfers if no amount is sent out as value for recycling.

In other words, the annual amount handled (1.25 kg/year) in (1) below is the annual off-site transfers of poly(oxyethylene). The calculation in and after (2) is usually not necessary but is given in order to explain the calculation procedure.

(1) Calculating the annual amount of poly(oxyethylene) handled

[Annual amount of poly(oxyethylene) handled]

= (consumption of cutting oil) × [content of poly(oxyethylene) in cutting oil]

= 100 kg/year × 1.25%

= 1.25 kg/year ・・・・・ Off-site transfer

The operating procedure below is shown for reference.

(2) Calculating the amount of poly(oxyethylene) contained in waste oil

(Amount contained in waste oil) = (annual amount of waste oil) × [content of poly(oxyethylene) in waste oil]

= 90 kg/year × 1.25%

= 1.13 kg/year

Since the content of poly(oxyethylene) in waste oil is unknown, it is assumed to be equal to the content in cutting oil for calculation.

(3) Calculating the amount of poly(oxyethylene) contained in cloths

(Amount contained in cloths) = (annual amount of cutting oil handled) - (amount released as waste oil)

=1.25 kg/year - 1.13 kg/year

=0.12 kg/year

The amount of poly(oxyethylene) released with cloths is calculated by subtracting the amount released as waste oil from the annual amount handled.

The balance between the annual amount handled and the amount of waste oil is regarded as the amount of poly(oxyethylene) released with cloths. (Recycling and other factors should be considered, if any.)

(4) Calculating the amount contained in waste

(Amount contained in waste) = (amount contained in waste oil) + (amount contained in cloths)

= 1.13 kg/year + 0.12 kg/year

= 1.25 kg/year ・・・・・ Off-site transfer

[Note] If poly(oxyethylene) is not used in any other process, no reporting is required because the amount handled is below one ton. If it is also used in other processes, the amount handled is determined by totaling in order to judge the need of reporting.

(Although omitted in later sections to avoid repetition, this [Note] also applies to 3.2 and later.)

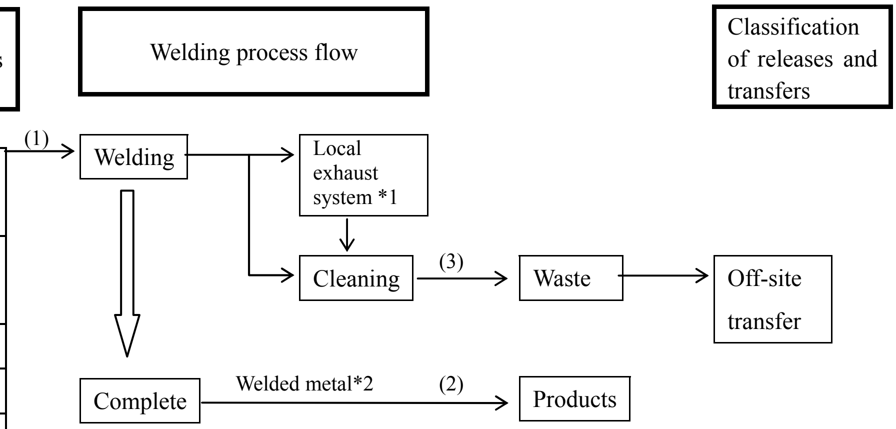
3.2 Welding process

Metal material is butted and bonded with welding rods or filler wires through electric arcing or gas heating. Releases to the environment include the transfer of PRTR chemicals contained in welding material as waste.

B. Welding process

[Examples of PRTR chemicals]

Cabinet Order No.	Examples of PRTR chemicals
Welding materials	
68	Chromium and trivalent chromium compounds
69	Hexavalent chromium compounds
231	Nickel
311	Manganese and its compounds
346	Molybdenum and its compounds



*1. There shall not be releases of PRTR chemical from fumes to the air.
When using a lot of welding material, see the calculation manual of the Japan Welding Rod Industry Association.

*2. The amount of PRTR chemicals shipped out as product is calculated on the basis of an "adhesion coefficient."

[Calculation flow]

(1) Calculate the annually handled amount of PRTR chemical contained in welding material ⇐ Annual amount of welding material handled × Content in welding material

⇩

(2) Calculate the amount of PRTR chemical shipped out as product (Amount fixed to product as welding metal) ⇐ Annual amount of PRTR chemical handled × Transfer coefficient to welded product

⇩

(3) Calculate the amount contained in waste (waste from soldering, slug, and sputter) ⇐ (1) - (2)

(Note) For stainless steel products, it should be noted that the annual amount handled shall also include PRTR chemicals contained in the base material.

[See Calculation example (2)]

[Calculation example 1]

This example shows how to calculate the releases and transfers of manganese and its compounds (hereinafter, manganese) when facilities and conditions are as given below. Other PRTR chemicals are also calculated in the same way.

(Facilities and conditions)

- Process: Welding switchgear/controlgear enclosure (made of steel plates)
- Welding method: Carbon dioxide gas arc welding (Shielding gas: CO_2)
- Welding material used: Solid wire (Manganese content: 1.2%)
- Base material: Soft steel (SS400), steel plate (SPCC, SPHC, etc.)
- Annual consumption of welding material: 10,000 kg/year
- Local exhaust system: None

Calculating the annual transfers of manganese (no release to the air)

(1) Calculating the annual amount of manganese compounds handled

(Annual amount of manganese handled) = (consumption of welding material) × (content of manganese in welding material)
= 10,000 kg/year × 1.2%
= 120 kg/year

(2) Calculating the amount of manganese shipped out as product

(Amount shipped out as product) = (annual amount of manganese handled) × (adhesion coefficient [%] to welded product)
= 120 kg/year × 70%
= 84 kg/year

If a business does not know the amount of manganese in welding material that is transferred to the welded product (base material), the value given in **Table 3.1** may be used. In this example, the value (adhesion coefficient) is 70%.

(3) Calculating the amount contained in waste

(Amount contained in waste) = (annual amount of manganese handled) - (amount of manganese shipped out as product)
= 120 kg – 84 kg
= 36 kg/year ･････Off-site transfer

The balance after the amount of manganese shipped out as product is subtracted from the annual amount handled indicates slug and sputter generated during welding operations that is carried off-site as waste.

Table 3.1 Transfer coefficient of Cr, Ni, Mn, and Mo to welded product (Reference)

Subject Material	Welding Material	Transfer coefficient (%) to welded product			
		Cr	Ni	Mn	Mo
Soft steel High tensile steel Weatherable steel Refractory steel Low-temperature steel Heat-resistant steel	Coated electrode (not low hydrogen type)	—	—	15	—
	Coated electrode (low hydrogen type)	95	98	60	98
	Flux cored wire	90	98	60	98
	Flux cored wire (self shielding)	—	—	80	—
	Solid wire (shielding gas: CO_2)	90	98	70	98
	Solid wire (shielding gas: Ar-CO_2)	95	98	80	98
	TIG welding material	99.9	99.9	99.9	99.9
	Solid wire for submerged arc welding	95	99	70	99
	Flux for submerged arc welding (fused flux)	—	—	2	—
	Flux for submerged arc welding (bonded flux)	—	—	20	—

(Source: PRTR presentation materials by the Japan Welding Rod Industry Association)

[Calculation example 2] Example of stainless steel enclosure

When welding, cutting, or polishing stainless steel materials, it is necessary to aggregate the annually handled amount of each PRTR chemical contained in stainless steel material and welding material. If the amount becomes one ton or more, reporting of the substance is required. If waste stainless steel materials (scraps), cuttings, and other refuse become waste, their releases and transfers shall also be aggregated. For waste sent to an agent as value, however, reporting is not required.

This example shows how to calculate the releases and transfers of chromium and trivalent chromium compounds when facilities and conditions are as given below.
Nickel and manganese (including its compounds) are also calculated in the same way.
(Facilities and conditions)

- Process: Welding switchgear/controlgear enclosure (made of stainless steel)
- Welding method: TIG welding (shielding gas: Ar)
- Welding material used: TIG welding material [content of chromium and trivalent chromium compounds (hereinafter, chromium): 20%]
- Annual consumption of welding material: 3,000 kg/year
- Stainless steel materials (base material): Content of Cr in stainless steel (SUS304): 18%
- Annual consumption of stainless steel material: 100,000 kg/year
- Annual amount of scraps (waste material): 10,000 kg/year (sold to an agent for recycling)
- Local exhaust system: None

Calculating the annual transfers of chromium (no release to the air)

(1) Calculating the annual amount of chromium handled

① Calculating the annual amount of chromium handled in stainless steel material

(Annual amount of chromium handled in base material) = (consumption of base material) ×

(content of chromium in base material)
= 100,000 kg/year × 18%
= 18,000 kg/year

② Calculating the annually handled amount of chromium in welding material

(Annually handled amount of chromium in welding material) = (consumption of welding material) × (content of chromium in welding material)
= 3,000 kg/year × 20%
= 600 kg/year

③Calculating the total annual amount of chromium handled

(Annual amount of chromium handled) = (amount of chromium in base material) + (amount of chromium in welding material)
= 18,000 kg/year + 600 kg/year
= 18,600 kg/year

(2) Calculating the amount of chromium shipped out as product

① Calculating the amount of welding material shipped out as welded product

(Amount shipped out as product) = (annually handled amount of chromium in welding material) × (transfer coefficient [%] to welded product)
= 600 kg/year × 99.9%
= 599.4 kg/year

If the business does not know the amount of manganese in welding material that is transferred to the welded product (base material), the value given in Table 3.2 may be used. In this example, the value (transfer coefficient) is 99.9%.

② Calculating the amount of chromium shipped out as product (base material) (including waste material because they are valued)

(Annually handled amount of chromium in base material) = (consumption of base material) × (content [%] of chromium in base material)
= 100,000 kg/year × 18%
= 18,000 kg/year

③ Calculating the total amount of chromium shipped out as product

(Amount shipped out as product) = (amount of chromium in base material) + (amount of chromium transferred from welding material)
= 18,000 kg/year + 599.4 kg/year
= 18,599.4 kg/year

(3) Calculating the amount of chromium transferred in waste

(Amount contained in waste) = (annually handled amount of chromium in welding material) - (amount of chromium shipped out as product)
= 600 kg - 599.4 kg
= 0.6 kg/year ····· Off-site transfer

(Note) If waste stainless steel materials (scraps) are transferred at value, they are handled in the same way as products. If the materials are transferred off-site not at value but as waste, the chromium content shall be calculated and added to the value for reporting.

Calculating the content of chromium in waste stainless steel material

(Amount contained in waste material) = (annual amount of waste material) × (content of chromium in waste material)

= 10,000 kg/year × 18%

= 1,800 kg/year ・・・・・Off-site transfer

Table 3.2 Transfer coefficient of Cr, Ni, Mn, and Mo to welded product (Reference)

Material to be welded	Welding Material	Transfer coefficient (%) to welded product			
		Cr	Ni	Mn	Mo
Stainless steel Hardfacing	Coated electrode	85	98	50	98
	Flux cored wire (shielding gas: CO_2)	90	98	60	98
	Flux cored wire (shielding gas: Ar-CO_2)	95	98	70	98
	Solid wire	95	98	90	98
	TIG welding material	99.9	99.9	99.9	99.9
	Flux cored filler rod for TIG welding	95	99	90	99
	Solid wire for submerged arc welding	95	99	70	99
	Flux for submerged arc welding (bonded flux)	35	45	25	45
	Strip electrode	90	99	70	99
	Flux for strip surfacing (fused flux)	—	—	—	—
	Flux for strip surfacing (bonded flux)	35	45	25	45

(Source: PRTR presentation materials by the Japan Welding Rod Industry Association)

3.3 Coating processes

Metal grounds are coated. The coating process is further divided into the following three sub-processes:

C: Pretreatment

D: Undercoating (D1: Electrodeposition, D2: Solvent-based coating)

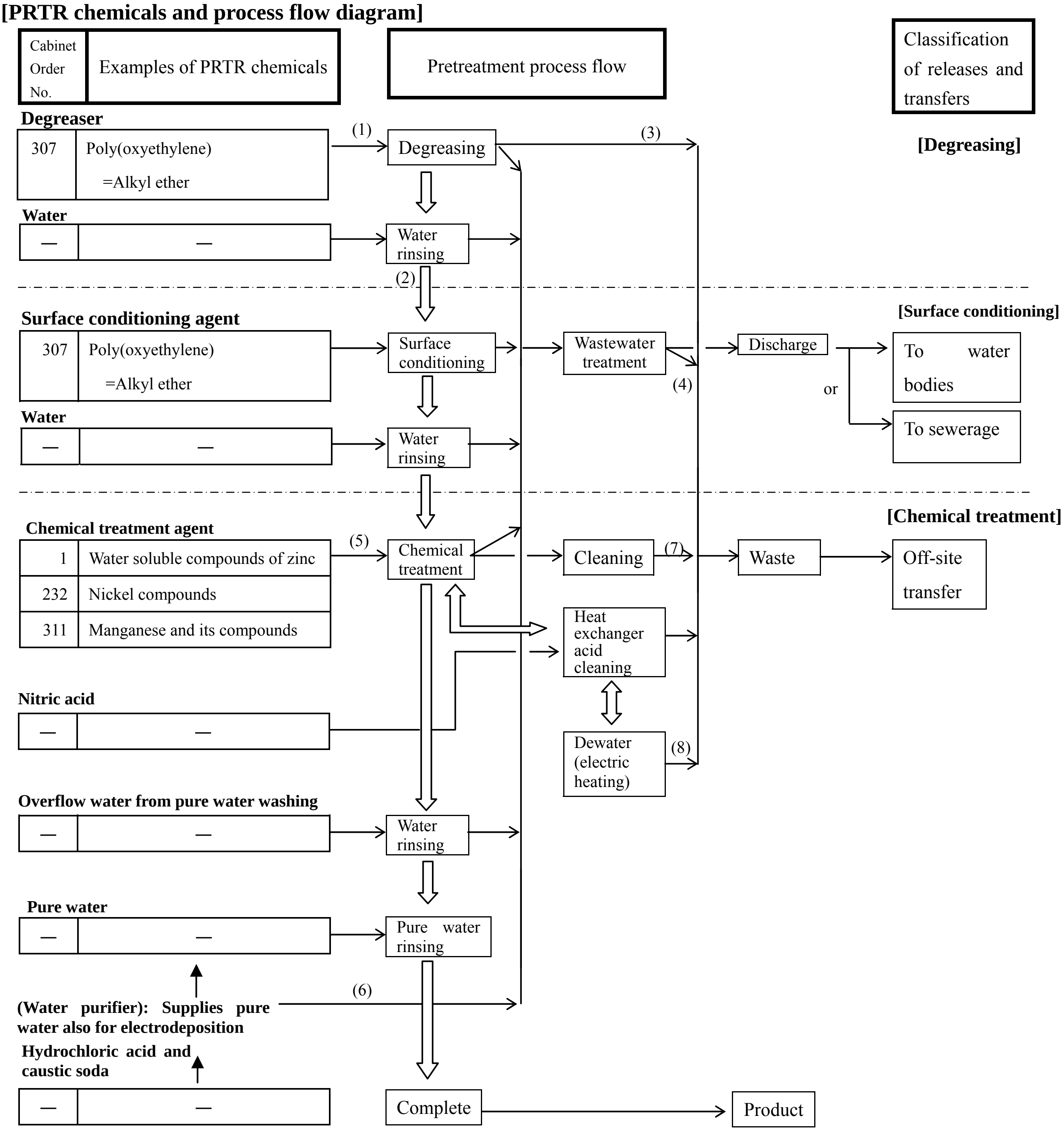
E: Finish oating (E1: Solvent-based coating, E2: Powder-based coating, E3: Water-based coating)

Releases to the environment include the release of PRTR chemicals from the pretreatment, paints, and solvents to the air and water and their transfer as waste.

