

Protocol: Other process emissions and product consumption emissions of CO₂, N₂O (direct and indirect) and CH₄

IPCC Category:	Partly 2.A, 2B, 2C, 2.G; entirely 3.A,B,C,D
NFR Code:	-
NOSE Code:	-
NACE Code 2008	-

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

In addition to CO₂ emissions from the combustion or non-energetic use of fossil fuels, relatively small amounts of CO₂ emissions are also caused by the *oxidation of limestone and dolomite* (i.e. CaCO₃ and CaCO₃.MgCO₃) respectively, plus other minerals that contain carbonate, from carbon in iron ore and the use of soda ash.

In the Netherlands this concerns the following sources, listed according to the IPCC guidelines:

- Limestone use from the production of cement clinker (CRF 2A1);
- Lime production (from limestone) (CRF 2A2);
- Other limestone and dolomite usage, including desulphurisation of flue gas (RO) (CRF 2A3);
- Use of soda ash (CRF 2A4);
- Limestone and dolomite use in glass production (CRF 2A7)
- Use of limestone and other non-fossil reduction means during the production of pig iron, including carbon in iron ore (2C1);
- Limestone and dolomite use in the agricultural sector (adding lime to soil) (CRF 5D); this source is *not* included in this protocol.

The following other direct CO₂ process emissions are also included:

- Use of carbon in peat when producing activated carbon ('norit') (CRF 2B5);

- Use of anodes during primary aluminium production (CRF 2C3);
Use of fireworks and candles (also non-CO₂ emissions) (CRF 2G).

Although this mostly concerns fossil carbon, this protocol also includes the use of anodes and burning of candles because it is not concerned with direct applications of fuel (such as petroleum coke and waxes), but the use of products made from such materials that are partially exported and imported.

According to the IPCC Guidelines (IPCC, 1997), indirect CO₂ emissions caused by further oxidation of fossil carbon in NMVOC emissions from solvents and other product usage (reported in CRF sector 3) also need to be reported, as these CO₂ usage emissions from fossil-carbon-retaining products are not covered elsewhere. However, this is incorrect: the CO₂ emissions from the *production* of petrochemical products are calculated separately, based on the reported NMVOC emissions for:

- Paint use (CRF 3A);
- Degreasing and cleaning (CRF 3B);
- Other (CRF 3D).

Since no NMVOC emissions are reported for 3C, no CO₂ emissions can be derived for this category.

Although peat can be considered a fossil fuel and carbon electrodes are made from fossil fuels, the use of these products is not registered in the national energy statistics as a fuel because only very small amounts are involved or there is actually no fuel involved.

Process emissions of CO₂ from the *production* of soda ash are described in the protocol entitled Fossil Process Emissions of CO₂ and CH₄; which also includes the CO₂ emissions from ammonia production, various industrial gases and anodes, plus the use of lubricants and whitening of sugar.

The CO₂ emissions from the use of limestone and dolomite in the agricultural sector (increasing the calcium in the soil) (CRF 5D) are described in the protocol entitled CO₂ emissions from total land-use categories.

The other sources of CH₄ and N₂O emissions included in this protocol are:

- CH₄ emissions from *fireworks* and *degasification of groundwater* to produce drinking water;
N₂O emissions from fireworks (CRF 2G);
- N₂O from the use of *laughing-gas-retaining products*: through the use of aerosols and anaesthetics (CRF 3D);

There are no CH₄ and N₂O emissions from any other sources described here.

The indirect N₂O emissions from RWZI (wastewater purification plants) effluent are described in the protocol for 'Wastewater'.

1.2 Significance and influences

1.2.1 Contribution to total national emissions

The non-fossil CO₂ emissions contribute about 1% to the Netherlands total annual greenhouse gas emissions. The non-fossil CH₄ and N₂O emissions both contribute less than 1% to the Netherlands total annual greenhouse gas emissions.

1.2.2 Major developments that influence emissions

Not applicable

2 METHOD, EMISSION FACTORS AND ACTIVITY DATA

2.1 Calculation method

2.1.1 Method for calculating CO₂ from the use of limestone and dolomite

Production of cement clinker (CRF 2A1)

The CO₂ process emissions during cement production occur when limestone is used to produce cement clinker. Cement is only produced by one company in the Netherlands (ENCI), which imports around half the cement clinker required.

Due to the changing composition of the raw materials, the manufacturer feels it is not possible to calculate realistic CO₂ emissions by multiplying the clinker production by the default EF. The manufacturer has therefore decided to calculate CO₂ emissions based on the amount of carbon entering the process oven and the amount leaving the process oven in the actual product. The carbon sources entering the oven are in the form of marl (made up of limestone, with a small amount of contamination (organic carbon) and sewage sludge).

