

1.A.3.a ii (i) - Domestic Civil Aviation: LTO

Short description

In NFR category *1.A.3.a ii (i) - Domestic Civil Aviation: LTO* emissions from domestic flights between German airports occurring during LTO stage (Landing/Take-off: 0-3,000 feet) are reported.

Method	AD	EF	Key Category
T1, T2, T3	NS, M	CS, D, M	no key category

T = key source by Trend **L** = key source by Level

Methods	
D	Default
RA	Reference Approach
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model
* as described in the EMEP/CORINAIR Emission Inventory Guidebook - 2007, in the group specific chapters.	
AD - Data Source for Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific data
AS	Associations, business organisations
Q	specific questionnaires, surveys
EF - Emission Factors	
D	Default (EMEP Guidebook)
C	Confidential
CS	Country Specific
PS	Plant Specific data

In the following, information on sub-category specific AD, (implied) emission factors and emission estimates are provided.

Methodology

Activity Data

Table 1: Percentual annual fuel consumption during LTO-stage of domestic flights

source: Knörr et al. (2019c) ¹⁾ & Gores (2019) ²⁾

Table 2: annual LTO fuel consumption for domestic flights, in terajoule

source: Knörr et al. (2019c) ³⁾ & Gores (2019) ⁴⁾

Emission factors

Furthermore, the **newly implemented EF(BC)** have been estimated via f-BCs as provided in the 2019 EMEP/EEA Guidebook ⁷⁾, Chapter 1.A.3.a, 1.A.5.b Aviation, page 49: “Conclusion”.

Table 3: Country-specific emission factors, in kg/TJ

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
JET KEROSENE														
NH₃														
NMVOC														
NO_x														
SO_x														
BC¹														
PM²														
CO														
AVIATION GASOLINE														

NH₃														
NMVOC														
NO_x														
SO_x														
BC¹														
PM²														
TSP³														
CO														

¹ estimated via a f-BCs (avgas: 0.15, jet kerosene: 0.48) as provided in ⁸⁾

² EF(PM₁₀,2.5) also applied for PM₁₀, and TSP (assumption: > 99% of TSP from diesel oil combustion consists of PM₁₀,2.5)

³ also including TSP from lead: EF(TSP) = 1.6 x EF(Pb) - see road transport



For the country-specific emission factors applied for particulate matter, no clear indication is available, whether or not condensables are included.

Table 4: Tier1 emission factors for heavy-metal and POP exhaust emissions

	= Pb	= Cd	= Hg	= As	= Cr	= Cu	= Ni	= Se	= Zn	= B[a]P	= B[b]F	= B[k]F	= I[...]	= PAH 1-4	= PCDD/F			
=	= [g/T]									= [mg/T]				= [μg/T]				
~ Kerosene	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE			
~ Aviation gasoline	> 9,481	1		> 0.005	> 0.200	> 0.007	> 0.145	> 0.103	> 0.053	> 0.005	> 0.758	> 126	> 182	> 90	> 205	> 602	= NE	
1																		

NFR 1.A.3.a ii (i) - Domestic Civil Aviation - LTO is **no key source**.

Where **sulphur oxides** emissions are dominated by jet kerosene due to the amount of fuel used, the majority of **carbon monoxide** stems from the consumption of avgas given the much higher emission factor applied to this fuel.

[gallery size="medium" : 1A3aii\(i\)_SOx.png : 1A3aii\(i\)_CO.png](#) [gallery](#)

Lead emissions on the other hand, with no emission factor available for jet kerosene, are only calculated for avgas.

[gallery size="medium" : 1A3aii\(i\)_Pb.png](#) [gallery](#)

Recalculations

Activity data

In order to keep in line with the EMEP/EEA Guidebook 2019 and the regularly updated data sets provided to the EEA by Eurocontrol, the average fuel use per LTO cycle has been updated again within TREMOD Aviation but with much smaller impact as in last year's submission.

Resulting from this revision, the percentual shares of kerosene consumed during LTO within TREMOD AV have been recalculated as shown in Table 4.

Table 4: Revised percentual share of kerosene consumed during LTO for domestic flights, in %

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	

Hence, the amount of kerosene allocated to sub-category 1.A.3.a ii (i) had to be revised accordingly:

Table 5: Revised fuel consumption data, in terajoule

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
JET KEROSENE																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
AVIATION GASOLINE																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
TOTAL FUEL CONSUMPTION																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	

In parallel, the majority of **country-specific emission factors** has been revised within TREMOD AV based on information available from the 2019 EMEP/EEA Guidebook ⁹⁾ and Eurocontrol's AEM model ¹⁰⁾. Here, among others, the EF for SO₂, from jet kerosene has been replaced by new and more reliable

data showing no sulphur reduction since 1990.

Furthermore, all EF applied for aviation gasoline have been revised widely based on better knowledge but with no significant impact on the emission inventory.

Table 6: Revised country-specific emission factors for jet kerosene, in [kg/TJ]

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-methane volatile organic compounds - NMVOC																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
Nitrogen oxides - NO_x																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
Sulphur oxides - SO_x																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	

The TSP emissions calculated depend directly on the reported lead emissions: The emission factor for TSP is 1.6 times the emission factor used for lead: $EF(TSP) = 1.6 \times EF(Pb)$. The applied procedure is similar to the one used for calculating TSP emissions from leaded gasoline used in road transport.

bibliography : 1 : Knörr, W., Schacht, A., & Gores, S. (2010): Entwicklung eines eigenständigen Modells zur Berechnung des Flugverkehrs (TREMOT-AV) : Endbericht. Endbericht zum F+E-Vorhaben 360 16 029, URL:

<https://www.umweltbundesamt.de/publikationen/entwicklung-eines-modells-zur-berechnung>; Berlin & Heidelberg, 2012. : 2 : Knörr et al. (2019c): Knörr, W., Schacht, A., & Gores, S.: TREMOD Aviation (TREMOT AV) 2018 - Revision des Modells zur Berechnung des Flugverkehrs (TREMOT-AV). Heidelberg, Berlin: Ifeu Institut für Energie- und Umweltforschung Heidelberg GmbH & Öko-Institut

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¹⁾ (bibcite 2)

²⁾ (bibcite 3)

³⁾ (bibcite 2)

⁴⁾ (bibcite 3)

⁵⁾ (bibcite 1)

⁶⁾ (bibcite 2)

⁷⁾ (bibcite 4)

⁸⁾ (bibcite 4)

⁹⁾ (bibcite 4)

¹⁰⁾ (bibcite 5)