PRTR Estimation Manual

# 06. Electroplating Industry

**January 2001**
**Revised: March 2002**

**Federation of Electro Plating Industry Association, Japan**

## Contents

## 1. Class I Designated Chemical Substances (Referred to as Class I Substances）

### 1.1. Class I Substances

A total of 354 chemical substances are designated as Class I Designated Chemical Substances under the Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management.

### 1.2. Class I Substances You Need to Report On

If your business has facilities which have a total of 21 or more full-time employees and where the annual amount of any of the Specified Class I Substances (probable human carcinogens) handled is 0.5 ton or more and the annual amount of any other Class I Substances handled is one ton or more (5 ton or more for the initial two years (FY 2001 and 2002)), each facility must report their releases and transfers to the local governments.

### 1.3. Major Class I Substances Related to the Electroplating Industry

A business selling a product containing any of the Class I Substances is required to deliver an MSDS (Material Safety Data Sheet) to the customers.

Therefore, you should thoroughly check the information in the MSDS to ensure whether the Class I Substances are contained in the chemical products purchased.

Of the 354 Class I Substances, those which are normally considered to be handled in the electroplating industry are listed as follows (Make sure if there are other Class I Substances which are used at your facilities):

Group A Substances

These are the listed Class Ⅰ Substances on which a large number of facilities are supposed to submit reports required because of their annual amounts handled which are described in 1.2 above.

Zinc compounds (water-soluble) (1)
Silver and its water-soluble compounds (64)
Copper water-soluble salts (excluding complex salts) (207)
Hexavalent chromium compounds (69)
Nickel compounds (232)
Chromium and trivalent chromium compounds (68)
Lead and its compounds (230)
Nickel (231)
Trichloroethylene (211)
Dichloromethane (methylene chloride) (145)
Tetrachloroethylene (200)
Inorganic cyanides (except complex salts and cyanate) (108)
Hydrogen fluoride and its water-soluble salts (283)
Boron and its compounds (304)

Group B Substances:

These are the listed Class I Substances but there are supposedly not many facilities that are required to submit reporting.

n-Alkylbenzenesulfonic acid and its salts (alkyl C= 10-14) (24)
Antimony and its compounds (25)
Cadmium and its compounds (60)
Xylene (63)
Chloroethylene (vinyl chloride) (77)
Cobalt and its compounds (100)
Selenium and its compounds (178)
Thiourea (181)
Toluene (227)
Hydrazine (253)
Berylium and its compounds (294)
Benzene (299)
Formaldehyde (310)
Manganese and its compounds (311)
Molybdenum and its compounds (346)

Notes: -The chemical substances underlined are the Specified Class I Substances.
-The number in parentheses shows Cabinet Order Number.

## 2. Basic Concept of Calculating Releases and Transfers

This section describes basic concept of calculating releases/transfers for the 14 chemicals of the Class I Substances (Group A Substances) (referred to as "major 14 substances" which are required to be reported under provisions of the law concerning the annual amounts handled (0.5 tons or more for the Specified Class I Substances and 1 ton or more for other Class I Substances) and on which a number of business facilities need to report in the plating industry.

In case it is determined that your facility needs to submit reporting on substances other than those 14 substances, also refer to the calculation procedure described in this chapter.

### 2.1. Points of Releases and Transfers in Processes

#### 2.1.1. Overview of the Plating Process

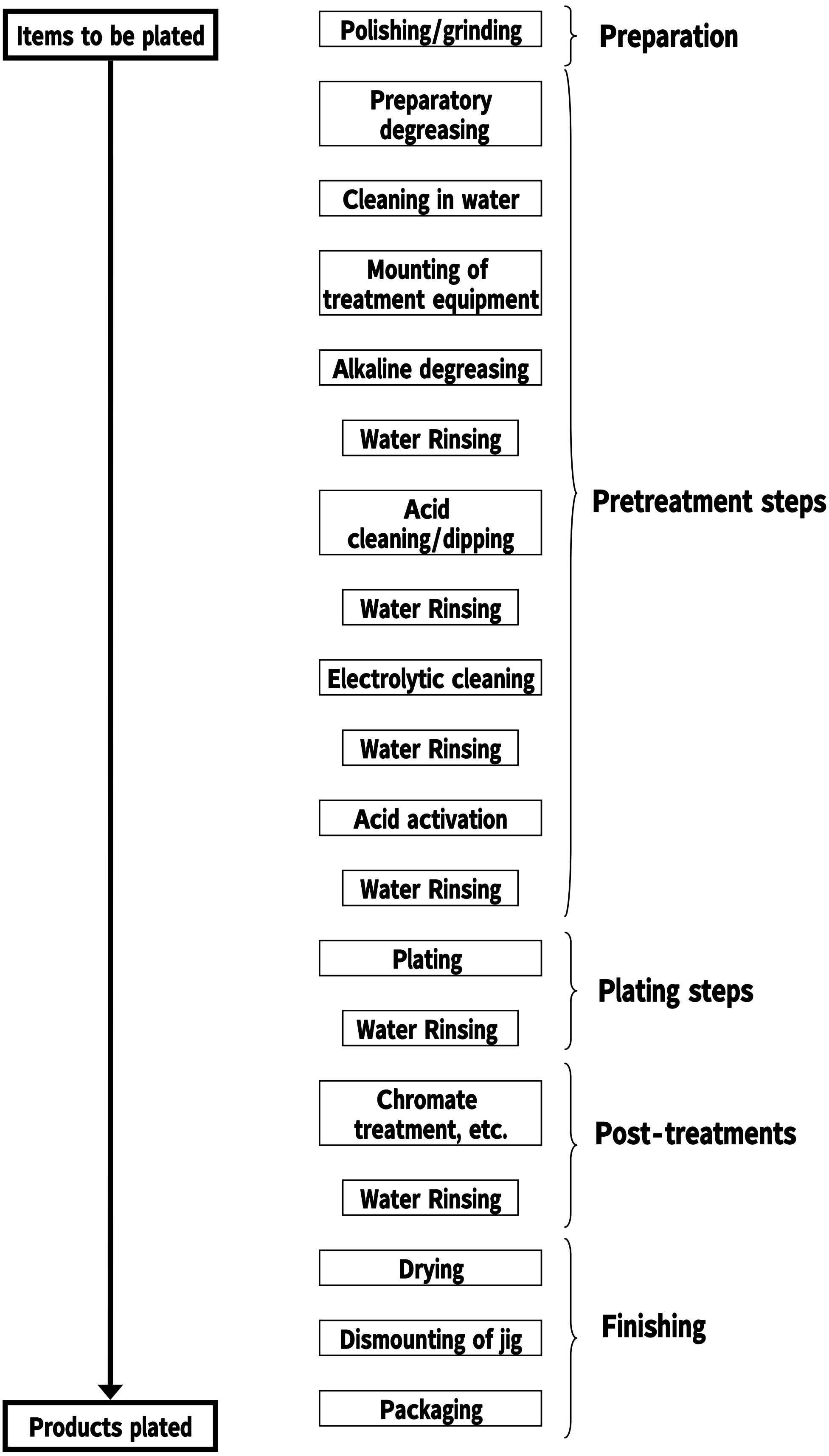
(1) The plating process falls into the following stages: preparation, pretreatment, plating, post-treatment and finishing. Normally Class I Substances are used in the stages of pretreatment, plating and post-treatment.
Preparation: polishing of a part to be plated, etc.

