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Ministry of Health, Welfare and Sport

Methodology for the **calculation of emissions** from **product usage** by consumers, construction and services

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A. Visschedijk et al.

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Colophon

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Synopsis

Methodology for the calculation of emissions from product usage by consumers, construction and services

Each year, the Netherlands reports both nationally and internationally on emissions of polluting substances into the air as a consequence of the use of consumer products, the construction industry and the service industry. Examples of these substances include solvents in cosmetics, air fresheners, aerosol cans and paint, and substances released when lighting wood fires and fireworks. This includes all substances listed in the Netherlands’ Emission Registration that require reporting for these sectors.

The Netherlands’ Emission Registration uses international guidelines for the relevant substances to calculate the amount released into the air. RIVM has updated and compiled a description of the methods used by the Netherlands’ Emission Registration. These methods are refined each year based on the latest scientific insights.

Emission data can be found at www.emissieregistratie.nl. The data is used for reports mandated by international agreements and EU legislation, such as the reporting obligations stemming from the United Nations Framework Convention on Climate Change (UNFCCC); the Paris Agreement (PA); the Convention on Long-Range Transboundary Air Pollution (CLRTAP), which includes the Gothenburg Protocol; the EU National Emission reduction Commitments Directive (NEC Directive); and Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. Furthermore, these reports serve as the basis for (international) review teams who conduct reviews on the Dutch reporting documents.

Keywords: emission, product use, greenhouse gases, air pollution, wood burning, fireworks

Publiekssamenvatting

Methodiek om de uitstoot te berekenen van stoffen bij het gebruik van producten voor consumenten, bouw en diensten

Nederland rapporteert elk jaar nationaal en internationaal welke verontreinigende stoffen in de lucht terechtkomen door het gebruik van producten, door de bouw en diensten. Dit zijn bijvoorbeeld oplosmiddelen uit cosmetica, luchtverfrissers, spuitbussen, verf en stoffen die vrijkomen bij het stoken van hout en het afsteken van vuurwerk. Het gaat om alle stoffen die in de Emissieregistratie voorkomen en voor deze sector moeten worden gerapporteerd.

De Emissieregistratie berekent op basis van internationale richtlijnen voor de relevante stoffen hoeveel ervan in de lucht vrijkomen. Het RIVM heeft de methoden die de Nederlandse Emissieregistratie gebruikt, geactualiseerd en beschreven. De methoden worden elk jaar bijgesteld volgens de meest actuele wetenschappelijke inzichten.

De emissiegegevens zijn te vinden op www.emissieregistratie.nl. De gegevens worden gebruikt voor de rapportages die vanwege internationale overeenkomsten en EU-wetgeving verplicht zijn. Zoals de rapportageverplichtingen in het kader van het Raamverdrag van de Verenigde Naties over klimaatverandering (UNFCCC), het Akkoord van Parijs (PA), het Verdrag over grensoverschrijdende luchtverontreiniging over lange afstand (CLRTAP), waaronder het Gothenburg-protocol, de EU-richtlijn over nationale emissiereductieverplichtingen (NEC-richtlijn) en de Governanceverordening van de Energie-unie (EU 2018/1999). De rapportage is ook de basis voor de (internationale) reviewers die de Nederlandse rapportages moeten controleren.

Kernwoorden: emissie, productgebruik, broeikasgassen, luchtverontreiniging, houtstook, vuurwerk

Contents

Introduction

This document reports on the methods of calculating emissions caused by consumers and some small trade and service companies within the taskforce WESP (Taskforce on product usage by consumers, construction and services). Both greenhouse gas (GHG) and air pollutant emissions are calculated with these methods.
This document is only available online and is updated yearly. The emissions described in this document are part of the Dutch emission inventory (Dutch PRTR). For more information, please check the website www.emissieregistratie.nl.

The emissions calculated by the WESP taskforce are largely caused by product uses which are mainly emitted to air. The emissions to the compartment water are calculated by the MEWAT taskforce (Taskforce on methodology development for water emissions). The emissions caused by industrial production, waste management and energy production are reported by the ENINA taskforce (Taskforce on emissions of energy, industry and waste).

This document describes the background of the process causing the emissions as well as the method of data collection, the source of the emission factors and other important information. It is important to give a description of the method because, in some cases, the calculation is based on a single measurement or data from a single year, and this information needs to be interpretated and used to arrive at an estimation method for the total period.

One of the purposes of this document is to provide information on emission estimations. The task force WESP only calculates direct emissions caused by the process or product use; these are included in this report. Environmental effects such as acidification, greenhouse gas effect or ozone layer depletion are not considered. The waste produced, the amount of energy used, and the resources needed for production or the described process are not also included. Waste management and energy used are calculated on a country scale by the ENINA taskforce. The emissions caused by the production of the products used are calculated in other parts of the Dutch emission inventory, but only if production occurs in the Netherlands.

In the method description, it is also explained how the spatial allocation occurs; this describes how the emissions are geographically distributed throughout the Netherlands. This is based on the location where the emissions are assumed occur. For example, if a product is mainly used by consumers, the distribution is based on the number of people living in a certain area. The spatially distributed emissions are used as input for the (air quality) models calculating the concentrations of the substances in the environment. This is then used to get an estimation of the environmental quality in the Netherlands.

The following chapters have been modified or added in this 2026 version of the methodology report (besides smaller modifications like references):

Chapter 13 Construction sites: A missing activity has been added to the methodology (which was removed in the previous version of this report)
Chapter 27 Smoking of cigarettes and cigars: Activity data has been corrected, now also including foreign and illegal cigarettes that are smoked in the Netherlands
Chapter 31 Dry cleaning of clothes and textiles: The methodology has been corrected for including different types of technology (resulting in a decreasing EF over time)
Chapter 32 Industrial cleaning of clothes and textiles: The methodology has been corrected for including different types of technology (resulting in a decreasing EF over time)
Chapter 37 Accidental fires: New activity data for the number of vehicles that are burnt in accidental fires

Each chapter in this methodology report provides information on the quality and uncertainty of the emission data. This is expressed as a 95% uncertainty range, and/or with a quality indicator. The quality indicator is expressed in a coding system using A, B, C, D and E scores. This corresponds to the method used in EPA emission inventories in the light of EMEP/CORINAIR. The quality scores are defined as follows:

- A. The data are gathered from very accurate (high precision) measurements.
- B The data are gathered from accurate measurements.
- C The data are gathered from a published source such as government statistics or industrial trade figures.
- D The data are derived from extrapolation of other measured activities.
- E The data are derived from extrapolation of foreign data.
- N Not applicable or no data available.

The reliability of the emission factors can vary substantially over time and between substances. Therefore, no confidence interval can be linked to the quality indications used. However, it can be assumed that, for a specific substance, the relative confidence declines along the data quality classifications A to E.

1 General assurance and quality control (QA/QC)

In accordance with the basic work agreements within the Dutch Pollutant Release and Transfer Register, the responsible work package leader checks that:

1. the basic data are well documented and adopted (check for typing errors, use of the correct units, and correct conversion factors);
2. the calculations have been implemented correctly;
3. assumptions are consistent and 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’ by the ER secretary. The work package leaders carry out these actions during the year and they communicate by e-mail regarding these QC checks, actions and results with the ER secretary. When adding a new emission year, the task forces perform a trend analysis in which data from the new year are compared with data from the previous year. The work package leader provides an explanation if the increase or decrease of emissions exceeds the minimum level of 5% at sector level, or 0.5% at national level. These explanations are also sent by e-mail to the ER secretary by the work package leaders. The ER secretary keeps a logbook of all these QC checks and trend explanations and archives all relevant e-mails. This shows explicitly that the required checks and corrections have been carried out.

Based on the results of the trend analysis and the feedback on the control and correction process (‘action list’), taskforce chairmen decide whether they can approve the emissions estimated within their taskforce. When all chairmen have approved, the head of the PRTR (ER project leader at RIVM) ascertains the full dataset. Furthermore, all changes of emissions in the whole time series as a result of recalculations are documented in CRT table 8(b).

2 Emissions of greenhouse gases

This report also provides the methodology descriptions of greenhouse gas emissions reported in the national inventory report (NIR) on greenhouse gases. The relevant emission sources are presented in the following table, including a reference to the chapter and the CRT code.

CRT	Chapter	Emission source code	Emission source (English)	Emission source (Dutch)
1.A.4.b	20	0801801	Charcoal use for barbecuing	Houtskoolverbruik door consumenten: barbecuen
	24	T012200	Residential combustion, wood stoves and fireplaces	Vuurhaarden consumenten, sfeerverwarming woning
	42	0012103	Woodburning residential outdoors	Houtverbranding Consumenten Buitenshuis
2.D.2	8	0801000	Burning candles	Branden van kaarsen
2.G.3.a	0	9310100	Solvent and other product use: anaesthesia	Oplosmiddel- en ander productgebruik: anesthesie, narcosegas
2.G.3.b	4	0811301	Solvent and other product use: sprays	Oplosmiddel- en ander productgebruik: spuitbussen, drijfgas/oplosmiddel, consumenten
2.G.4	17	0801700	Fireworks at New Year’s Eve	Afsteken vuurwerk
	16	0850000	Degassing of groundwater, production of drinking water	Ontgassen drinkwater
	27	0801001	Smoking of cigars	Roken van sigaren
		0801002	Smoking of cigarettes	Roken van sigaretten
5.C.2	38	0801400	Bonfires	Vreugdevuren

Emissions from the use of compost by consumers are described in the methodology report for agriculture (Van der Zee et al, 2026: Methodology for the calculation of emissions from agriculture in the Netherlands).

In the next table, an overview is provided on the Tier used to calculate the emissions and the source of the emission factor. When both CS and D is mentioned, this means that the methodology differs per emission source.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O	
	Method applied	**Emission factor**	**Method applied**	**Emission factor**	**Method applied**	**Emission factor**
1. Energy						
A. Fuel combustion						
4. Other sectors	T1	D	T1	D	T1	D
2. Industrial processes						
D. Non-energy products from fuels and solvent use	T1	D				
G. Other product manufacture and use	T1	CS	T1	CS	T1	CS, D
5. Waste						
C. Incineration and open burning of waste						
2. Open burning of waste	T1	D	T1	D	T1	D

D = default emission factors from the guidebook;
CS = Country specific emission factor;
T1 = Tier 1 methodology;

3 Emissions of air pollutants

This report provides the methodology descriptions of air pollutant emissions reported under the LRTAP convention in the Informative Inventory Report (IIR). The relevant emission sources are presented in the following table, including a reference to the chapter and the NFR code.

NFR	Chapter	Emission source code	Emission source (English)	Emission source (Dutch)
1A4bi	20	0801800	Meat preparation	Vleesbereiden: Bakken, braden en barbecueën
	20	0801801	Charcoal use for barbecuing	Houtskoolverbruik door consumenten: barbecuen
	24	T012200	Residential combustion, wood stoves and fire places	Vuurhaarden consumenten, sfeerverwarming woning
	42	0012103	Woodburning residential outdoors	Houtverbranding Consumenten Buitenshuis
1B2av	0	8920900	NACE 47.3: gas stations, spills tank refill	SBI 47.3: Benzinestations, lekverliezen vullen autotank
	0	8920901	NACE 47.3: gas stations, vapour expel - tank refill	SBI 47.3: Benzinestations, verdrijvingsverliezen - autotanks
	0	8920902	NACE 47.3: gas stations, vapour expel - storage tanks	SBI 47.3: Benzinestations, verdrijvingsverliezen - opslagtanks
	0	8921100	NACE 46.71: wholesale trade in fuels and other mineral oil products	SBI 46.71: Groothandel in brandstoffen en overige minerale olieproducten
2A5a	13	0802302	Building and construction sites	Stofemissies bouwplaatsen
2D3a	14	0801100	Solvent and other product use: cosmetics	Oplosmiddel- en ander productgebruik: Cosmetica en artikelen voor persoonlijke verzorging, consumenten
	9	0802300	Solvent and other product use: car products	Oplosmiddel- en ander productgebruik: Autoproducten, consumenten
	30	0802400	Solvent and other product use: domestic pesticides	Oplosmiddel- en ander productgebruik: NMVOS huishoudelijke bestrijdingsmiddelen
	19	0802800	Solvent and other product use: leather maintenance products	Oplosmiddel- en ander productgebruik: Leer- en meubelonderhoud
	6	0802901	Solvent and other product use: glues	Oplosmiddel- en ander productgebruik: Lijmen, consumenten

NFR	Chapter	Emission source code	Emission source (English)	Emission source (Dutch)
	12	0803000	Solvent and other product use: detergents	Oplosmiddel- en ander productgebruik: Schoonmaakmiddelen, consumenten
	6	0803100	Solvent and other product use: air fresheners	Oplosmiddel- en ander productgebruik: Luchtverfrissers, consumenten
	19	0820600	Solvent and other product use: office products	Oplosmiddel- en ander productgebruik: kantoorartikelen, consumenten
	35	0890401	Solvent and other product use: foam, applied in residential refrigerators	Oplosmiddel- en ander productgebruik: diffusie isolatieschuim koelkast/diepvriezer consumenten
	40	0890402	Solvent and other product use: hand sanitizers	Oplosmiddel- en ander productgebruik: handdesinfectiemiddelen
2D3d	21	0119800	Solvent and other product use: road-paint rural areas	Oplosmiddel- en ander productgebruik: Wegenverf buiten bebouwde kom
	21	0129800	Solvent and other product use: road-paint urban areas	Oplosmiddel- en ander productgebruik: Wegenverf binnen bebouwde kom
	21	0802200	Solvent and other product use: paint in construction	Oplosmiddel- en ander productgebruik: Verfgebruik bouw
	21	0802201	Solvent and other product use: paint by consumers	Oplosmiddel- en ander productgebruik: Verfgebruik consumenten
	21	8920800	NACE 45.2: specialised restoration of cars (painting and lacquering)	SBI 45.2: Gespecialiseerde reparatie van auto's (verven en lakken)
2D3f	32	8922100	NACE 96.012: washing and (dry-) cleaning and dye-works (> 10 employees)	SBI 96.012: Chemische wasserijen en ververijen (> 10 werknemers)
	31	8922200	NACE 96.012: washing and (dry-) cleaning and dye-works (< 10 employees)	SBI 96.012: Chemische wasserijen en ververijen (< 10 werknemers)
2D3i	22	0010300	Solvent and other product use: PCP pressure treated wood, stock	Oplosmiddel- en ander productgebruik: Emissie gevelbetimmering
	14	0801101	Solvent and other product use: cosmetics	Oplosmiddel- en ander productgebruik: Cosmetica en

NFR	Chapter	Emission source code	Emission source (English)	Emission source (Dutch)
				artikelen voor persoonlijke verzorging. HDO
	9	0802301	Solvent and other product use: car products	Oplosmiddel- en ander productgebruik: Autoprodukten, HDO
	10	0802500	Solvent and other product use: carbolized wood	Oplosmiddel- en ander productgebruik: Gecarbolineumd hout, consumenten
	10	0802501	Solvent and other product use: carbolized wood	Oplosmiddel- en ander productgebruik: Gecarbolineumd hout, landbouw
	10	0802600	Solvent and other product use: carbol like wood preservatives	Oplosmiddel- en ander productgebruik: Gebruik carbolineum, consumenten
	10	0802601	Solvent and other product use: carbol like wood preservatives	Oplosmiddel- en ander productgebruik: Gebruik carbolineum, landbouw
	6	0802900	Solvent and other product use: glues	Oplosmiddel- en ander productgebruik: Lijmen, bouw
	12	0803001	Solvent and other product use: detergents	Oplosmiddel- en ander productgebruik: Schoonmaakmiddelen, HDO
	34	0804000	Solvent and other product use: creosote pressure treated wood, new	Oplosmiddel- en ander productgebruik: gecreosoteerd hout in de bouw, consumenten
	34	0804001	Solvent and other product use: creosote pressure treated wood, new	Oplosmiddel- en ander productgebruik: gecreosoteerd hout in de bouw, HDO
	34	0804002	Solvent and other product use: creosote pressure treated wood, new	Oplosmiddel- en ander productgebruik: gecreosoteerd hout in de bouw, landbouw
	34	0804003	Solvent and other product use: creosote pressure treated wood, new	Oplosmiddel- en ander productgebruik: gecreosoteerd hout in de bouw, verkeer en vervoer
	34	0804100	Solvent and other product use: creosote pressure treated wood, stock	Oplosmiddel- en ander productgebruik: opstand van gecreosoteerd hout in de bouw, consumenten
	34	0804101	Solvent and other product use: creosote pressure treated wood, stock	Oplosmiddel- en ander productgebruik: opstand van gecreosoteerd hout in de bouw, HDO

NFR	Chapter	Emission source code	Emission source (English)	Emission source (Dutch)
	34	0804102	Solvent and other product use: creosote pressure treated wood, stock	Oplosmiddel- en ander productgebruik: opstand van gecreosoteerd hout in de bouw, landbouw
	34	0804103	Solvent and other product use: creosote pressure treated wood, stock	Oplosmiddel- en ander productgebruik: opstand van gecreosoteerd hout in de bouw, verkeer en vervoer
	34	0811200	Industrial cleaning of road tankers	Reinigen van tankauto's
	22	0811303	Solvent and other product use: aerosol, spray paint consumers	Oplosmiddel- en ander productgebruik: verfspuitbussen, drijfgas/oplosmiddel, consumenten
	22	0811304	Solvent and other product use: aerosol, spray paint other	Oplosmiddel- en ander productgebruik: verfspuitbussen, drijfgas/oplosmiddel, HDO
	30	0812400	Solvent and other product use: domestic pesticides	Oplosmiddel- en ander productgebruik: NMVOS niet landbouw bestrijdingsmiddelen
	19	0820601	Solvent and other product use: office products	Oplosmiddel- en ander productgebruik: kantoorartikelen, HDO
	35	0890400	Solvent and other product use: foam of refrigerators in waste dumps	Oplosmiddel- en ander productgebruik: diffusie isolatieschuim koelkast/diepvriezer afvalfase
	28	8920700	NACE 45.1: service stations, anti-corrosive treatment	SBI 45.1: Garagebedrijven, antiroest beh.
	33	E800000	Solvent and other product use: fumigation of transports	Oplosmiddel- en ander productgebruik: ontsmetten transporten
2G	8	0801000	Burning candles	Branden van kaarsen
	27	0801001	Smoking cigars	Roken van sigaren
	27	0801002	Smoking cigarettes	Roken van sigaretten
	17	0801700	Fireworks at New Year	Afsteken vuurwerk
5C1bv	15	8922001	NACE 96.032: crematories, mortuaries and cemeteries	SBI 96.032: Crematoria, mortuaria en begraafplaatsen
5C2	38	0801400	Bonfires	Vreugdevuren
5E	37	0801200	House fires	Woningbranden
	37	0801300	Car fires	Autobranden

NFR	Chapter	Emission source code	Emission source (English)	Emission source (Dutch)
	11	0890200	Solvent and other product use: scrapping of refrigerators	Oplosmiddel- en ander productgebruik: afdanken koelkast/diepvriezer
6A	18	0801600	Other sources and sinks: human transpiration and breathing	Transpiratie en ademen
	29	0802000	Manure from domestic animals	Huisdieren mest

4 Aerosol cans (CRT 2.G.3.b)

This section describes the emission of nitrous oxide from aerosol cans.

Process description	Emission source code	CRT code	Sector
Aerosol cans	0811301	2.G.3.b	Consumers

4.1 Description of the emission source

Nitrous oxide (N_2O) is used as a propelling agent in aerosol cans (for example, cans of cream).

Contribution to the national emission
The contribution of this source to the total national N_2O emission was 0.1% in 1990 and 0.7% in 2020 (ER dataset 1990-2022).

4.2 Calculation

For the complete time series, emissions are calculated as follows:

Emission = Activity data x Emission factor

Activity data = Number of N_2O containing aerosol cans sold
Emission factor = N_2O emission per aerosol can

a) Activity data
The Dutch Association of Aerosol Producers (NAV) reports data on the annual sales of N_2O-containing spray cans. Since the 2014 submission, the annual sales have been based on real sales figures instead of estimated sales. As a result of these improved activity data, the N_2O emissions have been recalculated for the whole time series.

b) Emission factor
The EF for N_2O from aerosol cans is estimated to be 7.6 g/can (based on data provided by one producer) and is assumed to be constant over time.

4.3 Uncertainty

For N_2O emissions, the uncertainty is estimated to be approximately 50 per cent based on expert judgement. Uncertainty in the activity data of N_2O use is estimated to be 50 per cent and that of the EF to be less than 1 per cent (the assumption is that all gas is released).

4.4 Spatial allocation

The emissions of consumers are spatially allocated in the Netherlands based on population density.

Emission source/process	Allocation-parameter
Aerosol cans	population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

4.5 References

The Dutch Association of Aerosol Producers (NAV).

4.6 Version, dates and sources

Version: 1.3
Date: September 2015
Contact:

Administrator	Organisation	E-mail address
E. Honig	RIVM/ER	erik.honig@rivm.nl

5 Air Fresheners (NFR 2D3a)

This section describes NMVOC emissions from consumer air fresheners.

Process description	Emission source code	NFR code	Sector
Air freshener	0803100	2D3a	Consumers

5.1 Description of the emission source

Air fresheners are used indoors to hide unpleasant odours and to fill the room with a pleasant scent. The ingredients include non-methane volatile organic compounds (NMVOCs) which enter the atmosphere as they travel from indoor to outdoor air. NMVOC emission is calculated for the use of passive, electric and combustible air fresheners.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.04% in 1990 and 0.14% in 2020 (ER dataset 1990-2022).

5.2 Calculation

Emissions from the use of air fresheners are calculated as follows:

Emission = Activity data × Emission Factor

Activity data = number of households in the Netherlands
Emission factor = kg NMVOC emission from air fresheners averaged per household

a) Activity data
The number of households in the Netherlands are reported annually by the Statistics Netherlands (CBS, www.cbs.nl).

b) Emission factor
The emission factor (EF) is calculated as the sum of three separate emission factors derived for combustible ($EF_{combustible}$), electric ($EF_{electric}$) and passive ($EF_{passive}$) air freshener products.

$$EF = EF_{combustible} + EF_{electric} + EF_{passive}$$

The emission factor per air freshener product is calculated as the emission rate ($e_{NMVOC\ per\ product}$) of the product (g per hour) multiplied by the fraction of households ($FR_{households\ using\ AF\ product}$) using the products, the number of air fresheners present in the households that use the product ($N_{AF\ product\ samples\ per\ household}$), and the duration per year in which the product is used (t_{use} in hours per year).

$$EF_{product} = e_{NMVOC\ per\ product} \times FR_{households\ using\ AF\ product} \times N_{AF\ product\ samples\ per\ household} \times t_{use}$$

The emission rate (g per hour) of an air freshener product is calculated by multiplying the product weight (g) with the weight fraction of the product that is NMVOC (WF_{NMVOC} in g_{NMVOC} per $g_{product}$) divided by the product exhaustion time ($t_{exhaustion}$ in hours), i.e. the duration at which all NMVOC has left the product.

$$e_{NMVOC\ per\ product} = (\text{Product Weight} \times WF_{NMVOC}) / t_{Exhaustion}$$

The VOC emissions per household are calculated per type of air freshener based on the use patterns described in the EPHECT ("Emissions, Exposure Patterns and Health Effects of Consumer Products in the EU") survey report (EPHECT, 2012), and product information of the most used brands of air fresheners reported in material safety data sheets (MSDSs). The EPHECT project is a European collaborative project co-funded by the European Union, in which important information has been gathered about the use of products by European consumers (EPHECT, 2015). The EPHECT survey was conducted in 2012 (EPHECT, 2012) and published in 2015 (Dimitroulopoulou et al., 2015a, b; Trantallidi et al., 2015); it includes survey data that describe the declared consumer use patterns of 4335 respondents including the use and non-use of air fresheners across Europe. Emission rates are calculated from the product information given in the MSDSs (SC Johnson, 2014; 2016a-e).

AF class	AF Products included	households using AF class using product[A] (%)	Product samples in households using products[A,B] (number)	Product Weight[B] (g)	Weight fraction NMVOCs (g per g)[B]	Product Exhaustion time (hour) [B]	Product use (hours per year)[B]	NMVOC Emission factor (g per year per household)
Combustible	Scented candles	22.6[A]	1.7	96	0.025	27	219	4.4
Electric	Active evaporators	22	2.14	38.6	0.76	1440	4061	38.9
Passive	Passive evaporator	20	1.62	170	0.01	1440	8760[C]	3.4
Total								46.7

A = see EPHECT, 2012
B = see Annex I
C = continuous emission (24 hours/day)

An emission factor of 46.7 g NMVOC per household per year has been calculated for the consumer use of air fresheners.

5.3 Uncertainty

Substance	Activity data	Emission factors	Emission
NMVOC	E	E	E

5.4 Spatial allocation

The emissions of consumers are allocated in the Netherlands based on population density. Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

5.5 References

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SC Johnson. 2016b. Material Safety Data Sheet GLADE® CANDLE CASHMERE WOODS. MSDS Number 350000023246

SC Johnson. 2016c. Material Safety Data Sheet GLADE® CANDLE HAWIIAN BREEZE. MSDS Number 350000027860

SC Johnson. 2016d. Material Safety Data Sheet GLADE® CANDLE PURE VANILLA JOY. MSDS Number 350000023248

SC Johnson. 2016e. Material Safety Data Sheet GLADE® 2 IN1 CANDLE SUNNY DAYS® & CLEAN LINEN. MSDS Number 350000023275

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5.6 Version, dates and sources

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Date: January 2018
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5.7 Annex I: Emission rates derived from air freshener product information data

Table AI 1 Product information data: scented candles

Product Sample	Sample Weight (g)	Exhaustion Time (h)	VOC Fraction (%)
Glade® 2 In 1 Candle - Sunny Days® & Clean Linen® - Jan 2014	96.3	30	1.5
Glade® 2 In 1 Candle - Vanilla Passionfruit & Hawaiian Breeze® - Aug 2013	96.3	20	2.9
Glade® Candle - Apple Cinnamon - Jan 2014	96.3	30	0.6
Glade® Candle - Blooming Peony & Cherry™ - Aug 2014	96.3	28	2.8
Glade® Candle - Blue Odyssey™ - June 2013	96	28	3.4
Glade® Candle - Hawaiian Breeze® (Large Jar) - Feb 2015	96.3	20	4.1
Glade® Candle - Pure Vanilla Joy™ - Jan 2014	96.3	30	4
Glade® Candle Cashmere Woods ® - Aug 2013	96.3	30	1
Average*1	96.3	27	2.54

*1 Average calculated from rows above

Table AI 2 Product information data: electric air fresheners

Product Sample	Sample Weight (g)	Exhaustion Time (h)	NMVOC Fraction (%)
Glade Plugins® Scented Oil - Blooming Peony & Cherry™ - Oct 2014	38.1	1440	84.4
Glade Plugins® Scented Oil - Clean Linen™ - Dec 2013	38.8	1680	72
Glade Plugins® Scented Oil - Hawaiian Breeze® - July 2014	37.9	1440	69.6
Glade Plugins® Scented Oil - Lavender & Vanilla - Dec 2013	37.4	1440	59.5
Glade Plugins® Scented Oil - Pure Vanilla Joy™ - Mar 2015	40.9	1440	95.2
Average*1	38.6	1488	76.14

*1 Average calculated from rows above

Table AI 3 Product information data: passive Air Fresheners

Product Sample	Sample Weight (g)	Exhaustion Time (h)	VOC Fraction (%)
Glade® Solid Air Freshener - Clean Linen™ - Mar 2015	170	1440	1.5
Glade® Solid Air Freshener - Hawaiian Breeze® - Mar 2015	170	1440	0.5
Average*1	170	1440	1

*1 Average calculated from rows above

5.8 Annex II: EPHECT Survey data

According to EPHECT, the average duration of scented candle being lit per occasion is, '85.6 minutes, ranging from 67 minutes in Spain and Italy to just over 120 minutes in Sweden.'

