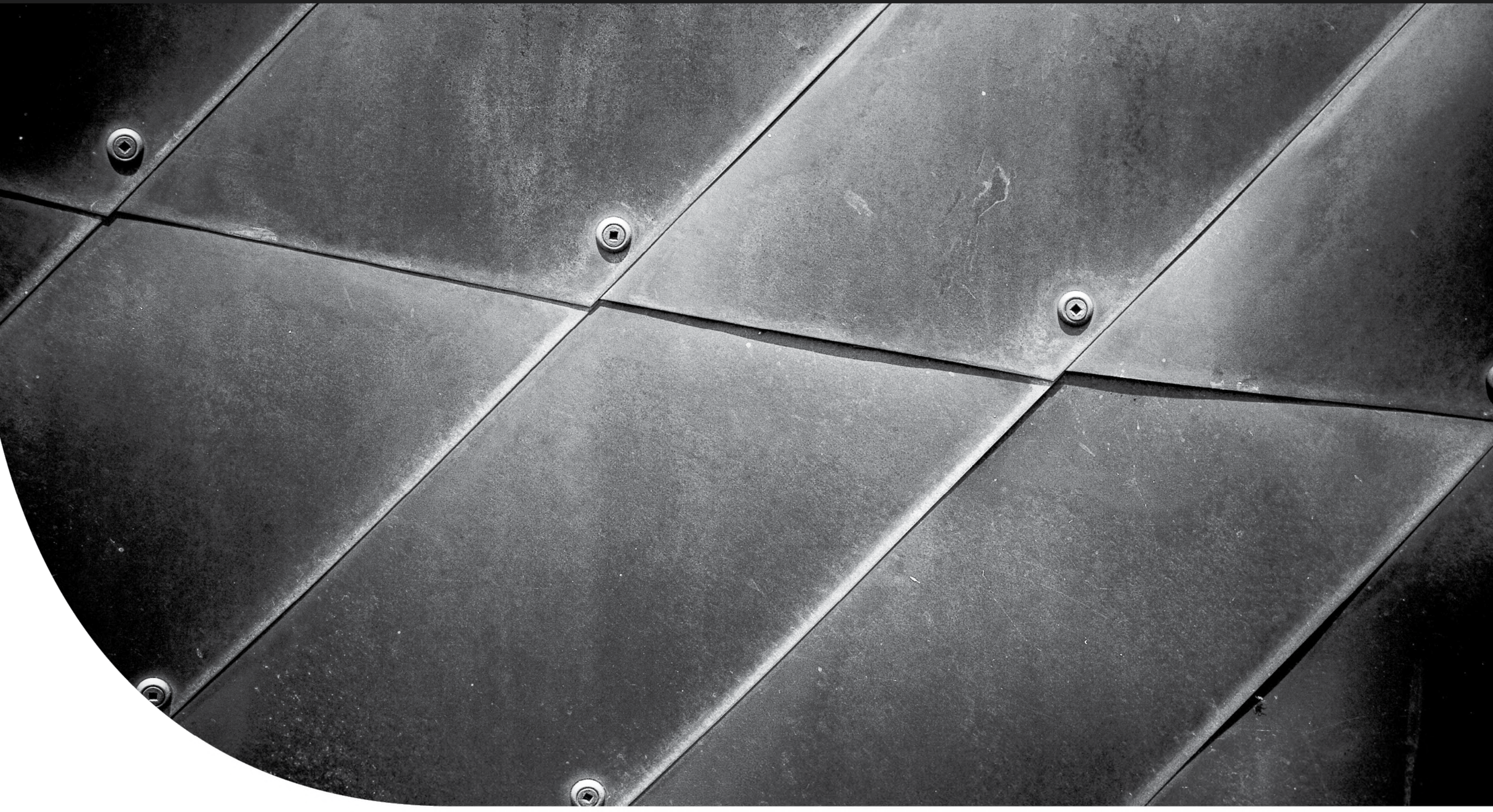
EMISSION ESTIMATE GUIDE

for primary aluminum producers



Environment and
Climate Change Canada

Environnement et
Changement climatique Canada

Canada

PDF
Cat. No.: En84-154/2020E-PDF
ISBN: 978-0-660-35026-4

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Emission estimate guide for primary aluminum producers

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The purpose of this document and the accompanying spreadsheet is to clarify the reporting requirements for aluminium smelters in the primary sector and describe the recommended procedures and approaches for estimating releases of substances listed in the National Pollutant Release Inventory (NPRI).

This guide was developed by Environment and Climate Change Canada (ECCC) in cooperation with the Aluminium Association of Canada (AAC), its member companies (Alcoa, Alouette and Rio Tinto Alcan) and the Ministère de l'Environnement et de la Lutte contre les changements climatiques du Québec (MELCC).

1. Description of the sector

This section provides a description of the primary aluminium industry in Canada. Firstly, to avoid ambiguity when reading this guide, here is a brief definition of the terms used, as proposed by the NPRI.

Primary aluminium production: Aluminium produced directly from the electrolysis of alumina.

Primary aluminium processing: Refining aluminium by any process; rolling, drawing, casting, extruding and alloying of aluminium to produce basic shapes.

