

# **ANNEX 5**

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## **MAPPING TABLES**

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## ANNEX 5. RELATING 2019 REFINEMENT METHODS TO THE 2006 GUIDELINES

This annex provides a road map for relating sections, equations, tables, figures and boxes in the *2019 Refinement* to the *2006 IPCC Guidelines*

Key:

NR = No Refinement

U = Update

E = Elaboration

NG = New Guidance

### A5.1 SECTIONS

TABLE A5.1 SECTIONS			
Section Title	Type of Refinement	2006 IPCC Guidelines Section Number	2019 Refinement Section Number
<b>Sub-Chapter 3.3</b>			
Choice of emission factors	U	3.3.2.2	3.3.2.2
<b>Sub-Chapter 3.10</b>			
Introduction	NR	3.10.1.1	3.10.1.1
Methodological issues	U, E	3.10.1.2	3.10.1.2
Uncertainty assessment	U, E	3.10.1.3	3.10.1.3
Quality assurance/Quality control (QA/QC), Reporting and Documentation	NR	3.10.1.4	3.10.1.4
Introduction	U, E	3.10.2.1	3.10.2.1
Methodological Issues	U, E	3.10.2.2	3.10.2.2
Uncertainty Assessment	U, E	3.10.2.3	3.10.2.3
Quality Assurance/Quality Control (QA/QC), Reporting and Documentation	NR	3.10.2.4	3.10.2.4
<b>Sub-Chapter 3.11</b>			
Hydrogen Production	NG	-	3.11

TABLE A5.1 (CONT.) SECTIONS			
Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
<b>Sub-Chapter 4.2</b>			
Introduction	NR	4.2.1	4.2.1
Methodological issues	U, E	4.2.2	4.2.2
Choice of method: metallurgical coke production	U, E	4.2.2.1	4.2.2.1
Choice of method: iron and steel production	U, E	4.2.2.2	4.2.2.2
Choice of emission factors	U, E	4.2.2.3	4.2.2.3
Choice of activity data	U	4.2.2.4	4.2.2.4
Completeness	U, E	4.2.2.5	4.2.2.5
Developing a consistent time series	NR	4.2.2.6	4.2.2.6
Uncertainty assessment	U, E	4.2.3	4.2.3
Quality Assurance/Quality Control (QA/QC), Reporting and Documentation	NR	4.2.4	4.2.4
<b>Sub-Chapter 4.4</b>			
Introduction	U, E, NG	4.4.1	4.4.1
Choice of method for CO <sub>2</sub> emissions from primary aluminium production	NR	4.4.2.1	4.4.2.1
Choice of emission factors for CO <sub>2</sub> emissions from primary aluminium production	NR	4.4.2.2	4.4.2.2
Choice of method for PFCs	U, E	4.4.2.3	4.4.2.3
Choice of emission factors for PFCs	U, E	4.4.2.4	4.4.2.4
Choice of activity data	U, E	4.4.2.5	4.4.2.5
Completeness	NR	4.4.2.6	4.4.2.6
Developing a consistent time series	U, E	4.4.2.7	4.4.2.7
Uncertainty assessment	U, E	4.4.3	4.4.3
Emission factor uncertainties	U, E	4.4.3.1	4.4.3.1
Activity data uncertainties	U, E	4.4.3.2	4.4.3.2
Quality assurance/quality control (QA/QC)	U, E	4.4.4.1	4.4.4.1
Reporting and documentation	U, E	4.4.4.2	4.4.4.2
Methodological Issues for alumina refining	NG	-	4.4.5
Alumina refining processes	NG		4.4.5.1
Choice of method	NG	-	4.4.5.2
Choice of emission factors for alumina production	NG	-	4.4.5.3
Choice of activity data	NG	-	4.4.5.4
Completeness	NG	-	4.4.5.5
Developing a consistent time series	NG	-	4.4.5.6