Table A II1 Average use frequency of combustible air fresheners calculated from EPHECT (2012) survey data

Multiple choice answer	% of respondents	Frequency per year	(% of respondents) X (Frequency per year)
At least once a day	19%	365	69.35
Several times a week	31%	104	32.24
Once a week	15%	52	7.8
Once every two weeks	9%	26	2.34
Once a month	9%	12	1.08
Less than once a month	12%	6	0.72
Weighted average (hours per year)			119.5

The average number of hours per day the consumer lights scented candles is then calculated as 85.6 minus X 153.4 per year = 219 hours per year.

Table A II2 Average use frequency of electric plug-in air fresheners calculated from EPHECT (2012) survey data

Multiple choice answer	% of respondents	Frequency per year	(% of respondents) X (Frequency per year)
At least once a day	40%	365	146
Several times a week	26%	208	54.08
Once a week	10%	52	5.2
Once every two weeks	3%	26	0.78
Once a month	7%	12	0.84
Less than once a month	8%	6	0.48
Weighted average (hours per year)			207

Table A II3 Average duration of electric air fresheners plugged in per occasion, excluding the population who permanently leave the device on

Multiple choice answer	**% of respondents**	**Hours per plug-in occasion**	**(% of respondents) X (Hours per plug-in occasion)**
Less than 1 hour	21%	0.5	0.105
Between 1 and 6 hours	28%	3.5	0.98
Between 6 and 12 hours	9%	9	0.81
Between 13 and 24 hours	2%	19	0.38
Between 25 and 48 hours	1%	36.5	0.365
Between 2 and 3 days	1%	60	0.6
More than 3 days	1%	72	0.72
Weighted average (hours per year)			3.96

The average use frequency of electric plug-in air fresheners is 207 times per year, whereas the average duration per occasion is 3.96 hours, excluding those consumers who permanently plug in the device. The number of hours per year is then 3.96 X 207 = 820 hours. However, the device is permanently plugged in at 37% of the households, so that on weighted average, the number of hours for all households in which an electric air freshener is plugged is 820 + 37% X 24 X 365 = 4061 hours.

Table AII 4 The use of in-house air fresheners per room

Room	**% of respondents claiming to have at least one electric freshener in the room**
Living/dining room	60%
Bathroom	32%
Bedroom	30%
Hallway	29%
Kitchen	24%
WC	23%
Closet/Storage room	9%
Other room in the house	7%
Average number of in-house[A] air fresheners	2.14

A: calculated as the sum of the % of respondents claiming to have at least one electric freshener in the rooms, divided by 100%.

6 Adhesive products (NFR 2D3a and 2D3i)

This section describes the emissions of substances from the use of adhesives in consumer glue and the use of adhesives in the construction sector.

Process description	Emission source code	Sector	NFR code
Adhesives	0802900	Construction sector	2D3i
Adhesives	0802901	Consumers	2D3a

6.1 Description of the emission source

Volatile organic compounds (VOCs) are used as substance ingredients in adhesive products such as glues available on the consumer market, or adhesive products used in the construction sector. These VOCs are released to the air during the application of adhesive products.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.3% in 1990 and 0.2% in 2020 (ER dataset 1990-2022).

6.2 Calculation

The activity data refer to the volume of adhesive products and sealants available on the professional and consumer market in The Netherlands per year (VLK, 2021). The market volumes for consumer and professional use are multiplied by the emission factor which refers to the average weight fractions of VOCs in adhesive products and sealants. When such data is not available, it is crudely estimated from European market volume data (FEICA, 2014), but it is recognized that uncertainty for such estimation is large (VLK, 2021). Such average weight fractions are calculated for each emission year based on the fraction of adhesive products and sealants that contain VOCs and by the mass fraction of VOCs in VOC holding adhesive products and sealants. About 98% of the estimated VOC content in adhesive products and sealants is released to the air (FEICA, 2018). These emission factors are estimated on internal stakeholder survey among adhesive and sealant companies (VLK, 2021). The delivered confidential company data replace earlier data of KWS (2002) and Milieumonitor (1997).

6.3 Uncertainty

Substances	Activity data	Emission factors	Emission
VOC	D	D	D

6.4 Spatial allocation

Spatial allocation of emissions is based on population density.

6.5 References

FEICA, 2015. Fédération Européenne des Industries de Colles Adhesifs. 2015. The European Adhesive and Sealant Industry Facts & Figures 2014. Publication N° FMI-EX-E08-018.

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6.6 Version, data and sources

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7 Anaesthesia (CRT 2.G.3.a and NFR 2G)

This section describes the emissions of N_2O and sevoflurane used as an anaesthetic.

Process description	Emission source code	CRT code	NFR code	Sector
Anaesthesia	9310100	2.G.3.a	2G	Trade and services

7.1 Description of the emission source

Nitrous oxide (N_2O) and sevoflurane are used as an anaesthetic and is emitted through exhalation of the patient. In addition to N_2O and sevoflurane, other anaesthetics are in use in the Netherlands, most commonly halothane, desflurane and enflurane. The use of these anaesthetics is limited compared to N_2O and sevoflurane.

Contribution to the national emission
The contribution of this source to the total national N_2O emission was 0.9% in 1990 and 0.1% in 2020 (ER dataset 1990-2022).

7.2 Calculation

For the complete time series, the emissions of N_2O are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Amount of N_2O sold for anaesthesia
Emission factor = N_2O emission from anaesthesia

This is a tier 1 methodology. The methodology is consistent with the IPCC 2006 Guidelines.

For the time series of the emissions of sevoflurane, 2 Dutch publications of medical organisations are used. The data in both publications are based on sevoflurane purchasing figures from a large number of hospitals, extrapolated to all hospitals in the Netherlands based on the total number of hospitals (per type).

a) Activity data
The amount of nitrous oxide sold in the Netherlands would be the best measure for the activity data. Therefore since 2011, all companies known to sell nitrous oxide as anaesthesia to the Dutch market are asked to report their annual sales to the Dutch market. The total of these sales results in the total amount of nitrous oxide used as an anaesthetic in the Netherlands.
In the years prior to 2010, and after that year occasionally, an estimate was made based on the sales of the major supplier. In years where sales were not reported by all companies, the total was estimated based on the sales of the other companies; based on the estimated market share of the largest company selling nitrous oxide as an anaesthetic.

If nitrous oxide is sold as a mixture with oxygen, only the nitrous oxide is calculated as sales.

Sales data is only available up to 2019. From 2020 onward, the emissions have been based on N2O consumption as reported in Venema et al (2022) and Jansen et al (2024).
Sevoflurane use in Dutch hospitals is only reported in Venema et al (2022) and Jansen et al (2024) for the years 2019-2022. In both studies, a bottom-up inventory of inhalation gases was made by survey's at all known hospital organizations in the Netherlands.

Sevoflurane was released for use by hospitals in the Netherlands 1996, but no statistics on the use was available for the years 1996-2018. Therefore, the sevoflurane use in 1996-2018 was assumed equal to the sevoflurane use in 2019.

b) Emission factor
The emission factor for nitrous oxide sold in the Netherlands is 1 kg per kg nitrous oxide. All nitrous oxide sold in a certain year is considered to be emitted after use in the same year. This emission factor is consistent with the 2006 IPCC guidelines.

The emission factor for sevoflurane in the Netherlands is 1 kg per kg sevoflurane. All the sevoflurane bought by hospitals in a certain year is considered to be emitted after use in the same year.

7.3 Uncertainty and Quality checks

In those cases where all companies report their sales, the uncertainty in the activity data is caused by stock changes on the consumer side (mainly hospitals). Those differences are considered to be negligible.
If, on the other hand, not all companies provide their sales, the uncertainty can be as much as 25%. The uncertainty in emission factor is 0%, because all N_2O and sevoflurane will be exhaled over time. Both the uncertainty in activity data and in emission factor are based on expert judgement.

Quality codes

Substance	Activity data	Emission factor	Emission
N_2O	B	A	B
Sevoflurane	B	A	B

Quality checks
There are no sector specific quality checks performed. For the general QA/QC, see chapter 2.

7.4 Spatial allocation

Consumer emissions are spatially allocated in the Netherlands based on the number of beds per hospital.

Emission source/process	Allocation-parameter
Anaesthesia	Number of beds per hospital

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

7.5 References

Written (or in early years oral) data on sales from companies selling anaesthetics for the years 1990-2019.

Jansen, K., Bloem, W., Yildirim, I., Boonen, L., 2024. Inventarisatie van het gebruik van anesthetics en lachgas in Nederland. Equalis Vintura, februari 2024.

Venema, P.A.H.T., Friedericy, H.J., Sarron, E.Y., Jansen, F.W., 2022. Een inventarisatie van het gebruik van inhalatieanesthetica en lachgas in Nederlandse ziekenhuizen. Nederlands tijdschrift voor anesthesiologie, volume 35, nr. 2, mei 2022.

7.6 Version, dates and sources

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Date: Jan 2025
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8 Burning Candles (CRT 2.D.2 and NFR 2G)

This section describes the emissions as a result of the burning of candles.

Process description	Emission source code	CRT code	NFR code	Sector
Burning of candles	0801000	2.D.2	2G	Consumers

8.1 Description of the emission source

Within households and in some catering industries, candles are burned to create a pleasant ambiance. Burning candles results in the emission of several substances, for example particulate matter (PM2.5 and PM10) and PAHs (benzo(ghi)pyrene and benzo(a)pyrene).

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was <0.01% in 1990 and <0.01% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national CO2 emission was 0.13% in 1990 and 0.15% in 2020 (ER dataset 1990-2020). The contribution of CH4 emissions was <0.01%.

8.2 Calculation

For the complete time series, the emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Amount of candles burned in kg
Emission factor = Emission per kg candle

This is a tier 1 methodology. The methodology is consistent with the IPCC 2006 Guidelines.

a) Activity data
The activity data consist of two parts: national statistics on the number of inhabitants of the Netherlands (Dutch bureau for statistics), and the amount of candles burned per person in the Netherlands.

The amount of candles burned per person is retrieved from information by a major supplier to the Dutch market (Bolsius). Up to 2009 the amount of candles burned per inhabitant was retrieved from www.bolsius.nl. From 2010, it has been based on expert judgement by a representative from a company selling candles.

A 2022 press release by a large insurance company (OHRA) in FONK-magazine showed that about one third of Dutch residents light up more candles and tea-lights to save on heating during the winter of 2022 – 2023. The main reason being the increased costs for heating due to the outbreak of the Russo-Ukrainian War.

As a result, the total yearly amount of candles used for 2022 and 2023 has increased by 0,6 kg/person, resulting in a proportional increase in the related emissions.

b) Emission factor
The emission factors for burning candles are dependent on the type of candle burned. Both tea lights and regular (gothic) candles have been taken into account, both estimated at 50% usage. Less-used candle types, e.g. beeswax candles, are not considered to be relevant for this calculation.
The CO_2 emission factor, given in g/MJ candle, is multiplied by a heating value of 42.7 MJ/kg. Both the CO_2 emission factor and the heating value for candles are derived from the Dutch fuel list 2026 (Zijlema, 2026).
All other emission factors (except black carbon (BC) or elemental carbon (EC)) are mainly calculated based on EPA 2001. The BC / EC fraction of $PM_{2.5}$ has been derived from Pagels et al. 2009.

Substance	EF	Unit
Benzo(ghi)pyrene	0.278	mg/kg candle
Benzo(a)pyrene	0.150	mg/kg candle
VOC	928	mg/kg candle
CO_2	73.3	g/MJ candle
PM_{10}	0.872	mg/kg candle
$PM_{2.5}$	0.872	mg/kg candle
BC / EC	0.3	- (Fraction of $PM_{2.5}$)
Pb	1.56	mg/kg candle
Zn	0.127	mg/kg candle

8.3 Uncertainty

The uncertainty of both the activity data and the CO_2 emission factor are determined in the report on uncertainties in greenhouse gas emissions by Olivier (2009). The uncertainty in activity data is estimated to be 100%. The uncertainty in the emission factor for CO_2 is estimated at 20%.

For the other substances (not greenhouse gases), the uncertainty was not determined. Instead, the reliability of the data is qualitatively indicated in the table below with codes A-E (see chapter 1).
The number of inhabitants in the Netherlands is accurately known, but the amount of candles burned per inhabitant is a rough estimate based on data from one manufacturer. Therefore, the activity data are relatively unsure and rated with a D.
The emission factors are retrieved by combining different sources to improve the reliability. However, since these sources did not take different candle types into account, the emission factors are rated with a C.

Quality codes

Substance	Activity data	Emission factor	Emission
Benzo(ghi)pyrene	D	C	D
Benzo(a)pyrene	D	C	D
VOC	D	C	D
CO_2	D	C	D
PM_{10}	D	C	D
$PM_{2.5}$	D	C	D
BC / EC	D	C	D
Pb	D	C	D
Zn	D	C	D

8.4 Spatial allocation

The emissions of consumers are spatially allocated in the Netherlands based on the population density, following the assumption that most candles are burned in residential areas/households.

Emission source/process	Allocation-parameter
Burning of candles	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling

8.5 References

CBS, Dutch Bureau of Statistics, Statline, annual data on the number of inhabitants.

EPA; January 2001, Candles and incense as potential sources of indoor air pollution: Market analysis and Literature review; EPA-600/R-01-001.

Fine M. Philip, Glen R. Cass, Bernd R.T. Simoneit; Characterization of fine particle emissions from burning church candles; Environmental Science & Technology vol. 33, NO. 14, 1999.

FONK-magazine: Fonk - Economisch: 31,1% van Nederland steekt vaker kaars dan kerstverlichting aan (https://beta.fonk.vs3.blueskies.nl/artikelen/economisch/311p-van-nederland-steekt-vaker-kaars-dan-kerstverlichting-aan-62708.html#sluiten) – in Dutch

Gruijter H.J. de, A.J.G. van Rossum; De Kaars; Lesbrief KNCV/NVON; first edition1983.

Information on the amount of candles burned, http://bolsius.nl.

Molder, R. te, Metadata gegevensbeheer emissieregistratie: beschrijving gegevens t.b.v ruimtelijke verdeling van emissies, PBL, Bilthoven, jaarlijks, intern document.

Olivier, J.G.J., Brandes, L.J. and te Molder, R.A.B., 2009, Uncertainty in the Netherlands' greenhouse gas emissions inventory, PBL publication 500080013.

Pagels, J., Wierzbicka, A., Nilsson, E., Isaxon, C., Dahl, A., Gudmundsson, A., ... & Bohgard, M. (2009). Chemical composition and mass emission factors of candle smoke particles. Journal of Aerosol Science, 40(3), 193-208.
Vebeka BV; Information on sizes and burning times: http://vebeka.nl.
Zijlema, P.J., 2026; Nederlandse lijst van energiedragers en standaard CO2 emissiefactoren.

8.6 Version, dates and sources

Version: 1.3
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9 Car Products (NFR 2D3a and 2D3i)

This section describes NMVOC emissions from car products.

Process description	Emission source code	NFR code	Sector
Car products	0802300	2D3a	Consumers
Car products	0802301	2D3i	Trade and services

9.1 Description of the emission source

NMVOC emissions are estimated from the use of car products to maintain and clean company and private cars. Windscreen fluid is considered to contribute 70% of NMVOC emissions (ER, 2017), whereas other car products such as car wax, plastic cleaners, and cockpit sprays together comprise 30% of the emissions. Four different sources of emission are defined:

1. Windscreen fluid used on private cars.
2. Windscreen fluid used on company cars.
3. Other car products used on private cars.
4. Other car products used on company cars.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 1.8% in 1990 and 4.7% in 2020 (ER dataset 1990-2022).

9.2 Calculation

Emissions from the use of windscreen fluids are calculated as follows:

Emission = Activity data x Emission Factor

Windscreen fluids
Activity data = total number of kilometres driven by automobiles in the Netherlands.
Emission factor = kg NMVOC emission per driven kilometre in the Netherlands.

a) Activity data
Data describing the number of driven kilometres by automobiles in the Netherlands are collected from the website of the Dutch Central Bureau for Statistics (CBS, 2017).

b) Emission factor
Data describing the market volumes of methanol, ethanol, and isopropanol as main ingredients in car windshield fluids in Finland for the years 2002-2014 (Table 1) became publicly available in 2015 (ECHA 2015a,b,c). The market volumes of these substances in windscreen fluids sold in the Netherlands have been estimated from the Finnish market volumes by correcting for the number of kilometres driven in the Netherlands and Finland as well as the number of frost days in the Netherlands and Finland. Finland’s climate is colder than the Netherlands, so relatively more windshield fluid is used for the purpose

of de-icing in Finland. According to the USEPA, the use of windshield fluids at local temperatures above 0°C is about equal to 23% of windshield use at local temperatures below 0°C (USEPA, 1996; 2012). Finland has about 233 days of frost per year (Plantmaps.com), whereas the Netherlands only has 38 days of frost annually (KNMI, 2017). Therefore, the following correction factor for the difference in climate between Finland and the Netherlands has been applied:

$$correction_{climate} = \frac{frost\ days_{Netherlands} + non\ frost\ days_{Netherlands} \times 0.23}{frost\ days_{Finland} + non\ frost\ days_{Finland} \times 0.23}$$

From this, the emissions of methanol, ethanol and isopropanol used in windscreen fluids per driven kilometre in the Netherlands are estimated as follows:

$$\frac{emission_{Netherlands}}{kilometers_{Netherlands}} = \frac{market\ volume_{Finland}}{kilometers_{Finland}} \times correction_{climate}$$

Table 1 includes the market volumes of methanol, ethanol and isopropanol in windscreen fluid in Finland (ECHA, 2015b), the number of kilometres driven by automobiles in Finland (Liikenneviraston Tilastoja, 2017) and the estimated emission per driven kilometre in the Netherlands (g/km).

	Kilometres driven in Finland (million km /y)	**Finnish market volumes (t/y)**			**Estimated emission per kilometre in The Netherlands (g/km)**		
Year		**Methanol**	**Ethanol**	**Isopropanol**	**Methanol**	**Ethanol**	**Isopropanol**
2002	31271	1326	3474	4323	0.02	0.05	0.06
2003	32211	1565	4061	4106	0.02	0.05	0.05
2004	33004	904	5606	3043	0.01	0.07	0.04
2005	33854	1334	4743	1995	0.02	0.06	0.03
2006	34473	1745	5061	2811	0.02	0.06	0.04
2007	34780	1358	5095	2617	0.02	0.06	0.03
2008	35661	1127	5952	1927	0.01	0.07	0.02
2009	35557	1246	6594	2892	0.02	0.08	0.03
2010	35868	1748	6353	1187	0.02	0.08	0.01
2011	36234	2559	7707	1746	0.03	0.09	0.02
2012	36740	935	4382	702	0.01	0.05	0.01
2013	36607	1819	6465	920	0.02	0.08	0.01
2014	36567	1422	4621	73	0.02	0.05	0.00
Average	34833	1468	5393	2180	0.018	0.066	0.028

The origin of the proportion of emissions from car products is assigned as follows: 60% from consumers and 40% by trades and services (ER, 2017). The emission factors for consumers and trades and services are calculated by multiplying the average estimated emission per kilometre in the Netherlands (g/km) over the period of 2002-2014 (Table 1) with these proportions (Table 2).

NMVOC in windscreen fluid	Emission factor consumers (g/km)	Emission factor trades and services(g/km)
Methanol	0.011	0.07
Ethanol	0.040	0.027
Isopropanol	0.017	0.011

Other car products
Activity data = amount of NMVOC in car products other than windscreen fluid sold in the Netherlands.
Emission factor = emission per kg NMVOC in car products.

a) Activity data
In 1997, bureau Consultancy and Research for Environmental Management (CREM) conducted a study using car product monitoring data for the years 1994 and 1996 (CREM, 1997). The monitoring data originated from questionnaires filled in producers and suppliers of car products. In 1998, a recall survey was conducted by telephone in which the data for 1997 was established. The recall contained information from 26 companies (18 companies in the 1997 survey and 8 new companies). It was estimated that these 26 companies cover 80% of the market. The companies provided sales data of car products and the average amount of NMVOC these products contained. This information was then used to determine the NMVOC emissions from car products.

The 1997 monitoring data (CREM 1998) are still used for calculating NMVOC. The data from CREM (1998) is the most recent information available that refers to car products other than windscreen fluid.

b) Emission factor
NMVOC totals are recalculated to individual substances using an average car product profile. The profiles were established for car products by TNO (1992) in cooperation with the car products branch.

Substance in car product profile	factor
Propane	0.12
Isobutane	0.12
Monohydroxyverbindingen	0.54
Dimethyl ether	0.03
Hydrocarbon. mixture. c2-c10 <25% aromatic.	0.18

These totals include the emissions from windscreen fluids. Windscreen fluid is considered to contribute 70% of the NMVOC emission (ER, 2017). Therefore, the NMVOC totals have been multiplied by 30% to correct for this, so that only emissions from the use of car products other than windscreen are estimated. Furthermore, the emissions from other car products have been divided into the sectors of consumers (≈ 60%) and of trade and services (mostly garages ≈ 40%).

9.3 Uncertainty

The uncertainty level of activity data for windscreen fluids is considered low, since the number of kilometres driven in the Netherlands is well known, therefore it is qualified with an A. The translation of the emission

factors from Finland to the Dutch situation is more uncertain, therefore qualified with a E as the original data is foreign (Finland). Both the emission factor and the activity data for the other car products are outdated, therefore the uncertainty is considered high and qualified with an D.
Since the NMVOC from windscreen products is about 70% of the emissions, the overall quality of the activity data is estimated with a E. The quality of the emission factors is qualified with a E.

9.4 Spatial allocation

The emissions of consumers and trade and services are allocated in the Netherlands based on population density.
Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

9.5 References

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9.6 Version, dates and sources

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Note: Since 1999, no new data has become available on emission variables and emission factors of car products other than windscreen fluids. Therefore, the data used may be outdated.

10 Carbolineum treated wood (NFR 2D3i)

This section describes emissions resulting from Carbolineum treated wood.

Process description	Emission source code	NFR code	Sector
Carbolineum treated wood	0802500	2D3i	Consumers
Carbolineum treated wood	0802501	2D3i	Agriculture
Carbolineum use	0802600	2D3i	Consumers
Carbolineum use	0802601	2D3i	Agriculture

Carbolineum is a pesticide that is brushed on wooden surfaces in order to prevent woodworm and moulds from affecting wooden constructions in housings, gardens and agriculture. The use of carbolineum for treatment of wood in contact with groundwater has been prohibited since 1999, and as a consumer product since 2001 (KWS, 2002).

10.1 Description of the emission source

Emission from carbolineum occurs via two processes:

- Emissions from wood that has been treated with carbolineum in the past. Carbolineum contains VOCs and PAHs that evaporate to outdoor air or leach to soil from the surfaces of the treated wood.
- Emissions during the treatment of wood with carbolineum (VOC).

10.2 Calculation

The emissions of VOCs and PAHs from carbolineum treated wood are calculated by multiplying activity rates (AR) with respective emission factors (EF).

Emission = AR X EF

a) Activity data

Four different activity rates are considered:

- the area of carbolineum treated wood (treated in the past) for consumer use (m^2)
- the area of carbolineum treated wood (treated in the past) for agricultural purposes (m^2)
- the volume of carbolineum used by consumers during treatment ($t.y^{-1}$)
- the volume of carbolineum for agricultural purposes during treatment ($t.y^{-1}$).

It is assumed that 25% of the total volume of carbolineum used is for agricultural purposes and 75% for consumer use. It is also assumed that 25% of the total area of treated wood is for agricultural purposes and 75% for consumer use. The total volumes of carbolineum used as well as the total surface area of carbolineum treated wood before 2001 are taken from

Infomil (KWS, 2002). The use of carbolineum has been prohibited since 2001, so there is no activity data and no emissions since then from treatment with carbolineum. After the year 2001, the surface area of the carbolineum standing treated wood is assumed to be removed with 5% each year, so that PAH emissions decline per year.

b) Emission factors
The emission factors for PAHs and VOCs released to the environment during treatment, as well as those for evaporation and leaching from the surface of treated wood is summarised in Table 1. The emission factors apply both to consumer use and agricultural use.

Table 1 Emission factors for carbolineum use and carbolineum treated wood.

Substance	kg emission per million kg carbinoleum used	kg emission per million m^2 treated wood
Naphthalene	0.02	0.0001
Anthracene	0.0005	0.00006
Fenanthene	0.015	0.0011
Fluoranthene	0.002	0.00049
Benzo(a)-anthracene	0.00027	0.000055
Chrysene	0.000026	0.00001
Benz(k)-Fluoranthene	2.9E-07	1.1E-07
Benzo(a)-pyrene	1.4E-06	5.70E-07
Benz(ghi)-Perylene	3.1E-07	1.20E-07
Pyrene	3.1E-07	1.2E-07
NMVOC	0.25	-

All NMVOC is assumed to be released upon use, so that there is no NMVOC left for release from treated wood.

10.3 Uncertainty

Carbinoleum use is prohibited after 2001. Current emissions are estimated from past applications estimated by KWS 2000.

Source	Activity dat	Emission factor	Emission
Carbinoleum use	D	C	D
Carbinoleum treated wood	D	D	D

10.4 Spatial allocation

Spatial allocation of emissions is based on population density.

10.5 References

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10.6 Version, date, sources

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11 CFCs from refrigerators and freezers (NFR 5E)

This section describes the emissions of chlorofluorocarbons (CFCs) as a result of the leakages in the refrigerant system and the processing of discarded refrigerators and freezers.

Process description	Emission source code	NFR code	Sector
Discarding refrigerators and freezers	0890200	5E	Consumers

11.1 Description of the emission source

Since 1995, the production and sale of refrigerators and freezers (R/F) using chlorofluorocarbons as refrigerant has been prohibited in the European Union. However, given an average lifetime of at least 15 years, some R/F equipment using CFCs is still in use and these are discarded annually. In the Netherlands, discarded R/F equipment is collected and processed by specialised companies which remove and destroy the CFCs still present in the equipment. Still, in some cases the CFCs have leaked to the environment before the equipment is discarded and processed. This emission source represents these leakage emissions of CFCs and possible processing inefficiencies which leads to the emission of CFCs to the environment.

Before the year 2000, a share of the discarded R/F units were exported to Eastern Europe and Africa. However, from 1999, the export of old R/F equipment has been prohibited.

