Category		Title
NFR:	**2.D.3.a**	**Domestic solvent use including fungicides**
SNAP:	**060408** **060411**	**Domestic solvent use (other than paint application)** Domestic use of pharmaceutical products
ISIC:		
Version	**Guidebook 2013**	

Coordinator
Jeroen Kuenen & Carlo Trozzi

Contributing authors (including to earlier versions of this chapter)
Patrik Fauser, Neil Passant and Mike Woodfield

Contents

1 Overview

This chapter addresses non-methane volatile organic compound (NMVOC) and some other pollutant emissions from the domestic use of solvent-containing products. Many of these products are also used in industry and commerce. It is not always possible to differentiate domestic and industrial/professional use. This is particularly the case in the 3D3 categories 060412 Other and 060604 Other-Other, but whenever possible this differentiation should be emphasised in the reporting. This section does not include the use of decorative paints, which is covered elsewhere in the Guidebook.

Earlier versions of the Guidebook were based on studies from the early 1990s covering the US (US EPA, 1995), UK (Atlantic, 1995) and Canada UNECE (1990). This present version emphasises utilising country-specific data, assessing comparability between countries, improving completeness and transparency, and improving uncertainty estimates. Priority has been given to compiling emission factors from national inventories that are based on high quality data characterised by a high degree of completeness, accuracy and transparency and have nationally-specific estimates that are independent from other inventories or previous Guidebook data. These countries represent western EU countries, and have detailed mass balances relying on e.g. national production, import and export statistics and information from industries and trade organisations. The additional information compared to the existing Guidebook is therefore high. Methods used by the different countries vary greatly, reasons being that the category comprises a large number of products and pollutants that are categorised as NMVOCs, and that use patterns may vary considerably.

In addition to country specific information from western European emission inventories, the following data sources were used:

- US survey on consumer and commercial solvent use (US EPA, 1996), where some data were included in the previous Guidebook. This survey is comprehensive and for many product categories includes formulation data for practically all products sold within that category. The overall quality of the US emission factors is likely to be good.
- UNECE data for Canadian conditions (UNECE, 1990).
- IIASA data (personal communication, 2011) with emission factors for EMEP regions from GAINS in 2010 for the total domestic sector (DOM_OS) for EU-15 including Iceland, Norway and Switzerland, and for EU-12 including 12 EECCA countries.
- Greek study by Tzanidakis et al. (2012).

Further improvements in the present version of the chapter are:

- update of emission factors for all categories.
- SNAP category 060411 Domestic use of pharmaceutical products has been moved to this chapter.

The ideal case would be to have access to activity data as 'used amount of product', as well as to know the solvent content in products, and measurements and/or estimates of emission factors for solvent species under the given conditions of product use. Realising that not all data are available and that assumptions are necessary, emission factors are given in the following way:

- Tier 1: g/person
- Tier 2: g/kg product and/or g/(kg solvent in product). In the ideal case the one can be derived from the other. Preference should be given to g/(kg solvent in product) when both units are stated in a table.

Emission factors are uncertain parameters and are represented by one number (mean value) with 95%-confidence interval limits, based on all values. When only one or two figures define an emission factor, the uncertainty was assessed from expert judgment, typically representing the 95% confidence interval as (- mean value/(2 to 10); + mean value *(2 to 10)), unless more reliable information was available. When more than two figures define an emission factor, the mean value and 95% confidence interval was calculated from these. In some cases the upper and lower intervals were set to the minimum and maximum values, respectively, from the available dataset.

2 Description of sources

2.1 Process description

NMVOCs are used in a large number of products sold for use by the public. These can be divided into a number of categories:

Cosmetics and toiletries	Products for the maintenance or improvement of personal appearance, health or hygiene.
Household products	Products used to maintain or improve the appearance of household durables.
Construction/DIY	Products used to improve the appearance or the structure of buildings such as adhesives and paint remover. This sector would also normally include coatings; however these fall outside the scope of this section (see B) and will be omitted.
Car care products	Products used for improving the appearance of vehicles to maintain vehicles or winter products such as antifreeze.

A further distinction is made between aerosol and non-aerosol products.

