

ANNEX 1

WORKSHEETS

3

Final Draft

Contents

Annex 1	Worksheets	
2B9	Fluorochemical Production (updated)	A1.3
2B10	Hydrogen Production (new)	A1.4
2C3	Aluminium Production (updated).....	A1.5
2C7	Rare Earth Production (new)	A1.12
2E	Electronics Industry (updated)	A1.14
2G2	Other Product Manufacture and Use – SF ₆ and PFCs from Other Product Uses (updated)	A1.20

In this Annex only new and updated worksheets are presented (Annex 1 Volume 3 of the *2019 Refinement*). The worksheets for categories 2B9, 2C3, 2E and 2G2 of this annex should be used instead of the worksheets of categories 2B9, 2C3, 2E and 2G2 in Annex 1 Volume 3 of the *2006 IPCC Guidelines*. The worksheets for categories 2B10 and 2C7 are new ones and should be used together with other worksheets in Annex 1 Volume 3 of the *2006 IPCC Guidelines*.

The other worksheets of Annex 1 of Volume 3 of the *2006 IPCC Guidelines* are not refined.

Final Draft

2B9 FLUOROCHEMICAL PRODUCTION (UPDATED)

(Updated Worksheet)

Sector		Industrial Processes and Product Use	
Category		Chemical Industry - Fluorochemical Production	
Category Code		2B9	
Sheet		1 of 2 HFC-23 Emissions from HCFC-22 Production	
A Amount of HCFC-22 Produced (kg)	B Emission Factor (kg HFC-23/kg HCFC-22 produced)	C HFC-23 Emissions (kg)	D HFC-23 Emissions (Gg)
		$C = A * B$	$D = C/10^6$

(Updated Worksheet)

Sector		Industrial Processes and Product Use			
Category		Chemical Industry - Fluorochemical Production			
Category Code		2B9			
Sheet		2 of 2 Emissions from Production of Fluorochemicals (other than HFC-23 emissions from HCFC-22 production)			
Principal Fluorochemical Produced ¹⁾		A	B	C	D
	Fluorochemical Emitted (may be compound produced, reactant, intermediate, or by-product) ¹⁾	Amount of Principal Fluorochemical Produced (or Other Process Activity)	Fluorochemical Product, Reactant, Intermediate, or Byproduct Emission Factor ^{2), 3)}	Emissions	Emissions
		(kg)	(kg fluorinated GHG emitted/kg fluorochemical produced)	(kg)	(Gg)
				$C = A * B$	$D = C/10^6$
1) Insert additional rows if necessary. 2) See Table 3.28a for Tier 1 default emission factors. The default emission factor includes process vents, equipment leak, and cylinder venting emissions					

Final Draft

27 **2B10 HYDROGEN PRODUCTION (NEW)**

28 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Chemical Industry - Hydrogen Production			
Category Code	2B10			
Sheet	1 of 3 CO ₂ Emissions from Hydrogen Production (calculation based on feedstock used)			
	A	B	C	D
Type of Feedstock	Feedstock Consumption	Carbon Content Factor	CO ₂ recovered	CO ₂ Emissions
	(GJ)	(tonne C / GJ feedstock)	(tonne CO ₂)	(Gg)
				$D = A * B * (44/12) - C$
Total				
Note: Inventory compilers should use either this sheet (1 of 3), the second sheet (2 of 3) or the third sheet (3 of 3), not all of them. This sheet is for the Tier 1a method.				

29

30 (New Worksheet)

Sector	Industrial Processes and Product Use				
Category	Chemical Industry - Hydrogen Production				
Category Code	2B10				
Sheet	2 of 3 CO ₂ Emissions from Hydrogen Production (calculation based on hydrogen produced)				
	A	B	C	D	E
Type of Feedstock	Hydrogen Produced	Feedstock Requirement Factor	Carbon Content Factor	CO ₂ recovered	CO ₂ Emissions
	(tonne)	(GJ feedstock / tonne hydrogen produced)	(tonne C / GJ feedstock)	(tonne CO ₂)	(Gg)
					$E = A * B * C * (44/12) - D$
Total					
Note: Inventory compilers should use either this sheet (2 of 3), the first sheet (1 of 3) or the third sheet (3 of 3), not all of them. This sheet is for the Tier 1b method.					

