Category		Title
NFR	2.D.3.g	Chemical products
SNAP	060301	Polyester processing
	060302	Polyvinylchloride processing
	060303	Polyurethane foam processing
	060304	Polystyrene foam processing
	060305	Rubber processing
	060306	Pharmaceutical products manufacturing
	060307	Paints manufacturing
	060308	Inks manufacturing
	060309	Glues manufacturing
	060310	Asphalt blowing
	060311	Adhesive, magnetic tapes, films and photographs manufacturing
	060312	Textile finishing
	060313	Leather tanning
	060314	Other
ISIC		
Version	Guidebook 2019	

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Contents

1 Overview

This chapter covers the emissions from the use of chemical products. This includes many activities, as can be seen in the chapter heading. However many of these activities are considered insignificant, meaning that emissions from these activities contribute less than 1 % to the national total emissions for every pollutant. However, care should be taken; in some countries activities not considered in this chapter may be significant for the national total of non-methane volatile organic compound (NMVOC) emissions.

This chapter deals with emissions from:

- polyurethane and polystyrene foam processing;
- asphalt blowing;
- tyre production;
- speciality organic chemical industry;
- manufacture of paints, inks and glues;
- fat, edible and non-edible oil extraction;
- industrial application of adhesives.

For all these processes, source descriptions and Tier 2 emission factors are available in this Guidebook.

This document has been drafted using texts from an earlier version of the Guidebook and more recent information from the Expert Group on Techno-economic Issues (EGTEI, 2003) and International Institute for Applied Systems Analysis (IIASA, 2008). Additional technical information that is not included in this chapter can be found in BIPRO (2002).

2 Description of sources

2.1 Process description

This section gives brief process descriptions of some important processes within this source category. The descriptions are largely based on the EGTEI background reports (EGTEI, 2003) and an earlier version of the Guidebook. More detailed descriptions may be found in the BREF documents that cover the processes discussed in this chapter. These may be the documents on Surface Treatment using Organic Solvents and Production of Speciality Inorganic Chemicals. Because there is a strong link between this source category and the chemical industry, further explanations may also be found in Chapter 2.B Chemical industry.

2.1.1 *Polyurethane and polystyrene foam processing*

Foam processing deals with the application and subsequent discharge of organic compounds as blowing agents for creating plastic foams (polyurethane and polystyrene). These blowing agents need to be liquids characterised by a low boiling point. By application of external heat (polystyrene) or due to the reaction heat (polyurethane), the liquid evaporates and helps create the foam, without actually taking part in the reaction. Chlorofluorocarbons (CFCs) (such as F11, F12, F22) have been used for polystyrene processing; most of these are now replaced by pentane. In extruded

polystyrene, other types of chemicals are used. In polyurethane, CFCs were also used, but presently other types of blowing agents are used. In polyurethane, the types of blowing agents used depend on the final use of the foam. Butane and pentane can be used as many substitutes of CFC such as HFC and HCFC. Some polyurethane foams can be expanded directly with CO_2 resulting from a reaction between polyols and water.

Emissions are from the release of these blowing agents during foaming, or subsequently by the long-term release over several years, and are strictly evaporative. The production of the raw materials is included in SNAP code 040500 covering bulk chemical production.

Polyurethane (PUR) and polystyrene (EPS) are used in building construction, for heat insulation, and for packaging material. Characteristic is a high proportion of on-site foaming, i.e. only the production takes place in well defined production plants, the foaming (EPS) and the actual formation (PUR) directly at the site needed, which leads to direct emissions without foreseeable control.

a) Polyurethane

Polyurethane is produced by the exothermic reaction of iso-cyanates with alcohols. About 80 % of the world production is foams (Stoeckhert et al, 1993), which are created by adding blowing agents. For soft polyurethane foams water may be used, which binds with iso-cyanate to form CO_2. Hard polyurethane foams utilise organic liquids as blowing agents, which evaporate due to the heat formation of the reaction. Hard foam is known for its good sealing and insulation properties. This also determines its use in refrigeration equipment as well as in the building and construction industry. While prefabricated compounds can be attributed to production sites directly, a considerable proportion of polyurethane foam is produced and applied directly, for example at a construction site. Figures for Germany (Greenpeace, 1991) indicate that this 'direct production' is almost as large as prefabrication (7 000 t CFCs used, vs. 9 500 t).

Another aspect of the sealing properties is that the blowing agent is included into the cells of the structure, and only eventually released. According to the German estimation (Rentz et al, 1993), only about 15–25 % of the blowing agent applied is released immediately; the rest is stored inside the cells of the foam and released eventually. Again, estimations are available for Germany (Plehn, 1990). The total amount of stored F11 (70 000 t) is about five times the annual usage of CFCs for hard foam polyurethane.

b) Polystyrene

Pentane-impregnated polystyrene beads contain about 6 % in mass of pentane. They are processed as follows (CCME, 1997; EGTEI, 2005):

- heating and stirring in an expander with steam. Pentane acts as a blowing agent which, when heated with steam, expands the beads. Additives such as antistatic and mould-release agents are also added to the vessel;

- drying in a fluidised bed: the resulting 'pre-expanded beads' are transferred to a fluidised bed dryer where they are dried and screened to remove the agglomerated beads;

- storage: dried pre-expanded beads are stored in large-volume hanging cloths or mesh sacks for between a few hours to several days according to the final product density to be obtained. During this curing time, air permeates into the beads and restores their internal pressure;

- moulding: the cured pre-expanded beads are transferred into a mould where steam is admitted. The beads expand again but are constrained by the mould. They squeeze out all space and fuse together to make an article of a shape determined by the mould;

- storage of products. When insulation blocks are produced, the storage time again depends on the quality of insulation block to be obtained (density of these blocks).

When insulation boards are produced, EPS blocks are cut with electrically-heated taut wires to the final dimensions desired. According to the products manufactured, one or two stages of pre-expansion and curing are required. Polystyrene wastes (polystyrene wastes from the production as recovered used polystyrene) can be recycled. All NMVOC emissions result from the release of blowing agent (pentane) from the beads during processing, curing, moulding and storage (EGTEI, 2005).