Note: These definitions may be modified over the years. Readers should therefore check the NPRI for the most recent definitions.

Primary aluminium production and processing industries that comply with the above definitions are listed under the following North American Industry Classification System (NAICS)* codes:

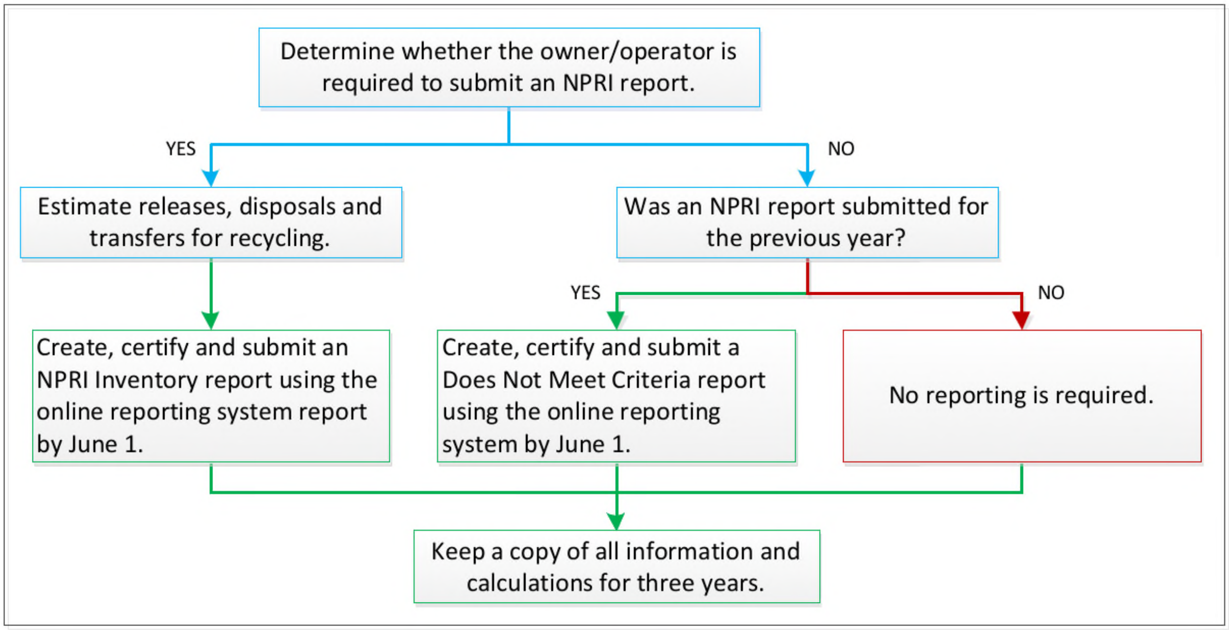
- 3313 - Alumina and Aluminum Production Processing
- 33131 - Alumina and Aluminum Production Processing
- 331313 - Primary Production of Alumina and Aluminum
- 331317 - Aluminum Rolling, Drawing, Extruding and Alloying

Note: Other NAICS codes (2017) may also apply to this sector.
* Source: Statistics Canada, North American Industry Classification System (NAICS) 2017.

2. Are you required to report to the NPRI?

The figure below shows the steps that will enable facilities to determine whether they need to produce a report for the current year.

Figure 1: Steps for determining whether a facility is required to report to the NPRI



Source: ECCC, 2018, p.14.

For further details on NPRI reporting requirements, please refer to the Reporting to the National Pollutant Release Inventory (NPRI) Guide for the current year.

NPRI substances are grouped into five categories based on their reporting criteria. For a complete list of NPRI substances, please refer to the notice in Part I of the Canada Gazette or the NPRI reporting guide for the year in question.

3. Overview of this guide

This manual provides examples of calculations, methods and useful links for estimating emissions of substances listed in the NPRI from many operations associated with the production and primary processing of aluminium.

An Excel spreadsheet was designed to harmonize the reporting methods for various air pollutants produced by certain processes mentioned in this document. The spreadsheet is based on published default emission factors and appropriate emission factor equations for the substances in Parts 1 through 5 of the NPRI. However, this file does not yet contain all the information for estimating releases from all emission sources. In addition, the current version of the spreadsheet does not provide any methodology for estimating releases to land and water bodies or off-site transfers. However, this document is updated annually by the joint working group and users are encouraged to refer to it regularly for the most recent information.