Pesticides such as garden herbicides and insecticides and household insecticide sprays may be considered as consumer products. Most agrochemicals, however, are produced for agricultural use and fall outside the scope of this section. Domestic use of pharmaceutical products and emissions of other pollutants, such as Hg, are also included in this chapter.

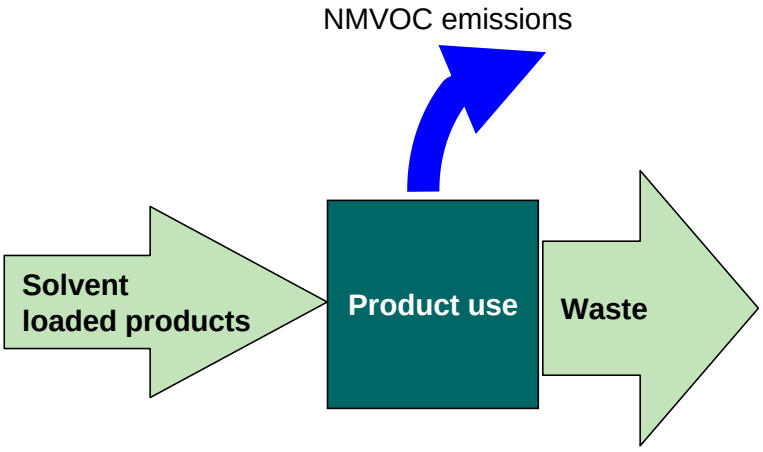

Figure 2-1 Process scheme for source category 2.D.3.a Domestic solvent use

2.2 Techniques

NMVOCs in consumer products are mainly there as solvents. In aerosols, NMVOCs such as butane and propane are also used as propellants. Propellants generally act as solvents as well. Aerosols are mainly comprised in cosmetics and paints, and are therefore not included separately in order to avoid double counting. Switching from an aerosol to a non-aerosol form of product will not necessarily reduce the proportion of solvent used in the product.

2.3 Emissions

Emissions occur due to the evaporation of NMVOCs contained in the products during their use. For most products all of the NMVOC will be emitted to atmosphere. However, in some products the NMVOC will be lost mainly in waste water.

There are few data on the NMVOC species present in consumer products. A breakdown of NMVOC emissions from all consumer products has been given by a Swiss study (ATAL, 1992).

Table 2-1 Breakdown of NMVOC emissions from all consumer products

VOC compound class	Total emission (t/a)	% of total emission
Aliphatic hydrocarbons	3 200	22
Alcohols	7 300	50
Amines	210	1
Ketones	70	1
Esters	140	1
Ethers	2 780	19
Aromatic hydrocarbons	450	3
Chlorinated hydrocarbons	190	1
Organic acids	190	1

The NMVOCs used are stated to include propane butane ethanol isopropanol ethyl acetate and butyl acetate. The following breakdown for emissions due to the use of aerosols is given in Passant (1993):

Table 2-2 Breakdown for emissions due to the use of aerosols

Compound	% wt
Alkanes	60
Alcohols	35
111-trichloroethane	2
Esters and ketones	1
Dimethylether	2

The alkanes present in emissions will be predominantly butane and propane propellants. Ethanol is likely to be the most commonly used alcohol. The most widely used solvent in cosmetics and toiletries is ethanol and in the absence of more detailed information it is recommended that all emissions from non-aerosol cosmetics and toiletries are assumed to be ethanol.

2.4 Controls

Control of emissions from use of consumer products can only be achieved through reformulation of products to contain less NMVOC or measures to promote the use of lower boiling NMVOC products.

3 Methods

3.1 Choice of method

Figure 3-1 presents the procedure to select the methods for estimating emissions from the domestic use of solvents. The basic idea is:

- if detailed information is available, use it. For this source category, however, facility-level data will not be available. Therefore, the Tier 3 method using facility data cannot be used for this chapter;
- if the source category is a key category, a Tier 2 method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method.