(2) Pretreatment process: mounting of treatment equipment and dipping in pretreatment baths (treatment baths with various chemicals) and water rinsing baths

(3) Plating process: soaking in plating baths and water rinsing

(4) Post-treatment process: dipping in post-treatment baths (chromate treatment, etc.) and water rinsing baths

(5) Finishing: drying, dismounting of treatment equipment, and packaging


Items to be plated
Polishing/grinding
Preparation
Preparatory degreasing
Cleaning in water
Mounting of treatment equipment
Alkaline degreasing
Water Rinsing
Acid cleaning/dipping
Pretreatment steps
Water Rinsing
Electrolytic cleaning
Water Rinsing
Acid activation
Water Rinsing
Plating
Plating steps
Water Rinsing
Chromate treatment, etc.
Post-treatments
Water Rinsing
Drying
Dismounting of jig
Finishing
Packaging
Products plated

2.1.2. Major 14 Substances Related to Processes

The following table presents the major 14 substances, ○ shows that the chemical substance may be used and × shows that the chemical substance may not be used in the process.

| Process | Plating process | | Pretreatment process | Post-treatment process |
|---|---|---|---|---|
| Handling forms Major 14 c | Electrodes | Plating solution | Pretreatment solution | Post-treatment solution |
| Zinc compounds (water soluble) | × | ○ | × | × |
| Silver and its water-soluble compounds | ○ | ○ | × | × |
| Copper water-soluble salts (except complex salts) | × | ○ | × | × |
| Hexavalent chromium compounds | × | ○ | × | ○ |
| Nickel compounds | × | ○ | × | × |
| Chromium and trivalent chromium compounds | × | ○ | × | ○ |
| Lead and its compounds | ○ | ○ | × | × |
| Nickel | ○ | × | × | × |
| Trichloroethylen | × | × | ○ | × |
| Dichloromethane (another name: methylene chloride) | × | × | ○ | × |
| Tetrachloroethylene | × | × | ○ | × |
| Inorganic cyanides (excluding complex salt and cyanate) | × | ○ | ○ | × |
| Hydrogen fluoride and its water-soluble salts | × | ○ | ○ | ○ |
| Boron and its compounds | × | ○ | ○ | ○ |

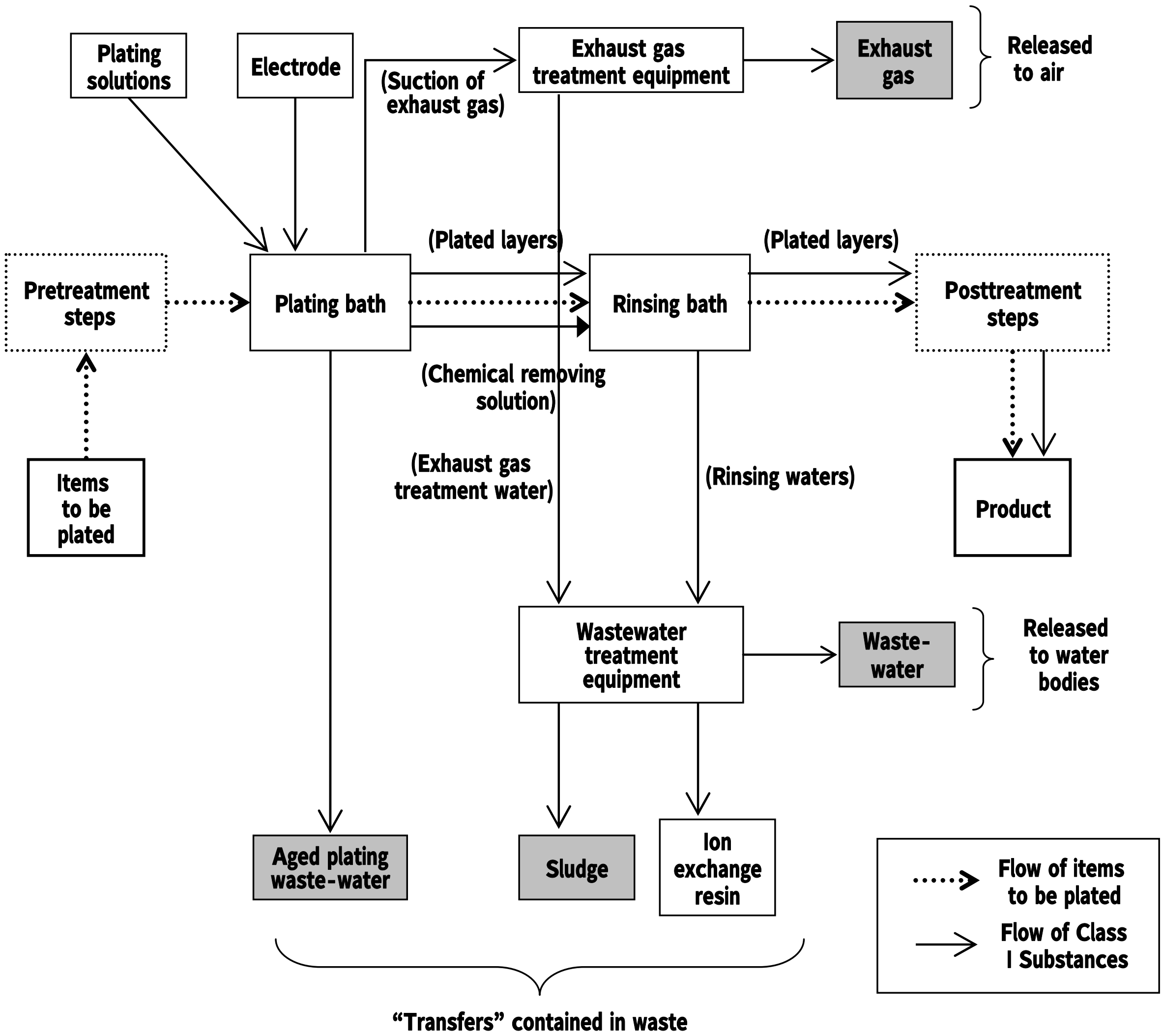
2.1.3. Points Where the 14 Major Substances Are Released/Transferred

Under the PRTR system, covered business facilities must estimate and report the releases of Class I Substances to the environment (bodies of water such as rivers, environment and soil) and transfers which are handed over to industrial waste contractors.

In order to make the above calculations, they first need to identify releases and transfers from specific processes where Class I Substances are handled.