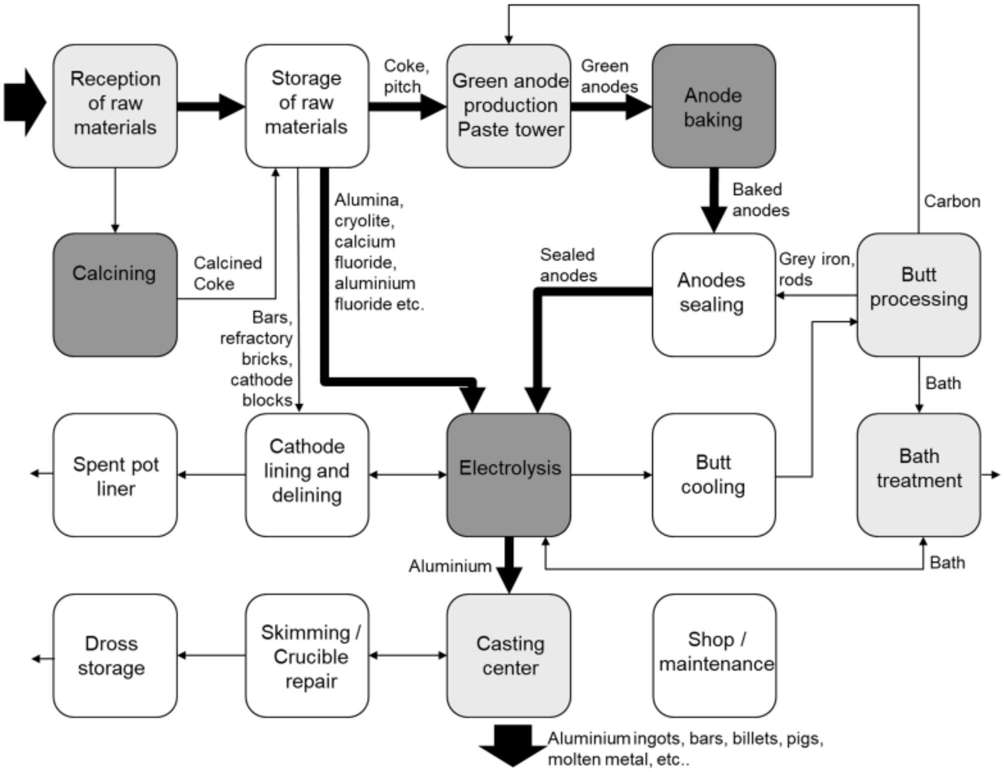
This document contains the emission factors for estimating some substances listed in the NPRI. Some of these factors are taken from the United States Environmental Protection Agency (EPA) document entitled Compilation of Air Pollutant Emission Factors, AP 42, Fifth Edition, Volume I, Chapter 12, section 12.1: Primary Aluminum Production Sources, the EPA WebFIRE application or other sources. This guide also uses emission factors obtained from direct measurement at Canadian aluminium smelters.

Facility specific data may be used in place of the emission factor data available within the spreadsheet, if deemed to be more representative. There are also other spreadsheets and guides for estimating releases from fugitive emission sources and internal and external combustion. These tools are available here.

4. Description of operations (raw materials, products, releases vs. reporting criteria)

The following figure illustrates the many operations that take place in a primary aluminium production plant.

Figure 2: Industrial process for primary aluminium production



Source: ECCC, 2019.

Once the raw materials are received and stored, the calcined petroleum coke and pitch are shipped to the anode manufacturing plant. In the prebaked anode process, the anodes are baked in ovens to produce blocks of solid carbon. The anode rods are then attached to these carbon anodes by pouring grey iron over them. The sealed anodes are sent to the electrolysis area. During the electrolytic phase, the alumina is reduced to aluminium in a bath of molten cryolite and other salts. Finally, a vacuum pump is used to remove the resulting aluminium from the pot. The spent anodes (butts) as well as the adhering bath are cooled, treated and reused in the process. The liquid aluminium produced by the process is sent to the casting centre to be processed into aluminium ingots, pigs, billets, etc.

The main air pollutants, which are released during these operations and listed as NPRI substances, are as follows: polycyclic aromatic hydrocarbons (PAHs), hydrogen fluoride (HF), volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NOx), sulphur dioxide (SO_2) and particulate matter (TPM, PM_{10} and $PM_{2.5}$).

5. Identification of sources of releases and off-site transfers

This section presents the sources of releases to air, land and water bodies as well as off-site transfers.

Sources of air emissions from the following processes:

- Receipt of raw materials
- Storage of raw materials
- Calcining of petroleum coke
- Anode manufacturing
- Anode baking
- Anode sealing
- Electrolysis
- Butt cooling
- Bath treatment
- Butt processing
- Casting centre
- Skimming operations and Crucible repair
- Dross storage
- Cathode lining and delining
- Spent pot liner storage
- Boilers
- Maintenance shops
- Accidental emissions

Emissions from these sources are released into the air by fans, dust collectors, outdoor vents, roof vents, etc.

Sources of releases to water bodies:

- Final effluent in runoff
- Process and cooling water
- Combined final effluent
- Accidental spills and leaks

Source of releases to land:

- Spills

Off-site transfers:

NPRI substances that may be contained in:

- Spent pot liner
- Wet scrubber sludge
- Wastewater treatment sludge
- Aluminium dross
- Other waste

6. Estimating air emissions

This section outlines the appropriate methodology for estimating emissions from some of the sources listed above.

The data in Table 1 below, produced by ECCC, contains the codes used by the NPRI to describe the various methods for estimating releases.