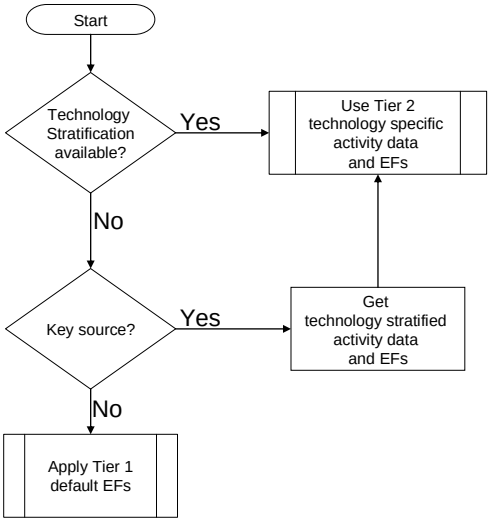

Figure 3-1 Decision tree for source category 2.D.3.a Domestic solvent use

3.2 Tier 1 default approach

3.2.1 Algorithm

The Tier 1 method uses emission factors expressed on a per-person basis to derive an emission estimate for the activity by multiplying the emission factor by population.

The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and include an integrated emission factor and emission factors for sub-processes within the source category. It is applied at a national level, using the population. Based on IIASA calculations, emission factors can be calculated for EU-15 including Iceland, Norway and Switzerland and for EU-12 including eastern European countries and 12 EECCA countries.

In cases where specific abatement options are to be taken into account a Tier 1 method is not applicable and a Tier 2 or Tier 3 approach must be used.

3.2.2 Default emission Factors

Table 3-1 presents the default emission factor for source category 2.D.3.a for NMVOC and Hg, for EU-15 including Iceland, Norway and Switzerland. Additional information on Tier 1 emission factors for the four main subcategories (household products, car care products, cosmetics and toiletries; DIY/buildings; pharmaceutical products; and various are shown in Table 3-2.

The Tier 1 emission factor in Table 3-1 is calculated as the bottom-up sum of emission factors for the four subcategories, i.e. Σ NMVOC (all), and Pharmaceutical products and Various, in Table 3-2. This is done because emission factors for the subcategories, NMVOC (all), are the most accurate and reliable, as they are based on the highest number of studies and are more up-to-date

than emission factors for aerosol and non-aerosol categories, which are typically based on 1980 and 1990 data.

Table 3-1 Tier 1 emission factors for source category 2.D.3.a Domestic solvent use including fungicides

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
Total 2.D.3.a					
NMVOC (3D2)	2 700	g/person	1 700	3 700	Sum of sub-categories in Table 3-2. Valid for EU15 + Iceland, Norway and Switzerland
Hg (fluorescent tubes)	5.6	mg/person	1	10	N=1 (Norwegian, 2012)

Table 3-2 Additional informative Tier 1 emission factors for subcategories in source category 2.D.3.a Domestic solvent use including fungicides

Additional informative Tier 1 emission factors					
Pollutant	**Value**	**Unit**	**95% confidence interval[a)]**		**Reference**
			Lower	**Upper**	
Household (cleaning) products					
NMVOC (all)	507	g/person	100	900	N=5 (Norwegian IIR, 2012; Swiss IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
NMVOC (aerosol)	201	g/person	130	270	N=3 (UK IIR, 2012; UNECE (Canada), 1990; Italian IIR, 2012)
NMVOC (non-aerosol)	252	g/person	150	350	N=3 (UK IIR, 2012; UNECE (Canada), 1990; Italian IIR, 2012)
NMVOC (other)	54[c)]	g/person	30	80	Calculated difference
Car care products					
NMVOC (all)	464	g/person	20	900	N=4 (Norwegian IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
NMVOC (aerosol)	161[b)]	g/person	40	280	N=2 (UK IIR, 2012; UNECE (Canada), 1990)
NMVOC (non-aerosol)	303[b)]	g/person	150	450	N=2 (UK IIR, 2012; UNECE (Canada), 1990)
Cosmetics and toiletries					
NMVOC (all)	1 ,088	g/person	400	1 800	N=4 (Norwegian IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
NMVOC (aerosol)	355	g/person	250	450	N=3 (UK IIR, 2012; Italian IIR, 2012; UNECE (Canada), 1990)
NMVOC (non-aerosol)	494	g/person	250	750	N=3 (UK IIR, 2012; Italian IIR, 2012; UNECE (Canada), 1990)
NMVOC (other)	239[c)]	g/person	40	440	Calculated difference
DIY/buildings					
NMVOC (all)	522	g/person	220	820	N=2 (Norwegian IIR, 2012; Greece, 1996-2006)

