

Protocol

1A3a: CO₂, N₂O, and CH₄ from Inland aviation

IPCC Category:	1A3a
NFR Code:	1A3a
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Foreword

Under the Kyoto Protocol, the Netherlands is required to set up and maintain a national system to monitor its greenhouse gas emissions. One of the elements of this system is a transparent and verifiable description of the methods and processes used in this monitoring system. These methods must meet international guideline criteria, which have been defined by the United Nations (UN) and the European Union (EU).

The Netherlands meets the aforementioned requirement, for example, by defining a series of Monitoring Protocols, which describe the methods and work processes used to determine greenhouse gas emissions and the amounts of carbon sinks available. Protocols have been written for about 40 greenhouse gas sources or sinks. This document describes the protocol for one of these sources or sinks.

The protocols have been compiled in close collaboration with experts from various sectors of society in the Netherlands, particularly experts from the Emissions Registration (ER). The ER is a collaborative group that includes institutions such as CBS, WUR, RIVM and PBL. Until 31 December 2009 this was coordinated by PBL (Planbureau for the Leefomgeving, or the Netherlands Environmental Assessment Agency), but on 1 January 2010 this coordination task was taken over by RIVM (the Netherlands institute for public health and the environment). Other institutions that have contributed to the protocols include NL Agency; Ministry of Agriculture, Nature and Food Quality; and the Ministry of VROM (Housing, Spatial Planning and the Environment).

1 Scope and significance of emission sources/activities

1.1 Scope and definition

This protocol describes the methodology for calculating the CO₂, N₂O, and CH₄ emissions from inland aviation in the Netherlands. It concerns the emissions due to the combustion of aviation gasoline (AVGAS) and jet kerosene. The aviation emissions reported in the CRF concern only emissions from inland aviation, that is flights with departure and destination within the Netherlands (including groundtraffic with departure and destination on airport). The vehicles with combustion engines that are active at airports (platform traffic) are not included separately because these vehicles are classified as mobile machinery.

The CO₂, N₂O, and CH₄ emissions are calculated according to an tier 2 methodology. Fuel deliveries of bunkers to international aviation (free of excise tax) are not included in this source category.

1.2 Significance and influences

1.2.1 Contribution to total national emissions

The emissions of CO₂, CH₄ and N₂O by inland aviation, each contribute less than 0.1% to the Netherlands annual greenhouse gas emissions.

1.2.2 Major developments that influence emissions

No developments known.

2 Methods, emission factors and activity data

2.1 Calculation method

The emissions by inland aviation are calculated by multiplying the fuel consumption by accompanying emission factors.

$$\text{Emission (kg)} = \text{fuel consumption (kg)} * \text{emission factor (gram/kg)} * 10^{-3}$$

The background figures used to calculate CO₂, N₂O and CH₄ emissions from domestic/inland aviation are published annually and updated in a *set of tables* that accompany the methodology report for calculating the emissions of mobile sources in the Netherlands [Klein et al.]. Each table in the set states which source is used for the figures. The methodology report itself contains a detailed description of the way in which emission factors and emissions are calculated.

2.2 Emission factors

The tables below show the used emission factors and fuel conversion factors.

CO₂-emission factors

	Specific heat (MJ/kg)	CO ₂ EF (gram/MJ)	CO ₂ EF (gram/kg)
Aviation gasoline (AVGAS)	44,0	72,0	3168
Jet Kerosene	43,5	71,5	3110

Source: Vreuls en Zijlema (2009)

IPCC Default factors N₂O en CH₄

	N ₂ O EF (gram/MJ)	N ₂ O EF (gram/kg)	CH ₄ EF (gram/MJ)	CH ₄ EF (gram/kg)
Aviation gasoline (AVGAS)	0,0006	0,0264	0,020	0,88
Jet Kerosene	0,002	0,087	0,0005	0,02175

Source: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories; Reference Manual p. 1.35 and p.1.36 (IPCC, 1997)