Points where release and transfers take place are shown by process below:

(1) Plating processes



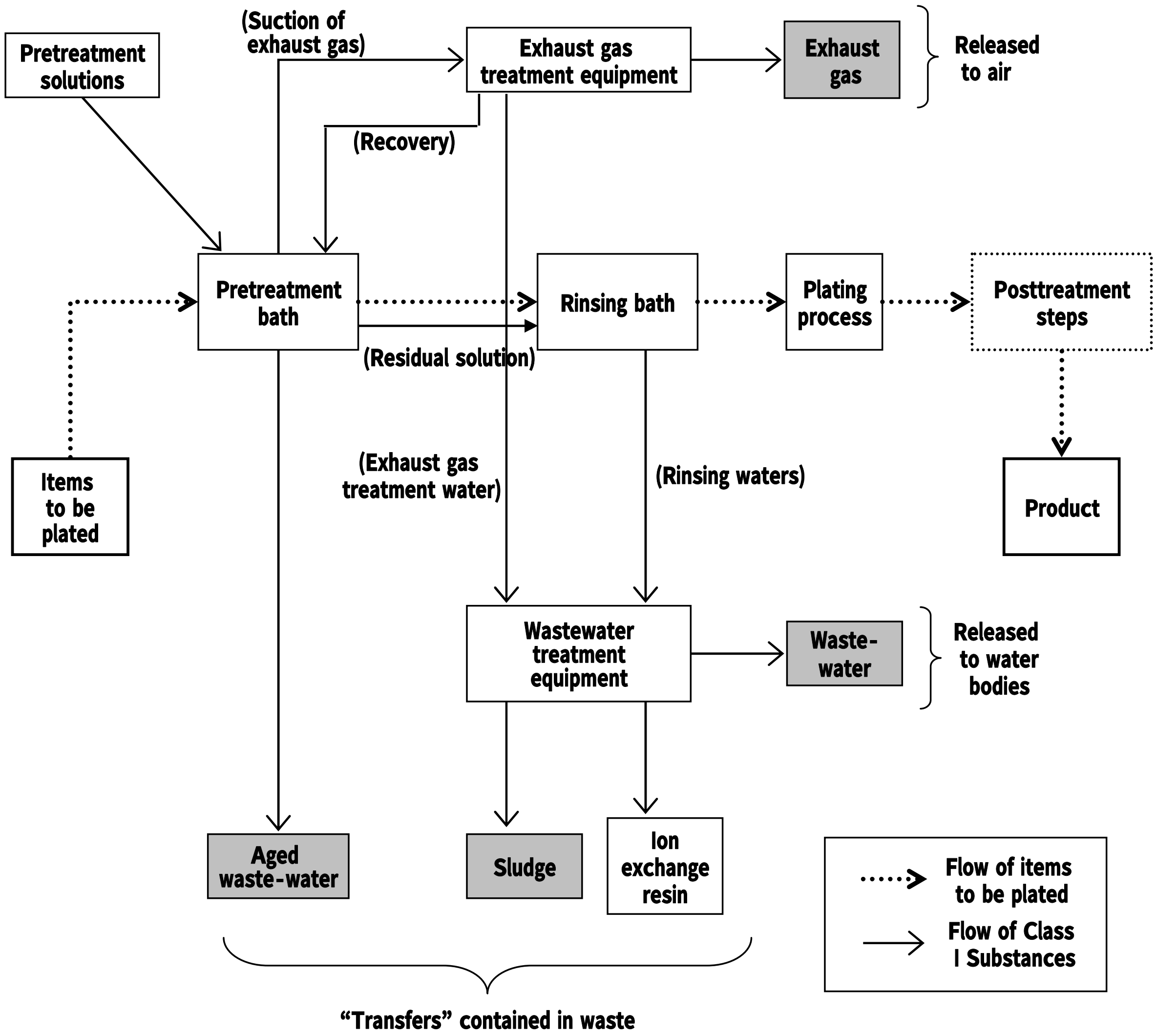

Notes:

Reporting methods for estimating quantities of the Class I Substances vary depending on the streams of wastewater discharged from waste treatment equipment as follows;

1) Releases to water bodies
2) Transfers to sewerage
3) Releases to common wastewater treatment facilities

(2) Pretreatment process

The difference between plating process and pretreatment process is that Class I Substances are not plated on the surface of products.

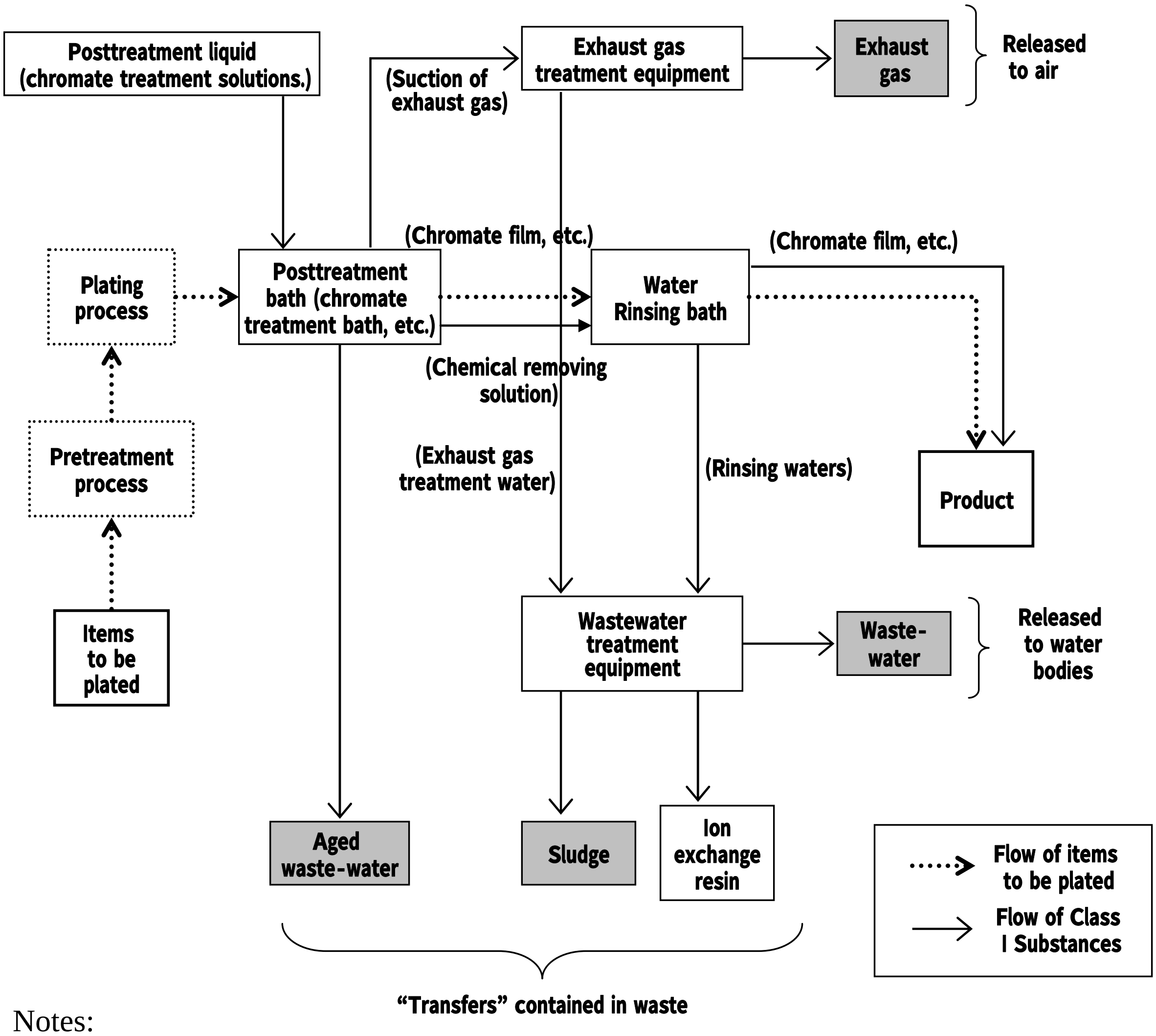



Notes:

Reporting methods for estimating quantities of the Class I Substances contained in wastewater vary depending on the streams of wastewater discharged from waste treatment equipment as follows;

1) Releases to water bodies
2) Transfers to sewerage
3) Releases to commonly shared wastewater treatment facilities

(3) Post-treatment process (Chromate process and others)




Notes:

Reporting methods for estimating quantities of the Class I Substances vary depending on the streams of wastewater discharged from waste treatment equipment as follows;

1) Releases to water bodies
2) Transfers to sewerage
3) Releases to commonly shared wastewater treatment facilities

## 2.2. Items for Calculations

Under the PRTR system, you need to calculate the amount for the following items for each Class I Substance. For the electroplating industry, (3) and (4) of 2.2.2 are not required for calculations.

### 2.2.1. Annual amount of Class I Substances Handled

### 2.2.2. Releases to the environment

(1) Releases to air

The amount of Class I Substances released to air by business facilities.

(2) Releases to water bodies

The amount of Class I Substances released to the water bodies (rivers, lakes and marshes, ocean waters).

(3) Releases to land

The amount of Class I Substances released to on-site land (except for the following (4)).

(4) The amount of Class I Substances contained in waste which is released as on-site landfills.

### 2.2.3. Transfers in waste

(1) Transfers in waste

The amount of Class I Substances in waste which is transferred off-site for disposal. (The waste delivery and disposal services are normally entrusted to waste disposal contractors.)

(2) Transfers to sewerage

The amount of Class I Substances contained in wastewater discharged to sewerage from business facilities.

(3) Transfers to other wastewater treatment facilities

The amount of Class I Substances in waste which is discharged to other wastewater treatment facilities such as wastewater treatment plants commonly shared.

### 2.3. Basic Concept for Calculations

Calculation of the amount of Class I Substances handled, released, and transferred for the following cases should be made by converting chemical compounds of metals, fluoride, and boron into an element and cyanide compounds into CN.

2.3.1. Class I Substances Plated on the Surface of Products in Plating Processes

**Category a**

1. Zinc compounds (water-soluble)
2. Silver and its water-soluble compounds
3. Copper water-soluble salts (except for complex salts)
4. Hexavalent chromium compounds

Features of category a:

◇The amount of Class I Substances contained in the sludge generated during water treatment processes that are handed over to industrial waste dealers are required to be reported as “transfers” in waste. However, for the above chemicals from 1 through 4, hydroxides which are flocculated and precipitated in the water treatment processes become “water insoluble”, they are not PRTR chemicals. Therefore that amount is not included in transfers. However, if any of the Class I Substances is contained in the water of sludge to be handed over to industrial waste dealers, the amount needs to be calculated as transfers.

◇The chemical substances from 1 though 4 are handled in the plating process, and hexavalent chromium compounds are also used in the post-treatment process for the chromate treatment.

(1) Calculating annual amounts of Class I Substances handled

→ Respective facilities should be responsible for ensuring whether the chemical substance is subject to reporting or not.

Annual amount of Class I Substances handled

= Annual amount of electrodes handled + annual amount of purchased raw materials containing Class I Substance × percentage (%) of Class I Substance in raw materials purchased ÷ 100 × conversion factor (CF) for metallic elements

Notes:

1. Annual amount of chemicals handled = Annual amount of chemicals purchased -stock at the end of FY + Initial stock
2. For the chemical content, refer to MSDSs provided by the raw material suppliers. Purchased chemicals with content of less than 1% (0.1% for the Specified Class I Substance) are not subject to the system. Chemical content of 95% or more may be calculated as 100%.
3. When a Class I Substance is contained in several different types of materials, the amount shall be calculated respectively by type of material and then be totaled.
4. The electrode currently being used is silver electrode.

(2) Releases to the Environment

① Releases to the air

Annual amount of exhaust gas generated × Concentration in air (the average analyzed)

or

Annual amount of Class I Substance handled × Emission factor (Note)

Note: It shows the percentage of Class I Substance emitted into the air of the total amount of Class I Substance handled. These factors have been under investigation.

② Releases to water bodies

Annual quantity of wastewater generated × concentration in wastewater (the average value analyzed)

(3) Transfers in waste

① Transfers in waste

(in aged wastewater)

Annual amount of aged wastewater generated × Concentration in the aged wastewater (the average value analyzed)

(in sludge)

Annual amount of sludge generated × Water content in the sludge the average value analyzed) × Concentration in water extracted (the average value analyzed)

or

(Annual amount of Class I Substance handled) × (Content factor in the sludge)

Note: This represents the percentage of Class I Substance contained in sludge transferred off-site of the total annual amount of such substance handled. This factor is currently being under examination.

(Ion exchange resins)

Annual number of columns of ion exchange resins sent for regeneration × amount adsorped per column

② Transfers to sewerage

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

③ Releases to other water treatment facilities

(Only for the case where wastewater is treated at commonly shared wastewater treatment facilities.)

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

**Category b**

1. Nickel compounds
2. Chromium and trivalent chromium
3. Lead and its compounds

Features of Category b:

◇For the Category b chemical substances, the amount of chemicals coagulated and deposited are considered as target Class I Substances. Therefore all the amounts of Class I Substances contained in sludge should be calculated as transfers.

◇These chemical substances are used only in the plating process.

◇For lead and its compounds, the lead electrode is included in the annual amount of Class I Substances handled.

(1) Calculating annual amounts of Class I Substances handled

→ Respective facilities should be responsible for ensuring whether the chemical substance is subject to reporting or not.

Annual amount of Class I Substances handled

= Annual amount of electrodes handled + Annual amount of purchased raw materials containing Class I Substance × content (%) of Class I Substance in raw materials purchased ÷ 100 × (CF for metallic element)

Note: Refer to the notes 1 through 3 of Category a.

(2) Releases to the Environment

① Releases to the air

Annual amount of exhaust gas generated × Concentration in the air (the average analyzed)

or

(Annual amount of Class I Substance handled) × (Emission factor (Note))

Notes:
- This shows the percentage of Class I Substance released to the air to the total annual amount of Class I Substance handled.
- This factor is now being under examination.

② Releases to water bodies

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

(3) Transfers in Waste

① Transfers in waste

(In aged wastewater)

Annual amount of aged wastewater generated ×Concentration in aged wastewater (the average analyzed)

(In sludge)

Annual amount of sludge generated × content (the average value analyzed)

or

Annual amount of Class I Substance handled × Content factor (the average value analyzed)

or

Annual amount of Class I Substance handled × Content factor (Notes)

Notes:
- This shows the percentage of Class I Substance contained in sludge transferred off-site to the total annual amount of Class I Substance handled.
- This factor is now being under examination.