11.2 Calculation

Emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = number of refrigerators and freezers that use CFCs as refrigerant that are discarded annually and that are not exported abroad.
Emission factor = CFC emission per unit of CFC R/F equipment

a) Activity data
To estimate the number of CFC R/F equipment discarded annually from 1990 to 2030, a combination of multiple data is needed. First, the number of R/F units put on the market between 1960 and 1994 in the Netherlands was extracted from CBS data. These R/Fs are assumed to all use CFC-12 as refrigerant. The average amount of CFC refrigerant present per unit is estimated at 165 grams (Brouwer & Hulskotte, 1995).

A statistical distribution (Weibull distribution) is used to estimate the number of CFC R/F units discarded annually. Based on data from CBS, the average lifetime of a refrigerator is estimated at 16.4 years and of a freezer at 18.6 years. Furthermore, the shape of the Weibull function is 2.2 for refrigerators and 1.3 for freezers (Magalini et al., 2014).

These calculations have resulted in an annual number of discarded CFC R/F units from 1990 to 2030. However, between 1990 and 1999, a share of the discarded units was exported and therefore did not cause emissions in the Netherlands. From 1990 to 1998, the share of discarded units was assumed to be 20%; in 1999 the share was assumed to be 10%. This ratio has been applied to the number of discarded CFC R/F units from 1990 to 1999 to estimate the number of CFC R/F units that were annually processed in the Netherlands. From 2000 onwards, it is assumed that no discarded CFC R/F units are exported and therefore the number of discarded CFC R/F units is assumed to be equal to the number of CFC R/F units processed.

Since the year 2013 no CFC R/F equipment is estimated to be in use in the Netherlands.

b) Emission factor
The emission factor is estimated by subtracting the average amount of CFC refrigerant recovered from processed R/F units, from the average amount of CFC refrigerant used in CFC R/F units (Brouwer & Hulskotte, 1994).
165 gram – 60 gram = 105 gram/unit.

This calculation was verified by dividing the amount of recovered CFCs by the number of units processed according to the CFK 'aktieprogramma' (action programme) (1994) and subtracting this from the current amount of CFCs, which resulted in an emission factor of 103 grams/unit. Furthermore, the Flanders Environment Agency (MIRA, 2010) reports an average CFC recovery percentage of 33%, which results in an EF of 101 grams per unit.

Substance	EF	Unit
CFC-12	0.105	kg/RF unit

11.3 Uncertainty

The uncertainties of both the activity data and the emission factors have not been determined.
Only rough estimates are available for the number of CFC R/F units present, discarded or exported in the Netherlands. Therefore, the activity data has a significant level of uncertainty, rated D.
The emission factor was verified by combining different sources, improving the reliability. It is therefore rated C.

Quality codes

Substance	Activity data	Emission factor	Emission
CFC-12	D	C	D

11.4 Spatial allocation

The emissions of consumers are spatially allocated in the Netherlands based on population density.

Emission source/process	Allocation-parameter
Discarding refrigerators and freezers	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

11.5 References

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11.6 Version, dates and sources

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12 Cleaning Products (NFR 2D3a and 2D3i)

This section describes the emission from the use of cleaning products.

Process description	Emission source code	NFR code	Sector
Solvent and other product use: detergents	0803000	2D3a	Consumers
Solvent and other product use: detergents	0803001	2D3i	Trades and services

12.1 Description of the emission source

NMVOCs are applied in cleaning products because of their fat dissolving capacities. The largest fraction of these NMVOCs is being released to the air during or after the use of the cleaning products by consumer and institutional services. The emissions described here are related to consumer uses, institutional users and cleaning companies. Industrial cleaning products are considered by the taskforce ENINA.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.9% in 1990 and 5.0% in 2020 (ER dataset 1990-2022).

12.2 Calculation

The emission of NMVOCs from cleaning products is calculated by multiplying an emission factor with activity data for the year of emission.

Emission = Activity data × Emission factor

The activity data refers to the annual market volume (in kton) in the Netherlands for cleaning products sold on the consumer market and sold for institutional cleaning.
The emission factors refer to the kg NMVOC released per kton sold.

Activity data consumer market
The consumer activity data refers to the amount of cleaning products sold on the consumer market expressed in ktons per year. This amount is estimated from the market turnover of consumer cleaning products annually reported by NVZ (2007, 2022), data on the amount of consumer cleaning products sold in The Netherlands in the years 2003-2008 and the CBS consumer price index (CBS, 2023) that presents the relative increase and decrease of market prices of consumer products, including cleaning products (see, Chapter 13 Annex I).

Activity data trades and services
The activity data for trades and services refer to the amount of cleaning products sold for institutional cleaning in ktons per year. This amount is estimated from the market turnover of institutional cleaning products annually reported by NVZ (2007, 2022), data on the amount of

institutional cleaning products and disinfectants sold in The Netherlands in the years 2003-2008 and the CBS consumer price index (CBS, 2023) that presents the relative increase and decrease of market prices of consumer products, including cleaning products (see, Chapter 13 Annex II).

Emission factor
The emission factor NMVOC for cleaning products sold to consumers and for institutional cleaning (in kg emission per kton sold) is estimated from cleaning products use patterns (EPHECT, 2012; Meesters et al., 2018), EcoLabel limits for the presence of VOCs (EC, 2017; Boyano et al., 2018) and NMVOC measurements in chamber experiments performed by Singer et al. (2006). As such an emission factor of 50 t/kton has been established (see, Chapter 13 Annex III)

Ammonia emission
Ammonia is also considered to be a cleaning product. It is assumed that each household use 1 liter of ammonia per year, so that the estimated emission is 1kton for the year 1990 (RIVM, 1994). The years after 1990 are corrected based on the number of households according to the CBS housing growth index.

12.3 Uncertainty

Substance	Activity data	Emission factors	Emission
NMVOC	B	C	C

12.4 Spatial allocation

Spatial allocation of emissions is based on population density.

12.5 References

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12.7 Annex I: consumer cleaning product activity data

Annex table 1 Calculation of activity data for consumer cleaning products

	Consumer cleaning product market turnover in million euro[A]	Consumer cleaning product market volume in kton	Average price in euro per kg	CBS Consumer Price Index (2006 =100)
2004	180	80[A]	2.25[B]	112
2005	140	71[A]	1.97[B]	105
2006	140	77[A]	1.82[B]	100
2007	200	99[A]	2.02[B]	97
2008	200	93[A]	2.15[B]	95
2009	230	103[A]	2.23[B]	99
2010	210	98[C]	2.15[D]	95
2011	210	102[C]	2.07[D]	92
2012	215	102[C]	2.11[D]	94
2013	216	101[C]	2.13[D]	95
2014	215	105[C]	2.05[D]	91
2015	214	110[C]	1.94[D]	86
2016	214	112[C]	1.90[D]	84
2017	216	114[C]	1.90[D]	84
2018	218	115[C]	1.89[D]	84
2019	222	118[C]	1.89[D]	84
2020	257	138[C]	1.87[D]	83
2021	247	134[C]	1.85[D]	82
2022	267	135[C]	1.98[D]	88
2023	277	125[C]	2.21[D]	108,5

A: Data directly collected from NVZ annual reports
B: Estimated as 'Consumer cleaning product market turnover' / 'Consumer cleaning product market volume'
C: Estimated as 'Consumer cleaning product market turnover' / 'Average price'
D: estimated as 'average price' of previous year × CBS consumer price index emission year / CBS consumer price index previous year

12.8 Annex II: institutional cleaning product activity data

Annex table 2 Market turnover (million euro)

Year	Institutional Cleaning	Industrial Cleaning	Disinfectants	Total professional market
2003	93 B	79 C	24 D	196 A
2004	93 B	79 C	24 D	196 A
2005	93 B	79 C	24 D	196 A
2006	95 B	81 C	25 D	201 A
2007	98 B	83 C	25 D	207 A
2008	104 B	88 C	27 D	219 A
2009	109 B	93 C	28 D	230 A
2010	110 B	93 C	29 D	232 A
2011	102 B	87 C	26 D	215 A
2012	101 B	86 C	26 D	213 A
2013	113 A	79 C	27 D	219 A
2014	108 A	86 C	26 A	220 A
2015	108 A	91 A	27 A	224 A
2016	112 A	98 A	29 A	236 A
2017	115 A	99 A	31 A	245 E
2018	121 A	101 A	30 A	252 E
2019	127 A	105 A	32 A	264 E
2020	228 A	163 A	71 A	462 E
2021	146 A	110 A	39 A	295 E
2022	170 A	130 A	48 A	348 E
2023	134 A	197 A	70 A	401 E

A: Data directly collected from NVZ annual reports
B: Estimated as Market turnover ‘total professional market ×47.4 %, with market turnover ‘institutional cleaning’ / ‘total professional market’ = 47.4% in 2016
C: Estimated as market turnover ‘total professional market’ – ‘institutional cleaning’ – disinfectants
D: Estimated as market turnover ‘total professional market ×12.3 %, with market turnover ‘disinfectants’ / ‘total professional market’ = 12.3% in 2016
E: Estimated as market turnover ‘institutional cleaning’ + ‘industrial cleaning’ + ‘disinfectants’

Annex table 3 Calculation of activity data for institutional cleaning products

Year	CBS Consumer Price Index (2006 =100)	Estimated total volume professional market (kt)	Estimated volume institutional cleaning products (kt)[C]	Estimated volume disinfectants sold (kt)[D]
2003	112		47	12
2004	112	98 [A]	47[A]	12
2005	105	99 [A]	47[A]	13
2006	100	104 [A]	49[A]	13
2007	97	104 [A]	49[A]	12
2008	95	100 [A]	47[A]	12
2009	99	98[A]	47	13
2010	95	103[B]	49	12
2011	92	99 [B]	47	12
2012	94	96 [B]	46	12
2013	95	98 [B]	50	12
2014	91	102 [B]	50	13
2015	86	110 [B]	53	14
2016	84	118 [B]	56	16
2017	84	123 [B]	58	15
2018	84	127 [B]	61	16
2019	84	133 [B]	64	36
2020	83	236 [B]	116	20
2021	82	151 [B]	75	23
2022	88	167 [B]	82	27
2023	108,5	156 [B]	52	12

A: Data directly collect from NVZ annual reports
B:Estimated as 'turnover total professional market' ×(CBS price index 2009 / CBS price index of emission year)
C: Estimated as 'market turnover institutional cleaning' / 'turnover total professional market'' × 'total volume professional market'
data collected from NVZ annual report
D: Estimated as 'market turnover disinfectants' / 'turnover total professional market'' × 'total volume professional market'×

12.9 Annex III: NMVOC emission factor surface cleaners

NVZ presents market turnovers and volumes for cleaning products. For these products the EU prescribes EcoLabel limits for the presence of VOCs (EC, 2017; Boyano et al., 2018). The Cleaning Products Fact Sheet (Meesters et al., 2018) describes use patterns for consumer cleaning products, such as the frequency and amount of product used per cleaning task (EPHECT, 2012). These use patterns are used here to derive the relative contributions of specific types of cleaning products, such as kitchen, bathroom, floor and all-purpose cleaners. The NMVOC emissions per kg product are estimated from the VOC limit for EU Ecolabels (EC, 2017; Boyano et al., 2018) and the VOC measurements in chamber experiments of Singer et al. (2006). The EU Ecolabel VOC limits for liquid products that are to be diluted are expressed in g / l solvent and the product is diluted in a ratio of 1:10 (Boyano et al., 2018), whereas the densities of ready-to-use products and sprays are considered to be 1 kg/L (Table 1).

Annex table 4 Calculation of NMVOC emission factor for consumer cleaning products

Surface cleaner product	Product type	EU Ecolabel VOC limit (g VOC / kg pure product)	Fraction of VOC volatilized (Singer et al. 2006)	Average amount of product g used per EU household per year (Visschedijk et al., 2022)	Calculated NMVOC released per product (g per year per household)
All Purpose Cleaner Cream	Ready-to-use	30	0.7	54	1.1
All Purpose Cleaner Liquid	To be diluted	300	0.11	3706	122.3
All Purpose Cleaner Spray	Spray	30	1	143	4.3
Bathroom Cleaner Gel	Ready-to-use	60	0.7	35	1.5
Bathroom Cleaner Liquid	To be diluted	600	0.11	2256	148.9
Bathroom Cleaner Spray	Spray	60	1	153	9.2
Floor Cleaner Liquid	To be diluted	300	0.11	3522	116.2
Floor Cleaner Spray	Spray	30	1	20	0.6
Glass Cleaner Liquid	To be diluted	1000	0.11	730	80.3
Glass Cleaner Spray	Spray	100	1	120	12.0
Kitchen Cleaner Cream	Ready-to-use	60	0.7	89	3.7
Kitchen Cleaner Liquid	To be diluted	600	0.11	2721	179.6
Kitchen Cleaner Spray	Spray	60	1	226	13.5
Total				13776	693

The result is a weighted average NMVOC emission factor of 50 g per kg surface cleaner product which equals 50 t/kton and 693 g NMVOC released per 13.8 kg used product.

13 Construction sites (NFR 2A5a)

This section describes the emissions of particulate matter from construction sites.

Process description	Emission source code	NFR code	Sector
Building and construction sites	0802302	2A5a	Trades and services

13.1 Description of the emission source

Particulate matter < 10 µm (PM_{10}) and < 2.5 µm ($PM_{2.5}$) is released as fine dust as a consequence of different work activities at construction sites such as milling, drilling, grinding, chopping, sawing, and blistering rocks, bricks or concrete, as well as dust suspension from ground movement and heavy transport of debris and construction works.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 0.5% in 1990 and 2.3% in 2020 (ER dataset 1990-2022).

13.2 Calculation

Emissions are calculated as follows:

Emission = Activity data × Emission Factor

The activity data of the construction refer to companies involved in ground, road and water (GRW), civil and utility building (C&U), demolition, finishing and other types of construction activity companies.

Ground, road and water construction sites
Particulate matter is released from GRW construction sites due to transport vehicles supply and removing construction materials, resuspension of materials from dusty locations and specific work related activities such as digging, asphalting, breaking, grinding and chopping. The most of relevant GRW activities leading to release considered are transport and the activities performed by construction workers, i.e. ground movement, test drilling, constructing arts, cable and tube placement, road and rail placement, street paving and wet water constructions (Haskoning, 2000).
The emission of fine dust from transport vehicles is estimated as 0.45 kg per km driven over unpaved road. It is estimated that 435,000 km was driven over unpaved road for the purpose of GRW construction in the year 1996. As such, 196 tonnes of fine dust emission is indexed for the year 1996 for transport vehicles at GRW construction sites.
Resuspension of fine dust at dusty locations resuspending from materials and construction activities are estimated 3.9 kg per ha construction site. In the year 1996 about 3470 ha was designated as construction site, so that 14 tonnes of fine dust was released. The total emission index for GRW activity is set as 210 tonnes for the year 1996 (Haskoning, 2000).

Civil and utility building
Particulate matter is released from civil and utility building sites due to resuspended dust from transport related activities and construction work performed in half-open buildings. These activities are performed outside, so that dust concentrations measured in personal breathing zones of constructions workers are suitable for estimating fine dust release (Haskoning, 2000). A total fine dust emission of 568 tonnes for the year 1996 is estimated for designated civil and utility building activities, based on the frequency of tasks performed in hours per week and the measured fine dust amounts in the personal breathing zone samples. A total fine dust emission of 30 tonnes is estimated for the suspension of dust from transport vehicles delivering construction materials, driving over 66,000 km of unpaved road. As such, the total fine dust emission for the year 1996 is indexed as 598 tonnes for civil and utility building.

Demolition
Fine dust emissions emerging from worker activity tasks is estimated from measured background concentrations onsite multiplied with local ventilation and the duration and frequencies of the demolition activities. This yield a total emission ranging from 9-35 tonnes for the year 1995 which is rounded to 20 tonnes (Haskoning, 2000).

Finishing
Based on personal sample data of construction workers, performing indoor finishing tasks, it is estimated that 234 tonnes is release in a year.

Aggregated emission factor index for the total construction sector
The annual emissions estimated for GRW, civil and utility building, demolition and finishing has been aggregated into one emission factor of 10.62 tonne particulate matter < 10 µm (PM10) emission per index point and 3.54 tonne for particulate matter < 2.5 µm (PM2.5). It is assumed that 1/3 of the PM10 emission is PM2.5. Here the year 1997 is set as an index year for which 100 index points has been assigned to. The number of index points are calculated for the other years as the production revenues of the Dutch construction sector expressed in currency (fl or €), corrected for economic deflation and inflation for the given year of emission related to revenues in the year of 1997 (VROM 2001;2002; TNO, 2005-2009).

13.3 Uncertainty

Substance	Activity data	Emission factors	Emission
PM10, PM2.5	C	D	D

13.4 Spatial allocation

Spatial allocation is based on population density.

13.5 References

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VROM, 2002. Bouwprognoses 2003-2008.

13.6 Versions, dates and sources

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14 Cosmetics for personal care (NFR 2D3a and 2D3i)

This section describes the emissions of NMVOC resulting from cosmetics and personal care products.

Process description	Emission source code	NFR code	Sector
Cosmetics for personal care	0801100	2D3a	Consumers
Cosmetics for personal care	0801101	2D3i	Trade and services

14.1 Description of the emission source

Cosmetics products for personal care contain NMVOC which are emitted to the air during and after use. This includes products used by consumers and hairdressing salons, barbershops, and beauty parlours. The cosmetics for personal consist of a wide range of products: hairsprays, deodorants, eau de toilette/perfumes, nail polish/remover, aftershave and miscellaneous. In 2012, the emissions were ascribed to consumers for 96%, and to trades and services for 4%. This distribution shifted from 90% to 10% in 2004, to 96% and 4% in 2012. This is based on a communication from the NCV (Dutch Cosmetics Association; 2004 2012).
In 2004, hairspray was with ~65% the main NMVOC contributor of the cosmetics group, followed by deodorants ~29%. However, in 2012, the two main contributors exchanged positions. Now deodorants contribute to ~54% (6.41 kton) and hairstyling products to ~35% (4.14 kton). According to the NCV, there have been no major changes of NMVOC concentration in products since 1996. Only within the group deodorant there has been an increase of the use of NMVOC-rich deodorant sprays. The increase of NMVOC emission is ascribed to the increased use of hairspray (flexible hairspray) and deodorant spray (roller sticks replaced by aerosol cans). Ultimately this has led to an increase in NMVOC emissions from cosmetics.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 1.2% in 1990 and 4.8% in 2020 (ER dataset 1990-2022).

14.2 Calculation

The calculation of NMVOC emission cosmetics and personal care products is based on market shares surveillance of these products, annually published by the NCV. In the past the NCV themselves estimated the emission of NMVOC for the years 1997, 2002 and 2003 (NCV 1998, 2003 and 2004). Since 2004 the market shares corrected with the annual Dutch central price index were used to estimate the emission.
In 2013 the NVC, on request of the ER, again estimated NMVOC emissions from cosmetics and personal care products for both

consumers and trades and services (NVC 2013). Based on this latest NVC estimation it is concluded that the annual published NVC report contains sufficient information to estimate the NMVOC emission for deodorants, hair sprays, scents, decorative products, shaving products and miscellaneous products. The emissions estimated for these product classes are used as indexes for the coming years. The 2012 index is derived by dividing the product emissions of 2012 with the product market volumes (€) in 2012. Emissions in the next years are then calculated by multiplying the product market volumes with the 2012 indexes. The ER estimated a sum of 11.76 kton for consumers while NVC estimated 11.7 kton. The NMVOC total is in its turn split up into the individual substances, using an average profile, established by TNO and the Dutch Cosmetics Association in 1992.

14.3 Uncertainty

The uncertainties of the emission calculation have not been quantified.

Quality codes

Substance	Activity data	Emission factors	Emission
NMVOC	B	C	C

14.4 Spatial allocation

The emissions of consumers and trade and services are allocated in the Netherlands based on population density. Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

14.5 References

Annual reports NCV, www.NCV-cosmetica.nl

CBS statline: www.statline.cbs.nl

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14.6 Version, dates and sources

Version: 2.0
Date: January 2019
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15 Crematoria (NFR 5C1bv)

This section describes the emissions of dioxin, mercury and PM_{10} resulting from cremation of human remains.

Process description	Emission source code	NFR code	Sector
Crematoria	8922001	5C1bv	Trade and services

15.1 Description of the emission source

In the Netherlands there are 71 crematoria for human remains (LEV 2012). In 2011, 59% of the deceased were cremated.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was <0.01% in 1990 and 0.01% in 2020 (ER dataset 1990-2022).

15.2 Calculation

Activity data
The activity data refers to the number of deceased human bodies that are cremated in The Netherlands per year. The total number of cremations in the Netherlands is provided by the LVC (National Association Crematoria); data can be downloaded from the LVC home page (https://lvc-online.nl/). However, the Dutch crematoria implemented measures to reduce the emission of pollutants (mercury in specific) in the period of 2006-2012 (LVC, 2005) according to the Dutch emission reduction guideline (NeR). As such, the activity data for the years 2006-2012 includes both number of cremations with and without NeR measures. From 1990 – 2005 all cremations are considered to be without NeR meaures, whereas in the year 2012 and after all cremations are considered to be with NeR measures implemented.

Emission factors
The substances emitted by crematoria are considered to be gaseous, vaporous, particulate or particle bound. Emission factors have been derived for crematoria with and without NeR measures.

Substance	GSF code	State	Emission factor before introduction NeR[1] (kg per cremation)	Emission factor with NeR[2,3] (kg per cremation)
NOx	4013	Gaseous	0.825	0.825
CO	4031	Gaseous	0.14	0.14
NMVOC	1631	Gaseous	0.013	0.013
SO_2	4001	Gaseous	0.113	0.113
PCB	3066	Particle bound	$4.1\ 10^{-7}$	$1.18\ 10^{-7}$
PCDD/F	3054	Particle bound	$2.7\ 10^{-11}$	$7.8\ 10^{-12}$
B(a)P	2912	Particle bound	$1.32\ 10^{-8}$	$3.80\ 10^{-9}$
B(b)FA	2913	Particle bound	$7.21\ 10^{-9}$	$2.08\ 10^{-9}$
B(b)FK	2914	Particle bound	$6.44\ 10^{-9}$	$1.86\ 10^{-9}$
I-pyrene	2917	Particle bound	$6.99\ 10^{-9}$	$2.01\ 10^{-9}$
HCB	2616	Particle bound	$1.5\ 10^{-7}$	$4.32\ 10^{-8}$
Pb	5172	Particle bound	$3.0\ 10^{-5}$	$8.65\ 10^{-6}$
Cd	5057	Particle bound	$5.03\ 10^{-6}$	$1.45\ 10^{-6}$
As	5018	Particle bound	$1.36\ 10^{-5}$	$3.92\ 10^{-6}$
Cr	5082	Particle bound	$1.36\ 10^{-5}$	$3.91\ 10^{-6}$
Cu	5142	Particle bound	$1.24\ 10^{-5}$	$3.58\ 10^{-6}$
Ni	5242	Particle bound	$1.73\ 10^{-5}$	$4.99\ 10^{-6}$
Se	5266	Particle bound	$1.98\ 10^{-5}$	$5.70\ 10^{-6}$
Zn	5342	Particle bound	$1.6\ 10^{-4}$	$4.61\ 10^{-5}$
PM_{10}	992	Particulate	0.0347	0.01
$PM_{2.5}$	998	Particulate	0.0347	0.01
Hg	5156	Vaporous	$1.49\ 10^{-3}$	$2.0\ 10^{-5}$

1: EEA guidebook 2019
2: Particulates and particle bound substances are estimated to be 71% less after implementation of NeR (see below)
3: Hg is estimated to be 98 – 99.5 % less after implementation of NeR (see below)

In earlier WESP methodology reports, the emission of PM10 of crematoria with NeR filters implemented was estimated to be 10 g per cremation, based on measurements performed at crematoria in Geleen and Bilthoven (Visschedijk, 2022), whereas according to the EEA Guidebook (2019) the emission of PM without NeR is 34.7 g per cremation. As such, the effectivity of NeR to reduce the emission of particulates and particle bound substance is estimated to be 71% (10 g - 34.7 g)/ 34.7 g), i.e. a multiplication factor of 0.289 (10 g/34.7 g). In the table above the emission factors of the particle bound substances and particulates are as such calculated as the emission factor before NeR multiplied with a factor of 0.289. NeR measures are also specifically aimed to reduce the emission of mercury (Hg) released from the cremations of human bodies with elevated mercury levels as a consequence of dental amalgam treatments in the past (EC, 2012). The effectivity of reducing Hg by the active charcoal is estimated to be 98 – 99.5% (EC Annex L, 2012). In the year 2008 the cremations of 49850 bodies in 38 Dutch crematoria yielded a total emission of 1 kg Hg, whereas in 2010 the cremations of 57439 bodies in 48 Dutch crematoria yielded a total emission of 1.2 kg Hg (EC Annex L, 2012; OSPAR, 2011). As such, the emission factor for Hg after implementation of NeR measure is set to 2.0 10^{-5} kg per cremation, which refers to the average Hg emission per cremation in 2008 and 2010.

15.3 Uncertainty

Substance	Activity data	Emission factors	Emission
Dioxins	A	B	B
Fly as	A	B	B
Mercury	A	B	B

15.4 Spatial allocation

The emissions of the crematoria are assigned to the locations of the crematoria (SBI 96.032) in the Netherlands according to the ratio of employees.

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

15.5 References

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15.6 Version, dates and sources

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16 Degassing of groundwater (CRT 2.G.4)

This section describes emissions from the degassing of groundwater.

Process description	Emission source code	CRT code	Sector
Degassing groundwater	0850000	2.G.4	Drinkwater companies

16.1 Description of the emission source

A part of the Dutch drink water is produced from ground water. Gasses dissolved in ground water are released during processing, including methane. Shallow groundwater extraction for use in agriculture or on construction sites is not included in this document, as this water contains no methane.

Contribution to the national emission
The contribution of this source to the total national CH4 emission was 0.2% in 1990 and 5.0% in 2020 (ER dataset 1990-2022).

16.2 Calculation

For the complete time series, the emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Amount of groundwater produced
Emission factor = Emission per m^3 groundwater

This is a tier 1 methodology. The methodology is not provided within the IPCC 2006 Guidelines.

a) Activity data
The amount of groundwater extracted for drink water purposes is used as activity data. The data are annually retrieved from VeWin, the Dutch society for (drink) water producing companies. Only the amount of groundwater is taken into account. In the year 2009, this resulted in 676 million m^3.

b) Emission factor
The emission factor for degassing groundwater was calculated for the year 1990 by dividing the estimated methane emissions (2000 tons) by the amount of extracted groundwater (810 million m^3), as reported by van den Born (1990).

Substance	EF	Unit
CH_4	2469	kg/ million m^3 groundwater

16.3 Uncertainty

The activity data for the degassing of drink water from ground water are derived from the statistics of VeWin (Dutch association for water win companies). It is estimated that the uncertainty is 10% at most, based on expert judgement.
The uncertainty of the emission factor for methane (50%) is derived from '*Olivier, 2009*'.

Quality codes

Substance	Activity data	Emission factor	Emission
CH_4	A	D	C

Quality checks

No sector specific quality checks were performed. For the general QA/QC, see chapter 2.