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<b>TABLE A5.1 (CONT.)</b>			
<b>SECTIONS</b>			
<b>Section Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Section Number</b>	<b>2019 Refinement Section Number</b>
Uncertainty assessment	NG	-	4.4.6
Emission factor uncertainties	NG	-	4.4.6.1
Activity data uncertainties	NG	-	4.4.6.2
Quality assurance/quality control (QA/QC)	NG	-	4.4.7
Reporting and documentation	NG	-	4.4.7.2
<b>Sub-Chapter 4.8</b>			
Rare earths production (and all sub-sections included)	NG	-	4.8
<b>Chapter 6</b>			
Introduction	U	6.1	6.1
Etching and CVD cleaning for semiconductors, liquid crystal displays, and photovoltaics	U, E, NG	6.2.1.1	6.2.1.1
Heat Transfer Fluids	U, NG	6.2.1.2	6.2.1.2
Choice of emission factors	U	6.2.2	6.2.2
Etching and CVD cleaning for semiconductors, liquid crystal displays, and photovoltaics	U	6.2.2.1	6.2.2.1
Heat Transfer Fluids	U	6.2.2.2	6.2.2.2
Choice of activity data	U	6.2.3	6.2.3
Completeness	NR	6.2.4	6.2.4
Developing a consistent time series	NR	6.2.5	6.2.5
Uncertainty Assessment	NR	6.3	6.3
Quality Assurance/Quality Control (QA/QC), Reporting, and Documentation	NR	6.4	6.4
<b>Chapter 7</b>			
Chemicals and relevant application areas covered	U, E	7.1.1	7.1.1
Overview of ODS substitute issues	NR	7.1.2.1	7.1.2.1
Choice of method	U, E	7.1.2.2	7.1.2.2
Choice of emission factors	NR	7.1.2.3	7.1.2.3
Choice of activity data	NR	7.1.2.4	7.1.2.4
Completeness	NR	7.1.2.5	7.1.2.5
Developing a consistent time series	NR	7.1.2.6	7.1.2.6
Uncertainty Assessment	NR	7.1.3	7.1.3
Quality Assurance/Quality Control (QA/QC), Reporting, and Documentation for all ODS substitutes applications	NR	7.1.4	7.1.4
Choice of method	E	7.5.2.1	7.5.2.1
Choice of emission factors	U, E	7.5.2.2	7.5.2.2
Choice of activity data	E	7.5.2.3	7.5.2.3

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TABLE A5.1 (CONT.) SECTIONS			
Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Applying Tier 2 methods – the example of mobile air conditioning (MAC)	U	7.5.2.4	7.5.2.4
Completeness	NR	7.5.2.5	7.5.2.5
Developing a consistent time series	NR	7.5.2.6	7.5.2.6
Uncertainty Assessment	NR	7.5.3	7.5.3
Quality Assurance/Quality Control (QA/QC), Reporting, and Documentation	NR	7.5.4	7.5.4
<b>Chapter 8</b>			
Introduction to Use of SF6 and PFCs in Other Products	NG	8.3.1	8.3.1
Methodological Issues	NG	8.3.2	8.3.2
<b>Appendix 1</b>			
Possible Approaches for Estimating Fluorinated Compounds Emissions from Textile, Carpet, Leather and Paper Industries: Basis for Future Methodological Development	NG	-	Appendix 1

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**DISCUSSION****Sub-Chapter 4.4**

- Update to T1 and T2 default factors (and uncertainties) with elaboration on newly defined technology classes and methods/default factors for low voltage anode effect emissions
- Update to PFC HVAE methodology (Tier 2/3 b) depending on maturity of literature/methodology at cut-off date
- Updates and elaboration to choice of activity data, uncertainty and time series consistency discussion to reflect changes
- Overvoltage method not updated – recommendation to use slope (or Tier 3 overvoltage only)
- New guidance for alumina refining from Bayer-sintering and nepheline ore processes

**Chapter 6**

- Guidance on tracking gas consumption and apportioning use to different process types/subtypes;
- An update to the Tier 2a method to account for fraction of gas in processes with emission control technologies and emissions control technology uptime;
- An update to the Tier 2b method for semiconductors to account for the size of manufactured wafers and the input gas rather than the process type and input gas;
- A new Tier 2c method for semiconductors that accounts for the size of manufactured wafers in addition to the process type and input gas as well as for the fraction of gas in processes with emission control technologies and emissions control technology uptime;
- A new section on adapting Tier 2 methods for technological changes;
- Updated Tier 3a to address similar recipes and provide guidance on when facility specific measurements should be considered;
- A new Tier 3b method that relies on the measurement of emission factors at the stack level rather than the process level;
- A new Tier 1 for heat transfer fluids;

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- Updates to the emission factors for Tier 1 and Tier 2 for all electronics industry types (still under development); and
- Corresponding updates to the Completeness; Time Series Consistency; Uncertainty; and QA/QC, Reporting and Documentation sections (still under development).