(Ion exchange resins)

Annual number of “ion exchange resin column” sent for regeneration × amount adsorbed per column

② Transfers to sewerage

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

③ Transfers to other wastewater treatment facilities

(Only for the case where wastewater is treated at commonly shared wastewater treatment facilities.)

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

**Category c**

1 Nickel

(1) Calculating Annual Amounts of Class I Substances Handled

→ Respective facilities should be responsible for ensuring whether the chemical substance is subject to reporting or not.

Annual amount of nickel handled = Annual amount of electrodes handled

Note: Refer to the Note1 of Category a.

(2) Releases to the Environment

① Releases to the air

Zero (none)

② Releases to water bodies

Zero (none)

(3) Transfers in waste

Zero (none)

2.3.2. Chemicals not Plated on the Surface of Products in Plating Processes

**Category d** (=chlorinated organic solvents):

1. Trichloroethylene
2. Dichloromethane (Synonym for methylene chloride)
3. Tetrachloroethylene

(1) Calculating the Annual Amount of Class I Substance Handled

→ Respective facilities should be responsible for ensuring whether the chemical substance is subject to reporting or not.

Annual amount of Class I Substance handled

= Annual amount of handled raw materials including Class I Substance

× Percentage of (%) of the Class I Substance to amount of raw materials handled÷100

Note: Refer to Note 1 for Category a.

(2) Releases to the Environment

① Releases to air

Annual amount of Class I Substance handled －Releases to water bodies－Transfers in waste

or

Annual amount of the Class I Substance handled × Emission factor (Note)

Notes: ・This factor shows the percentage of the Class I Substance released to air of the total annual amount of Class I Substance handled
・This factor is being under examination.

② Releases to water bodies
Annual amount of wastewater generated × concentration in wastewater (the average value analyzed)

(3) Transfers in Waste
① Transfers in waste
(In aged wastewater)
Annual amount of aged wastewater generated × Concentration in aged wastewater (the average value analyzed)

(In sludge)
Annual amount of sludge generated × Water content (the average value analyzed) × Concentration in water (the average value analyzed)
or
Annual amount of Class I Substance handled × Content factor in sludge
(Notes)
This represents the percentage of Class I Substance contained in sludge transferred off-site to the total annual amount of Class I Substance handled
This factor is now being under examination.

② Transfers to sewerage
Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

③ Transfers to other commonly shared wastewater treatment facilities
(Only for the case where wastewater is treated at commonly shared wastewater treatment facilities.)
Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

**Category e**
1 Inorganic cyanides (except for complex salts and cyanates)

Features of the chemical substance in this category

◇Inorganic cyanides used in plating solutions typically form complex salts with metals, which help deposition of target metals in equilibrium with alkali (or acid). Please note that wastewater used for rinsing must be treated using oxidation decomposition such as alkaline chlorination technology of cyanide.

◇Inorganic cyanides decompose into nitrogen gas and carbonate through the decomposition process via cyanic acid by wastewater treatment. When the metals are precipitated and separated as hydroxides, they are not contained in any form other than "complex salts and cyanates" in the air, wastewater or sludge. Therefore no inorganic cyanides (Class I Substance) is contained in wastewater or sludge which are generated from wastewater treatment.

(1) Calculating the Annual Amount of the Substance Handled

→ Respective facilities should be responsible for ensuring whether the chemical substance is subject to reporting or not.

"Annual amount of the Substance handled"

= Annual amount of purchased raw materials including the Substance
× Percentage (%) of the Substance to the total raw materials purchased
÷100 × Conversion factor to CN

Note: Refer to Notes1 through 3 for Category a.

(2) Releases to the Environment

① Releases to air

Annual amount of exhaust gas generated × Concentration in air (the average value analyzed)

or

Annual amount of the Substance handled × emission factor to air (Note)

Notes:
- This factor shows the percentage of the Substance released to air to the total annual amount of the Substance handled.
- This factor is now being under investigation.

② Releases to water bodies

Zero (None)

(3) Transfers Contained in Waste

① Transfers in waste

(In aged wastewater)

Annual amount of aged wastewater generated × Concentration in aged wastewater (the average value analyzed)

(In sludge)

Zero (None)

② Transfers to sewerage

Zero (none)

③ Transfers to other commonly shared wastewater treatment facilities

(Only for the case where wastewater is treated at the commonly shared wastewater treatment facilities.)

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

**Category f**

1. Hydrogen fluoride and its compounds
2. Boron and its compounds

(1) Calculating Annual Amount of the Substance Handled

→ Respective facilities should be responsible for ensuring whether the chemical substance is subject to reporting or not.

"Annual amount of the Substance handled"
= Annual amount of purchased raw materials containing the Substance
× Percentage (%) of the Substance to raw materials purchased
÷100 × Conversion factor to metallic element

Note: Refer to Notes 1 through 3 for Category a.

(2) Releases to the Environment

① Releases to air

Annual amount of exhaust gas generated × Concentration re in air (the average value analyzed)

or

Annual amount of the Substance handled × emission factor to air (Notes)

Notes:
- This factor shows the percentage of the Substance released to air to the total annual amount of the Substances handled.
- This factor is now being under investigation.

② Releases to water bodies

Annual amount of wastewater × Concentration in wastewater (the average value analyzed)

(3) Transfers Contained in Waste

① Transfers in waste

(In aged wastewater)

Annual amount of aged wastewater generated × Concentration in aged wastewater (the average value analyzed)

(In sludge)

Annual amount of sludge generated × Water content (the average value analyzed) × Concentration in water (the average value analyzed)

or

Annual amount of the Substance handled × Content factor in sludge (Notes)

Notes:
- This factor shows the percentage of the Substance contained in sludge transferred off-site to the total annual amount of the Substances handle.
- This factor is now being under study.

(Ion exchange resins)

Annual number of "ion exchange resin columns" sent for regeneration × amount adsorbed per column

② Transfers to sewerage

Annual amount of wastewater generated × Concentration in wastewater (the average value analyzed)

③ Transfers to other wastewater treatment facilities

(Only for the case where wastewater is treated at commonly shared wastewater treatment facilities.)

Annual amount of wastewater generated ×Concentration in wastewater (the average analyzed)

## 3. Calculation Examples by Chemical Substance

Chapter 2 categorizes the major Class I Designated Chemical Substances into a to f depending on the type of calculation procedure and describes the basic concept for respective calculations.

This chapter shows specific examples of typical calculations for Class I Substances by category. Descriptions are made on the model facilities which release wastewater to water bodies. The amount of listed Class I Substances contained in wastewater need to be reported as “releases to the environment.”

On the other hand, when wastewater is released to sewerage or other wastewater treatment facilities (commonly shared plants), the amount of listed Class I Substances contained in wastewater can be calculated by the same procedure used for those released to water bodies. In this case, however, the category for reporting will be “transfers in waste.”