16.4 Spatial allocation

Consumer emissions are spatially allocated in the Netherlands based on population density. Although this might not be completely accurate, it may be the best assumption.

Emission source/process	Allocation-parameter
Degassing of groundwater	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

16.5 References

Born, G.J. van den, A.F. Bouwman, J.G.J. Olivier, R.J. Swart, 1991, The emission of greenhouse gases in the Netherlands, RIVM-rapport 222901003.

VeWin, vereniging voor waterwinbedrijven. http://www.vewin.nl/

16.6 Version, dates and sources

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17 Fireworks (CRT 2.G.4 and NFR 2G)

This section describes the emissions from fireworks. This refers specifically to consumer fireworks set off on New Year's Eve, since only professional fireworks are permitted on other occasions. Other amounts are considered to be negligible.

Process description	Emission source code	CRT code	NFR code	Sector
Fireworks	0801700	2.G.4	2G	Consumers

17.1 Description of the emission source

On New Year's Eve, inhabitants of the Netherlands are allowed to set off fireworks. These include both 'firecrackers' and 'ornamental' types of firework, with an estimated 15% / 85% ratio. When setting off fireworks, various gasses and metal substances are emitted, depending on the type of firework.
During the coronavirus pandemic in 2020/2021 and 2021/2022 the sale and burning of fireworks was banned in the Netherlands. As a result of this ban, the number of firework injuries and the amount of damage caused during New Years eve festivities decreased dramatically.
Due to the positive effects of this ban, a growing number of local authorities have imposed yearly firework-free zones since 2022/2023. In many cases these local bans are compensated with professional firework shows.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 0.4% in 1990 and 2.7% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national N2) emission was 0.01% in 1990 and 0.06% in 2020 (ER dataset 1990-2020). The contribution of CO_2 and CH_4 emissions was <0.01%.

17.2 Calculation

The emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Amount of fireworks lighted in kg
Emission factor = Average emission per kg fireworks

a) Activity data
In order to calculate the amount of fireworks, the difference between import and export each year is taken into account. These statistics are derived from the national statistics agency (CBS). Fireworks that are set off on New Year's eve are included in the inventory of the new year (for example, emissions from fireworks set off during the New Year's eve of 1999/2000 are included in the inventory of 2000. As the difference between imported and exported fireworks does not need to be set off in the same year, we have calculated a moving average of the fireworks amount for three years according to the following rule:

Year3 = (Year1 + 2 * Year2 + Year3) / 4

There is a bias in the statistics, since smaller companies are not included and the import of illegal fireworks is not accounted for. To compensate for this bias, the amount calculated from the statistics is multiplied by a factor 1.5. This is based on expert judgement (estimated total fireworks divided by the CBS reported amount).

Activity data during the corona pandemic
During the Coronavirus pandemic many countries around the world restricted large gatherings in order to reduce the spread of the virus. As a result the sales and setting off of fireworks was banned in the Netherlands in 2020/2021 and 2021/2022. These restrictions had a disruptive effect on the trading of fireworks, even resulting in negative import numbers. Moreover, in practice, a certain amount of fireworks was set off in spite of the ban.

In order to determine the amount of fire-works burned in these years, a specific method has been derived, based on the amount of fireworks set-off in 2018/2019 and the number of injured people due to fire-works in 2018/2019. The number of injured people due to fireworks are published by VeiligheidNL (2023). The number of injured people in 2018/2019 has been set at 100%, the relative decrease/increase of injured people in 2020/2021, 2021/2022 and 2022/2023 has been used to calculate the amount of 'legal' fireworks burned. This 'legal' amount has been multiplied by 1.5 to take in to account illegal fireworks.

This method shows a credible decrease of the amount of fireworks burned during the Coronavirus pandemic restrictions. Furthermore the amount of fireworks burned after the coronavirus restrictions is back at pre-corona levels.

b) Emission factors
The emission factors for CO_2, CH_4, N_2O and H_2S are derived from Brouwer et al. (1995). The emission factors for other gaseous substances, PM and BC / EC caused by fireworks are derived from the EMEP/EEA Guidebook (2019) and Cheng et al. (2022), respectively.

Substance	**EF**	**Unit**	
CO_2	43250	kg/ million kg fireworks	Brouwer et al, 1995
CO	7150	kg/ million kg fireworks	EMEP/EEA, 2019
CH_4	825	kg/ million kg fireworks	Brouwer et al, 1995
H_2S	1195	kg/ million kg fireworks	Brouwer et al, 1995
SO_2	3020	kg/ million kg fireworks	EMEP/EEA, 2019
N_2O	1935	kg/ million kg fireworks	Brouwer et al, 1995
PM_{10}	109830	kg/ million kg fireworks	EMEP/EEA, 2019
$PM_{2.5}$	51940	kg/ million kg fireworks	EMEP/EEA, 2019
BC / EC	0.05	- (Fraction of $PM_{2.5}$)	Cheng et al., 2022
NO_x	260	kg/ million kg fireworks	EMEP/EEA, 2019

For the emissions of heavy metals, studies by Brouwer et al. (1995), Croteau et al. (2010), OVK (2014) and VPI (2021) were combined to derive an average metal content. To calculate a metal content per kg fireworks, it is assumed that fireworks consist of 30% pyrotechnic ingredients (average of data by Brouwer et al. (1995), Croteau et al. (2010), OVK (2014) and VPI (2021)).

The following table shows the metal emission content in the pyrotechnical mixture used in 'ornamental fireworks' from the several studies and the emission factor that is currently used for emissions from 'ornamental fireworks' in the Netherlands. The values in this table are based on the metal content of the fireworks (in g/kg fireworks) and form an emission factor for pollutants to all compartments (atmosphere, surface water, sewer and soil).

Pollutant	Brouwer 1995	Croteau 2010 (avg)	OVK 2014 (avg)	VPI 2021 (agv)	Avera-ge
Aluminium	-	28	48	50	42
Magnesium	-	20	29	42	30
Strontium	19	21	8.5	10	15
Barium	79	8.9	35	25	37
Copper	22	15	3.9	47	22
Antimony	3.0	1.7	0.05	-	1.6
Zinc	-	0.8	1.3	-	1.1

The data referenced above also suggests a significant lead content in fireworks (not shown). VPI indicates however that lead is banned from fireworks in Germany. Recent Dutch measurements of concentrations in ambient air show only slightly elevated lead concentrations on January 1st 0:00h – 03:00h. Lead has therefore not been included.

There is a difference between firecrackers and ornamental fireworks. the uncoloured 'fire crackers' do not contain these heavy metals and have a different emission profile. Therefore, the emission factors are weighted for the contribution of the different types of fireworks, with a ratio of 15% firecrackers and 85% ornamental fireworks.

According to Brouwer (1995), only 10% of the heavy metals is emitted to air. This is more or less in-line with Croteau et al. (2010).

For the part of metal emissions that are not emitted to air, 20% is assumed to be emitted to the sewer system and 60% is emitted to the soil, which is explained below. 10% of the metals are assumed to remain in the waste from used fireworks.

The amount of metals that enter the sewer system is estimated based on the amount of paved area and the amount of precipitation entering the sewer system. In 2012, the amount of paved and sewer area was $4.29 * 10^9$ m^2. This includes both built-up areas and traffic areas in the Netherlands. As fireworks are mainly used in built-up areas and on the streets in cities on New Year's eve, it is assumed that the emissions from fireworks are released in the built-up areas and the traffic areas. With an average amount of precipitation of 850 mm per year, this would result in $3.65 * 10^9$ m^3 precipitation falling on the paved area. In 2015, the sewer system received an influent of $0.58 * 10^9$ m^3 of precipitation (estimation by Liefting et al, 2017). This implies that only a fraction

(0.58 / 3.65 = 16%) of the precipitation on paved area enters the sewer system. In the study by Liefting (2017), approximately 20% of the influent to waste water treatment plants is not accounted for by waste water from companies and households and by precipitation. This fraction could enter the sewer system via other routes, but it is also possible that the estimation of the amount of precipitation in the sewer system is too low. If we assume that 10% of the water that is not accounted for is also precipitation, then $0.58 * 10^9 + 0.20 * 10^9 = 0.78 * 10^9$ m^3 precipitation enters the sewer system. This would result in a fraction of 0.78 / 3.65 = 21% of the precipitation on paved areas that enters the sewer system. On average, we assume that 20% of the precipitation on paved areas enters the sewer system. Most of the fireworks are used in built-up areas and on traffic areas in cities, which means that the main part of the emissions also falls on the paved areas. We assume that the fraction of fireworks that enter the sewer system is equal to the amount of precipitation that enters the sewer system. Thus, 20% of the emissions on the ground is assumed to enter the sewer system. As mentioned earlier, 10% is emitted to air and 10% is assumed to remain in the fireworks waste. The remaining 60% is assumed to be emitted to soil.

This results in the following metal emission factors to the several compartments (g/kg fireworks):

Substance	Atmosphere	Sewer system	Soil
Aluminium	1.1	2.2	6.5
Magnesium	0.77	1.5	4.6
Strontium	0.37	0.75	2.2
Barium	0.94	1.9	5.7
Copper	0.56	1.1	3.3
Antimony	0.041	0.082	0.25
Zinc	0.028	0.056	0.17

17.3 Uncertainty

In the Netherlands, the emissions of fireworks and candles are reported on an aggregated level under CRT 2G. For this aggregated level, Olivier (2009) reported uncertainties for CO_2 (20%), CH_4 (50%) and N_2O (50%). The uncertainty in activity data for fireworks is estimated to be 50% (Olivier, 2009).

The uncertainty of the emissions of other substances have not been studied. Instead, the reliability of the data is qualitatively indicated in the table below with codes A-E (see Appendix A). The codes are based on expert judgement.

Quality codes

Substance	Activity data	Emission factor	Emission
CO_2	D	D	D
CO	D	D	D
CH_4	D	D	D
H_2S	D	D	D
SO_2	D	D	D
N_2O	D	D	D
Strontium	D	C	D
Barium	D	C	D
Copper	D	C	D
Antimony	D	C	D
Zinc	D	C	D
PM_{10}	D	D	D
$PM_{2.5}$	D	D	D
NOx	D	D	D

Quality checks

The $PM_{2.5}$ emission factor was verified based on comparing ambient $PM_{2.5}$ levels observed on new year's eve between 24:00h and 1:00h with $PM_{2.5}$ levels modelled with the Lotos-Euros CTM model (Manders et al. 2014). The model results were in rough agreement with the used emission factor. For the general QA/QC, see chapter 2.

17.4 Spatial allocation

The emissions of consumers are spatially allocated in the Netherlands based on population density.

Emission source/process	Allocation-parameter
Fireworks	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

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17.6 Version, dates and sources

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18 Human ammonia emissions from transpiration and breathing (NFR 6A)

This section describes the emissions of NH_3 from human transpiration and breathing.

Process description	Emission source code	NFR code	Sector
Human transpiration and breathing	0801600	6A	Consumers

18.1 Description of the emission source

This emission source describes ammonia emissions produced by humans when sweating and breathing. Through the consumption of food, nitrogen (N) is introduced in our system, and then disposed. Most nitrogen is released into the sewer system; the ammonia released through sweating and breathing is calculated within this emission source.

Contribution to the national emission
The contribution of this source to the total national NH3 emission was 0.4% in 1990 and 1.4% in 2020 (ER dataset 1990-2022).

18.2 Calculation

For the complete time series, the emissions are calculated as follows.
Emission = Activity data x Emission factor

Activity data = the number of Dutch inhabitants
Emission factor = kg emission per inhabitant

a) Activity data
The number of inhabitants in the Netherlands is derived from CBS Statline on an annual basis. The number of people living in the Netherlands at the end of June in a specific year is taken as activity data for that year.

b) Emission factor
With the food humans consume, nitrogen (N) is consumed. It is estimated that a human excretes 5 kg N (NH_3) per year in different ways (urine, sweat, faeces etc.) (*Battye et al 1994*). Most N or NH_3 is released with the urine and faeces, and it is assumed this goes through the sewer system.
The first emission factor used by the Dutch emission inventory was based on *van der Hoek (1994)* who reported a total emission factor of 0.7 kg NH_3 per inhabitant per year, combining 0.3 kg NH3 from sweating and breathing, use of ammonia as cleaning product (1 litre of ammonia solution per household) and the ammonia emissions of cats and dogs.
In another report by *Bouwman et al (1997)* an emission factor of the same magnitude is reported for human emission of NH_3. In this study

the emissions calculated are used for a global emission inventory. The author mentions that it is difficult to come to a good estimation of the emission factor, but describes that this source should not be neglected. Therefore, he assumes 0.5 kg NH_3 per person per year, independent of sanitary arrangements and includes domestic pets (cats/dogs). Since the Dutch standard includes a good sewer system and the Netherlands reports the emissions of domestic pets separately, this emission factor is considered to too high for the Netherlands.

Joshua Fu et al (2010) report that, perspiration, respiration, untreated waste, cigarettes, household ammonia use, diapers and homeless people are sources of ammonia emissions directly caused by humans. They report an emission factor of 0.44 kg NH3 per person per year for all these emission sources. No separate emission factors are presented, though the distribution of the emission of the different sources is reported. Both perspiration and respiration are reported to contribute about 40% each. The emissions of untreated waste, household ammonia use, and homeless people contribute about 4-6% each. Cigarettes, (untreated) waste, and household ammonia are sources that are included as separate sources in the Dutch emission inventory. Other studies also report that the emissions from breathing are less than those from sweating. Therefore, the emissions in this document could be too high for the Netherlands.

Battye et al (1994) consider different references, varying from 0.25-1.3 kg NH_3/human/year from breathing and sweating. Although they mention that further research is needed, they recommend using the emission factor of 0.25 kg NH_3 p.p.p.y.; this emission factor was retrieved from a NAPAP report. The most interesting aspect is the reference to a measurement of NH_3 in a home. They report that an emission factor of 1 kg NH_3 should result in a concentration of about 431 µg/m^3, while the concentrations measured are between 32 and 39 µg/m^3. It could therefore be concluded, although this is not done in their study, that the emission factor is around 0.1 kg NH_3 per person per year.

One of the most comprehensive studies on the emissions of ammonia from non-agricultural sources was conducted by *Sutton et al (2000).* In this report, the emissions of sweating are calculated with a range of emission factors from 2.08 g NH_3 till 74.88 g NH_3 (as g N per person and year). For breathing the range is 1.0-7.7 g NH3 (as N per person per year). *They* reference a number of reports and explain their assumptions. One of the most important assumptions made is the amount of NH_3 that volatilizes from sweat (10-30%). If no volatilisation is assumed, the high-end emission factor is about 0.25 kg NH_3 per person per year. This is equal to that reported by *Battye et al (1994)* and a reference used by *Sutton et al (2000).*
Furthermore, studies by *Chang (2014), Zheng et al (2012)* and *Klimont&Brink (2004)* use the emission factors presented by *Sutton et al (2000).*

Some countries other than the Netherlands also report the emissions of human sweating and breathing, for example Switzerland, Canada and the UK (in the past). The three countries used the ‘best’ emission factors provided by *Sutton et al (2000) of 0.017 kg NH_3 p.p.p.y.* This is less

than the ammonia emission factor noted in the *guidebook 2013* of 0.05 kg NH_3 per person per year.
Only one study (*Sutton et al 2000*) reports an emission factor for the ammonia emissions from diapers. Depending on the age and some assumptions, the emission factor ranges from 2.4-68 g NH_3 per infant per year. A first estimate for children (age 0-3 year) in the Netherlands gives an emission of 2 to 50 tonnes NH_3 a year. Since this is only one reference and it forms a relatively low contribution to the national total, the decision was made not to include this emission (separately) in the Dutch emission inventory.

Emission factor used in the Netherlands emissions inventory
The high-end emission factors by *Sutton et al (2000)* are used in our calculations, resulting in a total emission factor of 0.0826 kg NH_3-N per person per year (sum of 74.88 and 7.7 gram p.p.p.y. for sweating and respiration respectively). For the Dutch national emission inventory, this was recalculated to 0.1004 kg NH3 per person per year. Because the emission factors in other reports are higher, it was decided to choose the *Sutton et al (2000)* high-end emission factors, instead of the 'best' emission factors. This reduces the risk of underestimating the human ammonia emissions and emission sources not calculated (homeless people and diapers) can be neglected.

18.3 Uncertainty

The uncertainty in the number of inhabitants in the Netherlands is considered to be very small, therefore the uncertainty is qualified as A. The uncertainty in the emission factor is estimated to be relatively high as emission factors vary between different sources and the amount of ammonia volatilized is based on an assumption. Hence the uncertainty is qualified as D.

Quality codes

Substance	Activity data	Emission factor	Emission
NH_3	A	D	C

18.4 Spatial allocation

The ammonia emissions of humans are spatially allocated in the Netherlands based on the inhabitants.

Emission source/process	Allocation-parameter
Human ammonia emission; sweating and breathing	inhabitants

Details available via [www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling](www.emissieregistratie.nl/Documentatie/07).

18.5 References

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18.6 Version, dates and sources

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19 Maintenance products and office supplies (NFR 2D3a and 2D3i)

This section describes the emissions of NMVOC from office supplies and leather maintenance products.

Process description	Emission source code	NFR code	Sector
Maintenance products	0802800	2D3a	Consumers
Office supplies	0820600	2D3a	Consumers
Office supplies	0820601	2D3i	Trade and services

19.1 Description of the emission source

Maintenance products consist of polishing wax, furniture polish, furniture cleaners, shoe polish, etc. All emissions from leather maintenance products are ascribed to consumers. Office supplies consist of tip-ex, ballpoints, fibre-tip pens, text markers, etc. The emissions from office supplies are ascribed to consumers (50%) and trade and services (50%). All these products contain NMVOC which emits to the air on use.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.2% in 1990 and 0.2% in 2020 (ER dataset 1990-2022).

19.2 Calculation

The emission of NMVOC from maintenance products is calculated by multiplying activity data with an emission factor

Emission = Activity data × Emission factor.

The maintenance products addressed are leather maintenance products and other maintenance products such as floor and furniture wax.

Leather maintenance products
The emission of NMVOC in leather and furniture products is estimated to be 30 g per inhabitant (Arcadis, 2010). The annual NMVOC emission from leather and furniture products is calculated by multiplying the number of inhabitants of the Netherlands with 30 g per person.

Other maintenance products including polish and wax
The emission of NMVOC from other maintenance products is extracted from market turnover data of maintenance products presented in the annual reports of NVZ (2008; 2023). The activity data refers to the amount of maintenance products sold per year (see Chapter 19 Annex I). The emission factor is set to 420 g/ per kg product which refers to the amount of NMVOC released from polish and wax products (McDonald et al., 2018).

Office supplies
The market share of NMVOC containing products in office products was monitored by InfoMil on a regular basis in the KWS2000 project. They performed producer and supplier surveys in 1997. From this year onwards, the emissions from office supplies are assumed constant, with the exception of tip-ex. The use of tip-ex has declined over the years, but there was no data available to quantify this decline. Therefore, it is assumed that consumer use and use of tip-ex in trades and services linearly decline from 36 t/y in the year 2000 to (practically) zero in 2020 and later.The NMVOC total is divided into the individual substances, using an average profile established by TNO in 1992.

19.3 Quality codes

Substance	Activity data	Emission factors	Emission
NMVOC	D	N	D

19.4 Spatial allocation

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

The emissions NMVOC are allocated in the Netherlands based on:

Emission source/process	Allocation-parameter	Source data
Office supplies	Floor area commercial and industrial buildings	LISA
Office supplies	Population density	Bridgris (ACN)
Leather maintenance products	Population density	Bridgris (ACN)

19.5 References

Arcadis, 2010, NMVOC emissions through domestic solvent use and the use of paints in the Brussels Capital Region. Brussels Instituut voor Milieubeheer (BIM/IBGE), Version E 02-11-2010
KWS2000/InfoMil, 1999, Jaarverslagen 1996-2000, InfoMil, Den Haag.

19.6 Version, dates and sources

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19.7 Annex I Estimation of activity data for polish and wax products

Annex I Table 1. Estimation of activity data for polish and wax products

Year	Total market turnover (in million euro)[A]	Estimated price in euro per kg[B]	kton used for maintenance products in total[C]	kton used for air fresheners[D]	kton used for leather maintenance[E]	kton used for polish and wax
2004	60	22.50	2.7	0.34	1.40	0.9
2005	45	19.72	2.3	0.34	1.40	0.5
2006	57	18.18	3.1	0.35	1.41	1.4
2007	58	20.20	2.9	0.35	1.41	1.1
2008	65	21.51	3.0	0.35	1.41	1.3
2009	67	22.32	3.0	0.35	1.42	1.2
2010	74	21.48	3.4	0.36	1.43	1.7
2011	95	20.68	4.6	0.36	1.43	2.8
2012	97	21.12	4.6	0.36	1.44	2.8
2013	92	21.31	4.3	0.37	1.44	2.5
2014	90	20.52	4.4	0.37	1.45	2.6
2015	87	19.40	4.5	0.37	1.46	2.7
2016	87	19.05	4.6	0.37	1.46	2.7
2017	87	18.99	4.6	0.38	1.47	2.7
2018	88	18.88	4.7	0.38	1.48	2.8
2019	90	18.85	4.8	0.38	1.49	2.9
2020	97	18.67	5.2	0.39	1.50	3.3
2021	98	18.53	5.3	0.39	1.50	3.4
2022	110	19.83	5.5	0.39	1.50	3.6
2023	115	24,46	4.7	0.40	1.55	2.7

A: Collected from NVZ annual reports
B: Estimated as 10 × price in euro of 1kg consumer cleaning products (see, Chapter 13)
C: Estimated as ‘Total market turnover’ / ‘Estimated price in euro per kg’
D: Estimated as described in Chapter 6
E: Estimated as described in section 19.2
F: Estimated as ‘kton used for maintenance products in total’ – ‘kton used for air fresheners’ – ‘kton used for leather maintenance’

20 Meat preparation and charcoal use (CRT 1.A.4.b and NFR 1A4bi)

This section describes emissions of charcoal use from barbecues and meat preparation.

Process description	Emission source code	CRT code	NFR code	Sector
Meat preparation	0801800		1A4bi	Consumers
Charcoal use	0801801	1.A.4.b.i	1A4bi	Consumers

20.1 Description of the emission source

During the indoor preparation of meat on electric or gas-fired stoves NMVOC and PM are released (PM was included in 2020). A large part of this emission is ultimately released to the atmosphere. During outdoor charbroiling on a barbecue, various compounds are emitted, for example particulate matter, CO, CH_4 and NMVOC. For charbroiling PM and NMVOC emissions are mostly the result of volatilisation of fat/grease, while CO and CH_4 mostly originate from the charcoal combustion.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 0.3% in 1990 and 1.3% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national CO2 and CH4 emission was <0.01% in 1990 and <0.01% in 2020 (ER dataset 1990-2020).

20.2 Calculation

Emissions are calculated as follows:
Emission = Activity data x Emission factor

This is a tier 1 methodology. The methodology is consistent with the IPCC 2006 Guidelines.

a) Activity data
Since no actual data is available for the use of charcoal in Dutch households, all emissions are calculated based on the amount of meat used. From 1990 until 2012 data on the number of inhabitants and the amount of meat consumed annually per inhabitant, were gathered from the national statistics bureau (CBS). Combined, these result in a total amount of meat consumed in the Netherlands.
From 2012 onwards, the latest data on the annual meat consumption per inhabitant was copied. In 2017 a new series of activity data is drafted up by WUR for 2005 – 2018, based on more detailed import and export data and consumer spending patterns. For the overlapping period 2005-2012, the statistics by WUR are 8.5% lower than the statistics from Statistics Netherlands. The household meat consumption is updated annually by the WUR. In order to have a good match/transition between the newly produced activity data (2005-2019 by the WUR) and

the previous activity data (1990-2004 by CBS) the CBS data have been decreased by 8.5%.

In 2023, a correction on the amount of meat consumed annually, per inhabitant, has been implemented for the entire range of data.
After closer examination of the data provided in the so-called Vleesnota by Wageningen University (WUR) and internal discussion on this subject, a 50% reduction of the annually consumed amount of meat was implemented. The main reason being the fact that within the Vleesnota the so-called Carcass weight (meat inclusive of bones) is used as an indicator of the annual amount of meat consumed (gross weight). This number was used in the calculations previously, but it seems better to use a number corrected for this bone weight (net weight). As a rule of thumb about half of this weight consists of bone. As a result, it was decided upon to halve the given carcass weight and use these corrected net weight numbers to calculate the emissions.

The trend in charcoal consumption is linked to the trend in meat consumption. The ratio between meat consumption and charcoal use was calculated based on an estimated charcoal consumption in the period 2001-2004 of 270 TJ per year and the reported meat consumption for these years.

b) Emission factor
The emission factors for NMVOC, PM_{10}, SO_2, NO_X and CO are derived from Brouwer et al. (1994), except the PM emission factors for indoor cooking. For indoor meat cooking PM emission factors are based on a literature survey by Visschedijk (2021). The emission factor for CO_2 (memo item), CH_4 and N_2O are derived from the 2006 IPCC guidelines; default emission factors are used.

Substance	EF	Unit
Meat preparation		
NMVOC	0.58	g/kg meat
PM_{10}	0.21[1)]	g/kg meat
$PM_{2.5}$	0.16[1)]	g/kg meat

Substance	EF	Unit
Barbecuing		
NMVOC	250	kg/TJ charcoal
SO_2	10	kg/TJ charcoal
N_2O	1	kg/TJ charcoal
NO_X	50	kg/TJ charcoal
CO	6000	kg/TJ charcoal
CH_4	200	kg/TJ charcoal
PM_{10}	150	kg/TJ charcoal
$PM_{2.5}$	75	kg/TJ charcoal
CO_2 (memo item)	112	ton/TJ charcoal

1) Weighed average for 2019 for electric and gas-fired cooking

20.3 Uncertainty

The activity data for burning charcoal in households are estimated based on the amount of meat consumed yearly. This in turn is based on the

assumption that barbecuing is solely responsible for charcoal usage in households. Since the amount of charcoal used in the Dutch households is based on meat consumption combined with estimated charcoal sales, the uncertainty is estimated at 50%, based on expert judgement.
The emission factors (and corresponding uncertainties) used for charcoal burning are derived from '*IPCC guidelines 2006*'. Therefore, the uncertainty bandwidth for N_2O ranges from -62.5% to 275%. For CH_4, the uncertainty bandwidth is -66.6% to 200%. The corresponding uncertainty of CO_2 (memo-item) is reported as 20%.

The uncertainty of PM emission for indoor meat cooking is estimated at ± and –75%. The other emission factors are estimated based on a single report from the US; these emission factors are therefore not very reliable.
The reliability of the data is qualitatively indicated in the table below with codes A-E (see Appendix A). The valuations are based on expert judgement.

Quality codes

Substance	Activity data	Emission factor	Emission
NMVOC (meat)	B	C	C
PM (meat)	B	C	C
NMVOC (BBQ)	B	C	C
SO_2	B	C	C
N_2O	B	B	B
NO_X	B	C	C
CO	B	C	C
CH_4	B	B	B
PM	B	C	C
CO_2	B	B	B

20.4 Spatial allocation

Consumer emissions are spatially allocated in the Netherlands based on population density.

