Protocol
1A5b: CO_2, N_2O, and CH_4 from Military activities

IPCC Category:	1A5b
NFR Code:	1A5b
NOSE Code:	202.05
NACE Code 2008	84.22

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 of calculating the CO_2, N_2O, and CH_4 emissions from military activities (IPCC-category: 1A5b; SBI-code: 8422). It concerns the emissions due to the combustion of jet kerosene and marine fuel in aeroplanes and ships from defence. The emissions by military activities reported in the CRF concern all activities by the air force and navy. The emissions by the land forces have been included in the emissions by road traffic and mobile machinery. This concerns the emissions of the Navy and Air Force resulting from the consumption of fuels taken on board in the Netherlands. In the actual emissions, the emissions from military activities are theoretically included in those for seagoing shipping and air traffic. Section 2.4.1.3 of the IPCC report “Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories” [IPCC, 2001] states that all fuel that is used for military operations must in principle be included in the emission inventories, although multilateral operations do not have to be included. If this distinction cannot be made, all fuel must be included.

1.2 Significance and influences

1.2.1 Contribution to total national emissions

CO_2-emissions by military activities contribute less than 0.5% to the Netherlands annual greenhouse gas emissions. The emissions of CH_4 and N_2O by military activities both contribute less than 0.1% to the Netherlands annual greenhouse gas emissions.

1.2.2 Developments that infuence emissions

The use of biofuel can influence emission levels. This is implicitly expressed, because this protocol is only concerned with emissions from fossil fuels.

2 Method, emission factors and activity data

2.1 Calculation method

A country-specific top-down (Tier 2) method is used for calculating the emissions for fuel combustion from military activities. The emissions by military activities are calculated by multiplying the fuel consumption by emission factors.

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

A detailed description of the emission calculation method is published in a background document [Klein et al]. This Methodology Report will be updated once a year.

The background figures used to calculate CO_2, N_2O and CH_4 emissions from military activities are published annually and updated in a *set of tables* that accompany the methodology report for mobile sources [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.

Table 8.1 of the *set of tables* concerns fuel consumption for military activities. Table 8.2 shows the emission factors that are relevant to military fuels.

2.2 Emission factors

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

CO_2- factors Ministry of Defence of the Netherlands

	Specific heat *(MJ/kg)*	**CO2 EF** *(gram/MJ)*	**CO2 EF** *(gram/kg)*
Marine fuel	42,7	75,3	3213
Jet Kerosine	42,5	72,9	3098

Source: Ministry of Defence of the Netherlands [Defence]

Emissionfactors N_2O en CH_4 for Military activities

	N_2O EF *(gram/MJ)*	**N_2O EF** *(gram/kg)*	**CH_4 EF** *(gram/MJ)*	**CH_4 EF** *(gram/kg)*
Marine fuel	0,0019	0,080	0,00264 [1)]	0,113
Jet Kerosine	0,0058	0,247	0,010	0,425

Source: Hulskotte, 2004

[1)] The CH_4-emisionfactor of marine fuel is determined by taking 4% of the VOC-emission factor. This method is according to [Veldt, 1993]. TheVOC-emission factor of marine fuel is 0,066 g/MJ (Hulskotte, 2004). The CH_4- emission factor of 0,00234 g/MJ (Hulskotte, 2004) is inconsistent with the method of Veldt and therefore not used in the calculations.

2.3 Activity data

The fuel consumption figures of military activities are reported to TNO-MEP by the Ministry of Defence. The totals are published in the Annual Environmental Reports of the Ministry of Defence.

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**
Consumption of marine fuel. **(A)** [1)] Consumption of jet kerosene. **(B)** [1)] Emission factors marine fuel**(C1)** [2)] Emission factors jet kerosene**(C2)** [2)]	**(A) x ($C1_{CO2}$)+(B) x ($C2_{CO2}$)** **(A) x ($C1_{N2O}$)+ (B) x ($C2_{N2O}$)** **(A) x ($C1_{CH4}$)+ (B) x ($C2_{CH4}$)**	CO_2, N_2O, and CH_4 emissions by military activities **(D)** Final data Work package leader (t-2)	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: Ministry of Defence [Defence]
[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 $_{tot}$
1A5	Military use of fuels (1A5 Other)	CO_2	20	2	20

The accuracy of military fuel consumption data (1A5) was tentatively estimated at 20%. The uncertainty in CO_2 emissions from military shipping and military aviation was tentatively estimated to be about 20% in annual emissions. For the negligible CH_4 and N_2O emissions this was estimated to be about 100% [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 MNP.

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

Not applicable

4.4.2 Future

Not applicable

5 Remaining aspects

5.1 Point source criteria

Not applicable

5.2 Substance profiles

Not applicable

5.3 Regionalisation

Not applicable

5.4 Time-based variations in source strength

Not applicable

6 References and additional information

6.1 References

- Defence, various years from 1999 onwards; Annual Environmental Reports of the Ministry of Defence. Compiled by the Coördinator Ruimtelijke Ordening en Milieuzaken, The Hague. www.defensie.nl ; choose "ZOEKEN"; zoeken naar: Milieujaarverslag.
- Hulskotte, J., 2004: Protocol for monitoring of greenhouse gas emissions from specific military activities in the Netherlands in comformity with IPCC guidelines (in Dutch;

'Protocol voor de jaarlijkse bepaling van de emissies van specifieke defensie-activiteiten conform de IPCC-richtlijnen']. TNO-MEP, Apeldoorn.

- 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
- IPCC, 2001: Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, IPCC-TSU NGGIP, Japan
- Klein, J.A.P. e.a. (CBS, PBL, RWS-Waterdienst/Deltares, RWS-DVS, TNO-M&L, TNO-EST), Methods for calculating the emissions of transport in the Netherlands. The report, including the tables in the Excelfile, can be found on: http://www.cbs.nl; choose: Thema's / Natuur en Milieu / Methoden / Onderzoeksbeschrijvingen / Aanvullende onderzoeksbeschrijvingen. The Methodoly Report and the tables in the Excelfile are being updated once a year.
- 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
- Veldt, C, P.F.J van der Most, Emissiefactoren: Vluchtige organische stoffen uit verbrandingsmotoren, Hoofdinspectie Milieuhygiëne, Publicatiereeks Emisieregistratie nr 10, Den Haag, 1993

6.2 Additional information

Not applicable