3.3.1 Pretreatment process

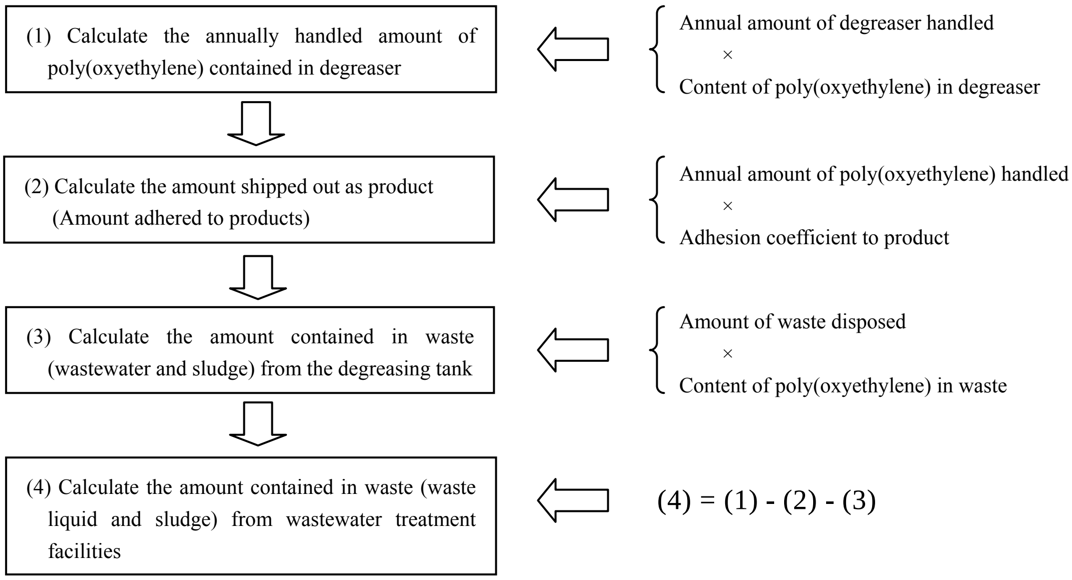
C. Pretreatment process

[PRTR chemicals and process flow diagram]



[Calculation flow 1]

The flowchart below shows the procedure for calculating the releases and transfers of Poly(oxyethylene) = Alkyl ether [hereinafter, "Poly(oxyethylene)"] release in the degreasing and surface treatment processes.



[Calculation example 1]

(Facilities and conditions)

• Process:	Degreasing process
• Annual amount of degreaser handled:	500 kg/year
• Content of poly(oxyethylene) in degreaser:	3.7%
• Annual amount of waste (wastewater and sludge) from the degreasing bath:	9,000 l/year

(1) Calculating the annually handled amount of poly(oxyethylene) contained in degreaser

(Annual amount handled) = (annual amount of degreaser handled) × [content of poly(oxyethylene) in degreaser]
= 500 kg/year × 3.7%
= 18.5 kg/year

(2) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount handled) × (adhesion coefficient to product)
= 18.5 kg/year × 0%
= 0 kg/year

No adhesion to products was detected in measurement.

(3) Calculating the amount contained in waste (waste liquid and sludge) from the degreasing tank

(Amount contained in waste) = [amount of waste disposed × content of poly(oxyethylene) in waste]
= 9,000 l/year × 1,000mg/l
= 9.0 kg/year ･････Off-site transfer

1,000mg/l was detected in water analysis before wastewater treatment.

(4) Calculating the amount contained in waste (waste liquid and sludge) from wastewater treatment facilities

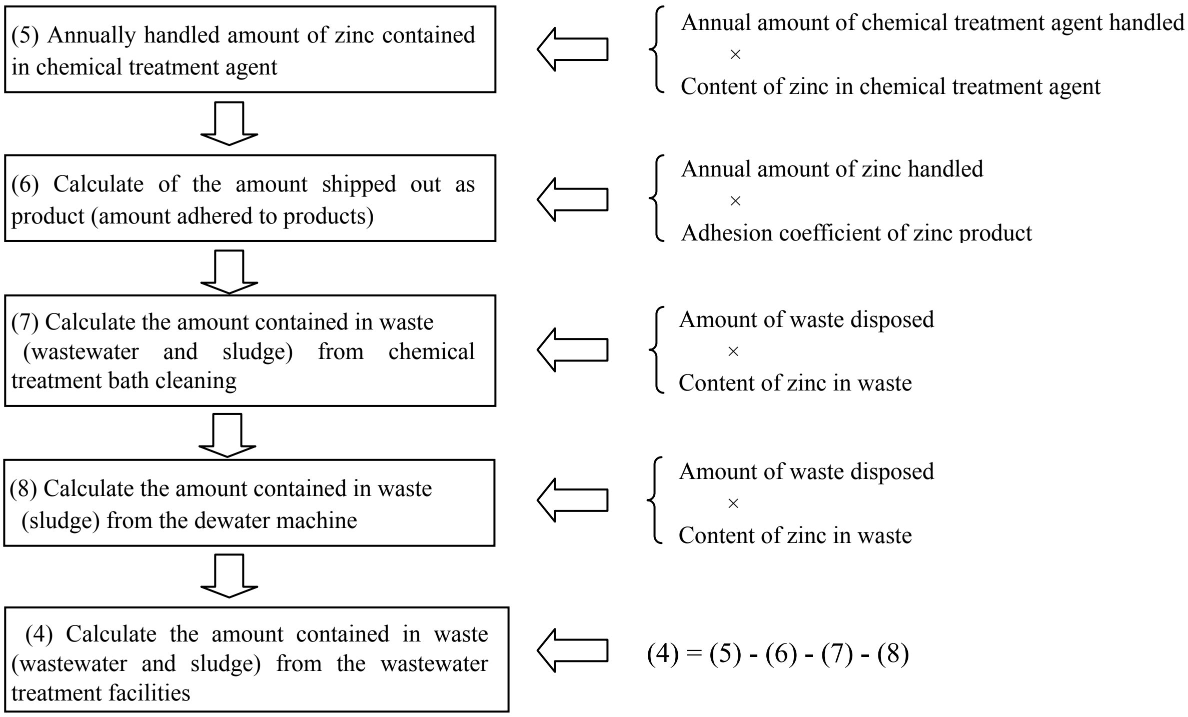
(Amount contained in waste from wastewater treatment facilities) = (1) - (2) - (3)

= 18.5 kg/year - 0 kg/year - 9.0 kg/year

= 9.5 kg/year ・・・・・Off-site transfer

[Calculation flow 2]

The flowchart below shows the procedure for calculating the releases and transfers of zinc in the chemical treatment process.



[Calculation example 2]

(Facilities and conditions)

• Process:	Chemical treatment process
• Annual amount of main chemical treatment agent handled:	400 kg/year
• Content of zinc in chemical treatment agent:	7.6%
• Annual consumption of additive to control zinc concentration:	100 kg/year
• Content of zinc in additive to control zinc concentration:	11%
• Annual amount of waste (waste solutions and sludge) from chemical treatment bath:	500 kg/year
• Annual amount of waste (sludge) from the dewater machine:	250 kg/year

(5) Calculating the annually handled amount of zinc contained in chemical treatment agent

(Annual amount handled) = (annual amount of main chemical treatment agent handled) × (content of zinc in main chemical treatment agent)

= 400 kg/year × 7.6%

= 30.4 kg/year

Calculating the annually handled amount of zinc contained in additive to control concentration

(Annual amount handled) = (annually handled amount of additive to control concentration) × (content of zinc in additive to control concentration)

= 100 kg/year × 11%

= 11 kg/year

(Total annual amount of zinc handled) = 30.4 kg/year + 11 kg/year

= 41.4 kg/year

(6) Calculating the amount shipped out as product

(Amount shipped out as product) = (total annual amount handled) × (adhesion coefficient to product)

= 41.4 kg/year × 33%

= 13.7 kg/year

The adhesion coefficient to product is an example of actual measurement.

(7) Calculating the amount of zinc contained in waste (waste solutions and sludge) from chemical treatment bath cleaning

(Amount contained in waste) = (amount of waste from chemical treatment bath cleaning) × (content of lead in waste)

= 500 kg/year × 2.7%

= 13.5 kg/year ･････Off-site transfer

For the content of zinc in waste, a measured value was used.

(8) Calculating the amount contained in waste (sludge) from dewater machine

(Amount contained in waste) = (amount of waste from dewater machine) × (content of lead in waste)

= 250 kg/year × 5.4%

= 13.5 kg/year ･････Off-site transfer

For the content of zinc in waste, a measured value was used.

(4) Calculating the amount contained in waste (waste solutions and sludge) from wastewater treatment facilities

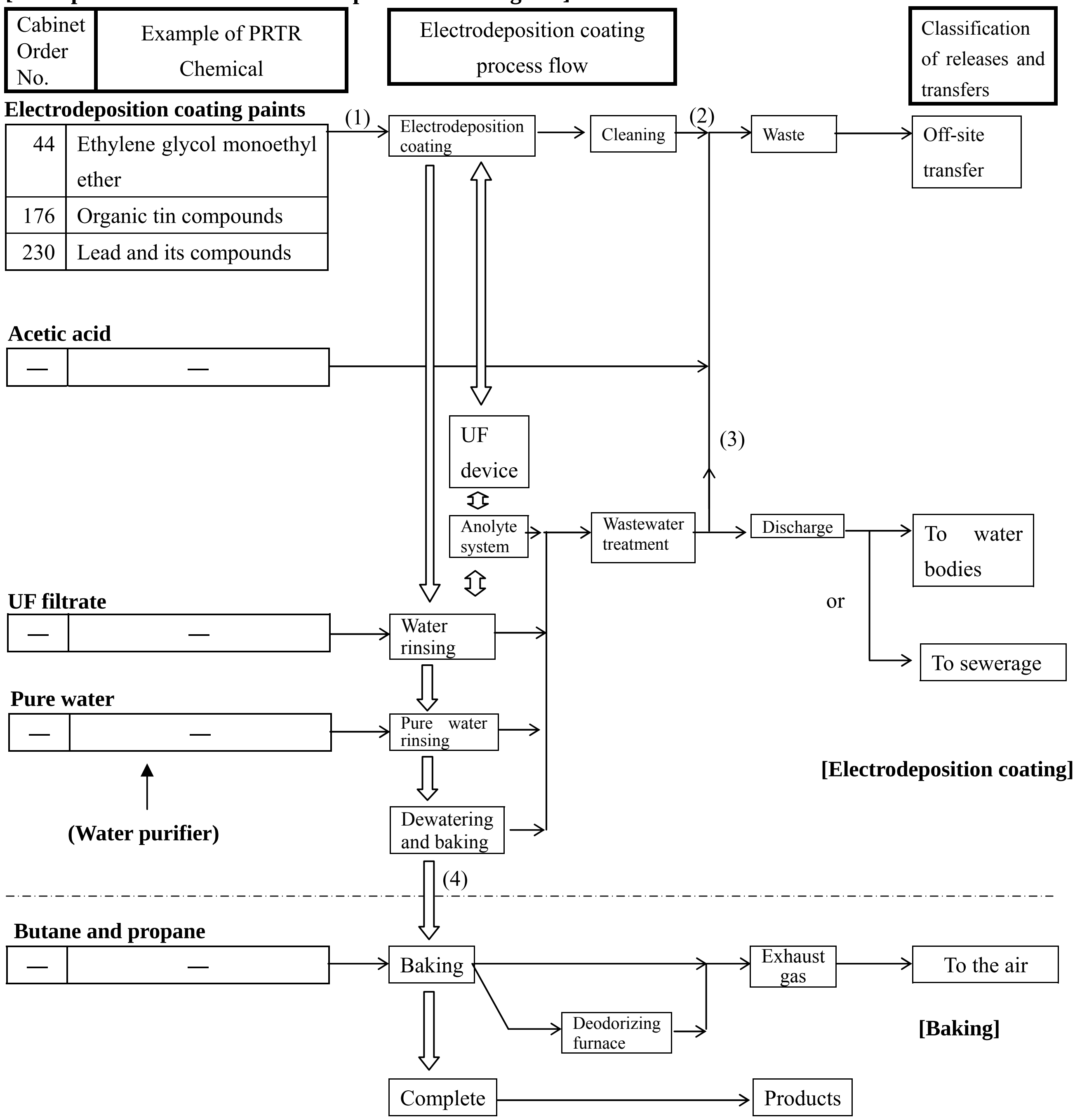
(Amount contained in waste) = 41.4 kg/year - 13.7 kg/year - 13.5 kg/year - 13.5 kg/year

= 0.7 kg/year ･･････Off-site transfer

3.3.2 Undercoating process

D1. Electrodeposition coating process

[Examples of PRTR chemicals and process flow diagram]



[Calculation flow]

The flowchart below shows the procedure for calculating the releases and transfers of lead in the electrodeposition coating process.

