SNAP CODE: **040301**

SOURCE ACTIVITY TITLE: **PROCESSES IN NON-FERROUS METAL INDUSTRIES**
Aluminium Production (electrolysis)

NOSE CODE: **105.12.21**
105.12.22

NFR CODE: **2 C 3**

1 ACTIVITIES INCLUDED

Production of primary aluminium, excluding alumina production.

2 CONTRIBUTION TO TOTAL EMISSIONS

Table 2.1 Contribution to total emissions of the CORINAIR90 inventory (*28 countries*)

Source-activity	SNAP-code	Contribution to total emissions [%]							
		SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Aluminium Production	040301	0.1	0	0	-	0.4	0.1	-	-

0 = emissions are reported, but the exact value is below the rounding limit (0.1 per cent)
- = no emissions are reported

For heavy metal emissions, specific figures for this source activity are available from Baart *et al.* (1995). /1/ The average relative contribution from the primary aluminium production industry to the total emission of heavy metals has been presented for European countries in table 2.

Table 2.2 Average relative contribution of the production of aluminium and the total non-ferrous industry to the total emission of heavy metals in European countries

	Contribution (%)	
Compound	Total non-ferrous industry (%)	Primary Aluminium production (%)
Cadmium	24	0.12
Chromium	0	-
Copper	11	-
Nickel	0	-
Lead	2.7	-
Zinc	28	0.004

- = not available

3 GENERAL

3.1 Description

Primary aluminium is produced by electrolytic reduction of alumina. The electrolytic process occurs in steel cells lined with carbon. Carbon electrodes extend into the cell and serve as anodes whereas the carbon lining of the cell is the cathode. Molten cryolite functions both as electrolyte and as a solvent for the alumina. Molten aluminium metal is deposited at the cathode and periodically tapped.

3.2 Definitions

Pots	Shallow rectangular cells lined with carbon.
Paste	Petroleum cake mixed with pitch binder.
Butts	Anode blocks prepared from paste by baking.

3.3 Techniques

3.4 Emissions during production activities

The main substances emitted are particulate matter, gaseous fluoride and particulate fluoride. The fluorides originate from the electrolyte. Emissions from the baking ovens include PAHs from the pitch binder. The dust produced contains some heavy metals.

3.5 Controls

4 SIMPLER METHODOLOGY

Multiplying the emission factor with the appropriate production figure yields the emission. Default emission factors to facilitate this approach are provided in Section 8.1

5 DETAILED METHODOLOGY

If an extensive measuring program is available, the emissions can be calculated on the basis of the measurements of the dust emission and the composition of compounds over the total process.

Reference emission factors for comparison with User's own estimates are provided for selected pollutant releases in Section 8.2

6 RELEVANT ACTIVITY STATISTICS

Standard national or international production statistics should be used.

7 POINT SOURCE CRITERIA

The primary aluminium plants usually are connected to high chimneys and can be regarded as point sources if plant specific data are available.

8 EMISSION FACTORS

8.1 Default Emission Factors For Use With Simpler Methodology

Table 8.1a Emission factors for the electrolysis process

Substance	Emission factor (g/Mg aluminium produced)
Fluoride (gas)	350
Fluoride (particles)	950
Fluoranthene	4.5
Benz(a)pyrene	0.12
Sulfurdioxide	14200
Carbondioxide	1550000
Carbonmonoxide	135000
Dust	4750
Nitrogenoxides	2150
Cadmium	0.15
Zinc	20
Nickel	15

Table 8.1b Emission factors for the anode production process

Substance	Emission factor (g/Mg aluminium produced)
Fluorides (gas)	40
Fluorides (particles)	2
Fluoranthene	30
Benz(a)pyrene	1.4
Sulfurdioxide	900
Carbon dioxide	2200
Carbon monoxide	400
Dust	600

8.2 Reference Emission Factors For Use With Detailed Methodology

The emission factors presented are derived from the SPIN document, based on the Emission Inventory in the Netherlands.

Table 8.2a Emission factors for the electrolysis process

Substance	**Emission factor range** (g/Mg aluminium produced)
Fluoride (gas)	200-500
Fluoride (particles)	400-1500
Fluoranthene	3-6
Benz(a)pyrene	0.10-0.14
Sulfur dioxide	11000-17500
Carbon dioxide	1500000-1600000
Carbon monoxide	120000-150000
Dust	2700-6800
Nitrogen oxides	1300-3000
Cadmium	0.1-0.2
Zinc	15-25
Nickel	10-20

Table 8.2b Emission factors for the anode production process

Substance	**Emission factor range** (g/Mg aluminium produced)
Fluorides (gas)	10-80
Fluorides (particles)	n.a.
Fluoranthene	20-40
Benz(a)pyrene	1.0-1.8
Sulfur dioxide	800-1000
Carbon dioxide	2000-2400
Carbon monoxide	n.a.
Dust	200-1000

9 SPECIES PROFILES

A profile for PAH emissions from a single aluminium plant in the Netherlands is given in table 5. This table can be used to get at least a first estimation of PAH emissions for cases where only information about a single substance (in most cases benz(a)pyrene) is available.

Table 9.1 Relative profile for PAH emissions from aluminium production (Benz(a)pyrene put at one)

Substance	**Relative amount**
Naphthalene	90
Anthracene	5
Phenanthrene	20
Fluoranthene	20
Chrysene	3
Benz(a)anthracene	3
Benz(a)pyrene	1
Benz(k)fluoranthene	3
Benz(ghi)perylene	0.3

10 UNCERTAINTY ESTIMATES

-

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

The contribution of heavy metals from the dust and the PAH emissions are the weakest aspects at the moment.

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

13 TEMPORAL DISAGGREGATION CRITERIA

Primary aluminium production can be considered as a continuous process.

14 ADDITIONAL COMMENTS

15 SUPPLEMENTARY DOCUMENTS

Environmental Protection Agency, COMPILATION OF AIR POLLUTANT EMISSION FACTORS AP 42, Chapter 12.1

Spindocument Productie van primair aluminium ; RIVM (report no. 736301131); November 1992 (in Dutch)

PARCOM-ATMOS Emission Factors Manual Actualised version 1993.

16 VERIFICATION PROCESSES

17 REFERENCES

1. A.C. Baart, J.J.M. Berdowski, J.A. van Jaarsveld; Calculation of atmospheric deposition of contaminants on the North Sea; IWAD; ref. TNO-MW-R 95/138; TNO MEP; Delft; The Netherlands; 1995

18 BIBLIOGRAPHY

For a detailed bibliography the primary literature mentioned in AP 42 or the PARCOM-ATMOS Manual may be used.

19 RELEASE VERSION, DATE AND SOURCE

Version: 3.1 (draft)

Date: April 2001

Source: J. J .M. Berdowski, P.F.J.van der Most, W. Mulder, J. PJ . Bloos
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20 POINT OF ENQUIRY

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