**Chapter 7**

- Section 7.1.1 “Chemicals and relevant application areas covered” in the *2006 IPCC Guidelines*: The text about HFCs and Montreal Protocol was outdated. The issue was in the mandate (TOC), but the place or section for the update was not specified.
- Section 7.1.2.2 “Choice of method” in the *2006 IPCC Guidelines*: Text elaborated in order to briefly describe the three new tables with consumption figures for 2015. This issue was suggested placed under 7.5.2.3 in the TOC (mandate), but we argue that this is the relevant section because it an elaboration related to table 7.3 which is located in section 7.1.2.2. New guidance on how to build a RAC inventory (Tier 1 and tier 2 emission factor approaches) appears in Boxes 7.2a-c.
- Section 7.5.2.2 “Choice of emission factors” in the *2006 IPCC Guidelines*: Text is elaborated to describe new information from studies of emission factors, according to TOC.

**Chapter 8**

- New guidance for waterproofing of electronic circuits has been added to the Emissions from Other Applications of SF<sub>6</sub> and PFCs section.
- Possible methods for Textile, carpet, leather and paper fluorinated treatment emissions (shift to Appendix 1)

## A5.2 EQUATIONS

TABLE A5.2 EQUATIONS			
Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
<b>Sub-Chapter 3.3</b>			
No refinements	NR	-	-
<b>Sub-Chapter 3.10</b>			
Tier 1 calculation of HFC-23 from HCFC-22 (produced) using default factor	NR	3.30	3.30
Tier 2 calculation of HFC-23 from HCFC-22 (produced) using factor(s) calculated from process efficiencies	NR	3.31	3.31
Calculation of HFC-23 emission factor from carbon balance efficiency	NR	3.32	3.32
Calculation of HFC-23 emission factor from fluorine balance efficiency	NR	3.33	3.33
Tier 3a calculation of HFC-23 emissions from individual process streams (direct method)	NR	3.34	3.34
Tier 3b calculation of HFC-23 emissions from individual process streams using a Site- Or Process-Specific Emission Factor	U	3.35	3.35
Tier 3c calculation of HFC-23 emissions from individual process streams (by monitoring reactor product)	NR	3.36	3.36
Tier 3a calculation of 'instantaneous' HFC-23 emissions in an individual process stream (direct method)	NR	3.37	3.37
Tier 3b calculation of HFC-23 emissions in an individual process stream using a Site- Or Process-Specific Emission Factor	U	3.38	3.38
Tier 3b calculation of standard emission for Emission Factor-based method	U	3.39	3.39
Tier 3c calculation of HFC-23 emissions from an individual facility by in-process measurement	NR	3.40	3.40
Tier 1 calculation of production-related emissions	NR	3.41	3.41
Tier 2 calculation of production-related emissions using a mass balance approach	NG	-	3.41a
Tier 3 summation of production-related emissions from process Vents and equipment leaks	NG	-	3.41b
Tier 3 direct calculation of production-related emissions from process Vents	U	3.42	3.42
Tier 3 calculation of production-related emissions from Process vents using a Site- Or Process-Specific Emission Factor	U	3.43	3.43
Tier 3 calculation of emissions from Equipment leaks using a Screening ranges approach	NG	-	3.43a