Emission source/process	Allocation-parameter
Meat preparation	Population density
Charcoal use in barbecue	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

20.5 References

CBS statline
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IPCC 2006 guidelines. http://www.ipcc-nggip.iges.or.jp/public/index.html
Visschedijk et al., 2021, Particulate matter emission from home cooking (Fijnstof emissie door koken), Tijdschrift Lucht, 2021

Vleesnota by Wageningen University (WUR) Vleesnota 2023: vleesconsumptie is verder gedaald in 2022 - WUR

20.6 Version, dates and sources

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21 Paint (NFR 2D3d and 2D3i)

This section describes the non-methane volatile organic compounds (NMVOC) emission from paint.

Process description	Emission source code	NFR code	Sector
Car paint – use of paint and lacquer	8920800	2D3d	Trade and services
Paint - construction	0802200	2D3d	Construction
Paint - consumers	0802201	2D3d	Consumers
Road paint	0119800/ 0129800	2D3d	Construction
Spray paint – consumers	0811303	2D3i	Consumers
Spray paint – other	0811304	2D3i	Trade and services

21.1 Description of the emission source

Paint may contain NMVOC which evaporates to the air during and after use. Paint includes products like coating, (wall) paint, lacquer, varnish, plaster, glue, stripper and filler and thinner. The Netherlands Association of Paint Producers (Vereniging Van Verf en drukinkt Fabrikanten (VVVF)) provides annual sales data for the calculation of NMVOC emission.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 7.1% in 1990 and 3.5% in 2020 (ER dataset 1990-2022).

21.2 Calculation

The annual national paint sales, including information on NMVOC content, are provided by the VVVF annual paint sales statistics, representing about 95% of the Dutch total market. The remaining 5% consists of directly imported paint. The VVVF divides different sub markets as shown in the table below. The ENINA task force covers the industry sector and therefore this is not addressed in this report.

Sub market VVVF	Sector
Car repair lacquer	Trade and services
Construction (including steel preservation and road marking)	Construction
Consumers	Consumers
Industry and carpentry factories	Industry
Ship building	Industry

Car repair lacquer
The total NMVOC emission from this source is calculated as follows:

$EM_{totalcrl}$ = EmN + EmI
EmN = NMVOC content national paint sales
EmI = NMVOC content directly imported paint

It is assumed that:

- all paint sold will be used the same year and that the NMVOC emitted is 100% and the imported paint has the same NMVOC percentage as the paint sold by VVVF;
- 5% is directly imported paint.

Construction (including steel preservation and road marking)
The total NMVOC emission from this source is calculated as follows:

$Em_{totalconstruction}$ = EmN-C + EmI-C + EmN-SP + EmI-SP
EmN-C = NMVOC content national paint sales of construction
EmI-C = NMVOC content directly imported paint of construction
EmN-SP = NMVOC content national paint sales of steel preservation
EmI-SP = NMVOC content directly imported paint of steel preservation

It is assumed that:

- all paint sold will be used the same year and that the NMVOC emitted is 100%;
- the NMVOC percentage of the imported construction paint is 2%;
- the imported paint of steel preservation has the same NMVOC percentage as the paint sold by VVVF;
- for construction, 35% is directly imported paint, and for steel perservation, 10% is directly imported paint.

The total NMVOC emission from the construction sector is divided into road markings and others, based on the amount of road markings.

Consumers
The total NMVOC emission from this source is calculated as follows:

$EM_{totalconsumers}$ = EmN + EmI
EmN = NMVOC content of national paint sales
EmI = NMVOC content of directly imported paint

It is assumed that:

- all paint sold will be used the same year and that the NMVOC emitted is 100% and the imported paint contains the same amount of NMVOCs as the paint sold by VVVF,
- 0% is directly imported paint.

a) Activity data
Total NMVOC emission is subdivided into individual substances based on paint profile statistics provided by the VVVF (VVVF 1997).

Substance in paint profile	Factor*
Additional Nonhalogenated volatile hydrocarbons	0.119
Additional Alif nonhalogenated hydrocarbons	0.264
Additional Aromatic nonhalogenated hydrocarbons	0.045
Methylenechloride	0.004
Ethanol	0.015
Esters boiling point <150°C	0.224
Ketone	0.075
Propyleneglycomethylether	0.045
Propyleneglycomethylether acet	0.045
Toluene	0.030
Xylene	0.134

*Based on VVVF statistics 1997

21.3 Uncertainty

The uncertainties of the emission calculation were quantified by Utrecht University (J. vd Sluys) in 2002.

Quality codes

Substance	Activity data	Emission factor	Emission
NMVOC			C

21.4 Spatial allocation

The emissions of consumers and trade and services are allocated in the Netherlands based on population density. The emission of road paint is allocated based on road density.

21.5 References

Instituut voor toegepaste milieu-economie (TME) 2003.Kosteneffectiviteit VOS maatregelen 2010. eindrapportage.

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Vereniging Van Verf en drukinktFabrikanten (VVVF) 1999. Grondstoffenverbruik in 1997 in de Nederlandse verfindustrie.

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VVVF Annual reports on www.vvvf.nl

21.6 Version, dates and sources

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22 PCP pressure treated wood (NFR 2D3i)

This section describes the emissions of pentachlorophenol (PCP) and dioxins from resident façade boarding treated with PCP. The section does not describe the NMVOC emission.

Process description	Emission source code	NFR code	Sector
PCP pressure treated wood	0010300	2D3i	Consumers

22.1 Description of the emission source

In the past, wooden façade boarding of residences was treated with PCP (pentachlorophenol). Over time, PCP and dioxins are emitted from the wood to the air. Dioxin emissions occur because wood was treated with contaminated paint. The use of PCP was prohibited in 1989. However, there are still façade boardings in use (‘stock’) that were treated before 1989 from which PCPs and dioxins evaporate to the ambient air.

Contribution to the national emission
The contribution of this source to the total national dioxine emission was 2.0% in 1990 and 18.2% in 2020 (ER dataset 1990-2022).
PCP from façade boarding is the only source within the ER.

22.2 Calculation

Pentachlorophenols
The annual stock of PCPs in façade boardings in the period 1955-1989 is estimated from the PCP application and import data of Bremmer et al. (1993). For this period it is assumed that reduction of the PCP stock is because of evaporation only, whereas placement of new PCP treated façade boardings leads to increase of PCP stocks (Annex Table 1). Over a period of 15 years half of the initially applied amount of PCPs is evaporated to the air (Bremmer et al., 1993). The rate constant for evaporation ($k_{evaporation}$) from wooden façade boardings is derived as

$$k_{evaporation} = -\ln(50\%)/15 \text{ years} = 0.0461 \text{ per year} \quad .$$

As such, it is derived that a total amount of 1176 tons of PCP is applied in the period of 1955-1989 from which a total amount of 654 tons is evaporated before the year 1990. Hence, the amount of PCPs in stock at the start of the year 1990 is estimated to be 522 tons.

For the period after 1990 it is assumed that PCP stock is reduced by evaporation and by removal of PCP treated façade boarding in renovation works. The PCP stocks at the end of each emission year are calculated as:

$$(Stock_{end\ of\ current\ year}) = (Stock_{\ end\ of\ previous\ year}) \times EXP(-(k_{evaporation}+k_{renovation})$$

The annual amounts of PCPs emitted to the air by means evaporation are calculated as:
$PCP\ emission = (Stock_{end\ of\ current\ year} - Stock_{end\ of\ previous\ year}) \times (k_{evaporation} \div (k_{evaporation}+k_{renovation}))$

Dioxins
The annual amounts of dioxins that are emitted to the air in The Netherlands are calculated with the same approach as PCPs. The concentration of dioxins in PCPs is 3 mg/kg (Sloof et al., 1990). Half of the initially applied amount of dioxins is evaporated in 150 years (Bremmer et al., 1993), so that the evaporation rate constant for dioxins is:

$k_{evaporation}= -ln(50\%)/150\ years =0{,}00461\ per\ year$.

As such, it is derived that a total amount of 3.53 kg of dioxin is applied in the period of 1955-1989 from which a total amount of 0.298 kg is evaporated before the year 1990, so that 3.23 kg was left in stock in the year 1990.

For the period after 1990 it is assumed that the dioxins stock is reduced by evaporation and by removal of PCP treated façade boarding in renovation works. The estimated annual amounts of dioxins that are evaporated, removed in renovation works, and in stock (Annex table 3) are calculated in the same way as described for PCPs in general.

Activity data
The activity data refer to renovation rate per year. According to survey data of BPIE (2011), 3.5% of the residential buildings and 1.6% of the non-residential building are renovated in The Netherlands in the year 2011 (BPIE, 2011). About 75 % of the building in the Netherlands are residential and 25% non-residential. As such, the weighted renovation rate for 2011 is 0.75*0.035 + 0.25*0.016 = 0.03025 per year. The renovation rates for residential and non-residential buildings in the year 2011 serve as index for the other years. It is assumed that the percentage of buildings that are renovated in a year is proportional the amount of money invested in large maintenance of buildings (TNO, 2010; CBS, 2010). A total of 7230 million euro is invested in the renovation of residential building In 2011 and 4020 million euros in the renovation of non-residential buildings. As such, the renovation rate of a given year is estimated as:

$k_{renovation} =0.75 \times((€_{invest.resident})/(€7230\ million)\times 0.035)+ 0.25 \times ((€_{invest.non\text{-}resident})/(€4060\ million)$

As such renovation rates have been derived for the years of 1990 – 2019 (Annex Table A2).

22.3 Uncertainty

The uncertainties of the emission calculation are quantified in the reports by Bremmer et al and Slooff et al. Bremmer calculated an average of 16 g dioxin toxic equivalent (I-TEQ) in 1990 and stated in the report that the maximum could not exceed 25 g I-TEQ dioxin. For

1990, the ER assumed an emission of 25 g I-TEQ. This would mean that the uncertainty is mainly in the low end of the value. The 95% confidence interval is skewed. As a rule in the ER, the highest uncertainty value is used and the 95% confidence interval is normally distributed around the 25 g I-TEQ.

Slooff et al reported the average PCP emission. The 95% confidence interval is normally distributed around the average.

Quality codes

Substance	Activity data	Emission factors	Emission
Dioxins	D	Not relevant	D
PCP	D	Not relevant	E

22.4 Spatial allocation

The dioxin and PCP emissions are allocated in the Netherlands based on population density. Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

22.5 References

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Slooff et.al, Basisdocument PCP, RIVM, november 1990.
TNO (Toegepast Natuurwetenschappelijk Onderzoek). 2005.Bouwprognoses 2005-2010. ISBN 9059861825
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VROM (Ministerie van Volkshuisvesting, Ruimtelijke Ordening). 2003. Bouwprognoses 2003-2008.

22.6 Version, dates and sources

Version: 1.2
Date: November 2022
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22.7 Annex: Activity data

Annex Table 1 Application of PCPs in façade boardings placed in The Netherlands in the period of 1955-1989

Period	Total application of PCPs (Bremmer et al. 1993)	Annual application of PCPs
1955-60[B]	200 t	33 t/y
1961-65[C]	275 t	55 t/y
1966-75[D]	275 t	27.5 t/y
1976-79[E]	250 t	62.5t/y
1980	45 t	45t/y
1981	40 t	40t/y
1982	35 t	35t/y
1983	28 t	28t/y
1984	15 t	15t/y
1985	6 t	6 t/y
1986	4 t	4 t/y
1987	2 t	2 t/y
1988	1 t	1 t/y
1989	0 t	0 t/y

Annex Table 2 Calculated renovation rate constants per year (1998-2020)

Year[1]	Millions of euros invested in renovation of residential buildings	Millions of euros invested in renovation of non-residential buildings	Reference	Residential renovation rate	Non-residential renovation rate	Weighted renovation rate ($k_{renovation}$)
1998	5360	3260	VROM, 2003	0.026	0.013	0.023
1999	5570	3480	VROM, 2003	0.027	0.014	0.024
2000	5670	3640	VROM, 2003	0.027	0.014	0.024
2001	6230	4000	TNO, 2006	0.030	0.016	0.027
2002	5750	3980	TNO, 2006	0.028	0.016	0.025
2003	5721	3900	TNO, 2006	0.028	0.016	0.025
2004	5790	3580	TNO, 2006	0.028	0.014	0.025
2005	6560	4060	TNO,2010	0.032	0.016	0.028
2006	6890	4110	TNO,2010	0.033	0.016	0.029
2007	7450	4590	TNO,2010	0.036	0.018	0.032
2008	7740	5180	TNO,2010	0.037	0.021	0.033
2009	7070	4750	TNO,2010	0.034	0.019	0.030
2010	7190	3940	TNO,2010	0.035	0.016	0.030
2011	7230	4020	TNO,2010	0.035	0.016	0.030
2012	7330	3960	TNO,2010	0.035	0.016	0.031

Year[1]	Millions of euros invested in renovation of residential buildings	Millions of euros invested in renovation of non-residential buildings	Reference	Residential renovation rate	Non-residential renovation rate	Weighted renovation rate ($k_{renovation}$)
2013	7460	3910	TNO,2010	0.036	0.016	0.031
2014	7640	3930	TNO,2010	0.037	0.016	0.032
2015	7840	3910	TNO,2010	0.038	0.016	0.032
2016	7754	3879	CBS productie bouw index	0.038	0.015	0.032
2017	7707	3883	CBS productie bouw index	0.037	0.015	0.032
2018	8146	3957	CBS productie bouw index	0.039	0.016	0.034
2019	8757	4082	CBS productie bouw index	0.042	0.016	0.036

1: There was no data available for the renovation rates for the years 1990-1997 and therefore they are assumed equal to the renovation rates of 1998.

23 Petrol stations (NFR 1B2av)

This section describes the NMVOC emissions from petrol stations.

Process description	Emission source code	NFR code	Sector
NACE 47.3: gas stations, spills tank refill	8920900	1B2av	Trade and service
NACE 47.3: gas stations, vapour expel - tank refill	8920901	1B2av	Trade and services
NACE 47.3: gas stations, vapour expel - storage tanks	8920902	1B2av	Trade and services

23.1 Description of the emission source

The term 'Petrol stations' includes the distributions points for road traffic as well as petrol stations on company grounds (meant for company cars). The NMVOC emissions of petrol and LPG are reported. LPG is reported as butane and propane (50/50). Emission occurs during the filling of tanks and results from two sources: the loss due to leakages of the fuel (petrol) and loss due to expulsion while filling car tanks and storage tanks (petrol and LPG). In the Netherlands, there are between 40 and 45 filling stations for cars using natural gas as fuel. However, it is assumed that the losses occurring during filling of natural gas are negligible. Before disconnecting the filling pistol, the natural gas in the dead space between pistol and tank is recovered; no gas is emitted into the air.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 1.7% in 1990 and 0.6% in 2020 (ER dataset 1990-2022).

23.2 Calculation

Emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = amount of fuel used in the Netherlands for road transportation
Emission factor = emission per litre fuel used

a) Activity data
Leakage losses
During filling car tanks spillage of petrol can occur.

On average, it is assumed that the minimal spillage is at least 1-2 ml and the average tank amount per filling is 40 litres. The density of petrol is 0.72 kg/litre. It is therefore assumed that a million litres of petrol produce 720 tons of NMVOC.
In the last decade, the Netherlands used 5.5 billion litres petrol for transportation by road (statline.CBS.nl). Based on these assumptions

and official data, we calculated a VOC emission of around 300,000 kg. Since the amount of petrol has been constant over time, the VOC emission due petrol spillage has not changed.

After disconnecting the LPG filling pistol, LPG (a mixture of butane and propane 50/50) will be-emitted into the air. The average dead volume of the pistol and connection nipple of the tank is 12.5 ml (personal communication LPG installation branch).
It is assumed that, on average, the tank is filled with 40 litres LPG. CBS (statline.CBS.nl) in the Netherlands provides data for the amounts of LPG used for transportation by road. Based on these assumptions and the official data, an LPG spillage of 97 tons was calculated.

Expulsion losses car tanks
At the start of refuelling with petrol, the tank is filled with petrol vapour. When petrol flows in the tank, the petrol vapour is emitted (Bernouille-principal). Therefore, during refuelling, petrol is emitted into the air. In the Netherlands, measures were implemented to reduce the emission of petrol. These measures were implemented in 2000 and 2005 respectively.

Measures influencing the calculation
Although both the stage 1 and the stage 2 measures have been implemented since 2005, a rest emission of 25% of pre-implementation emission will remain. No further emission reduction measures are foreseen.

b) Emission factors
The factors for the emission by petrol leakage are unknown.

NMVOC (kT)	**Amount Petrol**	**Expulsion losses**		**Spillage**	**Total**	**Realisation**
year	(billion litre)	storage	car's	refueling cars	losses	Stage I and II
1980	?	5.1	4.9	0.6	10.6	
1990	?	4.9	4.9	0.6	10.4	
2001	5.5	0.0	1.9	0.4	2.5	Stage 1
2005	5.5	0.0	1.3	0.3	1.6	Stage II
2011	5.7	0.0	1.3	0.3	1.6	
2012	5.4	0.0	1.3	0.3	1.6	

Substance in LPG	**Emission factor**
propane	0.5
butane	0.5

Butane/propane (kT)	Amount Petrol	Losses	Spillage refueling cars (kT)		
year	(billion litres)	storage	LPG total	wv butane	wv propane
1985	1.5	0.0	0.26	0.13	0.13
1990	1.5	0.0	0.24	0.12	0.12
2001	1.0	0.0	0.16	0.08	0.08
2005	0.7	0.0	0.11	0.06	0.06
2011	0.5	0.0	0.09	0.045	0.045

23.3 Uncertainty

The uncertainties of the emission calculation are not quantified.

Quality codes

Substance	Activity data	Emission factor	Emission
NMVOC	B	C	C

23.4 Spatial allocation

The emissions of the petrol stations are assigned to the locations of the petrol stations (SBI 47.3) in the Netherlands according the ratio of employees at the petrol stations. Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

23.5 References

CBS, Statline (https://opendata.cbs.nl/)

Comprimo (briefrapport 18 november1994) over schattingen voor lekverliezen van benzine.

VROM, Besluit ‘tankstations en milieubeheer’ en ‘herstelinrichtingen voor motorvoertuigen en milieubeheer’ en het wijzigingsbesluit daarop (Stb 1996, 228).

23.6 Version, dates and sources

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24 Residential combustion, Wood stoves and Fireplaces (CRT 1.A.4.b.i and NFR 1A4bi)

This section describes the emissions from wood combustion by consumers.

Process description	Emission source code	CRT code	NFR code	Sector
Residential wood combustion	T012200	1.A.4.b.i	1A4bi	Consumers

24.1 Description of the emission source

In the Netherlands, residential combustion of wood is mainly for creating a homely ambiance. Although wood combustion in stoves is sometimes considered more environmentally friendly, relatively few homes in the Netherlands use wood combustion as their main heat source.

Wood combustion in stoves and fireplaces leads to various emissions. The emissions of CO_2 are the result of biomass burning and therefore reported as such. In addition to CO_2, CH_4, N_2O, NO_X, particulate matter, VOCs and other compounds are emitted.

Contribution to the national emission

The contribution of this source to the total national PM2.5 emission was 10.3% in 1990 and 21.5% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national CH4 emission was 0.3% in 1990 and 0.3% in 2020, and the contribution of this source to the total national N2O emission was 0.1% in 1990 and 0.2% in 2020 (ER dataset 1990-2020).

24.2 Calculation

The emissions from fireplaces and different types of woodstoves are calculated using a model described in Jansen (2011), Jansen et al. (2016) and Visschedijk & Dröge (2020).

The emissions are calculated as follows for each type of stove;
Emission = Activity data x Emission factor

For the greenhouse gases (except methane (CH_4) this is a tier 1 methodology as there is no difference in the emission factors. For methane a distinction is made for conventional and more modern appliances. The methodology is consistent with the IPCC 2006 Guidelines.

a) Activity data

The amount of wood is based on Segers (2010), Segers (2013) and Van Middelkoop and Segers (2019) on wood burning in stoves for the Netherlands, and is distributed over appliance types in the emission model (for more details see Visschedijk & Dröge, 2020). Total use of fuel wood in The Netherlands has been relatively constant in the past decades.

Since the second half of 2020 natural gas prices have escalated in the Netherlands. Prices have since dropped and stabilised but remained at a much higher level than before 2020. Both TNO (Visschedijk et al. 2023) and CBS (CBS 2023) estimated that this may have led to a recent increase in the use of fuel wood, after a relatively long period of constant consumption. The foreseen rise in wood consumption since 2020 has been discussed by Visschedijk & Dröge (2025). It should be noted though that the rising fuel wood consumption has likely been dampened by the relatively warm winters in the Netherlands since.

In 2022 a temperature correction has been implemented in the timeseries of the activity data from 1990 onwards. This has been done to correct the activity data for differences in meteorology between years. Heating Degree Days (HDD) is a good predictor for energy requirements for space heating in a specific year, so this correction is based on statistical data on annual HDD. First, a linear trendline is fitted through annual HDD for 1990 to the most recent year, representing the baseline. This baseline shows a slight downwards trend over the whole period. Per year the relative difference between the actual recorded HDD and the point on the trendline is calculated. With this relative difference the uncorrected activity data as described in Visschedijk et al. (2019) is corrected up or downwards, resulting in an additional annual fluctuation in the wood consumption data of around 10 to 20% at most. This correction has however not been applied to the wood used in fireplaces, as with their low efficiency these are assumed not to be used for heating purposes, only for the cosmetic effect of a natural fire.

b) Emission factor
All emission factors are reported in the 2011, 2016 and 2021 reports about the emission model for woodstoves (Jansen 2011; 2016; Visschedijk & Dröge, 2020, Visschedijk & Dröge, 2025).
The emission factors for selected substances are listed in the following table. The table presents both the particulate matter emissions with and without condensable particulate matter. Note that particulate matter emissions are reported in the Emission Registry with condensable particulate matter.

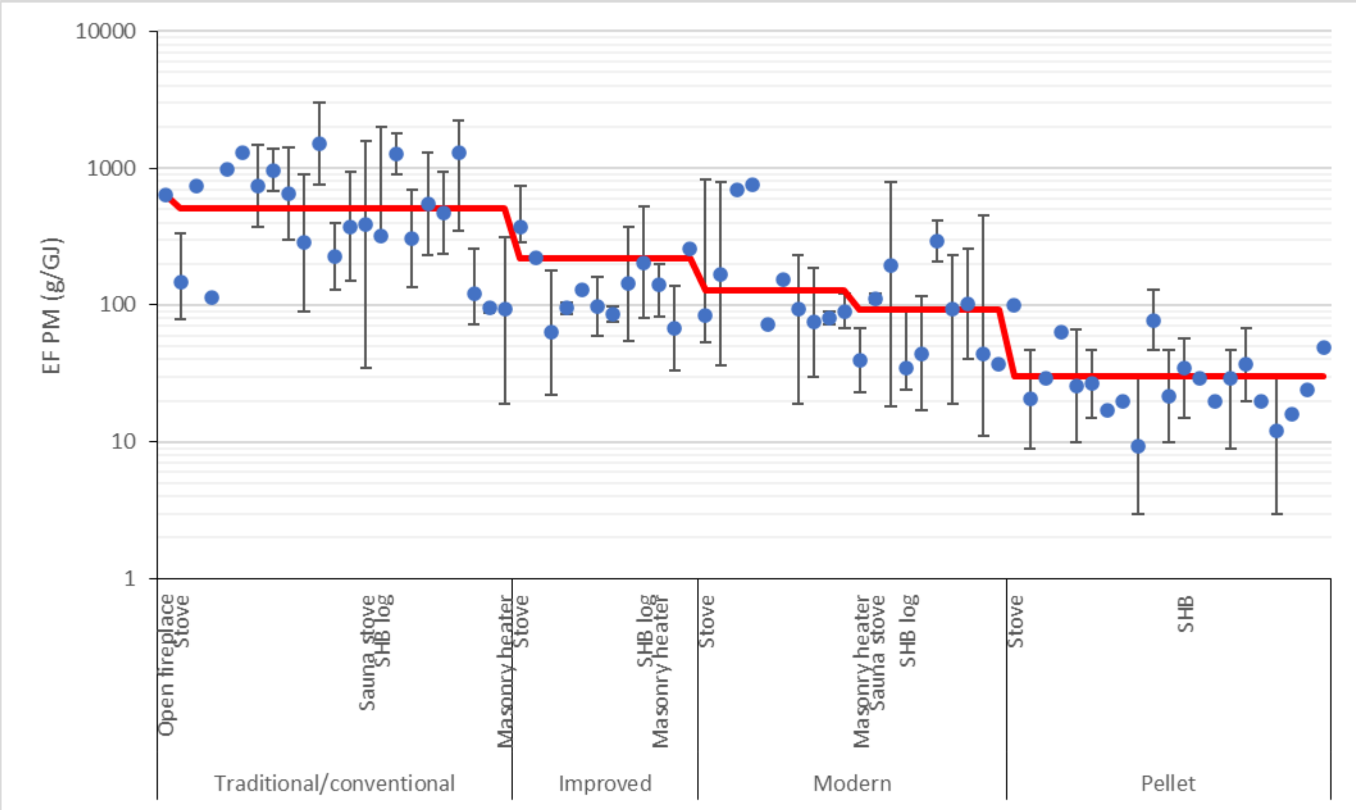
	EF (type of stove, g/GJ, CO_2 kg/GJ)					
Pollutant	**Fire place**	**Conventional**	**Approved**	**DIN-plus**	**Eco-design**	**Pellet stove**
CO_2	112					
CH_4	300			100		
N_2O	4					
$PM_{2.5}$ - total	637	507	221	129	93	30
PM_{10} - total	670	534	233	136	97	30
BC / EC	76	73	28	11	26	9

Pollutant	EF (type of stove, g/GJ, CO_2 kg/GJ)					
	Fire place	Conventional	Approved	DIN-plus	Eco-design	Pellet stove
PM10 – without condensable PM	161	194	97	52	49	30
PM2.5 – without condensable PM	153	183	92	49	47	30

The default emission factors from the IPCC 2006 guidelines are used for greenhouse gas emissions, except the emission factor for methane for modern stove types. Literature emission factors for methane from modern wood stoves are both scarce and show a very large variation but are on average lower than those of conventional stoves. Kindbom et al. (2018) have measured methane emissions from modern stoves and compared their measurements to factors used by other Scandinavian countries that used their own values instead of the IPCC default value. Between different stove types the methane emission factors appear to show a very rough correlation with NMVOC emission factors, as both pollutants are the result of incomplete combustion. When averaging the methane emission factors for modern stoves measured and quoted by Kindbom et al. 2018, a value of around 100 g/GJ is found, instead of 300 g/GJ. This is the average for modern manually fed stoves (DIN+ and Ecodesign), modern single house boilers and pellet stoves. The uncertainty is however high. Countries for which the methane emission factors for modern stoves are quoted by Kindbom include Denmark, Finland, Norway and Sweden.

