# 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** | **$SO_2$** | **$NO_x$** | **$NH_3$** | **NMVOC** | **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

### Actitvity 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 | 21.573 |
| **Avgas** | 1.580 | 614 | 614 | 291 | 260 | 228 | 259 | 244 | 237 | 283 | 246 | 199 | 180 | 233 | 145 | 142 | 116 | 72 |

source: Knörr et al. (2019c) [1)] & Gores (2019) [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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$NH_3$** | | | | | | | | | | | | | | | | | | |
| **NMVOC** | | | | | | | | | | | | | | | | | | |
| **$NO_x$** | | | | | | | | | | | | | | | | | | |
| **$SO_x$** | | | | | | | | | | | | | | | | | | |
| **PM[1]** | | | | | | | | | | | | | | | | | | |
| **BC[2]** | | | | | | | | | | | | | | | | | | |
| **CO** | | | | | | | | | | | | | | | | | | |

[1] EF(TSP) also applied for $PM_{10}$ 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.

# 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 for all years within TREMOD AV to keep in line with information available from the 2019 EMEP/EEA Guidebook [6)] and Eurocontrol's AEM model [7)].

Table 3: Revised kerosene 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **JET KEROSENE** | | | | | | | | | | | | | | | | | |
| **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 |
| **Submission 2020** | 20.024 | 20.875 | 22.967 | 21.565 | 22.122 | 22.904 | 23.145 | 21.771 | 21.579 | 21.776 | 20.673 | 18.717 | 19.614 | 19.730 | 19.746 | 19.074 | 19.178 |
| **absolute change** | 1.667 | -938 | 2.334 | 2.505 | 2.615 | 2.433 | 1.966 | 2.277 | 923 | -1.224 | 354 | 1.045 | -576 | -535 | 321 | 1.719 | 1.888 |
| **relative change** | 8,32% | -4,49% | 10,16% | 11,62% | 11,82% | 10,62% | 8,49% | 10,46% | 4,28% | -5,62% | 1,71% | 5,58% | -2,94% | -2,71% | 1,63% | 9,01% | 9,85% |
| **AVGAS** | | | | | | | | | | | | | | | | | |
| **Submission 2021** | 1.580 | 614 | 614 | 291 | 260 | 228 | 259 | 244 | 237 | 283 | 246 | 199 | 180 | 233 | 145 | 142 | 116 |
| **Submission 2020** | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE | IE |
| **absolute change** | 1.580 | 614 | 614 | 291 | 260 | 228 | 259 | 244 | 237 | 283 | 246 | 199 | 180 | 233 | 145 | 142 | 116 |

In parallel, the majority of **country-specific emission factors** has been revised within TREMOD AV based on information available from Eurocontrol's AEM model [8)].

Table 4: Revised emission-factor values, in [kg/TJ]

