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Do-It-Yourself Products Fact Sheet
To assess the risks for the consumer

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Abstract

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Exposure to compounds in consumer products can be assessed using the computer program ConsExpo (Consumer Exposure). Given the huge number of consumer products, it is not possible to calculate the exposure for each separate product, therefore a limited number of groups containing similar products are defined. The information for each group of products is described in a fact sheet. These fact sheets enhance a transparent and standardize exposure assessment. Paint products, cosmetics, children's toys and cleaning products are examples of fact sheets which have been published already. This fact sheet covers the use of Do-It-Yourself products by consumers, especially those concerning home improvement. The fact sheet describes 26 product categories, including glues, sealants, fillers, coatings, insulation foams, and removers. To assess consumer exposure to compounds in the Do-It-Yourself products category, default scenarios for all product categories have been determined.

Key words: Do-It-Yourself products, DIY, glues, solvents, exposure, consumer, risk, compounds

Rapport in het kort

Fact sheet doe-het-zelfproducten
Risicoschattingen voor de consument

ConsExpo 4 is een computerprogramma, dat gebruikt kan worden om de blootstelling van mensen aan stoffen in consumentenproducten uit te rekenen. Hierbij wordt rekening gehouden met verschillende blootstellingsroutes (dus via de huid, via inademing en via orale opname).
Bij het ConsExpo programma hoort ook een database, waarin standaardwaarden voor vele producttypen en voor een groot aantal blootstellingscenario's wordt aangeboden. De beschrijving van deze achtergrondinformatie behorende bij deze standaardwaarden wordt gerapporteerd in zogenoemde 'factsheets'. Deze factsheets dragen bij aan een gestandaardiseerde en transparante blootstellingschatting.
In dit rapport, factsheet doe-het-zelfproducten, is de meest recente informatie bijeengebracht om de blootstelling aan stoffen uit doe-het-zelfproducten te berekenen. De verschillende typen doe-het-zelfproducten zijn verdeeld in 26 categorieën, bijvoorbeeld houtlijm, siliconenkit, vullers en verwijderaars.
Voor iedere categorie wordt de samenstelling en gebruik van producten uit die categorie beschreven. Daarnaast wordt aangegeven welk model of welke modellen van ConsExpo het meest geschikt zijn om de blootstelling te berekenen. Daarnaast worden voor alle gegevens die nodig zijn voor de berekening, standaardwaarden aanbevolen. Naast deze factsheet doe-het-zelfproducten zijn er ook factsheets voor ongediertebestrijdingsmiddelen, verfproducten, reinigingsmiddelen, cosmetica en desinfectantia.

Trefwoorden: doe-het-zelfproducten, klussen, oplosmiddelen, blootstelling, consument, risico, stoffen

Contents

Summary

Proper information on exposure assessment is often lacking in current risk assessment. Mathematical models, such as ConsExpo, can be used when experimental data are limited to assess the exposure to consumer products and uptake of substances present. However, the large number of available consumer products prohibits the formulation of separate exposure models for every product. For this reason products are categorized into several main categories, such as paint products, children's toys, cosmetics, pest control products, and cleaning products for which fact sheets have already been prepared at the National Institute for Public Health and the Environment (RIVM).

In the fact sheet presented here, information on the use of Do-It-Yourself (DIY) products is provided. The use of the commercially available products from the main category of DIY products by consumers is described in 26 product categories, including the use of glues, sealants, fillers, coatings, insulation foams and removers. It aims to cover all uses of DIY products with a restricted number of product categories. To achieve this goal, products are categorized by type of DIY product use and consequently by type of exposure for consumers. Each product category deals with the composition and the use of the products within that specific category. To assess the exposure of substances from the use of DIY products, default models under ConsExpo and default parameter values were determined.

