

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⁾

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. As soon as better data allows the split of the consumption of aviation gasoline onto domestic and international flights as well as LTO and Cruise, Germany will accordingly adjust its inventory.

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

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Emission factors

All country-specific emission factors used for emission reporting were basically ascertained within UBA project FKZ 360 16 029 (Knörr, W., Schacht, A., & Gores, S. (2010)) ⁵⁾ and have since then been compiled, revised and maintained in TREMOD AV ⁶⁾.

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”.

For more details, please see [superordinate chapter](#) on civil aviation.

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

[illegible]

[illegible]

NOTE: 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

[illegible]

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.

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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.

	= 1990	= 1995	= 2000	= 2005	= 2006	= 2007	= 2008	= 2009	= 2010	= 2011	= 2012	= 2013	= 2014	= 2015	= 2016	= 2017		
< NMVOC																		
~ Submission 2020	> 29.1	> 30.2	> 30.5	> 32.4	> 33.9	> 34.7	> 35.1	> 33.9	> 33.4	> 33.2	> 33.5	> 36.8	> 37.7	> 38.8	> 39.0	> 40.9		
~ Submission 2019	> 19.7	> 20.0	> 18.4	> 20.6	> 22.2	> 22.8	> 22.2	> 19.7	> 17.8	> 18.9	> 19.8	> 22.4	> 23.2	> 19.4	> 20.2	> 22.3		
~ absolute change	> 9.42	> 10.14	> 12.13	> 11.82	> 11.67	> 11.91	> 12.90	> 14.22	> 15.54	> 14.27	> 13.74	> 14.39	> 14.49	> 19.37	> 18.82	> 18.64		
~ relative change	> 47.7%	> 50.7%	> 66.0%	> 57.3%	> 52.6%	> 52.3%	> 58.2%	> 72.2%	> 87.2%	> 75.4%	> 69.4%	> 64.2%	> 62.4%	> 99.9%	> 93.3%	> 83.5%		
< Nitrogen oxides - NO_x																		
~ Submission 2020	> 290	> 319	> 276	> 262	> 258	> 261	> 272	> 283	> 289	> 293	> 295	> 290	> 299	> 296	> 306	> 305		
~ Submission 2019	> 301	> 332	> 301	> 286	> 285	> 289	> 299	> 310	> 315	> 318	> 323	> 323	> 321	> 326	> 332	> 334		
~ absolute change	> -10.92	> -13.06	> -24.33	> -24.23	> -26.74	> -27.85	> -26.91	> -26.19	> -26.76	> -25.24	> -28.13	> -33.10	> -22.14	> -30.48	> -26.20	> -28.52		
~ relative change	> -3.63%	> -3.93%	> -8.10%	> -8.47%	> -9.38%	> -9.65%	> -9.01%	> -8.46%	> -8.49%	> -7.93%	> -8.71%	> -10.26%	> -6.89%	> -9.34%	> -7.89%	> -8.54%		
< Sulphur oxides - SO_x																		
~ Submission 2020	> 19.7	> 19.5	> 19.5	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6	> 19.6		
~ Submission 2019	> 25.1	> 15.2	> 8.5	> 6.3	> 5.9	> 5.5	> 5.1	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7	> 4.7		
~ absolute change	> -5.45	> 4.30	> 11.08	> 13.28	> 13.71	> 14.13	> 14.55	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98	> 14.98		
~ relative change	> -21.7%	> 28.2%	> 131%	> 209%	> 232%	> 257%	> 287%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%	> 322%		
< Black carbon - BC																		
~ Submission 2020	> 1.21	> 1.20	> 1.21	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22	> 1.22		
~ Submission 2019	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95	> 0.95		
~ absolute change	> 0.26	> 0.26	> 0.26	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27	> 0.27		
~ relative change	> 27.76%	> 27.11%	> 27.54%	> 28.52%	> 28.53%	> 28.58%	> 28.67%	> 28.75%	> 28.57%	> 28.56%	> 28.68%	> 28.94%	> 28.96%	> 28.95%	> 28.90%	> 28.94%		
< Particulate matter - PM																		
~ Submission 2020	> 2.52	> 2.51	> 2.52	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54	> 2.54		
~ Submission 2019	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97	> 1.97		
~ absolute change	> 0.55	> 0.53	> 0.54	> 0.56	> 0.56	> 0.56	> 0.57	> 0.57	> 0.56	> 0.56	> 0.57	> 0.57	> 0.57	> 0.57	> 0.57	> 0.57		
~ relative change	> 27.76%	> 27.1%	> 27.54%	> 28.5%	> 28.5%	> 28.6%	> 28.67%	> 28.75%	> 28.57%	> 28.56%	> 28.68%	> 28.94%	> 28.96%	> 28.95%	> 28.90%	> 28.94%		
< Carbon monoxide - CO																		
~ Submission 2020	> 203	> 201	> 254	> 262	> 260	> 255	> 250	> 240	> 240	> 234	> 232	> 238	> 241	> 246	> 238	> 238		
~ Submission 2019	> 182	> 184	> 238	> 254	> 255	> 248	> 240	> 226	> 217	> 215	> 210	> 212	> 214	> 206	> 201	> 199		

