SNAP CODE: **060408**

SOURCE ACTIVITY TITLE: **OTHER USE OF SOLVENTS & RELATED ACTIVITIES**
Domestic Solvent Use (Other than Paint Application)

NOSE CODE:

NFR CODE: **3 D**

1 ACTIVITIES INCLUDED

This chapter addresses non-methane volatile organic compound (NMVOC) emissions from the use of solvent containing products by members of the public in their homes. However many of these products are also used in industry and commerce. In many cases it will be difficult or impossible to separate total sales into domestic and industrial parts. This section does not include the use of decorative paints. That is covered in section 060104.

2 CONTRIBUTION TO TOTAL EMISSIONS

Table 1 Contribution to total emissions of the CORINAIR90 inventory *(13 countries)*

Source-activity	SNAP-code	Contribution to total emissions (including emissions from nature) [%]							
		SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Domestic Solvent Use	060408	-	-	2.3	-	-	-	-	-

0 = emissions are reported but the exact value is below the rounding limit (0.1 per cent)
- = no emissions are reported

Table 1 shows that the most important emission from the domestic solvent use sector is NMVOCs. In addition, emissions of sulphurhexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and some POPs (eg trichloroethylene and trichloroethane) could be significant (ETC/AEM-CITEPA-RISOE 1997; ref. 19).

This activity is not believed to be a significant source of $PM_{2.5}$ (as of December 2006).

3 GENERAL

3.1 Description

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

Cosmetics & 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 can be made between aerosol and non aerosol products.

Pesticides such as garden herbicides & insecticides and household insecticide sprays may be considered as consumer products. Most agrochemicals, however, are produced for agricultural use and fall outside of the scope of this section.

3.2 Definitions

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 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 top 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.
VOC Content	The VOC 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.

3.3 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. Switching from an aerosol to a non aerosol form of product will not necessarily reduce the proportion of solvent used in the product.

3.4 Controls

Emissions occur due to the evaporation of VOCs contained in the products during their use. For most products all of the VOC will be emitted to atmosphere. However, in some products the VOC will be lost mainly to waste water. Control of emissions from use of consumer products can only be achieved through reformulation of products to contain less VOC or measures to promote the use of lower VOC products.

4 SIMPLER METHODOLOGY

The simpler method uses a single emission factor expressed on a per person basis to derive an emission estimate for the activity by multiplying the emission factor by population.

5 DETAILED METHODOLOGY

The detailed method involves the collection of data on the VOC content of each type of consumer product. This can then be combined with consumption or production statistics in order to obtain estimates of quantities of VOC used in each category of product. The VOCs contained in some consumer products may not all be emitted to atmosphere therefore the VOC usage statistics are combined with suitable emission factors to derive emission estimates.

6 RELEVANT ACTIVITY STATISTICS

6.1 Simpler Methodology

The relevant activity statistics are national population figures.

6.2 Detailed Methodology

Production or preferably consumption statistics are required for each type of product together with data on typical formulations so that the VOC content can be calculated.

7 POINT SOURCE CRITERIA

Domestic products should be considered as area sources.

8 EMISSION FACTORS QUALITY CODES AND REFERENCES

8.1 Simpler methodology

The following per person emission factors have been derived from data for the UK Canada and the United States. Sources of these data are as follows:

- UK Atlantic Consulting 1995
- Canada UN ECE 1990
- USA EPA consumer products survey 1995 (draft only)

Table 8.1 - NMVOC Emission Factors in g/year per person

Product category	NMVOC Emission Factor (g/year per person)		
	UK	Canada	USA
Cosmetics & toiletries			1061.3
Non aerosol	236.6	400.4	
Aerosol	536.3	384.8	
Household products			431.4
Non aerosol	183.0	230.7	
Aerosol	55.4	346.9	
Car care products			649.0
Non aerosol	324.3	649[1]	
Aerosol	103.8	331[1]	
DIY/buildings			
Adhesives	70.1	47.6	277.2
Other[2]	(221.9)	(221.9)	221.9
Aerosol propellant	785.5	included above	included above
Total	2516.9	2612.3	2640.7

1. These emission factors are given as 0.649g/year/person and 0.331g/year/person in the reference. The units are incorrect and should be kg/year/person. (personnel communication Deslauriers Environment Canada 1995).
2. No data are available for Canada and the UK so the USA figure has been used in order to enable a comparison of total emissions.