2.1.2 Asphalt blowing

Asphalt blowing is used for polymerising and stabilising asphalt to improve its weathering characteristics. Air-blown asphalts are used in the production of asphalt roofing products, in the installation of built-up roofs and for the repair of leaky roofs. Air blowing of asphalt may be conducted at oil refineries, asphalt processing plants and asphalt roofing plants. The emissions from asphalt blowing are still primarily organic particulate with a fairly high concentration of gaseous hydrocarbon and polycyclic organic matter.

Asphalt blowing involves the oxidation of hot asphalt flux which is achieved by the bubbling air of the blowing still. Air is forced through holes in the sparger into a tank of hot asphalt flux. The result is an exothermic oxidation reaction, which raises the softening temperature of the asphalt, as well as modifying other characteristics.

The process is highly temperature dependent, as the rate of oxidation increases rapidly with increases in temperature. Since the reaction is exothermic, the temperature rises as blowing proceeds. Temperatures must be kept safely below the flash point of the asphalt. The temperature is therefore kept at an optimum level of 260 °C during blowing by spraying water onto the asphalt surface. For some crude auxiliary cooling may also be required.

Inorganic salts such as ferric chloride ($FeCl_3$) may be used as catalysts to achieve the desired properties and/or to increase the rate of reaction, thus decreasing the blowing time. Blowing times may vary in duration from 30 minutes to 12 hours, depending on the desired characteristics of the asphalt (softening point, penetration rate).

Stills may be either vertical or horizontal. Vertical stills are preferred because of the increased asphalt-air contact and consequent reduction in blowing times, as well as lower asphalt losses.

Asphalt blowing can be either a batch process or a continuous operation. Typically, stills at roofing plants and processing plants may be run as batch processes, while refineries may run in both modes, depending on the product demand.

In Canada, the percentage of asphalt produced that was sold for non-asphalt purposes, and was therefore likely to have been blown, ranged from 16.4 to 24.7 % of total reported asphalt sales in the period 1983 to 1991. In the U.S., 14 % of total sales was reported for non-paving uses in 1991. (Asphalt Institute 1992).

2.1.3 Tyre production

Tyres are produced using a large variety of materials. The main process steps are:

- mixing,
- extrusion,
- calendering,
- building,
- curing (vulcanisation).

2.1.4 Speciality organic chemical industry

This industry is very heterogeneous: plants manufacture a large range of products, using a large number of production processes and may store and use several hundred raw material substances or intermediate products. Processes are usually operated on a campaign basis and in multipurpose plants. For one active ingredient, several transformation stages are required. The processes typically involve between 1 to 40 transformation stages depending on molecules. Process stages cover the full range of unit operations, such as reactions, liquid/liquid extraction, liquid/liquid or liquid/solid or gas/solid separation, distillation, crystallisation, drying, gas adsorption, etc. Production is carried out in discontinuous processes (or batch processes). Equipment is rarely specific but, most often, multi-application. Processes frequently use solvents. Any reacted raw materials may be either recovered or recycled or ultimately discharged to the environment after appropriate treatment (HMSO, 1993; EGTEI, 2003).

Because of the diversity of processes used in this sector, no simple process description can be made (HMSO, 1993). Instead, a brief outline of characteristics of existing pharmaceutical product production plants is provided (Syndicat, 1998; Industrial experts, 1998; Allemand 1998).

2.1.5 Manufacture of paints, inks and glues

Raw materials used in the products manufacturing process include solids, binders, solvents and all kinds of additives.

- Solids provide the coating with colour, opacity, and a degree of durability.
- Binders are components which form a continuous phase, hold the solids in the dry film, and cause it to adhere to the surface to be coated. The majority of binders are composed of resins and drying oils which are to a great extent responsible for the protective and general mechanical properties of the film (more significant in decorative paints).
- For viscosity adjustment, solvents are required. Materials that can be used as solvents include aliphatic and aromatic hydrocarbons, alcohols, esters, ketones, and esters and ether-esters of ethylene and propylene glycol.
- Additives are raw materials which are added in small concentrations (0.2–10 %). They perform a special function or give a certain property to the coating. Additives include driers, thickeners, antifoams, dispersing agents, and catalysts.

The function of each paint is the same whether it is based on alkyd or latex (based on styrene-butadiene polymers). The selection of which to use will depend on the substrate and desired performance.

Only physical processes as weighing, mixing, grinding, tinting, thinning, and packaging take place; no chemical reactions are involved. These processes are carried out in large mixing tanks at approximately room temperature.

Figure 2-1   Process scheme for source category 2.D.3.g Chemical products
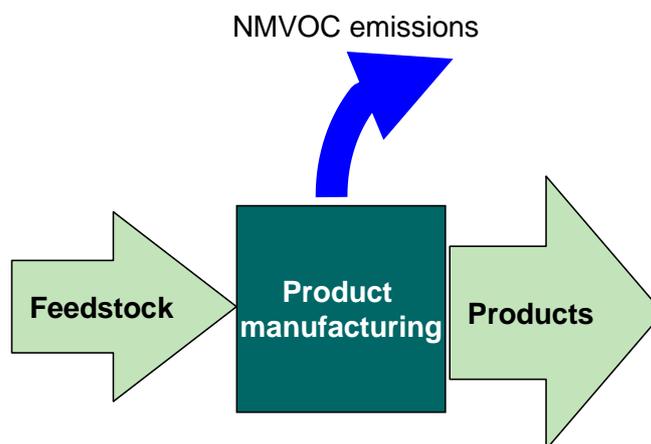
2.2   Techniques

Techniques are described in subsection 2.1 of the present chapter.

2.3   Emissions

2.3.1   Polyurethane and polystyrene foam processing

Emissions are due to evaporation of blowing agents and consist of CFCs or alkanes (pentane, butane), respectively. All blowing agent used will eventually be emitted into the atmosphere, unless some kind of capturing device exists. However, it may take years until all of the blowing agent is released from the cells of a PUR foam.

Depending on the blowing agent, emissions used to be F11, F12, F22, butane and pentane. Nowadays, emissions are almost exclusively pentane, since this is the most frequently used blowing agent and since it is forbidden by law to use F-gases.