Samenvatting

Om de blootstelling aan stoffen uit consumentenproducten en de opname daarvan door de mens te kunnen schatten en beoordelen zijn wiskundige modellen beschikbaar. Voor de berekening wordt gebruikgemaakt van het computerprogramma ConsExpo. Het grote aantal consumentenproducten maakt het onmogelijk voor elk afzonderlijk product blootstellingsmodellen en parameterwaarden te ontwikkelen. Daarom is een beperkt aantal hoofdcategorieën met gelijksoortige producten gedefinieerd. Voor elke hoofdcategorie wordt de informatie in een factsheet weergegeven. Verfproducten, reinigingsmiddelen, kinderspeelgoed en cosmetica zijn voorbeelden van factsheets die al gereed zijn. In deze factsheet wordt informatie gegeven over het gebruik van doe-het-zelfproducten.
Het gebruik van doe-het-zelfproducten door consumenten wordt beschreven in 26 productcategorieën, zoals lijmen, kitten, plamuur en gatenvullers, coatings, isolatie schuimen en verwijderaars. Het gehele gebied van het gebruik van doe-het-zelfproducten door consumenten wordt met deze productcategorieën bestreken. Voor elke productcategorie is de samenstelling en het type gebruik van producten gespecificeerd. Om de blootstelling van stoffen uit doe-het-zelfproducten te kunnen schatten en beoordelen zijn voor elke productcategorie standaardmodellen ontwikkeld en standaardwaarden voor de parameters vastgesteld.

1 Introduction

1.1 General

Descriptive models have been developed within the RIVM to estimate and assess the exposure to substances in consumer products and the uptake of these substances by humans. These models are brought together in a computer program called ConsExpo. When a model is chosen in ConsExpo, and the required parameters are filled in, the program calculates the exposure to, and the uptake of, the substance involved.

Because of the large number of consumer products currently on the market, it is not possible to assign exposure models and parameter values to each individual product. Therefore, a limited number of main categories of similar products have been defined. Examples of the main categories are paint products, cosmetics, children's toys, cleaning products, pest control products and Do-It-Yourself (DIY) products. The relevant information with respect to estimating the exposure to and uptake of substances from consumer products is given in a fact sheet for each of the main categories. These fact sheets can be used to characterize and standardize the exposure.

The diversity of tasks conducted indoors is large – from painting to laying carpets. And thus, there is a large diversity in the products, and in the types of use and application methods for the products. Some of these products can be used without any preparation, while others have to be processed (mixed and loaded) before use, for example by diluting or heating. All of these product types imply a different type of exposure, whereby differences can occur in the exposure phase (mixing and loading, during or after application) and the route of exposure (inhalation, oral, dermal).

Within the DIY products main category, as few product categories as possible are defined, which together describe the whole category. The DIY products' main category includes the following product categories: glues, sealants, insulation foams, coatings, fillers, and removers. The composition and the use of the type of products within the category are examined for every product category. To estimate the exposure to substances from DIY products, default models with default parameter values are determined for every product category in this fact sheet. The default-parameter values are available via a database in ConsExpo. Using these data, standardized exposure calculations for consumers resulting from the use of DIY products can be performed.

1.2 ConsExpo

ConsExpo is a software tool for Consumer Exposure assessment. ConsExpo is a set of coherent, general models that can be used to calculate the exposure to substances from consumer products and their uptake by humans. It is used for consumer exposure assessment for new and existing substances within the framework of Directive 67/548/EC and the Council Regulation 793/93/EC, respectively. Furthermore, ConsExpo is also one of the models that is used to assess consumer exposure to biocides (Technical Notes for Guidance (TNsG): Human Exposure to Biocidal Products – Guidance on Exposure Estimation [1] (http://ecb.jrc.it)).

ConsExpo was built using data on the use of products and using mathematical concentration models. The program is based on relatively simple exposure and uptake models. The starting point for these models is the route of exposure, that is, the inhalatory, dermal or oral route. The most appropriate exposure scenario and uptake model is selected for each route. The parameters needed for the exposure scenario and the uptake models are then filled in. It is possible that exposure and uptake occur simultaneously by different routes. In addition to data about the exposure and uptake, contact data are also needed, such as the frequency of use and the duration of use. Using the data mentioned above, ConsExpo calculates the exposure and uptake. ConsExpo 4, is described in detail in Delmaar et al. [2].

ConsExpo 4 can be used for a screening assessment or for an advanced (higher tier) assessment. Per exposure route i.e. inhalation, dermal and oral route, different models are offered for calculating external exposure. ConsExpo also integrates the exposure via the different routes resulting in a systemic dose. Different dose measures can be calculated (acute, daily, chronic exposure). ConsExpo can also run calculations using input parameters distributions and sensitivity analysis can be performed.

The computer model is publicly available. Default data are available via the database which is an integral part of ConsExpo. The software, the user manual and the various fact sheets (see section 1.3) can be downloaded via the website of the National Institute for Public Health and the Environment (RIVM; www.rivm.nl/consexpo) in the Netherlands.

