



**CLEAN DEVELOPMENT MECHANISM  
PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM)  
Version 01 - in effect as of: 1 July 2004**

**CONTENTS**

- A. Identification of methodology
- B. Proposed new monitoring methodology

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**SECTION A. Identification of methodology****A.1. Title of the proposed methodology:**

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Changes in industrial process, energy efficiency, fuel switching, self-generation, and cogeneration equipment at an aluminium smelting facility.

**A.2. List of category(ies) of project activity to which the methodology may apply:**

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The UNFCCC CDM web site appears not to provide a list of categories of project activities, from which one might choose that applicable for this proposed new methodology.

Using the “Sectoral Scope” classification as applied to Designated Operational Entities, the category would be (9) Metal production.

A more specific category of project activity might be as indicated in the proposed methodology title.

**A.3. Conditions under which the methodology is applicable to CDM project activities:**

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This methodology would apply to the case where the project activity involves any one or any combination of the following activities at an aluminium smelting facility:

- Improvements in the smelting process
- Changes in the energy efficiency of any equipment using electricity
- Fuel switching involved with any on-site power generation equipment
- Addition of, or changes in, electricity self-generation equipment
- Addition of, or changes in, electricity cogeneration equipment
- Changes in energy efficiency (fuel saving) of any equipment using fuels

**A.4. What are the potential strengths and weaknesses of this proposed new methodology?**

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The potential strengths of the proposed new methodology include the following:

- it is applicable to a number of types of possible mitigation activities in aluminium smelting
- it is straightforward to apply

The potential weaknesses of the proposed new methodology include the following:

- The uncertainty associated with Anode Effect Frequency (AEF) and Anode Effect Duration (AED) or Anode Effect Over-voltage (AEO) measurements is expected to be low, but it will depend on computer scan rates (e.g. long scan rates will yield higher uncertainties) and data collection systems at each site. However, statistical error estimates for AEF and AED or AEO shall be reported in the PDD.

**SECTION B. Proposed new monitoring methodology**

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**B.1. Brief description of the new methodology:**

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The methodology considers process emissions of all GHGs at the aluminium smelting facility or a specific part of the facility where project activities are implemented, both in the baseline and the project scenarios. Two PFCs, tetrafluoromethane (CF<sub>4</sub>), and hexafluoroethane (C<sub>2</sub>F<sub>6</sub>) are known to be emitted



from the process of primary aluminium smelting. These PFCs are formed during the phenomenon known as anode effect (AE), when the aluminium oxide concentration in the reduction cell electrolyte is low.

SF<sub>6</sub> is infrequently used as a cover gas only for special foundry products. Since SF<sub>6</sub> is assumed to be inert, SF<sub>6</sub> emissions should equal consumption.

Carbon dioxide emissions are the result of reactions at the carbon anode, Na<sub>2</sub>CO<sub>3</sub> used in the process, and internal transport at the industrial facility. Electricity purchased from the grid results in emissions elsewhere in the power grid and electricity sold from the industrial facility through the grid reduces such emissions. If the project activities include either: (a) improvements in electricity efficiency in the manufacture of aluminium or (b) increased electricity generation or cogeneration at the industrial site, or both, power plant emissions would decrease as a result of the project activity. Thus power plant emissions are proportional to *net* electricity purchases in the baseline and project scenarios. Any fuels used at the industrial facility to generate electricity or prebake anode production would produce emissions from combustion. Any such emissions would be included in the baseline and project scenarios. This new methodology incorporates the following methodology:

- Approved consolidated monitoring methodology ACM0002 “Consolidated monitoring methodology for grid-connected electricity generation from renewable sources.”

**B.2. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario:**

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**B.2.1. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived:**

ID number (Please use numbers to ease cross-referencing to table B.7)	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment
P.1	Current efficiency of aluminium production process (CE)	Aluminium plant	%	m	Monthly	100%	Paper (field record) Electronic (spreadsheet)	
P.2	Anode Effect Over-voltage (AEO)	Aluminium plant	mV/cell.day	m	Daily	100%	Paper (field record) Electronic (spreadsheet)	
P.3	Aluminium production ( $P_{Al}$ )	Aluminium plant	tonne	m	Monthly	100%	Paper (field record) Electronic (spreadsheet)	
P.4	Total of Specific Carbon Consumption ( $SCC_{Total}$ )	Aluminium plant	kgC/tAl	m		100%	Paper (field record) Electronic (spreadsheet)	
P.5	Green anode tonnage (GWA)	Aluminium plant	tonne	m		100%	Paper (field record) Electronic (spreadsheet)	
P.6	Baked anode production (BAP)	Aluminium plant	tonne	m		100%	Paper (field record) Electronic (spreadsheet)	
P.7	Weight of hydrogen from pitch (HW)	Aluminium plant	tonne	m		100%	Paper (field record) Electronic (spreadsheet)	
P.8	Paste consumption (tPaste)	Aluminium plant	tonne	m		100%	Paper (field record) Electronic (spreadsheet)	
P.9	Quantity of soda consumption (SC)	Aluminium plant	tonne	m		100%	Paper (field record) Electronic (spreadsheet)	
P.10	Quantity of fuel consumption (Fty)	Aluminium plant	MJ/year	m		100%	Paper (field record) Electronic (spreadsheet)	
P.11	SF <sub>6</sub> consumption	Aluminium plant	kg	m		100%	Paper (field record) Electronic (spreadsheet)	
P.12	Anode effect frequency(AEF)	Aluminium plant	Number of anode effects per cell.day	m		10% to 100%	Paper (field record) Electronic (spreadsheet)	
P.13	Anode effect	Aluminium	minutes	m		10 to 100%	Paper (field record)	

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	<i>duration (AED)</i>	<i>plant</i>					<i>Electronic (spreadsheet)</i>	
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**B.2.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO<sub>2</sub> equ.):**

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The project activity could involve a variety of mitigation measures. It could involve changes in order to reduce process PFC or carbon dioxide emissions. Process activities could also involve improved energy efficiency in aluminium production. The project activity may also include increased electricity generation at the facility with increased export to the connected power grid. Finally, the project activity could involve replacing some or all fossil fuels currently being used by other lower carbon fuels for providing heat and electricity at the industrial facility. Any of these components would reduce GHG emissions compared to the baseline.