31

32 (New Worksheet)

Sector	Industrial Processes and Product Use		
Category	Chemical Industry - Hydrogen Production		
Category Code	2B10		
Sheet	3 of 3 CO ₂ Emissions from Hydrogen Production (calculation based on hydrogen produced)		
	A	B	D
Hydrogen Produced	Feedstock Requirement Factor	Carbon Content Factor	CO ₂ Emissions
(tonne)	(GJ feedstock / tonne hydrogen produced)	(tonne C / GJ feedstock)	(Gg)
			$D = A * B * C * (44/12)$
Note: Inventory compilers should use either this sheet (3 of 3), the first sheet (1 of 3) or the second sheet (2 of 3), not all of them. This sheet is for the Tier 1c method.			

33

Final Draft

2C3 ALUMINIUM PRODUCTION (UPDATED)

(Updated Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	1 of 14: CO ₂ Emissions From Anode or Paste Consumption			
Type of Technology	A	B	C	D
	Amount of Aluminium Production	Emission Factor	CO ₂ Emissions	CO ₂ Emissions
	(tonne aluminium produced)	(tonne CO ₂ /tonne aluminium produced)	(tonne)	(Gg)
			$C = A * B$	$D = C/10^3$
Prebake				
Soderberg				
Total				

(New Worksheet)

Sector	Industrial Processes and Product Use				
Category	Metal Industry - Aluminium Production				
Category Code	2C3				
Sheet	2 of 14: CO ₂ Emissions From Sintering ¹⁾				
Type of Technology	A	B	C	D	E
	Mass of Alumina Produced	Mass Fraction of Alumina Produced by Sintering Process	Emission Factor for Sintering	CO ₂ Emissions	CO ₂ Emissions
	(tonne)	(fraction)	(tonne CO ₂ /tonne alumina)	(tonne CO ₂)	(Gg CO ₂)
				$D = A * B * C$	$E = D/10^3$
Bayer-sintering					
Nepheline-sintering process					
Total					
1) CO ₂ emissions from Sintering are estimated here only for alumina production via alternative Bayer-sintering and Nepheline-sintering processes. CO ₂ emissions from the conventional Bayer process are already accounted for in existing guidance for lime production (Volume 3, sub-chapter 2.3) and fossil fuel combustion (Volume 3, Chapter 2)					

Final Draft

48 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	3 of 14: CO ₂ Emissions From Lime Production ¹⁾			
Type of Lime Produced ^{2), 3)}	A	B	C	D
	Mass of Lime Produced	Emission Factor for Lime Production	CO ₂ Emissions	CO ₂ Emissions
	(tonne)	(tonne CO ₂ / tonne lime)	(tonne CO ₂)	(Gg CO ₂)
			$C = A * B$	$D = C/10^3$
Total				
1) CO ₂ emissions from Lime Production are estimated here, only if lime production is a part of the alumina production process <i>and</i> is not already accounted for separately as emissions from the Mineral Industry, under the Lime Production category. 2) Insert additional rows if more than two types of lime are produced. 3) When country-specific information on lime production by type is not available, apply the default emission factor to national level lime production data (see Equation 2.8 in sub-chapter 2.3, Chapter 2, Volume 3).				

49

50 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	4 of 14: CO ₂ Emissions (Total)			
	A	B	C	D
	Emissions from Anode or Paste Consumption	Emissions from Sintering ¹⁾	Emissions from Lime Production ²⁾	Total CO ₂ Emissions
	(Gg)	(Gg)	(Gg)	(Gg)
	From D in Sheet 1 of 14	From E in Sheet 2 of 14	From D in Sheet 3 of 14	$D = A + B + C$
Total				
1) CO ₂ emissions from Sintering are estimated here only for alumina production via alternative Bayer-sintering and Nepheline-sintering processes. 2) CO ₂ emissions from Lime Production are estimated here, only if lime production is a part of the alumina production process <i>and</i> is not already accounted for separately as emissions from the Mineral Industry, under the Lime Production category.				

51

52

53

Final Draft

54 (Updated Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	5 of 14: CF₄ Emissions (High Voltage Anode Effect)			
Type of Technology ^{1), 2)} (please specify)	A	B	C	D
	Amount of Aluminium Production	Emission Factor	HVAE-CF ₄ Emissions	HVAE-CF ₄ Emissions
	(tonne aluminium produced)	(kg CF ₄ /tonne aluminium produced)	(kg)	(Gg)
			C = A * B	D = C/10 ⁶
Total				
1) Insert relevant type of technology, e.g.: PFPB _L , PFPB _M , PFPB _{MW} , SWPB, VSS, HSS. For more details, refer to Section 4.4.1 in Volume 3, Chapter 4.				
2) Insert additional rows if necessary.				