~ absolute change	> 21.2	> 17.1	> 16.4	> 7.80	> 5.58	> 6.22	> 9.74	> 14.0	> 23.0	> 19.0	> 21.8	> 25.6	> 27.3	> 39.7	> 36.7	> 39.1		
~ relative change	> 11.6%	> 9.3%	> 6.9%	> 3.1%	> 2.2%	> 2.5%	> 4.1%	> 6.2%	> 10.6%	> 8.9%	> 10.3%	> 12%	> 12.7%	> 19.2%	> 18.3%	> 19.7%		

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

Table 7: Revised country-specific emission factors for aviation gasoline, in [kg/TJ]

< NMVOC																	
~ Submission 2020	> 612	> 622	> 608	> 616	> 614	> 612	> 612	> 615	> 612	> 622	> 619	> 621	> 619	> 618	> 619	> 614	
~ Submission 2019	> 181	> 182	> 179	> 177	> 175	> 174	> 177	> 178	> 180	> 186	> 186	> 186	> 184	> 183	> 187	> 187	
~ absolute change	> 431	> 440	> 429	> 439	> 439	> 437	> 435	> 436	> 432	> 436	> 433	> 435	> 434	> 435	> 432	> 426	
~ relative change	> 238%	> 242%	> 239%	> 248%	> 250%	> 251%	> 245%	> 245%	> 241%	> 235%	> 233%	> 234%	> 235%	> 237%	> 231%	> 228%	
< Nitrogen oxides - NO_x																	
~ Submission 2020	> 126	> 128	> 125	> 126	> 125	> 125	> 125	> 125	> 124	> 128	> 127	> 128	> 127	> 126	> 127	> 125	
~ Submission 2019	> 279	> 275	> 284	> 292	> 298	> 301	> 291	> 287	> 283	> 263	> 262	> 261	> 266	> 270	> 257	> 257	
~ absolute change	> -153	> -147	> -159	> -166	> -173	> -176	> -166	> -162	> -159	> -135	> -135	> -133	> -139	> -144	> -129	> -131	
~ relative change	> -54.8%	> -53.4%	> -56.0%	> -56.8%	> -58.0%	> -58.6%	> -56.9%	> -56.3%	> -56.1%	> -51.4%	> -51.4%	> -51.1%	> -52.3%	> -53.3%	> -50.4%	> -51.2%	
< Sulphur oxides - SO_x																	
~ Submission 2020	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	
~ Submission 2019	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	> 0.51	
~ absolute change	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	> -0.05	
~ relative change	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	> -9.5%	
< Black carbon - BC																	
~ Submission 2020	> 1.12	> 1.13	> 1.12	> 1.18	> 1.16	> 1.16	> 1.12	> 1.17	> 1.18	> 1.14	> 1.12	> 1.13	> 1.12	> 1.16	> 1.11	> 1.05	
~ Submission 2019	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	> 0.07	
~ absolute change	> 1.05	> 1.06	> 1.05	> 1.11	> 1.09	> 1.09	> 1.05	> 1.10	> 1.11	> 1.07	> 1.06	> 1.06	> 1.05	> 1.09	> 1.04	> 0.98	
~ relative change	> 1521%	> 1536%	> 1527%	> 1616%	> 1580%	> 1585%	> 1529%	> 1600%	> 1616%	> 1547%	> 1532%	> 1538%	> 1525%	> 1583%	> 1508%	> 1428%	
< Particulate matter - PM																	
~ Submission 2020	> 7.45	> 7.52	> 7.48	> 7.89	> 7.72	> 7.74	> 7.49	> 7.81	> 7.89	> 7.57	> 7.50	> 7.53	> 7.47	> 7.73	> 7.39	> 7.02	