The project emissions  $PE$  (tCO<sub>2</sub>e/year) are given by Eq. (1):

$$PE = \sum_i FC_i (EF_i + MEF_i \cdot GWP(CH_4) + NEF_i \cdot GWP(N_2O)) + (NBEP + NPES) \cdot EF_{elec\ gen} + PE_{PFC} + PE_{Na_2CO_3} + PE_{CO_2 transport} + PE_{SF_6} + \sum_j PE_{CO_2 anode\ j}$$

$PE$	baseline emissions (tCO <sub>2</sub> e/year)
$FC_i$	consumption of fuel $i$ used in the project scenario, measured in energy units (e.g. GJ)
$EF_i$	carbon dioxide emission factor per unit energy of fuel $i$ (e.g. tCO <sub>2</sub> e/GJ) (combustion)
$MEF_i$	methane emission factor per unit energy of fuel $i$ (e.g. tCH <sub>4</sub> /GJ) (combustion)
$GWP(CH_4)$	global warming potential of CH <sub>4</sub> set as 21 tCO <sub>2</sub> e/tCH <sub>4</sub> for the 1 <sup>st</sup> commitment period
$NEF_i$	nitrous oxide emission factor per unit energy of fuel $i$ (e.g. tN <sub>2</sub> O/GJ) (combustion)
$GWP(N_2O)$	global warming potential of N <sub>2</sub> O set as 310 tCO <sub>2</sub> e/tN <sub>2</sub> O for the 1 <sup>st</sup> commitment period
$PE_{PFC}$	project emissions from CF <sub>4</sub> and C <sub>2</sub> F <sub>6</sub> (tCO <sub>2</sub> e)
$PE_{Na_2CO_3}$	project emissions of CO <sub>2</sub> e from Na <sub>2</sub> CO <sub>3</sub> (tCO <sub>2</sub> e)
$PE_{CO_2 transport}$	project emissions from internal transport in the industrial facility (tCO <sub>2</sub> e)
$PE_{SF_6}$	project emissions from SF <sub>6</sub> consumption (tCO <sub>2</sub> e)
$\sum_j BE_{CO_2 anode\ j}$	Prebake Technology = $BE_{CO_2 anode} + BE_{CO_2\ from\ pitch\ cooking} + BE_{CO_2\ from\ packing\ coke}$ Söderberg technology = $BE_{CO_2 anode\ Soderberg}$
$PE_{CO_2 anode}$	project emissions from anode consumption (Prebake technology) (tCO <sub>2</sub> e)
$PE_{CO_2\ from\ pitch\ cooking}$	project emissions from pitch coking (tCO <sub>2</sub> e)
$PE_{CO_2\ from\ packing\ coke}$	project emissions from packing coke (tCO <sub>2</sub> e)
$PE_{CO_2 anode\ Soderberg}$	project emissions from anode consumption (Söderberg technology) (tCO <sub>2</sub> e)

Eq. (2)

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Project emissions correspond to process emissions as well as emissions from fuels burnt at the aluminium plant. These fuels may produce electricity. If any electricity were exported from the facility through the connected grid, this would offset emissions elsewhere in the grid. Such emissions are counted in baseline emissions, as also emissions associated with net electricity purchases from the grid in the baseline scenario.

### **CO<sub>2</sub> baseline emissions from reactions at the carbon anode: Prebake anode production and Anode consumption**

To calculate the CO<sub>2</sub> emissions evolved from aluminium production processes for Prebake cells, the methodology described in Part A, below, should be used. For Søderberg cells, Part B should be used if the quantity of carbon contained in anode materials is known (weight per reporting period or per unit of production in metric tonnes).

#### **Part A - Carbon dioxide emissions from Prebake cells**

##### **Part A.1 - CO<sub>2</sub> emissions from anode consumption**

Aluminium is produced by the electrolytic reduction of alumina (Al<sub>2</sub>O<sub>3</sub>). During the reduction process the aluminium smelting pot acts as the electrolytic cell. The pot itself forms the cathode, while the anode consists of one or more carbon blocks suspended in it. In the pot, Al<sub>2</sub>O<sub>3</sub> is dissolved in a bath of fluoride salts, consisting primarily of cryolite, Na<sub>3</sub>AlF<sub>6</sub>. Passing electrolysis current through the cell also causes Ohmic heating, which maintains the electrolyte in a liquid state. Molten aluminium is produced while the anode is consumed in the reaction. The aluminium forms at the cathode and gathers at the bottom of the pot. Most carbon dioxide is formed in the reaction of the carbon anode with the oxygen from alumina, but some is also formed by anode oxidation with other sources of oxygen (especially air). The proposed project activity is expected to reduce CO<sub>2</sub> emissions from anode consumption by increasing current efficiency.

**Estimated project anode CO<sub>2</sub> emissions,  $PE_{CO_2 \text{ anode}}$ , are given by:**

$$PE_{CO_2 \text{ anode}} (tCO_2/year) = PE_{CO_2 \text{ MRA}} (tCO_2/year) = \text{Mass Reducing Agent} \cdot 44/12 \quad \text{Eq. (3)}$$

where:

$$\text{Mass Reducing Agent} = SCC_{Total} \cdot P_{Al} \quad \text{Eq. (4)}$$

$$SCC_{Total} (tCO_2/year) = SCC_{Stoichiometric} + SCC_{CE} + SCC_{Non-electrochemical \text{ oxidation}} \quad \text{Eq. (5)}$$

$P_{Al}$  = annual aluminium production (tAl/year)

$SCC_{Stoichiometric}$  = Specific carbon consumption, given by the following reaction:

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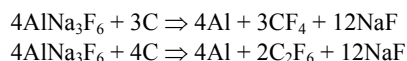
This value is: 333 kgC/tAl.