(1) Calculate the annual amount of lead contained in electrodeposition coating paint handled ⇐ { Amount of electrodeposition coating paint handled × Content of lead in electrodeposition coating paint × Conversion factor }

⇩

(2) Calculate the amount contained in waste (residual paints) from electrodeposition bath cleaning ⇐ { Amount of waste × Content of lead in waste }

⇩

(3) Calculate the amount contained in waste (sludge) from wastewater treatment facilities ⇐ { Amount of waste × Content of lead in waste }

⇩

(4) Calculate the amount shipped out as product (Amount adhered to product) (Reference) ⇐ (4) = (1) - (2) - (3)

[Calculation example]

(Facilities and conditions)

• Process:	Electrodeposition coating process
• Annual consumption of Paint Agent 1 for electrodeposition coating:	28,000 kg/year
• Content of lead in Paint Agent 1 for electrodeposition coating:	3.3%
• Nonvolatile content of Paint Agent 1 for electrodeposition coating:	55%
• Annual consumption of Paint Agent 2 for electrodeposition coating:	70,000 kg/year
• Content of lead in Paint Agent 2 for electrodeposition coating:	0.0%
• Nonvolatile content of Paint Agent 2 for electrodeposition coating:	36%
• Annual amount of waste (residual paint) from the electrodeposition bath:	1,100 kg/year
• Annual amount of wastewater (waste alkali and sludge) after paint rinsing:	780,000 kg/year

(1) Calculating the annually handled amount of lead contained in electrodeposition coating paint

(Annual amount handled) = (annual amount of electrodeposition coating paint handled)
× (content [%] of lead in paint) × (conversion factor)*
= 98,000 kg/year × 0.94% × 1
= 921 kg/year

Since the paint is a mixture of two liquids, the content of lead in the paint was calculated as follows (electrodeposition coating paint is often replenished by two liquids):

(Annual amount of paint handled) = (annual amount of Paint Agent 1 handled)
+ (annual amount of Paint Agent 2 handled)
= 28,000 kg/year + 70,000 kg/year
= 98,000 kg/year

(Content [%] of lead in paint) = (blending ratio [%] of Paint Agent 1) × (content [%] of lead in Paint Agent 1) + (Blending ratio [%] of Paint Agent 2) × (Content [%] of PRTR chemical in Paint Agent 2)

= [(28,000 kg/year) / (98,000 kg/year)] × 3.3%

+ [(70,000 kg/year) / (98,000 kg/year)] × 0.0%

= 0.94%

* If a lead alloy name is given on the MSDS, the conversion factor in **Attached Form 6** of **Reference 2** shall be used. If no name is given, the conversion factor shall be 1.

(2) Calculating the amount contained in waste (residual paints) from the electrodeposition coating bath cleaning

(Amount contained in waste) = (annual amount of residual paints disposed) × (content of lead in waste)

= 1,100 kg/year × 2.3%

= 25 kg/year ・・・・・Off-site transfers

Since residual paints that are produced during cleaning of the coating equipment can roughly be regarded as nonvolatile components of paint, the content of lead in waste is regarded as the content of lead in the nonvolatile components. By using the nonvolatile content [%] in catalog specifications, the nonvolatile components of paint are calculated as follows:

(Nonvolatile component [%] of paint) = (blending ratio [%] of Paint Agent 1) × (nonvolatile content [%] of Paint Agent 1) + (blending ratio [%] of Paint Agent 2) × (nonvolatile content [%] of Paint Agent 2)

= [(28,000 kg/year) / (98,000 kg/year)] × 55%

+ [(70,000 kg/year) / (98,000 kg/year)] × 36%

= 41%

(Content [%] of lead in waste residual paints) = (content [%] of lead in paint) / (nonvolatile content [%] in paint)

= 0.94% / 41%

= 0.023 (2.3%)

(3) Calculating the amount contained in waste (sludge) from wastewater treatment facilities (only non-closed facilities without a RO device)

(Amount contained in waste) = (annual release of paint wash water) × (nonvolatile content [%] in wastewater) × (content [%] of lead in the nonvolatile components of paint)

= 780,000 kg/year × 0.51% × 2.3%

= 91 kg/year ・・・・・Off-site transfer

The nonvolatile content (0.51%) in wastewater from paint rinsing was obtained by weighing the aluminum foil cup before and after wastewater evaporation. A heating furnace was used to cause evaporation. The content (%) of lead in the nonvolatile components of paint is the same as the content (2.3%) of lead in the waste of (2).

Wastewater is usually treated by wastewater treatment facilities. Lead is trapped in sediments and discarded as sludge.

Wastewater sent to a waste processing agent with no treatment is regarded as off-site transfer.

(4) Calculating the substance shipped out as product (Reference: Reporting not required)

(Amount shipped out as product) = (1) - (2) - (3)

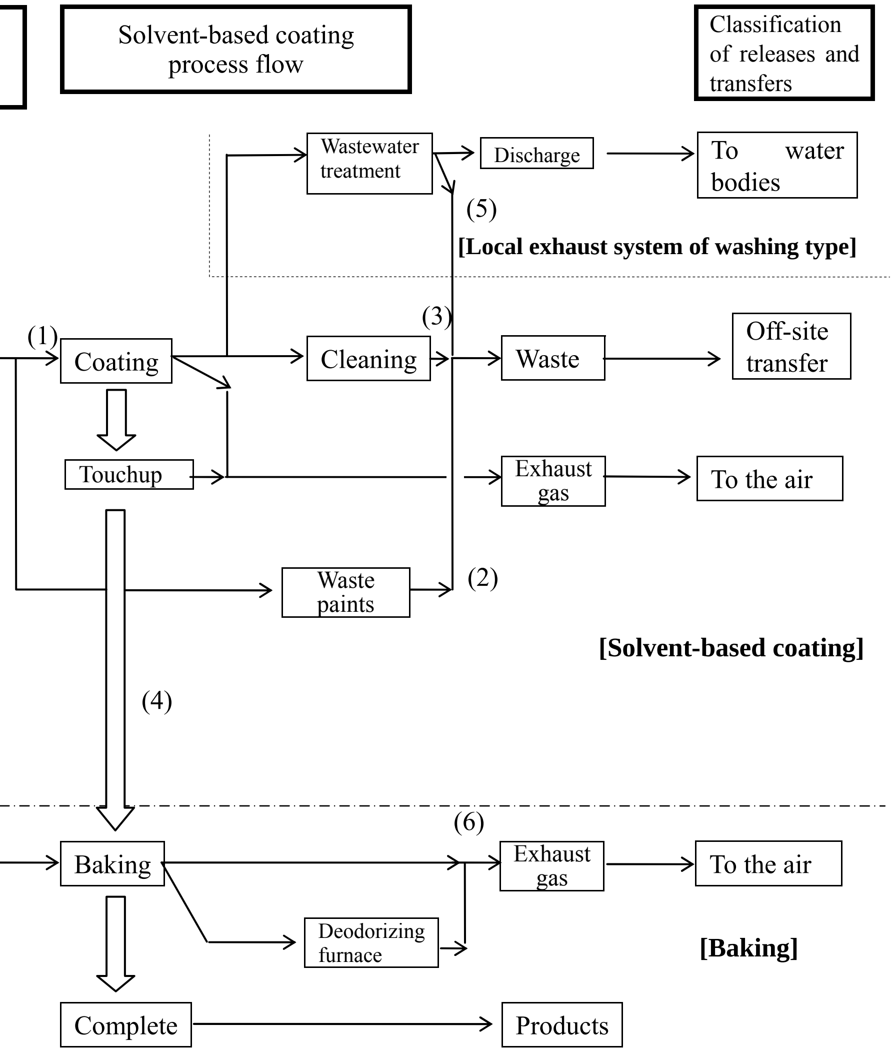
= 921 kg/year - 25 kg/year - 91 kg/year

= 805 kg/year

D2. Solvent-based coating process

[Examples of PRTR chemicals and process flow diagram]

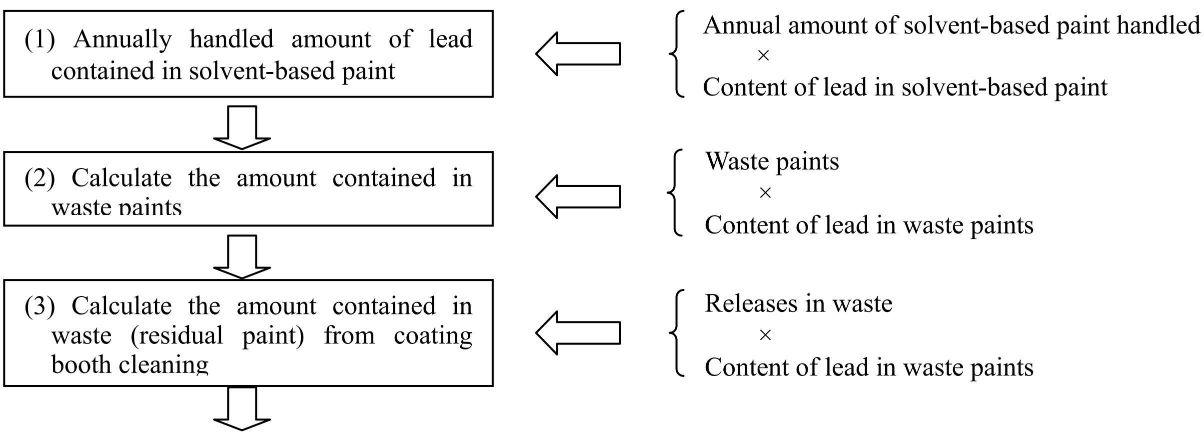
Cabinet Order No.	Examples of PRTR chemicals
Solvent-based paints	
40	Ethylbenzene
44	Ethylene glycol monoethyl ether
45	Ethylene glycol monomethyl ether
63	Xylene
101	2-etoxyethyl acetate
103	2-metoxyethyl acetate
224	Trimethylbenzene
227	Toluene
	Other volatile substances
69	Hexavalent chromium compounds
230	Lead and its compounds
69	Zinc chromate
Butane and propane	
—	—



Here are examples of calculation of lead and xylene in the solvent-based coating process.

[Calculation flow 1.1]

The flowchart below shows the procedure for calculating the releases and transfers of lead when the local exhaust system is of the water washing type and the portion of the annual amount of residual paints belonging to the paint section can be identified.



(4) Calculate the amount shipped out as product
(Amount of deposition to product)

⇦ Annual amount of lead handled × Adhesion coefficient to product

⇩

(5) Calculate the amount contained in waste (sludge) from wastewater treatment facilities

⇦ (5) = (1) - (2) - (3) - (4)

[Calculation example 1.1]

(Facilities and conditions)

• Process:	Solvent-based coating process
• Annual amount of paint (alkyd resin under) handled:	12,000 kg/year
• Content of lead in solvent-based paint:	2.2%
• Nonvolatile content of paint:	62%
• Annual amount of waste paint:	290 kg/year
• Annual amount of waste (residual paints) from coating booth:	1,700 kg/year

(1) Calculate the annually handled amount of lead contained in solvent-based paint

(Annual amount handled) = (annual amount of solvent-based paint handled) × (content [%] of lead in paint) × (conversion factor)
= 12,000 kg/year × 2.2% × 1
= 264 kg/year

(2) Calculate the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste solvent-based paint) × (content [%] of lead in paint)
= 290 kg/year × 2.2%
= 6.4 kg/year ・・・・・Off-site transfer

Because paints are usually stored in a sealed state soon after use, their composition was assumed to have not undergone much change up until the time of their disposal.

(3) Calculating the amount contained in waste from coating booth cleaning

(Amount contained in waste) = (annual amount of waste) × (content [%] of lead in waste)
= 1,700 kg/year × 3.5%
= 59.5 kg/year ・・・・・Off-site transfer

Residual paints are usually a mixture of several types. Here, however, the paint is assumed to be known (paints distinguished by facilities).

Since residual paints that are produced during cleaning of coating equipment can roughly be regarded as nonvolatile components of paint, the content of lead in waste is regarded as the content of lead in the nonvolatile components. With the nonvolatile content of paint identified as 62%, the content (%) of lead in waste can be calculated as follows:

(Content [%] of lead in waste) = (content [%] of lead in paint) / (nonvolatile component [%] of paint)
= 2.2%/62%
= 3.5%

(4) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount of lead handled) × (adhesion coefficient of paint to product [%])
= 264 kg/year × 40%
= 106 kg/year

For the adhesion coefficient of paint to product, the value of general liquid spray (manual type) on the portable switchgear/controlgear in **Attached Form 7** in **Reference 3** was used.

(5) Calculating the amount contained in waste (sludge) from wastewater treatment facilities

(Amount contained in waste) = (1) - (2) - (3) - (4)
= 264 kg/year - 6.4 kg/year - 59.5 kg/year - 106 kg/year
= 92 kg/year ･････Off-site transfer

Wastewater from a local exhaust system of the washing type is usually treated by wastewater treatment facilities. There, lead is trapped in sediments and discarded as sludge.

Wastewater sent to a waste processing agent with no treatment is regarded as off-site transfer.

[Calculation flow 1.2]

The flowchart below shows the procedure for calculating the releases and transfers of lead when the local exhaust system is not of the washing type.