Table 1: Estimation codes for the method used to calculate emissions

Code	Method
M1	Continuous emission monitoring
M2	Predictive emission monitoring
M3	Source testing
C	Mass balance
E1	Site-specific emission factors
E2	Published emission factors
O	Engineering estimates
NI	No information
NA	Not applicable

Source: ECCC, 2018.

Emission factors found in the spreadsheet were calculated using a specific method as indicated in the spreadsheet. Also, these emission factors can vary depending on the physical properties of the substance, the effectiveness of the controls and the estimation method used. In view of these limitations, please use them judiciously. Furthermore, the same pollutant can come from many different sources. Therefore, the user must use the appropriate emission factor to calculate the emissions of this pollutant in all processes from which it is released and add them up to estimate the total emissions produced annually.

When reporting emissions to the NPRI, the user must report all releases from primary sources, such as those from stacks, as “point releases.” Secondary emissions such as those released from roof vents will be classified as “fugitive emissions.”

Note for calculating polycyclic aromatic hydrocarbon (PAH) emissions:
Facilities use direct measurement methods and, according to the aluminium smelter industry spreadsheet, these source tests are used to calculate the quantity of PAHs released. Subsequently, the facility must add the PAHs to determine if the overall reporting threshold set by the NPRI has been exceeded. There are also individual thresholds for PAHs.

Note for calculating hydrogen fluoride (HF) emissions:
In general, the sum of emissions measured monthly at the pot room roof vents and emissions measured annually at the scrubber stack is used to estimate hydrogen fluoride emissions. The information under the “HF” tab in the spreadsheet indicates that the hydrogen fluoride

emission rate is calculated using sampling results.

Note for calculating emissions from fuel combustion:
In general, the appropriate emission factors are applied to the total amount of the same type of fuel used throughout the facility.

Note for calculating particulate matter (TPM, PM_{10} and $PM_{2.5}$) emissions:
The same emission factor can be used to calculate emissions from several similar combined sources such as fans and dust collectors.

Note for calculating volatile organic compound (VOC) emissions:
If the total amount of VOCs (i.e. Part 4 total VOCs) emitted exceeds the NPRI reporting threshold, a Part 4 total VOC report will be required. Following this, will need to consider specific VOCs (i.e. the Part 5 speciated VOCs) and report for those substances that meet or exceeded the Part 5 reporting threshold. The Part 5 speciated VOCs are listed under the “List Part 5 Speciated VOC” tab in the spreadsheet.

Note regarding calculation examples:
The examples in this guide refer to the data contained in the spreadsheet.

6.1 Emissions from raw material storage and handling

6.1.1 Process description

Raw materials (alumina, pitch, petroleum coke, bath constituents, fuel, etc.) are received and transferred by truck, train or boat to the plant storage site (silos, tanks and warehouses). Conveyors are generally used for loading and unloading.

Key operations: receipt of alumina and coke and storage in silos; alumina and coke transfer via conveyor.

6.1.2 Emissions

Reportable NPRI substances emitted during raw material storage and handling, which are listed in the spreadsheet, are particulate matter: TPM, PM_{10} and $PM_{2.5}$. Other potential emissions such as PAHs and volatile organic compounds (VOCs) may also be released during these activities.

6.1.3 Emission calculations

Sample calculation for total particulate matter (TPM) emissions:
A facility wants to estimate the amount of TPM released annually by a dust collector on an alumina silo with a 63,000 m^3/h flow rate. The dust collector operates 5,000 hours per year. The first step is to retrieve the emission factor under the “Total Particulate” tab of the spreadsheet in the NPRI toolbox.

The emission factor is shown below:

$EF_{(TPM)}$ = 5 mg/m^3 for dust collectors with flow rates greater than 17,000 m^3/h and 15 mg/m^3 for those with flow rates less than 17,000 m^3/h

Then, the user uses the following equation:

$$ETPM = EF * Ut * Ca * \frac{1kg}{10^6 mg} * 1t/1000kg$$

where:

- E_{TPM} = Emission of total particulate matter (tonne/yr)
- EF = Emission factor for the dust collector (mg/m^3)
- Ut = Number of hours the dust collector is used (h/yr)
- Ca = Dust collector cleaning capacity (m^3/h)

Therefore, the annual TPM emissions from the dust collector are:

$$ETPM = \frac{5mg}{m^3} * \frac{5000h}{yr} * \frac{63{,}000m^3}{h} * \frac{1kg}{10^6 mg} * \frac{1t}{1000kg} = 1.575\ tonnes/yr$$

6.2 Petroleum coke calcining emissions

6.2.1 Process description

In the aluminium industry, petroleum coke is typically calcined in rotary kilns at high temperatures. After it has been crushed and screened, the calcined coke is usually stored until it is fed into mixers to produce anodes.

Key operations: calcining, crushing, screening, handling and storage.

6.2.2 Emissions

Reportable NPRI substances are the following: VOCs, Nitrogen oxide (NOx), carbon monoxide (CO), sulphur dioxide (SO_2), TPM, PM_{10} and $PM_{2.5}$. Other potential emissions such as PAHs may also be released during these activities.

