PRTR Estimation Manual

17. Non-Ferrous Metal Casting Industry

January 2001
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Japan Non-ferrous Alloy Casting Association

Contents

1. The PRTR in the non-ferrous metal casting industry

1.1 Businesses required to report under the PRTR in the non-ferrous metal casting industry

The non-ferrous metal casting industry is roughly classified into the copper-alloy-casting manufacturing industry and the aluminum-alloy-casting manufacturing industry. According to the industrial statistics of 1998, the number of businesses of the non-ferrous metal casting industry is 905, of which 169 are the businesses with 20 employees or more (of these are 51 copper-alloy-casting manufacturing facilities) and three are with 300 employees or more. The biggest business in this industry branch is a business with a little over 500 employees. Consequently the non-ferrous casting industry is an industrial branch with small-sized business as a whole.

Many of the businesses with 21 employees or more are expected to fall under the PRTR, because some of main raw materials used in the copper-alloy-casting industry contain the Class I Designated Chemical Substances. With respect to sub-materials, although some of them contain Class I Designated Chemical Substances, they are not required to be reported in the most cases, considering the amounts used and the contents of the Class I Designated Chemical Substances in them.

Although classification is slightly different from that used in the PRTR designated business, the number of business required to report under the PRTR in the non-ferrous metal casting industry is estimated to be approximately 50, considering that there are 51 businesses with 20 employees or more in the copper-alloy-casting manufacturing industry.

1.2 Non-ferrous metal casting processes

The outline of a non-ferrous metal casting process and releases and transfers of main raw materials is shown in Fig.1.

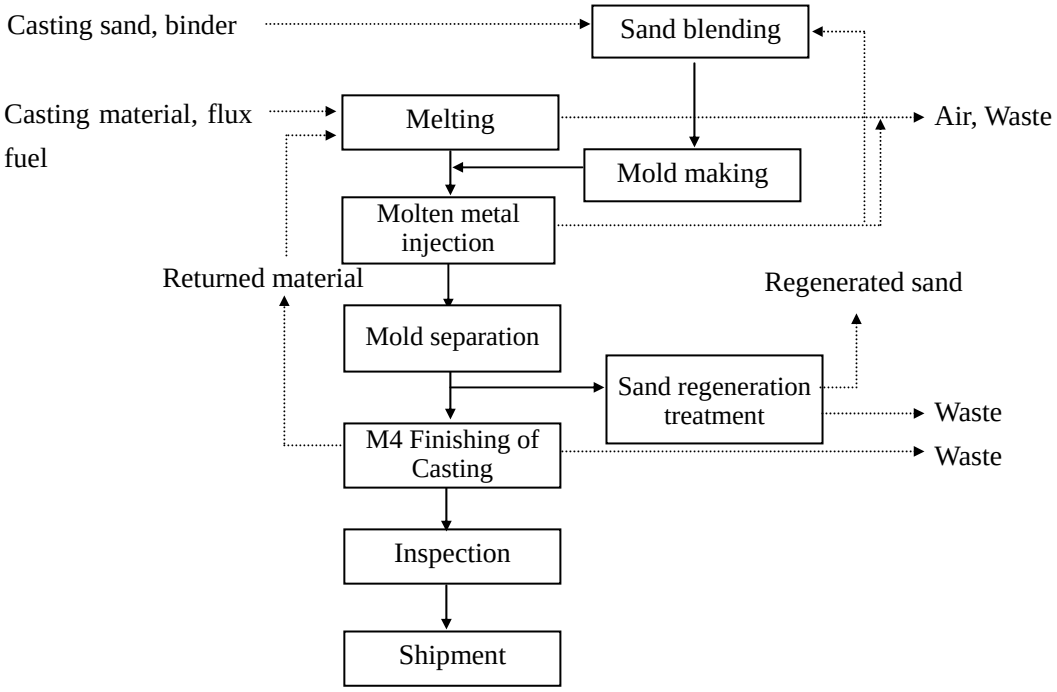

Fig. 1 Non-ferrous metal casting process and releases/transfers

1.3 Class I Designated Chemical Substances handled in non-ferrous metal casting manufacturing processes

The Class I Designated Chemical Substances contained in raw materials etc., used in non-ferrous metal cast manufacturing processes are shown in Table 1.