The emissions derived from marl are calculated monthly by multiplying the total amount of raw material used by the EF resulting from the process. Each month a sample is taken from each batch just before the raw material enters the process oven. A laboratory determines the EF and the composition of the sample. The measured weight loss (excluding the amount of organic carbon) determines the EF per batch. The monthly EF is calculated by taking the average of all samples. This method is also used to determine the other two carbon sources. Finally, the annual emission is determined by adding up all monthly figures for the three carbon sources.

Figures for cement clinker production are not available from CBS (Statistics Netherlands), only for cement production, and are thus taken from the MJV (annual environmental report), the same as the CO₂ process emissions. The calculated company-specific emission factor calculated from the MJV data varies from 0.52 to 0.54 kg/kg cement clinker (standard IPCC tier-1 factor is 0.51).

Calcium production (CRF 2A2)

This source category is currently not calculated due to the lack of data (both activity data and emissions) in the ER-I/MJVs, and is therefore reported as NE. There are four companies in the Netherlands producing calcium from limestone, either as a primary or secondary activity. Most of the limestone and lime processed in the Netherlands is imported from Germany and Belgium (Van de Bank and Venderbosch, 1997).

Use of soda ash (CRF 2A4)

The use of soda ash can be calculated from the net domestic consumption: production + import – export. The production figures are not published annually and, in the CBS statistics for foreign trade, the import figures prior to 1996 and the export figures prior to 2001 are considered confidential (CBS, Statline, Trade with other countries and types of goods, 1996-2002).

The only available source for estimating production is Struker (NEEDIS report 1994), which mentions a production capacity of 400 kton.

For the years 2001 and 2002, the net domestic consumption is estimated by taking the aforementioned production figure of 400 kton as a basis, and then adding the import figures and deducting the export figures for the relevant year.

For the years before 1990 through 2000 and the year 2003 and later, these figures are estimated by extrapolating from the figures for 2001 and 2002. This extrapolation uses the trend in sheet-glass production, since this is an important user of soda ash and constitutes the only production statistics

from the glass sector that are available for several years (CBS, Statline, Production statistics for multi-sided glass, 1993-2003).

The emissions are calculated using the standard IPCC factor of 415 kg CO₂ per ton of soda ash (Na₂CO₃), (IPCC guidelines, section 2.6.2, page 2.1; IPCC, 1997):

$$\text{CO}_2 = \text{soda ash use (Gg)} * \text{EF CO}_2 \text{ (kg/Gg)}$$

In order to prevent double input – because soda ash is also used in glass production – the CO₂ emissions from soda ash usage for glass production should be deducted from the above, because these are reported integrally. However, this has not occurred, due to lack of data and because the small amount of CO₂ emissions estimated as being associated with soda ash use contain a considerable margin of uncertainty.

Glass production (CRF 2A7)

The use of limestone, dolomite and soda ash during glass production results in CO₂ emissions. These are calculated for the period 1990-2003 from:

- Gross glass production (gross = molten glass from ovens; 15-18% of the molten glass is generally recycled and is thus not converted into sales products: figures for 1992, 1995, 1997, 1999, 2001 and later from VNG (Beerkens, press communication, 2004); for 1990-1991 from Matthijsen (1995) and via interpolation for other years;
- Emission factor per ton of glass.

Therefore:

$$\text{CO}_2 = \text{gross glass production (Gg)} * \text{EF CO}_{2\text{glass, total}} \text{ (kg/Gg)}$$

Due to the lack of default IPCC emission factors, the figures for 1990, 1995 and 1997 are based on the process emissions indicated in the ER-I (individual), with EFs estimates as 0.13, 0.15 en 0.18 kg/Gg. As there is insufficient information available for other years, emissions for the years 1991-1994 and 1995 have been determined via interpolation. A constant EF of 0.18 kg/Gg is used for the years following 1998.

These values are slightly higher than the average factor of 0.125 kg CO₂ per kg glass (30% CI, 2σ) that eight West European countries reported for 1990 and 2002 in their NIR/CRF 2004 (UNFCCC, 2004), but are still within the estimated reliability intervals.

Production of pig iron (2C1)

Limestone is used as a reduction medium in blast-furnace ovens during the production of pig iron. The CO₂ emissions from its usage are calculated from the carbon content of the limestone (CaCO₃), which oxidises to CO₂, taking into account the purity of the limestone:

$$\text{CO}_2 \text{ limestone use} = \text{amount of limestone} * \text{ZF (limestone)} * \text{EF}_{\text{CO}_2 \text{ limestone}}$$

where: EF = 440 kg CO₂ per ton of limestone (IPCC default, section 2.5.2, page 2.10).

