

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.

Category Code	Method					AD					EF				
1.A.3.a ii(i)	T1, T2, T3					NS, M					CS, D, M				
Key Category	SO ₂	NO _x	NH ₃	NMVOC	CO	BC	Pb	Hg	Cd	Diox	PAH	HCb	TSP	PM ₁₀	PM _{2.5}
1.A.3.a ii(i)	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-	-/-	-	-/-	-/-	-/-

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

Specific jet kerosene consumption during LTO-stage is calculated within TREMOD AV as described in the [superordinate chapter](#).

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jet Kerosene	30,2	29,4	27,9	27,6	27,5	27,3	27,3	27,3	27,6	27,7	28,0	27,9	27,7	27,7	28,1	28,3	28,4	28,1
Aviation Gasoline	18,9	36,0	33,6	50,2	52,1	55,4	51,6	51,2	49,9	46,7	49,1	54,0	56,8	51,4	61,8	62,0	68,0	76,0

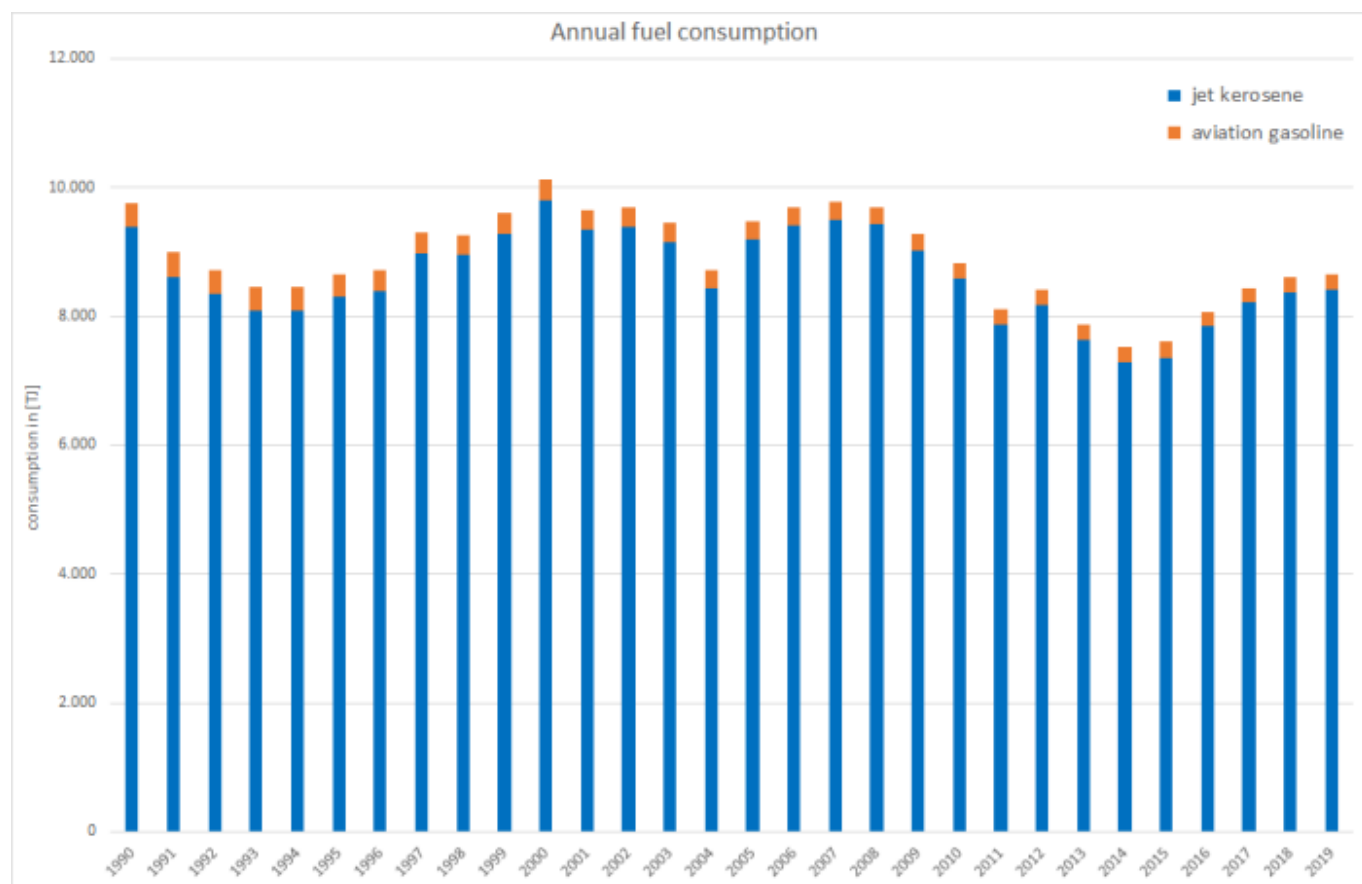
source: Knörr et al. (2019c) ¹⁾ & Gores (2019) ²⁾

As explained above, the use of aviation gasoline is - due to a lack of further information - assumed to entirely take place within the LTO-range.