For conversion factors described in each calculation example, refer to Table.

### 3.1. Zinc Compounds (water-soluble) Category a

Category a includes:

1. Zinc compounds (water-soluble)
2. Silver and its water soluble compounds
3. Copper water-soluble salts (except for complex salts)
4. Hexavalent chromium compounds

Calculations for the above chemical substances of 2 and 3 can be performed by using the same procedure.

As for hexavalent chromium, calculation shall be made by referring to Chapter 2 because mist in a very small quantity is generated.

Since there are many cases where this chemical is recovered in the ion exchange resin columns, the calculations for these cases shall be performed also by referring to Chapter 2.

#### 3.1.1. Calculation Example (Model Facility A)

(1) Annual amount handled

The annual amount of 2,400 kg of zinc chloride (corresponding to water-soluble zinc compounds) is used as an ingredient of zinc plating solution.

(2) Wastewater

| | |
|---|---|
| Daily amount of wastewater generated: | 100 $m^3$ (released to water bodies) |
| Number of operating days per year: | 200 days |
| Concentration of zinc in wastewater: | zinc 0.5 mg/liter |

(3) Sludge

Annual amount of sludge generated: 20,000 kg (sent to industrial waste contractors)
Concentration of zinc in sludge: 2 mg/liter
Water content 70 %

(4) Aged wastewater
Annual aged wastewater generated: 5,000 liters (sent to industrial waste contractors)
Concentration of zinc chloride in aged wastewater: 50 g/liter

3.1.2. Calculation Procedure

(1) Annual amount of zinc chloride handled

Chemical compounds shall be converted into metal elements.

Annual amount handled = Annual amount of zinc chloride × Conversion factor
= 2,400 kg × 0.480
= 1,152 kg

If the annual amount handled is 1,152 kg, reporting is not required for years 2001 and 2002, which is required in and after 2003.

(2) Releases to environment

Zinc chloride, which is not volatile, is not released to air. So the releases to the environment mean the amount released only to water bodies.

Releases to the environment = Releases to water bodies
= Annual amount of wastewater generated × Concentration of zinc chloride in wastewater
= 100 $m^3$/day × 200 days/year × 1000 $m^3$/liter × 0.5 mg/liter
= 10,000,000 mg
= 10 kg

(3) Transfers contained in aged wastewater

Transfers of zinc chloride take place contained in sludge and aged wastewater. So the amounts for both cases are calculated respectively before totaling.

Transfers in sludge = Annual amount of sludge generated × Water content × Concentration in sludge
= 20,000 kg × 0.7 × 2 mg/liter
= 28,000 mg
= 0.028 kg

Transfers in aged wastewater

= Annual amount of aged wastewater generated × Concentration of zinc chloride in aged wastewater

= 5,000 liters × 50 g/liter × 0.48 (CF)

= 120,000 g

= 120 kg

The transfers in waste = (Transfers in sludge) + (Transfers in aged wastewater)

= 0.028 kg + 120 kg

= 120,028 kg

### 3.2. Nickel Compounds (Category b)

Category b includes:

1. Nickel compounds
2. Chromium and trivalent chromium compounds
3. Lead and its compounds

The above chemicals of 2 and 3 can be calculated using the same procedure of 1.

#### 3.2.1. Calculation Example (Model Facility B)

(1) Annual amount handled

The total amount of nickel sulfate of 2,500 kg and nickel chloride of 500 kg is annually used as ingredients of nickel electroplating solution (Both substances correspond to "nickel compounds.")

(2) Wastewater

| | |
|---|---|
| Daily amount of wastewater generated: | 20 $m^3$ (released to water bodies) |
| Number of operation days per year: | 200 days |
| Concentration in wastewater: | nickel 5 mg/liter |

(3) Sludge

| | |
|---|---|
| Annual amount of sludge generated: | 10,000 kg (sent to industrial waste contractors) |
| Content in sludge: | nickel 10 g/kg |
| Water content: | 70% |

(4) Aged wastewater

| | |
|---|---|
| Annual amount of aged wastewater generated: | 5,000 liters (sent to industrial waste contractors) |
| Concentrations in aged wastewater: nickel sulfate: | 240 g/liter |
| nickel chloride: | 45 g/liter |

#### 3.2.2. Calculation Procedure

(1) Annual amount handled

Convert the annually handled amounts of nickel sulfate and nickel chloride into a metallic element respectively and aggregate them.

Annual amount handled

= (Annual amount of nickel sulfate handled) × CF + (Annual amount of nickel chloride handled) × CF

= 2,500 kg × 0.223 + 500 kg × 0.247

= 557.5 kg + 123.5 kg

= 681 kg

(2) Releases to the environment

Nickel sulfate and nickel chloride, which are not volatile, are not released to air. So the releases to the environment mean the amount released only to water bodies.

Releases to the environment

= (Releases to water bodies)

= (Annual amount of wastewater generated) × (Concentration in wastewater)

= 20 $m^3$/day × 200 days/year × 1,000 $m^3$/liter × 5 mg/liter

= 20,000,000 mg

= 20 kg

(3) Transfers contained in waste

Transfers of these substances take place contained in sludge and aged wastewater. So the amounts for both cases are calculated respectively before totaling.

Amounts of nickel sulfate and nickel chlorides which are transferred contained in aged wastewater must be calculated respectively before totaling.

Transfers in sludge = (Annual amount of sludge generated) × (Content in sludge)

= 10,000 kg × 10 g/kg

= 100,000 g

= 100 kg

Transfers contained in aged wastewater

= (Annual amount of aged wastewater generated) × (Concentration in aged wastewater)

= 5,000 liter × 240 g/liter × 0.223 (CF) + 5,000 L × 45 g/liter × 0.247 (CF))

= 267,600 g + 55,575 g

= 323,175 g

= 323.175 kg

The Transfers contained in waste

= (Transfers in sludge) + (Transfers in aged wastewater)

= 100 kg + 323.175 kg

= 423.175 kg

### 3.3. **Nickel (Category c)**

#### 3.3.1. Calculation Example (Model Facility C)

(1) Annual amount handled

The amount of 6,000 kg of nickel is used annually as an electrode for electroplating.

(2) Wastewater

Daily amount of wastewater generated: 20 $m^3$ (released to water bodies)
Number of operation days per year: 200 days
Concentration in wastewater: nickel 5 mg/liter

(3) Sludge

Annual amount of sludge generated: 10,000 kg (sent to industrial waste contractors)
Content in sludge: nickel 10g/kg
Water content: 70%

(4) Aged wastewater

Annual amount of aged wastewater generated: 5,000 liters (sent to industrial waste contractors)
Concentration in aged wastewater: nickel sulfate 240 g/liter

#### 3.3.2. Calculation Procedure

(1) Annual amount handled

The amount of nickel electrode used is equivalent to the annual amount handled.

Annual amount handled = (Annual amount of nickel electrode used)
= 6,000 kg

(2) Releases to the environment

No nickel is released to the air nor to water bodies. Therefore releases to the environment are determined as zero.

