

# 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 Analysis |       |     |     |       |     |     |      |     |          |     |                  |                   |  |
|----------------|-----------------|-----------------|-----------------------|-------|-----|-----|-------|-----|-----|------|-----|----------|-----|------------------|-------------------|--|
| T1, T2, T3     | NS, M           | CS, D, M        | no key category       |       |     |     |       |     |     |      |     |          |     |                  |                   |  |
| Category Code  |                 | Method          |                       |       |     |     | AD    |     |     |      |     | EF       |     |                  |                   |  |
| 1.A.3.a.ii.(i) |                 | T1, T2, T3      |                       |       |     |     | NS, M |     |     |      |     | CS, D, M |     |                  |                   |  |
| Key Category   | SO <sub>2</sub> | NO <sub>x</sub> | NH <sub>3</sub>       | NMVOC | CO  | BC  | Pb    | Hg  | Cd  | Diox | PAH | HCB      | TSP | PM <sub>10</sub> | PM <sub>2.5</sub> |  |
| 1.A.3.a.ii.(i) | -/-             | -/-             | -/-                   | -/-   | -/- | -/- | -/-   | -/- | -/- | -    | -/- | -        | -/- | -/-              | -/-               |  |

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

| Methods   |                                 |
|-----------|---------------------------------|
| <b>D</b>  | Default                         |
| <b>RA</b> | Reference Approach              |
| <b>T1</b> | Tier 1 / Simple Methodology *   |
| <b>T2</b> | Tier 2*                         |
| <b>T3</b> | Tier 3 / Detailed Methodology * |
| <b>C</b>  | CORINAIR                        |
| <b>CS</b> | Country Specific                |
| <b>M</b>  | Model                           |

\* as described in the EMEP/CORINAIR Emission Inventory Guidebook - 2007, in the group specific chapters.

| AD - Data Source for Activity Data |                                      |
|------------------------------------|--------------------------------------|
| <b>NS</b>                          | National Statistics                  |
| <b>RS</b>                          | Regional Statistics                  |
| <b>IS</b>                          | International Statistics             |
| <b>PS</b>                          | Plant Specific data                  |
| <b>AS</b>                          | Associations, business organisations |
| <b>Q</b>                           | specific questionnaires, surveys     |
| EF - Emission Factors              |                                      |
| <b>D</b>                           | Default (EMEP Guidebook)             |
| <b>C</b>                           | Confidential                         |
| <b>CS</b>                          | Country Specific                     |
| <b>PS</b>                          | Plant Specific data                  |

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



|                          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|--------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| SO <sub>x</sub>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BC <sup>1</sup>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PM <sup>2</sup>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CO                       |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>AVIATION GASOLINE</b> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NH <sub>3</sub>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NMVOC                    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NO <sub>x</sub>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SO <sub>x</sub>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BC <sup>1</sup>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PM <sup>2</sup>          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TSP <sup>3</sup>         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CO                       |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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

<sup>2</sup> EF(PM<sub>2.5</sub>) also applied for PM<sub>10</sub> and TSP (assumption: > 99% of TSP from diesel oil combustion consists of PM<sub>2.5</sub>)

<sup>3</sup> 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/TJ] |      |      |         |         |         |         |         |         | = [mg/TJ] |         |         |          | = [μg/TJ] |          |       |      |  |
| ~ 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" : 1A3a\(ii\)\\_SOx.png : 1A3a\(ii\)\\_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" : 1A3a\(ii\)\\_Pb.png](#) [gallery](#)



[illegible]

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 <sup>9)</sup> and Eurocontrol's AEM model <sup>10)</sup>. Here, among others, the EF for SO<sub>2</sub> 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]

|                             |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <b>relative change</b>      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>CARBON MONOXIDE - CO</b> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Submission 2021</b>      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Submission 2020</b>      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>absolute change</b>      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>relative change</b>      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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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**bibliography**

<sup>1)</sup> (bibcite 2)

<sup>2)</sup> (bibcite 3)

<sup>3)</sup> (bibcite 2)

<sup>4)</sup> (bibcite 3)

<sup>5)</sup> (bibcite 1)

<sup>6)</sup> (bibcite 2)

<sup>7)</sup> (bibcite 4)

<sup>8)</sup> (bibcite 4)

<sup>9)</sup> (bibcite 4)

<sup>10)</sup> (bibcite 5)