NMVOC (adhesives)	76	g/person	15	140	N=4 (Norwegian IIR, 2012; UK IIR, 2012; US EPA, 1996; UNECE (Canada), 1990)
NMVOC (paint thinner)	205	g/person	50	360	N=1 (UK IIR, 2012)
NMVOC (paint and varnish removers, solvents)	68	g/person	15	120	N=3 (Norwegian IIR, 2012; Swiss IIR, 2012)
NMVOC (sealants, filling agents)	23	g/person	13	33	N=2 (Norwegian IIR, 2012; US EPA, 1996)
NMVOC (other)	150[c)]	g/person	20	280	Calculated difference
Pharmaceutical products (SNAP 060411)					
NMVOC	48	g/person	16	100	N=2 (Swiss IIR, 2012; Italian IIR, 2012)
Various					
NMVOC (pesticides)	76	g/person	60	90	N=2 (Norwegian IIR, 2012; UK IIR, 2012)

Notes:

[a)] 95% confidence intervals are calculated or set to minimum and maximum data values (n>2), or estimated from expert judgment (n=1 and n=2)

[b)] Emission factors for aerosol and non-aerosol are reduced for their sum to be equal to the emission factor for subcategory NMVOC (all)

[c)] Calculated difference: (emission factor for subcategory NMVOC (all)) – (sum of emission factors at most differentiated level of categories)

In Table 3-2, the sum of emission factors at the most differentiated level of categories must be equal to emission factor for the corresponding subcategory NMVOC (all). Consequently an emission factor at the most differentiated level is added, comprising 'not included' categories. In cases when the sum of emission factors at the most differentiated level exceed the emission factor for subcategory NMVOC (all), see car care products, there will be a reduction of the emission factors.

3.2.3 Comparison

For comparison a Tier 1 NMVOC emission factor for Total 2.D.3.a, was calculated based on data from Italy (Italian IIR, 2012), Greece (Tzanidakis et al., 2012) and IIASA (2011) for EU-15 + Iceland, Norway and Switzerland), to be 2 300 ±1 100 g/person. This is a factor of 1.16 lower and thus comparable to the recommended emission factor in Table 3-1.

3.2.4 Emission factor for EU12 and 12 EECCA countries

An IIASA Tier 1 NMVOC emission factor for western European Union Member States (EU-15 including Iceland, Norway and Switzerland) is 1 519 ± 559 g/person. An IIASA Tier 1 NMVOC emission factor for eastern EU countries (EU-12 and 12 EECCA countries) is 703 ± 273 g/person. This suggests that an emission factor for EU-12 can be derived from Table 3-1 by multiplying with a factor of 703/1 519 = 0.46. Total 2.D.3.a for EU-12 and 12 EECCA countries is thus: 0.46*(2 700 (-1 700; + 3 700) = 1 200 (-780; + 1 700) g/person.

3.2.5 Activity data

Basic activity statistics for using the Tier 1 emission factor are national population figures.

3.3 Tier 2 technology-specific approach

3.3.1 Algorithm

The Tier 2 approach is similar to the Tier 1 approach. To apply the Tier 2 approach, both the activity data and the emission factors are stratified according to the same domestic product categories as in Tier 1. The four main sub categories comprise a list of different products (regarded here as 'techniques'), as listed in subsection 3.3.2 of the present chapter.

The Tier 2 algorithm is as follows.

Stratify the domestic use of products in the country to model the different products occurring in this sector into the inventory by

- defining the products used in this sector (called 'technologies' in the formulae below) separately; and
- applying technology-specific emission factors for each product:

$$E_{pollutant} = \sum_{technologies} AR_{product,technology} \times EF_{technology,pollutant} \quad (2)$$

If, however, no direct activity data are available, penetration of different technologies within the domestic use of solvents could be estimated from other data that might reflect the relative size of each product.