ZF = purity factor (fraction) = 0.95

In addition to CO₂ emissions from the use of limestone, CO₂ is also released during net oxidation of the carbon in the iron ore when producing raw steel. This can be calculated via:

$$\text{CO}_2_{\text{ ore/steel}} = \{ \text{C-mass in ore, scrap and raw iron purchased} - \text{C-mass in raw steel} \} * 44/12$$

The limestone usage figures have been published (via the manufacturer) since the year 2000. An average amount of limestone input per ton of pig iron has been determined for the years 2000-2003. This amounts to 0.12 ton of limestone per ton of pig iron. For the years 1990-1999 limestone usage is calculated – using the average consumption for the period 2000-2003 from the use of ‘carbon additives’ (other than cokes and coals) per ton of raw steel – from the MJVs for 2000, 2001 and 2002 (Corus, 2001-2003) and the production of raw steel from 1990-1999 (CBS, Corus MJVs); this also applies to the carbon content of the iron ore used and the amount of raw steel produced.

The data necessary to calculate the net CO₂ emissions for converting iron ore into steel are taken from the manufacturers’ carbon balance, which were first reported in the year 2000.

For the years 1990-1999 the CO₂ emissions are estimated using the average CO₂ emissions per ton of raw steel for 2000-2003 and the production of raw steel in the particular year.

Other limestone and dolomite use (CRF 2A3)

Limestone from southern Limburg is used in the Dutch cement industry, as well as for producing lime-based fertilisers, fillers, animal fodder lime, flue gas desulphurisation lime, and lime for the brick industry, while Winterwijk limestone (dolomite) is used to produce agricultural lime and acts as a filler for asphalt in the road-construction sector (DWW, the agency for road and hydraulic engineering, 2005). Usage is known for only a few applications, e.g. limestone use for cement, iron and steel, agriculture and flue-gas desulphurisation.

The production of limestone and dolomite is registered by DWW (LCCO/WIG (national coordination commission for extraction/workgroup inventory data), Department of Raw Materials. The total production figures for all limestone and dolomite use can be found on the website for Constructional Raw Materials Database in the Netherlands (in 2005 for the period 1980-2000). The import and export of limestone is not fully registered by the CBS. The dolomite import/export statistics seem to be complete, if it is assumed that limestone is only used for iron and steel production.

Incomplete limestone import/export statistics seem to have a negative impact on the category ***other limestone use*** for most years: the amount left after deducting for the material used by Corus and ENCI is less than the (known) use by flue-gas desulphurisation (FGD) plants. It has therefore been decided to consider the calculated amounts of limestone for FGD as being equal to that of ‘other limestone use’.

The category for ***other dolomite use*** consists of the net domestic consumption minus the previously (separately) calculated use in the agricultural sector (adding to the soil), as described in the protocol CO₂ Emissions for Total Land-use Categories.

The emissions are therefore calculated as:

a) The CO₂ process emissions from flue-gas desulphurisation installations (FGDIs) at coal-fired power plants are determined (through lack of a more accurate method), via the gypsum production from FGDIs, based on the gypsum production and the stoichiometric relationship between

limestone, FGD-gypsum production and CO₂: CaCO₃ + .. → CaSO₄ + CO₂ with a molecule mass of 100, 136 and 44 respectively:

$$\text{CO}_2 \text{ other limestone} = \text{amount of FGD-gypsum} * \text{ZF} * \text{EF}$$

where ZF = purity factor = 1/1.08

$$\text{EF} = \text{MM}_{\text{CaCO}_3} / \text{MM}_{\text{CaSO}_4} * \text{ZF} * \text{EF}_{\text{limestone}} = 100/136 * 1/1.08 * 440$$

where EF_{limestone} = 440 kg CO₂/ton pure limestone with a multiplication factor of (ZF * EF) = 4.044

The gypsum production (calcium-sulphate, CaSO₄) is based on annual reports by the Fly-ash Association. FGD-gypsum consists primarily of calcium-sulphate, with small amounts of metal-oxides, such as magnesium-, sodium-, potassium- and aluminium-oxides, and also includes around 8% water (less than 10% own moisture) (Fly-Ash Association, 2005).

b) The CO₂ emissions from **other dolomite use** consist of the difference between the net usage and the amount used in the agricultural sector:

$$\text{CO}_2 \text{ other dolomite} = (\text{Total net dolomite use} - \text{Dolomite use in agriculture}) * \text{EF}_{\text{dolomite}}$$

where EF_{dolomite} = 477 kg CO₂/ton pure dolomite

2.1.2 Method for calculating other direct CO₂ process emissions

Production of activated carbon ('norit') (CRF 2B5)

Norit is one of the largest producers of activated carbon in the world. Carbon from peat is used in the production process. Since peat use is not included in national energy statistics, the associated CO₂ emissions are calculated from the norit production and an emission factor based on the use of peat per ton of product, from MJV data (Norit, MJV 2002). Since the CO₂ emissions are well under 0.1 Mton, the production is set as equal to that of 2002 (3 kton) with an emission factor of 1 kg CO₂/kg norit.