(3) Transfers contained in waste

No nickel is transferred contained in sludge nor in wastewater. Therefore transfers contained in waste are determined as zero

### 3.4. Trichloroethylene (Category d)

Category d includes:

1. Trichloroethylene
2. Dichloromethane (methylenechloride)
3. Tetrachloroethylene

The above chemicals of 2 and 3 can be calculated using the same procedures of 1.

#### 3.4.1. Calculation Example (Model Facility D)

(1) Annual amount handled

Trichloroethylene of 6,000 kg is used annually as a pretreatment agent (degreasing agent) for plating.

(2) Wastewater

| | |
|---|---|
| Daily amount of wastewater: | 20 $m^3$ (released to water bodies) |
| Number of operation days per year: | 200 days |
| Concentration in wastewater: | trichloroethylene 0.03 mg/liter |

(3) Sludge

| | |
|---|---|
| Annual amount of sludge generated: | 10,000 kg (sent to industrial waste contractors) |
| Concentration in sludge: | trichloroethylene – less than 0.03 mg/liter |
| Water content: | 70% |

(4) Aged waste solution

Annual amount of aged waste solution generated: 1,000 kg (sent to industrial waste contractors)

#### 3.4.2. Calculation Procedure

(1) Annual amount handled

Annual amount handled = 6,000 kg

(2) Releases to the environment

The releases of these substances to the environment mean those to the air and water bodies. They are calculated separately as follows:

Releases to water bodies = (Annual amount of wastewater) × (Concentration in wastewater)

= 20 $m^3$/day × 200 days/year × 1,000 liters/$m^3$ × 0.03 mg/liter

= 120,000 mg

= 0.12 kg

Releases to air = (Annual amount handled) – (Releases to water bodies) –

(Transfers in waste)

= 6,000 kg – 0.12 kg – 1,000 kg

= 4,999.88 kg

(3) Transfers contained in waste

Actual measuring shows that there is no transfer contained in sludge. Therefore the transfers contained in waste represent the transfers contained only in aged waste solution.

The chemical contained in the aged waste solution is 100 percent of trichloroethylene.

Transfers contained in waste

= (Transfers contained in aged waste solution)

= 1,000 kg

### 3.5. Inorganic Cyanides (except complex salts and cyanates) (Category e)

#### 3.5.1. Calculation Example (Model Facility E)

(1) Annual amount handled

The amount of 1,900 kg of sodium cyanide (corresponding to inorganic cyanides (except complex salts and cyanates) is annually used as an ingredient of zinc plating solution.

(2) Concentration of CN in the exhaust gas less than 0.01 mg/$m^3$

(3) Wastewater

| | |
|---|---|
| Daily amount of wastewater: | 50 $m^3$ (released to water bodies) |
| Number of operation days per year: | 200 days |
| Concentration in wastewater: | 0.05 mg/liter |

(4) Sludge

| | |
|---|---|
| Annual amount of sludge generated: | 10,000 kg (sent to industrial waste contractors) |
| Concentration of cyanates in sludge: | less than 0.01 mg/liter |
| Water content: | 70% |

(5) Aged wastewater

| | |
|---|---|
| Annual amount of wastewater effluent generated: | 1,000 liters (sent to industrial waste contractors) |
| Concentration: | sodium cyanide 45 g/liter |

#### 3.5.2. Calculation Procedure

(1) Annual amount handled

The annual amount of sodium cyanide handled is converted by using the conversion factor into the CN amount.

Annual amount handled = (Annual amount of sodium cyanide handled)
× (Conversion factor)
= (1,900 kg × 0.531)
= 1008.9 kg

If the annual amount of sodium cyanide is1008.9 kg, reporting is not required for 2001 and 2002, but that is required for and after 2003.

(2) Releases to the environment

Actual measuring shows that there is no release from exhaust gas after its treatment. Cyanides which are contained in a very small amount in wastewater after treatment are complex salts, which do not correspond to inorganic cyanides (except complex salts and cyanates). Therefore it is decided that there is no release to the water bodies i.e. there is no release to the environment.

(3) Transfers contained in waste

Cyanides which are contained in a very small amount in sludge after treatment are complex salt, which do not correspond to inorganic cyanides (except complex salts and cyanates). Therefore it is decided that there is no transfer in sludge. So, transfers in waste represent only the transfers in aged wastewater.

Transfers contained in waste = (Transfers contained in aged wastewater)
= (Annual amount of aged wastewater generated) × Concentration in waste
= 1000 liter × 45 g/liter × 0.531 (CF)
= 23,895 g
= 23.895 kg

### 3.6. Hydrogen Fluoride and Its Water-Soluble Salts (Category f)

Category f includes:

1. Hydrogen fluoride and its water-soluble salts
2. Boron and its compounds

Calculations for the above chemicals 1 and 2 can be performed using the same procedure.

#### 3.6.1. Calculation Example (Model Facility F)

(1) Annual amount handled

Mixed solution (content of hydrogen fluoride 60 g/liter) of 18,000 liters is used annually as a pretreatment agent for plating.

(2) Wastewater

Daily amount of wastewater: 20 $m^3$ (released to water bodies)
Number of operation days per year: 200 days
Concentration of hydrogen fluoride: 30 mg/liter

(3) Sludge

Annual amount of sludge generated: 10,000 kg (sent to industrial waste contractors)
Concentration of fluorine in extracted water: less than 20 mg/liter
Water content: 70%

(4) Aged wastewater

Annual amount of wastewater effluent generated: 10,000 kg (sent to industrial waste contractors)
Concentration of hydrogen fluoride in wastewater 60 g/liter

#### 3.6.2. Calculation Procedure

(1) Annual amount of hydrogen fluoride handled

First calculate the amount of hydrogen fluoride in the mixed solution and then convert it into the amount of fluorine using the conversion factor.

Annual amount handled

= Annual amount of mixed solution handled × Content × conversion factor
= 18,000 liters × 60 g/liter × 0.950
= 1,026,000 g
= 1,026 kg

If the annually handled amount of hydrogen fluoride is 1,026 kg, reporting is not required for 2001 and 2002, but that is required in and after 2003.

(2) Releases to the environment

Hydrogen fluoride is not released to the air, because its volatility is lost when treated with lime and/or calcium chloride. Therefore releases to the environmental mean those only to water bodies.

Releases to the environment

= (Releases to water bodies)

= (Annual amount of wastewater) × (Concentration in wastewater)

= 20 $m^3$/day × 200 days/year × 1,000 $m^3$/liter × 30 mg/liter

= 120,000,000 mg

= 120 kg

(3) Transfers Contained in Waste

The transfers in waste represent transfers contained in sludge and aged wastewater. They must be calculated respectively as follows before totaling.

Transfers in sludge

= (Annual amount of sludge generated) × (Water content) × Concentration in extracted water.

= 10,000 kg × 0.7 × 20 mg/liter

= 140,000 mg

= 0.14 kg

Transfers in aged wastewater = (Annual amount of aged wastewater generated) × Concentration in aged wastewater

= 10,000 liters × 60 g/liter × 0.95 (CF)

= 570,000 g

= 570 kg

Transfers contained in waste

= (Transfers in sludge) + (Transfers in wastewater)

= 0.14 kg + 570 kg

= 570.14 kg

REFERENCE:

## Conversion Factors for Metallic Compounds to Metallic Element

Main Class I Substances in this industry are shown in the following table.