Table 1 The Class I Designated Chemical Substances handled in non-ferrous metal casting manufacturing processes

Cabinet Order No. *4	Judgment criteria of designated facility		Class I Designated Chemical Substance	Raw materials etc. containing the substance
	Content	Amount handled *5		
68	1% or more	1T or more	Chromium and trivalent chromium compounds	Casting materials
178			Selenium and its compounds	
230			Lead and its compounds	
231			Nickel	
※ 294	0.1% or more	0.5T or more	Beryllium and its compounds	
311	1% or more	1T or more	Manganese and its compounds	
304			Boron and its compounds	Fluxes
224			1,3,5-trimethylbenzene	Binders
266			Phenol	

NOTE

*4: The substance marked with ※ is the Specified Class I Designated Chemical Substance. (Carcinogenic substance)

*5: In the first 2 years, 5 tons or more

There is a question whether the zinc white (zinc oxide) contained in the molten dust of bronze casting etc. belongs to the Class I Designated Chemical Substance required to be reported. The answer is No. Because only the water-soluble compounds of zinc are required to be reported, and zinc oxides are not water-soluble. Similarly, only the water-soluble copper salts (except complex salts) are required to be reported, consequently copper oxides do not belong to the target substances. Examples of copper compounds and zinc compounds targeted under the PRTR are shown in Table 2.

Table 2　Examples of copper compounds and zinc compounds required to be reported under the PRTR

Cabinet Order No.	Class I Designated Chemical Substance *6	Examples
1	Water-soluble zinc compounds	Zinc chloride
207	Water-soluble copper salts (except complex salts)	Copper (II) chloride (anhydride)
		Copper (II) chloride (dihydrate)
		Copper (II) borofluoride
		Copper sulfate (anhydride)
		Copper sulfate (pentahydrate)

Note *6:"Water-soluble" means the state that a substance dissolves in neutral water at the 1 % by mass or more at room temperature.

1.4 The procedures in accordance with the PRTR Law

In accordance with the PRTR Law, each business must judge whether it could be the facility required to report under the PRTR system. When fulfilling the requirements for the PRTR system, the business must be prepared to establish appropriate techniques for estimating releases and transfers of the Class I Designated Chemical Substances. A business which does not fulfill the requirements is also expected to understand the types and the amount of the chemicals contained in the raw materials used in the business. In this section, the procedures for the non-ferrous metal casting industry will be explained. However, in the case where a business operates with various industrial branches, the business is required to follow the similar procedures for these branches.

(1) Judgment of whether a facility belongs to the facility required to report under the PRTR system.

The following are the procedures for judging whether a facility belong to the facility required to report under the PRTR system. The facility required to report must fulfill all of the requirements, 1) to 5).

1) Are you fall under the industrial category under the PRTR system?
The non-ferrous metal casting industry naturally falls with the target industry, because all of manufacturing industries are designated as the industries under the PRTR system.

2) Do you have 21 or more full-time employees?
As for the 2001 fiscal year, judgment is made based on the number of the full-time employees as of April 1, 2001.
A business with 20 or less full-time employees is not regarded as the facility required to report. However, it is also encouraged to take the procedures below, 3), 4), and 5).

3) Are you using raw materials etc., containing the Class I Designated Chemical Substances?
List the raw materials used in the manufacturing processes in your factory.
Identify the components of the raw materials by using the MSDS when the components are unidentified. In non-ferrous metal casting manufacturing processes, the following raw materials etc. are used: casting materials, fluxes, mold binders, coating materials on mold, and resin for repairing molds.

4) Do the raw materials contain 1 % or more of the Class I Designated Chemical Substances (carcinogenic substances: 0.1% or more)?

List the raw materials and the substances when the raw materials contain the designated amount or more of the Class I Designated Chemical Substances.

5) Do you use annually 5 tons or more of the Class I Designated Chemical Substances? (After a two-year transitional measures: 1 ton. Carcinogenic substances: 0.5 tons)

Add up the annual amounts used for each of the Class I Designated Chemical Substances. When two or more of raw materials etc. contains, the same kind of Class I Designated Chemical Substances, total the amounts of the substances.

(2) Estimation and report of the amount of releases and transfers of Class I Designated Chemical Substances.

As the 1st PRTR report, the businesses required to report should estimate releases and transfers of the Class I Designated Chemical Substances used from April 2001 to March 2002. By June 30, 2002, they should submit the results in the form of PRTR to the minister having jurisdiction over the industry via a local government.