55

56 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	6 of 14: CF₄ Emissions (Low Voltage Anode Effect)			
Type of Technology ^{1), 2)} (please specify)	A	B	C	D
	Amount of Aluminium Production	Emission Factor	LVAE-CF ₄ Emissions	LVAE-CF ₄ Emissions
	(tonne aluminium produced)	(kg CF ₄ /tonne aluminium produced)	(kg)	(Gg)
			C = A * B	D = C/10 ⁶
Total				
1) Insert relevant type of technology, e.g.: PFPB _L , PFPB _M , PFPB _{MW} , SWPB, VSS, HSS. For more details, refer to Section 4.4.1 in Volume 3, Chapter 4.				
2) Insert additional rows if necessary.				

57

58

Final Draft

59 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	7 of 14: CF₄ Emissions (Cell Start-Up)¹⁾			
Type of Technology ^{2), 3)} (please specify)	A	B	C	D
	No. of Cell Start-Ups	CSU Emission Factor	CSU-CF ₄ Emissions	CSU-CF ₄ Emissions
	(cell start-ups)	(kg CF ₄ / cell-start up)	(kg)	(Gg)
			C = A * B	D = C/10 ⁶
Total				
<p>1) Cell start-up (CSU) emissions are estimated, only if they are not already accounted for with HVAE and LVAE emissions. The worksheet here relates to the Tier 3 method of accounting CSU emissions; there are no Tier 1 default values are available for CSU emissions. For more details, refer to Section 4.4.2.3 in Volume 3, Chapter 4.</p> <p>2) Insert relevant type of technology, e.g.: PFPB_L, PFPB_M, PFPB_{MW}, SWPB, VSS, HSS. For more details, refer to Section 4.4.1 in Volume 3, Chapter 4.</p> <p>3) Insert additional rows if necessary.</p>				

60

61 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	8 of 14: CF₄ Emissions (Total)			
	A	B	C	D
	HVAE-CF ₄ Emissions	LVAE-CF ₄ Emissions	CSU-CF ₄ Emissions ¹⁾	Total CF ₄ Emissions
	(Gg)	(Gg)	(Gg)	(Gg)
	From D in Sheet 5 of 14 ²⁾	From D in Sheet 6 of 14	From D in Sheet 7 of 14	D = A + B + C
Total				
<p>1) Cell start-up (CSU) emissions are estimated, only if they are not already accounted for with HVAE and LVAE emissions. For more details, refer to Section 4.4.2.3 in Volume 3, Chapter 4.</p> <p>2) Alternatively, if Tier 2b method is used, total HVAE-CF₄ emissions can be sourced from either: (a) from E in Sheet 12 of 14, or (b) from E in Sheet 13 of 14.</p>				

62

63

64

65

66

Final Draft

67 (Updated Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	9 of 14: C₂F₆ Emissions (High Voltage Anode Effect)			
Type of Technology ^{1), 2)} (please specify)	A	B	C	D
	Amount of Aluminium Production	Emission Factor	HVAE-C ₂ F ₆ Emissions	HVAE-C ₂ F ₆ Emissions
	(tonne aluminium produced)	(kg C ₂ F ₆ /tonne aluminium produced)	(kg)	(Gg)
			C = A * B	D = C/10 ⁶
Total				
1) Insert relevant type of technology, e.g.: PFPB _L , PFPB _M , PFPB _{MW} , SWPB, VSS, HSS. For more details, refer to Section 4.4.1 in Volume 3, Chapter 4.				
2) Insert additional rows if necessary.				

68

69 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Aluminium Production			
Category Code	2C3			
Sheet	10 of 14: C₂F₆ Emissions (Cell Start-Up)¹⁾			
Type of Technology ^{2), 3)} (please specify)	A	B	C	D
	No. of Cell Start-Ups	CSU Emission Factor	CSU-C ₂ F ₆ Emissions	CSU-C ₂ F ₆ Emissions
	(cell start-ups)	(kg C ₂ F ₆ / cell-start up)	(kg)	(Gg)
			C = A * B	D = C/10 ⁶
Total				
1) Cell start-up (CSU) emissions are estimated, only if they are not already accounted for with HVAE and LVAE emissions. The worksheet here relates to the Tier 3 method of accounting CSU emissions; there are no Tier 1 default values available for CSU emissions. For more details, refer to Section 4.4.2.3 in Volume 3, Chapter 4.				
2) Insert relevant type of technology, e.g.: PFPB _L , PFPB _M , PFPB _{MW} , SWPB, VSS, HSS. For more details, refer to Section 4.4.1 in Volume 3, Chapter 4.				
3) Insert additional rows if necessary.				