(1) Calculate the annual amount of lead contained in solvent-based paint ⇐ { Annual amount of solvent-based paint handled × Content of lead in solvent-based paint }

⇓

(2) Calculate the amount contained in waste paints ⇐ { Waste paints × Content of lead in waste paints }

⇓

(4) Calculate the amount shipped out as product ⇐ { Annual amount of lead handled × Adhesion coefficient to product }

⇓

(3) Calculate the amount contained in waste (residual paints) from coating booth cleaning ⇐ (3) = (1) - (2) - (4)

[Calculation example 1.2]

(Facilities and conditions)

- Process: Solvent-based coating process
- Annual amount of solvent-based paint (one-liquid epoxy resin primer) handled: 15,000 kg/year
- Content of lead in solvent-based paint: 1.2%
- Annual amount of waste paints: 300 kg/year

(1) Calculate the annually handled amount of lead contained in solvent-based paint

(Annual amount handled) = (annual amount of solvent-based paint handled) × (content [%] of lead in paint) × (conversion factor)

= 15,000 kg/year × 1.2% × 1

= 180 kg/year

(2) Calculate the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste solvent-based paint) × (content [%] of lead in paint)

=300 kg/year × 1.2%

=3.6 kg/year ・・・・・Off-site transfer

Because paints are usually stored in a sealed state early after use, their composition was assumed to have not undergone much change up until the time of their disposal.

(4) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount handled) × (adhesion coefficient of paint to product [%])

= 180 kg/year × 60%

= 108 kg/year

For the adhesion coefficient to products, the value of low-pressure atomizing spray (manual type) on the standalone switchgear/controlgear in **Attached Form 7** in **Reference 3** was used.

(3) Calculating the amount contained in waste from coating booth cleaning

(Amount contained in waste) = (1) - (2) - (4)

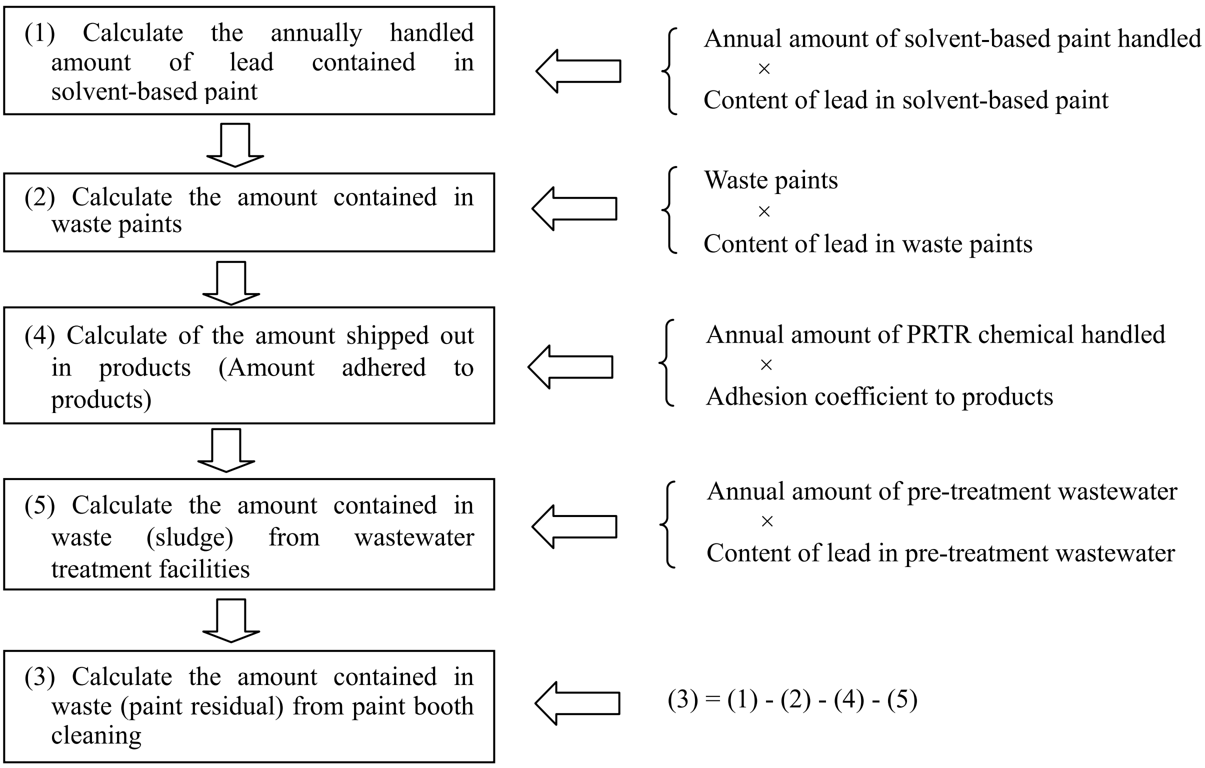
= 180 kg/year - 3.6 kg/year - 108 kg/year

= 68 kg/year ・・・・・Off-site transfer

Residual paints adhere to coating equipment and are produced when the equipment is cleaned.

[Calculation flow 1.3]

The flowchart below shows the procedure for calculating the releases and transfers of lead when the local exhaust system is of the washing type and the amount of waste from the coating booth cannot be estimated (i.e. several types of paints are used and their residuals cannot be separated from each other).



[Calculation example 1.3]

(Facilities and conditions)

- Process Solvent-based coating process
- Annually handled amount of main agent (epoxy resin primer) in solvent-based paint: 17,000 kg/year
- Content of lead in main agent of solvent-based paint: 2.8%
- Annual amount of paint curing agent handled: 4,000 kg/year
- Content of lead in paint curing agent: 0.0%
- Annual amount of waste paints: 570 kg/year
- Waste (residual paints) from the coating booth: 1,700 kg/year
- Annual amount of pre-treatment wastewater: 250,000 l/year

(1) Calculating the annual amount of lead contained in solvent-based paint

(Annual amount handled) = (annual amount of paint handled) × (content [%] of PRTR chemical in paint) × (conversion factor)

= 21,000 kg/year × 2.3% × 1

= 483 kg/year

Because the paint is mixed from two liquids, the content of lead in paint was calculated as follows:

(Annual amount of paint handled) = (annual amount of main agent in paint handled) + (annual amount of paint curing agent handled)

= 17,000 kg/year + 4,000 kg/year

= 21,000 kg/year

(Content [%] of lead in paint) = (blending ratio [%] of main agent in paint) × (content [%] of lead in main agent in paint) + (blending ratio [%] of paint curing agent) × (content [%] of PRTR chemical in paint curing agent)

= [(17,000 kg/year) / (21,000 kg/year)] × 2.8%

+ [(4,000 kg/year) / (21,000 kg/year)] × 0.0%

= 2.3%

(2) Calculating the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste paints) × (content [%] of lead in paint)

= 570 kg/year × 2.3%

= 13 kg/year ･････Off-site transfer

Because paints are usually stored in a sealed state early after use, their composition was assumed to have not undergone much change up until the time of their disposal.

(4) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount of paint handled) × (adhesion coefficient of paint to product [%])

= 483 kg/year × 50%

= 242 kg/year

For the adhesion coefficient of paint to product, the value of electrostatic liquid spray (manual type) on the portable switchgear/controlgear in **Attached Form 7** in **Reference 3** was used.

(5) Calculating the amount contained in waste (sludge) from wastewater treatment facilities

(Amount contained in pre-treatment wastewater) = (annual amount of pre-treatment wastewater)
× (ion concentration [mg/l] of lead in pre-treatment wastewater)
= 250,000 l/year × 410mg/l
= 103 kg/year ・・・・・Off-site transfer

The lead ion concentration in pre-treatment wastewater is obtained (410mg/l) through water analysis. Wastewater from a local exhaust system of the washing type is usually treated by wastewater treatment facilities. There, lead is trapped in sediments and discarded as sludge.

Wastewater sent to a waste processing agent with no treatment is regarded as off-site transfer.

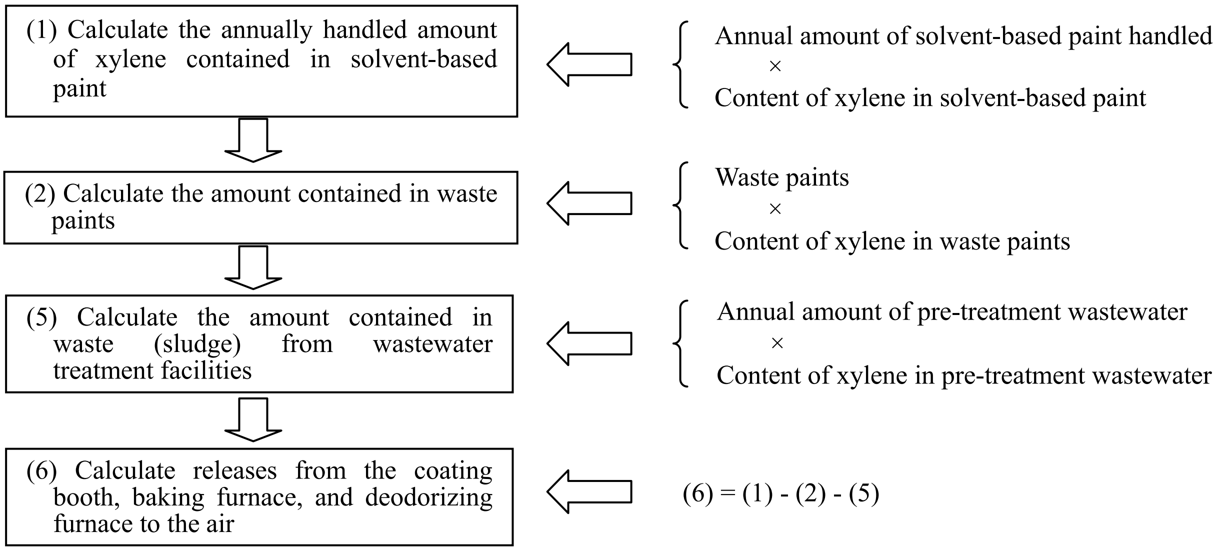
(3) Calculating the amount contained in waste from coating booth cleaning

(Amount contained in waste) = (1) - (2) - (4) - (5)
= 483 kg/year - 13 kg/year - 242 kg/year - 103 kg/year
= 125 kg/year ・・・・・Off-site transfer

Residual paints adhere to the coating equipment and are produced when such equipment is cleaned.

[Calculation flow 1.4]

The flowchart below shows the procedure for calculating the releases and transfers of xylene (all solvent-based substances) when the local exhaust system is of the washing type and the portion of the annual amount of residual paints belonging to the paint section can be identified.



[Calculation example 1.4]

(Facilities and conditions)

- Process: Solvent-based coating process
- Annual amount of solvent-based paint (solvent for melamine resin primer) handled: 5,200 kg/year
- Content of xylene in solvent-based paint: 41%
- Amount of waste paints: 340 kg/year
- Annual amount of pre-treatment wastewater: 10,000 l/year

(1) Calculating the annual amount of xylene contained in solvent-based paint handled

(Annual amount handled) = (annual amount of solvent-based paint handled) × (content [%] of xylene in paint)

= 5,200 kg/year × 41%

= 2,132 kg/year

(2) Calculate the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste paints) × (content [%] of xylene in paint)

= 340 kg/year × 41%

= 139 kg/year ·····Off-site transfer

(5) Calculating the amount contained in waste (sludge) from wastewater treatment facilities

(Amount contained in pre-treatment wastewater) = (annual amount of pre-treatment wastewater) × (concentration l/kg of xylene in pre-treatment wastewater)

= 10,000 l/year × 0.0mg/l

= 0.0 kg/year ·····Off-site transfer

Despite analysis, xylene could not be detected (0.0mg/l) in pre-treatment wastewater from the local washing-type exhaust system. It is thought that this may be due to evaporation attributable to pauses that exceeded 80% of the total time and to the local exhaust system structure in which water can run uncontrolled quite easily. [See **Attached Form 4** of **Reference 2**.]

(6) Release to the air

(Release to the air) = (1) - (2) - (5)

= 2,132 kg/year - 139 kg/year - 0.0 kg/year

= 1,993 kg/year ·····To the air

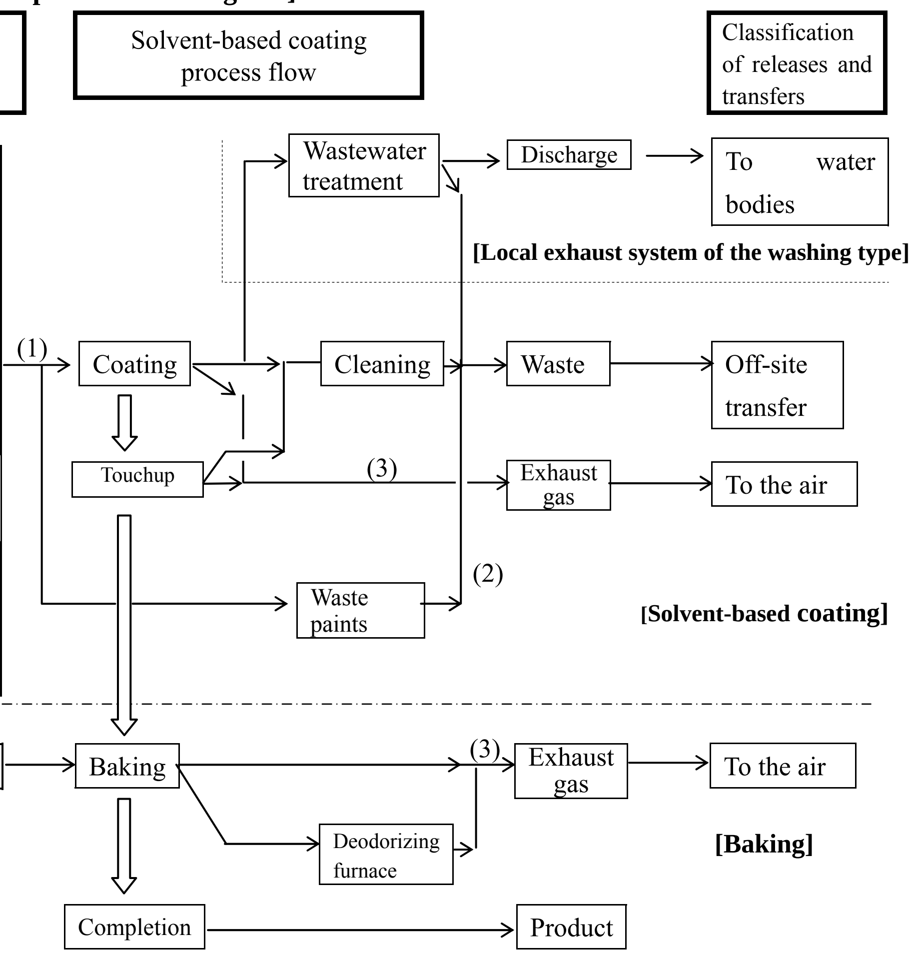
There is no transfer as product because xylene does not remain in the coating at the end of curing and drying through baking. Xylene evaporates and only leaves a trace amount in residual paints. Therefore, no off-site transfer (through disposal of residual paints) is assumed.

