ANNEX 1

WORKSHEETS

Contents

In this Annex only new and updated worksheets are presented (Annex 1 Volume 3 of the *2019 Refinement)*. The worksheets for categories 2B9, 2C1, 2C3, 2E and 2G2 of this annex should be used instead of the worksheets of categories 2B9, 2C1, 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.

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	B	C	D
Amount of HCFC-22 Produced (kg)	Emission Factor (kg HFC-23/kg HCFC-22 produced)	HFC-23 Emissions (kg)	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)**				
		A	B	C	D
Principal Fluorochemical Produced[1)]	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)]	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

(Worksheet 3 of 3 from the *2006 IPCC Guidelines* - Removed)

2B10 HYDROGEN PRODUCTION (NEW)

(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)/1000
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.

(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)/1000
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.

(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	C	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))/1000

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.

2C1 IRON AND STEEL PRODUCTION (UPDATED)

(Updated Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Iron and Steel Production			
Category Code	2C1			
Sheet	1 of 3 CO_2 Emissions			
Type of Steelmaking Method, etc	A	B	C	D
	Amount of Steel or Iron Production	Emission Factor	CO_2 Emissions	CO_2 Emissions
	(tonne crude steel produced, pig iron, DRI, sinter or pellet)	(tonne CO_2/tonne production)	(tonne CO_2)	(Gg CO_2)
			C = A * B	D = C/10^3
Basic Oxygen Furnace				
Electric Arc Furnace				
Open Hearth Furnace				
Pig Iron Production (not converted into steel)				
Direct Reduced Iron (DRI) Production				
Sinter Production				
Pellet Production				
Blast Furnace Gas (BFG) and Converter Gas (LDG) from flaring				
TOTAL				

(Updated Worksheet)

Sector	Industrial Processes and Product Use			
Category	Metal Industry - Iron and Steel Production			
Category Code	2C1			
Sheet	2 of 3 CH_4 Emissions			
Type of Production	A	B	C	D
	Amount of Production	Emission Factor	CH_4 Emissions	CH_4 Emissions
	(tonne sinter, DRI or pig iron)	(kg CH_4/tonne production)	(kg)	(Gg)
			C = A * B	D = C/10^6
Sinter Production				
Direct Reduced Iron (DRI) Production				
Pig Iron Production				
TOTAL				

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Iron and Steel Production**
Category Code	**2C1**
Sheet	**3 of 3 N_2O Emissions**

Type of Production	A	B	C	D
	Amount of Production	Emission Factor	N_2O Emissions	N_2O Emissions
	(tonne BFG and LDG)	(tonne N_2O/tonne production)	(tonne)	(Gg)
			C = A * B	D = C/10^3
Blast Furnace Gas (BFG) and Converter Gas (LDG) from flaring				
TOTAL				

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)

(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 *and* 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).

(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 *and* is not already accounted for separately as emissions from the Mineral Industry, under the Lime Production category.

(Updated Worksheet)

Sector	**Industrial Processes and Product Use**			
Category	**Metal Industry - Aluminium Production**			
Category Code	**2C3**			
Sheet	**5 of 14: CF_4 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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**			
Category	**Metal Industry - Aluminium Production**			
Category Code	**2C3**			
Sheet	**6 of 14: CF_4 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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Aluminium Production**
Category Code	**2C3**
Sheet	**7 of 14: CF_4 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				

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.

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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Aluminium Production**
Category Code	**2C3**
Sheet	**8 of 14: CF_4 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				

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.

2) Alternatively, if Tier 2b method is used, total HVAE-CF_4 emissions can be sourced from either: (a) from E in Sheet 12 of 14, or (b) from E in Sheet 13 of 14.