2.3.2   Asphalt blowing

Asphalt blowing stills are sources of particulate hydrocarbon, gaseous hydrocarbon and carbon monoxide. Emissions of gaseous hydrocarbons are small because of the prior removal of volatile hydrocarbons in the distillation units.

The type of crude and characteristics of the asphalt may influence the emissions. For instance, the US Environmental Protection Agency (USEPA, 1980) hypothesizes that uncontrolled emissions are higher for asphalts derived from the more volatile West Coast or Middle East crudes than from the mid-continent crudes. Process parameters influencing emissions include the blowing temperature,

air rate, design/configuration of the still, and the type of product desired (e.g. saturant or coating asphalt).

2.3.3 Tyre production

NMVOCs are emitted during the various process steps.

2.3.4 Speciality organic chemical industry

Significant number of NMVOC-emission release points

Gaseous discharge circuits are complex. For the same equipment, several discharge points do exist, depending on the performed operations. The large number of discharge points is due to:

• quality constraints required in this sector in order to avoid risks of cross-contamination;

• security constraints in order, for example, to avoid contact with incompatible gases.

Plants having an annual solvent consumption ranging from 900 to 1 500 t may have from10 to 50 NMVOC emission discharges in the atmosphere.

A large number of discharge points are equipped with condensers to trap NMVOC. To trap corrosive or toxic gases, several vents are related to abatement absorption columns. When secondary abatement techniques are applied, collecting the vents proves to be necessary.

High variability of NMVOC discharges over time

NMVOC concentrations may vary widely from one discharge point to another. Discharges with high waste gas flow rates and low concentrations do exist; general ventilation of a factory belongs to this group. Other discharges, such as production equipment vents, are characterised by very low waste gas flow rates (some Nm^3/h) and NMVOC concentrations that may be high.

NMVOC discharges present a very high variability: high variability with time when there is a discharge and non-permanent discharges.

This situation leads to more significant costs for emission treatment: the gas-cleaning device should be able to accept emission peaks. Abatement technique dimensioning must be based on the peak discharge (the frequency of peaks should be considered as well). Investments are thus higher than for more regular emissions in time.

A large number of solvents used

In this activity, even though five solvents (methanol, toluene, acetone, ethanol, methane dichloride) represent about 70 % of the new solvent consumption, around 40 different solvents are in use. In France, for example (Allemand, 1998), the consumption of chlorinated solvents represents about 20 % of the total consumption of solvents. This large number of solvents, the presence of chlorinated solvents and security and quality constraints make the use of secondary abatement techniques more difficult and more expensive (treatment of HCl if incineration, limited potential for collection and recycling of solvents).

2.3.5 Manufacture of paints, inks and glues

Emission losses may arise from several steps in the process. Major emission sources are:

• fugitive losses during the manufacturing process,

- losses during filling and cleaning activities,

- losses from product clinging to the vessels and equipment,

- fugitive losses during mixing of preparations and storage of solvents.

2.3.6 Fat, edible and non-edible oil extraction

NMVOCs are emitted during the various process steps.

2.3.7 Industrial application of adhesives

NMVOCs are emitted during the various process steps.

2.4 Controls

Within the EU-27, solvent emissions have reduced considerably since the 1990s, following the introduction of the Solvents Emissions Directive 1999/13/EC. This directive, however, does not cover emissions from polyurethane and polystyrene foam processing, asphalt blowing and pharmaceutical products. Many countries, however, have their own regulations that reduce emissions from this source category even further.

The descriptions regarding the control measures below discuss the situation before this Directive came into force and may therefore be outdated. Outside the EU-27, however, the emissions may still be at higher levels.

2.4.1 Polyurethane and polystyrene foam processing

Possibilities to reduce NMVOC emissions are:

- replacement of CFCs by pentane and butane is reducing CFC emissions at the cost of increasing alkane emissions (already done in most cases);

- control/combustion of pentane, wherever defined production units are available;

- reduction of long-term emissions by controlled destruction of used foam material (like the insulation of refrigerators);

- replacement of plastic foams as packaging materials.

Another reduction technique consists in ducting waste gases into a boiler. However, costs of this technique have not been studied.

Add-on techniques can be used to reduce the emissions. Applications exist in several countries. Oxidation techniques are the most frequently used techniques, but waste gases containing pentane can also be destroyed in a boiler.

For polystyrene, measures that can be taken to reduce emissions (EGTEI, 2005) are detailed before:

- **expandable polystyrene beads with only 4 % of pentane** are presently available. However, all product types cannot be produced with this 4 % polystyrene. Low-density products that are the most produced ($< 20–25$ kg/m^3) cannot be obtained. In France for example, this limitation reduces the use of 4 % expandable polystyrene to only 25 % of the total production of expanded polystyrene.

- **waste polystyrene recycling** (Wastes from the site production as well as polystyrene wastes from outside recovery) is more and more frequently used. Wastes of expanded polystyrene are introduced during moulding. In Netherlands for example, the total volume of recycled

polystyrene in the production units (waste can be recycled in other type of activities) is 5 % (Infomil, 2002). The use of recycled polystyrene is limited, however, for quality reasons. A level of 15 % is taken into account in this document.

As a secondary measure, activated carbon adsorption or incineration can be used to treat the pre-expander emissions. A gas collection system has to equip the pre-expander and the fluidised bed.

2.4.2 Asphalt blowing

Process controls include the following:

- vertical rather than horizontal stills;
- asphalts that inherently produce lower emissions;
- higher flash point asphalts;
- lower asphalt blowing temperatures.

Thermal afterburners in combination with closed capture systems are used to control combustible emissions from asphalt blowing stills. Although they consume less supplemental fuels, catalytic afterburners cannot be used because the catalyst is subject to rapid poisoning and plugging due to constituents of the fumes from the process.

2.4.3 Tyre production

Operators concerned can conform to the Directive in either of the following ways (EGTEI, 2003):

- by complying with the canalised and fugitive emission limit values (option I);
- by introducing a reduction scheme to comply with the total emission limit value (in particular by replacing conventional high solvent contents products by low-solvent or solvent-free products) (option II).

The Directive applies to installations with a solvent consumption above 15 t per year. Emission limits for application of the Directive are presented in Table 2-1.