Anode use during primary aluminium production (CRF 2C3)

CO₂ is created through oxidation of the carbon anodes. This emission can be calculated from the stoichiometric ratio (3/4) that results from the basic reaction comparison: Al₂O₃ + 3/2C -> 2Al + 3/2 CO₂. Because extra CO₂ is formed through the reaction with oxygen in the air (see IPCC, 1997), a slightly higher value is used for the emission factor compared to the aluminium production, indicated by 'F'. The F = factor for stoichiometric ratio (3/4) plus extra CO₂ formed through the reaction with oxygen in the air.

The IPCC guidelines (IPCC, 1997) therefore give a higher value as default: the IPCC default value for Prebake Anode is 1.5t CO₂/t aluminium.

The country-specific emission factor is based on recent information from the Greenhouse Gas Protocol Initiative (GHG Protocol) of the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) which, with typical industrial values of 0.4 ton carbon use per ton of aluminium and (for impurities in the anode) use a default value of F x 44/27 = 1.43, are 17% higher than the stoichiometric value of 1.22, but slightly lower (5%) than the IPCC default value.

There are indications that the default value 'average' has dropped by 5% over the years, but this could not be substantiated through additional (Netherlands) information concerning the 0.4 ton carbon use per ton aluminium and the impurities in the anode. A fixed factor for Fx44/27 has therefore chosen of 1.45, with an uncertainty margin of $\pm 5\%$.

The emissions calculations for oxidation of the carbon anodes are thus:

$$\text{CO}_2 \text{ (year t) (in Gg)} = \text{Primary aluminium production (year t) (in Gg = kt)} \times [\text{F} \times 44/27] \times 1000 \text{ (CO}_2\text{)}$$

where F = factor for stoichiometric ratio (3/4) plus extra CO₂ formed through reaction with oxygen in the air, and value of F x 44/27 = 1.45 [+/- 5%].

This results in CO₂ emissions of around 0.4 Mton/year.

Fireworks and candles (CRF 2G)

The description of the various emissions has been integrated into Section 2.1.4..

2.1.3 Method for calculating indirect CO₂ of NMVOC from the use of solvents

Calculating indirect CO₂ emissions from the use of solvents and other products is based on the reported NMVOC evaporation emissions and the carbon content thereof for the CRF subcategories 3A through 3D:

- Paints (CRF 3A);
- Degreasers and cleaners (CRF 3B);
- Chemical products (CRF 3C);
- Other (CRF 3D).

The reporting of NMVOC emissions is described in a separate protocol. Emissions are interpolated for intermediate years (1991-1994 and 1996-1999).

There are no NMVOC emissions reported for the category 3C, but these are included elsewhere. For each subcategory (3A, 3B and 3D), the average C-content-factors are calculated for the 85-95% of the most important contributing substances. Since there are no data for 3C, an average – pro-forma – weighed average has been calculated for the other three subcategories. These fractions are calculated for both the 1990 and 2000 emissions. Since the trend for 3A and 3B is not robust (because the 2000 figures make up only a small percentage of the total) fixed carbon fractions are used: 3A = 0.72; 3B = 0.16; 3C = 0.68; and 3D = 0.69. The emissions are thus calculated as follows:

$$\text{CO}_2 \text{ (in Gg)} = \sum \{ \text{NMVOC emissions in subcategory } i \text{ (in Gg)} \times \text{C-fraction subcategory } i \} \times 44/12$$

It is assumed that the fraction of organic carbon in these NMVOC emissions is negligible. By basing the calculation on the estimated NMVOC emissions, the changes in the 1990s are automatically included for the types of paint used (with fewer, or other, solvents), whereby fewer NMVOC emissions are generated.

NB: The indirect CO₂ emissions from using mineral turpentine (registered by CBS in the energy statistics) are not calculated separately in the energy statistics because these are already included in the aforementioned NMVOC emissions.

2.1.4 Method for other sources of CO₂, CH₄ and N₂O

Fireworks and candles (CRF 2G)

Emissions of CO₂, CH₄ and N₂O are released when fireworks are set off. Emissions are estimated based on annual sales figures from the fireworks sector, coupled with fixed emission factors (Brouwer et al., 1995):

- for CO₂: 43 kg CO₂ per kiloton of fireworks;
- for CH₄: 0.78 kg CH₄ per kiloton of fireworks;
- for N₂O: 1.96 kg N₂O per kiloton of fireworks.

Activity data were previously registered by the CBS, calculated from the difference between imports and exports. It was assumed that the effect from irregular stock control was negligible. The amount of illegal fireworks (not included in the statistics) was calculated with a constant factor = 0.316. Since 1997 CBS has only registered fireworks imported by companies with a turnover in excess of 5 ton; previously this threshold was 2 ton. This modified registration by CBS meant that in 1997 (compared to 1996) there was a considerable drop in the sale of fireworks. However, the trade association could not confirm this trend, and therefore another calculation method has been used since 1997:

1. Annual sales figures are provided by the company Schuurmans in Leeuwarden (the largest fireworks importer in the Netherlands);
2. These figures are then extrapolated based on Schuurmans share of the market;
3. The volume is then multiplied by a factor for illegal import. It is not known whether this produces reliable figures.