(Updated Worksheet)

Sector	**Industrial Processes and Product Use**			
Category	**Metal Industry - Aluminium Production**			
Category Code	**2C3**			
Sheet	**9 of 14: C_2F_6 Emissions (High Voltage Anode Effect)**			
Type of Technology[1), 2)] (please specify)	A	B	C	D
	Amount of Aluminium Production	Emission Factor	HVAE-C_2F_6 Emissions	HVAE-C_2F_6 Emissions
	(tonne aluminium produced)	(kg C_2F_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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**			
Category	**Metal Industry - Aluminium Production**			
Category Code	**2C3**			
Sheet	**10 of 14: C_2F_6 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_2F_6 Emissions	CSU-C_2F_6 Emissions
	(cell start-ups)	(kg C_2F_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 are 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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Aluminium Production**
Category Code	**2C3**
Sheet	**11 of 14: C_2F_6 Emissions (Total)**

	A	B	C
	HVAE-C_2F_6 Emissions	CSU-C_2F_6 Emissions	Total C_2F_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-C_2F_6 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 CF_4 and C_2F_6 emissions from HVAEs (using the duration of individual HVAEs) – these can be used in place of Sheets 5 of 14 for HVAE-CF_4 and Sheet 9 of 14 for HVAE-C_2F_6. For more details refer to section 4.4.2.3 in Volume 3, Chapter 4:

- Sheet 12 of 14 is for estimating CF_4 and C_2F_6 using the Tier 2b method – Marks and Nunez approach.
- Sheets 13 and 14 of 14 are for estimating CF_4 and C_2F_6, 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_2F_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_2F_6 / CF_4 ratio	HVAE-C_2F_6 Emissions
(seconds)	(kA)	(dimension-less)	(dimension-less)	(Gg)	(kg C_2F_6 / kg CF_4)	(Gg)
				$E = ((C*A^D)*B)/10^9$		G = E * F
Total						

1) This Tier 2b method estimates CF_4 and C_2F_6 emissions for individual HVAEs. Total HVAE-CF_4 and total HVAE-C_2F_6 emissions are the sum of respective emissions for all individual HVAEs.

2) Insert additional rows for every new HVAE.

3) For K_1 and K_2 emission rate coefficients, refer to Table 4.16a in Volume 3, Chapter 4, section 4.4.2.4.

(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 *et al.* 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)	(g CF_4 / s. tonne aluminium)	(dimensionless)	(Gg)
		0.6415 * B + 5.878	-0.0972* B + 0.8905	$E = ((C * A^D) * B) / 10^9$
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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Aluminium Production**
Category Code	**2C3**
Sheet	**14 of 14: C_2F_6 Emissions (High Voltage Anode Effect) Based on Individual HVAE Durations (Tier 2b – Dion *et al.* approach)[1)]**

A	B	C	D	E
Individual HVAE Duration[2)]	Average Daily Metal Production per Cell	C_3 Emission Rate Coefficient for C_2F_6	C_4 Emission Rate Coefficient for C_2F_6	HVAE-C_2F_6 Emissions
(seconds)	(tonnes aluminium / day)	(g C_2F_6 /s. tonne aluminium)	(dimensionless)	(Gg)
		$0.238 * B^2$ - 1.407 * B + 2.342	$-0.0981 * B^2$ + 0.381 * B + 0.3413	$E = ((C * A^D) * B) / 10^9$
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.

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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Rare Earths Production**
Category Code	**2C7**
Sheet	**3 of 4: C_2F_6 Emissions**

Type of Rare Earth Metal / Alloy [1), 2)] (please specify)	A	B	C	D
	Amount of Rare Earth Production	Emission Factor	C_2F_6 Emissions	C_2F_6 Emissions
	(tonne rare earth metal produced)	(g C_2F_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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Metal Industry - Rare Earths Production**
Category Code	**2C7**
Sheet	**4 of 4: C_3F_8 Emissions**

Type of Rare Earth Metal / Alloy [1), 2)] (please specify)	A	B	C	D
	Amount of Rare Earth Production	Emission Factor	C_3F_8 Emissions	C_3F_8 Emissions
	(tonne rare earth metal produced)	(g C_3F_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.

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 3: Gaseous FC and N_2O Emissions**

Fluorinated Compounds (FCs)	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production[1)]	Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor[2)]	CO_2 Equivalent Conversion Factor[3)]	FC Emissions[4)]
	(Gm^2 of silicon processed)	(fraction)	(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_2F_6			0.12		
C_3F_8			0.03		
C_4F_6			0.003		
c-C_4F_8			0.01		
C_4F_8O			7E-05		
C_5F_8			0.001		
CHF_3			0.05		
CH_2F_2			0.003		
NF_3			0.15		
SF_6			0.05		
N_2O			1.01		
Total					

1) If data on actual production are available, enter that data into column A and enter "1" into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

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.