| **< NMVOC** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ~ Submission 2020 | > 15.1 | > 17.0 | > 17.2 | > 19.9 | > 20.9 | > 21.5 | > 21.7 | > 21.6 | > 21.3 | > 21.4 | > 21.7 | > 23.3 | > 23.6 | > 23.8 | > 19.1 | > 19.5 | |
| ~ Submission 2019 | > 9.3 | > 11.6 | > 10.5 | > 12.1 | > 13.2 | > 13.3 | > 13.0 | > 13.1 | > 13.1 | > 13.3 | > 13.2 | > 13.7 | > 14.1 | > 13.5 | > 13.4 | > 13.6 | |
| ~ absolute change | > 5.84 | > 5.46 | > 6.68 | > 7.76 | > 7.69 | > 8.21 | > 8.69 | > 8.49 | > 8.24 | > 8.10 | > 8.48 | > 9.68 | > 9.48 | > 10.28 | > 5.66 | > 5.83 | |
| ~ relative change | > 63.0% | > 47.2% | > 63.8% | > 64.0% | > 58.1% | > 61.7% | > 66.7% | > 64.8% | > 63.1% | > 61.1% | > 64.0% | > 70.9% | > 67.1% | > 75.9% | > 42.2% | > 42.7% | |
| **< Nitrogen oxides - NO,,x,,** | | | | | | | | | | | | | | | | | |
| ~ Submission 2020 | > 330 | > 367 | > 332 | > 319 | > 317 | > 320 | > 333 | > 346 | > 354 | > 356 | > 360 | > 359 | > 366 | > 365 | > 379 | > 380 | |
| ~ Submission 2019 | > 342 | > 381 | > 351 | > 338 | > 339 | > 346 | > 358 | > 366 | > 372 | > 375 | > 380 | > 385 | > 384 | > 388 | > 396 | > 402 | |
| ~ absolute change | > -12.51 | > -14.42 | > -18.74 | > -19.36 | > -21.48 | > -26.16 | > -25.15 | > -20.71 | > -18.06 | > -19.21 | > -20.09 | > -26.37 | > -17.21 | > -22.82 | > -17.11 | > -21.59 | |
| ~ relative change | > -3.65% | > -3.79% | > -5.34% | > -5.72% | > -6.34% | > -7.55% | > -7.02% | > -5.65% | > -4.86% | > -5.13% | > -5.29% | > -6.85% | > -4.48% | > -5.88% | > -4.33% | > -5.38% | |
| **< 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 | |
| ~ 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 | |
| ~ relative change | > -21.7% | > 28.2% | > 131% | > 209% | > 232% | > 257% | > 287% | > 322% | > 322% | > 322% | > 322% | > 322% | > 322% | > 322% | > 322% | |
| **< Black carbon - BC** | | | | | | | | | | | | | | | | |
| ~ Submission 2020 | > 2.02 | > 2.49 | > 2.44 | > 2.53 | > 2.56 | > 2.47 | > 2.20 | > 2.22 | > 2.28 | > 2.25 | > 2.26 | > 2.27 | > 2.38 | > 2.40 | > 2.24 | > 2.21 |
| ~ Submission 2019 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 | > 2.23 |
| ~ absolute change | > -0.21 | > 0.26 | > 0.21 | > 0.30 | > 0.32 | > 0.24 | > -0.03 | > -0.01 | > 0.05 | > 0.02 | > 0.03 | > 0.03 | > 0.15 | > 0.17 | > 0.01 | > -0.02 |
| ~ relative change | > -9.52% | > 11.61% | > 9.50% | > 13.39% | > 14.49% | > 10.85% | > -1.42% | > -0.49% | > 2.32% | > 0.82% | > 1.34% | > 1.55% | > 6.53% | > 7.57% | > 0.29% | > -0.95% |
| **< Particulate matter - PM** | | | | | | | | | | | | | | | | |
| ~ Submission 2020 | > 4.21 | > 5.19 | > 5.09 | > 5.27 | > 5.33 | > 5.16 | > 4.58 | > 4.63 | > 4.76 | > 4.69 | > 4.71 | > 4.72 | > 4.95 | > 5.00 | > 4.66 | > 4.61 |
| ~ Submission 2019 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 | > 4.65 |
| ~ absolute change | > -0.44 | > 0.54 | > 0.44 | > 0.62 | > 0.67 | > 0.50 | > -0.07 | > -0.02 | > 0.11 | > 0.04 | > 0.06 | > 0.07 | > 0.30 | > 0.35 | > 0.01 | > -0.04 |
| ~ relative change | > -9.52% | > 11.6% | > 9.50% | > 13.4% | > 14.5% | > 10.8% | > -1.42% | > -0.49% | > 2.32% | > 0.82% | > 1.34% | > 1.55% | > 6.53% | > 7.57% | > 0.29% | > -0.95% |
| **< Carbon monoxide - CO** | | | | | | | | | | | | | | | | |
| ~ Submission 2020 | > 144.5 | > 145.2 | > 179.0 | > 195.3 | > 194.5 | > 193.3 | > 195.1 | > 194.2 | > 190.2 | > 190.0 | > 194.1 | > 205.0 | > 206.2 | > 208.5 | > 149.0 | > 145.3 |
| ~ Submission 2019 | > 85.5 | > 88.2 | > 111.7 | > 111.0 | > 111.0 | > 105.2 | > 102.4 | > 104.8 | > 105.8 | > 105.2 | > 102.1 | > 98.7 | > 100.4 | > 104.3 | > 98.2 | > 91.7 |
| ~ absolute change | > 58.93 | > 56.97 | > 67.33 | > 84.30 | > 83.50 | > 88.08 | > 92.71 | > 89.41 | > 84.38 | > 84.77 | > 91.96 | > 106.30 | > 105.85 | > 104.16 | > 50.81 | > 53.62 |
| ~ relative change | > 68.9% | > 64.6% | > 60.3% | > 75.9% | > 75.2% | > 83.7% | > 90.5% | > 85.3% | > 79.7% | > 80.6% | > 90.1% | > 108% | > 105.4% | > 99.9% | > 51.7% | > 58.5% |

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

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