$SCC_{CE}$  = Specific carbon consumption generated by the current passing through an anode without producing aluminium. Such a value may be estimated by means of the following formula:

$$SCC_{CE} (t\text{CO}_2/\text{year}) = SCC_{Stoichiometric} (1 - CE)/CE \quad \text{Eq. (7)}$$

where CE is the current efficiency.

This value includes specific carbon consumption during the anode effect, given by the following reactions:



Carbon consumption during the anode effect is determined from the specific generation of  $\text{CF}_4$  and  $\text{C}_2\text{F}_6$  (kgPFC/tAl). This value is extremely low and is accounted for in the PFC emissions. Thus, these values need to be discounted from  $SCC_{CE}$ . The redefined value ( $SCC_{CE*}$ ) is given by the following formula:

$$SCC_{CE*} (t\text{CO}_2/\text{year}) = SCC_{CE} - SCC_{AE} \quad \text{Eq. (8)}$$

$SCC_{Non-electrochemical \text{ oxidation}}$  = Carbon consumption produced by air oxidation of the anode. Current circulation causes anode temperature increase, favoring anode oxidation and break-up. Thus there is an additional carbon consumption that is not involved in aluminium production.

**Comment [GSD1]:** Suggest deleting.

Three terms contributes to  $SCC_{Total}$ , but if the project activity involves changes in the CE, only  $SCC_{CE}$  is affected by it. Thus, only CE and  $P_{Al}$  will need to be monitored. Thus we redefine  $\text{CO}_2$  project emissions as:

$$PE_{\text{CO}_2 \text{ anode}} (t\text{CO}_2/\text{year}) = SCC_{CE*} \cdot 44/12 \cdot P_{Al} \quad \text{Eq. (9)}$$

If the project involves anode consumption savings Eq. (3) will be used. Following project implementation  $SCC_{Total}$ , CE, and  $P_{Al}$  will be monitored, and then *ex post* project emissions will be obtained from Eq. (3) or Eq. (9).



**Part A.2 - Process carbon dioxide emissions from anode baking furnace**Part A.2.1. Pitch volatile matter oxidation from pitch cooking

$$PE_{CO_2 \text{ from pitch cooking}} (tCO_2 e) = (GWA - BAP - HW - RT / 1000) \cdot 44 / 12$$

and

$$HW(t) = H_2 / 100 \cdot PC / 100 \cdot GWA$$

Eq. (10)

where:

$GWA$  = green anode tonnage (t)

$BAP$  = baked anode production (t)

$HW$  = weight of hydrogen from pitch (t)

$H_2$  = hydrogen content in pitch (wt%) = 4.45

$PC$  = average pitch content (wt%) in green anode = 15

$RT$  = recovered tar (t) = 5 kg/t BAP for Riedheimer furnace and  
0 kg/t for other furnaces

Following project implementation  $GWA$ ,  $BAP$  and  $HW$  will be monitored, and then *ex post* project emissions will be obtained from Eq. (10).

Part A.2.2. Bake pitch volatile matter oxidation from pitch cooking

$$PE_{CO_2 \text{ from packing coke}} (tCO_2 e) = [PCC \cdot BAP \cdot (100 - \%Ash_{pc} - \%S_{pc}) / 100] \cdot 44 / 12$$

Eq. (11)

where:

$PCC$  = packing coke consumption per tonne of baked anode ( $t_{coke} / t_{anodes}$ ) = 0.050

$BAP$  = baked anode production (t)

$Ash_{pc}$  = ash content in packing coke (wt%) = 5

$S_{pc}$  = sulphur content in packing coke (wt%) = 3

Following project implementation  $BAP$  will be monitored, and then *ex post* project emissions will be obtained from Eq. (11).

**Part B - Søderberg CO<sub>2</sub> emissions from anode consumption ( $BE_{CO_2, anode\ Soderberg}$ )**

$$PE_{CO_2 \text{ anode Söderberg}} (tCO_2 e / year) = [(PC \cdot P_{Al}) - (BSM \cdot P_{Al} / 1000)] -$$

$$- [\%BC / 100 \cdot PC \cdot P_{Al} \cdot [\%S_p + \%Ash_p + (H_2 / 100)]] -$$

$$- \{[(100 - \%BC) / 100] \cdot PC \cdot P_{Al} \cdot [(\%S_c + \%Ash_c) / 100]\} \cdot 44 / 12$$

Eq. (12)

where:

$$PC = \text{paste consumption (tPaste/tAl)}$$

$BSM$  = emissions of benzene soluble matter (kg/tAl) = 0.5 (VSS)  
= 4.0 (HSS)

$$BC = \text{average binder content (wt \%)} \text{ in paste} = 25 - 30$$
$$S_p = \text{sulphur content in pitch (wt \%)} = 0.55$$
$$Ash_p = \text{ash content in pitch (wt \%)} = 0.15$$
$$H_2 = \text{hydrogen content (wt \%)} \text{ in pitch} = 4.5$$
$$S_c = \text{sulphur content in calcinated coke (wt \%)} = 1.8$$
 $Ash_c$  = ash content in calcinated coke (wt %) = 0.1

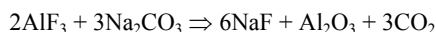
Following project implementation  $P_{Al}$  and PC ( $tPaste/tAl$ ) will be monitored, and then *ex post* project emissions will be obtained from Eq. (12).

**Note:** Parts A.2 and B of the new methodology are based on “Calculating Direct GHG Emissions from Primary Aluminium Metal Production,” GHG Protocol.

### Project emission of CO<sub>2</sub> from Na<sub>2</sub>CO<sub>3</sub> used in aluminium production processes

$\text{Na}_2\text{CO}_3$  is used to correct the relation of  $\text{AlF}_3/\text{NaF}$  concentrations in the electrolytic bath. The objective is to exceed  $\text{AlF}_3$  by 11% of  $\text{NaF}$ . After reconstruction of the cathodic coating, pot bottom absorbs  $\text{NaF}$  increasing  $\text{AlF}_3$  proportion in the bathroom.  $\text{Na}_2\text{CO}_3$  is also added when surplus of  $\text{AlF}_3$  increases for some reason and it is necessary to correct diversion. However, this last cause is not frequent since there are other measures to control deviation.