Table 2-1   Emission limits for the manufacture of paints, inks and glues (EGTEI, 2003)

Solvent consumption threshold [t/year]	Option I		Option II
	VOC emission limit value in residual gases [mg C/Nm³]	Fugitive emissions % of solvent input	Total emissions % of solvent input
> 15	20	25	25

Primary measures have been defined to represent real average emission factors for the whole European tyre industry sector (from bicycle to truck tyres). These measures have been described with the help of BLIC (2003). The base situation reflects the European situation in 1990. Solvent emissions are estimated to 10 kg VOC/t products (BLIC, 2003).

The percentage of solvent-based adhesives, coatings, inks, and cleaning agents cannot be reduced to less than 25 % (estimation) due to safety reasons.

As a secondary measure, thermal oxidation is available to further reduce the NMVOC emissions.

2.4.4 Specialty organic chemical industry

Only the production of pharmaceutical products is considered by the EC Directive. The solvent consumption threshold is 50 t/y. Operators concerned can conform to the Directive in either of the following ways (EGTEI, 2005):

- option 1: by complying with both the NMVOC emission limit values in residual gases and the fugitive emission limit values;

- option 2: by complying with the total emission limit values.

Emission limits are presented in Table 2-2.

Table 2-2   Emission limits for the manufacture of paints, inks and glues (EGTEI, 2005)

	Option I		Option II
	NMVOC emission limit in residual gases [mg C/Nm³]	Fugitive NMVOC emission limit % of solvent input	Fugitive NMVOC emission limit % of solvent input
New installations	20	5	5
Existing installations	20	15	15

In order to reduce solvent losses and emissions into the atmosphere, a wide range of best practices and process improvements are possible and were implemented in plants several years ago. These measures aim at containing NMVOC emissions. Such measures include (Syndicat, 1998; Industrial experts, 1998; Allemand, 1998; USEPA, 1994a; EGTEI, 2005), for example, (the list presented is not exhaustive):

- work in concentrated environments in order to reduce the consumption of solvents;

- increased use of low volatile solvents and of solvents easier to condense;

- modification of certain operating conditions for distillation (e. g. distillation under ordinary pressure instead of vacuum distillation);

- implementation of good housekeeping, increased condenser efficiency (increased exchanger surfaces and increased refrigerating capacities);

- technology change: dry-sealed vacuum pumps instead of liquid ring vacuum pumps; closed pressure filters or vacuum filters more leak free than open filters; vacuum dryers leading to a better solvent condensation, etc.

According to Syndicat (1998) and Industrial experts (1998), the above-mentioned measures allow a significant NMVOC emission reduction.

Remark

Good housekeeping includes (USEPA, 1991; Allemand, 1998; EGTEI, 2005):

- better controlling of feed rate, mixing, temperature as well as other reaction parameters (pressure control to minimize nitrogen consumption and associated losses from reactors, etc.);

- optimisation of process parameters;

- effective production and maintenance scheduling;

- improved material handling and storage procedures;

- other.

No unique abatement technique can be implemented in a general way in all plants, due to the diversity of situations. Consequently, secondary abatement techniques which could be applied in pharmaceuticals production plants are not defined separately; since it is difficult to determine the implementation potential of each of these reduction technologies, secondary measure 01 takes into account the use of several techniques: thermal incineration, condensation, activated carbon adsorption, absorption (EGTEI, 2005).

Conclusion

According to information received from Syndicat (1998), Industrial experts (1998) and Allemand (1998), three situations may be considered:

- installations emitting more than 15 % of the solvent input: an average value of 30 % is taken into account. This corresponds to the base case (where no specific primary controls nor secondary measure are used);

- installations emitting between 5 to 15 % of the solvent input: an average value of 8 % is taken into account;

- installations emitting less than 5 % of the solvent input: an average value of 3.5 % is taken into account.

2.4.5 *Manufacture of paints, inks and glues*

Operators concerned can conform to the Directive in either of the following ways:

- by complying with the canalised and fugitive emission limit values (solution I);
- by complying with the total emission limit value (solution II).

The Directive applies to installations with a solvent consumption above 100 t per year. Emission limits for application of the Directive are presented in Table 2-3.

Table 2-3   Emission limits for the manufacture of paints, inks and glues (EGTEI, 2003)

	Solution I		Solution II
Solvent consumption threshold [t/year]	VOC emission limit value in residual gases [mg C/Nm^3]	Fugitive emissions % of solvent input[1] [1]	Total emissions % of solvent input[1]
100–1 000	150	5	5
> 1 000	150	3	3

According to US EPA (1992), the overall average emission factor for this sector is 3.4 % of the solvent input. Only primary measures based on good practices are taken into account since emissions are presently low. These measures are (USEPA, 1992; EGTEI, 2003):

- recovery of solvent vapours during raw material distribution;

- unloading of the barrels with forklifts to avoid leakages;

- coverage of mobile reactors;

---

[1] Solvent input: quantity of organic solvents used as input into the process in the time frame over which the mass balance is being calculated (purchased solvent) + quantity of organic solvents recovered and reused as solvent input into the process (recycled solvents are counted every time they are used in the installations).

- use of heavier solvents to reduce fugitive emissions;

- use of cleaning agents containing less solvents;

- use of automatic cleaning devices whenever possible;

- recycling of cleaning solutions;

- other.

Secondary measures can either be incineration or condensation to recycle lost solvents. Conditions are not optimal for incineration: many vents have to be treated leading to high flow rates with low VOC concentrations. In addition, solvents are raw materials which can be reused into the process (EGTEI, 2003).

3 Methods

3.1 Choice of method

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

- if detailed information is available, use it;

- if the source category is a key category, a Tier 2 or better 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, since it is expected that it is more easy to obtain the necessary input data for this approach than to collect facility level data needed for a Tier 3 estimate;

- the alternative of applying a Tier 3 method, using detailed process modelling, is not explicitly included in this decision tree. However, detailed modelling will always be done at facility level and results of such modelling could be seen as 'facility data' in the decision tree.