The factor for illegal import is based on an estimate of the illegal fireworks share of the market, made by the Federation of Fireworks Traders, and is published annually in the national newspapers. If this percentage of illegal fireworks increases (or decreases) over the next few years, the factor will be modified accordingly.

Burning candles also produces (limited) CO₂ emissions. CH₄ and N₂O emissions are not estimated, due to the lack of emission factors and the expected limited emissions.

Based on the number of candles per person, the numbers of inhabitants and the various literature sources concerning emissions from candles, an estimate has been made of the annual emissions resulting from burning candles in the Netherlands. Each inhabitant burns a certain number of candles per year, and in 2000 this was an average of 3.3 kg/person (www.bolsius.com). Information concerning measurements and burn-hours can be obtained from: Vebeka BV, www.vebeka.nl or www.bredasekaarsenfabriek.nl.

The emission factors are based on various studies and the assumption that half the candles burnt annually consist of mini-candles (i.e. used to keep things warm) and the other half consist of 'normal' so-called gothic candles. Paraffin/stearine candles and the less popular candle types (based on beeswax, for example) were not included when defining the emission factors.

CO₂ emissions are calculated based on annual estimates of candle usage in the Netherlands, multiplied by a fixed emission factor of 2.3 kg CO₂ per kg candle (EPA, 2001). The emissions are updated if the average number of candles per person changes, or if new literature sources indicate that this is necessary.

Degasification of groundwater when preparing drinking water (CH₄) (CRF 2G)

Deep groundwater contains various dissolved gases, including methane. Part of consumer drinking water is obtained from this groundwater; after pumping to the surface these dissolved gases are removed. Methane is emitted into the air as a result of this degasification process. Extracting groundwater by the agricultural sector or for construction sites concerns surface groundwater, which does not contain methane.

The amount of groundwater extracted to produce drinking water (CBS calls it 'own groundwater') is published annually by CBS (Annual Statistics report and Statline website) based on an annual update by VEWIN (the association of water companies in the Netherlands).

Methane emissions are calculated by multiplying the amount of extracted groundwater by an emission factor of 2.469135443 ton CH₄ per million m³ of extracted groundwater. The total methane emissions resulting from drinking water preparation are estimated at approximately 2 kiloton per year (Van den Born et al., 1991).

N₂O emissions from product use (CRF 3D)

The use of aerosols and anaesthetics release limited amounts of N₂O emissions that are reported separately under category 3D:

- Use of N₂O for anaesthetics;
- N₂O from aerosols.

National laughing gas usage figures by the **health sector** are provided by the market leader (the company Hoekloos), which makes an annual estimate of the national use of laughing gas in hospitals based on its own turnover. The past few years have seen a downward trend in the use of laughing gas, partly through increased local anaesthesia (including lumbar punctures) and partly through using lower dosages. The emission factor is 1 kg/kg N₂O, assuming that all N₂O supplied is used in the same year.

National turnover figures for laughing-gas-based **aerosols** are taken from the annual report by the NAV (National Aerosol Association). The figure for 1990 is estimated based on extrapolation from the figures reported for 1992 1993 and 1994. The emission factor is 7.6 g N₂O per aerosol, which is assumed to be constant throughout the years (report by manufacturer, Mencken, in 2000).

2.2 Emission factors

The following emission factors are used:

- 0.13, 0.15 and 0.18 CO₂ per kg gross glass production for 1990, 1995 and 1997: these are derived from the indicated process emissions in the ER-I: the EF values for 1991-1994 and 1996 have been determined via interpolation, and the value 0.18 is used from 1998 onwards.;
- 415 kg CO₂ per ton soda ash: IPCC default standard
- 0.16 kg CO₂ per kg glass, country-specific value
- 440 kg CO₂ per ton limestone: IPCC default standard
- 477 kg CO₂ per ton pure dolomite : IPCC default standard
- 1 kg CO₂/kg norit: country-specific value
- 1.45 kg/kg primary aluminium production: country-specific value
- carbon fractions of NMVOC in IPCC categories 3A-B-C-D of 0.72; 0.16; 0.68 and 0.69, based on country-specific NMVOC profiles.
- fireworks: country-specific values
 - for CO₂: 43 kg CO₂ per kiloton fireworks;
 - for CH₄: 0.78 kg CH₄ per kiloton fireworks;

