

## Primary NO<sub>2</sub> Emission Factors for Aviation and Other Transport Sources

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Nitrogen oxides (NO<sub>x</sub>) are emitted in the form of nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>). The fraction emitted directly as NO<sub>2</sub> (f-NO<sub>2</sub>) is of particular interest for air quality modelling.

The EMEP/CORINAIR Emissions Inventory Guidebook does not provide values of f-NO<sub>2</sub> for transport sources other than road transport. There is no information on primary NO<sub>2</sub> emissions from rail, shipping and off-road machinery. Since these sources all operate with compression ignition internal combustion engines running on diesel fuel (or heavier fuels in the case of shipping), and without any advanced exhaust after-treatment systems fitted, it can be assumed that values of f-NO<sub>2</sub> for these sources are similar to those for older pre-Euro IV diesel engines on HGVs and buses.

**On this basis, an average f-NO<sub>2</sub> value of 0.15 is recommended for the fraction of NO<sub>x</sub> emitted as primary NO<sub>2</sub> from these sources.**

The emissions inventory for Heathrow developed by AEA for the Project for the Sustainable Development of Heathrow (PSDH) used information on the primary NO<sub>2</sub> fraction for aircraft exhaust emissions provided by experts at Sheffield University (Underwood, 2007). The work yielded different ranges of f-NO<sub>2</sub> for different thrust settings, as shown in Table 1. The mean value at each thrust setting was used in the PSDH study. It can be seen how f-NO<sub>2</sub> is significantly larger under low engine load conditions, consistent with the trends that have been observed in engine-out emissions from diesel vehicles. Under idle conditions aircraft emissions have particularly high NO<sub>2</sub> fractions.

The mean f-NO<sub>2</sub> for aircraft emissions, weighted by the NO<sub>x</sub> emissions calculated in the PSDH study for the four different thrust settings relevant to a take-off and landing cycle is 0.14. A value of 0.15 is suggested for a cruise cycle.

**Table 1: Fraction of NO<sub>x</sub> emitted as NO<sub>2</sub> for aircraft emissions over different thrust settings in an LTO cycle (Underwood, 2007)<sup>1</sup>**

f-NO <sub>2</sub>	Range	Mean
Take-off	0.01-0.08	0.045
Climb out	0.02-0.085	0.053
Approach	0.1-0.2	0.15
Idle	0.25-0.5	0.375

These figures refer to the mixing ratio of NO<sub>2</sub> in emitted NO<sub>x</sub>, i.e. the molar/volume fraction of NO<sub>2</sub> in the emitted NO<sub>x</sub>.

These factors will be reviewed annually after submission of each version of the NAEI's UK inventory figures. Any queries regarding the factors should be directed to [air.emissions@ricardo-aea.com](mailto:air.emissions@ricardo-aea.com)

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<sup>1</sup> Underwood, BY (2007). Revised Emissions Methodology for Heathrow. AEA Report for the Department for Transport, AEAT/ENV/R/2193 (October 2007)