3.3.3 Finish coating process

E1. Solvent-based coating process

[Examples of PRTR chemicals and process flow diagram]

Cabinet Order No.	Examples of PRTR chemicals
Solvent-based paints	
40	Ethylbenzene
63	Xylene
224	1,3,5-trimethylbenzene
227	Toluene
230	Lead and its compounds
69	Hexavalent chromium compounds
69 230	Chromate
230 346	Molybdate
346	Molybdenum and its compounds
Butane and propane	
—	—



[Calculation flow]

The flowchart below shows the procedure for calculating the releases and transfers of ethylbenzene when the exhaust system is not of the washing type.

(1) Calculate the annually handled amount of ethylbenzene in solvent-based paint ⇐ Annual amount of solvent-based paint handled × Content of ethylbenzene in solvent-based paint

⇩

(2) Calculate the amount contained in waste paints ⇐ Waste paints × Content of ethylbenzene in waste paints

⇩

(3) Calculate the amount of releases to the air ⇐ (3) = (1) - (2)

[Calculation example]

(Facilities and conditions)

- Process: Solvent-based coating process
- Annual amount of solvent-based paint (melamine resin paint) handled: 11,000 kg/year
- Content of ethylbenzene in solvent-based paint: 5.6%
- Annual amount of waste paints: 1,000 kg/year

(1) Calculating the annually handled amount of ethylbenzene in solvent-based paint

(Annual amount handled) = (annual amount of paint handled) × (content [%] of ethylbenzene in paint)

= 11,000 kg/year × 5.6%

= 616 kg/year

(2) Calculating the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste paints) × (content [%] of ethylbenzene in paint)

= 1,000 kg/year × 5.6%

= 56 kg/year ･････Off-site transfer

Because paints are usually stored in a sealed state early after use, their composition was assumed to have not undergone much change up until the time of their disposal.

(3) Release to the air

(Release to the air) = (1) - (2)

= 616 kg/year - 56 kg/year

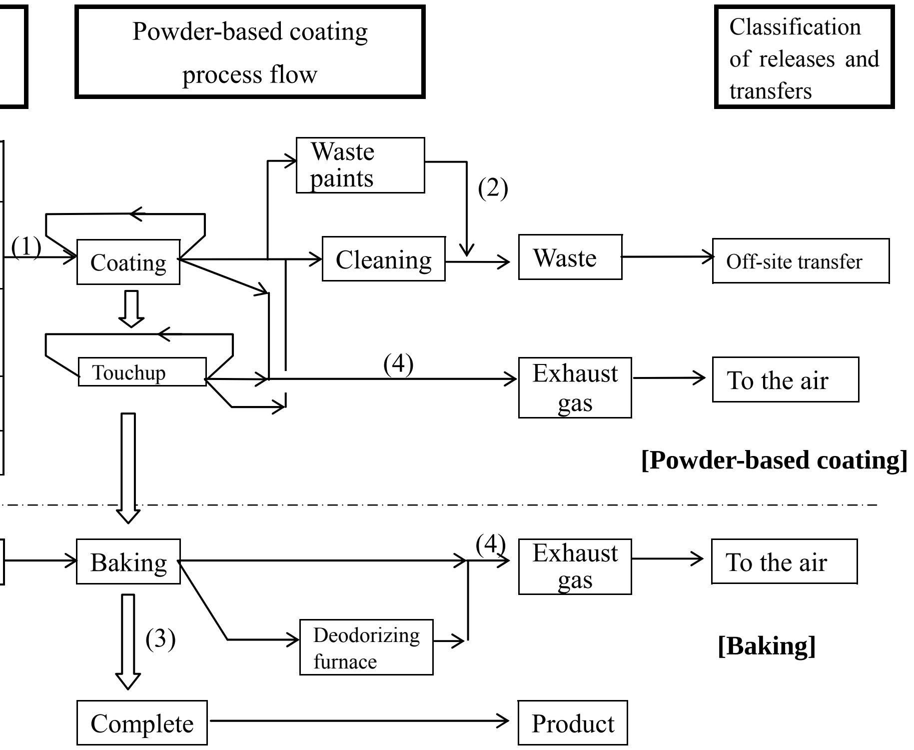
= 560 kg/year ･････To the air

There is no amount shipped out as product because ethylbenzene does not remain in the coating at the end of curing and drying through baking. Ethylbenzene evaporates and only leaves a trace in residual paints. Therefore, no off-site transfer (through disposal of residual paints) is assumed.

E2 Powder-based coating process

[Examples PRTR chemicals and process flow diagram]

Cabinet Order No.	Examples of PRTR chemicals
Powder-based paints	
69	Hexavalent chromium compounds
69 230	Chromate
230 346	Molybdate
346	Molybdenum and its compounds
230	Lead and its compounds
Butane and propane	
—	—



[Calculation flow]

The flowchart below shows the procedure for calculating the releases and transfers of molybdenum and its compounds (hereinafter, "molybdenum") contained in molybdate in the powder-based coating process when the local exhaust system is not of the washing type.

Lead contained in molybdate is also calculated in the same way.

(1) Calculate the annually handled amount of molybdenum in powder-based paint ⇐ Annual amount of powder-based paint handled × Content of molybdenum in powder-based paints

⇩

(2) Calculate the amount contained in waste paints ⇐ Waste paints × Content of molybdenum in waste paints

⇩

(3) Calculate the amount shipped out as product ⇐ Annual amount of molybdenum handled × Adhesion coefficient to product

⇩

(4) Calculate off-site transfer as residual paints (waste) ⇐ (4) = (1) - (2) - (3)

[Calculation example]

(Facilities and conditions)

- Process: Powder-based coating process
- Annual amount of powder-based paint (polyester resin powder-based paint [dark orange]) handled: 950 kg/year
- Content of molybdate in solvent-based paint: 4.6%
- Annual amount of waste paints: 33 kg/year

(1) Calculating the annually handled amount of molybdenum contained in powder-based paint

(Annual amount handled) = (annual amount of powder-based paint handled) × (content [%] of molybdenum in paint) × (conversion factor)

= 950 kg/year × 4.6% × 0.261

= 11.4 kg/year

The value of 0.261 (from **Attached Form 6** of **Reference 2**) was used as the conversion factor from molybdate to lead.

(2) Calculating the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste paints) × (content [%] of molybdate in paint) × (conversion factor)

= 33 kg/year × 4.6% × 0.261

= 0.4 kg/year ・・・・・Off-site transfer

Because paints are usually stored in a sealed state early after use, their composition was assumed to have not undergone much change up until the time of their disposal.

(3) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount handled) × (adhesion coefficient of paint to product)

= 11.4 kg/year × 60%

= 6.8 kg/year

For the adhesion coefficient to products, the value of the electrostatic powder with no collection (manual type) on the portable switchgear/controlgear in **Attached Form 7** of **Reference 3** was used.

(4) Calculating the amount contained in waste (residual paints) from paint coating cleaning

(Amount contained in residual paints) = (1) - (2) - (3)

= 11.4 kg/year - 0.4 kg/year - 6.8 kg/year

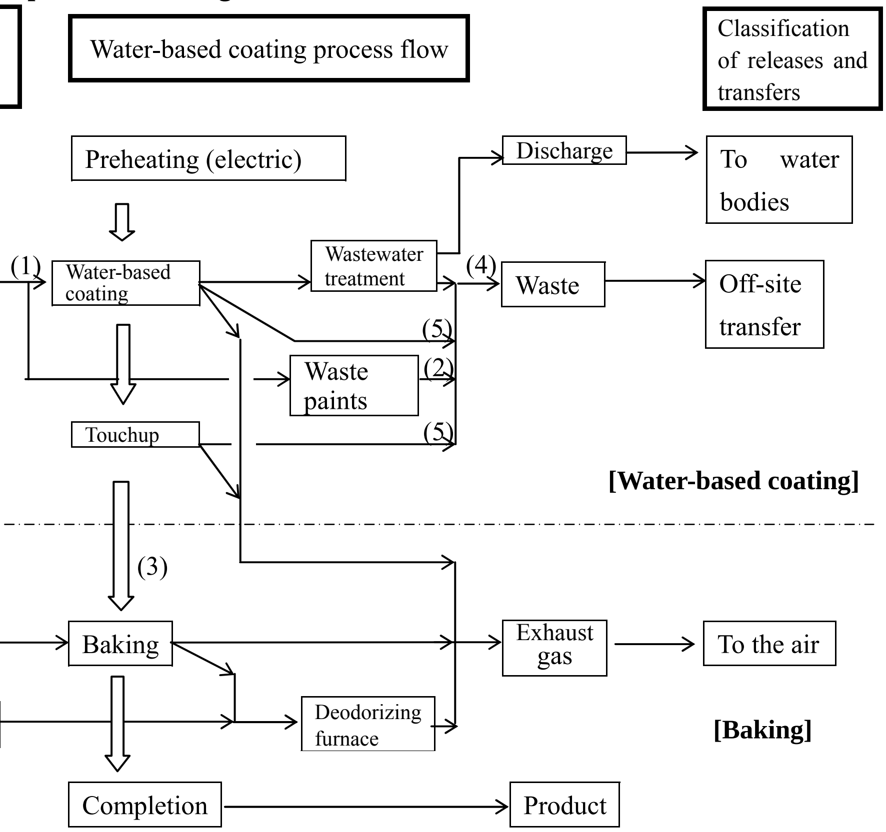
= 4.2 kg/year ・・・・・Off-site transfer

Residual paints adhere to coating equipment and are produced when such equipment is cleaned.

E3 Water-based coating process

[Examples of PRTR chemicals and process flow diagram]

Cabinet Order No.	Examples of PRTR chemicals
Water-based paints	
44	Ethylene glycol monoethyl ether
45	Ethylene glycol monomethyl ether
101	2-etoxyethyl acetate
103	2-metoxyethyl acetate
—	—
Butane and propane Exhaust from electrodeposition baking furnace	
—	—
Butane and propane	
—	—



[Calculation flow]

The flowchart below shows the procedure for calculating the releases and transfers of hexavalent chromium in the water-based coating process when the local exhaust system is of the washing type and the portion of the annual amount of residual paints belonging to the paint section can be identified.

(1) Calculate the annually handled amount of hexavalent chromium in water-based paint ⇐ Annual amount of water-based paint handled × Content of hexavalent chromium in water-based paint

⇓

(2) Calculate the amount contained in waste paints ⇐ Waste paints × Content of hexavalent chromium in waste paints

⇓

(3) Calculate the amount shipped out as product (amount adhered to products) ⇐ Annual amount of hexavalent chromium handled × Adhesion coefficient to product

⇓

(4) Calculate the amount contained in waste (sludge) from wastewater treatment facilities ⇐ Annual amount of pre-treatment wastewater × Content of hexavalent chromium in pre-treatment wastewater

⇓

(5) Calculate the amount contained in waste (residual paints) from the coating booth ⇐ (5) = (1) - (2) - (3) - (4)

[Calculation example]

(Facilities and conditions)

- Process: Water-based coating process
- Annual amount of water-based paint (melamine resin paint [dark yellow]) handled: 600 kg/year
- Content of lead chromate in solvent-based paint: 21%
- Annual amount of waste paints: 10 kg/year
- Annual amount of pre-treatment wastewater: 750,000 l/year

(1) Calculating the annually handled amount of hexavalent chromium contained in water-based paint

(Annual amount handled) = (annual consumption of water-based paint) × (content [%] of lead chromate in paint) × (conversion factor)
= 600 kg/year × 21% × 0.161
= 20 kg/year

The value of 0.161 (from Attached Form 6 of Reference 2) was used for the conversion factor from lead chromate to hexavalent chromium.

(2) Calculating the amount contained in waste paints

(Amount contained in waste paints) = (annual amount of waste paints) × (content [%] of lead chromate in paint) × (conversion factor)
= 10 kg/year × 21% × 0.161
= 0.3 kg/year ・・・・・Off-site transfer

Because paints are usually stored in a sealed state early after use, their composition was assumed to have not undergone much change up until the time of their disposal.

(3) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount handled) × (adhesion coefficient of paint to product [%])
= 20 kg/year × 35%
= 7.0 kg/year

The transfer coefficient to product (35%) is an example measured using the method shown in **Reference 3**.

(4) Calculating the amount contained in waste (sludge) from wastewater treatment facilities

(Amount contained in pre-treatment wastewater) = (annual amount of pre-treatment wastewater) × (ion concentration mg/l of hexavalent chromium in pre-treatment wastewater)
= 750,000 l/year × 10mg/l
= 7.5 kg/year ・・・・・Off-site transfer

The ion concentration of hexavalent chromium in pre-treatment wastewater is obtained (10mg/l) by water analysis. Wastewater from a local exhaust system of the washing type is usually treated by wastewater treatment facilities. Hexavalent chromium is trapped in sediments and discarded as sludge.

Wastewater sent to a waste processing agent with no treatment is regarded as off-site transfer.

(5) Calculating the amount contained in waste (residual paints) from the coating booth

(Amount contained in waste) = (1) - (2) - (3) - (4)

= 20 kg/year - 0.3 kg/year - 7.0 kg/year - 7.5 kg/year

= 5.2 kg/year ・・・・・Off-site transfer

Residual paints adhere to coating equipment and are produced when such equipment is cleaned.