70

71

Final Draft

(New Worksheet)

Sector	Industrial Processes and Product Use		
Category	Metal Industry - Aluminium Production		
Category Code	2C3		
Sheet	11 of 14: C ₂ F ₆ Emissions (Total)		
	A	B	C
	HVAE-C ₂ F ₆ Emissions	CSU-C ₂ F ₆ Emissions	Total C ₂ F ₆ Emissions
	(Gg)	(Gg)	(Gg)
	From D in Sheet 9 of 14 ¹⁾	From D in Sheet 10 of 14	C = A + B
Total			

1) Alternatively, if Tier 2b method is used, total HVAE-C₂F₆ emissions can be sourced from either: (a) from G in Sheet 12 of 14, or (b) from E in Sheet 14 of 14.

The following worksheets are included to provide extra clarity on the use of new Tier 2b methods for estimating CF₄ and C₂F₆ emissions from HVAEs (using the duration of individual HVAEs) – these can be used in place of Sheets 5 of 14 for HVAE-CF₄ and Sheet 9 of 14 for HVAE-C₂F₆. For more details refer to section 4.4.2.3 in Volume 3, Chapter 4:

- Sheet 12 of 14 is for estimating CF₄ and C₂F₆ using the Tier 2b method – Marks and Nunez approach.
- Sheets 13 and 14 of 14 are for estimating CF₄ and C₂F₆, respectively, using the Tier 2b method – Dion *et al.* approach.

(New Worksheet)

Sector	Industrial Processes and Product Use					
Category	Metal Industry - Aluminium Production					
Category Code	2C3					
Sheet	12 of 14: CF ₄ and C ₂ F ₆ Emissions (High Voltage Anode Effect) Based on Individual HVAE Durations (Tier 2b – Marks & Nunez approach) ¹⁾					
A	B	C	D	E	F	G
Individual HVAE Duration ²⁾	Average Line Current during Individual HVAE	K ₁ Emission Rate Coefficient for CF ₄ ³⁾	K ₂ Emission Rate Coefficient for CF ₄ ³⁾	HVAE-CF ₄ Emissions	Weight fraction C ₂ F ₆ / CF ₄ ratio	HVAE-C ₂ F ₆ Emissions
(seconds)	(kA)	(dimensionless)	(dimensionless)	(Gg)	(kg C ₂ F ₆ / kg CF ₄)	(Gg)
				$E = ((C \cdot A^D) \cdot B) / 10^9$		$G = E \cdot F$
Total						

1) This Tier 2b method estimates CF₄ and C₂F₆ emissions for individual HVAEs. Total HVAE-CF₄ and total HVAE-C₂F₆ emissions are the sum of respective emissions for all individual HVAEs.

2) Insert additional rows for every new HVAE.

3) For K₁ and K₂ emission rate coefficients, refer to Table 4.16a in Volume 3, Chapter 4, section 4.4.2.4.

Final Draft

86 (New Worksheet)

Sector		Industrial Processes and Product Use		
Category		Metal Industry - Aluminium Production		
Category Code		2C3		
Sheet		13 of 14: CF ₄ Emissions (High Voltage Anode Effect) Based on Individual HVAE Durations (Tier 2b – Dion <i>et al.</i> approach) ¹⁾		
A	B	C	D	E
Individual HVAE Duration ²⁾	Average Daily Metal Production per Cell	C ₁ Emission Rate Coefficient for CF ₄	C ₂ Emission Rate Coefficient for CF ₄	HVAE-CF ₄ Emissions
(seconds)	(tonnes aluminium / day)	(kg CF ₄ / tonne aluminium)	(dimensionless)	(Gg)
		0.6415 * B + 5.878	-0.0972 * B + 0.890	$E = ((C * A^D) * B) / 10^9$
Total				
1) This Tier 2b method estimates CF ₄ emissions for individual HVAEs. Total HVAE-CF ₄ emissions is the sum of emissions for all individual HVAEs.				
2) Insert additional rows for every new HVAE.				

87

88

89 (New Worksheet)

Sector		Industrial Processes and Product Use		
Category		Metal Industry - Aluminium Production		
Category Code		2C3		
Sheet		14 of 14: C ₂ F ₆ Emissions (High Voltage Anode Effect) Based on Individual HVAE Durations (Tier 2b – Dion <i>et al.</i> approach) ¹⁾		
A	B	C	D	E
Individual HVAE Duration ²⁾	Average Daily Metal Production per Cell	C ₃ Emission Rate Coefficient for C ₂ F ₆	C ₄ Emission Rate Coefficient for C ₂ F ₆	HVAE-C ₂ F ₆ Emissions
(seconds)	(tonnes aluminium / day)	(kg C ₂ F ₆ / tonne aluminium)	(dimensionless)	(Gg)
		$0.238 * B^2 - 1.407 * B + 2.342$	$-0.0981 * B^2 + 0.381 * B + 0.341$	$E = ((C * A^D) * B) / 10^9$
Total				
1) This Tier 2b method estimates CF ₄ emissions for individual HVAEs. Total HVAE-CF ₄ emissions is the sum of emissions for all individual HVAEs.				
2) Insert additional rows for every new HVAE.				