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<b>TABLE A5.2 (CONT.) EQUATIONS</b>			
<b>Equation Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Equation Number</b>	<b>2019 Refinement Equation Number</b>
Tier 3 calculation of emissions from equipment leaks using a correlation approach	NG	-	3.43b
Tier 3 calculation of a unit-specific Correlation	NG	-	3.43c
Tier 3 calculation of emissions from equipment leaks using a unit-specific correlation approach	NG	-	3.43d
Tier 3 calculation of production-related emissions from Process vents using a Site- Or Process-Specific Emission Factor	NG	-	3.43e
<b>Sub-Chapter 3.11</b>			
All equations are new	NG	-	3.44-3.47
<b>Sub-Chapter 4.2</b>			
Emissions from coke production (Tier 1a)	U	4.1	4.1
CO <sub>2</sub> emissions from metallurgical coke production (Tier 1b)	NG	-	4.1a
CO <sub>2</sub> emissions from onsite coke production (Tier 2)	NR	4.2	4.2
CO <sub>2</sub> emissions from iron and steel production (Tier 1)	NR	4.4	4.4
CO <sub>2</sub> emissions from production of pig iron not processed into steel (Tier 1)	NR	4.5	4.5
CO <sub>2</sub> emissions from production of direct reduced iron (Tier 1)	NR	4.6	4.6
CO <sub>2</sub> emissions from sinter production (Tier 1)	NR	4.7	4.7
CO <sub>2</sub> emissions from pellet production (Tier 1)	NR	4.8	4.8
CO <sub>2</sub> emissions from iron & steel production (Tier 2)	NR	4.9	4.9
CO <sub>2</sub> emissions from sinter production (Tier 2)	NR	4.10	4.10
CO <sub>2</sub> emissions from direct reduced iron production (Tier 2)	NR	4.11	4.11
CH <sub>4</sub> emissions from sinter production (Tier 1)	NR	4.12	4.12
CH <sub>4</sub> emissions from blast furnace production of pig iron (Tier 1)	NR	4.13	4.13
CH <sub>4</sub> emissions from direct reduced iron production (Tier 1)	NR	4.14	4.14
<b>Sub-Chapter 4.4</b>			
Process CO <sub>2</sub> emissions from anode and/or paste consumption (tier 1 method)	NR	4.20	4.20
CO <sub>2</sub> emissions from prebaked anode consumption (tier 2 and tier 3 methods)	NR	4.21	4.21
CO <sub>2</sub> emissions from pitch volatiles combustion (tier 2 and tier 3 methods)	NR	4.22	4.22
CO <sub>2</sub> emissions from bake furnace packing material (tier 2 and tier 3 methods)	NR	4.23	4.23

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TABLE A5.2 (CONT.) EQUATIONS			
Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
CO <sub>2</sub> emissions from paste consumption (tier 2 and tier 3 methods)	NR	4.24	4.24
HVAE PFC emissions (Tier 1 method)	U	4.25	4.25
LVAE PFC emissions (Tier 1 method)	NG	-	4.25a
HVAE PFC emissions by Slope method (Tier 2A and Tier 3A methods)	U	4.26	4.26
HVAE PFC emissions by Overvoltage method (Tier 3 method)	NR	4.27	4.27
HVAE PFC emissions (Tier 2b and Tier 3b method )	NG	-	4.27a
HVAE PFC emissions (Tier 2b and Tier 3b method )	NG	-	4.27b
LVAE PFC emissions (Tier 2 and Tier 3 methods)	NG	-	4.27c
Emission rate coefficients for HVAE PFC (Tier 2b method)	NG	-	4.27d
Tier 1: Sintering process emissions based on alumina production data	NG	-	4.27e
Tier 3: Emissions based on carbonate raw material inputs to the sintering kiln	NG	-	4.27f
Emissions captured during carbonization process and contained in produced sodium carbonate	NG	-	4.27g
Emissions from un-calcined SKD not recycled to the kiln	NG	-	4.27h
Weighted average content CO <sub>2</sub> in 'i' Bauxites (Nephelines)	NG	-	4.27i
Emissions from Bauxites (Nephelines) residue	NG	-	4.27j
Emissions from carbon-bearing non-fuel materials	NG	-	4.27k
CO <sub>2</sub> absorption through use of circulating water collected from bauxite/nepheline storage residue area and/or absorption through bauxite residue neutralization	NG	-	4.27l
<b>Sub-Chapter 4.8</b>			
Process CO <sub>2</sub> Emissions from anode consumption (Tier 1)	NG	-	4.35
Process CO <sub>2</sub> emissions from anode consumption (Tier 3)	NG	-	4.36
PFC Emissions (Tier 1 and Tier 3)	NG	-	4.37
<b>Chapter 6</b>			
Tier 1 Method for estimation of the set of FC emissions	U	6.1	6.1
Consumption of input gas i	NG	-	6.2
Transfers of Input Gas i	NG	-	6.3
Apportioning of C to Process Types/Subtypes	NG	-	6.4
Emissions of input gas i	U	6.2	6.5
By-product emissions	U	6.3-6.6	6.6