1.3 Fact sheets

This report is one of a series of fact sheets that describe a main category of consumer products, such as paint, cosmetics, children's toys, pest control products and, in this report, DIY products. The fact sheets give information that is important for the consistent estimation and assessment of the exposure to, and the uptake of, substances from consumer products.

A separate fact sheet called the 'General Fact Sheet' [3] provides general information about the fact sheets, and deals with subjects that are important for several main categories. The General Fact Sheet gives details of:

- the boundary conditions under which the defaults are estimated,
- the way in which the reliability of the data are shown,
- parameters such as the ventilation rate and room size, and
- parameters such as body weight and the surface area of the human body, or parts of the body.

The facts sheets contain information about exposure to chemical substances from consumer products, which have been grouped into product categories. These product categories are set in such way that consumer products are grouped based on a similar way of exposure.

During the development of the fact sheets, feedback was requested from associated organizations in the branch. For this report, the Association of the Dutch Adhesive Industry (Vereniging Nederlandse Lijmindustrie, VNL) was asked for their expertise.

On the one hand, the fact sheets give general background information; while on the other, they quantify exposure parameters which, together with one or more of the ConsExpo exposure models, produce a quantitative estimate of the exposure.

The fact sheets are dynamic documents. As new research becomes available or as perceptions change, the parameter default values may need to be altered. Additional models can also be developed within ConsExpo; this too will require adaptations. The fact sheets are linked with ConsExpo since the fact sheets define the default values for the parameters used in the different ConsExpo models. Alterations in either the default values or the parameters influence both the fact sheets and (database of) ConsExpo. We intend to produce updates of the published fact sheets on a regular basis.

This fact sheet is principally aimed at exposure to the whole product and is, as such, independent of the compound. This means that the information about the compound must be added separately. This mainly concerns information about the concentration and the physico-chemical properties of the compound.

1.3.1 Definition of the consumer

Non-professional use only

The default values in the fact sheets have been collected for consumers (non-professional users). They are not aimed at describing exposure for people who professionally work with similar products, such as glues used in the industrial sector, for example. This fact sheet, therefore, only describes products which are available to the consumer for non-professional use.

Using the models in ConsExpo and the default values for consumers presented here as background data, it is nonetheless possible to calculate the exposure of DIY products for professional users. Of course, the differences in products and product use between the consumer and those using DIY products professionally must then be taken into account.

1.3.2 ‘Reasonable worst case’ estimate

The basis for calculating and/or estimating parameter values is a realistic worst-case scenario where consumers frequently use a certain DIY product under relatively less favourable circumstances. For example, when using a DIY product, basic assumptions include relatively frequent use, application of a relatively large amount in a small room with poor ventilation, and a relatively long stay in that room.

The parameter values in the fact sheets are aimed at (Dutch) consumers. They are chosen such that a relatively high exposure and uptake are calculated, in the order of magnitude of a 99th percentile of the distribution. To achieve this goal, the 75th or the 25th percentile is calculated (or estimated) for each parameter. The 75th percentile is used for parameters which give a higher exposure for higher values, and the 25th percentile is used in the reverse case. For a significant number of parameters, there is too little data available to calculate the 75th or 25th percentile. In such cases, an estimate is made which corresponds to the 75th or 25th percentile.

Multiplication of two 75th percentile parameter values will result in a 93.75th percentile, whereas multiplication of three 75th percentile parameter values will result in a 98.5th percentile. Since a 75th /25th percentile is calculated or estimated for all parameter values, the resulting outcome in the calculation is a higher exposure and/or uptake. Given the number of parameters and the relationship between the parameters, it is expected that in general the calculated values for exposure and uptake will result in a 99th percentile.

1.3.3 Reliability of the data

A number of parameters is difficult to estimate based on literature sources and unpublished research. A value must still be chosen for these parameters; otherwise it is not possible to carry out any quantitative exposure assessments. This is why a quality factor (Q; ranging from 1 to 4) has been assigned to all parameter values in the fact sheets, indicating the reliability of the default value (see Table 1). Low Q-factors of 1 or 2 indicate that the default value is based on insufficient (or no) data. If such a default is used in an exposure analysis, it should be carefully considered and, if possible, refined. If representative data are provided by applicants or producers, it can replace the default values. High Q-factors of 3 or 4 indicate that the defaults are based on sufficient (or more) data. These defaults generally require less attention, although they may need to be adapted to specific exposure scenarios. For example, an exposure estimate might be carried out for a room of a particular size. The well-established default room size should then be replaced by the actual value.