- for N₂O: 1.96 kg N₂O per kiloton fireworks.
- 2.3 kg CO₂ per kg candles: country-specific value
- 2.469135443 ton CH₄ per million m³ extracted groundwater: country-specific value
- for product use:
 - 1 kg/kg N₂O used for anaesthesia
 - 7.6 g N₂O per aerosol: country-specific value

2.3 Activity data

The following information for the year t-2 is supplied before 1 September each year to the secretariat of the ENINA task force (i.e. Agricultural/Sinks for limestone/dolomite use in the agricultural sector), and also shows which organisation supplied this information:

- Cement clinker production and CO₂ emissions: MJV submitted by ENCI ;
- Limestone use and carbon balance Corus: MJV submitted by Corus to the Province of North Holland ;
- FGD-gypsum production plants: Fly Ash Association annual report;
- Aluminium production: MJVs submitted by the two companies;
- Glass production: VNG or the index for sheet-glass production (CBS, Statline);
- Total use of dolomite: import/export figures (CBS, Statline) and own estimate of the (very small and reducing) domestic production (less than 5% of the net use) based on information from DWW (LCCO/WIG).
- Use of limestone ('lime-marl') and dolomite ('carbonic magnesium lime') in the agricultural sector: annual statistics from LEI (agricultural economic institute);
- NMVOC from solvents and paint use: from the ER, determined from the relevant calculation protocol for these sources.

The following information is used to estimate emissions for the year t-1 (in contrast to the t-2 data sources if the information sources are not available):

- Limestone use and carbon balance Corus: steel production from IISI (International Iron and Steel Institute) statistics published on the Internet;
- FGD-gypsum production plants: MJVs from 4-5 coal-fired plants;
- Total use of dolomite: trend extrapolation;
- Limestone ('lime-marl') and dolomite ('carbonic magnesium lime') use in the agricultural sector: annual report 'Land- en tuinbouwcijfers 200x' (Agricultural and horticultural figures 200x) from LEI/CBS.
- NMVOC from using solvents and paints: see calculation method t-1 for NMVOC from these sources (usually via trend extrapolation).

The backup option is to use production index figures for the base metal industry, construction material industry etc. as proxy for the t-1/t-2 trend in activity data.

3 WORKING PROCESSES

Process for estimating (t-1)

If preliminary figures are required at any point, the following process is used to estimate the figure for t-1. The preliminary data for the work package leader are calculated by extrapolating them from the previous years' figures, based on prognoses for the developments in the most important activity data (taken from CBS (Statistics Netherlands) or other statistical sources).

Protocol Other process emissions and product consumption emissions of CO₂, N₂O (direct and indirect) and CH₄ CRF source category, partly 2.A, 2B, 2C 2.G; entirely 3.A-D (NIR 2010)

INPUT	PROCESS	OUTPUT	BY WHOM
Preliminary data work package leader (t-1)	Include t-1 data in ER database	ER-db with (t-1) data	Work package leader
ER-db with (t-1) data	Check emission figures: compare with previous years (trend), modify if required and document everything	ER-db (t-1) with any modified figures	Task force

Process for final determination of (t-2)

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

INPUT	PROCESS	OUTPUT	BY WHOM
Annual production, import/export, and/or usage figures from CBS, DWW (production of limestone and dolomite); Cement clinker production and CO ₂ emissions (ENCI), Glass production (VNG), Production of FGD-gypsum (Fly Ash Assoc./MJVs coal-fired plants); Limestone use and carbon balance (Corus), NMVOC from use of solvents etc.	Control figures: - Comparing with previous years - Looking at the trend Checking with supplier concerning non-substantiated figures → modifying figures where necessary and documenting everything	Production, import/export, and usage figures	Work package leader
Aggregated emissions		Detailed emissions and aggregated emissions (=Final data Work package leader (t-2))	Work package leader
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

The ENINA task force under the ER (Emissions Registration) processes the information in a spreadsheet model. After checking and approval this information is archived within the ER. These emissions figures and activity data are not treated as confidential.

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 [Olivier et al, 2009].

IPCC	Category	Gas	AD _{onz.}	EF _{onz.}	Uncertainty estimates _{tot}
2B5	Other chemical product manufacture	CO ₂	50	50	71
2C1	Iron and steel production (carbon inputs)	CO ₂	3	5	6
2C3	CO ₂ from aluminium production	CO ₂	2	5	5
2A1	Cement production	CO ₂	5	10	11
2A3	Limestone and dolomite use	CO ₂	25	5	25
2A7	Other minerals	CO ₂	25	5	25
2G	Other industrial: CO ₂	CO ₂	5	20	21
2G	Other industrial: CH ₄	CH ₄	10	50	51
2G	Other industrial: N ₂ O	N ₂ O	50	50	71
3	Indirect CO ₂ from solvents/product use	CO ₂	25	10	27
3	Other N ₂ O	N ₂ O	20	50	54

Mineral products (2A)

Uncertainty estimates were based on expert judgements, since no detailed information was available for assessing the uncertainties in the emissions reported by the producers (Cement clinker production, Limestone and dolomite use, and Soda ash production).

