

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

Short description

Category Code	Method					AD					EF				
1.A.3.a ii (ii)	T1, T2, T3					NS, M					CS, D, M				
Key Category	SO ₂	NO _x	NH ₃	NMVO	CO	BC	Pb	Hg	Cd	Diox	PAH	HCB	TSP	PM ₁₀	PM _{2.5}
1.A.3.a ii (ii)	not included in key category analysis														

In NFR category 1.A.3.a ii (ii) - Domestic Civil Aviation: Cruise emissions from domestic flights between German airports during cruise stage (above 3,000 feet of altitude) are reported.

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

Methodology

Activity Data

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

Table 1: annual jet kerosene & avgas consumption during cruise-stage, in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Kerosene	21,690	19,937	25,301	24,071	24,736	25,337	25,111	24,048	22,503	20,552	21,026	19,762	19,038	19,195	20,067	20,793	21,067	21,672	10,114
Avgas	1,681	805	779	472	437	408	432	404	382	440	398	354	343	393	322	320	310	256	170

source: Knörr et al. (2021c) ¹⁾ & Gores (2021) ²⁾

Emission factors

All country specific emission factors used for emission reporting were basically ascertained within UBA project FKZ 360 16 029 ³⁾ and have since then been compiled, revised and maintained in TREMOD AV ⁴⁾.

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

Table 2: Annual country-specific emission factors, in kg/TJ

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
JET KEROSENE																			
NH ₃	3.98	3.95	3.95	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97	3.97
NMVO	14.4	16.0	16.6	18.9	19.9	20.4	20.6	20.3	19.9	19.9	20.2	21.7	22.7	22.0	17.7	18.1	17.7	19.4	26.1
NO _x	337	375	348	340	341	347	358	368	374	376	381	383	381	386	397	400	396	396	370
SO _x	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	19.6	19.6	19.6
BC	1.82	2.15	2.00	2.20	2.28	2.23	1.98	1.97	2.02	2.00	2.02	2.02	1.95	2.05	1.95	1.99	2.18	2.13	2.66
PM	3.80	4.48	4.16	4.58	4.75	4.65	4.13	4.11	4.22	4.17	4.20	4.21	4.07	4.27	4.06	4.15	4.54	4.45	5.55
CO	147	149	186	203	203	203	204	202	197	197	201	212	219	214	154	151	152	159	241
AVGAS																			
NH ₃	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
NMVO	549	559	545	551	550	548	549	551	548	558	557	557	556	555	557	552	561	579	580
NO _x	132	134	130	132	131	130	131	131	130	134	133	134	133	132	133.2	130.4	134.7	142.5	143.5
SO _x	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	0.46	0.46	0.46
BC	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.43	0.42	0.42	0.42
PM	2.78	2.81	2.78	2.80	2.80	2.81	2.80	2.81	2.81	2.82	2.83	2.82	2.83	2.83	2.82	2.85	2.83	2.80	2.79
TSP	17.9	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
CO	21,184	21,581	21,324	21,543	21,663	21,780	21,630	21,761	21,850	21,864	21,979	21,921	22,002	22,097	21,979	22,459	21,962	21,040	20,928

¹ EF(TSP) also applied for PM₁₀ and PM_{2.5} (assumption: > 99% of TSP consists of PM_{2.5})

² estimated via a f-BC of 0.48 as provided in ⁵⁾, Chapter: 1.A.3.a, 1.A.5.b Aviation, page 49: "Conclusion".



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



For information on the **emission factors for heavy-metal and POP exhaust emissions**, please refer to Appendix 2.3 - Heavy Metal (HM) exhaust emissions from mobile sources and Appendix 2.4 - Persistent Organic Pollutant (POP) exhaust emissions from mobile sources.

Trend discussion for Key Sources

NFR 1.A.3.a ii (ii) - Domestic Civil Aviation - Cruise is **not included in the national emission totals** and hence **not included in the key category analysis**.

Recalculations

Activity data have been revised within TREMOD AV to keep in line with information the final 2019 NEB.

Furthermore, after the implementation of aviation gasoline (avgas) for international flights, the distribution onto LTO and Cruise stage have been revised widely for all years.

Table 3: Revised annual fuel consumption in 1.A.3.a ii (ii), in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
JET KEROSENE																		
Submission 2022	21,690	19,937	25,301	24,071	24,736	25,337	25,111	24,048	22,503	20,552	21,026	19,762	19,038	19,195	20,067	20,793	21,067	21,672
Submission 2021	21,690	19,937	25,301	24,071	24,736	25,337	25,111	24,048	22,503	20,552	21,026	19,762	19,038	19,195	20,067	20,793	21,067	21,573
absolute change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	98.9
relative change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.46%
AVGAS																		
Submission 2022	1,681	805	779	472	437	408	432	404	382	440	398	354	343	393	322	320	310	256
Submission 2021	1,580	614	614	291	260	228	259	244	237	283	246	199	180	233	145	142	116	72.5
absolute change	101	191	165	181	177	181	174	160	146	156	152	155	163	160	177	178	193	184
relative change	6.42%	31.1%	26.9%	62.2%	67.8%	79.4%	67.2%	65.7%	61.6%	55.0%	61.9%	77.7%	90.3%	68.7%	122%	125%	166%	254%

In parallel, the majority of **country-specific emission factors** applied for 2019 has been revised within TREMOD AV.

Table 4: Revised country-specific emission-factors 2019, in [kg/TJ]

	NH ₃	NM VOC	NO _x	SO ₂	BC	PM	CO
KEROSENE							
Submission 2022	3,97	19,39	396	19,6	2,13	4,45	159,0
Submission 2021	3,97	19,18	390	19,6	2,26	4,71	155,3
absolute change	0,00	0,21	5,54	0,00	-0,13	-0,27	3,75
relative change	0,00%	1,11%	1,42%	0,00%	-5,64%	-5,64%	2,41%
AVGAS							
Submission 2022	NE	579	142,5	0,46	0,42	2,80	21040

	NH ₃	NM VOC	NO _x	SO ₂	BC	PM	CO
Submission 2021	NE	579	142,6	0,46	0,42	2,80	21025
absolute change	0,00	-0,26	-0,14	0,00	0,00	0,00	15,2
relative change		-0,05%	-0,10%	0,00%	0,02%	0,02%	0,07%



For more information on recalculated emission estimates for Base Year and 2019, please see the pollutant specific recalculation tables following chapter [8.1 - Recalculations](#).

Uncertainties

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

Planned improvements

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

^{1), 4)} Knörr et al. (2021c): Knörr, W., Schacht, A., & Gores, S.: TREMOD Aviation (TREMOD AV) 2018 - Revision des Modells zur Berechnung des Flugverkehrs (TREMOD-AV). Heidelberg, Berlin: Ifeu Institut für Energie- und Umweltforschung Heidelberg GmbH & Öko-Institut e.V., Berlin & Heidelberg, 2020.

²⁾ Gores (2021): Inventartool zum deutschen Flugverkehrsinventar 1990-2018, im Rahmen der Aktualisierung des Moduls TREMOD-AV im Transportemissionsmodell TREMOD, Berlin, 2020.

³⁾ Knörr, W., Schacht, A., & Gores, S. (2010): Entwicklung eines eigenständigen Modells zur Berechnung des Flugverkehrs (TREMOD-AV) : Endbericht. Endbericht zum F+E-Vorhaben 360 16 029, URL: <https://www.umweltbundesamt.de/publikationen/entwicklung-eines-modells-zur-berechnung>; Berlin & Heidelberg, 2012.

⁵⁾ 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.