6.2.3 Emission calculations

Sample calculation for volatile organic compound (VOC) emissions:

A facility wants to estimate the amount of VOCs released annually by a rotary kiln that calcines 16 tonnes of green coke/hour. The kiln operates 6,000 hours per year (96,000 tonnes of green coke/year).

The following emission factor can be found under the “VOC” tab of the spreadsheet in the NPRI toolbox:

$$EF(VOC) = \frac{0{,}007\ kg}{t\ green\ coke}$$

The user can use the following equation to calculate the VOC emissions:

$$EVOC = EF * Qty * \frac{1t}{1{,}000kg}$$

Where:

- E_{VOC}= VOC emissions during coke calcining (tonne/yr)
- EF = Emission factor for VOCs released during coke calcining (kg/tonne)
- Qty = Quantity of green coke calcined per year (tonne/yr)

Therefore, the annual VOC emissions from the kiln are:

$$EVOC = \frac{0.007kg}{t} * \frac{96000t}{yr} * \frac{1t}{1000kg} = 0.672\,tonnes/yr$$

6.3 Emissions from anode manufacturing

6.3.1 Process description

Anode manufacturing is a process by which calcined petroleum coke is mixed with pitch (used as a binder) and carbon from recycled anode butts to produce anode paste which is then compacted to form a green anode block (prebaked pots). This process is performed in the paste plant.

Key operations: handling, grinding, mixing and vibro-compaction.

6.3.2 Emissions

Particulate matter (TPM, PM_{10} and $PM_{2.5}$), PAHs and VOCs

6.3.3 Emission calculations

Sample calculation for fine particulate matter ($PM_{2.5}$) emissions:

A stack releases a 12 mg/Nm^3 concentration (dry basis) of TPM and a dry volume flow of 22,000 Nm^3/h where ''N'' stands for normal conditions of temperature and pressure (i.e. 25^{o}C and 1 atm). The stack operates 24 hours a day, 365 days a year (8,760 h/yr). We need to calculate the $PM_{2.5}$ released by the scrubber on the paste plant.

The first step is to open the spreadsheet in the NPRI toolbox and retrieve the appropriate emission factor under the "$PM_{2.5}$" tab.

The emission factor is shown below:

$EF_{(PM2.5)}$ = 70% x Total Particulate sampling (TPM)

The following approach can be used:

Use the stack flow rate and the measured concentration to calculate the annual TPM mass emissions:

$$\frac{12mg}{1Nm^3} * \frac{22{,}000\ Nm^3}{h} * \frac{1t}{10^9mg} * \frac{8760h}{yr} = 2.313\,t/yr\ \ TPM$$

Therefore, the annual $PM_{2.5}$ emissions from the paste plant are:

Emissions $PM_{2.5}$ = 0.7 * 2.313 t/yr = 1.619 tonnes/yr

6.4 Emissions from anode baking

6.4.1 Process description

Baking green anodes in ring furnaces to produce blocks of solid carbon that can be used for electrolysis. Fuel is used to heat the furnace.

Key operations: storage, handling and combustion.

6.4.2 Emissions

Particulate matter (TPM, PM_{10} and $PM_{2.5}$), PAHs, hydrogen fluoride, SO_2, CO and VOCs.

6.4.3 Emission calculations

Sample calculation for sulphur dioxide (SO_2) emissions from anode baking:

A facility produces 105,000 tonnes of green anodes annually, which after baking, yields 103,000 tonnes of baked anodes. The annual average sulphur content in the green anodes is 2.04% and 2% in the baked anodes. The annual average sulphur content in the alumina is considered negligible.

How much sulphur is released during this process?

The following equation can be found under the “SO2” tab of the spreadsheet in the NPRI toolbox:

$$ESO2 = \left(\left[\frac{\%Sacr}{100} * PACR\right] - \left[\frac{\%Sac}{100} * PAC\right] - \left[\frac{\%Sai}{100} * AR\right]\right) * \frac{64}{32}$$

where:

- E_{SO2} = SO_2 emissions (t/yr)
- $\%S_{acr}$ = percentage of average annual sulphur content in green anode
- PAC_R = green anode production (t/yr)
- $\%S_{ac}$= percentage of sulphur content in baked anodes
- AC = production of baked anodes (t/yr)
- $\%S_{ai}$ = percentage of annual average sulphur content in the alumina recovered from the Fume Treatment Centre of the Anode baking furnace
- AR = quantity of recovered alumina in t/yr

NB: The sulphur content in the recovered alumina is equal to zero (0) if not significant.
Therefore, SO_2 released by the anode baking oven is:

$$ESO2 = \left(\left[\frac{2{,}04}{100} * \frac{105{,}000t}{yr}\right] - \left[\frac{2}{100} * \frac{103{,}000t}{yr}\right]\right) * \frac{64}{32} = 164\, tonnes/yr$$

Sample calculation for SO_2 emissions from fuel combustion during anode baking:
Assume that 17,000 litres per year of fuel oil (Bunker No. 2) are used for anode baking. The fuel has 0.5% sulphur content and a mass volume of 820 kg/m^3.

How much sulphur is released?