The overall emission factors for the three countries are similar although there are some differences in the detail. The average of these three emission factors is recommended for calculating emissions from this sector :

Emission factor 2590g(VOC)person^{-1}year^{-1}

It should be noted that the per capita emission factor is likely to vary considerably between countries, particularly Western and Eastern European countries.

In the case of car care products the ownership of cars may be a more accurate activity statistic than population and if the number of vehicles is known then the following emission factor can be used:

Emission factor 782g(VOC)person^{-1}year^{-1}

If this factor is used for car care, then the average factor of 2590g(VOC)person-1year-1 should be modified to 1904g(VOC)person-1year-1 (i.e. the car care component removed).

The US survey is comprehensive and for many product categories includes formulation data for practically all products sold within that category. There is likely to be greater uncertainty over the proportion of solvent lost to atmosphere from such products however the overall quality of the US emission factors is likely to be good. A data quality B rating is probably realistic. The UK factors for non aerosol products are based on a smaller set of formulation data however the results have been discussed with industry who were in broad agreement with the estimates. A data quality B rating was given to these estimates. Emissions from aerosols are based on a survey by the UK aerosol manufacturers. These estimates are assigned a C data quality. The methods used to calculate the Canadian figures are not known and so no data quality rating can be given. The application of per person emission factors to other countries does increase the uncertainties in emission estimates however a data quality C rating seems justified for emission estimates calculated using the simpler method.

8.2 Detailed methodology

Studies such as that carried out in the US are useful in providing an extensive list of consumer products which contain VOC. However the bulk of VOC emissions will be due to the use of a relatively small number of consumer products and these should be given priority in developing detailed estimates. Based on the US and UK data 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, pump
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

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 and UK surveys assumed 100% VOC emitted to atmosphere except in the case of products which are either used diluted in water (ie 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% VOC 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.

9 SPECIES PROFILES

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

Table 9.1 - breakdown of VOC emissions from all consumer products

VOC compound class	Total emission (t/a)	% of total emission
Aliphatic hydrocarbons	3200	22
Alcohols	7300	50
Amines	210	1
Ketones	70	1
Esters	140	1
Ethers	2780	19
Aromatic hydrocarbons	450	3
Chlorinated hydrocarbons	190	1
Organic acids	190	1

The VOCs 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 9.2 - breakdown for emissions due to the use of aerosols

Compound	%wt
Alkanes	60
Alcohols	35
111-trichloroethane	2
Esters & 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. No data have been found for solvent types used in household and car care non aerosol products.

10 UNCERTAINTY ESTIMATES

The simple method relies upon a per person emission factor. This was derived from emissions estimates for the US UK and Canada. The estimates for the US and UK are likely to be quite accurate perhaps +/- 20%. In the case of the US since data on the VOC content was obtained for products representing most of the US market the largest uncertainty will be the proportion of VOC in some products which is actually emitted to air. 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 derived from the simple method may therefore be high perhaps as much as +/- 50%.

The use of the detailed method will remove one uncertainty which is present in the simpler method namely whether per person consumption of products is the same in each country. 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 VOC which is emitted to air.

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHOD

The weakest aspect of the simple 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. Emission estimates from other countries derived using the detailed method should be fed back into the simple method to improve the emission factors. The adoption of a range of factors to reflect geographical and economic factors could be considered.

The detailed method should provide reasonably accurate estimates depending upon the quantity of data on product VOC content which is available. More information is required on the VOC 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 VOC 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 VOCs contained in such products.

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

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

National emissions should be disaggregated by population.

13 TEMPORAL DISAGGREGATION CRITERIA

Assume continual emission throughout the year unless better information is available for instance monthly sales statistics. There is likely to be a variation in emissions between summer and winter, with higher emissions likely in summer when more DIY activity takes place, and a strong diurnal variation with emissions highest during the day.

14 ADDITIONAL COMMENTS

No additional comments.

15 SUPPLEMENTARY DOCUMENTS

No supplementary documents are required.

16 VERIFICATION PROCEDURES

Verification of emission estimates can be carried out in a number of ways. The detailed method should be carried out 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 should be borne in mind however that there may be significant differences in the use of VOCs 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.

17 REFERENCES

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

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18 BIBLIOGRAPHY

No additional documents to those in Section 17.

19 RELEASE VERSION DATE AND SOURCE

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20 POINT OF ENQUIRY

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