The uncertainty in CO₂ emissions from cement production was estimated to be about 10%, annually (IPCC Tier 2 default uncertainty); based on 5% uncertainty in activity data –concerning the production of cement clinkers, as reported by the only Dutch company that produces them– and 10% in the CO₂ emission factor.

For limestone/dolomite use and ‘other minerals’ (soda ash use and glass production), an uncertainty of 25% was used, as a result of the relatively large uncertainty in the activity data (25%). The uncertainty in the CO₂ emission factor was estimated at 5% [Olivier et al, 2009].

Chemical industry (2B)

Uncertainty estimates were based on expert judgements, since no accurate information was available for assessing the uncertainties in the emissions reported by the producers (i.e. ammonia, nitric acid, caprolactam production). Emissions from HCFC-22 manufacture were reported under category 2E.

CO₂ from ammonia production

The uncertainty in CO₂ emissions from ammonia was estimated to be about 2%, (2% in activity data and 1% in emission factor). For other chemicals production, this uncertainty was estimated to be

about 70%, as the result of a 50% uncertainty in activity data and a 50% uncertainty in the CO₂ emission factor.

N₂O from nitric acid and caprolactam production

The uncertainty in N₂O emissions from nitric acid was estimated to be about 50%, resulting from an uncertainty in activity data of 10% and 50% in the N₂O emission factor. The uncertainty in annual N₂O emissions from caprolactam production was estimated to be about 70% (based on uncertainties of 50% in activity data and 50% in the N₂O emission factor) [Olivier et al, 2009].

Metal production (2C)

The uncertainty in annual CO₂ emissions was estimated at about 5% for iron and steel production (carbon inputs); based on 3% uncertainty in activity data and 5% in the CO₂ emission factor.

For aluminium production, the uncertainty in annual CO₂ emissions was also estimated at about 5%, with an uncertainty in activity data of 2% and 5% in the CO₂ emission factor. The uncertainty in PFC emissions from aluminium production was estimated to be about 20% (2% in activity data and 20% in the PFC emission factor) [Olivier et al, 2009].

Food and drink (2D)

The uncertainty in CO₂ emissions was estimated at about 5%. Since this is a very small emission source, the uncertainties in this category were not analysed in more detail, and not included separately in the Tier 1 uncertainty analysis [Olivier et al, 2009].

Solvent and the use of other products (3)

This source category comprised: paint application [3A], degreasing and dry-cleaning [3B], and other [3D]. The indirect CO₂ emissions from NMVOC were calculated as follows:

$$CO_2 \text{ (in Gg)} = \sum \{ \text{NMVOC emission in subcategory } i \text{ (in Gg)} * \text{C-fraction subcategory } i \} * 44/12$$

The activity data refer to NMVOC emissions from solvent use. These were calculated assuming 100% evaporation of the solvents: NMVOC (in kg) from solvent use = solvent use (in kg) * 1. So the uncertainty in the NMVOC emissions was actually the uncertainty in the amount of solvents used, often calculated as fraction of the total product: consumption data and NMVOC contents of products. Data on the latter mainly originated from trade associations, such as the VVVF (paints), the NCV (cosmetics), and the NVZ (detergents). The NMVOC contents of these products remained the same during the whole period.

The emission factor refers to the carbon contents of the NMVOC emissions, for which the average carbon contents reported in categories 3A, 3B and 3D were used. The fraction of organic carbon (from natural sources) in the NMVOC emissions was assumed negligible [Olivier et al, 2009].

The following fixed carbon fractions were used for the total time series:

3A	3B	3C	3D
0.72	0.16	0.68	0.69

The carbon contents were based on the composition of compounds responsible for 85 to 95% of the total NMVOC emission within each category. The fractions were calculated based on the 1990 and 2000 emissions.

The uncertainty in indirect CO₂ emissions was not explicitly estimated for this category, but was expected to be fairly low. Based on expert judgments, the uncertainty in the NMVOC emissions was estimated to be 25%, and for the carbon contents this was 10%, resulting in an uncertainty in CO₂ emissions of approximately 25% [Olivier et al, 2009].

Miscellaneous N₂O emissions from solvents and product use

The uncertainty in annual N₂O emissions was estimated to be approximately 50%, based on expert judgments. Uncertainty in the activity data of N₂O use was estimated to be 50%, and for the emission factor this was 0% (all gas was released) [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

Use of soda ash

CO₂ emissions (less than 0.1 Mton CO₂) are currently counted twice: the soda ash used in glass production is not deducted from the total estimated soda ash use. The CO₂ process emissions are reported integrally with glass production. Since implementing this correction from 1990 is somewhat complicated and has no influence on reduction targets, this possible improvement has been given a low priority.