In 2020 the Dutch Pollutant Release and Transfer Register (PRTR) made an international review and comparison of $PM_{2.5}$ emission factors for wood combustion appliance types as distinguished in the Dutch emission model for wood burning emissions. This review was done because there were some indications that the PRTR emission factors were too low in some cases. The model distinguishes six different environmental standards: Open Fireplaces, Conventional/Traditional, Improved, DIN+, Ecodesign and Pellet stoves. The figure below shows international literature emission factors as compiled in this review (blue dots including range), grouped by similar environmental standards. Also shown in this figure are the PRTR emission factors per standard (as a red line). From this review the conclusion was drawn that the PRTR emission factors did not represent a systematic underestimation compared to recent literature data.

Emission factors of total PM2.5 (including condensable particulate matter) per type of wood stove (in grams PM2.5/GJ). The blue dots and the accompanying error bars indicate PM2.5 emission factors reported in literature. The red line indicates the PM2.5 emission factor used in the emission calculations for the Emission Registration.



24.3 Uncertainty

The activity data for wood burning is calculated yearly, based on 5-yearly questionnaires. The uncertainty might therefore fluctuate over time and is estimated at 35% (ND) based on expert judgement in combination with the data in *Van Middelkoop, 2019*.

For the emission factors the uncertainty has been determined on a substance by substance basis. The result is shown in the table below:

Pollutant	EF uncertainty	Reference
CO_2	±15%	IPCC Guidelines
CH_4	300 g/GJ, Factor 3	IPCC Guidelines
CH_4	100 g/GJ, Factor 7	Range in Kindbom et al. 2018
N_2O	Factor 3.5	IPCC Guidelines
NO_x	±50%	EEA Guidebook 2016
CO	Factor 2.5	EEA Guidebook 2016
PM_{10}	Factor 2.5	Expert judgement TNO
$PM_{2.5}$	Factor 2.5	Expert judgement TNO
BC / EC	Factor 3	Expert judgement TNO
SO_2	Factor 3 up; -20% down	EEA Guidebook 2016
NH_3	Factor 5	Expert judgement TNO
NMVOC	Factor 2.5 up; factor 4 down	EEA Guidebook 2016

Note that in many cases the uncertainty of emission factors has an asymmetric (mostly lognormal) distribution.

24.4 Spatial allocation

The emissions due to wood combustion are spatially allocated based on the distribution of various types of houses, with each type having a specific average number of wood combustion appliances.

Emission source/process	Allocation-parameter
Burning wood in Stoves	Various types of residential homes

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

24.5 References

CBS, 2023. Klimaatverandering en energietransitie: opvattingen en gedrag van Nederlanders in 2023. https://longreads.cbs.nl/klimaatverandering-en-energietransitie-2023/

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24.6 Version, dates and sources

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25 Shooting

This section describes the emissions of lead to the soil from shooting.

Process description	Emission source code	Sector
Shooting	E800200	Trade and services

25.1 Description of the emission source

The emission source is related to clay-pigeon shooting. Hunting and traditional shooting is not included. Since 2008, the use of lead has been prohibited in both disciplines and has been replaced by steel. The emission of steel (iron) is reported by the agriculture group. Only official clay-pigeon shooters (match) had an exemption from the minister until 2016 to shoot with lead, but this may be continued because lead is still used in international competition. Clay-pigeon shooting with lead is only performed at one location in the Netherlands, in Emmen. Currently the number off match shooters is small.

25.2 Calculation

The use of lead-shot is prohibited since December 2004. According to the information from the KNSA (Koninklijke Nederlandse Schutters Associatie) there are currently only 3 competitive clay-pigeon shooters. Official clay-pigeon shooters (match) were permitted to use lead by the minister until 2016. A competitive shooter trains on a regular basis and shoots 14000 times per year. A shell contains 24 grams lead. Thus, a shooter uses 336 kg lead. In 2012, there were 3 competitive shooters in the Netherlands, thus, the emission of lead due to clay-pigeon shooting was ~1 ton. According to the KNSA, the lead is not removed from the shooting range.

25.3 Uncertainties

Quality codes

Substance	Activity data	Emission factors	Emission
Lead	B	A	C

25.4 Spatial allocation

There is only one location in the Netherlands, Schietsportcentrum Emmen in Emmer-Compascuum.

25.5 References

Bon, 1988, Bon, J. van en J.J. Boersema, feb 1988, Metallisch lood bij de jacht, de schietsport en de sportvisserij, IVEM rapport nr 24, Groningen.

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25.6 Version, dates and sources

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26 Wholesale Business in fuel and remaining mineral oil products (NFR 1B2av)

This section describes NMVOC emissions from Wholesale business in fuel and remaining mineral oil products. Prior to 2010, this emission source was addressed using the terms “petrol distribution points” or petrol distribution chain”.

Process description	Emission source code	NFR code	Sector
Wholesale business in fuel and remaining mineral oil products.	8921100	1B2av	Trade and services

26.1 Description emission source

The petrol distribution points are viewed as the link between petrol stations and the refinery. In the KWS2000 project this was termed “petrol distribution chain”. The emissions resulting from loading tank-lorries at refineries and filling large storage tanks are incorporated in the emission trend of the distribution chain. Since 2001, the expulsion losses when filling tank-lorries and storage tanks have no longer been reported individually, but as a total and imply emissions resulting from petrol only.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.9% in 1990 and 0.4% in 2020 (ER dataset 1990-2022).
The NMVOC emissions from the petrol distribution chain decreased after a light increase in 1996. The decrease was mainly due to reduced NMVOC emission from storage tanks.

26.2 Calculation

Until 1999, emission data was based on data for 1997 and overall estimates of branch developments in the following years. In 2001, the petrol storage facilities were sent questionnaires in order to gain information about the implementation of measures and the residual emissions in 2000. As the response to this questionnaire was limited, it was not possible to use this questionnaire in order to obtain a good picture of the VOC emissions and the degree of implementation. The individual companies have therefore not gained any insights in their VOC emissions. With regard to the degree of implementation of measures, the questionnaire data show that the major petrol storage facilities have implemented these measures, but the situation at the smaller storage facilities remains unclear (KWS 2000, 2002).

In 2004, the VPNI (Vereniging Nederlandse Petroleum Industrie: Association of the Dutch Petrol Industry) developed a reduction plan for VOC emissions for the years 2000-2010. The VPNI produced emission calculations based on measures mentioned in KWS 2000.

Measure affecting the calculation
Due to the KWS2000, the following precautions were undertaken for the distribution chain:

- storage tanks with internal floating deck;
- treatment of expulsion air.

These measures were established in the departmental regulation "Storage, transfer and distribution of petrol environmental management" in December 1995. No further reductions were presented in the reduction plan VOC 2000-2010 for petrol distribution (VPNI). Since 2003 the emissions from distribution points are kept constant.

26.3 Uncertainty

The uncertainties of the emission calculation are not quantified. Two general measures were taken (labelling and environmental car), however the effects of these measures are unknown.

Quality codes

Substance	Activity data	Emission factor	Emission
NMVOC	C	C	C

26.4 Spatial allocation

The emissions of the Wholesale Business in fuel and remaining mineral oil products are assigned to the locations of the petrol distribution points (SBI 46.71) in the Netherlands according to the ratio of employees at the distribution point. Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

26.5 References

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VROM Ministeriele regeling Op-, overslag en distributie benzine milieubeheer, 27 december 1995.

26.6 Version, dates and sources

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Note: Since 1999, no new data is available on emission variables and emission factors. Therefore, the data might be outdated.

27 Smoking of cigarettes and cigars (CRT 2.G.4 and NFR 2G)

This section describes the emissions caused by smoking cigars and cigarettes.

Process description	Emission source code	CRT code	NFR code	Sector
Smoking of cigars	0801001	2.G.4	2G	Consumers
Smoking of cigarettes	0801002	2.G.4	2G	Consumers

27.1 Description of the emission source

When tobacco products are burned, the fumes contain a mix of different substances. These substances are inhaled and exhaled by the smoker or emitted to the air directly. Since smoking has been found to be unhealthy, the number of smokers has been declining steadily, with a comparable reduction in the consumption of tobacco products.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 1.6% in 1990 and 2.6% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national CH4 and N2O emission was <0.01% in 1990 and 0<0.01% in 2020 (ER dataset 1990-2020).

27.2 Calculation

Emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Number of cigars (or cigarettes) smoked
Emission factor = kg emission per number of cigars (or cigarettes) smoked

a) Activity data
Cigarettes
The number of cigarettes is based on statistics from cigarette taxes. For the years 1990-2009, this is published by Statistics Netherlands as a cigarette and tobacco consumption per person (see: https://opendata.cbs.nl/#/CBS/nl/dataset/37154/table?dl=CDF15). For the years 2012-current, this is published by Accijnsmonitor (see: https://accijnsmonitor.nl/overzichten-toelichtingen-en-downloads/)

The statistics on cigarette taxes does not include cigarettes that are non-domestic or illegal in the Netherlands. Therefore, the number of smoked cigarettes in the Netherlands is raised, for the whole time series, by an annual amount of non-domestic and Counterfeit & Contraband cigarettes found in the so-called empty-pack survey (WSPM Group, multiple years). This publication series presents quarterly information on the numbers of collected sticks and packs (any brand, any market variant) from streets and public bins in the largest cities from European countries.

This fieldwork provides an indication of:
- the incidence of non-domestic or illicit cigarettes consumed per country;
- Tax-paid and non-tax paid cigarettes from other countries;
- Counterfeit cigarettes;
- Information related to non-domestic or counterfeit cigarettes by: Manufacturer, City, Brand family, Market variant.

Based on the outcome of this new data-source, the amount of cigarettes consumed in the Netherlands has been raised for 2015 - 2024 by the number provided in these publications.

The amount of cigarettes in the years 1990-2014 have been raised by the average raise from 2015 – 2020 (2,2 billion cigarettes).
A deliberate choice has been made to raise the previous years by an average of 2015 – 2020. This is because in more recent years the annual amount of non-domestic and Counterfeit & Contraband cigarettes reported in the empty-pack survey show a steep incline, due to recent raised excise duty in the Netherlands, potentially resulting in a disproportionate increase for previous years. Because of this, the amount of non-domestic and Counterfeit & Contraband cigarettes in recent years are not representative for 1990-2014, and therefore only an average amount from the years 2015-2020 is taken into account.

Cigars
For the years 1990 to 2006, the Dutch Centre for Statistics (CBS) presented information on the consumption of cigars in the Netherlands. This information was the average number of cigars smoked per inhabitant. However, from 2006 this information is no longer available from the CBS, so in 2014 contact was made with the Dutch Cigar Manufacturers Association (NVS). The NVS was willing to provide data annually starting with the year 2013. The number of cigars consumed in the years between 2006 and 2013 are interpolated. After 2017 cigar consumption data were no longer available, and for 2018 and later the same consumption as for 2017 has been assumed. Note that the total amount tobacco consumed as cigars is less than 10% of the total amount of tobacco consumed as cigarettes.

b) Emission factor
The emission factors for tobacco smoking are primarily based on the EMEP/EEA Guidebook 2019, and are identical for cigars and cigarettes. For CO_2 and NMVOC the emission factors are based on Brouwer et al., 1994.

Substance	**Tobacco**	
	EF	**Unit**
NOx	1.8	g/kg tobacco*
NH_3	4.15	g/kg tobacco*
CO	55.1	g/kg tobacco*
PM_{10}	27	g/kg tobacco*
$PM_{2.5}$	27	g/kg tobacco*
BC / EC	0.0045	- (fraction of $PM_{2.5}$)
NMVOC	22.8	g/kg tobacco*

Substance	Tobacco	
	EF	Unit
CO_2 (memo-item)	294	g/kg tobacco*
CH_4	1.625	g/kg tobacco*
N_2O	0.065	g/kg tobacco*

* It is assumed that one cigarette contains 1 g of tobacco on average and one cigar contains 5 g tobacco on average

27.3 Uncertainty

The activity data is reported by reliable third parties. However, due to inconsistency between years, the uncertainty with respect to illegal imported tobacco products, and the data from branch organisations, the activity data is rated with an B.
The emission factors are based on old reports; for cigars and cigarettes an average weight is assumed. Therefore, the emission factors are rated with a C.
Overall, the emissions are rated with an C.

Substance	Activity data	Emission factors	Emission
All	B	C	C

27.4 Spatial allocation

The emissions of consumers are regionalised in the Netherlands based on population density.

Source	Allocation-parameter
Smoking	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

27.5 Reference

- Accijnsmonitor, multiple years. https://accijnsmonitor.nl/overzichten-toelichtingen-en-downloads/
- Brouwer J.G.H., J.H.J. Hulskotte, H. Booij, 1994, Roken van tabaksproducten, WESP Rapportnr. C4, RIVM-rapportnr. 773009006.
- European Environment Agency (EEA), Emission Inventory Guidebook 2019, https://www.eea.europa.eu/publications/emep-eea-guidebook-2019
- KPMG, Illicit cigarettes consumption in the EU, UK, Norway and Switzerland, multiple years (www.pmi.com).
- Statistics Netherlands, multiple years. https://opendata.cbs.nl/#/CBS/nl/dataset/37154/table?dl=CDF15
- WSPM Group, Empty packs survey Netherlands, multiple years (www.rijksoverheid.nl).

27.6 Version, dates and sources

Version 1.2
Date: January 2026
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28 Service stations, anti-corrosive treatment (NFR 2D3i)

This section describes the emissions caused by the anti-corrosive treatment of cars.

Process description	Emission source code	NFR code	Sector
Service stations, anti-corrosive treatment	8920700	2D3i	Trade and Services

28.1 Description of the emission source

When old cars lose their corrosive protection, they are treated with anti-corrosive products. This is mainly true for older cars because newly produced cars are generally equipped with a chassis of anti-corrosive materials such as plastics or galvanized steel. This treatment is mainly done by specialised service stations (garages). Due to decreasing demand, the number of workshops providing this service is decreasing. The anti-corrosive products used are a source of NMVOC, the NMVOC emissions are released in a short period after the product is applied.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.10% in 1990 and 0.04% in 2020 (ER dataset 1990-2022).

28.2 Calculation

Between 1990 and 1999, the sale of anti-corrosive products was estimated by the company with the largest market share of the anti-corrosive product (KWS2000).

Starting with the year 2000, the emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Number of cars treated
Emission factor = kg emission per treated car

a) Activity data
It is assumed that only cars produced in 1985 or earlier need an anti-corrosive treatment. The number of old cars in the Netherlands is based on data from Statistics Netherlands (CBS). They provide the number of cars still in use in the Netherlands which were manufactured before 1986. Not all those cars have to be treated each year. Under normal circumstances the treatment is only needed once every ten years. However, it is thought that most old-timers are treated more frequently, hence it is assumed that these cars are treated once per eight years, or that 12.5% of the old-timers are treated.

b) Emission factor
For each car treated, the emission of NMVOC is estimated at 8 kilograms. This is based on the EMEP/EEA air pollutant emission inventory guidebook (2.D.3.d. table 3-6). However, this emission factor

is not specific for this type of treatment, but for a general coating application.
The emission of NMVOC is distributed to individual substances based on an emission profile created by TNO in 1992.

28.3 Uncertainty

Up until 1999, the amount of NMVOC emission was estimated by expert judgement. This results in an uncertainty qualified with an C.
The total number of cars is reported by a reliable third party starting from the year 2000. However, the number of cars treated is based on literature study combined with expert judgement. Therefore, the activity data should be rated with a B.

The emission factor for NMVOC is based on the EMEP/EEA guidebook, with the concession that the emission factor is not specific for this type of treatment. Therefore, the emission factor is rated with a D.
Overall, the emissions for the whole time-series are rated with a C.

Substance	Activity data	Emission factors	Emission
NMVOC	B	D	C

28.4 Spatial allocation

The emissions of consumers are regionalized in the Netherlands based on the amounts of employees within the service stations (SBI 50: garages).

Source	Allocation-parameter
Anti-corrosive treatment	Employee density within SBI 50

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

28.5 Reference

CBS statline. https://opendata.cbs.nl/statline/#/CBS/nl/
Dutch Emission Inventory. www.emissieregistratie.nl
European Environment Agency.
https://www.eea.europa.eu/publications/emep-eea-guidebook-2016
KWS2000, multiple years, Annual reports. InfoMil, Den Hague.

28.6 Version, dates and sources

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29 Manure from domestic animals (NFR 6A)

This section describes the emissions of NH_3 caused by domestic animals.

Process description	Emission source code	NFR code	Sector
Manure of domestic animals	0802000	6A	Consumers

29.1 Description emission source

This emission source is calculated using the emissions from domestic animals. Domestic animals are defined as animals not used as livestock in the agricultural industry, with the exception of horses and ponies, which are calculated by the agriculture and nature task force. When animals consume food, the nitrogen (N) from the food is (partly) re-released. Most N is released through the excretion of faeces and urine, which results in the emission of ammonia. Emissions of other substances caused by domestic animals are considered irrelevant and therefore are not calculated.

Contribution to the national emission
The contribution of this source to the total national NH_3 emission was 0.3% in 1990 and 1.3% in 2020 (ER dataset 1990-2022).

29.2 Calculation

For the complete time series, the emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Amount of households
Emission factor = kg NH_3 per household

a) Activity data
The number of households is derived from Statistics Netherlands.

b) Emission factor
The emission factor used by the Dutch emission inventory is based on Booij 1995, who calculated a total emission of 1220 tons of NH_3 from domestic animals (cats, dogs, rabbits and birds) for the year 1990. The emission factors for cats and dogs calculated by Booij 1995 are 0.18 and 0.36 kg NH_3 per animal and per year respectively. The emission calculated for cats and dogs by Booij 1995 is about 70% of the total NH3 emission from pets. With the total emission in 1990 and the number of households in 1990, an emission factor of 0.2 kg NH_3 per household was calculated.

Some other authors, Joshua Fu et al 2010 and Bouwman et al 1997, report emission factors of around 0.7 kg NH_3 per year for cats and around 2 kg NH_3 per year for dogs. This is high when compared to Booij 1995. Furthermore, most other reports seem to base their emission factor on the work of Sutton et al (2000). The emission factor presented in Sutton et al (2000) is 0.61 kg NH3 for dogs and 0.11 kg NH_3 for cats; each per animal and per year.

29.3 Uncertainty

The number of cats and dogs is based on a survey commissioned by DIBEVO. A sample survey generally has a relatively high uncertainty due to the number of respondents and because not all animals are taken into account. Since the data are not available annually and incomplete, these data are only used as a check.
Combining data from the DIBEVO survey with the emission factors in Sutton et al (2000) results in a NH3 emission approximately 20% lower than the NH3 emission calculated with the emission factor of 0.2 kg per household. However, the DIBEVO survey only includes cats and dogs and the emission factors are derived from Sutton et al (2000).

In Sutton et al (2000), the uncertainty range provided is 50%. However, emission factors can be higher than this, according to the other studies.

The uncertainty in the activity data is small; rated as an A.

The emission factor depends on the share of different domestic animals, which varies in time. In addition, the emission factor is relatively uncertain, therefore the emission factor is qualified with an E.

The uncertainty of the total emissions is similar to the uncertainty in the emission factor. Therefore, the uncertainty for the total emission is qualified as E.

Quality codes

Substance	Activity data	Emission factor	Emission
NH_3	A	E	E

29.4 Spatial allocation

The emissions of ammonia from the manure of domestic animals are spatially allocated in the Netherlands based on inhabitants.

Emission source/process	Allocation-parameter
Manure of domestic animals	Inhabitants

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

29.5 References

Booij H., 1995, Gezelschapsdieren, WESP-rapport C6, RIVM-rapport 772414003.
Bouwman et al, 1997, A global high-resolution emission inventory for ammonia, global biochemical cycles, Vol. 11, No. 4, pages 561-587
DiBeVo, https://dibevo.nl/
Feiten en cijfers gezelschapsdierensector 2015, August 2015, HAS Hogeschool
Joshua Fu et al, 2010, Quality Improvement for Ammonia Emission Inventory, Department of Civil and Environmental Engineering, University of Tennessee, Knoxville, TN 37996-2010

Neijenhuis F. and Niekerk T., 2015, 'Als de kat van huis is…', WUR report 316
NU.nl, http://www.nu.nl/algemeen/699151/nederlanders-houden-steeds-meer-huisdieren.html, 2006, viewed May 2015.
Sutton M.A. et al, 2000, Ammonia emissions from non-agricultural sources in the UK, Atmospheric Environment 34 (2000) 855-869

29.6 Version, dates and sources

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Date: February 2018
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30 Pesticides, domestic and non-agricultural use (NFR 2D3a and 2D3i)

This section describes the emissions caused by the use of domestic pesticides; it excludes any agricultural use.

Process description	Emission source code	NFR code	Sector
Domestic pesticides	0802400	2D3a	Consumers
Pesticides (non-agricultural use)	0812400	2D3i	Trade and Services

30.1 Description of the emission source

During domestic use of pesticides, emissions of NMVOC occur as a result of the propelling agent and/or other additives needed to distribute the pesticides in the appropriate dosage. Domestic pesticides are mainly used against unwanted indoor bugs (flies, mosquitos, ants etc.).
The non-agricultural use of pesticides is mainly subscribed to the professional treatment of woodworm. The active pesticides are mixed with additives containing volatile organic compounds (NMVOC) which are emitted.
Pesticides used for agricultural purposes are reported by the Agriculture taskforce.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.1% in 1990 and 0.2% in 2020 (ER dataset 1990-2022).

30.2 Calculation

During the KWS2000 project, annual domestic and non-agricultural use of pesticides was estimated for the period 1990-2000. After 2001, the emissions were no longer updated.
For pesticides used for the pest control of woodworm, the estimate was based on information from the largest product reseller.
For domestic pesticides, the emission estimation was based on information provided by four companies responsible for the majority of the market share.
In 2017, TNO investigated possibilities to improve the NMVOC emissions in the WESP taskforce. However, no easy solution could be found to improve estimates of emissions for domestic and non-agricultural pesticide use due to the lack of activity data. Therefore, the emissions are still based on data from the KWS2000 project.

The NMVOC is divided into single substances according to emission profiles. For domestic pesticides, the NMVOC profile is based on the composition of propellant agents in aerosol cans. For the non-agricultural (woodworm) pesticides, the NMVOC emission profile is based on the permitted pesticide register ('Toelatingsregistratie Bestrijdingsmiddelen') (Klein, 1996).

30.3 Uncertainty

As the data are outdated, the uncertainty level for current emissions and the emission profiles is unclear. Up until 2000, the emission data and emission factors could be rated with an C. Currently, the emission data and emission factors should be rated with an E.

Substance	Activity data	Emission factors	Emission
NMVOS	B	C	C

30.4 Spatial allocation

The emissions of non-agricultural and domestic pesticides are regionalised in the Netherlands based on population density.

Source	Allocation-parameter
Domestic pesticides	Population density
Non-agricultural pesticides	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

30.5 References

Dutch Emission Inventory. www.emissieregistratie.nl

Klein A.E. 1996, Risico-evaluatie van hulpstoffen in niet-landbouwbestrijdingsmiddelen, TNO rapport R 96/319.

KWS2000, multiple years, Annual reports. InfoMil, Den Hague.

30.6 Version, dates and sources

Version 1.1
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31 Dry cleaning of clothing and textiles (NFR 2D3f)

This section describes the emissions caused by the dry cleaning of clothes and textiles. This section includes smaller consumer-focussed companies (<10 employees). Industrial cleaning of clothing and textiles is covered in section 32.

Process description	Emission source code	NFR code	Sector
Chemical cleaning of clothing and textile	8922200	2D3f	Trade and Services

31.1 Description of the emission source

The dry cleaning of clothing and textiles leads to emissions of solvents. Hundreds of smaller companies (<10 employees) provide dry cleaning of clothing and textiles as service to consumers. The emissions calculated in this section only relate to the emissions of perchloroethylene (PER). Although the number of dry cleaning installations using PER has been declining since 1998, no alternative emission substances have been identified and/or calculated. Alternative solvents are, for example, CO_2, petroleum-based hydrocarbons, or specialised detergents in water.

When the dry cleaning process is started, the clothing is put in a special washing machine containing PER and detergents. The PER is heated and vaporised; after cleaning the clean PER vapours are cooled and reused. A part of the PER forms a residue with the detergents and is wasted. A part of the PER vapour is emitted to the air. Another part of the PER goes into the 'contact' water, this contact water is filtered with active carbon filters and released to the sewage system.

Contribution to the national emission

The contribution of this source to the total national NMVOC emission was 0.1% in 1990 and 0.04% in 2020 (ER dataset 1990-2022).

31.2 Calculation

Emissions are calculated as follows:

Emission = Activity data x Emission factor

Activity data = Tonne of clothing and textile cleaned with PER

Emission factor = kg emission per tonne dry cleaned

a) Activity data

The activity data for 1990 – 1993 is based on data provided by NETEX, a branch organisation for dry cleaning in the Netherlands.

Between 1994 and 1998, the amount of clothing was estimated based on number of inhabitants and the average amount of clothing and textiles dry cleaned.

From 1999 to 2015, the amount of clothing cleaned is based on the statistics from NETEX, a branch organisation for dry cleaning in the Netherlands. In their annual reports the distribution of the turn-over and the percentage of PER cleaning was mentioned, although not all years give insights in the percentage of PER used as cleaning method. The use of PER as a cleaning method was declining since 1998 up until 2008 after which it seemed to stabilise (data available until 2015). After 2015 no NETEX data are available anymore and the annual amount of clothing have been assumed constant. This assumption is supported by the trend in number of employees and the annual turnover in this sector (as published by Statistics Netherlands: https://opendata.cbs.nl/#/CBS/nl/dataset/81156ned/table?dl=CDF1A). For the period for which NETEX data were available, the turnover distribution was corrected for inflation using the data from Statistics Netherlands. For the years that no percentage of PER cleaning is mentioned in the NETEX annual report, the emissions have been calculated with an interpolated value of the percentage PER used. An overview of the annual % of PER treated clothing and the annual total amount of clothing cleaned with PER is presented in the table below.

Year	% PER treated clothing	PER treated clothing (ton)
1990	76.0	15,849
1991	76.0	15,849
1992	76.0	15,849
1993	76.0	15,849
1994	76.0	15,955
1995	76.0	15,069
1996	76.0	13,758
1997	76.0	11,007
1998	76.0	10,000
1999	76.0	10,796
2000	74.0	10,051
2001	65.0	8,741
2002	55.0	6,648
2003	58.0	7,013
2004	59.6	7,610
2005	58.3	7,200
2006	57.0	7,081
2007	55.8	6,438
2008	51.9	5,605
2009	48.0	5,620
2010	47.0	4,866
2011	46.0	4,124
2012	45.0	3,957
2013	43.8	4,044
2014	43.8	4,200
2015	43.0	4,500
2016	43.0	4,500
2017	43.0	4,500
2018	43.0	4,500

Year	% PER treated clothing	PER treated clothing (ton)
2019	43.0	4,500
2020	43.0	4,500
2021	43.0	4,500
2022	43.0	4,500
2023	43.0	4,500
2024	43.0	4,500

b) Emission factor
Since 1980, there has been a constant push to reduce the emissions of PER from dry cleaning. First the PER machines had to be closed, later the vapours cooled and filtered. This has led to a significant reduction in the emission factor over time. In 1990, the emission factor started with 40 kilograms PER for each tonne of clothing and textiles cleaned.