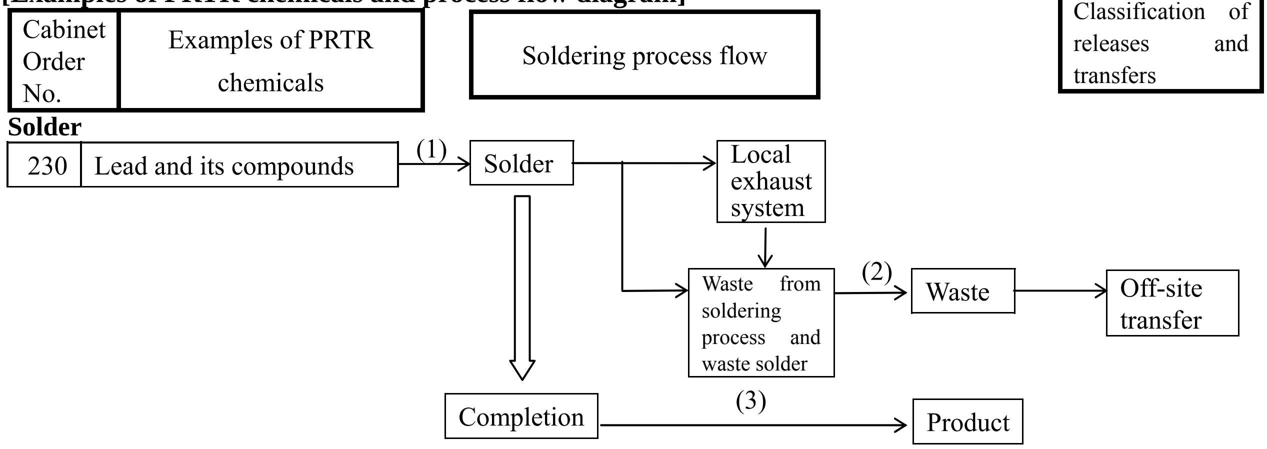
3.4 Assembly Processes

3.4.1 Soldering process

Wires are joined by soldering during switchgear/controlgear assembly. Release to the environment includes the transfer of PRTR chemicals contained in solder as waste.

F1 Soldering process

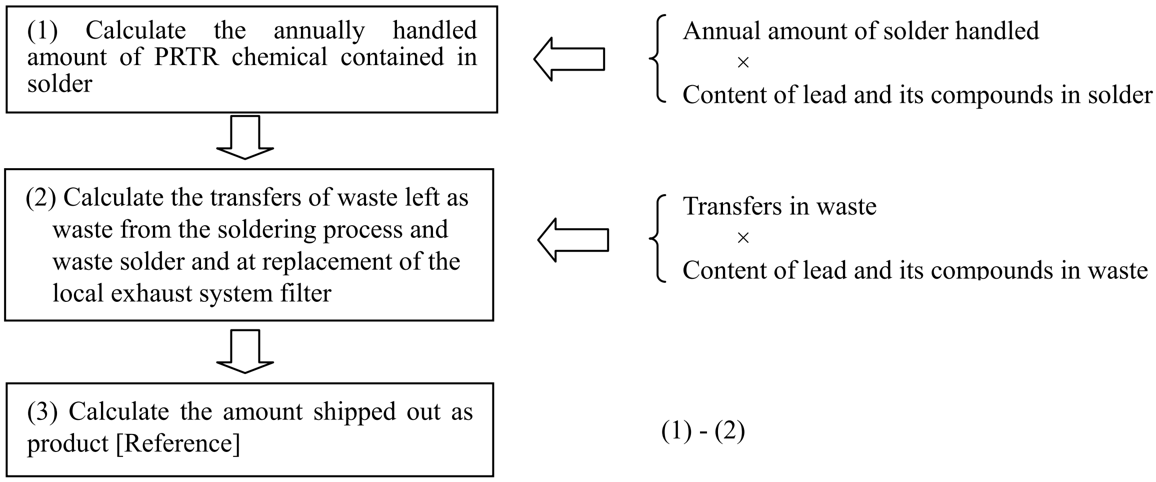
[Examples of PRTR chemicals and process flow diagram]



(Note) It is assumed that there is no release of PRTR chemicals from fume to the air.

[Calculation flow]

The flowchart below shows the procedure for calculating the releases and transfers of lead and its compounds in the soldering process.



[Calculation example]

This example shows how to calculate the releases and transfers of lead and its compounds when the facilities and conditions are as follows:

(Facilities and conditions)

• Process:	Wire soldering process
• Annual solder consumption:	100 kg/year
• Content of lead and its compounds:	37%
• Amount of waste from the soldering process and waste solder:	5 kg/year (content of lead in waste solder unknown)
• Local exhaust system:	None

Calculating the releases and transfers of lead and its compounds

(1) Calculating the annual amount of lead and its compounds handled

(Annual amount of lead handled) = (annual consumption of solder) × (content [%] of lead and its compounds in solder)
= 100 kg/year × 37%
= 37 kg/year

(2) Calculating the amount contained in waste

(Amount contained in waste) = (amount of waste from the soldering process and waste solder) × (content [%] of lead and its compounds in solder)
= 5 kg/year × 37%
=1.9 kg/year ・・・・・Off-site transfer

Lead and its compounds contained in waste from the soldering process and waste solder become waste.

Since the content of lead and its compounds in waste solder was unknown, it was assumed to be equal to that of the solder.

If the waste from the soldering process and waste solder of lead and its compounds are sent (sold) to an agent, it is assumed that there is no transfer as waste.

(3) Calculating the amount shipped out as product (Reference)

(Amount shipped out as product) = (annual amount of lead handled) - (transfers in waste)
= 37 kg - 1.9 kg
= 35.1 kg/year

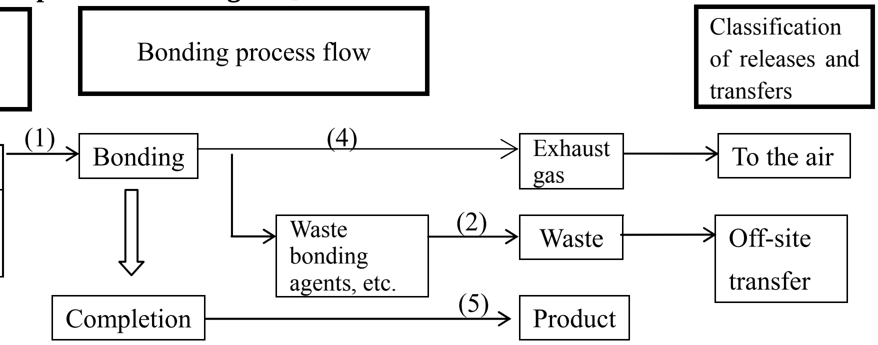
3.4.2 Bonding process

Rubber materials are bonded in switchgear/controlgear assembly.
Release to the environment includes the evaporation of solvent components from the bonding agent to the air and the transfer of solvent and additive components as waste.

F2 Bonding process

[Examples of PRTR chemicals and process flow diagram]

Cabinet Order No.	Examples of PRTR chemicals
Bonding agents	
227	Toluene
272	Bisphthalate (2-ethylhexyl)



[Calculation flow]

The calculation procedure for the releases and transfers of PRTR chemicals in the bonding process is as follows:

(1) Calculate the annually handled amount of PRTR chemical contained in bonding agent ⇐ Annual amount of bonding agent handled × Content in bonding agent

⇩

(2) Calculate the amount contained as waste (waste bonding agent) ⇐ Annual amount of waste (waste bonding agent) generated × Content in waste

⇩

(3) Calculate the amount shipped out as product (Reference) ⇐ (Annual amount handled - Content in waste)

[Calculation example]

This example shows how to calculate the releases and transfers of bisphthalate (2-ethylhexyl) when the facilities and conditions are as follows:

(Facilities and conditions)

• Process:	Packing bonding process
• Annual consumption of bonding agent:	80 kg/year
• Content of toluene in bonding agent:	30%
• Content of bisphthalate (2-ethylhexyl) in bonding agent:	10%
• Annual amount of waste bonding agents generated:	3 kg/year
• Local exhaust system:	None

Calculating the annual releases and transfers of bisphthalate (2-ethylhexyl) (additive) (No release to the air)

(1) Calculating the annual amount of bisphthalate (2-ethylhexyl) handled

[Annual amount of bisphthalate (2-ethylhexyl)] handled
= (annual consumption of bonding agent) × (content in bonding agent [%])
= 80 kg/year × 10%
= 8 kg/year

(2) Calculating transfers in waste

(Transfers in waste) = (amount of waste bonding agent)
× [content [%] of bisphthalate (2-ethylhexyl) in bonding agent]
= 3 kg/year × 10%
= 0.3 kg/year ・・・・・Off-site transfer

Since the content of bisphthalate (2-ethylhexyl) in the waste bonding agents was unknown, it was assumed to be equal to that of the bonding agents.

(3) Calculating the amount shipped out as product (Reference)

(Amount shipped out as product) = (annual amount of bisphthalate handled) - (transfers in waste)
= 8 kg/year - 0.3 kg/year
= 7.7 kg/year

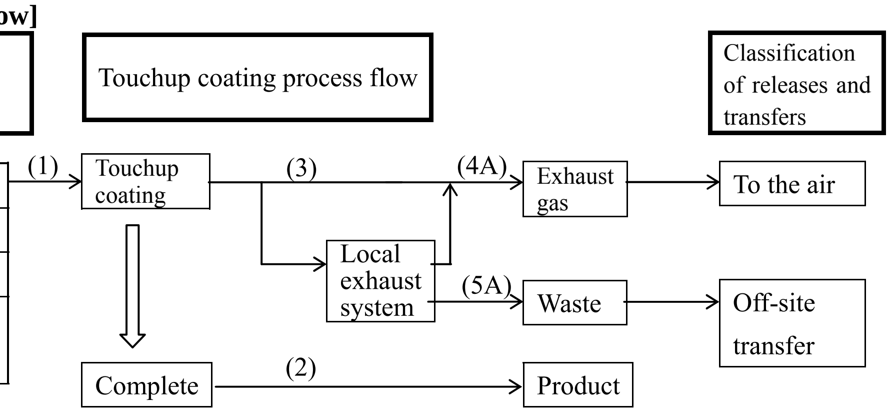
3.4.3 Touchup coating process

Coating is touched up in switchgear/controlgear assembly. Release to the environment includes the release of solvent components in paints to the air and the transfer of pigments and additives as waste.

F3 Touchup coating process

[PRTR chemicals and process flow]

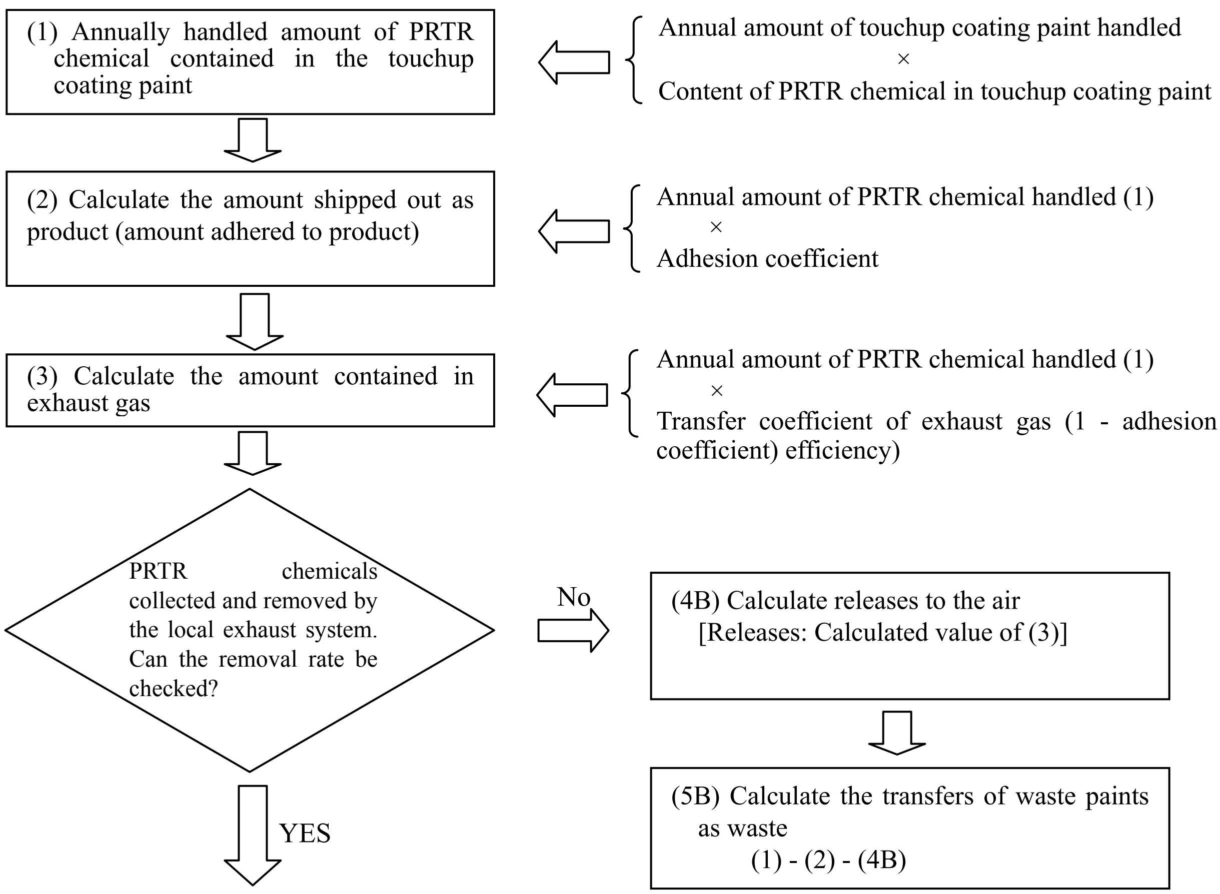
Cabinet Order No.	Example of PRTR chemicals
Touchup coating paints	
40	Ethylbenzene
63	Xylene
227	Toluene
272	Bisphthalate (2-ethylhexyl)



(Note) Ordinarily there is no baking process because paints that dry at room temperature are used for touchup coating.