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.

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.

(Updated Worksheet)

Sector	Industrial Processes and Product Use				
Category	**Electronics Industry - Integrated Circuit or Semiconductor**				
Category Code	**2E1**				
Sheet	**2 of 3: Fluorinated Liquids from Heat Transfer Fluid Applications During Manufacturing**				
Fluorinated Liquids	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production[1)]	Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor [2)]	CO_2 Equivalent Conversion Factor [3)]	Fluorinated Liquids Emissions
	(Gm^2 of silicon consumed)	(fraction)	(kg/m^2)	(tonne CO_2 /tonne FC)	(Gg CO_2 equivalent)
					$E = A * B * C * D * 10^3$
$HFE\text{-}449_{sl}$			0.06		
C_6F_{14}			0.07		
PFPMIE			0.04		
Total					

1) If data on actual production are available, enter that data into column A and enter “1” into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

2) In using Tier 1, inventory compilers should not modify, in any way, the set of the fluorinated liquids assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 method. Neither may inventory compilers change the values of any factors in this column.

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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**				
Category	**Electronics Industry – Integrated Circuit or Semiconductor**				
Category Code	**2E1**				
Sheet	**3 of 3: Fluorinated Liquids from Testing, Packaging, and Soldering**				
Fluorinated Liquids	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production[1)]	Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor[2)]	CO_2 Equivalent Conversion Factor [2)]	Fluorinated Liquids Emissions
	(Thousands of packaged devices)	(fraction)	(kg/kpcs)	(tonne CO_2 /tonne FC)	(Gg CO_2 equivalent)
					$E = (A * B * C * D)/10^6$
$HFE\text{-}449_{sl}$			1 x 10-4		
C_6F_{14}			3 x 10-5		
PFPMIE			1 x 10-5		
Total					

1) If data on actual production are available, enter that data into column A and enter "1" into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

2) In using Tier 1, inventory compilers should not modify, in any way, the set of the fluorinated liquids assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 method. Neither may inventory compilers change the values of any factors in this column.

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.

(Updated Worksheet)

Sector	**Industrial Processes and Product Use**
Category	**Electronics Industry - Display**
Category Code	**2E2**
Sheet	**1 of 2: Gaseous FC and N_2O Emissions**

Fluorinated Compounds (FCs)	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production[1)]	Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor[2)]	CO_2 Equivalent Conversion Factor[3)]	FC Emissions[4)]
	(Gm^2 of glass processed)	(fraction)	(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		
$c\text{-}C_4F_8$			0.001		
CHF_3			0.0024		
NF_3			1.29		
SF_6			4.14		
N_2O			17.06		
Total					

1) If data on actual production are available, enter that data into column A and enter “1” into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

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.

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.

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.

(Updated Worksheet)

Sector	**Industrial Processes and Product Use**				
Category	**Electronics Industry - Display**				
Category Code	**2E2**				
Sheet	**2 of 2: Fluorinated Liquids from Heat Transfer Fluid Applications During Manufacturing**				
Fluorinated Liquids	A	B	C	D	E
	Annual Manufacturing Design Capacity Or Actual Production[1)]	Fraction of Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor [2)]	CO_2 Equivalent Conversion Factor [3)]	Fluorinated Liquids Emissions
	(Gm^2 of glass processed)	(fraction)	(kg/m^2)	(tonne CO_2 /tonne FC)	(Gg CO_2 equivalent)
					$E = A * B * C * D * 10^3$
$HFE\text{-}449_{sl}$			0.00002		
C_6F_{14}			0.00004		
PFPMIE			0.00004		
Total					

1) If data on actual production are available, enter that data into column A and enter “1” into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

2) In using Tier 1, inventory compilers should not modify, in any way, the set of the fluorinated liquids assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 method. Neither may inventory compilers change the values of any factors in this column.

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.