~ Submission 2019	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46	> 0.46			
~ absolute change	> 6.99	> 7.06	> 7.02	> 7.43	> 7.26	> 7.28	> 7.03	> 7.35	> 7.43	> 7.11	> 7.04	> 7.07	> 7.01	> 7.27	> 6.93	> 6.57			
~ relative change	> 1521%	> 1536%	> 1527%	> 1616%	> 1580%	> 1585%	> 1529%	> 1600%	> 1616%	> 1547%	> 1532%	> 1538%	> 1525%	> 1583%	> 1508%	> 1428%			
< Carbon monoxide - CO																			
~ Submission 2020	> 20,728	> 21,069	> 20,855	> 20,973	> 21,124	> 21,248	> 21,122	> 21,229	> 21,326	> 21,339	> 21,463	> 21,389	> 21,513	> 21,555	> 21,468	> 21,944			
~ Submission 2019	> 14,951	> 15,047	> 14,832	> 14,644	> 14,479	> 14,421	> 14,648	> 14,750	> 14,853	> 15,354	> 15,384	> 15,406	> 15,269	> 15,174	> 15,502	> 15,503			
~ absolute change	> 5,777	> 6,022	> 6,023	> 6,329	> 6,645	> 6,827	> 6,474	> 6,479	> 6,473	> 5,985	> 6,079	> 5,983	> 6,244	> 6,381	> 5,966	> 6,441			
~ relative change	> 38.6%	> 40.0%	> 40.6%	> 43.2%	> 45.9%	> 47.3%	> 44.2%	> 43.9%	> 43.6%	> 39.0%	> 39.5%	> 38.8%	> 40.9%	> 42.1%	> 38.5%	> 41.5%			



For more information on recalculated emission estimates for Base Year and 2018, please see the pollutant specific recalculation tables following chapter [8.1 - Recalculations](#).

Uncertainties

For uncertainties information, please see [main chapter](#) on civil aviation.

Planned improvements

For information on planned improvements, please see [main chapter](#) on civil aviation.

FAQs

Why are emissions from aviation gasoline reported using a Tier 1 approach whereas for jet kerosene Tier 2a has been applied?

For reporting emissions from the consumption of jet kerosene, the party uses an annual split factor provided by Eurocontrol to divide the total amount of kerosene used (from Energy Balances & Official oil data for the Federal Republic of Germany) onto national and international civil aviation. For aviation gasoline, such split factor does not exist. - Furthermore, the deviation of kerosene used onto flight stages LTO and Cruise has been carried out using data on numbers of take-offs from German airports provided by the German Federal Statistical Office. At the moment, such data is not available for aircraft using aviation gasoline.

On which basis does the party estimate the reported lead emissions from aviation gasoline?

assumption by party: aviation gasoline = AvGas 100 LL (AvGas 100 LL is the predominant sort of aviation gasoline in Western Europe)^{footnote} <https://en.wikipedia.org/wiki/Avgas> : "...Common in North America and western Europe, limited availability elsewhere worldwide." ^{footnote} lead content of AvGas 100 LL: 0.56 g lead/liter (as tetra ethyl lead)^{footnote} EMEP/EEA GB 2016: "Thus, general emission factors for the stationary combustion of kerosene and the combustion of gasoline in cars may be applied. The only exception is lead. Lead is added to aviation gasoline to increase the octane number. The lead content is higher than in leaded car gasoline, and the maximum permitted levels in the UK are shown below. A value of 0.6 g of lead per litre of gasoline should be used as the default value if there is an absence of more accurate information. Actual data may be obtained from oil companies."^{footnote}

The applied procedure is similar to the one used for calculating lead emissions from leaded gasoline used in road transport. (There, in contrast to aviation gasoline, the lead content constantly declined resulting in a ban of leaded gasoline in 1997.)

On which basis does the party estimate the reported TSP emissions from aviation gasoline?

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 e.V., Berlin & Heidelberg, 2019. : 3 : Gores (2019): Inventartool zum deutschen Flugverkehrsinventar 1990-2018, im Rahmen der Aktualisierung des Moduls TREMOD-AV im Transportemissionsmodell TREMOD, Berlin, 2019. : 4 : EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019, <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⁾ (bibcite 2)

²⁾ (bibcite 3)

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⁴⁾ (bibcite 3)

⁵⁾ (bibcite 1)

⁶⁾ (bibcite 2)

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