2.3 Activity data

The national statistics concerning fuel sales to the aviation industry cannot be used to calculate greenhouse gas emissions, because it is not possible to determine which percentage of the sales are used for domestic aviation purposes, and which are used for international aviation. An internal study by the Rijksluchtvaartdienst (Civil Aviation Authority, Pulles, 2000) is used to estimate domestic aviation usage. This shows that the CO₂ emissions from domestic aviation for the year 2000 amounted to around 27.9 kton. In order to calculate CO₂ emissions from AVGAS, the report uses an emission factor of 1.45 kg per kilogram of fuel, rather than the emission factor from the table above. If this factor is corrected for this, then the CO₂ emissions for domestic aviation in the year 2000 amounted to around 41.4 kton. The CO₂ emissions reported by the RLD can also be used to determine fuel consumption and the consequential CH₄ and N₂O emissions for domestic aviation for the year 2000.

There are no later insights available concerning fuel sales for domestic aviation purposes. Since the number of domestic flights and territorial flights has fallen since 2000, and the contribution made by domestic aviation to the total greenhouse gas emissions in the Netherlands is very small, the insights in the RLD's report are applied to the entire time period 1990-2008.

3 Working processes

Process for estimating (t-1)

The ER produces annual preliminary emission figures for the previous year (T-1). These preliminary data are calculated by extrapolating the figures from the previous year, based on the development prognoses for the most important activity data (derived from CBS and other statistics).

Process for final determination of (t-2)

The final emission figures (as described in this protocol) are calculated using the following process.

INPUT	PROCESS STEP	OUTPUT	BY WHOM
Estimation of inland fuel consumption of avgas. (A) ¹⁾ Estimation of inland fuel consumption of jet kerosene. (B) ¹⁾ Emission factors avgas (C1) ²⁾ Emission factors jet kerosene (C2) ²⁾	$(A) \times (C1_{CO2}) + (B) \times (C2_{CO2})$ $(A) \times (C1_{N2O}) + (B) \times (C2_{N2O})$ $(A) \times (C1_{CH4}) + (B) \times (C2_{CH4})$	CO ₂ , N ₂ O, and CH ₄ emissions by inland aviation (D) Final data	Statistics Netherlands (CBS)
Final data Work package leader (t-2)	Include (t-2) data in ER database	ER-db with (t-2) data	Work package leader
ER-db with (t-2) data	Check, and trend analysis of air emissions: explain deviations or modify figures	Final defined emission figures (t-2)	Task forces and PBL experts

¹⁾ Source: Structure Scheme Regional and small airports [SKRL, 2000].

²⁾ IPCC-factors.

4 Uncertainty and quality

4.1 Estimating uncertainties

A Tier-1 uncertainty analysis is implemented every year before the NIR is submitted by the ER, based on the greenhouse gas inventory and in compliance with IPCC guidelines. The assumptions used and the results thereof are described in a background report to the NIR. In addition to this, where included in the QA/QC programme for the relevant period, extra analyses are implemented regularly in specific situations, which include any updating of the Tier-2 uncertainty analyses.

The Tier-2 uncertainty assessment was last updated in 2006. This assessment showed that a Tier-1 uncertainty assessment is sufficiently reliable and that Tier-2 uncertainty assessments need only be implemented at periodic intervals of around 5 years, unless a major change in an important source is sufficient to require earlier reassessment.

- Source-specific uncertainty

The uncertainty estimate-totaal concerns the root of the sum of uncertainty in the data sources used (AD_{onz}) in the square and the uncertainty of the emission factor (EF_{onz}) in the square. The extent of the total uncertainty is here primarily determined by the greatest AD or EF uncertainty.

$$\text{Uncertainty estimate}_{\text{total}} = \sqrt{EF_{onz.}^2 + AD_{onz.}^2}$$

The uncertainty estimates concerning the data sources (AD) and emission factors (EF) used, and the total uncertainty estimate, are listed in the following table.