(Updated Worksheet)

Sector	**Industrial Processes and Product Use**		
Category	**Electronics Industry - Photovoltaics**		
Category Code	**2E3**		
Sheet	**1 of 2: Gaseous FC Emissions**		
Fluorinated Compounds (FCs)	A	B	C
	Annual Manufacturing Design Capacity or Actual Production[1)]	Fraction of Annual Plant Production Capacity Utilization[1)]	Fraction of PV manufacture that uses fluorinated compounds
	(Mm^2 of substrate processed)	(fraction)	(fraction)
CF_4			
C_2F_6			
Total			

1) If data on actual production are available, enter that data into column A and enter "1" into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

(Updated Worksheet)

Sector	**Industrial Processes and Product Use**		
Category	**Electronics Industry - Photovoltaics**		
Category Code	**2E3**		
Sheet	**2 of 2: Gaseous FC Emissions**		
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_2F_6	0.2		
Total			

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.

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.

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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**				
Category	**Electronics Industry – Microelectromechanical Systems (MEMS)**				
Category Code	**2E4**				
Sheet	**1 of 3: Gaseous FC Emissions**				
Fluorinated Compounds (FCs)	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production [1)]	Annual Plant Production Capacity Utilization [1)]	Tier 1 Default FC Emission Factor [2)]	CO_2 Equivalent Conversion Factor [3)]	FC Emissions [4)]
	(Gm^2 of silicon processed)	(fraction)	(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_4F_8			0.076		
SF_6			1.86		
Total					

1) If data on actual production are available, enter that data into column A and enter "1" into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

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.

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.

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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**				
Category	**Electronics Industry – Microelectromechanical Systems (MEMS)**				
Category Code	**2E4**				
Sheet	**2 of 3: Fluorinated Liquids from Heat Transfer Fluid Applications During Manufacturing**				
Fluorinated Liquids	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production[1)]	Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor[2)]	CO_2 Equivalent Conversion Factor [3)]	Fluorinated Liquids Emissions
	(Gm^2 of silicon consumed)	(fraction)	(kg/m^2)	(tonne CO_2 /tonne FC)	(Gg CO_2 equivalent)
					$E = A * B * C * D * 10^3$
$HFE\text{-}449_{sl}$			0.06		
C_6F_{14}			0.07		
PFPMIE			0.04		
Total					

1) If data on actual production are available, enter that data into column A and enter "1" into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

2) In using Tier 1, inventory compilers should not modify, in any way, the set of the fluorinated liquids assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 method. Neither may inventory compilers change the values of any factors in this column.

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.

(New Worksheet)

Sector	**Industrial Processes and Product Use**				
Category	**Electronics Industry – Microelectromechanical Systems (MEMS)**				
Category Code	**2E4**				
Sheet	**3 of 3: Fluorinated Liquids from Testing, Packaging, and Soldering**				
Fluorinated Liquids	A	B	C	D	E
	Annual Manufacturing Design Capacity or Actual Production[1)]	Annual Plant Production Capacity Utilization[1)]	Tier 1 Default FC Emission Factor[2)]	CO_2 Equivalent Conversion Factor [3)]	Fluorinated Liquids Emissions
	(Thousands of packaged devices)	(fraction)	(kg/kpcs)	(tonne CO_2 /tonne FC)	(Gg CO_2 equivalent)
					$E = (A * B * C * D)/10^6$
$HFE\text{-}449_{sl}$			1 x 10-4		
C_6F_{14}			3 x 10-5		
PFPMIE			1 x 10-5		
Total					

1) If data on actual production are available, enter that data into column A and enter "1" into each cell in column B. The same value for capacity utilization should be entered in each row of column B, and the same value for capacity (or actual production) should be entered in each row of column A.

2) In using Tier 1, inventory compilers should not modify, in any way, the set of the fluorinated liquids assumed here. Inventory compilers should not combine emissions estimated using Tier 1 method with emissions estimated using the Tier 2 method. Neither may inventory compilers change the values of any factors in this column.

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.

2G2 OTHER PRODUCT MANUFACTURE AND USE - SF_6 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

(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	**3 of 8 SF_6 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					

(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	**4 of 8 SF_6 Emissions[1)] 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.

(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

(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.

(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[)]
		(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_2F_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

(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.