Use of dolomite and limestone

Production of dolomite (and limestone) is registered by DWW (LCCO/WIG), Dept. of Raw Materials. Since dolomite use is calculated from production and import/export figures, and the production figures are not regularly collated by CBS, cooperation with DWW is required to ensure that up-to-date figures are supplied to the Emissions Registration (task force ENINA). The ER will need to make further agreements concerning the continuation of the information flow (frequency, dates, contact person).¹

Fireworks and burning candles

The reliability of the estimate concerning illegal imports of *fireworks* is unknown. Consultations are currently ongoing between the sector, the Ministry of VROM (Spatial Planning, Housing and the Environment) and the Customs Department in order to create a better monitoring system. Due to an error, the calculated CO₂ for *candles* was not included in the CRF for 2005. This was corrected in the report for CRF2006.

5 REMAINING ASPECTS

5.1 Point source criteria

- Corus
- ENCI
- Brummermond (from Akzo Delfzijl)
- Coal-fired plants with FGD
- Aluminium producers (Aldel and Pechiney)

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

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¹ The production figures for limestone and dolomite are not published, due to the limited number of stakeholders involved. These figures therefore cannot be converted back to individual companies. The totals are published and the information is included on a public website: <http://dwwintron.inproduction.nl>.

extraction). The LCCO figures for 1980-2000 are available via the Dutch Building Materials database (total for limestone + dolomite, on the website: <http://dwwintron.inproduction.nl/>).

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- Van de Bank, M.P. and Venderbosch, H.M., 1997, *Sectorstudie bouwmaterialen (Sector study into construction materials)*, Adromi, NDS—96-013 NEEDIS study
- www.bolsius.com for information regarding the number of candles per person in the Netherlands
- www.vebeka.nl or www.bredasekaarsenfabriek.nl for information regarding measurements and burning-hours.

6.2 Additional information

If emissions and/or background information are not reliable enough to be included in the UNFCCC report, further agreements with the NEA (Netherlands Emission Authority) are required, regarding documenting the calculation methodology used and verifying/validating emissions figures.

Protocol Other process emissions and product consumption emissions of CO₂, N₂O (direct and indirect) and CH₄ CRF source category, partly 2.A, 2B, 2C 2.G; entirely 3.A-D (NIR 2010)

APPENDIX 1: IPCC subcategories in Sectors 2 and 3

2 INDUSTRIAL PROCESSES	CO ₂ source for this protocol	CH ₄ or N ₂ O source for this protocol
A. Mineral Products		
1. Cement Production	X	
2. Lime Production		(NE)
3. Limestone and Dolomite Use	X	
4. Soda Ash		
Soda Ash Production		NEU
Soda Ash Use	X	
5. Asphalt Roofing		(NE)
6. Road Paving with Asphalt		(NE)
7. Other (<i>please specify</i>)		
Glass Production	X	
B. Chemical Industry		
1. Ammonia Production ⁽³⁾		NEU
2. Nitric Acid Production		-
3. Adipic Acid Production		-
4. Carbide Production		
Silicon Carbide	IE ¹	NEU
Calcium Carbide		NO
5. Other (<i>please specify</i>)		
Carbon Black		NEU
Ethylene		NEU
Dichloroethylene		NO
Styrene		-
Methanol		NEU
Production caprolactam		-
Production other chemicals		NEU
Carbon electrodes		NEU
Production activated carbon	X	
C. Metal Production⁽⁴⁾		
1. Iron and Steel Production		
Steel	X	
Pig Iron		(IE)
Sinter		-
Coke		-
Other (<i>please specify</i>)		
Coke, incl. inputs in blast furnace (- BF and oxygas)		NEU
Limestone use	X	
2. Ferroalloys Production		NO
3. Aluminium Production	X	
4. SF ₆ Used in Aluminium and Magnesium Foundries		-
5. Other (<i>please specify</i>)		-
D. Other Production		
1. Pulp and Paper		NEU
2. Food and Drink	X	
G. Other (<i>please specify</i>)		
Fireworks and candles	X	CH ₄ (fireworks & candles); N ₂ O (fireworks)
Process emissions in other economic sectors		NEU
Degassing of groundwater for drinking water production		CH ₄
3 SOLVENTS AND OTHER PRODUCT USE		
A. Paint Application	X	
B. Degreasing and Dry Cleaning	X	
C. Chemical Products, Manufacture and Processing		NO
D. Other (<i>please specify</i>)⁽¹⁾		
N ₂ O from Aerosol Cans		- N ₂ O
Use of N ₂ O for Anaesthesia		- N ₂ O
Other Product use	X	

NO = Not occurring; NE = Not Estimated; NEU = In protocol 'CO₂ Non-Energetic use of fossil fuels'.

¹ Reported as combustion emission from chemical residual gas under Sector 1A2.