Figure 3-1   Decision tree for source category 2.D.3.g Chemical products
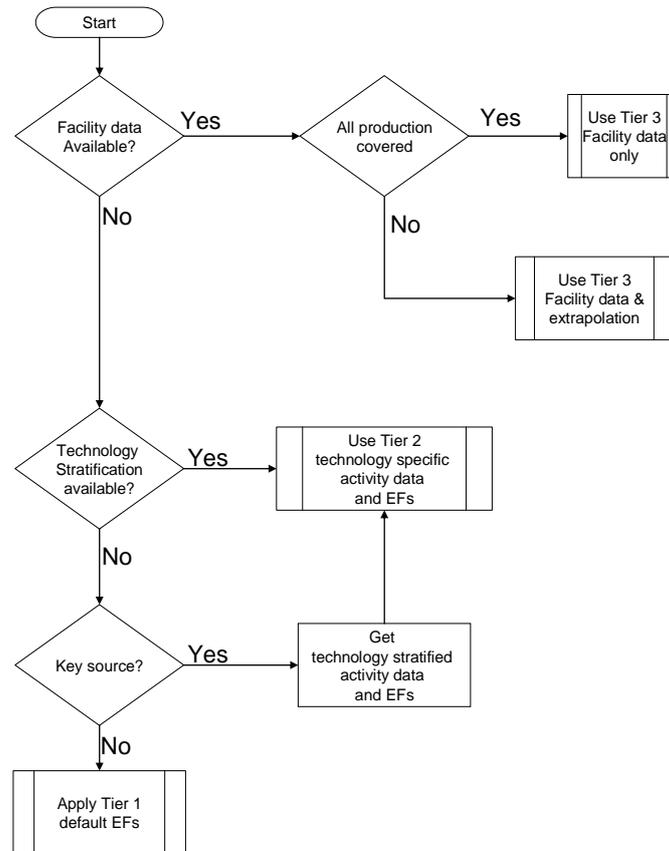
3.2   Tier 1 default approach

3.2.1   Algorithm

The Tier 1 approach for emissions from chemical products use uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

(1)

This equation is applied at the national level, using annual totals of the production or application of chemical products.

The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all different sub-processes within the source category.

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

3.2.2 Default emission factors

Table 3-1 provides the default emission factor for NMVOC emissions from chemical products. It has been derived from the IIASA **G**reenhouse Gas and **A**ir Pollution **In**teractions and **S**ynergies (GAINS) model, taking into account all the GAINS activities that are part of this source category. Only the speciality organic chemistry has not been included, since emissions from this source category are expressed per mass unit of solvent consumed rather than product produced.

The emission factor below is an average over all these activities and should therefore be applied with care. The wide uncertainty range accounts for the variety of processes included within this source category. If product-specific activity data are available, it is good practice to indeed use these data and apply product-specific emission factors (see Tier 2).

Background information with respect to the GAINS model is available via the IIASA website: http://gains.iiasa.ac.at/

Table 3-1   Tier 1 emission factors for source category 2.D.3.g Chemical products use

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	10	g/kg product	0.1	60	IIASA (2008)

3.2.3 Activity data

The relevant activity statistics for Tier 1 is the total mass of product produced. In Tier 1, the mass of all the chemical products can be added together and subsequently multiplied by the emission factor to obtain the national total NMVOC emission. Because of this very simple approach, the factor should be applied with care and has a very wide 95 % confidence interval.

The products that have been considered for deriving this Tier 1 estimate are (between brackets is the abbreviation used in GAINS):

- products incorporating solvents (PIS)
- polystyrene processing (PLSTYR_PR)
- polyvinylchloride processing (PVC_PR)
- synthetic rubber processing (SYNTH_RUB).

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 need to be stratified according to the different products that are used in the country, represented by the relevant SNAP codes in this chapter and possibly other specific chemical products. This chapter distinguishes a number of chemical products, as shown in the

process description (subsection 2.1 of the present chapter) and in the Tier 2 technology-specific tables below.

The following approach is used to estimate emissions from chemical products.

Stratify the use of chemical products in the country to model the different process types occurring in the chemical product use into the inventory by:

- defining the use of each of the products (together called 'technologies' in the formulae below) separately, and

- applying technology-specific emission factors for each product:

$$E_{pollutant} = \sum_{technologies} AR_{use,technology} \times EF_{technology,pollutant}$$

(2)

where:

$AR_{use,technology}$ = the use of a specific chemical product,

$EF_{technology,pollutant}$ = the emission factor for this technology and this pollutant.

If no direct activity data are available, penetration of different products within the source category 'chemical products' could be estimated from data on capacities, number of employees or other data that reflect the relative size of each of the different technologies.

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 (2) reduces to:

$$E_{pollutant} = AR_{production} \times EF_{technology\,pollutant}$$

(3)

3.3.2 Technology-specific emission factors

This section contains Tier 2 for chemical product processes that are part of this source category. Most emission factors are taken from the EGTEI background documents (EGTEI, 2003; EGTEI, 2005). Emission factors for activities not covered by the EGTEI documents are taken from an earlier version of the Guidebook and the BREF document for Surface Treatment using Organic Solvents (European Commission, 2007).

Polyester processing

The table below gives a default emission factor for NMVOC emissions from polyester processing. The emission factor is an average factor derived from USEPA data on the emissions from polyester processing (USEPA, 2007). More specific information is available from USEPA.

Table 3-2   Tier 2 emission factors for source category 2.D.3.g Chemical products, polyester processing

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060301	Polyester processing			
Technologies/Practices					
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	50	g/kg monomer used	10	100	US EPA (2007)

Polyurethane foam processing

The polystyrene emission is equal to the amount of blowing agent applied, which is approximately 12 % of the content of the material for polyurethane foam processing. The figure is derived for CFCs used as a blowing agent. No data are available for pentane as a replacement. It is suggested to use the same emission factor, but with a downgraded quality rating (E, see General Guidance, Chapter 5, Uncertainties, for explanation on the quality ratings).

Table 3-3   Tier 2 emission factors for source category 2.D.3.g Chemical products, polyurethane foam processing

Tier 2 emission factors		
	Code	Name
NFR Source Category	2.D.3.g	Chemical products
Fuel	NA	
SNAP (if applicable)	060303	Polyurethane processing
Technologies/Practices		
Region or regional conditions		
Abatement technologies		
Not applicable		
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB	

Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NMVOC	120	g/kg foam processed	40	400	Rentz (1993)

Polystyrene processing

The polystyrene emission is equal to the amount of blowing agent applied. For the so-called reference case (EGTEI, 2005), it is assumed that 100 of 6 % pentane expandable beads are used and no secondary measures are in place to further reduce NMVOC emissions. The emission factor in the table below is therefore equal to 6 % of the polystyrene processed.