A country where only one technology is implemented is basically a special case of the above approaches. The penetration of this technology in such a case is 100 % and the algorithm in equation (3) reduces to:

$$E_{pollutant} = AR_{product} \times EF_{technology,pollutant} \quad (3)$$

3.3.2 Technology-specific emission factors

Studies such as those carried out in the US are useful in providing an extensive list of consumer products which contain NMVOC. However, the bulk of NMVOC emissions will be due to the use of a relatively small number of consumer products and it is good practice to give these products priority in developing detailed estimates. Based on US and UK data and country specific inventories, the following products may contribute significantly to emissions:

Cosmetics and toiletries
Aerosols, all types
Styling aids, pumps
Styling gels
Other hair care, pumps
Antiperspirants/deodorants, pumps
Perfumes
After shave
Nail-polish remover
Astringent
Healthcare products, external
Rubbing alcohol

Car care products
Aerosols, all types
Antifreeze
Brake fluids
Car waxes and polishes
De-icer pumps
Engine degreasers
Windscreen washing fluid

Household products
Aerosols, all types
General purpose cleaners
Glass cleaner
Air freshener, slow release
Toilet blocks
Disinfectants
Waxes and polishes

DIY/buildings
Carpet/tile adhesives
Pipe cements
Construction adhesives
Paint thinners
Paint remover
Solvents

Use of pesticides and use of pharmaceutical products are also included in this category, and cooling liquid (ethylene glycol) may be an important contributor to the national total emissions from this source category.

The proportion of solvent contained in a product which is actually emitted to atmosphere will vary depending upon the manner in which it is used. The US survey assumed 100 % NMVOC emitted to atmosphere except in the case of products which are either used diluted in water (i.e. dishwasher detergents, fabric detergents, bleach, etc.), in which case 1 % was generally assumed, or products which are removed with water after performing their function (i.e. shampoos, soaps, toothpaste, household cleaners, etc.), which were assigned factors of between 5 % and 50 % NMVOC emitted to atmosphere. The data quality of estimates made using the detailed method will depend upon the quality and quantity of data used. In theory it may be possible to obtain estimates deserving of an A rating (refer the General Guidance, Chapter 5, Uncertainties, for an explanation of the quality ratings).

3.3.2.1 Cosmetics and toiletries

Table 3-3 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Cosmetics and toiletries (all)

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Cosmetics and toiletries (all)				
Region or regional conditions	European Union and USA				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	127	g/kg product	60	250	N=2 (Italian IIR, 2012; US EPA, 1996)
NMVOC	830	g/kg solvent	800	900	N=1 (US EPA, 1996). This value is given preference

Table 3-4 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Cosmetics and toiletries, Non-aerosol

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Cosmetics and toiletries, non-aerosol				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	85	g/kg product	50	120	N=2 (Italian IIR, 2012; UK IIR, 2012)

Table 3-5 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Cosmetics and toiletries, Aerosol

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Cosmetics and toiletries, Aerosol				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	270	g/kg product	140	540	N=1 (Italian IIR, 2012)

Table 3-2 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Cosmetics and toiletries, Other

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Cosmetics and toiletries, Other				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	239	g/person	40	440	Calculated from Tier 1 emission factors

3.3.2.2 Household products

Table 3-3 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Household products (all)

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Household products (all)				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	16.2	g/kg product	8	33	N=2 (US EPA, 1996; Italian IIR, 2012)
NMVOC	650	g/kg solvent	500	800	N=2 (SMED, 2006; US EPA, 1996). This value is given preference

Table 3-4 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Household products, Non-aerosol

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Household products, Non-aerosol				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	10	g/kg product	7	15	N=2 (UK IIR, 2012; Italian IIR, 2012)

Table 3-5 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Household products, Aerosol

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Household products, Aerosol				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	201	g/person	130	270	N=2 (UK IIR, 2012; UNECE (Canada), 1990; Italian IIR, 2012)

Table 3-6 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Household products, Other

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Household products, Other				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	54	g/person	30	80	Calculated from Tier 1 emission factors

3.3.2.3 Car care products

Table 3-7 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Car care products (all)

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Car care products (all)				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	183	g/kg product	100	340	N=2 (Italian IIR, 2012; US EPA, 1996)
NMVOC	940	g/kg solvent	920	960	N=2 (SMED, 2006; US EPA, 1996). This value is given preference

Table 3-8 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Car care products, Non-aerosol

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Car care products, Non-aerosol				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	247	g/kg product	125	500	N=1 (UK IIR, 2012)

Table 3-9 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Car care products, Aerosol

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Car care products, Aerosol				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	161	g/person	40	280	N=2 (UK IIR, 2012; UNECE (Canada), 1990)