Table 1: Value of quality factor Q.

Q	Value
4	Good quality relevant data, parameter value reliable
3	Number and quality of the data satisfactory, parameter value usable as default value
2	Parameter value based on single data source supplemented with personal judgement
1	Educated guess, no relevant data available, parameter value only based on personal judgement

1.4 Classification into product categories

For this fact sheet, DIY products are classified into 26 product categories, which are characterized according to the type of use and exposure (Table 2). The aim is to reduce the large number of individual products and applications to a limited number of product categories. The way of exposure within each category is very similar, so that one or in some cases two default exposure scenarios can be drawn up for all products which fall into that category. Only those product categories are described for which exposure is expected. Further, the product categories are grouped in such way, that they can be used to assess exposure for other DIY products, for which no specific product category was drawn up.

1.4.1 Hobby use and DIY tasks

DIY tasks are carried out mainly during leisure time. According to data from Statistics Netherlands (Centraal Bureau voor de Statistiek), approximately 25% of the Dutch population (age over 14 years) spends one to four hours per week on DIY tasks [4]. Furthermore, Statistics Netherlands specifies that 6% of that population spends over five hours per week on DIY tasks during their leisure time. There is a grey area between hobbying and conducting DIY tasks. For instance, fixing or making furniture can be seen as a hobby, but also as a DIY task. Still, some slight differences between hobby use and DIY tasks can be identified. First, the frequency of performing a hobby is higher than for DIY tasks, especially concerning smaller tasks. Using glue for a DIY task, such as repairing a chair, is normally performed less often. Second, DIY tasks are tasks that must be done (mainly improve, fix and repair tasks), while hobbies are performed voluntarily and during leisure time.

The product type which is commonly used for hobbies and DIY tasks alike is glue. There are all sorts of glues, and their uses are consequently very diverse. For instance glues are often used in several DIY tasks, but can also be used in tinkering tasks. But their application is comparable and thus, the scenarios and the default values for these products are given in the DIY Products Fact Sheet. Another reason for taking up glues for hobby use here is so that all kinds of glues are categorized in one fact sheet. However, tinkering by children is not described in this fact sheet. For this specific use is referred to Van Engelen and Prud'homme de Lodder [5] for more information on children's exposure.

Table 2: Overview of product types and related product categories (for a description of the products see chapters 3 – 9).

Product type	Product category
Glue	Tube glue Bottled glue - universal/wood - construction Super glue Two-component glue Wood parquet glue - parquet glued to surface - floating parquet Carpet glue Tile glue Wall paper glue Hot melt adhesive Spray glue
Sealant	Sealant – cartridge - joints - assembly (glue)
Fillers and putty	General filler from powder Large hole filler Filler/putty from tube Two-component filler Putty from spray
Plasters and equalizers	Floor equalizer Wall plaster
Coating	Coating large surfaces Repair coatings
Remover	Paint remover Glue remover Wall paper remover Sealant / foam remover
Miscellaneous	Insulation foam Joint colour

1.5 Principles behind the exposure estimate

Preference is given to the use of existing product data and measured exposure values. If these data are not available (and this is usually the case), a consumer exposure model like ConsExpo can be used. For the product under study, the most relevant models are chosen from ConsExpo for each relevant route (inhalation, dermal and oral) and the parameters needed for the models are then collected.

In this fact sheet, default models and default parameter values are proposed for each product category. If additional data are available for a particular application, this should be taken into consideration. For example, if the product amount to be applied per unit of surface is given in the user directions. The user information and/or directions for use are not always followed by the user. Therefore, the assessment takes this possible alternative use circumstances into account. For example, if the use of gloves is advised, the exposure estimate will nevertheless assume that application without gloves will occur. Even if gloves are sold with the product, it is assumed that gloves are not worn every time, since the gloves are disposed of after the first use. When reusing the product it is assumed that no gloves will be worn, as the gloves are no longer readily available.

This fact sheet is principally aimed at exposure to the whole product and, as such, independent of the active substance.