Reduction efficiencies when measures for emission reduction are in place are given in subsection 3.3.3 of the present chapter.

Table 3-4   Tier 2 emission factors for source category 2.D.3.g Chemical products, polystyrene foam processing

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060304	Polystyrene foam processing			
Technologies/Practices					
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	Upper	
NMVOC	60	g/kg polystyrene	30	100	EGTEI (2005)

Rubber processing

The emission factor given in the table below is applicable to rubber processing in general. For tyre production, a separate emission factor is given.

Table 3-5   Tier 2 emission factors for source category 2.D.3.g Chemical products, rubber processing except tyre production

Tier 2 emission factors		
	Code	Name
NFR Source Category	2.D.3.g	Chemical products
Fuel	NA	
SNAP (if applicable)	060305	Rubber processing
Technologies/Practices	Rubber processing except tyre production	
Region or regional conditions		

Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NMVOC	8	g/kg rubber produced	5	21	IIASA (2008)

The table below presents the reference emission factor for the emissions from the production of tyres. In most cases, paints with less solvent and/or abatement measures will be used. For these different paint types and add on abatement measures, reduction efficiencies are provided in subsection 3.3.3 of the present chapter.

Table 3-6   Tier 2 emission factors for source category 2.D.3.g Chemical products, manufacture of tyres

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060314	Other			
Technologies/Practices	Tyre production				
Region or regional conditions					
Abatement technologies	Production of 100% vulcanised rubber; use of 100% solvent-based adhesives, coatings, inks and cleaning agents (90 wt-% solvent) No secondary measures				
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NMVOC	10	g/kg tyres	6	14	EGTEI (2003)

Specialty organic chemical industry

The table below presents the reference emission factor for the emissions from the production of pharmaceutical products with only conventional measures. Reduction efficiencies to calculate the relevant emission factors when using improved abatement measures are provided in subsection 3.3.3 of the present chapter.

Table 3-7   Tier 2 emission factors for source category 2.D.3.g Chemical products, pharmaceutical products manufacturing

Tier 2 emission factors		
	Code	Name
NFR Source Category	2.D.3.g	Chemical products
Fuel	NA	
SNAP (if applicable)	060306	Pharmaceutical products manufacturing

Technologies/Practices	Speciality organic chemical industry, including the pharmaceutical product manufacturing industry				
Region or regional conditions					
Abatement technologies	conventional primary measures; no secondary measures				
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NMVOC	300	g/kg solvents used	200	400	EGTEI (2003)

The definition of solvent used is the same as the definition used by the Directive 1999/13/EC. It corresponds to new solvents or bought solvents + solvents recycled. In the Directive, fugitive emissions are expressed in a percentage compared to solvent used.

Asphalt blowing

The table below provides Tier 2 emission factors for asphalt blowing, as listed in an earlier version of the Guidebook. The table presents uncontrolled emission factors. When controls are in operation, it is good practice to use reduction efficiencies as provided in the abatement section to derive the emission factors for the controlled process. *It should be noted that PAH is based on PAH-16 as defined by US EPA, which may therefore be overestimating PAH-4.*

Table 3-8   Tier 2 emission factors for source category 2.D.3.g Chemical products, asphalt blowing

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060310	Asphalt blowing			
Technologies/Practices					
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, PM10, PM2.5, BC, Pb, Hg, Cu, Zn, PCB, PCDD/F, benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NMVOC	27200	g/Mg asphalt	10000	100000	Robinson (1992)
TSP	400	g/Mg asphalt	100	1000	EMEP/EEA (2006)
Cd	0.0001	g/Mg asphalt	0.00003	0.0003	EMEP/EEA (2006)
As	0.0005	g/Mg asphalt	0.0002	0.002	EMEP/EEA (2006)
Cr	0.006	g/Mg asphalt	0.002	0.02	EMEP/EEA (2006)
Ni	0.05	g/Mg asphalt	0.02	0.2	EMEP/EEA (2006)
Se	0.0005	g/Mg asphalt	0.0002	0.002	EMEP/EEA (2006)

PAH	2.55	g/Mg asphalt	1	10	US EPA (1998)

The older version of the Guidebook gives NMVOC factors with a wide range from Robinson (1992). All other factors are unreferenced in the older Guidebook and should therefore be used with care. Additional information is available in an older version of the Guidebook, however because this information is unclear it has not been included here.

Table 3-9   Tier 2 emission factors for source category 2.D.3.g Chemical products, asphalt blowing, saturant

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060310	Asphalt blowing			
Technologies/Practices	Saturant				
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, PM10, PM2.5, BC, Pb, Hg, Cu, Zn, PCB, PCDD/F, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	660	g/Mg asphalt	70	7000	US EPA (1994b)
TSP	3300	g/Mg asphalt	300	30000	US EPA (1994b)
Cd	0.0001	g/Mg asphalt	0.00003	0.0003	EMEP/EEA (2006)
As	0.0005	g/Mg asphalt	0.0002	0.002	EMEP/EEA (2006)
Cr	0.006	g/Mg asphalt	0.002	0.02	EMEP/EEA (2006)
Ni	0.05	g/Mg asphalt	0.02	0.2	EMEP/EEA (2006)
Se	0.0005	g/Mg asphalt	0.0002	0.002	EMEP/EEA (2006)
PAH	2.55	g/Mg asphalt	1	10	US EPA (1998)

Table 3-10   Tier 2 emission factors for source category 2.D.3.g Chemical products, asphalt blowing, coating

Tier 2 emission factors		
	Code	Name
NFR Source Category	2.D.3.g	Chemical products
Fuel	NA	
SNAP (if applicable)	060310	Asphalt blowing
Technologies/Practices	Coating	
Region or regional conditions		
Abatement technologies		
Not applicable		

Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCDD/F, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB, PCP, SCCP				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	1710	g/Mg asphalt	170	17000	US EPA (1994b)
TSP	12000	g/Mg asphalt	1000	100000	US EPA (1994b)
Cd	0.0001	g/Mg asphalt	0.00003	0.0003	EMEP/EEA (2006)
As	0.0005	g/Mg asphalt	0.0002	0.002	EMEP/EEA (2006)
Cr	0.006	g/Mg asphalt	0.002	0.02	EMEP/EEA (2006)
Ni	0.05	g/Mg asphalt	0.02	0.2	EMEP/EEA (2006)
Se	0.0005	g/Mg asphalt	0.0002	0.002	EMEP/EEA (2006)
PAH	2.55	g/Mg asphalt	1	10	US EPA (1998)

For blowing stills associated with petroleum refineries, USEPA (1985) cites an uncontrolled emission factor for VOC emissions of 30 kg/Mg of asphalt, stating that emissions may be controlled to negligible levels by vapour scrubbing, incineration or both. No quality factor is given.

Paints, inks and glues manufacturing

The table below presents the reference emission factor for the emissions from the production of paints, inks and glues. In most cases, paints with less solvent and/or abatement measures will be used. For these different paint types and add on abatement measures, reduction efficiencies are provided in subsection 3.3.3 of the present chapter.

Table 3-11   Tier 2 emission factors for source category 2.D.3.g Chemical products, manufacture of paints, inks and glues

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060307 060308 060309	Paints manufacturing Inks manufacturing Glues manufacturing			
Technologies/Practices					
Region or regional conditions					
Abatement technologies	45% water-based coatings (4 wt-% solvent) 50% high-solvent based coatings (50 wt-% solvent) 5% other products (100 wt-% solvent) usual practices; no secondary measure				
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	11	g/kg product	7	15	EGTEI (2003)

Products that the emission factor in the table above refers to include paints, varnishes, inks and glues.

Adhesive tape manufacturing

Table 3-12   Tier 2 emission factors for source category 2.D.3.g Chemical products, adhesive tape manufacturing

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)					
Technologies/Practices	Adhesive tape manufacturing				
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	3	g/m2	0	5.5	European Commission (2007)

Manufacturing of shoes

Table 3-13   Tier 2 emission factors for source category 3.D.3 Other product use, manufacturing of shoes

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)					
Technologies/Practices	Manufacture of shoes				
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NMVOC	0.045	kg/pair of shoes	0.02	0.06	IIASA (2008)

Leather tanning

The table below gives a default emission factor for NH$_3$ emissions from leather tanning. This is only applicable when ammonium salts are used for deliming. Emissions of NMVOC occur when organic solvents are used, but no default emission factor is available.

Table 3-14 **Tier 2 emission factors for source category 2.D.3.g Chemical products, leather tanning**

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.D.3.g	Chemical products			
Fuel	NA				
SNAP (if applicable)	060313	Leather tanning			
Technologies/Practices					
Region or regional conditions					
Abatement technologies					
Not applicable					
Not estimated	NOx, CO, NMVOC, SOx, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NH3	0.68	g/kg raw hid	0.2	2	European Commission (2007)

Synthetic fibres

Information on fibre manufacturing activities is available from AP-42 (USEPA, 1982). Data are available for various fibre manufacturing activities, including ryanoin, acetate, acrylic and nylon. However, these data are old and should be used with care.

3.3.3 Abatement

A number of add-on technologies exist that are aimed at reducing the emissions of specific pollutants. The resulting emission can be calculated by replacing the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{technology,abated} = (1 - \eta_{abatement}) \times EF_{technology,unabated}$$ (4)

This section presents default abatement efficiencies for a number of abatement options, applicable in this sector.

Polystyrene processing

This section presents the reduction efficiencies for the processing of polystyrene when using improved control measures. The efficiencies provided in the table below relate to the conventional emission factor for NMVOC presented in Table 3-4.

Table 3-15   Abatement efficiencies (η_{abatement}) for source category 2.D.3.g Chemical products, polystyrene processing

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060304	Polystyrene foam processing			
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Use of 100% of 6% pentane expandable beads; thermal incineration on the expander	NMVOC	34%	0%	70%	EGTEI (2005)
Use of 85% of 6% pentane expandable beads + 15% of EPS wastes (recycling); no secondary measure	NMVOC	15%	10%	30%	EGTEI (2005)
Use of 85% of 6% pentane expandable beads + 15% of EPS wastes (recycling); thermal incineration on the expander	NMVOC	44%	20%	80%	EGTEI (2005)
Use of 100% of 4% pentane expandable beads; no secondary measure	NMVOC	33%	20%	70%	EGTEI (2005)

Specialty organic chemical industry

This section presents the reduction efficiencies for the production of pharmaceutical products when using improved control measures. The efficiencies provided in the table below relate to the conventional NMVOC emission factor in Table 3-7.

Table 3-16   Abatement efficiencies (η_{abatement}) for source category 2.D.3.g Chemical products, pharmaceutical products manufacturing

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060306	Pharmaceutical products manufacturing			
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Primary measure program 1; low use of secondary measures	NMVOC	73%	63%	84%	EGTEI (2003)
Primary measure program 2; high use of secondary measures (both incineration, adsorption and/or condensation)	NMVOC	88%	84%	93%	EGTEI (2003)

The primary measure programs described in the table correspond to:

• conventional primary measures: installations emitting more than 15 % of the solvent input: an average value of 30 % is taken into account;

• primary measure program 1: installations emitting between 5 and 15 % of the solvent input: an average value of 8 % is taken into account;

• primary measure program 2: installations emitting less than 5 % of the solvent input: an average value of 3.5 % is taken into account.

Asphalt blowing

This section presents abatement efficiencies for asphalt blowing. Relevant emission factors can be calculated by applying the reduction efficiency to the Tier 2 emission factors for asphalt blowing as provided in subsection 0 of the present chapter.