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<b>TABLE A5.2 (CONT.) EQUATIONS</b>			
<b>Equation Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Equation Number</b>	<b>2019 Refinement Equation Number</b>
Emissions reduction impact of emissions control technology	E	6.2-6.6	6.7
Estimate of the fraction of gas i volume in processes with emission control technologies	NG	-	6.8
Uptime of emissions control systems	NG	-	6.9
Emission of Ci	U	6.7	6.10
By-product Emissions	U	6.8-6.11	6.11
Emissions reduction impact of emissions control technology	E	6.7-6.11	6.12
Uptime of emissions control systems	NG	-	6.13
Preliminary estimate of stack process gas emissions	NG	-	6.14
Preliminary estimate of byproduct emissions from stacks	NG	-	6.15
Total fluorinated GHG input gas emitted from stack system during sampling period	NG	-	6.16
Total fluorinated GHG By-product gas emitted from stack system during sampling period	NG	-	6.17
Gas specific emission factor	NG	-	6.18
Gas specific by-product emission factor	NG	-	6.19
Average weighted fraction of greenhouse input gas and byproduct gas	NG	-	6.20
Annual emissions of fluorinated GHG	NG	-	6.21
Annual emissions of fluorinated GHG by-product	NG	-	6.22
Average abatement system uptime	NG	-	6.23
Tier 1 Method for estimation of total Fc emissions from heat transfer fluids	NG	-	6.24
Tier 2 Method for estimation of FC emissions from heat transfer fluids	U	6.25	6.25
<b>Chapter 8</b>			
Waterproofing of electric circuits	NG	-	8.14
<b>Appendix 1</b>			
All equations are new	NG	-	1.a1-1a.18

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93 **DISCUSSION**94 **Sub-Chapter 4.8**

- 95 • Numbering of Equations in existing *2006 IPCC Guidelines* and *2019 Refinement* .

96 **Chapter 6**

- 97 • Equations 6.3 through 6.6 of the 2006 GL, which each covered an individual F-GHG by-product, have  
 98 been merged into a new Equation 6.6 that covers all F-GHG by-products.
- 99 • Equations 6.8 through 6.11 of the 2006 GL, which each covered an individual F-GHG by-product, have  
 100 been merged into a new Equation 6.11 that covers all F-GHG by-products.

- The term that accounts for emission reductions in Equations 6.2 through 6.6 in the 2006 GL,  $a_i \cdot d_i$ , has been replaced by the term  $D_i$ , which is elaborated and defined through three new equations:
  - Equation 6.7 defines  $D_i$ , the overall reduction of gas  $i$  emissions, in terms of  $a_i$ , the fraction of gas volume used in processes with emission control technologies,  $d_i$ , the destruction and removal efficiency for gas  $i$ , and  $UT$ , the average uptime of all abatement systems.
  - Equation 6.8 defines  $a_i$  for facilities using the Tier 2a method.
  - Equation 6.9 defines  $UT$ .
- The term that accounts for emission reductions in Equations 6.7 through 6.11 in the 2006 GL,  $a_{i,p} \cdot d_{i,p}$ , has been replaced by the term  $D_{i,p}$ , which is elaborated and defined through two new equations:
  - Equation 6.12 defines the overall reduction of gas  $i$  emissions in terms of  $a_{i,p}$ , the fraction of gas volume used in processes with emission control technologies in process type  $p$ ,  $d_{i,p}$ , the destruction and removal efficiency for gas  $i$  in process type  $p$ , and  $UT_p$ , the average uptime of all abatement systems for process type  $p$ .
  - Equation 6.13 defines  $UT_p$ .
- Equation 6.8: the factor  $\gamma$  is still being developed.