1.6 Uncertainties and limitations

This fact sheet presents a number of default parameters which can be used in the exposure assessment for the non-professional use of DIY products, applying ConsExpo. Quantitative data about consumer exposure to DIY products is limited. The model approach makes it possible to extrapolate limited data for certain products to other products and other scenarios, for which there is no specific data. The determination of default values for the various model parameters also ensures that a high degree of consistency can be achieved in the assessments.

One should realize that the exposure estimates from a model depend on the quality and the reliability of the input data. It is therefore recommended that parameter values and default values are critically selected. Scenarios and the related parameters can have a major influence on the final exposure estimate. Future versions of ConsExpo and/or updates of fact sheets will elaborate on these aspects once more data are available. Depending on what is needed, examples of improvements may include further adaptation of exposure models for certain scenarios or development of new models.

2. Collecting data for DIY product exposure

2.1 Preliminary observational study

At present there are limited data available on exposure assessment concerning DIY products. Information on consumer use of these kinds of products is lacking. Therefore in 2004 an observational study was conducted at the RIVM by Magré [6] to provide more insight in the way consumers use DIY products. This behavioural study revealed habits of consumers when working on DIY tasks in their homes. During the observational study twenty-five observations were conducted in four main product categories, i.e. glues for small surfaces, glues for large surfaces, sealants, and fillers. During the observations measurements were taken and the following parameters were taken into account: duration of use, amount product used per task, ventilation, frequency of use, contact with the product, behavioural characteristics such as reading safety or product information and experience level. The number of observations was rather low; furthermore the range of DIY products included was rather small. Therefore, it is not expected that the limited amount of observations represent the habits of the Dutch population. However, the information gathered in the study by Magré [6] can be used as preliminary data which can be considered indicative for consumer use of DIY products.

2.2 Scenarios and models

Users can be exposed during application of DIY products as well as post-application. Bystanders can also be exposed, but this exposure will not be considered in this report, because their exposure is expected to be lower than that of the user. Most DIY products are ready for use. Some of the DIY products require preparation before they can be used: so-called mixing and loading has to be applied first. During the mixing and loading process additional exposure may occur. The DIY products described in mixing and loading are two-component glues and glues, fillers, or joints made from powders.

In the following chapters default models for the exposure are determined for each of the product categories listed in Table 2. Furthermore, default parameter values were established for these models. Table 3 gives an overview of the models used in this fact sheet to calculate (or estimate) the exposure for the different types of DIY applications, including models used to calculate mixing and loading. The models themselves and their associated parameters are described in the ConsExpo 4 help file and user manual.

Table 3: Overview of models used to calculate (or estimate) the exposure for DIY product applications.

Situation	**Route of exposure**	
Before application	*Inhalation*	*Dermal*
Mixing and loading: two-component	Evaporation from constant surface	Instant application
Mixing and loading: powder	-	Constant rate
During application		
General	Evaporation from increasing area	Instant application *or* constant rate
Parquet glue, tile glue, and carpet glue Super glue	Evaporation from constant area	Constant rate Instant application
Insulation foam	Instantaneous release	Instant application
Wall paper glue (remover), filler powder, filler for large holes, floor equalizer, wall plaster, gutter coating	-	Instant application
Sprays (glue, putty)	Spray	Constant rate

2.3 Spray model

In this fact sheet there are few scenarios described with the spray model. Among those are glue spray and putty from spray. Here, general parameters for the spray model will be discussed.

2.3.1 Inhalation exposure during spraying

To calculate the inhalation exposure, the ‘spray model’ from ConsExpo 4 is used for spray applications when using trigger sprays or spray cans. In this section some parameters from the ‘spray model’ are discussed.

The spray model is developed on the basis of the results of experimental work and describes inhalation exposure to slightly evaporating or non-volatile compounds in droplets that are released from a spray can or trigger spray indoors [2, 7]. For volatile substances, the evaporation model is more appropriate. If the spray model is used for volatile substances the inhalation exposure will be underestimated, because exposure to vapour is not considered in the spray model. Volatile substances are defined as compounds with a vapour pressure > 0.1 Pa, non-volatile < 0.01 Pa, and slightly volatile between 0.01 and 0.1 Pa [8].

2.3.2 Density

One of the parameters in the spray model is the density of the non-volatile fraction. Compounds in liquid concentrates can be dissolved in volatile organic solvents. The density of these solvents is around 0.7 g/cm^3; this value is used as the default value for the density of liquid concentrates. If it turns out that water is the main constituent of a liquid concentrate, a density of 1 g/cm^3 is used. The density of salts generally varies between 1.5 and 3.0 g/cm^3 (Table 4), therefore 3.0 g/cm^3 is set as default.