This circumstance (i.e. high surplus of  $\text{AlF}_3$  in the bathroom) has an effect on the thermal balance of the pot. The temperature of the bath goes down and current performance also decreases. Less aluminium produced by kA and passed through the pot. Then  $\text{Na}_2\text{CO}_3$  is added to transform  $\text{AlF}_3$  into  $\text{NaF}$  in accordance with the following reaction:



Estimated project CO<sub>2</sub> emissions,  $PE_{N_{a_2}CO_2}$ , are given by:

$$PE_{Na,CO_2}(tCO_2) = SC \cdot 44/106 \quad Eq. (13)$$

where:

$$SC = \text{quantity of soda consumed } (t)$$

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Following project implementation  $\text{Na}_2\text{CO}_3$  consumption will be monitored, and then *ex post* project emissions will be obtained from Eq. (13).

### **CO<sub>2</sub> project emissions from transport**

There are CO<sub>2</sub> emissions from internal transport of anodes and aluminium within the plant location. For each year  $y$ , these emissions are expressed as:

$$BE_{CO_2 \text{ transport}_y} = FT_y \cdot E_{F_y} \quad \text{Eq. (14)}$$

where:

$BE_{CO_2 \text{ transport}_y}$  = CO<sub>2</sub> baseline emissions from internal transport (tCO<sub>2</sub>e/year)

$FT_y$  = Quantity of fuel consumed by the heavy-duty vehicles (MJ/year)

$E_{F_y}$  = Emission factor of fuel consumed by heavy-duty vehicles (tCO<sub>2</sub>e/MJ of fuel)

$FT_y$  can be obtained from:

- (1) Volume of fuel consumed by heavy-duty vehicles (litres/year)
- (2) Fuel density (kg/litre)
- (3) Lower heating value of fuel (MJ/kg)

$$FT_y = (1) \times (2) \times (3) \text{ in MJ/yr}$$

Following project implementation fuel consumption will be monitored, and then *ex post* project emissions will be obtained from Eq. (14).

### **SF<sub>6</sub> project emissions**

In the aluminium industry SF<sub>6</sub> is infrequently used as a cover gas only for special foundry products. Since SF<sub>6</sub> is assumed to be inert, SF<sub>6</sub> emissions should equal consumption.

Estimated project CO<sub>2</sub>e emissions,  $PE_{SF_6}$ , are given by:

$$PE_{SF_6} = \text{Consumption of } SF_6 \quad \text{Eq. (15)}$$

$$\text{Emission of } SF_6 \text{ (tCO}_2\text{e)} = \text{consumption of } SF_6 \text{ (kg)} \cdot \text{CO}_2 \text{ Conversion Factor (tCO}_2\text{/kgSF}_6\text{)}$$

Following project implementation SF<sub>6</sub> consumption will be monitored, and then *ex post* project emissions will be obtained from Eq. (15).

**PCF baseline emissions**

Estimated project PFC emissions,  $PE_{PFC}$ , are given by:

$$PE_{PFC} (tCO_2e / year) = \left( \frac{EF_{CF_4} \cdot GWP_{CF_4} + EF_{C_2F_6} \cdot GWP_{C_2F_6}}{1000} \right) \cdot P_{Al} \quad Eq. (16)$$

where:

$EF_{CF_4}$  = Emission factor of  $CF_4$  (kg $CF_4$ /tAl)

$EF_{C_2F_6}$  = Emission factor of  $C_2F_6$  (kg $C_2F_6$ /tAl) = 1/10 of  $EF_{CF_4}$

$GWP_{CF_4}$  = Global Warming Potential of  $CF_4$  = 6,500

$GWP_{C_2F_6}$  = Global Warming Potential of  $C_2F_6$  = 9,200

$P_{Al}$  = Total aluminium production of the company (tAl/year)

The *IPCC Guidelines* describe three general methods for estimating PFC emission factor from aluminium production (Vol.3, Section 2.13.6, PFCs from Aluminium Production). These three methods correspond to tiers, but are not identified as such. To be consistent with other sections of the *IPCC Guidelines* and the *good practice guidance*, the methods presented in the *IPCC Guidelines* are referred to as tiers in this section. The most accurate method is either to monitor smelter emissions continuously (Tier 3a) or to develop a smelter specific long-term relationship between measured emissions and operating parameters and to apply this relationship using activity data (Tier 3b). The Tier 3b method requires comprehensive measurements to develop the smelter-specific relationship and on-going collection of operating parameter data (e.g. frequency and duration of anode effects and the Anode Effect Over-voltage) and production data. Where a smelter-specific relationship has not been developed but information on operating parameters and production is available, default technology specific slope and over-voltage coefficients may be used (Tier 2). Where the only information available is the annual quantity of aluminium produced, default emission factors by technology type may be used (Tier 1). The level of uncertainty in the Tier 1 method will be much greater than for estimations produced using Tier 3 or Tier 2 methods. For this reason Tier 3 or Tier 2 Methods will be used in this methodology.

**Tier 3a Method – Continuous emission monitoring**

Continuous monitoring of emissions is possible and is the most accurate means of determining emissions. Given likely cost and other resource considerations, however, it is not regarded as necessary for *good practice*. For details on direct measurement techniques, see Direct Measurement Techniques, below.

**Direct measurement techniques**

Sampling and measurement must be performed to a *good practice* standard to ensure the accuracy of the data, which means that:

- Measurements of PFCs at smelters should account for both emissions captured by the reduction cell hooding and extracted by the fume exhaust duct, and also fugitive emissions released into the

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potroom<sup>1</sup> atmosphere. Ideally, these data can be obtained by direct measurement of PFCs in duct and fugitive emissions. Otherwise, direct measurement of PFCs in duct emissions can be conducted along with careful measurement of the cell hooding capture efficiency, allowing fugitive emissions to be calculated.