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<b>TABLE A5.3 FIGURES</b>			
<b>Figure Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Figure Number</b>	<b>2019 Refinement Figure Number</b>
<b>Sub-Chapter 3.3</b>			
No refinements	NR	-	-
<b>Sub-Chapter 3.10</b>			
Decision tree for HFC-23 emissions from HCFC-22 production (or other similar by-product emissions from fluorochemical production)	NR	3.16	3.16
Decision tree for emissions of fluorinated greenhouse gases from production processes, applicable to product, by-product, reactant, and fugitive both fugitive and by-product emissions	U	3.17	3.17
<b>Sub-Chapter 3.11</b>			
All figures are new	NG	-	3.18-3.20
<b>Sub-Chapter 4.2</b>			
Illustration of main processes for integrated iron and steel production	NR	4.1	4.1
Estimation of CO <sub>2</sub> emissions from metallurgical coke production	U	4.6	4.6
Decision tree for estimation of CO <sub>2</sub> emissions from iron and steel production	NR	4.7	4.7
Decision tree for estimation of CH <sub>4</sub> emissions from iron and steel production	NR	4.8	4.8
Energy or IPPU CO <sub>2</sub> emissions allocation in an integrated iron and steel facility	NG	-	4.8a
<b>Sub-Chapter 4.4</b>			
Decision tree for calculation of CO <sub>2</sub> emissions from primary aluminium production	NR	4.11	4.11
Decision tree for calculation of PFC emissions from primary aluminium production	U, E	4.12	4.12
Alumina production processes	NG	-	4.12a
Decision tree for estimation of CO <sub>2</sub> emissions from alumina production	NG	-	4.12b

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TABLE A5.3 (CONT.) FIGURES			
Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
<b>Sub-Chapter 4.8</b>			
Decision tree for calculation of CO <sub>2</sub> emissions from primary rare earth (RE) metal production.	NG	-	4.17
Decision tree for calculation of PFC emissions from primary rare earth (RE) metal production.	NG	-	4.18
<b>Chapter 6</b>			
Decision tree for estimation of GHG emissions from electronics manufacturing	U	6.1	6.1
Decision tree to determine need for measured emission factors	NG	-	6.2
Decision tree for estimation of FC emissions from HT fluid loss from electronics manufacturing	NR	6.3	6.3
Decision Tree for Process GHG Emission Abatement Default Emission Factors	NG	-	6.4

## DISCUSSION

### Sub-Chapter 3.10

- The current version of Figure 3.17 may be further refined

### Sub-Chapter 4.8

- Numbering of Figures in existing *2006 IPCC Guidelines* and *2019 Refinement*.

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**A5.4 TABLES**

<b>TABLE A5.4 TABLES</b>			
<b>Table Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Table Number</b>	<b>2019 Refinement Table Number</b>
<b>Sub-Chapter 3.3</b>			
Different plant types for the production of HNO <sub>3</sub>	NG	-	3.3.a
Default factors for nitric acid production	U	3.3	3.3
<b>Sub-Chapter 3.10</b>			
HFC-23 default emission factors	U	3.28	3.28
Tier 1 default emission factor for fluorochemical production	NG	-	3.28a
Representative chemical composition of the emitted mass	NG	-	3.28b
<b>Sub-Chapter 3.11</b>			
All tables are new	NG	-	3.29-3.30
<b>Sub-Chapter 4.2</b>			
Emission allocations from metallurgical coke production	NG	-	4.1a
Tiers to estimate CO <sub>2</sub> emissions from metallurgical coke production	NG	-	4.1b
Tier 1 default CO <sub>2</sub> emission factors for coke production and iron & steel production	U	4.1	4.1
Tier 1 default CH <sub>4</sub> emission factors for coke production and iron & steel production	U	4.2	4.2
Tier 2 material-specific carbon contents for iron & steel and coke production	U	4.3	4.3
Uncertainty ranges	U	4.4	4.4
<b>Sub-Chapter 4.4</b>			
Tier 1 technology specific emission factors for calculating carbon dioxide emissions from anode or paste consumption	NR	4.10	4.10
Data sources and uncertainties for parameters used in tier 2 or 3 method for CO <sub>2</sub> emissions from prebake cells (cwpb and swpb) , see equation 4.21	NR	4.11	4.11
Data sources and uncertainties for parameters used in tier 2 or 3 method for CO <sub>2</sub> emissions from pitch volatiles combustion (cwpb and swpb)	NR	4.12	4.12
Data sources and uncertainties for parameters used in tier 2 or 3 method for CO <sub>2</sub> emissions from bake furnace packing material (cwpb and swpb)	NR	4.13	4.13
Data sources and uncertainties for parameters used in tier 2 or 3 method for CO <sub>2</sub> emissions from soderberg cells	NR	4.14	4.14