[Calculation flow]

The calculation procedure for the releases and transfers of PRTR chemicals in the touchup coating process is as follows:



(4A) Calculate releases to the air ⇐ Amount contained in exhaust gas (3) × (1 - Removal rate)

(5A) Calculate the amount contained in exhaust gas collected by the local exhaust system and transferred as waste at filter replacement and as waste paints ⇐ (1) - (2) - (4A)

* If the transfer as waste can be known, do as follows:

(6) Calculate the amount contained in waste ⇐ Amount of waste (waste paints) generated × Content in waste

(7) Calculate releases to the air ⇐ (1) - (2) - (6)

[Calculation example] Example of calculation for the touchup coating process

This example shows how to calculate the releases and transfers of xylene when the facilities and conditions are as follows.

Ethylbenzene and toluene can be calculated in the same way.

(Facilities and conditions)

- Coating method: Air spraying of polyurethane resin paint (diluted)
- Annual consumption of paint: 7,100 kg/year
- Content of xylene: 38%
- Adhesion coefficient: 41% (Xylene: 0.0%)
- Local exhaust system: Used
- Annual consumption of filters for the local exhaust system: 120 kg
- Annual amount of disposed waste filters for the local exhaust system: 1,420 kg (with residual paints)

Calculating the annual releases and transfers of xylene

(1) Calculating the annual amount of xylene handled

(Annual amount of xylene handled) = (annual consumption of paint) × (content of xylene in paint)
= 7,100 kg/year × 38%
= 2,698 kg

(2) Calculating the amount shipped out as product

(Amount shipped out as product) = (annual amount of PRTR chemical handled) (1) × (adhesion coefficient)
= 2,698 kg/year × 0.0%
= 0.0 kg/year

(3) Calculating the amount contained in exhaust gas

(Amount contained in exhaust gas) = (annual amount of PRTR chemical handled) (1) × (transfer coefficient to exhaust gas = 1 – adhesion coefficient)
= 2,698 kg/year × 100%
= 2,698 kg/year

(4A) Calculating releases to the air

(Release to the air) = (amount contained in exhaust gas) (3) × (1 - removal rate by local exhaust system)
= 2,698 kg/year × (100%-0.0%)
= 2,698 kg/year ・・・・・To the air

* The annual amount of residual paints adhered to the filters of the local exhaust system is:

(Annual amount of residual paints adhered to filters) = (annual amount of filters disposed) - (annual consumption of filters)
= 1,420 kg/year - 120 kg/year
= 1,300 kg/year

* Xylene was not detected when the residual paints adhered to the filters of the local exhaust system was analyzed. Xylene may have evaporated because of plentiful air flow.

The annual amount of xylene adhered to the filters of the local exhaust system is:

(Annual amount of xylene adhered to filters) = (annual amount of residual paints) × (concentration of xylene through analysis of residual paints)
= 1,300 kg/year × 0.0 mg/kg
= 0.0 kg/year

Therefore, the rate of removal by the local exhaust system is:

(Rate [%] of removal by local exhaust system)
= 100% × (annual amount of xylene adhered to filters) ÷ (amount contained in releases)
= 100% × 0.0 kg/year ÷ 2,698 kg/year

Xylene was not detected when the residual paints adhered to the filters of the local exhaust system were analyzed.

(5A) (Disposed amount adhering to filters of local exhaust system)
= (1) - (2) - (4A)
= 2,698 kg/year-0.0 kg/year-2,698 kg/year
= 0.0 kg/year

As is shown above, 100% of the xylene is released to the air (evaporated) due to long-term exposure to the air.

3.5 Aggregation of Releases and Transfers

The balance between the amount handled and the amount of releases and transfers in each process is listed from the **[calculation examples]** to determine whether PRTR chemicals need to be reported or not.

Balance between the annual amount of PRTR chemicals handled and the releases and transfers from the [calculation examples]

The annual amounts handled and the releases and transfers at each process shall be collected, and a judgment shall be made on whether reporting is required. Then, the specified forms (**Attached Forms 1** and **2 of Reference 1**) shall be created and submitted in accordance with **Table 3.5**.

A form (**Attached Form 1**) shall be prepared for each business facility and a form for releases and transfers (**Attached Form 2**) shall be created for each substance.

Table 3.5 Aggregation of the annual amounts of PRTR chemicals handled and the releases and transfers (from the [calculation examples])

Unit: kg/year

Cabinet Order No.	PRTR chemical	Process	Amount Handled	Releases				Transfers		Reporting
				Air	Water	Soil	Landfill	Sewerage	Off-site transfer	
309	Poly(oxyethylene) = nonyl phenyl ether	Cutting and bending	1.25	–	–	–	–	–	1.25	Not required
311	Manganese and its compounds	Welding	120	–	–	–	–	–	36	Not required
68	Chromium and trivalent chromium compounds	Welding (stainless steel)	18,600*	–	–	–	–	–	0.6	Required
307	Poly(oxyethylene) =alkyl ether	Coating: pretreatment	18.5	–	–	–	–	–	9.0 + 9.5 = 18.5	Not required
1	Water soluble compounds of zinc	Coating: pretreatment	41.4	–	–	–	–	–	13.5 + 13.5 + 0.7 = 27.7	Not required
230	Lead and its compounds	Coating: solvent	921	–	–	–	–	–	25 + 91 = 116	Required
		Coating: undercoating	264	–	–	–	–	–	6.4 + 59.5 +92 = 157.9	
		Coating: solvent for undercoating	180	–	–	–	–	–	3.6 + 68 = 71.6	
		Coating: solvent for undercoating	483	–	–	–	–	–	13 + 103 + 125 = 241	
		Assembly: solder	37	–	–	–	–	–	1.9	
	(Total)		1,885						588.4	
63	Xylene	Coating: solvent for undercoating	2,132	1,993	–	–	–	–	139 + 0.0 = 139	Required
		Assembly: (coating)	2,698	2,698	–	–	–	–	–	
	(Total)		4,830	4,691					139	
40	Ethylbenzene	Coating: solvent	616	560	–	–	–	–	56	Not required
346	Molybdenum and its compounds	Coating: finish-coating, powder	11.4	–	–	–	–	–	0.4 + 4.2 = 4.6	Not required
69	Hexavalent chromium compounds	Coating: finish-coating, Water-based	20	–	–	–	–	–	0.3 + 7.5 +5.2 = 13	Not required
272	Bisphthalate (2-ethylhexyl)	Assembly	8	–	–	–	–	–	0.3	Not required

Notes: 1. If "reporting" is "required", releases and transfers must be reported.
(If the annual amount of a PRTR chemical handled is 1 ton or more, reporting is required (0.5 tons or more for Specified Class I Designated Substances).)
2. Amounts of PRTR chemicals handled in stainless steel product marked with an asterisk indicate the amount of such chemicals contained in stainless steel material and welding material (welding rods, etc).

Chapter 4　PRTR chemicals

4.1 Relationship between the PRTR Law and Environmental Ordinances

As a rule, an environmental law prescribes criteria that are uniformly applicable throughout the nation. To protect local residents from environmental contamination and improve welfare, however, local governments may establish ordinances by considering geographical, social, and cultural conditions and take restrictive measures by establishing stricter criteria than the uniform criteria of the law and by increasing the number of items targeted for control.

For example, the Tokyo Metropolitan Government enacted the "Ordinance on Environmental Preservation to Secure the Health and Safety of Citizens of the Tokyo Metropolitan Area (the Ordinance on Environmental Preservation)” and prescribed articles for the optimum control of chemical substances.

The Saitama Prefectural Government established the "Saitama Prefectural Ordinance for Environmental Preservation (Appropriate Management of Specified Chemical Substances)."

Both ordinances oblige conformance with ordinances together with the PRTR Law.

Since other local governments may also have their own ordinances on chemical substances, it is necessary to conform not only to the PRTR Law but also to environmental ordinances, if any.

As examples of local governmental ordinances, **Table 4.1** gives the outlines of the PRTR law, the Ordinance on Environmental Preservation and the Saitama Prefectural Ordinance for Environmental Preservation. **Tables 4.2** and **4.3** list the chemical substance names designated by these ordinances.

Table 4.1: Covered businesses and report contents required for notification (Outline)

Item \ Laws/regulations	PRTR Law	Ordinance on Environmental Preservation (Tokyo)	Saitama Prefectural Ordinance for Environmental Preservation
Listed industry categories	23 types	Factories and specified business facilities in Tokyo	Same as the PRTR Law
Business scale	21 or more employees (entire company)	Any scale	Same as the PRTR Law
	Do the following checks for each business facility:		
Target chemicals	Class I Designated Chemical Substances (PRTR chemicals): 354 substances (including 12 Specified Class I Designated Chemical Substances)	Optimized Control Chemicals: 58 substances (including 16 substances not designated by the PRTR Law)	Specific Chemical Substances: 499 substances (354 Class I Designated Chemical Substances and 81 Class II Designated Chemical Substances designated by the PRTR Law and 64 chemical substances designated by the ordinance)
Content of PRTR chemical in products and materials	Class I Designated Chemical Substance (PRTR Chemicals): 1 mass % or more Specified Class I Designated Chemical Substance: 0.1 mass % or more	Amount of component checked with MSDS	Specific Chemical Substance: 1 mass % or more (0.1 mass % or more for Specified Class I Designated Chemical Substances)
Annual amount handled	Class I Designated Chemical Substance: 1 ton or more/year Specified Class I Designated Chemical Substance: 0.5 ton or more/year	Optimized Control Chemicals: 100 kg or more/year	Specific Chemical Substance: 500 kg or more/year
Name of business requiring notification	Business requiring reporting (reporting is required for each business facility)	Business handling Optimized Control Chemicals (reporting is required for each business facility)	Business handling specific chemical substances (notification by each business facility)
Reporting content (data of the previous fiscal year to be notified in the period from April 1 until June 30)	Releases and transfers of each Class I Designated Chemical Substance in a "Notification of Release and Transfer of Class I Designated Chemical Substances"	Volume of chemical used, production volume, volume of chemical shipped as product, and releases and transfers for each Optimized Control Chemical.	Consumption, production, and amount handled of each specific chemical substance in a "Report on the Amount of Specific Chemical Substances Handled "
Other matters (After submission of the above report)		Businesses having 21 or more regular employees, are required to submit the “Chemical Substance Control Method Sheet” as soon as possible. The revised Sheet must be submitted each time any change is made in the content.	Submit "Manager Responsible for Reducing Environmental Loads" and "Report on Preparation (Revision) of Procedural Manual on Optimum Control for Specific Chemical Substances" by September 30. If the content is revised, submit a notification each time revisions are made.

Table 4.2: Chemical substances under the Ordinance on Environmental Preservation in Tokyo

No.	Chemical Name	Reference: PRTR Law (Cabinet Order No. of Class I Designated Chemical Substance)
1	Acrolein	8
2	Acetone	Not applicable
3	Isoamyl alcohol	Not applicable
4		Not applicable
5	Ethylene	Not applicable
6	Chlorosulfonic acid	Not applicable
7	Vinyl chloride monomer	77
8	Hydrochloric acid	Not applicable
9	Chlorine	Not applicable
10	Cadmium and its compound	60
11	Xylene	63
12	Chrome and trivalent chrome compound	68
13	Hexavalent chrome compound	69
14	Chloropicrin	214
15	Chloroform	95
16	Ethyl acetate	Not applicable
17	Butyl acetate	Not applicable
18	Methyl acetate	Not applicable
19	Ethylene oxide	42
20	Cyanogen compound (excluding complex salt and cyanate)	108
21	Carbon tetrachloride	112
22	1,2-dichloroethane	116
23	1,1-dichloroethylene	117
24	Cis-1,2-dishloroethylene	118
25	1,3-dichloropropane	137
26	Dichloromethane	145
27	Simazine	90
28	Boronic compound (methyl bromide only)	288
29	Nitric acid	Not applicable
30	Mercury and its compound	175
31	Styrene	177
32	Selenium and its compound	178
33	Thiuram	204
34	Thio-bencarb	110
35	Tetrachloroethylene	200
36	1,1,1-trichloroethane	209
37	1,1,2-trichloroethane	210
38	Trichloroethylene	211
39	Toluene	227
40	Lead and its compound	230
41	Nickel	231
42	Nickel compound	232
43	Carbon disulfide	241
44	Arsenic and its compound	252
45	Polychlorinated biphenyl (PCB)	306
46	Pyridine	259
47	Phenol	266
48	Hydrogen fluoride and its water soluble salt	283
49	Hexane	Not applicable
50	Benzene	299
51	Formaldehyde	310
52	Manganese and its compound	311
53	Methanol	Not applicable
54	Methyl isobutyl ketone	Not applicable
55	Methylethyl ketone	Not applicable
56	Organic phosphoric compound (EPN only)	37
57	Sulfuric acid	Not applicable
58	Boron and its compounds (Note: Applicable from April 1, 2003. If the amount handled becomes 100 kg or more in the period from April 1, 2003 to March 31, 2004, reporting shall be made in the period from April to the end of June 2004.)	304
		Non-PRTR chemicals: 16

Excerpts from the website of the Tokyo Metropolitan Government
"No." refers to the numbers taken from the Ordinance on Environmental Preservation in Tokyo.