2. Examination of individual raw materials

Among materials etc., used in non-ferrous metal casting processes, casting materials, fluxes, self-hardening mold binders, coating materials on mold, resin for mold repairing could contain the Class I Designated Chemical Substances. When casting materials designated by the PRTR system are used, the amount of the Class I Designated Chemical Substances handled is possible to exceed the designated value, 5 tons (after two years transitional period: 1 ton). However, there seems to be few possibilities that the amounts of raw material other than the casting materials exceed the designated value because the amounts of the other raw materials used are extremely small, considering the contents of the chemicals contained.

In this section, casting materials, and fluxes and self-hardening mold binders both of which are used in relatively large amount, will be examined.

2.1 Casting materials

2.1.1 Casting materials required to be reported under the PRTR

Of the copper alloy castings authorized in Japanese Industrial Standards (JIS), the types of those containing 1% or higher of the Class I Designated Chemical Substances under the PRTR and the contents of the substances are shown in Table 3. No aluminum alloy castings which are authorized as JIS standards contain 1% or more of Class I Designated Chemical Substances.

There are alloy castings containing chromium, selenium or beryllium, which are not authorized in JIS standards, though with small production volumes.

Table 3 Casting materials required to be reported under the PRTR

Alloy type and Code \ Class I Designated Chemical Substance (Cabinet Order No.)		Zinc (230)	Nickel (231)	Manganese (311)
Brass castings (Class 2)	CAC202	0.5-3.0 *7		
Brass castings (Class 3)	CAC203	0.5-3.0 *7		
High-strength-brass castings (Class 1)	CAC301			0.1-1.5 *7
High-strength-brass castings (Class 2)	CAC302			0.1-3.5 *7
High-strength-brass castings (Class 3)	CAC303			2.5-5.0
High-strength-brass castings (Class 4)	CAC304			2.5-5.0
Bronze castings (Class 1)	CAC401	3.0-7.0		
Bronze castings (Class 6)	CAC406	4.0-6.0		
Bronze castings (Class 7)	CAC407	5.0-7.0		
Lead-bronze castings (Class 2)	CAC602	4.0-6.0		
Lead-bronze castings (Class 3)	CAC603	9.0-11.0		
Lead-bronze castings (Class 4)	CAC604	14.0-16.0		
Lead-bronze castings (Class 5)	CAC605	16.0-22.0		
Aluminum bronze castings (Class 2)	CAC702		1.0-3.0	0.1-1.5 *7
Aluminum bronze castings (Class 3)	CAC703		3.0-6.0	0.1-1.5 *7
Aluminum bronze castings (Class 4)	CAC704		1.0-4.0	7.0-15.0

Unit: %

NOTE*7: The contents may be 1% or more or less than 1%, depending on a lot.

2.1.2 Estimation of the annual amount handled

The annual amount of each Class I Designated Chemical Substances handled is estimated. When the same kinds of Class I Designated Chemical Substances are contained in two or more alloy castings, the amounts of the chemicals should be added up. In order to estimate transfers mentioned below, the content of the substances used in each alloy needs to be identified.

(1) [Annual amount of casting materials handled]

= [Stock amount at the beginning of term] + [Annual purchased amount]

- [Stock amount at the end of term]

(2) [Content]

Estimation examples of the contents are shown in Table 4. In the examples, the average content is calculated by using the total content of lead. However, when the maximum content is known and its value is considered to be almost the same as the average content, the maximum contents may be used instead. (Under the PRTR, the principle dictates that risks should not be at a low estimate, and maximum values are used instead of average values.)

Table 4: Estimation examples of the lead content in the bronze casting

Purchased Date	Material	Weight (kg)	Pb Content	Pb Weight (kg)
2001.5.20	CAC406	10,751	5.44%	585
2001.9.30	CAC406	11,002	5.23%	575
2001.11.5	CAC406	10,850	4.83%	524
2002.1.16	CAC406	11,100	4.92%	546
2002.3.21	CAC406	10,820	5.30%	573
2001 FY	Total	54,505 (A)		2,803 (B)

The range of Pb of the material CAC406: 4.0 - 6.0 %

The average content of Pb = (B)/(A) x 100 = 5.14 %

The maximum content of Pb in the range of component = 6%

(3) [Annual amount of Class I Designated Chemical Substances handled]