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<b>TABLE A5.4 (CONT.) SECTIONS</b>			
<b>Table Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Section Number</b>	<b>2019 Refinement Section Number</b>
Technology specific default emission factors for the calculation of HVAE and LVAE emissions from aluminium production (Tier 1 method)	U	4.15	4.15
Technology specific coefficients for the calculation of HVAE PFC emissions from Aluminium production using slope methodology (Tier 2a method)	U	4.16	4.16
Specific HAVE-PFC emission rate coefficients based on the anode effect duration as calculated by (Tier 2b method)	NG	-	4.16a
Technology specific default emission factors for the calculation of LVAE PFC emissions from aluminium production (Tier 2 Method)	NG	-	4.16b
Good practice reporting information for calculating CO <sub>2</sub> and PFC emissions from aluminium production by tier	U	4.17	4.17
Technology specific default emission factors for the calculation of CO <sub>2</sub> emissions from alternative sintering processes (Tier 1 method)	NG	-	4.17a
Default uncertainty values for Bauxite/nepheline sintering process	NG	-	4.17b
<b>Sub-Chapter 4.8</b>			
Tier 1 default emission factors for calculating CO <sub>2</sub> emissions from anode consumption	NG	-	4.26
Data sources and uncertainties for parameters used in Tier 3 method for CO <sub>2</sub> emissions from anode consumption	NG	-	4.27
Tier 1 default emission factors and uncertainty ranges for the calculation of PFC emissions from rare earth production	NG	-	4.28
Data sources and uncertainties for parameters used in Tier 3 method for PFC emissions	NG	-	4.29
Good practice reporting information for calculating CO <sub>2</sub> and PFC emissions from rare earth metal production by Tier	NG	-	4.30
<b>Chapter 6</b>			
Information sources necessary for completing the tiered emission estimating methods for electronics manufacturing	U	6.1	6.1
Tier1 Gas-specific emission factors for FC emissions from electronics manufacturing	U	6.2	6.2
Tier 2a method – default emission factors for GHG emissions from Semiconductor manufacturing	U	6.3	6.3
Tier 2b method – default emission factors for GHG emissions from Semiconductor manufacturing	NG	6.3	6.4

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<b>TABLE A5.4 (CONT.) TABLES</b>			
<b>Table Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Table Number</b>	<b>2019 Refinement Table Number</b>
Tier 2c method ( $\leq 200\text{mm}$ ) – default emission factors for GHG emissions from semiconductor manufacturing	NG	-	6.5
Tier 2c method (300mm) – default emission factors for GHG emissions from semiconductor manufacturing	NG	-	6.6
Abatement suitability table	NG	-	6.7
Tier 2 default DRE parameters for electronics industry process GHG emissions reduction technologies	NG	6.6	6.8
Tier 1 Default Emission Factors for Heat Transfer Fluids (HTFs), Using Representative HTFs	NG	-	6.9
<b>Chapter 7</b>			
Main application areas for HFCs and PFCs as ODS substitutes	U	7.1	7.1
Example distribution of HFC/PFC use by application area (2002)	NR	7.3	7.3
Distribution of HFC use by application area for 2015	NG	-	7.3a
HFC consumption for RAC in article 5 countries. Per cent of total by substance and sub-application area for 2015	NG	-	7.3b
HFC consumption for RAC in article 5 countries. Per cent of total by manufacturing and servicing for 2015	NG	-	7.3c
Default Estimates for charge, lifetime and emission factors for refrigeration and air-conditioning systems	U	7.9	7.9
German study: Emission factors for refrigeration and air conditioning systems	NG	-	7.9a
<b>Chapter 8</b>			
Emission Factor for Waterproofing of Electronic Circuits	NG	-	8.11
<b>Appendix 1</b>			
All tables are new	NG	-	1a.1-1a.4

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144 **DISCUSSION**145 **Sub-Chapter 4.8**

- 146 • Numbering of Tables in existing *2006 IPCC Guidelines* and *2019 Refinement*.

147 **Chapter 6**

- 148 • Tables 6.3-6.5 in the 2006 GL, which include both the Tier 2a and the Tier 2b EFs for semiconductors,  
 149 LCD, and PV, respectively, have been (or will be) elaborated into Tables 6.3-6.5, which include (or will  
 150 include) the Tier 2a EFs for semiconductors, display, and PV manufacturing, respectively; and Tables  
 151 6.7-6.9, which include (or will include) the Tier 2b EFs for semiconductors, display, and PV  
 152 manufacturing, respectively, by wafer size.