3.3.2.4 DIY/buildings

Table 3-14 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, DIY/buildings (all)

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	DIY/buildings (all)				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	950	g/kg solvent	900	1000	N=1 (SMED, 2006)

Table 3-15 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, DIY/buildings, Adhesives

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	DIY/buildings, Adhesives				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	66	g/kg product	5	130	N=2 (UK IIR, 2012; US EPA, 1996)
NMVOC	950	g/kg solvent	900	1000	N=1 (SMED, 2006). This value is given preference

Table 3-16 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, DIY/buildings, Paint/varnish removers and solvents

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	DIY/buildings, Paint/varnish removers and solvents				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	950	g/kg solvent	930	1000	N=2 (SMED, 2006)

Table 3-17 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, DIY/buildings, Sealants, filling agents

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	DIY/buildings, Sealants, filling agents				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	45	g/kg product	20	100	N=1 (US EPA, 1996)
NMVOC	975	g/kg solvent	950	1000	N=2 (SMED, 2006; US EPA, 1996). This value is given preference

Table 3-18 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, DIY/buildings, Paint thinner

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	DIY/buildings, Paint thinner				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	205	g/person	50	360	N=1 (UK IIR, 2012)

Table 3-19 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, DIY/buildings, Other

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	DIY/buildings, Other				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	150	g/person	20	280	Calculated from Tier 1 emission factors

3.3.2.5 Various

Table 3-10 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Pesticides

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Pesticides				
Region or regional conditions	European Union and US				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	152	g/kg product	140	160	N=2 (UK IIR, 2012; US EPA, 1996)
NMVOC	865	g/kg solvent	800	930	N=2 (Norwegian IIR, 2012; US EPA, 1996). This value is given preference

Table 3-111 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Hg (fluorescent tubes)

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060408	Domestic solvent use (other than paint application)			
Technologies/Practices	Fluorescent tubes				
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NMVOC, NOx, CO, SOx, NH3, Pb, Cd, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
Hg	5.6	mg/person	1	10	N=1 (Norwegian IIR, 2012)

3.3.2.6 Domestic use of pharmaceutical products

Table 3-22 Tier 2 emission factors for source category 2.D.3.a Domestic solvent use including fungicides, Pharmaceutical products

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.a	Domestic solvent use including fungicides			
Fuel	NA				
SNAP (if applicable)	060411	Domestic use of pharmaceutical products			
Technologies/Practices					
Region or regional conditions	European Union				
Abatement technologies					
Not applicable	NOx, CO, SOx, NH3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCH , PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Not estimated	PM2.5				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	606	g/kg product	250	950	N=2 (Austrian IIR, 2012; Italian IIR, 2012)

3.3.3 Abatement

Abatement options are not available for this source category.

3.3.4 Activity data

Basic activity statistics are solvent consumption and/or quantity of products used for the detailed methodology.

3.4 Tier 3 emission modelling and use of facility data

Tier 3 is not applicable for this source.

4 Data quality

4.1 Completeness and transparency

Care should be taken to include all emissions from solvent use. There could be overlaps with other NFR source categories. It is good practice to check that indeed all emissions are included.

Consistency and continuity between Tier 1 and Tier 2 categories is important. With respect to the four large aggregated categories (Household products, Car care, Cosmetics, DIY/buildings) plus Pharmaceuticals and Various, these are present in both tiers. Furthermore, the Tier 1 and Tier 2 sub-categories are also identical. The data are compiled from different sources, and it is often difficult, if not impossible, to define the exact product groups that are comprised in all categories. Hence, the most detailed level of categories has been used, bearing in mind that a high degree of

differentiation (split of categories) makes comparison between data sources more difficult. A compromise has therefore been established.

There are no data sources that comprise emission factors for all categories and sub-categories that are provided in this Guidebook. Therefore the emission factor tables are aggregates of all available reliable data. This implies that the same references cannot always be found in all categories and associated sub-categories. However, this approach reflects the most reliable and comparable estimates to be used for other countries.

4.2 Avoiding double counting with other sectors

Care should be taken not to double count emissions from solvent use. There could be overlapping with other NFR source categories. It is good practice to check that indeed no emissions are double counted.