90

Final Draft

2C7 RARE EARTH PRODUCTION (NEW)

(New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry – Rare Earths Production			
Category Code	2C7			
Sheet	1 of 4: CO ₂ Emissions			
Type of Rare Earth Metal / Alloy ^{1), 2)} (please specify)	A	B	C	D
	Amount of Rare Earth Production	Emission Factor	CO ₂ Emissions	CO ₂ Emissions
	(tonne rare earth metal produced)	(tonne CO ₂ /tonne metal produced)	(tonne)	(Gg)
			$C = A * B$	$D = C/10^3$
Total				
1) Insert relevant rare earth metal or alloy, e.g.: Nd metal, Pr metal, Dy-Fe alloy, etc. For more details, refer to Section 4.8.1 in Volume 3, Chapter 4.				
2) Insert additional rows if necessary.				

(New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Rare Earths Production			
Category Code	2C7			
Sheet	2 of 4: CF ₄ Emissions			
Type of Rare Earth Metal / Alloy ^{1), 2)} (please specify)	A	B	C	D
	Amount of Rare Earth Production	Emission Factor	CF ₄ Emissions	CF ₄ Emissions
	(tonne rare earth metal produced)	(g CF ₄ /tonne metal produced)	(kg)	(Gg)
			$C = A * B / 10^3$	$D = C/10^6$
Total				
1) Insert relevant rare earth metal or alloy, e.g.: Nd metal, Pr metal, Dy-Fe alloy, etc. For more details, refer to Section 4.8.1 in Volume 3, Chapter 4.				
2) Insert additional rows if necessary.				

Final Draft

98 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Rare Earths Production			
Category Code	2C7			
Sheet	3 of 4: C₂F₆ Emissions			
Type of Rare Earth Metal / Alloy ^{1), 2)} (please specify)	A	B	C	D
	Amount of Rare Earth Production	Emission Factor	C ₂ F ₆ Emissions	C ₂ F ₆ Emissions
	(tonne rare earth metal produced)	(g C ₂ F ₆ /tonne metal produced)	(kg)	(Gg)
			$C = A * B / 10^3$	$D = C / 10^6$
Total				
1) Insert relevant rare earth metal or alloy, e.g.: Nd metal, Pr metal, Dy-Fe alloy, etc. For more details, refer to Section 4.8.1 in Volume 3, Chapter 4. 2) Insert additional rows if necessary.				

99

100 (New Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Rare Earths Production			
Category Code	2C7			
Sheet	4 of 4: C₃F₈ Emissions			
Type of Rare Earth Metal / Alloy ^{1), 2)} (please specify)	A	B	C	D
	Amount of Rare Earth Production	Emission Factor	C ₃ F ₈ Emissions	C ₃ F ₈ Emissions
	(tonne rare earth metal produced)	(g C ₃ F ₈ /tonne metal produced)	(kg)	(Gg)
			$C = A * B / 10^3$	$D = C / 10^6$
Total				
1) Insert relevant rare earth metal or alloy, e.g.: Nd metal, Pr metal, Dy-Fe alloy, etc. For more details, refer to Section 4.8.1 in Volume 3, Chapter 4. 2) Insert additional rows if necessary.				

101

102

Final Draft

2E ELECTRONICS INDUSTRY (UPDATED)

(Updated Worksheet)