Table 3-17   Abatement efficiencies (η_{abatement}) for source category 2.D.3.g Chemical products, asphalt blowing

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060310	Asphalt blowing			
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Controlled (unknown control level)	NMVOC	98%	90%	100%	Robinson (1992)

Table 3-18   Abatement efficiencies (η_{abatement}) for source category 2.D.3.g Chemical products, asphalt blowing, saturant

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060310	Asphalt blowing			
Technologies/Practices	Saturant				
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Afterburner	NMVOC	96%	90%	100%	US EPA (1994b)
	TSP	100%	100%	100%	US EPA (1994b)

Table 3-19   Abatement efficiencies (η_{abatement}) for source category 2.D.3.g Chemical products, asphalt blowing, coating

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060310	Asphalt blowing			
Technologies/Practices	Coating				
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Afterburner	NMVOC	95%	90%	100%	US EPA (1994b)

Manufacture of paints, inks and glues

This section presents the reduction efficiencies for the production of paints, inks and glues when using improved control measures and primary/secondary measures. The efficiencies provided in the table below relate to the conventional emission factors in Table 3-11.

Table 3-20   Abatement efficiencies (η$_{abatement}$) for source category 2.D.3.g Chemical products, manufacture of paints, inks and glues

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060307 060308 060309	Paints manufacturing Inks manufacturing Glues manufacturing			
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Improved production mix: 80% water-based coatings (4 wt-% solvent); 15% high solvent-based coatings (50 wt-% solvent); 5% other products (100 wt-% solvent)	NMVOC	50%	30%	70%	EGTEI (2003)
Use of good practices	NMVOC	27%	0%	60%	EGTEI (2003)
Upgrading of the consdensation units or carbon adsorption and solvent recovery	NMVOC	50%	30%	70%	EGTEI (2003)

Examples of what 'good practices' may include (USEPA, 1992):

• recovery of solvent vapours during raw material distribution;

• unloading of the barrels with forklifts to avoid leakages;

• coverage of mobile reactors;

• use of heavier solvents to reduce fugitive emissions;

• use of cleaning agents containing less solvents;

• use of automatic cleaning devices whenever possible;

• recycling of cleaning solutions.

Rubber production (tyres)

This section presents the reduction efficiencies for the production of tyres when using improved control measures and the use of less solvent paints. The efficiencies provided in the table below relate to the conventional emission factors in Table 3-6.

Table 3-21   Abatement efficiencies (η$_{abatement}$) for source category 2.D.3.g Chemical products, tyre production

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.G	Chemical products			
Fuel	NA	not applicable			
SNAP (if applicable)	060305	Rubber production			
Technologies/Practices	Tyre production				
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence**		**Reference**
		Default Value	**Lower**	**Upper**	
Process optimisation Use of 70% solvent-based adhesives, coatings, inks and cleaning agents (90 wt-% solvent)	NMVOC	30%	0%	60%	EGTEI (2003)
New processes Use of 25% solvent-based adhesives, coatings, inks and cleaning agents (90 wt-% solvents)	NMVOC	75%	65%	85%	EGTEI (2003)

3.3.4 Activity data

Activity data necessary for applying a Tier 2 methodology are the amount (mass) of solvent or product used, or the amount of product created using solvents, depending on the technology. These statistics may be obtained from the industry.

For asphalt blowing, the total weight of asphalt blown from asphalt blowing stills is required. This information may be available from a national or regional basis from industry. For example, the Asphalt Institute publishes annual asphalt usage statistics for the United States and Canada.

3.4 Tier 3 emission modelling and use of facility data

Tier 3 is not available for this source category.

4 Data quality

4.1 Completeness

Care should be taken to include all emissions. Emissions from source categories 2.D.3.g Chemical products and other 2.D chapters (covering e.g. printing and domestic solvent use) may get mixed up. It is good practice to check that all activities covered by this source category are indeed included.

4.2 Avoiding double counting with other sectors

Care should be taken not do double count emissions, especially between 2.D.3.g and other 2.D source categories. It is good practice to check that activities are not accounted for in both source categories.

4.3 Verification

The total emissions from the solvent sector (NFR 3) may be assessed applying a solvent balance (Import - Export + Production - Destruction) for a country. In many countries good statistics can be obtained which may be more reliable than the data available for individual source activities.

4.3.1 Best Available Technique emission factors

For the use of solvents in general (European Commission, 2007), BAT is to:

- minimise emissions at source, recover solvent from emissions or destroy solvents in waste gases. Emission values are given for individual industries. (Using low solvent materials can lead to excessive energy demands to operate thermal oxidisers. Oxidisers may be decommissioned where the negative cross-media effects outweigh the benefits of destroying the VOC);

- seek opportunities to recover and use excess heat generated in VOC destruction and minimise the energy used in extraction and destruction of VOCs;

- reduce solvent emissions and energy consumption by using the techniques described, including reducing the volume extracted and optimising and/or concentrating the solvent content.

No generic emission limit value for this source category can be given. For more information on the BAT emission factors and description, refer to the BREF document on Surface Treatment using Organic Solvents (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

No specific issues.

4.5.1   Emission factor uncertainties

As the production figures of polyurethane and polystyrene as well as the content of blowing agent can be found quite straightforwardly, the uncertainty is not too high and may be in the range of +/- 30 % (see also Rentz et al, 1993), where uncertainty is estimated at +/- 20 %). No information is available on the amount of blowing agent being transferred to other media (soil, water) than air.

It is not possible to estimate the accuracy of estimates based on Tier 2 emission factors for asphalt blowing. Based on the low data qualities and the large differences in emission factors, the level of uncertainty is high. The comments received from other panel members suggest that the uncertainty is greater than a factor of two.

4.5.2   Activity data uncertainties

No specific issues.

4.6   Inventory quality assurance/quality control QA/QC

The weakest aspect of the methodology is the requirement for activity data on market share. This is likely to be difficult.

It is recommended that improvements be made in the emission factors through new testing programmes for uncontrolled and controlled blowing of asphalt.

4.7   Gridding

Much of the emissions are associated with final distribution of goods (packaging) or building industry (insulation). These emissions are most appropriately attributed to population. Thus it is good practice to perform disaggregation of emissions according to population.

4.8   Reporting and documentation

No specific issues.

5 Glossary

Blowing agent	Usually a liquid substance which evaporates during the process (or releases gas) in order to expend the volume of the substrate ('blow') into a foam.
PUR	Polyurethane.
EPS	Expandable polystyrene.

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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.