4.3 Verification

Verification of emission estimates can be carried out in a number of ways. It is good practice to carry out the most detailed methods in co-operation with product manufacturers who may be able to provide formulation data and production statistics. Estimates derived using the detailed method could be cross checked against estimates made for other countries. It is good practice to keep in mind, however, that there may be significant differences in the use of NMVOCs in consumer products from country to country. Estimates may also be compared with estimates of the quantity of solvent sold to manufacturers of consumer products derived perhaps in consultation with solvent suppliers. Formulation data where obtained from manufacturers could be verified through analysis of products.

In 2002, a study for the European Commission identified many products and emissions that are important for this source category (European Commission, 2002). This report can be very useful to verify the emissions.

4.3.1 Best Available Technique emission factors

The Best Available Techniques are available from the BREF STS document (European Commission, 2007).

4.4 Developing a consistent time series and recalculation

Temporal allocation of emissions can be derived from monthly consumption statistics and from information on operating schedule, work-shifts, weekend interval ,etc. If these data are not available, it is good practice to assume constant operation.

4.5 Uncertainty assessment

4.5.1 Emission factor uncertainties

The simple Tier 1 method relies upon a per person emission factor and the detailed Tier 2 method relies on access to activity data as used amount of product and/or data on solvent content in products, and measurements and/or estimates of emission factors for solvent species under the given conditions of product use. Tier 1 and 2 emission factors were derived from emissions estimates for European countries with high quality independent data and for the USand Canada.

The estimates for Europe and the US are likely to be relatively accurate, perhaps +/- 20 %. In the case of the US, since data on the NMVOC content was obtained for products representing most of the US market, the largest uncertainty will be the proportion of NMVOC in some products which is actually emitted to air. It is good practice to note that the per capita emission factor is likely to vary considerably between countries, particularly Western and Eastern European countries. There are likely to be differences in the per person consumption of products as the formulations used from country to country vary due to economic geographical and cultural reasons. The overall uncertainty of estimates may therefore be high, as much as +/- 50 %. The use of the detailed method will remove one uncertainty which is present in the simpler method. Depending upon the quantity of data relating to formulations which can be obtained, there is no reason why the detailed method should not give an accuracy of perhaps +/- 20 %. As with the US data, the largest uncertainty may be the proportion of NMVOC which is emitted to air.

4.5.2 Activity data uncertainties

Activity data may vary between countries in relation to amounts and type of solvents in products. In order to implement the emission factors in this Guidebook in the most accurate way, emphasis should be on obtaining country specific information on the solvent content in products e.g. from producers, manufacturers or importers,.

4.6 Inventory quality assurance/quality control QA/QC

The weakest aspect of the Tier 1 method is the use of per person emission factors. There are likely to be differences in the use of consumer products in different countries due to, for instance, differences in car ownership, household size, wealth, lifestyle, product formulation and climate. It is good practice to feed back emission estimates from other countries derived using the Tier 2 or Tier 3 method into the Tier 1 method to improve the emission factors. The adoption of a range of factors to reflect geographical and economic factors could be considered.

The Tier 2 method should provide reasonably accurate estimates depending upon the quantity of data on product NMVOC content which is available. More information is required on the NMVOC contents of consumer products, especially those products which contribute most to emissions. If the formulations used are comparable in different countries, then default emission factors could be developed for use in the detailed method. The proportion of NMVOC in a product actually emitted to atmosphere may be considerably less than 100 % for some products. Further research may be necessary to determine the fate of NMVOCs contained in such products.

Better speciated data are required, especially for household and car-care non-aerosol products.

4.7 Gridding

It is good practice to disaggregate national emissions by population.

4.8 Reporting and documentation

No specific issues.