"Water solubility" is designated as one mass % or more of the compounds soluble in neutral water at normal temperature.

| Name of substances | Example of individual substance | Composition formula | Molecular weight | Total of atomic weights of metals (M) | Conversion factor (M/molecular weight) | Reporting not required (x) | Reason why reporting not required | Covered by other Class I Substances |
|---|---|---|---|---|---|---|---|---|
| Zinc compounds (water soluble) | Zinc chloride | $ZnCl_2$ | 136.3 | 65.4 | 0.480 | | | |
| | Zinc sulfate | $ZnSO_4 \cdot 7H_2O$ | 287.5 | 65.4 | 0.227 | | | |
| | Zinc oxide | $ZnO$ | 81.4 | 65.4 | 0.803 | × | Water solubility: less than 1% | |
| | Zinc cyanide | $Zn(CN)_2$ | 117.4 | 65.4 | 0.557 | × | Water solubility: less than 1% | Covered as inorganic cyanides (except complex salts and cyanate) |
| Silver and its water Soluble compounds | Silver | Ag | 107.9 | 107.9 | 1.000 | | | |
| | Silver nitrate | $AgNO_3$ | 169.9 | 107.9 | 0.635 | | | |
| | Silver chloride | AgCl | 143.3 | 107.9 | 0.753 | × | Water solubility: less than 1% | |
| | Silver cyanide | AgCN | 133.9 | 107.9 | 0.806 | × | Water solubility: less than 1% | Covered as inorganic cyanides (except complex salts and cyanate) |
| | Potassium silver cyanide | $KAg(CN)_2$ | 199.0 | 107.9 | 0.542 | | | Covered as inorganic cyanides (except complex salts and cyanate) |
| Copper water-soluble salts (except complex salts) | Copper sulfate | $CuSO_45H_2O$ | 249.7 | 63.5 | 0.255 | | | |
| | Copper pyrosulfate | $Cu_2P_2O_7 \cdot 3H_2O$ | 355.2 | 127.0 | 0.358 | × | Water solubility: less than 1% | |
| | Copper cyanide | CuCN | 89.6 | 63.5 | 0.709 | × | Water solubility: less than 1% | Covered as inorganic cyanides (except complex salts and cyanate) |
| | Cupric fluoroborate | $Cu(BF_4)_2$ | 237.2 | 63.5 | 0.268 | | | Covered as boron and its compounds. |
| Hexavalent chromium | Chromium oxide | $CrO_3$ | 100.0 | 52.0 | 0.520 | | | |

| Name of substances | Example of individual substance | Composition formula | Molecular weight | Total of atomic weights of metals (M) | Conversion factor (M/molecular weight) | Reporting not required (x) | Reason why reporting not required | Covered by other Class I Substances |
|---|---|---|---|---|---|---|---|---|
| Nickel Compounds | Nickel sulfate | $NiSO_4 \cdot 6H_2O$ | 262.9 | 58.7 | 0.223 | | | |
| | Nickel dichloride | $NiCl_2 \cdot 6H_2O$ | 237.7 | 58.7 | 0.247 | | | |
| | Nickel cyanide | $Ni(CN)_2 \cdot 4H_2O$ | 182.8 | 58.7 | 0.321 | | | Covered as inorganic cyanides (except complex salts and cyanate) |
| Chromium and trivalent chromium | Chromium oxide | $Cr_2O_3$ | 152.0 | 104.0 | 0.684 | | | |
| Lead and its compounds | Lead | Pb | 207.2 | 207.2 | 1.000 | | | |
| | Lead fluoroborate | $Pb(BF_4)_2$ | 380.8 | 207.2 | 0.544 | | | Covered as boron and its compounds. |
| Inorganic cyanides (except complex salts and cyanate) | Sodium cyanide | NaCN | 49.0 | 26.0 | 0.531 | | | |
| | Potassium cyanide | KCN | 65.1 | 26.0 | 0.400 | | | |
| | Gold cyanide | AuCN | 223.0 | 26.0 | 0.117 | | | |
| | Silver cyanide | AgCN | 133.9 | 26.0 | 0.194 | | | Not covered as silver and its water-soluble compounds |
| | Zinc cyanide | $Zn(CN)_2$ | 117.4 | 52.0 | 0.443 | | | Not covered as zinc compounds (water-soluble) |
| | Copper cyanide | CuCN | 89.6 | 26.0 | 0.290 | | | Not covered as copper water-soluble salts (except complex salt) |
| | Gold cyanide | $KAu(CN)_2$ | 288.1 | 52.0 | 0.180 | | | |
| | Potassium silver cyanide | $KAg(CN)_2$ | 199.0 | 52.0 | 0.261 | | | Covered as silver and its water-soluble compounds |
| | Nickel cyanide | $Ni(CN)_2 \cdot 4H_2O$ | 182.8 | 52.0 | 0.284 | | | Covered as nickel compounds |

| Name of substances | Example of individual substance | Composition formula | Molecular weight | Total of atomic weights of metals (M) | Conversion factor (M/molecular weight) | Reporting not required (x) | Reason why reporting not required | Covered by other Class I Substances |
|---|---|---|---|---|---|---|---|---|
| Hydrogen fluoride and its water-soluble salts | Hydrogen fluoride | HF | 20.0 | 19.0 | 0.950 | | | |
| | Fluoroboric acid | $HBF_4$ | 87.8 | 76.0 | 0.865 | × | Not covered as hydrogen fluoride and its water-soluble salts. | Covered as boron and its compounds |
| | Cupric fluoroborate | $Cu(BF_4)_2$ | 237.2 | 152.0 | 0.641 | × | Not covered as hydrogen fluoride and its water-soluble salts. | Covered as boron and its compound and copper and its water-soluble |
| | Stannous fluoroborate | $Sn(BF_4)_2$ | 292.3 | 152.0 | 0.520 | × | Not covered as hydrogen fluoride and its water-soluble salts. | Covered as boron and its compounds |
| | Lead fluoroborate | $Pb(BF_4)_2$ | 380.8 | 152.0 | 0.399 | × | Not covered as hydrogen fluoride and its water-soluble salts. | Covered as boron and its compounds and lead and its |
| Boron and its compounds | Boric acid | $H_3BO_3$ | 61.8 | 10.8 | 0.175 | | | |
| | Fluoroboric acid | HBF | 87.8 | 10.8 | 0.123 | | | Not covered as hydrogen fluoride and its water-soluble salts |
| | Cupric fluoroborate | $Cu(BF_4)_2$ | 237.2 | 21.6 | 0.091 | | | Covered as copper water-soluble salts |
| | Stannous fluoroborate | $Sn(BF_4)_2$ | 292.3 | 21.6 | 0.074 | | | Not covered as hydrogen fluoride its water-soluble salts |
| | Lead fluoroborate | $Pb(BF_4)_2$ | 380.8 | 21.6 | 0.057 | | | Covered as lead and its compounds. Not covered as hydrogen fluoride |