## Chapter 7

- Table 7.1: Footnote 2 is elaborated, specifying that methodology for estimating emissions for plasma etching is not included in chapter 7. This issue was not in the mandate/TOC.
- Three new tables with consumption figures to address the issue of adding data on the distribution of ODS-substitutes by application, e.g. broadening the set of countries to include developing as well as developed countries. This issue was suggested placed under 7.5.2.3 in the TOC (mandate), but we argue that 7.1.2.2 is the relevant section because it an elaboration related to table 7.3 which is located in section 7.1.2.2.
  - New table 7.3a: Provides information similar to table 7.3 in 2006 Guidelines, but for 2015.
  - New table 7.3b: Provides information for 2015 on use of HFCs in RAC by substance and sub-application area.
  - New table 7.3c: Provides information for 2015 on the share of HFCs used for manufacturing and servicing in RAC.
- Table 7.9: A specification is made for the charge of buses in sub-application mobile air conditioning, as this is above the ranges given in the *IPCC 2006* Guidelines. Also, foot note 5 regarding other studies for mobile air conditioning is erased because of the introduction of a new table on this issue.
- New table with emission factors to address the issue of updating emission factors by further segregating equipment types, regions, and time periods, are presented:
  - “German study” - provides emission factors for commercial and industrial refrigeration, based on a study in Germany in 2011.

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**A5.5 BOXES**

<b>TABLE A5.5 BOXES</b>			
<b>Box Title</b>	<b>Type of Refinement</b>	<b>2006 Guidelines Box Number</b>	<b>2019 Refinement Box Number</b>
<b>Sub-Chapter 3.10</b>			
Plant measurement frequency	NR	3.14	3.14
<b>Sub-Chapter 3.11</b>			
All boxes are new	NG	-	3.15-3.21
<b>Sub-Chapter 4.4</b>			
Fully automated anode effect intervention strategies for PFC emissions	NG	-	4.1a
High and low voltage anode effect description	U	4.2	4.2
High voltage anode effects following start-up of electrolysis cells	NG	-	4.2a
<b>Sub-Chapter 4.8</b>			
Anode Effect Description (for rare earth metal production by fluoride electrolysis)	NG	-	4.3
<b>Chapter 6</b>			
Fluorinated greenhouse gas by-products	NG	-	6.1
Fab specific apportioning model verification example	NG	-	6.2
<b>Chapter 7</b>			
How to build a RAC inventory in a few simple steps – Tier 1 and 2 emission factor approaches	NG	-	Box 7.2a
Overview of the basic elements of the ODS-substitutes emission inventory	NG	-	Box 7.2b
How to build the bank of ODS-substitutes in RAC	NG	-	Box 7.2c
Accounting for imports and exports of refrigerant and equipment	NR	7.3	7.3
Common data sources for the ODS-substitutes inventory	NG	-	Box 7.3a
Example of the application of a Tier 2a calculation for mobile air conditioning	U	Box 7.4	Box 7.4
<b>Appendix 1</b>			
All boxes are new	NG		Box 1A.1-1A.2

**DISCUSSION****Chapter 7**

- Three new boxes to address the issue of increased user-friendliness and suggestion of box with “recipe”-style guidance on how to launch the ODS-substitutes inventory. Location according to suggestion in TOC (mandate):
  - New box 7.2a: Intended to simplify the process of starting an inventory on ODS-substitutes, focusing on the larger areas of use and the tier 1 and 2 EF approach.
  - New box 7.2b: Aims at giving an overview of the annual estimation process.

- New box 7.2c: Provides information on two ways to establish the bank of ODSs for all relevant years.
- One new box to address the issue of increased user-friendliness, suggestion of examples regarding the collection of activity data, and the suggestion to further emphasizing the data and literature associated with the Montreal protocol. Location according to suggestion in TOC (mandate):
  - New box 7.3a: List of data sources commonly used for collecting data on HFCS, with a short description of each.
- Box 7.4 in the *2006 IPCC Guidelines* contains misleading information in terms of the emission factors used for MAC. They are outside the default ranges presented in Table 7.9 in 2006 GL due to assumptions on frequent A/C service with high leakage rate. We suggest to reduce the figure to be inside the default ranges provided in the *2006 IPCC Guidelines* Table 7.9 to consistent with the methodologies described.