= [Annual amount of raw materials handled]

x [Content of Class I Designated Chemical Substances]

Estimation example

When the annual amount of bronze castings handled (Class 6, CAC406) is 20,000kg and the content of Pb is 6%:

[The annual amount of lead handled]

= [The annual amount of bronze castings handled (Class 6)] 20,000kg x 6%

= 1,200kg

2.1.3 Releases / Transfers points

As shown in Fig. 2, the Class I Designated Chemical Substances contained in casting materials are possible to be released and transferred in melting processes, molten metal injection processes and finishing processes. As for releases and transfers of the Class I Designated Chemical Substances, melting processes and molten metal injection processes can be considered as a single process, and they are described as melting/molten metal injection process in this section.

In melting/molten metal injection processes, molten slag and molten dust are generated and some of these is considered to be released to air. There are no releases to water bodies and soil. Chips and shavings are generated in cast-finishing processes. Their components are basically the same as the components of alloy, and include others such as dusts.

The releases to air in melting processes are extremely small, and could be estimated zero, because the boiling points of lead, nickel and manganese (1750 ℃, 2731 ℃, and 2152 ℃, respectively) are 500 ℃ or more higher than melting points of copper alloys (the maximum is 1250 ℃), and those chemicals pass through dust collectors etc.

The chemical substances in the molten slag, molten dust, chips and shavings generated in the processes, when recycled, are treated as the shipped-out amounts. When disposed as waste, they are regarded as transfers.

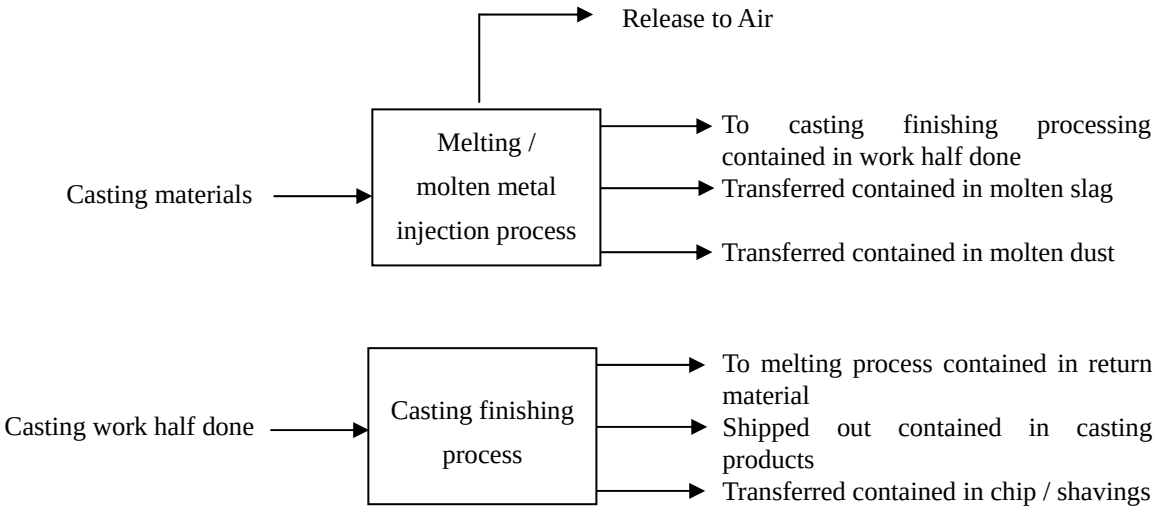

Fig.2 Releases / Transfers points of the Class I Designated Chemical Substances contained in casting materials

2.1.4 Estimation of releases and transfers

(1) Estimation of the amount shipped-out contained in products (castings)

Being contained in products, most of the Class I Designated Chemical Substances contained in casting materials are shipped out. There is no need to estimate the amount shipped-out for casting materials, although the amount shipped-out may be required, depending on an estimation technique of releases and transfers.

(2) Estimation of the amount shipped-out as contained in recycled materials

Molten slag, molten dust, chips and shavings are usually recycled. Under the circumstances, the chemicals contained in the recycled products are not required to be estimated as the same as those contained in products.