The following equation can be found under the "SO_2" tab of the spreadsheet in the NPRI toolbox:

$$E_{SO2} = \rho * \%S * V * \frac{MWSO2}{MWS} * \frac{1t}{1000kg}$$

Where:

- E_{SO2} = SO_2 emissions (t/yr)
- ρ = volumetric mass (kg/litre)
- %S = percentage of sulphur in fuel
- V = number of litres of fuel (litre)
- $MWSO_2$ = molecular weight of SO_2 = (64 g/mol)
- MWS = molecular weight of sulphur = (32 g/mol)

Therefore, SO_2 released through combustion is:

$$ESO2 = \frac{820kg}{1{,}000litres} * 0{,}5 * \frac{17{,}000litres}{yr} * \frac{64}{32} * \frac{1t}{1000kg} = 13.94\, tonnes/yr$$

6.5 Emissions from electrolysis

6.5.1 Process description

Production of aluminium by electrolysis of alumina dissolved in a cryolite bath. The carbon anodes are immersed in the bath and electricity is supplied, breaking the aluminium-oxygen bond. The aluminium is deposited at the bottom of the pot and siphoned off at regular intervals.

Key operations: changing the anodes, siphoning the metal, siphoning the bath, pot maintenance, and pot start up and shut down.

6.5.2 Emissions

Primary emissions (stacks): Most of the emissions are captured in the pots and sent to the dry (GTC) or wet scrubbers.

Secondary emissions: Fugitive emissions not captured in the pots (opening of pot panels, siphoning, anode butt tray).

Emissions: PAHs, HF, SO_2, TPM, PM_{10}, $PM_{2.5}$, CO, VOCs, COS (carbonyl sulfide) and TRS (total reduced sulphur). For TRS, emissions of sulfur compounds are calculated at the source and then converted according to the equivalence factor mentioned in the spreadsheet.

6.5.3 Emission calculations

Sample calculation for carbon monoxide (CO) emissions:

A prebaked anode facility wants to determine the amount of CO released from the pots, knowing that the plant produces 400,000 tonnes of aluminium annually and its Faraday efficiency is 93%.

Begin by retrieving the equation shown below under the "CO" tab of the spreadsheet in the NPRI toolbox.

$E_{CO} = P_{A1} * [100\text{-}F(\%)/ F(\%)] * 84/54$

Where:

- E_{CO} = Carbon monoxide emissions (tonne/yr)
- P_{Al} = Aluminium production (tonne/yr)
- F = Faraday efficiency (%)

Therefore, the annual CO emissions from the pots are:

$$ECO = \frac{400000t}{yr} * \left(\frac{100-93}{93}\right) * \frac{84}{54} = 46{,}833.93 \ tonnes/yr$$

6.6 Casting centre emissions

6.6.1 Process description

The liquid aluminium produced during electrolysis is sent to the casting centre where it is skimmed before being solidified in molds to make aluminium ingots, pigs, billets, etc. The dross are the impurities found on the surface of the metal in the foundry furnaces. These impurities are usually removed and sent to a subcontractor, which extracts the aluminium and returns it to the plant.

Key operations: receiving the molten metal, casting the metal, skimming and cooling the pigs, ingots, aluminium billets, alloying, etc.

6.6.2 Emissions

TPM, PM_{10}, $PM_{2.5}$, NOx, CO, SO_2

Air pollutant emissions from fuel combustion are calculated for metal melting.

6.6.3 Emission calculations

Sample calculation for nitrogen oxide (NOx) emissions:

A facility wants to estimate the amount of NOx released annually if its casting centre burns 4,000,000 m^3 of natural gas. (In most cases, the calculation of emissions from fuel combustion will be for the entire facility, not for individual processes.)

The following emission factor can be found under the “NOx” tab of the spreadsheet in the NPRI toolbox:

$$EF(NOx) = \frac{1600\ kg}{10^6 m^3}$$

The following equation can be used to calculate the emissions:

$$ENOx = EF * Qty * \frac{1t}{1000kg}$$

Where:

- E_{NOx}: NOx emissions (tonne/yr)
- EF = Emission factor for NOx from natural gas combustion (kg/m^3)
- Qty = Quantity of natural gas per year (m^3/yr)

Therefore, the NOx emissions from the casting centre are:

$$ENOx = \frac{1600kg}{10^6 m^3} * \frac{4{,}000{,}000 m^3}{yr} * \frac{1t}{1000kg} = 6.4\ tonnes/yr$$

6.7 Emissions from related processes

Related processes are associated with electrolysis and have similar characteristics in terms of operations (storage, handling, etc.) and particulate matter emissions.