Based on multiple interviews with a TNO expert and new information on the technical development of PER dry-cleaning machines a complete trend adjustment has been implemented in 2024 for the dry-cleaning of clothing and textiles for both the private and industrial market.

On bases of the average life-time expectation of different generations of PER-cleaning machines (GEN 3 – GEN 5) an overview has been constructed of the phasing out of older generation machines and incorporation of newer generation (cleaner) machines.
In combination with the corresponding emission factors per machine generation, an average emission factor is constructed per year per ton of textile to be cleaned.

For a better understanding of the different types of PER dry-cleaning machines the main statistics of the different types have been presented in the table below.

Generation type	Year of introduction	sold until	Average life-time expectation (years)	Average EF (kg PER/ton textile)
GEN 3	1970's	2000	15-20	40
GEN 4	1990	2010	15-20	15
GEN 5	2000	present	15-20	3.5

Based on the life-time expectation and the corresponding emission factor per generation new average emission factors have been calculated. See the table below for an overview of newly calculated average PER emission factors per year.

Year	estimated share (%) of total population			Average EF calculated (kg/ton textile)
	GEN3 (%)	GEN4 (%)	GEN5 (%)	
1990	100			40
1991	100			40

Year	estimated share (%) of total population			Average EF calculated (kg/ton textile)
	GEN3 (%)	GEN4 (%)	GEN5 (%)	
1992	100			40
1993	100			40
1994	100			40
1995	100			40
1996	100			40
1997	100			40
1998	75	25		33.8
1999	75	25		33.8
2000	75	25		33.8
2001	75	25		33.8
2002	75	25		33.8
2003	50	30	20	25.2
2004	50	30	20	25.2
2005	50	30	20	25.2
2006	50	30	20	25.2
2007	50	30	20	25.2
2008	30	40	30	19.1
2009	30	40	30	19.1
2010	30	40	30	19.1
2011	30	40	30	19.1
2012	30	40	30	19.1
2013	10	50	40	12.9
2014	10	50	40	12.9
2015	10	50	40	12.9
2016	10	50	40	12.9
2017	10	50	40	12.9
2018	0	40	60	8.1
2019	0	40	60	8.1
2020	0	40	60	8.1
2021	0	40	60	8.1
2022	0	40	60	8.1
2023	0	25	75	6.4
2024	0	25	75	6.4

31.3 Uncertainty

The activity data is calculated by using data from different sources, therefore the activity data is rated with an E.
The emission factors are based on reliable reports, but the market share of the technique used is unknown. Also, NETEX has doubts about the emission factor used. Therefore, emission factors are rated with a D.
Overall, the emissions are rated with an E.

Substance	Activity data	Emission factors	Emission
NMVOC/PER	E	D	E

31.4 Spatial allocation

The emissions of consumers are regionalised in the Netherlands based on population density.

Source	Allocation-parameter
Dry cleaning	Companies within SBI 93.01 (empl. <10)

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

31.5 References

EMEP/EEA air pollutant emission inventory guidebook 2016, 2.D.3.f Dry cleaning.

NETEX annual reports, multiple years. https://www.netex.nl/

Interview (and some additional telephone conversations) with TNO expert Aike Wypkema, 2 July 2025

Greet Janssens, Siebe Janssens, Diane Huybrechts, VITO, Beste Beschikbare Technieken (BBT) voor de droogkuissector, augustus 2019

31.6 Version, dates and sources

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32 Industrial cleaning of clothing and textiles (NFR 2D3f)

This section describes the emissions caused by cleaning clothes and textiles. This section includes industrial cleaning companies (>10 employees). Dry cleaning of clothing and textiles for consumers is covered in section 31.

Process description	Emission source code	NFR code	Sector
Chemical cleaning of clothing and textiles	8922100	2D3f	Trade and Services

32.1 Description of the emission source

The industrial dry cleaning of clothing and textiles leads to emissions from solvents. The major companies considered for this emission source clean, for example, company clothing and cleaning cloths. The emissions calculated in this section contain the emissions of perchloroethylene (PER) and trichloroethene (TRI). Although in recent years the number of installations using PER and TRI are thought to be declining, no alternative emission substances have been identified and/or calculated. Alternative solvents used are, for example, CO_2, petroleum-based hydrocarbons or specialised detergents in water.

When the dry cleaning process starts, clothing is put in a special washing machine containing solvents (PER or TRI) and detergents. The PER is heated and vaporised, after the cleaning the clean PER vapours are cooled and reused. A part of the PER or TRI forms a residue with the detergents and is wasted. A part of the vapour is emitted to the air. Another part of the solvent goes into the 'contact' water, this contact water is filtered with active carbon filters and released to the sewage system.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.1% in 1990 and 0.2% in 2020 (ER dataset 1990-2022).

32.2 Calculation

Emissions are calculated as follows.
For the year 1991, the emissions of PER were calculated by the amount of PER sold to the market for cleaning purposes. This was (according to VHCP) an amount of 1690 tonnes. The amount of chemical waste containing PER was 600 tonnes, containing about 225 tonnes of PER. This resulted in a total emission of 1690 – 225 = 1465 tonnes of PER for industrial cleaning and dry cleaning for consumers together. In 1991, the PER emissions caused by dry cleaning for consumers was estimated at 965 tonnes. This results in an emission of 500 tonnes PER from the industrial cleaning of textiles and clothing.

All other estimates for this emission source were made based on expert judgement by H. vd Berg from TNO (industrial cleaning techniques). For 1995, the PER emission of industrial cleaning was estimated at 400

tonnes. The emissions of TRI were estimated at 11.9 tonnes in 1991 and 9.5 tonnes in 1995; no new estimates are available. Thus, the amount of emissions of both PER and TRI has been assumed to be constant from 1995 onwards.
Most of the PER and TRI are emitted to the atmosphere. The extra emissions to water are estimated to be about 0.015% of the emissions to air.

As mentioned in the previous chapter on the dry-cleaning of the private market a complete trend adjustment has been implemented in 2024 for the dry-cleaning of clothing and textiles for both the private and industrial market, based on multiple interviews with an expert and new information on the technical development of dry-cleaning machines.

In contrast to the dry-cleaning market for the private sector, which was based on a certain, steady flow of clothing to be cleaned, the annual PER-emission of the industrial market was assumed to be constant at 400 tons annually (regardless of the actual amount of clothing cleaned).

On bases of the average life-time expectation of different generations of PER-cleaning machines (GEN 3 – GEN 5) an overview has been constructed of the phasing out of older generation machines and incorporation of newer generation (cleaner) machines.
In combination with the corresponding emission factors per machine generation an average emission factor is constructed per year per ton of textile to be cleaned.

On basis of the total amount of PER emissions and the applicable emission factor the total tonnes of clothing is derived.
As with the dry-cleaning in the private sector the total amount of clothing is kept constant as from 2015.

For more information on the main statistics of the different types of PER dry-cleaning machines and the newly calculated annual emission factors, see the applicable tables in Chapter 31 on dry cleaning of clothing and textiles for consumers.

32.3 Uncertainty

Since the data is outdated and based on expert judgement, the uncertainty is qualified with an E.

Substance	Activity data	Emission factors	Emission
All	E	E	E

32.4 Spatial allocation

The emissions of industrial cleaning companies are regionalised in the Netherlands based on company location.

Source	Allocation-parameter
Dry cleaning	Companies within SBI 93.01 (empl. >10)

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

32.5 References

Berg H. van den, expert judgement by oral communication, TNO Cleaning techniques, Delft
CFK-project centre, 1991-1995, Tilburg
Dutch emission inventory, www.emissieregistratie.nl
Interview (and some additional telephone conversations) with TNO expert Aike Wypkema, 2 July 2025
Greet Janssens, Siebe Janssens, Diane Huybrechts, VITO, Beste Beschikbare Technieken (BBT) voor de droogkuissector, augustus 2019

32.6 Version, dates and sources

Version 1.1
Date: February 2026
Contact:

Administrator	Organisation	E-mail address
A.J.H. Visschedijk	TNO	Antoon.visschedijk@tno.nl

33 Fumigation of transports (NFR 2D3i)

This section describes the emissions caused by fumigation of transports.

Process description	Emission source code	NFR code	Sector
Fumigation of transports	E800000	2D3i	Trade and Services

33.1 Description of the emission source

Until 2008, containers and some bulk cargo ships were treated with methyl bromide for overseas transport. Treatment of overseas transport occurs in order to comply with the import legislations. For the Dutch market this is mainly done for grain, rice, cacao, nuts and animal feed. Fumigation occurs by putting pellets or tablets within the cargo container; during transport the humidity and oxygen react with the pellet to form toxic fumes containing methyl bromide. During transport and at the port, the methyl bromide is released to the air.

Contribution to the national emission
The contribution of this source to the total national methylbromide emission was 90% in 1990 and 100% in 2008 (ER dataset 1990-2022).

33.2 Calculation

The emissions up to 2004 are based on numbers provided by the inspection of VROM (Ministry of housing, spatial planning and environment) called the 'Inspectie Milieuhygiëne' (IMH, stands for inspection environmental hygiene). The IMH checks incoming transports which have been chemically treated in order to supervise safe degassing of the transport in question. However, this is only the case for bulk transport. Container transport is not monitored, as it is not mandatory to report incoming containers which have been fumigated. Thus, only bulk transport was reported by IMH.

Between 2004 and 2008 no new data were provided by IMH. Since 2008, the use of methyl bromide has been prohibited. Although it is expected that other substances are used, no information can be found regarding amounts and substances used.
KPMG used to monitor the use of methyl bromide by questioning relevant companies with regards to the CFK action program. The data obtained by KPMG were higher than the data provided by IMH. This was due to illegal use; i.e. not reporting actual consumption to IMH as well as the lack of checks by IMH. However, the data provided by IMH are considered more consistent in time, so the KPMG data have not been used.

33.3 Uncertainty

As this emission source is outdated, it is hard to quantify the uncertainty.
However, due to the difference between the KPMG data and the IMH data, it is assumed that the uncertainty is high and rated with an E.

33.4 Spatial allocation

The emissions caused by the fumigation of transports were regionalised in the Netherlands based on the location where they take place.

Source	Allocation-parameter
Fumigation of transports	Location of activity

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

33.5 References

Dutch emission inventory, www.emissieregistratie.nl

VROM, IMH, department pest control, written and oral communication.

33.6 Version, dates and sources

Version 1.1
Date: February 2018
Contact:

Administrator	Organisation	E-mail address
A.J.H. Visschedijk	TNO	antoon.visschedijk@tno.nl

34 Preserved wood (NFR 2D3i)

This section describes the emission from preserved wood.

Process description	Emission source code	NFR code	Sector
Solvent and other product use: creosote pressure treated wood, new	0804000	2D3i	Consumers
Solvent and other product use: creosote pressure treated wood, new	0804001	2D3i	Trade and services
Solvent and other product use: creosote pressure treated wood, new	0804002	2D3i	Agriculture
Solvent and other product use: creosote pressure treated wood, new	0804003	2D3i	Transport
Solvent and other product use: creosote pressure treated wood, stock	0804100	2D3i	Consumers
Solvent and other product use: creosote pressure treated wood, stock	0804101	2D3i	Trade and services
Solvent and other product use: creosote pressure treated wood, stock	0804102	2D3i	Agriculture
Solvent and other product use: creosote pressure treated wood, stock	0804103	2D3i	Transport
CCA pressure treated wood: constructions	0804200	-	
CCA pressure treated wood: garden furniture	0804201	-	
Leaching CCA pressure treated wood at waterline boarders, stock	0804300	-	

34.1 Description of the emission source

Emissions from preserved wood originate from three types of preserved wood:

- wood treated with Wolman salts (CCA pressure treated wood);
- wood treated with creosote (creosote pressure treated wood);.
- carbolized wood (addressed separately in Chapter 11).

Wolman salts can cause emissions of arsenic, chromium and copper. Creosote preserved and carbolized wood are a source of emission of polycyclic aromatic hydrocarbons (PAHs).

34.2 Calculation

Emissions are calculated for each substance by multiplying an activity rate (AR), in this case the quantity of preserved wood, by an emission factor (EF) expressed in kg of the specific substance per m^2 of preserved wood. This method of calculation is explained in the 'Handreiking Regionale aanpak diffuse bronnen' [1]. For creosote treated wood, this is calculated using the following equation:

Emission = $AR_l \times EF_l + \Sigma\ (AR)_S + EF_S$

Where:

AR_l = Creosote treated wood (added last year) (m^2),
EF_l = Emission factor creosote treated wood added last year (kg/m^2) AR_S = Creosote treated wood (standing from previous years) (m^2)
EF_S = Emission factor creosote treated wood standing from previous years (kg/m^2)

A distinction is made between new application of creosote treated wood and standing quantities of creosote treated wood. "New application" refers to the amount of wood placed in the past year. "Standing" creosote treated wood refers to the amount of creosote treated wood placed in previous years and which is still a source of emissions.
For wood treated with Wolman salts, the emissions caused by standing wood from past years is calculated and totalled separately, as with the following formula:

Emission = $\Sigma\ (AR_J * EF_J)$

Where:

AR_J = Amount of wood treated with Wolman salts placed in year J (m^3)
EF_J = Emission factor for wood treated with Wolman salts placed in year J (kg/m^3) The emission calculated in this way is referred to as the total emission.

a) Activity data
The activity data is the amount of preserved wood. The activity data for creosote treated wood, wood treated with Wolman salts is determined by different methods.

Creosote treated wood
For creosote treated wood, the assumption is that the emissions in the first year are higher than those in the years thereafter. This is why there are separate calculations for the new application (placed in the past year) and the standing (placed in previous years) wood.

The activity data are determined in the following manner:
The new application in 1985 and 1992 was determined by Hulskotte [2]. The quantities in 1990, 1995 and 2000 are interpolated. From 2001 on, no new creosote treated wood was placed, pursuant to the governmental regulation called PAK-besluit [3].

The standing wood in 1992 was calculated by multiplying the new application from 1980 (500,000 m2) by the lifetime (25 years) minus 10 years and then adding the new application of 1992 (250,000 m2) times 10 years [2]. Because the new application is not counted from the last year with the standing wood, we subtract the 1992 figure for new application from the standing wood calculated. This results in a figure of 9,750,000 m2 for standing wood 1992. This figure is used for the further calculation of the standing wood in the other years. Figures for standing wood in other years is calculated in the same manner:
Standing Wood reporting year = Standing Wood 1992 – a * New App 1980 + New App 1992 - reporting year

Where:

Standing Wood reporting year	=	Standing Wood in 1985, 1990, 1995, 2000, 2004 or 2005, (m2)
Standing Wood 1992	=	Standing Wood in 1992, (9,750,000 m2)
A	=	Number of years between reporting year and 1992
New App 1980	=	New Application in 1980, (500,000 m2)
New App 1992–reporting year	=	Sum of the new application in the years 1992 until reporting year, (m2).

Wood treated with Wolman salts
Calculating the emissions by wood treated with Wolman salts requires knowing how much wood was placed in previous years. These quantities are based on [4]. Because the emission factor declines as the wood ages, counting the total amount of standing wood does not lead to a correct result. Instead, the emission per year of new application must be determined.

Wood treated with Wolman salts has only been used since 1979. In the years prior to that, creosote treated wood was most commonly used. For the years before 1979, the amount of Wolman salts treated wood placed is set at 0 m3. Its lifetime is set at 40 years [4]. From 2001 on, no new wood treated with Wolman salts was used in bank revetments, because no further WVO permits (permits under the Act on Water Pollution) were issued for the product after that time.

b) Emission factors
The emission factor is the emission per quantity of preserved wood in bank revetments. The emission factors for creosote treated and wood treated with Wolman salts are determined using different methods.

Creosote treated wood
For creosote treated wood, emission factors are formulated as being higher in the first year than in the years thereafter. This is why different emission factors are used for the new application of creosote treated wood and standing creosote treated wood. First, the emission factor for fluoranthene is determined. The emission factors for other PAH

substances are determined using a substance profile at leaching of the PAH.
For new application of creosote treated wood, the emission factor for fluoranthene is calculated using the following assumptions:

Emission is highest for the first 31 days. For pine wood, the assumed emission factor is 4.0 * 10-6 kg fluoranthene/m^2/day, and for fir, the assumed emission factor is 1.9 * 10-6 kg fluoranthene/m2/day [5]. For days 32-365 of the first year, the assumed emission factor is 0.9 * 10-6 kg fluoranthene/m^2/day for both woods [5]. Additionally, it is assumed that pine makes up approximately 75% of the wood used, with 25% being fir [6]. When combined, this information results in an emission factor of 4.1 * 10-4 kg fluoranthene/m^2/year.

To calculate the emission factor for fluoranthene for standing creosote treated wood, the assumption is that this emission factor is the same as the emission factor for days 32-365 in the first year. This is an emission factor of 0.9 * 10-6 kg fluoranthene/m2/day for both woods [5]. This results in an emission factor of 3.3 * 10-4 kg fluoranthene/m^2/year.
The emission factors for phenanthrene, anthracene and pyrene are determined using data from a report by TNO [7]. This report presents the substance profile in the leaching fluids from two reports [5, 8].
Based on the substance profile, we estimate the ratios at leaching for phenanthrene, anthracene, fluoranthene and pyrene at 65%, 5%, 15% and 15% respectively.
The emission factor for naphthalene is taken from [9], in which the quantity of naphthalene is equal to the quantity of phenanthrene. This is why the same emission factor is used for these two substances.

Table 3 Emission factors for PAH-compounds from creosote treated wood, (10-3 kg/m2) [5].

	New application	**Standing[A]**
Phenanthrene	1.78	1.43
Anthracene	0.14	0.11
Fluoranthene	0.41	0.33
Pyrene	0.41	0.33
Naphthalene	1.78	1.43

A: Standing wood refers to wood that is placed before the year of emission

Wood treated with Wolman salts

The emission factors for wood treated with Wolman salts depend on the type of preservative compound used to treat the wood and the leaching over the lifetime of the wood. More details about the calculation of the emission factors is available in [4]. Tables 4-6 show the emission factors for arsenic, chromium and copper, depending on the year of placement of the wood.

Table 4 Emission factors for arsenic from wood treated with Wolman salts based on [4], (10-3 kg/m^3)

	Emission factor in reported year															
Year of new application	**1985**	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1979	8.19	7.61	7.15	6.83	6.44	6.44	6.4	6.3	6.2	6.2	6.1	6.0	6.0	5.9	5.9	5.9
1980	8.11	7.48	7.04	6.66	6.28	6.22	6.2	6.2	6.1	6.03	5.97	5.91	5.84	5.78	5.72	5.72
1981	7.95	7.28	6.86	6.49	6.13	6.07	6.0	6.0	5.9	5.88	5.82	5.76	5.70	5.64	5.58	5.52
1982	7.9	7.14	6.67	6.32	5.97	5.91	5.9	5.8	5.8	5.73	5.67	5.62	5.56	5.50	5.44	5.38
1983	7.83	6.99	6.53	6.14	5.8	5.75	5.7	5.6	5.6	5.58	5.52	5.46	5.41	5.35	5.30	5.24
1984	7.85	6.83	6.34	5.96	5.69	5.58	5.5	5.5	5.4	5.36	5.36	5.31	5.25	5.20	5.15	5.09
1985	8.37	6.71	6.19	5.82	5.51	5.46	5.4	5.3	5.3	5.20	5.15	5.15	5.10	5.04	4.99	4.94
1986		6.81	6.24	5.88	5.56	5.51	5.5	5.4	5.3	5.25	5.20	5.15	5.15	5.10	5.04	4.99
1987		7.02	6.34	5.93	5.62	5.56	5.5	5.5	5.4	5.30	5.25	5.20	5.15	5.15	5.10	5.04
1988		7.23	6.45	6.03	5.67	5.62	5.6	5.5	5.5	5.36	5.30	5.25	5.20	5.15	5.15	5.10
1989		7.54	6.55	6.08	5.72	5.67	5.6	5.6	5.5	5.46	5.36	5.30	5.25	5.20	5.15	5.15
1990		4.51	3.61	3.33	3.14	3.08	3.1	3.0	3.0	2.97	2.94	2.88	2.86	2.83	2.80	2.77
1991			3.67	3.36	3.16	3.14	3.1	3.1	3.0	3.00	2.97	2.94	2.88	2.86	2.83	2.80
1992			3.78	3.42	3.19	3.16	3.1	3.1	3.1	3.02	3.00	2.97	2.94	2.88	2.86	2.83
1993			3.89	3.47	3.25	3.19	3.2	3.1	3.1	3.05	3.02	3.00	2.97	2.94	2.88	2.86
1994			3.05	2.65	2.46	2.44	2.4	2.4	2.4	2.31	2.29	2.27	2.25	2.23	2.21	2.16
1995			3.1	2.48	2.29	2.25	2.2	2.2	2.2	2.16	2.12	2.10	2.08	2.06	2.04	2.02
1996				2.29	2.1	2.08	2.0	2.0	2.0	1.98	1.96	1.93	1.91	1.89	1.87	1.86
1997				2.13	1.92	1.89	1.9	1.8	1.8	1.80	1.78	1.76	1.73	1.72	1.70	1.69
1998				1.95	1.74	1.71	1.7	1.7	1.6	1.62	1.60	1.58	1.57	1.54	1.53	1.51
1999				1.69	1.47	1.45	1.4	1.4	1.4	1.37	1.35	1.33	1.32	1.31	1.28	1.27
2000				1.5	1.2	1.18	1.2	1.1	1.1	1.11	1.09	1.08	1.06	1.05	1.05	1.03
2001-2016					0	0	0	0	0	0	0	0	0	0	0	0

Table 5 Emission factors for chromium from wood treated with Wolman salts based on [4], (10-3 kg/m3)

Year of new application	1985	1990	1995	2000	2005	2006	2007	2008-2017
1979	0.200	0	0	0	0	0		
1980	0.202	0	0	0	0	0		
1981	0.204	0	0	0	0	0		
1982	0.206	0	0	0	0	0		
1983	0.208	0.208	0	0	0	0		
1984	0.420	0.210	0	0	0	0		
1985	1.855	0.212	0	0	0	0		
1986		0.212	0	0	0	0		
1987		0.212	0	0	0	0		
1988		0.212	0.212	0	0	0		
1989		0.424	0.212	0	0	0		
1990		2.065	0.236	0	0	0		
1991			0.236	0	0	0		
1992			0.236	0.000	0	0		
1993			0.236	0.236	0	0		
1994			0.432	0.216	0	0		
1995			1.523	0.218	0	0		
1996				0.219	0	0		
1997				0.221	0	0		
1998				0.222	0.222	0		
1999				0.431	0.215	0.215		
2000				1.461	0.209	0.209	0.209	0
2001-2016					0	0	0	0

Table 6 Emission factors for copper from wood treated with Wolman salts (10^{-3} kg/m^3) based on [4].

	Emission factor in reported year															
Year of new application	**1985**	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
1979	2.0	1.2	0.8	0.6	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1980	2.2	1.4	0.8	0.6	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1981	2.4	1.4	1.0	0.6	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1982	2.6	1.6	1.0	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2
1983	2.8	1.8	1.2	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2
1984	3.4	2.0	1.2	0.8	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2
1985	22.0	2.2	1.4	0.8	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2
1986		2.4	1.4	1.0	0.6	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2
1987		2.6	1.6	1.0	0.6	0.6	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.2
1988		2.8	1.8	1.2	0.8	0.6	0.6	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4
1989		3.4	2.0	1.2	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.4
1990		17.6	1.8	1.1	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3
1991			1.9	1.1	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3
1992			2.1	1.3	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.3	0.3
1993			2.2	1.4	1.0	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.3
1994			2.6	1.5	0.9	0.9	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5
1995			5.2	1.8	1.1	1.0	1.0	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.5	0.5
1996				2.0	1.2	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.6	0.5	0.5	0.5
1997				2.2	1.3	1.2	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.7	0.5	0.5
1998				2.5	1.5	1.4	1.2	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.7	0.5
1999				3.2	1.7	1.5	1.4	1.2	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.7
2000				6.4	1.9	1.7	1.5	1.4	1.2	1.2	1.0	1.0	0.8	0.8	0.7	0.7
2001-2016					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Until 1989, treatment compound CCA type B was used. In 1990, this was replaced by preservative type C [4] (see appendix 1). Preservative CCA type C contains less arsenic than CCA type B. The replacement of Type B with Type C resulted in an emission reduction of arsenic.

From 2001 on, no new creosote treated wood was placed, pursuant to the governmental regulation called PAK-besluit [3]. Likewise, from 2001 on, no new wood treated with Wolman salts was used in bank revetments because no further WVO permits (permits under the Act on Water Pollution) were issued for the product after that time. Application of preserved wood in, along or above water is obliged to obtain a WVO permit. One consideration in any permitting procedure is that creosote treated wood and wood treated with Wolman salts are a source of environmental problems, even though alternatives are available. Consequently, these wood preservatives are no longer allowed in bank revetments.
From 2001 on, only emission occurs from preserved wood that was placed prior to that year.

Release into environmental compartments
The assumption for wood treated with Wolman salts is that all emissions go directly to surface water [4]. For creosote treated wood, the assumption is that half of the wood comes into direct contact with water, and consequently that half of the emissions goes to the soil and half to the surface water [5].

34.3 Uncertainty

The activity data for creosote treated wood, wood treated with Wolman salts are both based on extrapolation of estimates. This is assigned a classification of D. The emission factors are determined using measurements supplemented with assumptions and estimates. This is assigned a classification of C (for creosote treated, wood treated with Wolman salts).

34.4 Spatial allocation

The emissions of preserved wood are allocated in the Netherlands based on length of bank revetments. Details are available at http://www.emissieregistratie.nl/erpubliek/misc/documenten.aspx?ROOT=Algemeen (General)\Ruimtelijke toedeling (Spatial allocation)

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Zee, M.E. van der, 2002. Emissies van koper, chroom en arseen uit verduurzaamd hout. SHR rapport 1.513, Wageningen.

34.6 Version, date and sources

Version: 1.0
Date: January 2018
Contact:

Emission expert	Organisation	E-mail adress
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35 Refrigerator foam (NFR 2D3a and 2D3i)

This section describes the emissions caused by CFC in refrigerator foam.

Process description	Emission source code	NFR code	Sector
Diffuse emission insulation foam refrigerator	0890400	2D3i	Waste disposal
Diffuse emission insulation foam refrigerator	0890401	2D3a	Consumers

35.1 Description of the emission source

When refrigerator foam is made with CFCs as blowing agent, the CFCs are released during the use and after disposal of the refrigerator. Since the Montreal protocol prohibited the use of CFCs, the production of foam with CFC-11 has ceased. Since 1995, no new refrigerators with CFC-11 insulation foam have been produced for the Dutch market. The emissions are distributed evenly between the sectors consumers and waste disposal. From 2013 on, the emissions are supposed to have been reduced to zero.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.2% in 1990 and 0% in 2020 (ER dataset 1990-2022).