Sector	Industrial Processes and Product Use				
Category	Electronics Industry - Integrated Circuit or Semiconductor				
Category Code	2E1				
Sheet	1 of 1				
Fluorinated Compounds (FCs)	A	B	C	D	E
	Fraction of Annual Plant Production Capacity Utilization ¹⁾	Annual Manufacturing Design Capacity ¹⁾	Tier 1 Default FC Emission Factor ²⁾	CO ₂ Equivalent Conversion Factor ³⁾	FC Emissions ⁴⁾
	(fraction)	(Gm ² of silicon processed)	(kg FC/m ² of silicon processed)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
					$E = A * B * C * D * 10^3$
CF ₄			0.36		
C ₂ F ₆			0.12		
C ₃ F ₈			0.03		
C ₄ F ₆			0.003		
c-C ₄ F ₈			0.01		
C ₄ F ₈ O			7E-05		
C ₅ F ₈			0.001		
CHF ₃			0.05		
CH ₂ F ₂			0.003		
NF ₃ Remote			0.02		
NF ₃			0.13		
SF ₆			0.05		
N ₂ O			1.01		
Total					
<p>1) The same value should be entered in each row.</p> <p>2) In using Tier 1, inventory compilers should not modify, in any way, the set of the FCs assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 or 3 methods. Neither may inventory compilers change the values of any factors in this column.</p> <p>3) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.</p> <p>4) The Tier 1 method, unlike the Tier 3 or 2 methods, is designed to give an aggregated estimate of FC emissions although its methodology appears to produce gas-specific emissions.</p>					

Final Draft

(Updated Worksheet)

Sector	Industrial Processes and Product Use				
Category	Electronics Industry - Display				
Category Code	2E2				
Sheet	1 of 1				
Fluorinated Compounds (FCs)	A	B	C	D	E
	Fraction of Annual Plant Production Capacity Utilization ¹⁾	Annual Manufacturing Design Capacity ¹⁾	Tier 1 Default FC Emission Factor ²⁾	CO ₂ Equivalent Conversion Factor ³⁾	FC Emissions ⁴⁾
	(fraction)	(Gm ² of glass processed)	(g FC/array input glass area m ²)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
					$E = A * B * C * D$
CF ₄			0.65		
c-C ₄ F ₈			0.001		
CHF ₃			0.0036		
NF ₃ Remote			0.91		
NF ₃			0.38		
SF ₆			4.14		
N ₂ O			17.06		
Total					
<p>1) The same value should be entered in each row.</p> <p>2) In using Tier 1, inventory compilers should not modify, in any way, the set of the FCs assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 or 3 methods. Neither may inventory compilers change the values of any factors in this column.</p> <p>3) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.</p> <p>4) The Tier 1 method, unlike the Tier 3 or 2 methods, is designed to give an aggregated estimate of FC emissions although its methodology appears to produce gas-specific emissions.</p>					

Final Draft

(Unchanged Worksheet)

Sector	Industrial Processes and Product Use		
Category	Electronics Industry - Photovoltaics		
Category Code	2E3		
Sheet	1 of 2		
Fluorinated Compounds (FCs)	A	B	C
	Fraction of Annual Plant Production Capacity Utilization ¹⁾	Annual Manufacturing Design Capacity ¹⁾	Fraction of PV manufacture that uses fluorinated compounds
	(fraction)	(Mm ² of substrate processed)	(fraction)
CF ₄			
C ₂ F ₆			
Total			
1) The same value should be entered in each row.			

(Unchanged Worksheet)

Sector	Industrial Processes and Product Use		
Category	Electronics Industry - Photovoltaics		
Category Code	2E3		
Sheet	2 of 2		
Fluorinated Compounds (FCs)	D	E	F
	Tier 1 Default FC Emission Factor ¹⁾	CO ₂ Equivalent Conversion Factor ²⁾	FC Emissions ³⁾
	(g FC/m ² of substrate processed)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
			$F = A * B * C * D * E / 10^3$
CF ₄	5		
C ₂ F ₆	0.2		
Total			
<p>1) In using Tier 1, inventory compilers should not modify, in any way, the set of the FCs assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 or 3 methods. Neither may inventory compilers change the values of any factors in this column.</p> <p>2) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.</p> <p>3) The Tier 1 method, unlike the Tier 3 or 2 methods, is designed to give an aggregated estimate of FC emissions although its methodology appears to produce gas-specific emissions.</p>			

Final Draft

(New Worksheet)

Sector	Industrial Processes and Product Use				
Category	Electronics Industry – Microelectromechanical Systems (MEMS)				
Category Code	2E4				
Sheet	1 of 1				
	A	B	C	D	E
Fluorinated Compounds (FCs)	Fraction of Annual Plant Production Capacity Utilization ¹⁾	Annual Manufacturing Design Capacity ¹⁾	Tier 1 Default FC Emission Factor ²⁾	CO ₂ Equivalent Conversion Factor ³⁾	FC Emissions ⁴⁾
	(fraction)	(Gm ² of silicon processed)	(kg FC/m ²)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
					$E = A * B * C * D * 10^3$
CF ₄			0.015		
c-C ₄ F ₈			0.076		
SF ₆			1.86		
Total					
<p>1) The same value should be entered in each row.</p> <p>2) In using Tier 1, inventory compilers should not modify, in any way, the set of the FCs assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 or 3 methods. Neither may inventory compilers change the values of any factors in this column.</p> <p>3) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.</p> <p>4) The Tier 1 method, unlike the Tier 3 or 2 methods, is designed to give an aggregated estimate of FC emissions although its methodology appears to produce gas-specific emissions.</p>					