5 Glossary

Consumption	Refers to sales of products in the country concerned.
Decorative paints	Paints applied to internal walls, ceilings, woodwork, etc. As well as being decorative, they also provide protection against moisture penetration and consequent damage.
DIY	'Do It Yourself', i.e. home decoration by the general public.
Domestic	Refers to the use of products by members of the public in their own homes. These products will usually have been purchased from retail stores.
Formulation	The substances from which the product is manufactured. For aerosols this includes the propellant and solvent. Does not include the packaging materials.
Industrial use	Refers to the use of products by firms engaged in business. Includes products used for cleaning and maintaining buildings and vehicles as well as those used in the production process itself. Many products are used in industry and by households. In the construction industry there is almost a complete overlap with most of the products used by the industry also sold to the DIY market.
Production	Refers to the amount of product manufactured in the country concerned. In many cases production statistics have to be used instead of consumption statistics. They are, however, less appropriate and, if they are used, the resulting emission will have to be assigned a lower data quality.
Propellant	A compressed gas present in the headspace of an aerosol can. Until recently, CFCs were used for this purpose, but now hydrocarbons such as butane are often used. Propellants are chosen to be liquid under pressure, so that when propellant vapour is lost from the headspace on discharge of the aerosol, it is replenished by evaporation of the liquid. The liquid propellant is intimately mixed with the active ingredients and can also act as a solvent, thereby blurring the distinction between propellant and solvent. If the propellant were replaced by a mechanical pump, extra solvent would be needed.
Solvent	A liquid present in an aerosol can to dissolve solid active ingredients.
NMVOC content	The NMVOC content of a product such as a coating can be inferred from its formulation or measured by evaporation tests. The latter are more accurate, but such data are unlikely to be available.

6 References

ATAL (1992). Amt fur technische Anlagen und Lufthygiene NMVOC Emissionen aus Haushaltproduckten, Zurich, February 1992.

Atlantic Consulting (1995). Emissions of Volatile Organic Compounds from Non Aerosol Consumer Products in the UK. Unpublished report commissioned by AEA Technology on behalf of the UK Department of the Environment, March 1995.

Austrian IIR (2012), Informative Inventory report 2012 http://webdab1.umweltbundesamt.at/download/submissions2012/AT_IIR2012.zip?cgiproxy_skip=1

European Commission (2002). Screening study to identify reductions in VOC emissions due to the restrictions in the VOC content of products. Final report, available via http://ec.europa.eu/environment/air/pdf/paint_solvents/2002_02_bipro_final_report.pdf.

European Commission (2007). Integrated Pollution Prevention and Control (IPPC). Reference document on Best Available Technologies on Surface Treatment using Organic Solvents, August 2007.

Greece (1996-2006). Tzanidakis, K., Karnoutsos, D., Sidiropoulos, C., Tsilingiridis, G. J. Variations in emission rates from solvent use in the residential sector: The case of Greece. Environ, Sci. Technol. (2012) 9: 173-182.

Guidebook (2006). EMEP/Corinair Emission Inventory Guidebook, version 4 (2006 edition), published by the European Environmental Agency. Technical report No 11/2006. Available via http://reports.eea.europa.eu/EMEPCORINAIR4/ .

IIASA (2008 & 2012). Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model, www.iiasa.ac.at/rains/gains-online.html.

Italian IIR (2012). Informative Inventory report 2012 http://webdab1.umweltbundesamt.at/download/submissions2012/IT_IIR2012.zip?cgiproxy_skip=1

Norwegian IIR (2012). Informative Inventory report 2012 http://webdab1.umweltbundesamt.at/download/submissions2012/NO_IIR2012.zip?cgiproxy_skip=1

Passant N.R. (1993). Emissions of Volatile Organic Compounds from Stationary Sources in the United Kingdom, Warren Spring Laboratory Report No LR990.

SMED (2006). Skårman, T., Danielsson, H., Henningsson, E. and Östmann, M. Revised Method for Estimating emissions of NMVOC from Solvent and Other Product Use in Sweden. Swedish Methodology for Environmental Data.

Swiss IIR (2012). Informative Inventory report 2012
http://webdab1.umweltbundesamt.at/download/submissions2012/CH_IIR2012.zip?cgiproxy_skip=1

UK IIR (2012). Informative Inventory report 2012
http://webdab1.umweltbundesamt.at/download/submissions2012/GB_IIR2012.zip?cgiproxy_skip=1

UN ECE (1990). United Nations Economic Commission for Europe, Emissions of Volatile Organic Compounds (VOC) from Stationary Sources and Possibilities for their Control, University of Karlsruhe, July 1990.

US EPA (1995). EPA consumer products survey 1995 (draft only).

7 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projection's expert panel on combustion and industry. Please refer to the TFEIP website (www.tfeip-secretariat.org/) for the contact details of the current expert panel leaders.