35.2 Calculation

Emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Number of refrigerators
Emission factor = kg emission per refrigerator

a) Activity data
The number of refrigerators is based on the year 1992, in which a total of 6.35 million refrigerators was estimated. From 1994, the number of refrigerators containing CFCs has declined by 350,000 annually. This has resulted in zero refrigerators in 2013.

b) Emission factor
The emission factor is based on the year 1992. The emission calculated for this year was divided by the total number of refrigerators. This results in an emission to air of 17 grams trichlorofluoromethane per refrigerator. This emission factor was distributed between both emission sources, giving an emission factor of 8.5 gram trichlorofluoromethane per refrigerator per emission source.

35.3 Uncertainty

The activity data was based on a single report from 1995, thus the uncertainty is high, especially for later years, resulting in an E
The emission factor is also based on the same report. Together with the amount of CFC diffusing from foam declining over time; these factors make the uncertainty high and are rated with an E.

Substance	Activity data	Emission factors	Emission
All	E	E	E

35.4 Spatial allocation

The diffuse emissions of refrigerators are regionalised in the Netherlands based on population density.

Source	Allocation-parameter
Refrigerator diffuse emissions from insulation foam	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

35.5 Reference

Brouwer J.G.H. et al, 1995, Verwerking afgedankte koelapparatuur, WESP-report H-2, RIVM report 772414004, Bilthoven.

35.6 Version, dates and sources

Version 1.1
Date: February 2018
Contact:

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36 Tanker truck cleaning (NFR 2D3i)

This section describes the emissions of substances from tanker truck cleaning.

Process description	Emission source code	NFR categorycode	Sector
Tanker truck cleaning	0811200	2D3i	Trades and services

36.1 Description emission source

The process is defined as the cleaning of tanker trucks by 20 specialised cleaning companies united in the Association of Tankcleaning Companies Netherlands (ATCN). There is a large variation in the loads carried by tanker trucks, e.g. orange juice, chalk powder, formaldehyde, glycol, phosphoric acid, natron leach, kerosene, wine, etc. In many cases the tanks still contain vapour or a rest load of volatile substances which are released during cleaning. This was the case for 41,000 tanker trucks in 1999.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 0.2% in 1990 and 0.2% in 2020 (ER dataset 1990-2022).

36.2 Calculation

Emissions from cleaning tanker trucks were measured by TNO in 1999 and reported in 2000 (TNO, 2000). Annual emissions in the period 1999 - 2008 have been set equal to these measured emissions. Annual emission estimations for the years prior to 1999 are based on estimations from the tanker truck branch and the KWS project (Infomil, 2002). For the years after 2008 the annual emission is estimated based on the number of active tanker trucks for which data is delivered by CBS in personal communication. It is assumed that annual emissions are proportional to in- or decreases in the active number of tanker trucks.

36.3 Uncertainty

Substance	Activity data	Emission factors	Emission
NMVOC			D

36.4 Spatial allocation

Spatial allocation of emissions is based on population density.

36.5 References

CBS. 2021. Number of active tanker truck. Personal communication.
Infomil, 2002. KWS 2000 eindrapportage, Infomil, Den Haag 52
TNO. 2000. Vervolgonderzoek naar emissies van VOS bij tankautoreiniging in Nederland, sept 2000, TNO-MEP r2000/280, Apeldoorn

36.6 Version, date and sources

Version: 1.0
Date: January 2018
Contact:

Emission expert	Organization	E-mail adress
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37 Accidental fires (NFR 5E)

This section describes the emissions caused by accidental fires of cars and houses.

Process description	Emission source code	NFR code	Sector
Accidental fires, houses	0801200	5E	Consumers
Accidental fires, cars	0801300	5E	Consumers

37.1 Description of the emission source

Due to accidents and/or purposeful actions, cars and houses are lost in a fire. The smoke resulting from the fire is a source of emissions. When a house or car burns, the amount of material lost in the fire is dependent on the response time of (professional) fire fighters.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 0.6% in 1990 and 2.5% in 2020 (ER dataset 1990-2022).

37.2 Calculation

Emissions are calculated as follows:
Emission = Activity data x Emission factor

Activity data = Number of accidental fires (house or car)
Emission factor = kg emission per accidental fire

a) Activity data
The number of buildings and cars exposed to fire, was collected by all fire brigades in the Netherlands and reported yearly via Statistics Netherlands, until the year 2013. Those numbers are used for the timeseries 1990-2013.

For the amount of car fires in 2020-2024, data from the Netherlands Institute for Public Safety (NIPV) was used.

For the amount of car fires 2013-2019, data from the Dutch Verbond van Verzekeraars (Dutch Association of Insurers) is used. This only includes car fires of insured cars. An estimate of the number of uninsured cars is made based on the number of car fires from NIPV in 2020-2024 and the number of car fires according to the Dutch Verbond van Verzekeraars in 2020-2024. Comparison of these data shows that the total number of car fires according to NIPV is on average 19% higher than the number of insured car fires. This percentage of 19% has been used to estimate the number of uninsured car fires in the period 2013-2020.
For the number of indoor fires from 2014 onwards, no accurate data are available from Statistics Netherlands. Before 2014 the reported number of indoor fires seemed roughly proportional to the total number of buildings. On an annual basis a relatively constant fraction of all

buildings was affected by a fire incident. Based on this percentage an estimate of the number of indoor fires occurring from 2014 to 2018 was made, indicating about 14,000 – 15,000 indoor fires annually.

b) Emission factor
For the car fires the emission factors have been derived from the EMEP/EEA guidebook (EMEP/EEA, 2019) (chapter 5.E. table 3.2).

The emission factors of house fires in the EMEP/EEA guidebook (chapter 5.E. table 3.3 till 3.5) seems inappropriate for the Dutch situation. The emission factor in the guidebook is based on a Norwegian study. However, the houses built in Norway contain more wood and Norway is more rural.

To get an estimate on the amount of combustible materials in an average Dutch household, a study on the Dutch house stock by TNO [TNO, 2017] is used, leaving out the 90% non-combustible materials like concrete, bricks and mineral insulation materials. Without the interior of the house, this results in about 10.3 tonne of combustible material (8,6 tonne wood/triplex and 1,7 tonne plastics). Based on expert judgement the (combustible) interior is estimated te be around 4,5 tonne (a.o. cabinets, floor coverings, beds, etc.), making a total of 14.8 tonne. According to multi-year statistics on the number of fatal housefires in the Netherlands (IFV-BWA-Jaaroverzichten-FataleWoningbranden), in about 55% of the cases studied the destruction by fire is limited to the same room, in 17% the destruction is limited to the same floor and in 28% of the cases the complete house is burned down.

On bases of this information an estimate has been made on the amount of combustible materials being burned in an average house fire, based on an average Dutch situation of a one-family home made up of 3 floors and 4 rooms per floor.

Destruction by fire (limited to)	**combustible materials burned (%)**	**combustible materials burned (tonne)**
same room	10	1.48
same floor	33	4.9
Complete house	100	14.8

When these data on fire destruction and occurrence are combined, this results in the following amount of combustible materials burned:
1.48 x 55% + 4.9 x 17% + 14.8 x 28% = 5,8 tonne.

It is estimated that half of the interior consists of wood, the other half is believed to consists of a mixture of different plastics.

The emissions of all pollutants (except dioxin) from the combustible materials of the construction and the combustible materials of the interior materials are calculated with the emission factors in table 3.39 on small combustion in chapter 1A4 of the guidebook. The emissions of dioxin are calculated using the EF from Aasestad (2017) of 170 µg I-TEQ per tonne burned material.

37.3 Uncertainty

The uncertainty in the activity data for the years before 2014 is relatively low as the data are reported by a reliable source. From 2014 onwards, the activity data is not reported annually or had to be estimated. Therefore, the uncertainty is rated with a C.

The emission factor for car fires is reported within the guidebook, with a relatively high bandwidth with only 1 source mentioned. Therefore, the emission factor is rated with a B.

For house fires, the emission factors are based on expert judgment in combination with reliable sources. Therefore, the emission factor is rated with a B.

Source	Activity data	Emission factors	Emission
House fires	C	B	C
Car fire	C	B	C

Quality checks

The number of house fires reported by the CBS is not in-line with the number of house fires reported in a report from the Dutch association of insurance companies. The insurance companies report about 7 times more house fires. However, it is believed that the insurance companies report every fire-related incident, for example an incident with burn stains in a kitchen.

37.4 Spatial allocation

The spatial allocation of accidental fires is based on population density

Source	Allocation-parameter
Accidental fires, houses and cars	Population density

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

37.5 References

https://www.verzekeraars.nl/publicaties/actueel/risicomonitor-woningbranden-2017

Aasestad K., 2007. Norwegian Emission Inventory 2007. Documentation of methodologies for estimating emissions of greenhouse gases and long-range transboundary air pollutants. Report 2007/38, Statistics Norway.

EMEP/EEA air pollutants emission inventory guidebook, 2019, https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

CBS statline

https://opendata.cbs.nl/statline/#/CBS/en/

Brandweerstatistiek 2013

IFV-BWA-Jaaroverzichten-FataleWoningbranden2010-2018 (Annual analyses on the cause(s), development and effects of all the fatal indoor fires in the Netherlands).

TNO, 2017, KIP Waste and Resource Platform, March 2017, TNO 2017 R10373, Utrecht.
Nederlands Instituut Publieke Veiligheid (NIPV) - Home - Nederlands Instituut Publieke Veiligheid
Verbond van Verzekeraars - Verbond van Verzekeraars - brancheorganisatie

37.6 Version, dates and sources

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38 Bonfires (CRT 5.C.2 and NFR 5C2)

In this paragraph the emissions caused by bonfires are described.

Process description	Emission source code	CRT -code	NFR code	Sector
Bonfires*	0801400	5.C.2	5C2	Consumers

*) this includes all known bonfires per year, spontaneous (small) bonfires and non-registered fires have not been included.

38.1 Description of the emission source

According to tradition, a number of holidays are brightened up with bonfires.
These bonfires have a strong regional background and as a result, most of them are only celebrated in specific parts/regions in the Netherlands. The actual number of bonfires in the Netherlands fluctuates per year mainly depending on how strong the tradition is respected and the local weather circumstances at the moment.
The bonfires are composed of waste wood (pallets) or pruning wood, this is regulated and ensured by local enforcing authorities.

The listing below gives an overview of the commonly known bonfires incorporated in this method with the date/period of occurrence and the geographical occurrence.

Name	Date/period	Location(s)
New Year's eve	First day of new Year	Scheveningen
Christmas tree burning	First day of new Year	Netherlands
Easter fires	Easter (March/April)	Northern and eastern part the Netherlands
Meierblis	30 April	Texel (the largest island of the Dutch Wadden Islands)
Luilak	On Saturday before Whitsunday (May/June)	North-west part of the Netherlands
Saint-Maarten	11 November	The most Northern Provinces and the most southern province.

*) spontaneous (small) bonfires and non-registered/regulated fires have not been included.

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 0.2% in 1990 and 0.02% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national CH4 emission was 0.01% in 1990 and <0.01% in 2020, and the contribution of this source to the total national N2O emission was 0.01% in 1990 and <0.01% in 2020 (ER dataset 1990-2020).

38.2 Calculation

Emissions are calculated as follows:
Emission pruning wood = Activity data x density x Emission factor
Emission pallets = Activity data x density x Heating value x Emission factor

Activity data = Total amount of wood burned (number of bonfires x volume)
Density = Weight per m^3 of pruning wood or pallets
Heating value = Energy (GJ) per kg of pallet
Emission factor (pruning wood) = kg emission per Mg pruning wood
Emission factor (pallets) = g emission per GJ pallets burned

a) Activity data
The activity data largely originates from specific websites, local newspapers and news articles.

The yearly amount of pallets and pruning wood burned in bonfires is partly based on actual registered volumes of material, supplemented with estimates. Of the large scale bonfires on New Year's Eve in Scheveningen and large part of the Easter fires, exact amounts of burned material are being registered. This is due to the fact that there is a fierce competition between several villages and/or neighbourhoods for building the biggest and highest woodpile.
Of the other bonfires the total amount of material being burned is not registered. Because they are subjected to local regulations on location, volume and type of materials to be burned and in combination with expert judgement an estimate can be made on the total amount of material being burned.

Easter fires
The total amount (m^3) of pruning burned in the 4 large Easter fires can be found on the following website:
http://www.paasvuurdijkerhoek.nl/wordpress/uitslagen, and is presented below. In 2019, the Easter fires were limited in size because of the drought, and no data on the size of these fires is known, it is assumed that they were 500 m^3 per fire. In 2020 and 2021, the Easter fires were cancelled due to COVID-19 restrictions.
In 2022 the Easter piles fires burned as in previous years. As of 2023 the size of the piles is limited to 1,000m^3 due to nitrogen restrictions applied.

	Dijkerhoek	**Espelo***	**Beuseberg**	**Holterbroek**
2015	5,308	5,783	2,289	1,634
2020	0	0	0	0
2021	0	0	0	0
2022	4,293	3,644	1,852	1,468
2023	1,000	1,000	1,000	1,000

*) the pile of Espelo is registered twice as a World Record by the Guinness book of World Records.

All other Easter fires in the Netherlands are much smaller and the occurrence of these bonfires is very dependent on local initiatives and organisation. In the majority of the Netherlands no further permits are needed in case the volume of the bonfire is below 1000m^3.
As a result, the number of (small) Easter fires and the volumes of these fires are not registered and can only be estimated on basis of local newspapers and the number of inhabitants per Province.

The average volume of the smaller Easter fires is estimated to be 250 m$^{3.}$ The number of Easter fires is estimated to be roughly 400 and is linked to the number of inhabitants per province.

For earlier years, the activity data has been based on the trend in inhabitants (a 10% increase in inhabitants results in a 10% increase in amount of pruning burned).

New Year's Eve
The volume of pallets burned in Scheveningen on New Year's Eve is measured accurately because of the fierce competition between 2 neighbourhoods.
Based on measurements of the height and the footprint of the pile, the annual volume of the wood piles was calculated and is presented below. For some years, the volume is an estimation based on the height. There were no fires in Scheveningen and Duindorp in 2019-2021, due to safety restrictions (2019) and COVID-19 (2020 and 2021). From 2022 the size of the piles is limited to 1,000m^3 due to nitrogen restrictions applied.

	Duindorp	**Scheveningen***
2015	9,453	8,695
2020	0	0
2021	0	0
2022	1,000	1,000
2023	1,000	1,000

*) Just as with the Easter fires both the pile of Scheveningen and Duindorp have been officially registered as the largest bonfire by the Guinness book of World Records, for different years.

As with the Easter fires all other bonfires on New Year's Eve in the Netherlands are much smaller and the occurrence of these bonfires is very dependent on local initiatives and organisation. In the majority of the Netherlands no further permits are needed in case the volume of the bonfire is below 1000 m^3.
As a result, the number of (small) Easter fires and the volumes of these fires are not registered and can only be estimated on basis of local newspapers.

As a result of the nitrogen restrictions applied from 2022 the total volume of wood burned in New Year's Eve's is estimated to be 4,000 m^3 (around 2,000m^3 for Scheveningen and Duindorp + 2,000 m^3 for the other smaller non-registered bonfires). This volume is used for the complete time series.

Meierblis
This bonfire is solely celebrated on Texel (the largest island of the Dutch Wadden Islands). Based on local newspapers it is estimated that around 7 large fires and around 65 smaller fires are lit every year.
It is estimated the large bonfires account for about 3,500 m^3 together and the smaller bonfires amount to 16,250 m^3 total. This volume is used for the complete time series.

Luilak
This is a folkloristic celebration characterised by the loud noises in the early morning by the participants.
Based on local newspapers it is estimated that the number of bonfires is about 10 and the amount of wood burned is restricted to 16m^2 max. thus resulting in a total amount of about 640 m^3. The number of Luilak-fires decreased. It is assumed that the total amount of pruning decreased from 2000 to 500 m^3 in the period 1990-2017.

Saint-Maarten
This celebration is restricted to specific areas in the Netherlands. Based on regional newspapers and expert judgement it is estimated that the volume of wood burned is 5,000 m^3. This volume is used for the complete time series.

Christmas tree burning
This celebration takes place in all of the Netherlands. Based on regional newspapers and expert judgement it is estimated that the volume of wood burned is 5,000m^3. This volume is used for the complete time series.

b) Density
The density of pruning wood is based on a Belgian report from the Flemish government on waste from 2014 (www.lne.be) and is equal to 0.15 ton/m^3. The density of pallets is based on a standard pallet size of 0.8 x 1.2 x 0.144 meter and a standard pallet weight of 25 kg, resulting in a density of 0,18 ton/$m^{3.}$

c) Heating value of pallets
The heating value of pallets has been derived from the kachelmodel Jansen B.I., 2010, Emissiemodel houtkachels, TNO, The Netherlands. This is equal to 15.6 MJ/kg.

d) Emission factor
A distinction in emission factor is made for the burning of pallets and the burning of pruning wood. The emission factors for the burning of pallets have been derived from EEA LRTAP NFR Category 1A4 - Guidebook 2016, July 2017 (table 3.39 open fireplaces burning wood) and from the IPCC 2006 Guidelines (Volume 2, chapter 2, table 2.5). The emission factors for the burning of pruning wood have been derived from EEA LRTAP NFR Category 5C2 - Guidebook 2016 (table 3.2 Open burning of agricultural wastes/forest residue) and from the IPCC 2006 Guidelines (EF of CH4 and N2O from Volume 5, chapter 5; EF of CO2 and dry matter content from garden and park waste in Volume 5, chapter 2).

For greenhouse gases, the following emission factors have been used:

Gas	EF pallets (kg/GJ)	EF pruning wood (kg/ton)
CO_2	112	719
CH_4	0.3	6.5
N_2O	0.004	0.375

38.3 Uncertainty

The uncertainty in the activity data is relatively high, since only part of the data is being measured, the remainder of the data is being estimated on basis of newspapers and websites from the applicable bonfire organisation. The uncertainty of the activity data is estimated at 100%.

The emission factors for pallet burning and for the burning of pruning wood are reported in the EMEP/EEA guidebook and the IPCC Guidelines, with a relatively high bandwidth. Therefore, uncertainty in the emission factors is estimated at 300%.

38.4 Spatial allocation

The emissions of bonfires are regionalized in the Netherlands based on population density.

Source	Allocation-parameter
Bonfires	Number of bonfires per province

Details are available via:
http://www.emissieregistratie.nl/erpubliek/misc/documenten.aspx?ROOT=Algemeen (General)\Ruimtelijke toedeling (Spatial allocation)

38.5 References

https://vreugdevuur-scheveningen.nl/historie/
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http://www.paasvuurdijkerhoek.nl/wordpress/uitslagen/
https://www.immaterieelerfgoed.nl/nl/page/828/meierblis-on-texel
https://nl.wikipedia.org/wiki/Sint-Maarten_(feest)
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Jansen B.I., 2016, Emissiemodel houtkachels update, TNO, The Netherlands
LNE, 2014. Overzichtstabel soortelijk gewicht afvalstromen

38.6 Version, dates and sources

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Date: January 2019
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39 Degreasing new vehicles

This section describes the emissions caused by degreasing new vehicles. These emissions occurred until 1999.

Process description	Emission source code	Sector
Degreasing of new vehicles	8920701	Trade and Services

39.1 Description of the emission source

Until 1998, cars were sometimes protected with a paraffin coating (wax) to protect them during transport. At the dealer, the protective coating was removed with a solvent, resulting in emissions of NMVOC. Currently cars are protected by a plastic film or a water solvable coating. However, some car producers apply no protection at all, or only for a certain type of transport.

Contribution to the national emission
This emission source is no longer relevant.

39.2 Calculation

a) Activity data
Prior to 1999, emissions were calculated based on the number of imported cars (of certain brands) that were paraffin coated and dewaxed at the dealer. Most car brands had central depots with adequate air cleaning installations, so no significant emissions occurred.
Between 1990 and 1993 fewer cars were dewaxed each year. As mentioned above, other options (centralized cleaning, other coatings) reduced the need for dewaxing a new car.
Between 1994 and 1998, only one car brand used decentralized dewaxing.

b) Emission factors
An emission factor to air of 0.64 kg NMVOC per cleaned car was applied for each year. The emission factor to the sewer system was about 4.5 g NMVOC and the direct emissions to water were estimated to be 0.3 g NMVOC per treated car. These emission factors were estimated by TNO based on the reference year 1992. An emission profile for the NMVOC was also determined by TNO; the NMVOC emissions were supposed to be non-aromatic hydrocarbons.

39.3 Uncertainty

As this method is no longer used, it is hard to quantify the uncertainty. The TNO report on the emission profile is not (publicly) available, therefore it is difficult to qualify the value of the emission factors.
If the uncertainty had to be rated, it would be qualified with an E.

39.4 Spatial allocation

The emissions of consumers are regionalised in the Netherlands based on population density.

Source	Allocation-parameter
Degreasing of new vehicles	Car maintenance companies

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

39.5 References

CREM, November 1998, 'Monitoring VOS-emissie van 9 sectoren 1997', Amsterdam (not publicly available).
InfoMil, KWS2000 Annual reports, multiple years, Den Hague.

39.6 Version, dates and sources

Version 1.0
Date: February 2018
Contact:

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40 Disinfectants (NFR 2D3a)

This section describes NMVOC emissions from disinfectants.

Process description	Emission source code	NFR code	Sector
Solvent and other product use: hand sanitizers	0890402	2D3a	Consumers

40.1 Description of the emission source

Disinfectant hand gels are used to sanitize the hands. They are used professionally in the healthcare sector and are available on the consumer market. The active ingredient is most often ethanol (Huiberts et al., 2021), which is a volatile organic compound.

Contribution to the national emission
The contribution of this source to the total national NMVOC emission was 1.1% in 1990 and 7.5% in 2020 (ER dataset 1990-2022).

40.2 Calculation

The emission of NMVOCs from disinfectants is calculated by multiplying an emission factor with activity data for the year of emission.

Emission = Activity data × Emission factor

The activity data refers to the annual market volume (in kton) in The Netherlands for disinfectant sold on the market for the purpose of disinfecting surfaces and hands by consumers and for professional use (NVZ, 2023).

Activity data
The annual market volume of disinfectants sold in The Netherlands is estimated from data collected in the annual reports of NVZ (see Chapter 13 Annex II).

Emission factor
An emission factor of 0.67 kg NMVOC emission per kg disinfectant sold has been established. The density of disinfectants is about 0.89 g/ml (QRS, 2023) and comprise comprises a volume fraction of NMVOCs of 70 to 83.7 % ml NMVOC per ml disinfectant (Hendriks et al., 2021), i.e. a volume fraction that is on average 77 %. Ethanol is the main NMVOC ingredient of disinfectants (Huiberts et al., 2021) which has a density of 0.79 g/ml. As such 1 g disinfectant contains (0.89 /77%) 0.79 = 0.68 g NMVOC per g disinfectant. About 98% of the NMVOC evaporates during application (Hendriks et al., 2021), so that the emission is 98% × 0.68 g/g = 0.67 kg NMVOC emission per kg disinfectants sold.

40.3 Uncertainty

Substance	Activity data	Emission factors	Emission
NMVOC	C	C	C

40.4 Spatial allocation

The emissions of disinfectants are allocated in the Netherlands based on inhabitants. Details are available at
Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

40.5 References

Hendriks HS, Woutersen M, ter Burg W, Bos PMJ, Schuur AG. 2021. Health risk assessment of ethanol-containing hand sanitizer. RIVM report 2021 - 0026

Huiberts EHW, Wezenbeek JM, Komen CMD. 2021. Inventory of active substances in hand disinfectants. RIVM report 2021-0212

NVZ. Nederlandse Vereniging van Zeepfabrikanten. Website: https://www.nvz.nl/over-de-nvz/jaarverslagen/

QRS

40.6 Version, dates and sources

Version 1.0
Date: January 2022
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41 Residential combustion, Outdoor combustion (CRT 1.A.4.b.i and NFR 1A4bi)

This section describes the emissions from outdoor wood combustion by consumers.

Process description	Emission source code	CRT code	NFR code	Sector
Outdoor wood combustion	0012103	1.A.4.b.i	1A4bi	Consumers

41.1 Description of the emission source

Besides indoor wood combustion for space heating purposes (discussed in chapter 25), a significant amount of wood and wood waste is burned outdoors in garden chimineas, fire pits and braziers ("tuinhaarden", "vuurschalen" en "vuurkorven" in Dutch).

Contribution to the national emission
The contribution of this source to the total national PM2.5 emission was 0.4% in 1990 and 1.9% in 2020 (ER dataset 1990-2022). For greenhouse gases, the contribution of this source to the total national CH4 emission was <0.01% in 1990 and 0.02% in 2020. The contribution of N2O emissions was <0.01%.

41.2 Calculation

The emissions are calculated using the basic approach:

Emission = Activity data x Emission factor

A) Activity data
Activity data for outdoor wood combustion was asked in a large Dutch Survey for the year 2012 (Segers, 2013), which reported around 30 kt wood for 2012. This value was scaled according to the evolution of the number of houses in the Netherlands, to create a timeseries from 1990 onwards.

There are indications in literature (e.g. Oomen et al., 2019) that the estimate by Segers is actually an underestimation, especially during the COVID lockdowns of 2020 and 2021. Reliable and realistic data are however not (yet) available for the Netherlands.

b) Emission factor
The emission factors used for outdoor wood combustion are identical to the emission factors for conventional fireplaces (see Visschedijk et al., 2020). It is implicitly assumed that combustion efficiencies are comparable.

Pollutant	EF (g/GJ, CO_2 kg/GJ)
CO_2	112
CH_4	300
N_2O	4
$PM_{2.5}$	637
PM_{10}	670
BC / EC	76

41.3 Uncertainty

The activity data for outdoor wood combustion is particularly uncertain at this stage and currently estimated at 500% upwards and 50% downwards.

For the emission factors the uncertainty of the emission factors for fireplaces has been assumed to be valid for outdoor combustion as well. They are as follows:

Pollutant	EF uncertainty	Reference
CO_2	±15%	IPCC Guidelines
CH_4	300 g/GJ, Factor 3	IPCC Guidelines
CH_4	100 g/GJ, Factor 7	Range in Kindbom et al. 2018
N_2O	Factor 3.5	IPCC Guidelines
NO_x	±50%	EEA Guidebook 2016
CO	Factor 2.5	EEA Guidebook 2016
PM_{10}	Factor 2.5	Expert judgement TNO
$PM_{2.5}$	Factor 2.5	Expert judgement TNO
BC / EC	Factor 3	Expert judgement TNO
SO_2	Factor 3 up; -20% down	EEA Guidebook 2016
NH_3	Factor 5	Expert judgement TNO
NMVOC	Factor 2.5 up; factor 4 down	EEA Guidebook 2016

Note that in many cases the uncertainty of emission factors has an asymmetric (mostly lognormal) distribution.

41.4 Spatial allocation

The emissions due to outdoor wood combustion are spatially allocated in a similar way as indoor wood combustion and based on the distribution of various types of houses, with each type having a specific average number of wood combustion appliances.

Emission source/process	Allocation-parameter
Burning wood in Stoves	Various types of residential homes

Details available via www.emissieregistratie.nl/Documentatie/07 Ruimtelijke verdeling.

41.5 References

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41.6 Version, dates and sources

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