Final Draft

(New Worksheet)

Sector	Industrial Processes and Product Use				
Category	Electronics Industry - Integrated Circuit or Semiconductor Fluorinated Liquids				
Category Code	2E5				
Sheet	1 of 3				
	A	B	C	D	E
Fluorinated Liquids	Fraction of Annual Plant Production Capacity Utilization	Annual Manufacturing Design Capacity	Tier 1 Default FC Emission Factor	CO ₂ Equivalent Conversion Factor ¹⁾	Fluorinated Liquids Emissions
	(fraction)	(Gm ² of silicon consumed)	(kg/m ²)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
					$E = A * B * C * D * 10^3$
HFE-449 _{sl}			0.06		
C ₆ F ₁₄			0.07		
PFPME			0.04		
1) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.					

(New Worksheet)

Sector	Industrial Processes and Product Use				
Category	Electronics Industry - Semiconductor “burn-in” testing Fluorinated Liquids				
Category Code	2E5				
Sheet	2 of 3				
	A	B	C	D	E
Fluorinated Liquids	Fraction of Annual Plant Production Capacity Utilization	Annual Manufacturing Design Capacity	Tier 1 Default FC Emission Factor	CO ₂ Equivalent Conversion Factor ¹⁾	Fluorinated Liquids Emissions
	(fraction)	(Gm ² of silicon consumed)	(kg/kpcs)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
					$E = A * B * C * D * 10^3$
HFE-449 _{sl}			1 x 10 ⁻⁴		
C ₆ F ₁₄			3 x 10 ⁻⁵		
PFPME			1 x 10 ⁻⁵		
1) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.					

Final Draft

(New Worksheet)

Sector	Industrial Processes and Product Use				
Category	Electronics Industry - Display Fluorinated Liquids				
Category Code	2E5				
Sheet	3 of 3				
Fluorinated Liquids	A	B	C	D	E
	Fraction of Annual Plant Production Capacity Utilization	Annual Manufacturing Design Capacity	Tier 1 Default FC Emission Factor	CO ₂ Equivalent Conversion Factor ¹⁾	Fluorinated Liquids Emissions
	(fraction)	(Gm ² of silicon consumed)	(kg/m ²)	(tonne CO ₂ /tonne FC)	(Gg CO ₂ equivalent)
					$E = A * B * C * D * 10^3$
HFE-449 _{sl}			0.00002		
C ₆ F ₁₄			0.00004		
PFPME			0.00004		
1) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory.					

Final Draft

2G2 OTHER PRODUCT MANUFACTURE AND USE - SF₆ AND PFCs FROM OTHER PRODUCT USES (UPDATED)

The sheet 7 of 8 is introduced, so it changes the numbering of worksheets.

(Unchanged Worksheet)

Sector	Industrial Processes and Product Use		
Category	Other Product Manufacture and Use - SF ₆ and PFCs from Other Product Uses		
Category Code	2G2		
Sheet	1 of 8 SF ₆ Emissions from Military Applications (AWACS)		
A	B	C	D
National AWACS Fleet	Emission Factor	SF ₆ Emissions	SF ₆ Emissions
(number of AWACS)	(kg SF ₆ /plane)	(kg)	(Gg)
		C = A * B	D = C/10 ⁶

(Unchanged Worksheet)

Sector	Industrial Processes and Product Use				
Category	Other Product Manufacture and Use - SF ₆ and PFCs from Other Product Uses				
Category Code	2G2				
Sheet	2 of 8 SF ₆ Emissions from University and Research Particle Accelerators				
A	B	C	D	E	F
Number of University and Research Particle Accelerators in the Country	SF ₆ Use Factor	SF ₆ Charge Factor	SF ₆ Emission Factor	SF ₆ Emissions	SF ₆ Emissions
(number)	(fraction)	(kg SF ₆ /particle accelerator)	(fraction)	(kg)	(Gg)
				E = A * B * C * D	F = E/10 ⁶

Final Draft

146 (Unchanged Worksheet)