(3) Estimation of transfers contained in wastes

When molten slag, molten dust, chips and shaving are not recycled but disposed as waste, the amount of the chemicals contained in the waste is regarded as transfers. To estimate the transfers, actual measurements are employed. However, because of various values depending on samplings, it may be necessary to conduct further analyses depending on circumstances in order to obtain reliable values, which may entail great cost. Consequently, samples from molten slag and dust of bronze, aluminum bronze and high strength brass were respectively collected in the standard-type factories selected for each of them. The samples are examined by the number of analyses and the preparation methods of the samples, with care of dispersion of analysis results. The factors defined by using the results and the contents of Class I Designated Chemical Substances in alloys are shown in Table 5.

By using the factors according to the formula below, a facility without its own actual measurement values may obtain contents of the chemicals contained in waste and employ them as substitute for the measured values.

[Content of Class I Designated Chemical Substance contained in waste]

= [Content of Class I Designated Chemical Substances in alloy used] x [Factor]

Table 5 Estimation of factors of the contents of Class I Designated Chemical Substances

Alloy type and Class I Designated Chemical Substance	State of waste	Factor	Content of Class I Designated Chemical Substance (%)	
			Waste	Alloy used
Lead contained in bronze castings etc.	Molten slag	0.3	1.59	5.37
	Molten dust	0.6	3.11	5.1
Nickel contained in aluminum bronze castings etc.	Molten slag	0.8	3.18	4.03
	Molten dust	0.4	1.61	4.03
Manganese contained in aluminum bronze castings etc.	Molten slag	0.9	0.68	0.79
	Molten dust	0.7	0.54	0.79
Manganese contained in high-strength-brass castings etc.	Molten slag	1.0	0.85	0.88
	Molten dust	0.2	0.14	0.88

[1] Estimation of transfers as contained in molten slag

[Transfers] = [Amount of molten slag traded] x [Content]

Estimation example

When the amount generated of molten slag of bronze castings is 400kg, the content of lead in the original alloy is 6% and the content of lead in molten slag is calculated using the factor in Table 5:

[Content of lead in molten slag] =6% x [Factor] 0.3 = 1.8%

[Transfers] = [Amount of disposed molten slag] 400kg x 1.8% = 7.2kg

[2] Estimation of transfers as contained in molten dust

[Transfers] = [Amount of molten dust traded] x [Content]

Estimation example

When the annual amount of disposed molten dust in bronze castings is 50kg, the content of lead in the original alloy is 6% and the content of lead in molten dust is calculated using the factor in Table 5:

[Content of lead in molten dust] =6%x [factor] 0.6 = 3.6%

[Transfers] = [Amount of disposed molten dust] 50kg x 3.6% = 1.8kg

[3] Estimation Transfers as contained in chips and shavings etc.

[Transfers] = [Amount of chips and shavings traded] x [Content]

(4) The maximum potential releases

The Class I Designated Chemical Substances contained in casting materials are not released to air, water, and soil, therefore the maximum potential releases are zero.

2.2 Fluxes

2.2.1 Fluxes required to be reported under the PRTR

Of fluxes used for degassing and removing oxides in melting processes, the fluxes required to be reported under the PRTR are shown in Table 6. In order to facilitate removal of oxides in melting processes of bronze, anhydrous borax, the Class I Designated Chemical Substance, may be used. Anhydrous borax is a metal compound, and metal compounds are converted into the amount of metal elements contained in the compounds. In Table 6, the factor for the converting was in advance calculated from the atomic weight of each element, shown as the conversion factor.

Table 6 The flux required to be reported

Cabinet Order No.	Class I Designated Chemical Substance	Substance	Chemical formula	Conversion factor	Metal element
304	Boron and its compounds	Anhydrous borax	$Na_2B_4O_7$	0.21	B

2.2.2 Estimation of the annual amount handled (Anhydrous borax)

The anhydrous borax used as a flux is a metal compound, and is converted into the amount of the metal element.

Estimation example:

When the annual amount of the flux handled containing 99% of anhydrous borax ($Na_2B_4O_7$) is 5000kg:

[The annual amount of anhydrous borax handled]

= [The annual amount of the flux handled] 5,000kg x 99% = 4,950kg

[The annual amount of boron handled]

= [The annual amount of anhydrous borax handled] 4,950kg x [The conversion factor] 0.21 1,040kg

2.2.3 Estimation of releases and transfers

The released and transferred points of the flux (anhydrous borax) are shown in Fig. 3. The flux is injected into molten metals in melting processes and then taken out as molten slag with oxides. Although some of the flux may be released to air, the amount is extremely small and could be regarded as negligible. Therefore, [the transfers] of boron is zero when the molten slag is recycled, and, when the molten slug is disposed as waste, [the transfers] = [the amount handled].