- The analytical technology used should be capable of measuring both CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> gases simultaneously. Several suitable analytical technologies are available. The technology chosen must have a suitable dynamic range for the measurement of expected concentrations of duct emissions and fugitive emissions. The sensitivity of the detection should be capable of reliable measurement at the lowest levels expected in electrolysis cell exhaust ducts and for fugitive emissions where fugitive emissions account for 5% or more of total PFC emissions. The dynamic range of the measurement device should be capable of reliable measurement to the highest concentration to be measured. For duct emissions, this means a concentration measurement range of 0 to 1000 ppmv (parts per million by volume). Measurements should be normalised for temperature and pressure and these measurement conditions must be reported and recorded with the concentration measurements that will be used when calculating mass emissions.
- Duct volumetric gas flow measurements should be performed according to nationally or internationally recognised standards. Gas flow measurements should be performed during the course of the concentration measurement program at sufficient intervals to ensure accurate representation of the volumetric gas flow. Measurements should be normalised for temperature and pressure and these measurement conditions must be reported and recorded with the flow measurements that will be used when calculating mass emissions.
- Calibration of analytical instruments should be performed at regular intervals during the measurement campaign. The required schedule for calibrations will vary according to the type and known stability of the analytical instrumentation used but must be sufficient to minimise the effect of instrument calibration drift. The results of all calibrations should be reported and recorded with the concentration measurement. Measurements affected by drift should be omitted from emission estimations. Calibration gases should be traceable to recognised national or international standards. The calibration method should be thoroughly documented and recorded with the emission measurements.

### **Tier 3b Method – Smelter-specific relationship between emissions and operating parameters based on field measurements**

This method uses periodic measurements to establish a smelter-specific relationship between operating parameters (i.e. frequency and duration of anode effects or Anode Effect Over-voltage) and emissions of CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub>. Once established, the relationship can be used along with process data collected on an on-

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<sup>1</sup> The potroom is the standard industry term for the large room in which the reduction cells or 'pots' are housed. The smelting cells have hooding which, depending on the smelter design, age etc., will have varying fume collection efficiency. The collected fume is transported via ducts to a fume scrubbing facility where other pollutants are removed. Fume that escapes from the hooding may either be collected in a fume manifold and also transported to the fume scrubbing facility or exhausted to atmosphere through the potroom roof. Since the potrooms may be up to a kilometre long and 20 metres or more in width, accurate measurements of fugitive emissions may not be feasible. Therefore, measurements of PFCs in collected fume and fugitive fume are required or else measurements of collected fume along with a comprehensive understanding of the fume collection efficiency is required to ensure that PFCs captured by the scrubbing system along with fugitive emissions are included in estimations.



going basis, to estimate emissions factors over time. These emission factors are multiplied by smelter-specific production (tonnes) to estimate smelter emissions.

The following estimation relationships can be used:

**Slope Method:** This method uses a linear least squares relationship between anode effect (*AE*) minutes per cell.day<sup>2</sup> and emissions, expressed as an emission factor (*EF*):

$$EF (kg CF_4 \text{ or } C_2F_6 \text{ per tonne of Al}) = Slope \cdot AE \text{ min/ cell.day} \quad Eq. (17)$$

To develop an accurate estimate of the slope, simultaneous measurements of emissions and collection of anode effect data over an appropriate period of time are required. The Slope Method is a variant of the **Tabereaux approach** described in the *IPCC Guidelines*. It is recommended that specific CF<sub>4</sub> emissions for anode effects longer than 2 minutes be calculated as follows:

#### Tabereaux Approach

$$EF (kg CF_4 \text{ or } C_2F_6 \text{ per tonne of Al}) = Slope \cdot AE \text{ min/ cell.day} \quad Eq. (18)$$

$$Slope = 1.698 (p / CE) \quad \text{and} \quad AE \text{ min/ cell.day} = AEF \cdot AED$$

where:

*p* = Average fraction of CF<sub>4</sub> in the cell gas during anode effects for the CF<sub>4</sub> slope or Average fraction of C<sub>2</sub>F<sub>6</sub> in the cell gas during anode effects for the C<sub>2</sub>F<sub>6</sub> slope

Prebake: *p* = 0.08 (8%)

Söderberg: *p* = 0.04 (4%)

*CE* = Current Efficiency for the aluminium production process, expressed as a fraction rather than as a percentage

*AEF* = Number of anode effects per cell.day

*AED* = Anode effect duration in minutes

**Pechiney Overvoltage Method:** This method uses the Anode Effect Over-voltage as the relevant process parameter. The Anode Effect Over-voltage is the extra cell voltage, above 8V, caused by anode effects, when averaged over a 24-hour period (mV/day). The correlation formula was derived from measurements of PFC generation at smelters with Pechiney technology, expressed as an emission factor (*EF*):

$$EF (kg CF_4 \text{ or } C_2F_6 \text{ per tonne of Al}) = OVC \cdot AEO / CE \quad Eq. (19)$$

where:

<sup>2</sup> The 'cell.day' term really means 'the number of cells operating multiplied by the number of days of operation.' At a smelter this would more usually be calculated (for a certain period of time, e.g. a month or a year) using 'the average number of cells operating across the smelter over a certain period of days multiplied by the number of days in the period.'



$OVC$  = Over-Voltage Coefficient

$AEO$  = Anode effect over-voltage in mV/cell.day

$CE$  = Aluminium production process current efficiency expressed in percent

### Tier 2 Method – Smelter-specific relationship between emissions & operating parameters based on default technology-based slope and over-voltage coefficients

If measurement data are not available to determine smelter-specific Slope or Over-voltage coefficients, default coefficients may be used together with smelter-specific operating parameters. *Good practice* default coefficients are listed in Table 1, Default Coefficients for the Calculation of PFC Emissions from Aluminium Production (Tier 2 Methods).