6.7.1 Process description

This part applies to the following processes:

Butt storage:

- Butts are what remain of anodes after they have been used in the pots. The spent anode assembly is usually cooled by natural ventilation in a storage area.
- Key operations: storage and handling

Bath treatment:

- The bath recovered from the anode butts is ground, processed and stored, then sent to electrolysis for reuse in the process.
- Key operations: grinding, ground bath silo and bath treatment

Butt processing:

- The anode butts (spent anodes) are cleaned, ground and completely reused to produce new anodes.
- Key operations: the butts are cleaned and shot blasted, the casting is ground and the rods are brushed

Anode sealing:

- Grey iron is poured to attach the rod-leg assemblies to the carbon anodes.
- Key operations: a thimble stripping station, rod maintenance, induction oven for melting the grey iron

Crucible cleaning and relining operations:

- Crucible cleaning. Some of the residues recovered are recycled in the bath circuit.
- Key operations: storage and handling

Dross storage:

- The dross is placed in a bin and stored until it is shipped to a subcontractor that processes the waste.
- Key operations: storage and handling

Pot lining and delining shops:

- Lining: installation of the inside pot lining, the refractory bricks, cathode blocks and ramming paste
- Delining: removal of the interior lining of used pots in order to replace them
- Key operations: storage, handling, conveyor and steel shot blasting

Spent Pot Liner storage:

- The spent pot liner is stored as hazardous waste material.
- Key operations: handling spent pot liners and storing them in the warehouse

6.7.2 Emissions

Particulate matter (TPM, PM_{10} and $PM_{2.5}$). Other potential emissions such as HF and ammonia can also be produced during these activities.

6.7.3 Emission calculations

The emission factors for fans and dust collectors presented in the spreadsheet can be used to estimate particulate emissions from related operations.

The spreadsheet does not yet contain an emission factor for estimating the release of certain substances from these related processes; users can therefore use one of the approaches mentioned above in Table 1.

6.8 Boiler emissions

6.8.1 Process description

Boilers are combustion or heat recovery systems that produce steam.

6.8.2 Emissions

TPM, PM_{10}, $PM_{2.5}$, CO, SO_2, NOx

6.8.3 Emission calculations

The spreadsheet does not yet contain an emission factor for estimating releases specifically from boilers; users can therefore use the same approach as the one used for fuel or one of the approaches mentioned above in Table 1 or appropriate spreadsheets available in the NPRI toolbox.

6.9 Solvent and paint emissions

6.9.1 Process description

Solvent use includes degreasing with a solvent, used solvent recovery, fugitive emissions generated during product preparation and use of commercial solvents. Many solvents contain VOCs that are emitted by evaporation during use.

Paints used for coating storage tanks or any other products that also contain VOCs must be considered and reported to the NPRI as needed.

6.9.2 Emissions

VOCs

6.9.3 Emission calculations

Releases can be estimated by assuming all VOCs in paint and solvents are released. The percentage of total VOC emissions and individual VOCs in paint and solvents is normally indicated on the product SDS. If not, you can obtain this information from your supplier.
The total release will equal the percentage of VOCs multiplied by the total weight of the paint used. There are also generic emission factors for paint and coatings. (references: Chapter 4.2 of document AP-42 and Chapter 7 - Preferred and Alternative Methods for Estimating Air Emissions from Surface Coating Operations).

Emission factors, mass balances and engineering calculations are often used to calculate VOC emissions from the use of solvents (reference: www.epa.gov/ttn/chief/ap42/ch04/final/c4s06.pdf).

6.10 Dust emissions from unpaved roads

6.10.1 Process description

Gravel surfaced roads and roads with thin membrane bituminous surface treatments and bituminous cold mix surfaces are referred to as unpaved roads. Even if a dust suppressant is applied to an unpaved road, this section of road is still considered an unpaved road.

6.10.2 Emissions

Particulate matter: TPM, PM_{10} and $PM_{2.5}$

610.3 Emission calculations

Dust emissions can be estimated using the following general equation:

$$Ex = VK * EFx * COR * (\frac{1 - EC}{100})$$

Where:

- E_X = Emission of contaminant x, (kg/year)
- VK = Total annual vehicle kilometres travelled (km)
- EF_X = Emission factor of contaminant x, (kg/KV)
- COR = Correction factor for the days of precipitation, snow cover and frost
- EC = Effectiveness of dust suppression method (%)

The following equation is used to calculate the number of vehicle kilometres travelled (VKT) per year:

VK = T * L * N

Where:

- VK = Total annual vehicle kilometres travelled (km)
- T = Average daily traffic
- L = Length of unpaved road
- N = Number of days of use per year

The average daily traffic is equal to the total number of vehicles that travel on a section of road every day. The length of the roads at the facility and the number of vehicles accessing the facility during a typical day. If such data is unavailable, surveys can be conducted during representative operating days during the year to estimate total VKs. The VK calculation is described in detail in the Facility Information sheet in the Unpaved Industrial Road Dust Calculator spreadsheet.

The emission factor, expressed in metric units (kilograms/VK) is calculated using the following equation:

$$EF = k(\frac{s}{12})^a (\frac{W}{2.72})^b$$

Where:

- EF = Size-specific emission factor (kg/VK)
- s = Surface material silt content (%)
- W = Mean vehicle weight, metric tonnes
- k, a, b = Numerical constants

Source: Document AP 42, Chapter 13: Miscellaneous Sources, Section 2.2 (USEPA, 2006).
Note: For more detailed information, please refer to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces in the NPRI toolbox.

6.11 Accidental releases

6.11.1 Process description

Unplanned releases into the atmosphere, other than normal emissions from stacks or point releases and releases attributable to storage or handling and fugitive emissions, are considered accidental releases.