Sector	Industrial Processes and Product Use				
Category	Other Product Manufacture and Use - SF₆ and PFCs from Other Product Uses				
Category Code	2G2				
Sheet	3 of 8 SF₆ Emissions from Industrial and Medical Particle Accelerators				
Process Description	A	B	C	D	E
	Number of Particle Accelerators that use SF ₆ by Process Description in the Country	SF ₆ Charge Factor	SF ₆ Emission Factor	SF ₆ Emissions	SF ₆ Emissions
	(number)	(kg SF ₆ /particle accelerator)	(fraction)	(kg)	(Gg)
				$D = A * B * C$	$E = D/10^6$
Industrial Accelerator (High Voltage: 0.3-23 MV)					
Industrial Accelerator (Low Voltage: <0.3 MV)					
Medical					
Total					

147

148 (Unchanged Worksheet)

Sector	Industrial Processes and Product Use		
Category	Other Product Manufacture and Use - SF₆ and PFCs from Other Product Uses		
Category Code	2G2		
Sheet	4 of 8 SF₆ Emissions¹⁾ from Adiabatic Uses		
Type of Applications ^{2), 3)} (please specify)	A	B	C
	Sales into application in year t-3	SF ₆ Emissions in year t	SF ₆ Emissions in year t
	(tonne)	(tonne)	(Gg)
		$B = A$	$C = B/10^3$
Total			
1) Emissions of PFCs can be estimated by the same calculation procedure. 2) For example, car tires, sport shoe soles and tennis balls. 3) Insert additional rows, if necessary.			

149

150

Final Draft

151 (Unchanged Worksheet)

Sector	Industrial Processes and Product Use				
Category	Other Product Manufacture and Use - SF ₆ and PFCs from Other Product Uses				
Category Code	2G2				
Sheet	5 of 8 SF ₆ Emissions from Sound-Proof Glazing				
A	B	C	D	E	F
SF ₆ Purchased to Fill Windows Assembled in Inventory Year	Assembly Emission Factor	Assembly Emissions	Capacity of Existing Windows in Inventory Year	Leakage Emission Factor	Leakage Emissions
(tonne SF ₆)	(fraction)	(tonne SF ₆)	(tonne SF ₆)	(fraction)	(tonne SF ₆)
		$C = A * B$			$F = D * E$

152

153 (Unchanged Worksheet)

Sector	Industrial Processes and Product Use			
Category	Other Product Manufacture and Use - SF ₆ and PFCs from Other Product Uses			
Category Code	2G2			
Sheet	6 of 8 SF ₆ Emissions from Sound-Proof Glazing			
G	H	I	J	K
Amount Left in Windows at End of Lifetime (Disposed of in Inventory Year)	Recovery Factor ¹⁾	Disposal Emissions	Total Emissions	Total Emissions
(tonne SF ₆)	(fraction)	(tonne SF ₆)	(tonne SF ₆)	(Gg SF ₆)
		$I = G * (1 - H)$	$J = C + F + I$	$K = J/10^3$
1) Recovery factor is assumed to be zero unless country-specific information is available.				

154

155

Final Draft

156 (New Worksheet)

Sector	Industrial Processes and Product Use					
Category	Other Product Manufacture and Use - SF ₆ and PFCs from Other Product Uses					
Category Code	2G2					
Sheet	7 of 8 Emissions of PFCs from Waterproofing of Electronic Circuits					
Fluorinated Compounds (FCs)	A	B	C	D	E	F
	Number of circuit boards manufactured	Emission Factor	Emissions in g	Emissions in Gg	CO ₂ Equivalent Conversion Factor ¹⁾	FC Emissions ¹⁾
		(g/circuit board)	(g)	(Gg)	(Gg CO ₂ /Gg FC)	(Gg CO ₂ equivalent)
			$C = A * B$	$D = C/10^9$		$F = D * E$
CF ₄						
C ₂ F ₆						
CHF ₃						
Total						
1) Typically, global warming potential (100 year time horizon) identified in the IPCC Assessment Report can be used. These factors should be the same as those used for other sectors/categories to ensure that they are all internally consistent in the inventory						

157

158 (Unchanged Worksheet)

Sector	Industrial Processes and Product Use			
Category	Other Product Manufacture and Use - SF ₆ and PFCs from Other Product Uses			
Category Code	2G2			
Sheet	8 of 8 Emissions of SF ₆ and PFCs from Other Prompt Emissive Applications			
Type of Applications ^{1), 2)} (please specify)	A	B	C	D
	Sales into application in year t	Sales into application in year t-1	Emissions in year t	Emissions in year t
	(tonne)	(tonne)	(tonne)	(Gg)
			$C = 0.5 * (A + B)$	$D = C/10^3$
Total				
1) For example, tracers and use in production of optical cables.				
2) Insert additional rows, if necessary.				

159