IPCC Category	Gas	AD _{onz.}	EF _{onz.}	Uncertainty estimates _{tot}
1A3 Mobile combustion: aircraft	CO ₂	50	0.5	50
1A3 Mobile combustion: other (non-road)	CH ₄	50	100	112
1A3 Mobile combustion: other (non-road)	N ₂ O	50	100	112

The uncertainty in fuel used by 'Civil Aviation' is estimated to be about 50%. The uncertainty in the CH₄ and N₂O emission factor in domestic aviation is estimated to be approximately 100% and the uncertainty in the CO₂ emission factor is estimated to be 0,5% [Olivier et al, 2009].

The uncertainty in CO₂ emissions from domestic aviation was estimated to be about 50%. The uncertainty in CH₄ and N₂O emissions from non-road transport (c.q. domestic aviation) was estimated to be about 100% in annual emissions. Data on the share of CH₄ in total VOC were based on information in Veldt and Van der Most (1993) and have not been validated since [Olivier et al, 2009].

4.2 Quality assurance and quality control (QA/QC)

The ER work package leaders check that:

1. the basic data are well documented and adopted (check for typing errors, use of the correct unit sizes and correct conversion);
2. the calculations have been implemented correctly;

3. assumptions are consistent, also whether specific parameters (e.g. activity data) are used consistently;
4. complete and consistent data sets have been supplied.

Any actions that result from these checks are noted on an 'action list'. Before defining the data, supervisors check whether the relevant actions on this list, plus the QC checks, have all been completed. Defining the data is carried out by the WEM (working group on emissions monitoring), and confirmed in writing via an e-mail from the institute representatives to the ER project leader at PBL.

The work package leaders fill out a new documentation sheet when adding new data. For reasons of efficiency a minimum level has been set for obligatory documentation, i.e. 5% changes at target group level, and 0.5% at levels concerning the national total. These documentation sheets form part of the trend analysis, as well as the eventual definition of the data set.

The ER work package leaders communicate by e-mail regarding these QC checks, results and actions. They send a printed copy to the ER secretary, who keeps a logbook and compiles these e-mails into an 'action list'. This shows explicitly that the required checks and corrections have been carried out.

4.3 Verification

In order to check the quality of the emission figures for the sources in this protocol, general QA/QC procedures have been followed that are in line with the IPCC guidelines. These are described further in the QAQC programme used by the National System, and the annual working plans published by the ER.

- Sector-specific QC

No additional specific verification procedures are implemented for the sources defined in this protocol.

4.4 Possibilities for improvement compared to the current calculation method

4.4.1 History

Considering the negligible amount of emissions (see chapter 2) no effort has been made to calculate the emissions on a yearly basis, thus the 2000-figures have been kept constant during 1990-2008.

4.4.2 Future developments

Not applicable

5 Remaining aspects

5.1 Point source criteria

Not applicable

5.2 Substance profiles

Not applicable

5.3 Regions

Not applicable

5.4 Time-based variations in source strength

Not applicable

6 References and additional information

6.1 References

- IPCC, 1997: Revised 1996 IPCC Guidelines for National Greenhouse Gas Emission Inventories, Three volumes: Reference Manual, Reporting Guidelines and Workbook. IPCC/OECD/IEA. IPCC WG1 Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK
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- Olivier J.G.J., L.J. Brandes and R.A.B. te Molder, 2009 (in print) Uncertainty in the Netherlands' greenhouse gas emissions inventory: Estimate of annual and trend uncertainty for Dutch sources of greenhouse gas emissions using the IPCC Tier 1 approach, PBL-Report 500080013, Bilthoven
- Pulles, H., 2000. Structuurschema Regionale en Kleine Luchthavens (Structure Scheme Regional and small airports). Part 1, CO₂ Calculation scheme and results (in Dutch), H.Pulles, Rijksluchtvaartdienst (Civil Aviation Authority Netherlands), 2000.
- Veldt, C. and P.F.J. van der Most, 1993: Emissiefactoren Vluchtige organische stoffen uit verbrandingsmotoren. VROM, Den Haag, Publikatiereeks Emissieregistratie No. 10
- Vreuls H.H.J. and Zijlema P.J. (2009), The Netherlands: list of fuels and standard CO₂ - emission factors, version december 2009, SenterNovem, Utrecht

6.2 Additional information

Not applicable