#### Default Coefficients for the Calculation of PFC Emissions from Aluminium Production (TIER 2 Methods)

Technology <sup>a</sup>	Slope <sup>b,d</sup> [(kg <sub>PFC</sub> /tAl)/(AE-Minutes/cell.day)]				Over-voltage coefficient <sup>b</sup> [(kg <sub>PFC</sub> /tAl)/(mV/cell.day)]	
	CF <sub>4</sub>	Uncertainty	C <sub>2</sub> F <sub>6</sub>	Uncertainty	CF <sub>4</sub>	C <sub>2</sub> F <sub>6</sub>
CWPB	0.14	±0.009	0.018	±0.004	1.9	NA
SWPB	0.29	±0.02	0.029	±0.01	1.9	NA
VSS	0.068 <sup>g</sup>	±0.02	0.003	±0.001	See note e	-
HSS	0.18 <sup>f</sup>		0.018		-	-

a Centre Worked Prebaked (CWPB), Side Worked Prebaked (SWPB), Vertical Stud Søderberg (VSS), Horizontal Stud Søderberg (HSS).

b Source: IPAI, EPA field measurements, and other company measurement data.

c There is inadequate data for establishing a slope coefficient for C<sub>2</sub>F<sub>6</sub> emissions from SWPB cells based on measurement data; therefore a default of one-tenth of the CF<sub>4</sub> coefficient is *good practice*, consistent with the *IPCC Guidelines*.

d Embedded in each Slope coefficient is an assumed emissions collection efficiency as follows: CWPB 95%, SWPB 90%, VSS 85%, HSS 90%. These collection efficiencies have been assumed based on expert opinion. While collection efficiency for HSS cells may vary, the company measurement data used for calculation of these coefficients are consistent with a collection efficiency of at least 90%.

e Overvoltage coefficients are not relevant to VSS and HSS technologies.

f The HSS Slope coefficients are based on 1991 IPAI survey data.

g Further work on emission measurement and uncertainty analysis should be pursued for VSS. These default coefficients are based on a small number of data, and it is expected that the uncertainty might be higher than for other coefficients (Bjerke, 1999a, and Bjerke *et al.*, 1999b).

NA = not available.

Following project implementation the ex post emissions of the project are obtained by placing the monitored values,  $AEO$  (or  $AED$  and  $AEF$ ),  $CE$  and  $PAI$ , in the Eq. (16).

**Note:** The uncertainty associated with  $AEF$  and  $AED$  or  $AEO$ , when measured, is expected to be low but will depend on computer scan rates (e.g. long scan rates will yield higher uncertainties) and data collection systems at each site. However, statistical error estimates for  $AEF$  and  $AED$  or  $AEO$  should be reported in the PDD.

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<b>B.2.3. Relevant data necessary for determining the <u>baseline</u> of anthropogenic emissions by sources of greenhouse gases (GHG) within the project boundary and how such data will be collected and archived:</b>								
ID number (Please use numbers to ease cross-referencing to table B.7)	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
B.1	Current efficiency of aluminium production process (CE)	Aluminium plant	%	m	Monthly	100%	Paper (field record) Electronic (spreadsheet)	
B.2	Aluminium production ( $P_{Al}$ )	Aluminium plant	tonne	m	Monthly	100%	Paper (field record) Electronic (spreadsheet)	
B.3	Baseline Anode effect frequency(AEF)	Aluminium plant	Number of anode effects per cell.day	m		10% to 100%	Paper (field record) Electronic (spreadsheet)	
B.4	Baseline Anode effect duration (AED)	Aluminium plant	minutes	m		10 to 100%	Paper (field record) Electronic (spreadsheet)	
B.5	Net electricity supplied to grid in the project (NPES)	Aluminium plant / electricity purchaser	MWh	m	monthly	100%	Electronic (paper can be used for field record)	
B.6	Net electricity purchased from grid in the baseline (NBEP)	Aluminium plant / electricity supplier	MWh	m	monthly	100%	Electronic (paper can be used for field record)	

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**B.2.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO<sub>2</sub> equ.):**

>>

Baseline emissions  $BE$  (expressed in tonne CO<sub>2</sub> equivalent per year, tCO<sub>2</sub>e/year) are given by Eq. (20):

$$BE = \sum_i BFC_i (EF_i + MEF_i \cdot GWP(CH_4) + NEF_i \cdot GWP(N_2O)) + (NBEP + NPES) \cdot EF_{elec\ gen} + BE_{PFC} + BE_{CO_2 transport} + BE_{SF_6} + BE_{Na_2CO_3} + \sum_j BE_{CO_2 anode\ j}$$

where:

$BE$	baseline emissions (tCO <sub>2</sub> e/year)
$BFC_i$	consumption of fuel $i$ used in the baseline scenario, measured in energy units (e.g. GJ)
$EF_i$	carbon dioxide emission factor per unit energy of fuel $i$ (e.g. tCO <sub>2</sub> /GJ) (combustion)
$MEF_i$	methane emission factor per unit energy of fuel $i$ (e.g. tCH <sub>4</sub> /GJ) (combustion)
$GWP(CH_4)$	global warming potential of CH <sub>4</sub> set as 21 tCO <sub>2</sub> e/tCH <sub>4</sub> for the 1 <sup>st</sup> commitment period
$NEF_i$	nitrous oxide emission factor per unit of energy of fuel $i$ (e.g. tN <sub>2</sub> O/GJ) (combustion)
$GWP(N_2O)$	global warming potential of N <sub>2</sub> O set as 310 tCO <sub>2</sub> e/tN <sub>2</sub> O for the 1 <sup>st</sup> commitment period
$NBEP$	net electricity purchased (electricity purchased less electricity sold) through the grid in the baseline (e.g. MWh)
$EF_{elec\ gen}$	baseline emission factor for grid electricity generation (e.g. kg CO <sub>2</sub> e/MWh)
$BE_{PFC}$	baseline emissions from CF <sub>4</sub> and C <sub>2</sub> F <sub>6</sub> (tCO <sub>2</sub> e)
$BE_{CO_2 transport}$	baseline emissions from internal transport in the industrial facility (tCO <sub>2</sub> e)
$BE_{SF_6}$	baseline emissions from SF <sub>6</sub> consumption (tCO <sub>2</sub> e)
$BE_{Na_2CO_3}$	baseline emissions of CO <sub>2</sub> e from Na <sub>2</sub> CO <sub>3</sub> (tCO <sub>2</sub> e)
$\sum_j BE_{CO_2 anode\ j}$	Prebake technology = $BE_{CO_2 anode} + BE_{CO_2 from pitch\ cooking} + BE_{CO_2 from packing\ coke}$ Eq. (21)
	Söderberg technology = $BE_{CO_2 anode\ Söderberg}$
$BE_{CO_2 anode}$	baseline emission from anode consumption (Prebake technology) (tCO <sub>2</sub> e)
$BE_{CO_2 from pitch\ cooking}$	baseline emission from pitch cooking (tCO <sub>2</sub> e)
$BE_{CO_2 from packing\ coke}$	baseline emission from packing coke (tCO <sub>2</sub> e)
$BE_{CO_2 anode\ Söderberg}$	baseline emission from anode consumption (tCO <sub>2</sub> e) (Söderberg technology)