6.11.2 Emissions

All substances used on the site that can be released accidentally.

6.11.3 Emission calculations

The spreadsheet does not contain an emission factor for estimating releases from accidental spills; users can therefore use one of the approaches mentioned above in Table 1.

7. Estimating releases to water bodies

This section presents the appropriate tools for estimating releases to water bodies.

7.1 Release of final effluent in runoff, process and cooling water, or combined final effluent

7.1.1 Process description

All points at which there is a release of effluent in runoff, process water, cooling water or a combination of these outside the grounds of the facility, i.e. all points of release to the environment (rivers and lakes), including points of release to a ditch or municipal sewer system.

7.1.2 Releases

Polycyclic aromatic hydrocarbon (PAHs), metals

7.1.3 Release calculations

The spreadsheet provides a list of parameters typically measured in liquid effluents. If the information or measurement is not available, for example, users can use one of the approaches mentioned in Table 1.

7.2 Accidental spills and leaks

7.2.1 Process description

Any accidental release that may have occurred in the facility. The difference between a leak and a spill has to do with the duration of the event: a spill extends over a period ranging from a few minutes to a few days, whereas a leak lasts a few days to a few months.

7.2.2 Releases

All substances used on the site that can be released accidentally or substances that may leak.

7.2.3 Release calculations

The spreadsheet does not contain a standard procedure for estimating accidental spills and leaks into water bodies; users can therefore use one of the approaches mentioned in Table 1.

8. Estimating releases to land

This section presents the appropriate methodology for estimating emissions to land.

8.1 Spills and accidental leaks

8.1.1 Process description

Any accidental release that may have occurred in the facility. The difference between a leak and a spill has to do with the duration of the event: a spill extends over a period ranging from a few minutes to a few days, whereas a leak lasts a few days to a few months.

8.1.2 Releases

All substances used on the site that can be released accidentally or substances that may leak.

8.1.3 Release calculations

The spreadsheet does not contain a standard procedure for estimating accidental spills and leaks into land; users can therefore use one of the approaches mentioned in Table 1.

9. Estimating off-site transfers (disposal and recycling)

This section presents the appropriate tools for estimating releases during off-site transfers.

9.1 Main types of waste transferred off site: spent pot liners, wet scrubber sludge, water treatment sludge and aluminium dross

9.1.1 Process description

NPRI substances that may be contained in residues from the dismantling of electrolysis pots (spent pot liners), wet scrubber sludge, wastewater sludge and aluminium dross. What goes out (transfer) needs to be separated from what returns (raw material to be included in calculating the substance threshold).

9.1.2 Releases

Polycyclic aromatic hydrocarbon (PAHs), metals

9.1.3 Transfer calculations

The spreadsheet provides a list of substances generally contained in waste transferred off site for disposal or recycling. If the information or measurement is not available, for example, users can use one of the approaches mentioned in Table 1.

9.2 Other waste

9.2.1 Carbon-based waste

9.2.1.1 Process description

NPRI substances contained in carbon-based waste, such as excess ramming paste and used oil containing PCBs.

9.2.1.2 Releases

Metals, PAHs

9.2.1.3 Transfer calculations

The spreadsheet does not yet contain a standard procedure for estimating transfers from other carbon-based waste; users can therefore use one of the approaches mentioned above in Table 1.

9.2.2 Non-carbon-based waste

9.2.2.1 Process description

NPRI substances that may be contained in other materials, water contaminated with oil and carbon, used filter bags, refractories from baking furnaces etc.

9.2.2.2 Releases

Metals, PAHs

9.2.2.3 Transfer calculations

The spreadsheet does not yet contain a standard procedure for estimating transfers from other waste; users can therefore use one of the approaches mentioned in Table 1.

10. Glossary

This section presents the terms commonly used in connection with primary aluminium production.

- **Alumina:** Aluminium oxide (Al_2O_3), produced by refining bauxite ore.
- **Anode:** (Positive) carbon electrode consumed in the electrolysis process.
- **Bath:** Liquid component of the cell in which the alumina is reduced to aluminium.
- **Calcined petroleum coke**: Raw material used to manufacture the anode.
- **Cathode:** (Negative) carbon electrode insulated with refractory bricks in the electrolytic cells.
- **Cryolite:** Molten salt (Na_3AlF_6), which is added to the bath and can dissolve the alumina.
- **Dust collector:** Bags used to filter the dust.
- **Dry scrubber:** System that uses the adsorbent properties of a material (coke and alumina) to control atmospheric Volatile Organic Compound (VOC), polycyclic aromatic hydrocarbon (PAH), hydrogen fluoride (HF) and process dust emissions.
- **GTC:** Gas Treatment Center.
- **Normal conditions of temperature and pressure:** Gas at 25°C and 101.3 kPa.
- **Pitch:** Raw material used to manufacture the anode; acts as a binder.
- **Pyroscrubber:** System designed to remove carbon-rich materials in a gas stream at high temperature.
- **Wet scrubber:** Removes contaminants in an air stream by bringing them into contact with a liquid (alkaline solutions).

11. References

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