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jet Kerosene	9,380	8,303	9,811	9,187	9,402	9,493	9,422	9,021	8,589	7,869	8,171	7,633	7,297	7,358	7,844	8,210	8,362	8,417
Aviation Gasoline	368	346	311	293	283	283	276	255	236	248	237	234	237	246	234	232	248	229
Σ 1.A.3.a ii (i)	9,748	8,649	10,122	9,481	9,686	9,776	9,698	9,277	8,825	8,117	8,408	7,868	7,534	7,604	8,078	8,442	8,610	8,647

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



~ 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 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.

Furthermore, as explained in the superordinate chapter, avgas consumption for international flights and outside the LTO range has been estimated for the first time for this submission, with the respective amounts of avgas re-allocated accordingly.

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	30,2	29,4	27,9	27,6	27,5	27,3	27,3	27,3	27,6	27,7	28,0	27,9	27,7	27,7	28,1	28,3	28,4
Submission 2020	30,5	29,5	28,1	27,7	27,7	27,4	27,4	27,4	27,7	27,8	28,1	28,0	27,6	27,8	28,2	28,4	28,5
absolute change	-0,29	-0,10	-0,13	-0,11	-0,11	-0,11	-0,10	-0,11	-0,11	-0,13	-0,13	-0,13	0,07	-0,12	-0,10	-0,10	-0,11
relative change	-0,94%	-0,33%	-0,45%	-0,39%	-0,40%	-0,42%	-0,37%	-0,40%	-0,41%	-0,45%	-0,45%	-0,48%	0,24%	-0,43%	-0,37%	-0,35%	-0,40%

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	9.380	8.303	9.811	9.187	9.402	9.493	9.422	9.021	8.589	7.869	8.171	7.633	7.297	7.358	7.844	8.210	8.362
Submission 2020	8.777	8.734	8.962	8.276	8.455	8.631	8.728	8.212	8.284	8.390	8.084	7.278	7.492	7.609	7.758	7.568	7.655

absolute change	602	-431	849	912	948	862	694	810	306	-521	87	355	-196	-251	85	642	707
relative change	6,86%	-4,94%	9,48%	11,02%	11,21%	9,99%	7,95%	9,86%	3,69%	-6,21%	1,08%	4,88%	-2,61%	-3,29%	1,10%	8,48%	9,24%
AVIATION GASOLINE																	
Submission 2021	368	346	311	293	283	283	276	255	236	248	237	234	237	246	234	232	248
Submission 2020	2.438	1.142	1.120	698	653	611	638	594	568	614	558	496	472	553	407	403	389
absolute change	-2.070	-796	-809	-405	-370	-328	-362	-339	-332	-366	-321	-262	-235	-307	-173	-171	-141
relative change	-84,9%	-69,7%	-72,2%	-58,0%	-56,6%	-53,6%	-56,8%	-57,0%	-58,5%	-59,6%	-57,5%	-52,8%	-49,7%	-55,5%	-42,5%	-42,4%	-36,3%
TOTAL FUEL CONSUMPTION																	
Submission 2021	9.748	8.649	10.122	9.481	9.686	9.776	9.698	9.277	8.825	8.117	8.408	7.868	7.534	7.604	8.078	8.442	8.610
Submission 2020	11.215	9.876	10.082	8.974	9.108	9.242	9.366	8.806	8.852	9.004	8.642	7.774	7.964	8.162	8.165	7.971	8.044
absolute change	-1.467	-1.227	40	507	578	534	331	471	-27	-887	-234	93	-430	-557	-87	471	566
relative change	-13,1%	-12,4%	0,40%	5,65%	6,34%	5,78%	3,54%	5,35%	-0,30%	-9,85%	-2,70%	1,20%	-5,40%	-6,83%	-1,07%	5,91%	7,03%

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/T]

[illegible]

relative change																	
BLACK CARBON - BC																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
PARTICULATE MATTER - PM																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
CARBON MONOXIDE - CO																	
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:

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<https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-a-aviation/view>; Copenhagen, 2019. : 5 : Eurocontrol (2019): Advanced emission model (AEM); <https://www.eurocontrol.int/model/advanced-emission-model>; 2019 **bibliography**

¹⁾ (bible 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)