A part of baseline emissions correspond to the emissions from fuels burnt at the aluminium plant in the baseline scenario. Electricity purchased through the connected power grid to meet a part or all of the demand at the plant would cause emissions elsewhere in the power grid. Such emissions are included. The emissions associated with grid electric power generation depend on  $NBEP$  and  $EF_{elec\ gen}$ , the emissions



factor for electricity generation in the connected power grid. Electricity sales in the project scenario would increase baseline emissions elsewhere in the grid. Thus net electricity sales in the project scenario needs to be included in the baseline emissions.

The CDM Executive Board has already approved a consolidated methodology for determining  $EF_{elec\ gen}$ . We recommend the incorporation of this methodology denominated ACM0002 as a component of the proposed new methodology, for the purpose of determining  $EF_{elec\ gen}$ . ACM0002 offers some alternative pathways for determining  $EF_{elec\ gen}$ , and each specific PDD should adopt a specific procedure, according to its circumstances.

Note that ACM0002 is actually designated “Consolidated baseline methodology for grid-connected electricity generation from renewable sources.” When the project involves electricity generation from renewable sources, project emissions for electricity generation are negligible, and the baseline emissions are emissions avoided elsewhere in the power grid. The new methodology being proposed here is related to electricity generation at an aluminium plant using fuels, which need not be renewable. However, the emissions from these fuels are being estimated and counted as part of project emissions, and thus, as far as the baseline is concerned, ACM0002 should be perfectly applicable.

AM0014 offers an alternative procedure for estimating  $EF_{elec\ gen}$ , namely the “Simplified Methodology for Small-scale CDM Project Activities,” which would be applicable in case electricity displaced is less than or equal to 15 MW equivalent.

Thus, this proposed new methodology recommends the use of either ACM0002 or the simplified methodology for small-scale projects, as appropriate.

Process emissions are discussed in detail below.

### **CO<sub>2</sub> baseline emissions from reactions at the carbon anode: Prebake anode production and Anode consumption**

#### **Part A - Electrolysis carbon dioxide emissions from Prebake cells**

##### **Part A.1 - CO<sub>2</sub> emissions from anode consumption**

Estimated anode baseline CO<sub>2</sub> emissions,  $BE_{CO_2\ anode}$ , are given by:

$$BE_{CO_2\ anode} (tCO_2/year) = BE_{CO_2\ MRA} (tCO_2/year) = Mass\ Reducing\ Agent \cdot 44/12 \quad Eq. (22)$$

Three terms contribute to  $SCC_{Total}$ , but if the project activity involves only changes in the  $CE$ , only  $SCC_{CE}$  would be affected by it ( $CE$ : these value is set ex ante and will remain constant through the project activity). *Ex post* calculations of CO<sub>2</sub> baseline emissions could be obtained from Eq. (22), but if  $SCC_{Stoichiometric}$  and  $SCC_{Non-electrochemical\ oxidation}$  will not change along project implementation, we could redefine CO<sub>2</sub> baseline emissions as:

$$BE_{CO_2\ anode} (tCO_2/year) = SCC_{CE*} \cdot 44/12 \cdot P_{Al} \quad Eq. (23)$$

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Thus,  $P_{Al}$  will need to be monitored.

If the project activity involves anode consumption savings, the project emissions will be obtained from Eq. (22). During the project  $SCC_{Total}$ ,  $CE$  and  $P_{Al}$  will be to be monitored.

## Part A.2 - Process carbon dioxide emissions from anode baking furnace

### Part B - Søderberg baseline $CO_2$ emissions from anode consumption ( $BE_{CO_2anode\ Soderberg}$ )

$$BE_{CO_2anode\ Soderberg} (tCO_2e / year) = [(PC \cdot P_{Al}) - (BSM \cdot P_{Al} / 1000)] - \left\{ \%BC / 100 \cdot PC \cdot P_{Al} \cdot [\%S_p + \%Ash_p + (H_2 / 100)] \right\} - \left\{ [(100 - \%BC) / 100] \cdot PC \cdot P_{Al} \cdot [\%S_c + \%Ash_c] / 100 \right\} \cdot 44 / 12 \quad Eq. (24)$$

where:

$PC$  = paste consumption (tPaste/tAl)  
 $BSM$  = emissions of benzene soluble matter (kg/tAl) = 0.5 (VSS) = 4.0 (HSS)  
 $BC$  = average binder content (wt %) in paste = 25 – 30  
 $S_p$  = sulphur content in pitch (wt %) = 0.55  
 $Ash_p$  = ash content in pitch (wt %) = 0.15  
 $H_2$  = hydrogen content (wt %) in pitch = 4.5  
 $S_c$  = sulphur content in calcinated coke (wt %) = 1.8  
 $Ash_c$  = ash content in calcinated coke (wt %) = 0.1

During the project,  $P_{Al}$  will be monitored and then *ex post* baseline emissions will be obtained from Eq. (24). *Ex post* baseline emissions will be determined through historical data of PC (tPaste/tAl, fixing its value for the entire crediting period) and annual aluminium production ( $P_{Al}$ ).

