

ANNEX IV U.K.

Activity-specific monitoring methodologies related to installations (Article 20(2))**8. PFC emissions from production or processing of primary aluminium as listed in Annex I to Directive 2003/87/EC U.K.****A. Scope U.K.**

The operator shall apply the following for emissions of perfluorocarbons (PFCs) resulting from anode effects including fugitive emissions of PFCs. For associated CO₂ emissions, including emissions from electrode production, the operator shall apply section 7 of this Annex.

B. Determination of PFC emissions U.K.

PFC emissions shall be calculated from the emissions measurable in a duct or stack ('point source emissions') as well as fugitive emissions using the collection efficiency of the duct:

PFC emissions (total) = PFC emissions (duct)/collection efficiency

The collection efficiency shall be measured when the installation-specific emission factors are determined. For its determination the most recent version of the guidance mentioned under Tier 3 of section 4.4.2.4 of the 2006 IPCC Guidelines shall be used.

The operator shall calculate emissions of CF₄ and C₂F₆ emitted through a duct or stack using one of the following methods:

- (a) Method A where the anode effect minutes per cell-day are recorded;
- (b) Method B where the anode effect overvoltage is recorded.

Calculation of PFC emissions using the Slope Method U.K.**Method A**

The operator shall use the following equations for determining PFC emissions:

$$\text{CF}_4 \text{ emissions [t]} = \text{AEM} \times (\text{SEF}_{\text{CF}_4}/1\ 000) \times \text{Pr}_{\text{Al}}$$

$$\text{C}_2\text{F}_6 \text{ emissions [t]} = \text{CF}_4 \text{ emissions} * \text{F}_{\text{C}_2\text{F}_6}$$

Where:

AEM	= Anode effect minutes/cell-day;
SEF _{CF₄}	= Slope emission factor [(kg CF ₄ /t Al produced)/(anode effect minutes/cell-day)]. Where different cell-types are used, different SEF may be applied as appropriate;
Pr _{Al}	= Annual production of primary Aluminium [t];
F _{C₂F₆}	= Weight fraction of C ₂ F ₆ (t C ₂ F ₆ /t CF ₄).

The anode effect minutes per cell-day shall express the frequency of anode effects (number anode effects/cell-day) multiplied by the average duration of anode effects (anode effect minutes/occurrence):

$$\text{AEM} = \text{frequency} \times \text{average duration}$$

Emission factor : The emission factor for CF₄ (slope emission factor, SEF_{CF₄}) expresses the amount [kg] of CF₄ emitted per tonne of aluminium produced per anode effect minute/cell-day. The emission factor (weight fraction

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- $F_{C_2F_6}$ of C_2F_6 expresses the amount [t] of C_2F_6 emitted proportionate to the amount [t] of CF_4 emitted.
- Tier 1 : The operator shall use technology-specific emission factors from Table 1 of this section of Annex IV.
- Tier 2 : The operator shall use installation-specific emission factors for CF_4 and C_2F_6 established through continuous or intermittent field measurements. For the determination of those emission factors the operator shall use the most recent version of the guidance mentioned under tier 3 of section 4.4.2.4 of the 2006 IPCC Guidelines⁽¹⁾. The operator shall determine each emission factor with a maximum uncertainty of $\pm 15\%$.

The operator shall determine the emission factors at least every three years or earlier where necessary due to relevant changes at the installation. Relevant changes shall include a change in the distribution of anode effect duration, or a change in the control algorithm affecting the mix of the types of anode effects or the nature of the anode effect termination routine.

Table 1:

TECHNOLOGY-SPECIFIC EMISSION FACTORS RELATED
TO ACTIVITY DATA FOR THE SLOPE METHOD

Technology	Emission factor for CF_4 (SEF_{CF_4})[(kg CF_4 /t Al)/ (AE-Mins/cell-day)]	Emission factor for C_2F_6 ($F_{C_2F_6}$)[t C_2F_6 /t CF_4]
Centre Worked Prebake (CWPB)	0,143	0,121
Vertical Stud Søderberg (VSS)	0,092	0,053

Calculation Method **U.K.**

Method

B —

Where the anode effect overvoltage is measured, the operator shall use the following equations for the determination of PFC emissions:

$$CF_4 \text{ emissions [t]} = OVC \times (AEO/CE) \times Pr_{Al} \times 0,001$$

$$C_2F_6 \text{ emissions [t]} = CF_4 \text{ emissions} \times F_{C_2F_6}$$

Where:

OVC = Overvoltage coefficient ('emission factor') expressed as kg CF_4 per tonne of aluminium produced per mV overvoltage;

AEO = Anode effect overvoltage per cell [mV] determined as the integral of (time \times voltage above the target voltage) divided by the time (duration) of data collection;

CE = Average current efficiency of aluminium production [%];

Pr_{Al} = Annual production of primary Aluminium [t];

$F_{C_2F_6}$ = Weight fraction of C_2F_6 (t C_2F_6 /t CF_4);

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The term AEO/CE (Anode effect overvoltage/current efficiency) expresses the time-integrated average anode effect overvoltage [mV overvoltage] per average current efficiency [%].

- Emission factor : The emission factor for CF₄ ('overvoltage coefficient' OVC) shall express the amount [kg] of CF₄ emitted per tonne of aluminium produced per millivolt overvoltage [mV]. The emission factor of C₂F₆ (weight fraction F_{C₂F₆}) shall express the amount [t] of C₂F₆ emitted proportionate to the amount [t] of CF₄ emitted.
- Tier 1 : The operator shall apply technology-specific emission factors from Table 2 of this section of Annex IV.
- Tier 2 : The operator shall use installation-specific emission factors for CF₄ [(kg CF₄/t Al)/(mV)] and C₂F₆ [t C₂F₆/t CF₄] established through continuous or intermittent field measurements. For the determination of those emission factors, the operator shall use the most recent version of the guidance mentioned under tier 3 of section 4.4.2.4 of the 2006 IPCC Guidelines. The operator shall determine the emission factors with a maximum uncertainty of ± 15 % each.

The operator shall determine the emission factors at least every three years or earlier where necessary due to relevant changes at the installation. Relevant changes shall include a change in the distribution of anode effect duration or a change in the control algorithm affecting the mix of the types of anode effects or the nature of the anode effect termination routine.

Table 2:

TECHNOLOGY-SPECIFIC EMISSION FACTORS
RELATED TO OVERVOLTAGE ACTIVITY DATA

Technology	Emission factor for CF ₄ [(kg CF ₄ /t Al)/mV]	Emission factor for C ₂ F ₆ [t C ₂ F ₆ /t CF ₄]
Centre Worked Prebake (CWPB)	1,16	0,121
Vertical Stud Søderberg (VSS)	N.A.	0,053

C. *Determination of CO_{2(e)} emissions* **U.K.**

The operator shall calculate CO_{2(e)} emissions from CF₄ and C₂F₆ emissions as follows, using the global warming potentials listed in Annex VI, section 3, Table 6:

$$\text{PFC emissions [t CO}_{2(e)}\text{]} = \text{CF}_4 \text{ emissions [t]} * \text{GWP}_{\text{CF}_4} + \text{C}_2\text{F}_6 \text{ emissions [t]} * \text{GWP}_{\text{C}_2\text{F}_6}$$

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- (1) International Aluminium Institute; The Aluminium Sector Greenhouse Gas Protocol; October 2006; US Environmental Protection Agency and International Aluminium Institute; Protocol for Measurement of Tetrafluoromethane (CF₄) and Hexafluoroethane (C₂F₆) Emissions from Primary Aluminium Production; April 2008.

Changes to legislation:

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