Table 4.3: Chemical substances under the Saitama Prefectural Ordinance for Environmental Preservation

No.	Specified Chemical Substances	Synonym	CAS No.	Category of Chemical Substance
1	Aluminum (powder only)		7429-90-5	Category 1 (Inorganic compounds and organic metal compounds)
2	Ammonium (including ammonia water)		1336-21-6	
7	Hydrogen chloride (including hydrochloric acid)		7647-01-0	
8	Chlorine		7782-50-5	
10	Yellow phosphorous		7723-14-0	
14	Chlorosulfonic acid		7790-94-5	
18	Phosphorous pentachloride		1314-56-3	
19	Phosphorous trichloride		7719-12-2	
24	Bromine		7726-95-6	
25	Nitric acid		7697-37-2	
26	Talc (talc containing asbestos-like fibers only)		14807-96-6	
30	Sulfur dioxide (excluding combustion products)	Liquefied sulfur dioxide gas	7446-09-5	
43	Silicon fluoride	Silicon tetrafluoride	7783-61-1	
44	Fluorine		7782-41-4	
52	Magnesium		7439-95-4	
60	Hydrogen sulfide		7783-06-4	
61	Sulfuric acid (including sulfur troixide)		7664-93-9	
63	Hydrogen phosphide (Alias: phosphine)		7803-51-2	
64	Rock wool			
3	Isooctane		540-84-1	Category 2 (Chain hydrocarbon compounds and halogen chain hydrocarbon compounds)
15	Chloroprene		126-99-8	
31	Ethylene dibromide		590-11-4,590-12-5	
45	n-hexane		110-54-3	
59	Methyl iodide		74-88-4	
16	Chloromethyl-mether ether		107-30-2	Category 3 (Chain hydrocarbon compounds having amine, nitro, alcohol, ether, aldehyde, and ketone structures)
20	Diethanolamine		111-42-2	
27	Triethylamine		121-44-8	
32	N-nitrosodi-n-butylamine		924-16-3	
54	Methanol		67-56-1	
55	Methyl isobutyl ketone		108-10-1	
56	Methyl ethyl ketone (Alias: MEK)		78-93-3	
57	Methyl-t-butyl ether		1634-04-4	
11	Ethyl carbamate	Urethane	51-79-6	Category 5 (Other chain hydrocarbon compounds)
21	Diethyl sulfate	Diethyl sulfate	64-67-5	
53	Mesomyl		16752-77-5	
62	Dimethyl sulfate		77-78-1	
4	Isopropylbenzene		98-82-8	Category 6 (Monocyclic hydrocarbon compounds and halogen monocyclic hydrocarbon compounds)
22	2,4-dichlorophenol		120-83-2	
28	1,2,4-trichlorobenzene		120-82-1	
23	N,N-dimethylaniline		121-69-7	Category 7 (Monocyclic hydrocarbon compounds having amine, nitro, and azo structures)
33	4-nitrotoluene	p-nitrotoluene	99-99-0	
41	4-n-butyl phenol		1638-22-8	Category 8 (Monocyclic hydrocarbon compounds having alcohol, ether, aldehyde, and ketone structures)
42	4-t-butyl phenol	p-t-butyl phenol	98-54-4	
46	4-n-hexyl phenol		2446-69-7	
47	4-n-heptyl phenol		1987-50-4	
50	4-n-pentyl phenol		14938-35-3	
5	Isophorone		78-59-1	Category 9 (Monocyclic hydrocarbon compounds having structures of carboxylic acid, sulfuric acid, nitrogen acid, carbonic acid, cyanic acid, and their derivative structures, and alicyclic monocyclic hydrocarbon compounds)
6	Isophane valerate		66230-04-4	
34	Diethyl phthalate		84-66-2	
35	Dicyclohexyl phthalate		84-61-7	
36	Dipropyl phthalate		131-16-8	
37	Dihexyl phthalate		84-75-3	
38	Dipentyl phthalate		131-18-0	
39	Dimethyl phthalate		131-11-3	
40	o-phthalodinitrile		91-15-6	
48	p-benzoquinone		106-51-4	
9	Auramine		2465-27-2	Category 10 (Other monocyclic hydrocarbon compounds)
17	Coal tar pitch		65996-93-2	
29	Naphthalene		91-20-3	
49	Benzophenone		119-61-9	
51	Polybrominated biphenyls		67774-32-7 etc.	
13	Captan		133-06-2	Category 12 (Heterocyclic compounds of three to
12	Quinoline		91-22-5	Category 13 (Other heterocyclic compounds)
58	Metribuzin		21087-64-9	

Excerpts from the website of the Saitama Prefectural Government

Reference 2: PRTR Chemicals

Attached Table 3: Examples of Emission Factors for Releases to Air of PRTR Chemicals

Chemical names	Classification of generation sources	Emission factors (kg/t - Amount handled)
Trichloroethylene	Manufacturing	0.001
	Storage	0.23
	Solvent	979
	Washing	838
Tetrachloroethylene	Manufacturing	0.09
	Raw materials	0.0003
	Storage	0.086
	Solvent	643
	Washing	790
Dichloromethane	Manufacturing	0.002
	Storage	0.26
	Solvent	336
	Washing	891
1,2-dichloroethane	Manufacturing	0.14
	Storage	0.048
	Solvent	0.083
	Washing	822
Vinyl chloride monomer	Manufacturing	0.06
	Raw materials	0.81
Acrylonitrile	Manufacturing	0.006
	Raw materials	0.33
	Storage	0.08
Benzene	Manufacturing	0
	Raw materials	0.002
	Storage	0.04
	Solvent	658

(Source: "A Report on Sources of Harmful Air Pollutants" by the Study Group for Sources of Harmful Air Pollutants commissioned by the Environment Agency, March 1996)

Note: More accurate emission factors and information on other chemical substances in terms of emission factors may be available in the future.

Attached Table 4 Classification of notifications for volatile and nonvolatile substances in the handling processes (Reference)

Classification of Notification		Operation Leading to Release or Transfer	Release or Transfer Route	Volatile Substance	Example	Nonvolatile Substance	Example
Releases	To air	Adding materials to product	Direct from workshop to air	○	Solvents in paints and bonding agents	–	
			Exhaust gas system	○		–	
			Exhaust gas treatment facilities (deodorizing furnace, etc.)	○		–	
			Via two of the above	○		–	
		Heating or drying materials	Direct from workshop to air	○	Paint solvents and bonding agents to be dried (baked) and components of welding rods	–	
			Direct from drying facilities to air	○			
			Exhaust gas system	○		–	
			Exhaust gas treatment facilities (deodorizing furnace, etc.)	○		–	
			Via two of the above	○		–	
	To bodies of waters	Collection and release of scattered or fluid materials using water	Washing-type exhaust gas system	Δ	Water-based components in paint solvents and in pretreatment agents released through wastewater treatment facilities	○	Water-based components in paints, pigments and resins and in pretreatment agents released via wastewater treatment facilities
			Wastewater treatment facilities	Δ		○	
			Via two of the above	Δ		○	
	(To on-site soil)			–		–	
	(On-site landfills)			–		–	
Transfers	To sewerage	Collection and release of scattered or fluid materials using water	Washing-type exhaust system	Δ	Water-based components in paint solvents and in pretreatment agents released through wastewater treatment facilities	○	Water-based components in paint pigments and resins and in pretreatment agents released via wastewater treatment facilities
			Wastewater treatment facilities	Δ		○	
			Via two of the above	Δ		○	
	Off-site transfer	Disposal of surplus materials kept in sealed storage	Workshop	○	Solvents in waste paints and bonding agents	○	Pigments in waste paints
		Disposal of scattered materials through cleaning of workshop or exhaust system	Workshop	–		○	Pigment and resin components in residual paints
			Exhaust gas system	–		○	
		Collection and release of scattering and fluid materials using water	Wastewater treatment facilities	Δ	Coating pretreatment agents and paint solvents released via washing-type exhaust system and wastewater treatment facilities	○	Coating pretreatment agents and components in paint pigment and in resins released via washing-type exhaust system and wastewater treatment facilities

Notification is:
○: Required
Δ: Required depending on processing conditions. (The amount of volatile components dissolved in wastewater should be reported as transfers to sewerage, and the released amount escaping from exhaust gas systems should be reported as releases to air.)
–: Not required.

Attached Table 5: Volatile Class I Designated Chemical Substances in Paints

Chemical Name on the Material Safety Data Sheet	Type of Designated Chemical Substance	Number of Designated Chemical Substance	Name of Designated Chemical Substance	Conversion Factor
Xylene	Class I	63	Xylene	1
Ethylbenzene	Class I	40	Ethylbenzene	1
Toluene	Class I	227	Toluene	1
Ethylene glycol monoethyl ether	Class I	44	Ethylene glycol monoethyl ether	1
Ethylene glycol monomethyl ether	Class I	45	Ethylene glycol monomethyl ether	1
Ethylene glycol monoethyl ether acetate	Class I	101	2-ethoxyethyl acetate	1
Ethylene glycol monomethyl ether acetate	Class I	103	2-ethoxymethyl acetate	1
1,3,5-trimethyl benzene	Class I	224	1,3,5 - trimethyl benzene	1

Attached Table 6: Nonvolatile Class I Designated Chemical Substances in Paints

Chemical Name on Material Safety Data Sheet	Type of Designated Chemical Substance	Number of Designated Chemical Substance	Name of Designated Chemical Substance	Conversion Factor
Styrene	Class I	177	Styrene	1
Chromate (Chrome yellow)	Class I Specified Class I	230 69	Lead and its compound Hexavalent chrome compound	0.641 0.161
Lead molybdate	Class I Class I	230 346	Lead and its compound Molybdenum and its compound	0.564 0.261
Lead sulfate	Class I	230	Lead and its compound	0.683
Zinc chromate	Specified Class I	69	Hexavalent chrome compound	0.287
Strontium chromate	Specified Class I	69	Hexavalent chrome compound	0.255

Reference 3: Examples of Transfer Coefficient to Products during Spraying Process

1. Adhesion coefficient to products during spraying process

If the amount of diluted paint sprayed is Wtr [kg] and the adhesion amount of diluted paint is Wta [kg], the adhesion coefficient to product Ea [%] during the spraying process (including electrostatic and low-pressure spraying) is:

$$Ea\,[\%] = 100 \times Wta/Wtr$$

However, it is considered that the evaporation of diluted solvent after spraying through adhesion is very small and that there is almost no difference in the composition of the diluted paint in terms of its content between the times of spraying and adhesion. Therefore, if the amount of the paint component in diluted paint sprayed is Wpr [kg] and the amount of paint in diluted paint adhered is Wpa [kg]:

$$Ea\,[\%] = 100 \times Wta/Wtr = 100 \times Wpa/Wpr$$

If the nonvolatile content in the amount of paint sprayed (solid component of diluted paint sprayed) is Wsr [kg] and the nonvolatile content in the amount of paint adhered (paint weight) is Wsa [kg]:

$$Ea\,[\%] = 100 \times Wta/Wtr = 100 \times Wpa/Wpr = 100 \times Wsa/Wsr \quad \cdots(1)$$

With the nonvolatile content Ku [%] in the coating catalog specifications, the amount of the solid component of diluted paint sprayed (Wa) can be expressed as follows:

$$Wsr = Wa \times Ku/100 \quad \cdots(2)$$

If the product surface area is Sa [m^2], the average coating thickness is Tsa [μm], and the paint specific gravity is Dsa, the coating weight (Wsa [kg]) is:

$$Wsa = Sa \times Tsa \times Dsa/1000 \quad \cdots(3)$$

If the product weight before paint adhesion and that after baking can be measured with high accuracy, their difference may be regarded as the paint weight Wsa[kg]. With regard to switchgear/controlgear, it is easy to check the product surface area (Sa [m^2]).

For the average coating thickness Tsa [μm], the coating thickness is measured with an electromagnetic thickness meter at many points.

With the paint specific gravity Dp and the specific gravity Dpl of solvent in paint (not diluted solvent) in the coating catalog's specifications, the paint specific gravity Dsa is calculated as follows:

$$Dsa = \frac{Ku \times Dp \times Dpl}{Ku \times Dp - 100 \times (Dp - Dpl)} \quad \cdots(4)$$

In powder-based coating, volatile component need not be assumed. Therefore,

Ku = 100

Wsr = Wa

Dsa = Dp

Thus, the equation becomes easy.

2. Measurement and Calculation of Adhesion Coefficient to Product in the Spraying Process

The storage tank was filled with melamine resin paint of Ku = 68.0, Dp = 1.27, and Dpl = 0.870 and its diluted solvent up to the prescribed level. After a cubicle enclosure of Sa = 35.8m^2 was coated, about 0.60 of a can containing 16 kg paint was consumed to fill the tank up to the prescribed level. (The decrease of the liquid level in the paint can was measured with a ruler.)

When the coating of this cubicle enclosure was baked and dried and the coating thickness was measured at 100 points, Tsa was 73.1 μm. Using Equation (2) in 1, the amount of solid component of diluted paint sprayed Wsr[kg] is:

$$Wsr = 16 \times 0.60 \times 68.0/100 = 6.53kg$$

Using Equation (4) in 1, the paint specific gravity Dsa is:

$$Dsa = \frac{68.0 \times 1.27 \times 0.870}{68.0 \times 1.27 - 100 \times (1.27 - 0.870)} = 1.62$$

Using Equation (3) in 1, the paint weight Wsa[kg] is:

$$Wsa = 35.8 \times 73.1 \times 1.62/1000 = 4.24kg$$

And using Equation (1) in 1, the adhesion coefficient to product Ea [%] is:

$$Ea = 100 \times Wsa/Wsr = 100 \times 4.24/6.53 = 64.9\% \text{ (about 65\%)}$$

3. Transfer Coefficient to Product in the Spraying Process

Attached Table 7 gives some examples of adhesion coefficient to product in the spraying process.

Attached Table 7 Transfer coefficient to products in the spraying process

Unit: %

Manual/Auto	Coating Method	Product Type		
		Portable switchgear/controlgear	Standalone switchgear/controlgear	Cubicle switchgear/controlgear
Manual	General liquid spray	40	55	65
	Low-pressure atomizing liquid spray	55	60	70
	Electrostatic liquid spray	50	60	70
	Electrostatic powder not collected	60	60	70
	Electrostatic powder collected	75	N.A.	N.A.
Auto	General liquid spray	35	N.A.	N.A.
	Low-pressure atomizing liquid spray	45	N.A.	N.A.
	Electrostatic liquid spray	40	N.A.	N.A.
	Electrostatic powder not collected	45	N.A.	N.A.
	Electrostatic powder collected	75	N.A.	N.A.
	(Reference) Electrodeposition	99	99	99