### Baseline PFC emissions

Estimated baseline PFC emissions,  $BE_{PFC}$ , are given by:

$$BE_{PFC} (tCO_2e / year) = \left( \frac{EF_{CF_4} \cdot GWP_{CF_4} + EF_{C_2F_6} \cdot GWP_{C_2F_6}}{1000} \right) \cdot P_{Al} \quad Eq. (25)$$

where:

$EF_{CF_4}$  = Emission factor of  $CF_4$  (kg $CF_4$ /tAl)  
 $EF_{C_2F_6}$  = Emission factor of  $C_2F_6$  (kg $C_2F_6$ /tAl) = 1/10 of  $EF_{CF_4}$   
 $GWP_{CF_4}$  = Global Warming Potential of  $CF_4$  = 6,500  
 $GWP_{C_2F_6}$  = Global Warming Potential of  $C_2F_6$  = 9,200  
 $P_{Al}$  = Total aluminium production of the company (tAl/year)

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By using historic data of the plant (*AEO* (or *AED* and *EAF*) and *CE*), *ex-ante*  $\text{CF}_4$  and  $\text{C}_2\text{F}_6$  emission factor are set and will remain constant throughout the crediting period. *Ex-post* baseline emissions will be estimated from Eq. (25) using the aluminium production data by the plant for the crediting period. During the project  $P_{Al}$  will be monitored and then *ex-post* baseline emissions will be obtained from Eq. (25).

**Note:** The uncertainty associated with *AEF* and *AED* or *AEO*, when measured, is expected to be low but will depend on computer scan rates (e.g. long scan rates will yield higher uncertainties) and data collection systems at each site. However, statistical error estimates for *AEF* and *AED* or *AEO* should be reported in the PDD.

**B.3. Option 2: Direct monitoring of emission reductions from the project activity:**

&gt;&gt;

**B.3.1. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived:**

ID number (Please use numbers to ease cross-referencing to table B.7)	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment

**B.3.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO<sub>2</sub> equ.):**

&gt;&gt;

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**B.4. Treatment of leakage in the monitoring plan:**

&gt;&gt;

No leakage is associated with reduction in process emissions at an aluminium plant.

One possible source of leakage is in changes in fuel use patterns whereby there is increased fugitive emissions associated with increased fuel use at the industrial site and/or where there are increased energy consumption associated with fuel transport.

Possible leakage is likely to be small in magnitude compared to other emission, and it will be estimated using fuel consumption values monitored. No additional monitoring is required.

**B.4.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity:**

ID number (Please use numbers to ease cross-referencing to table B.7)	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment

**B.4.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO<sub>2</sub> equ.):**

&gt;&gt;

Fugitive CH<sub>4</sub> emissions from fuel production and CO<sub>2</sub> emissions from fuel transportation are categorized as leakage. Emissions from fuel production/transportation is counted only if the fuel is produced/transported in a non-Annex I country.

The leakage  $LE_y$  is expressed as

$$LE = (FC_i - BFC_i) \cdot FE_i(CH_4) \cdot GWP(CH_4) + \sum_j TF_j \cdot EF_j - \sum_k BTF_k \cdot EF_k \quad Eq. (31)$$

where  $FE_i(CH_4)$  is the IPCC default methane emission factor of fuel  $i$  associated with fugitive emissions. Typical fuels might be natural gas and coal, the former more likely in the project scenario and that latter more likely in the baseline. Fugitive methane emissions are associated with natural gas production and pipeline leakage. Fugitive methane emissions are also associated with coal mining. In case that the effect of these methane emissions cannot be neglected, they should be included here.

The second line in the above formula refers to emissions from fuel transportation, shown as a product of the transportation fuels used and the corresponding CO<sub>2</sub> emissions factor for the fuel. The first sum applies to transport fuels used in the project scenario while the second term corresponds to the baseline

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scenario (such as marine, railroad or truck). In case those information and data are not available due to uncertainties and diversities in energy market, the IPCC default value could apply. Otherwise, it could be estimated qualitatively in view of the relatively small magnitude of CO<sub>2</sub> emissions from fuel transportation in typical industrial fuels.

**B.5. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO<sub>2</sub> equ.):**

>>

The emission reduction *ER* by the project activity is given by:

$$ER = BE - PE - LE \quad \text{Eq. (32)}$$

expressed in tonnes of CO<sub>2</sub> equivalent (tCO<sub>2</sub>e/year).

The detailed formulae for determining project, baseline and leakage emissions were provided in earlier sections.

**B.6. Assumptions used in elaborating the new methodology:**

>>

All equations that make up the determination of project emissions are straightforward and transparent.

The uncertainty associated with Anode Effect Frequency (*AEF*) and Anode Effect Duration (*AED*) or Anode Effect Over-voltage (*AEO*) measurements is expected to be low, but it will depend on computer scan rates (e.g. long scan rates will yield higher uncertainties) and data collection systems at each site. However, statistical error estimates for *AEF* and *AED* or *AEO* shall be reported in the PDD.

Wherever data limitations might exist, this methodology proposes alternative procedures and, in case of doubt, how to make conservative assumptions.

**B.7. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored:**

Data (Indicate table and ID number e.g. 3.-1.; 3.2.)	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
P.1	Low	The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process
P.2	Low	The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process
P.3	Low	The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process
P.4	Low	The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process
P.5	Low	The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process

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P.6	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.7	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.8	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.9	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.10	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.11	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.12	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
P.13	Medium	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
B.1	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
B.2	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
B.3	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
B.4	Medium	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
B.5	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>
B.6	Low	<i>The aluminium plant should have a series of internal procedures that ensures data have low uncertainties during monitoring process</i>

**B.8. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?**

&gt;&gt;

It is the first time this methodology is applied.

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