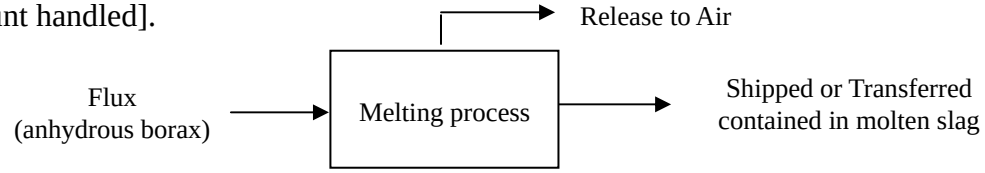

Fig.3 The released and transferred points of the Class I Designated Chemical Substances contained in the flux

2.3 Binders of self-hardening molds

2.3.1 Binders of Self-hardening molds required to be reported under the PRTR

The binders of the self-hardening molds required to be reported under the PRTR are shown in Table 7. Since the contents of the binders depend on manufactures and products, not all of the same type binders are required to be reported. According to the earlier findings, there have been no furan resin and no alkali phenol resin, that contain 1% or more of Class I Designated Chemical Substances.

Table 7 Binders of self-hardening molds required to be reported under the PRTR

Resin type (molding process)	Cabinet Order No.	Class I Designated Chemical Substance	Content (%)
Phenol resin (Shell molding process)	266	Phenol	～ 5%
	224	1,3,5-trimethylbenzene	～ 5%
Urethane resin (Cold box process)	266	Phenol	～ 5%

Phenol resin by shell molding processes could be the target material required to be reported. However the resin is usually purchased and used in the forms of coated sand (molding sand coated with a binder) or its castings, and under the circumstances, the contents of the target chemical substances are clearly less than 1%. Therefore, the phenol resin is not required to be reported.

2.3.2 Estimation of the annual amount handled

[1] Annual amount of a binder handled = Stock amount at the beginning of term + Annual purchased amount - Stock amount at the end of term

[2] Annual amount of Class I Designated Chemical Substances handled = Annual amount of raw materials handled x Content of Class I Designated Chemical Substances

Estimation example:
The annual amount of phenol resin handled (Shell molding process): 20,000kg
[The annual amount of phenol handled] = [The annual amount of the material handled]
20,000kg x 5% = 1,000kg

2.3.3 Estimation of releases and transfers

The Class I Designated Chemical Substances contained in binders of self-hardening molds could be released to air or transferred as waste in casting processes (sand preparation, molding, molten metal injection, mold separation, and sand treatment) (Fig. 4). The estimation techniques of releases and transfers are based on the use of emission factors. Examples of the emission factors defined based on actual measurements etc., are shown in Table 8.

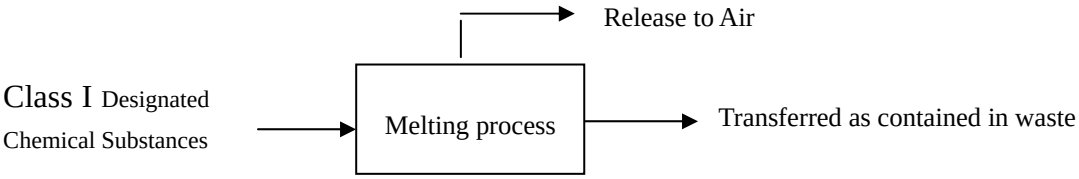

Fig.4 Releases / Transfers point of the Class I Designated Chemical Substances contained in Binders

Table 8 Emission factors of the Class I Designated Chemical Substances contained in binders

Cabinet Order No.	Class I Designated Chemical Substance	Emission Factor %		
		Product	Air	Waste
224	1,3,5-trimethylbenzene	0	100	0
266	Phenol	0	0	0

NOTE: The emission factors in the table were published in “The PRTR manual for the iron casting manufacturing industry” by Japan Cast Iron Foundry Association, Japan High Grade Cast Iron Association and the Japan Malleable Iron Society.