Table 4: Default values for density.

Type	**Main ingredient**	**Density** [g/cm^3]	**Q**
Solvents	Volatile organic solvents	0.7	3
	Water	1	4
Non-volatile compounds	Large organic compounds	1.5	3
	Salts	3.0	3
	Complex mixture of compounds, especially organic compounds	1.8	3

2.3.3 Parameters for the spray model

To calculate the inhalation exposure for the user, the spray model from ConsExpo is used for all spray applications.

- *Initial particle size distribution*

The droplet size is an important parameter when estimating the exposure. Smaller drops fall at a lower speed and stay in the air longer. Large droplets will quickly disappear from the air after being formed. As an indication, the falling time of droplets with a diameter of 100 µm from a height of 3 metres is calculated to be 11 sec, and for droplets of 10 µm it is calculated to be 17 min [9]. If a larger droplet is sprayed, part of the aerosol cloud will consist of finer droplets which will stay in the air longer, as a result of edge effects around the nozzle and the 'bounce back' effect due to spraying onto a surface. A classification of aerosol droplets is provided in Table 5 according to data from the Biocides Steering Group.

Table 5: Classification of aerosol droplets [9].

Droplet diameter [µm] [a]	Classification
< 15	fog
< 25	aerosol, fine
25–50	aerosol, coarse
51–100	mist
101–200	spray, fine
210–400	spray, medium
> 400	spray, coarse

[a] The median diameter: half of the particles are larger, half are smaller.

The same study also provides a classification for the droplet size for various types of agricultural applications (Table 6). It provides an indication of the relationship between particle size and target (air, surface or ground) as well.

Table 6: Droplet size for different types of agricultural applications [9].

Target	Droplet diameter [μm]
Flying insects	10–50
Insects on plants	30–50
Precipitation on a surface	40–100
Application on the ground	250–500

The Dutch Aerosol Association [10] distinguishes between aerosol sprays in aerosol cans with very fine atomized dry sprays (such as asthma sprays and insecticides) and fine atomized wet sprays (such as hair sprays and paint sprays). Matoba et al. [11] measured the droplet size of an aerosol can of a spray for air space applications. The average droplet size was 30 μm with a range of 1–120 μm. Based on the measurements, Matoba et al. classified the droplets into three groups:
(1) 10 % of the particles have a droplet size of 60 μm, (2) 80 % have a droplet size of 20 μm and (3) 10 % of the particles have a droplet size of 5 μm. A spray for air space applications generally has a smaller droplet diameter than for surface applications.

TNO-PML [12] has investigated the initial particle size distributions from aerosols spray cans and trigger sprays. The investigated spraying devices were aerosol spray cans, ready-to-use trigger sprays and plant sprayers with an adjustable nozzle to produce a spray with droplets as small as possible or a spray with coarse droplets. In DIY products aerosol spray cans are generally used for surface treatment and therefore only data concerning surface spraying is provided in this fact sheet. The percentiles of different spraying devices are given in Table 7. The 10, 50, and 90 percentiles for the volume distributions of the spray cans are given as d_p (V, 0.10), d_p (V, 0.50) and d_p (V, 0.90), which means that 10%, 50% or 90% of the product mass is below the mentioned size.

Table 7: Percentiles of the initial volume distribution of spray can products. [12]

Application	**Content**	**Percentiles of the initial particle distribution [µm]**		
		D_p (0.10)	**D_p (0.50)**	**D_p (0.90)**
Targeted spot on plants (affecting insects)	Full	55	97	232
	Nearly empty	20	68	152
Crack and crevice/ surface (against fleas)	Full	9.4	30	142
	Nearly empty	9.8	27	97
Wood preservative	Full	15	40	106
	Nearly empty	20	52	92
Hairspray 1	Full	17	39	98
	Nearly empty	18	42	74
Hairspray 2	Full	17	38	66
	Nearly empty	17	38	66
Hairspray 3	Full	23	50	87
	Nearly empty	24	50	84
Paint 1	Full	27	114	352
	Nearly empty	20	76	186
Paint 2	Full	11	39	88
	Nearly empty	10	37	101
Cockpit spray	Full	18	55	113
	Nearly empty	19	50	98
Furniture polish	Full	30	63	114
	Nearly empty	52	98	154
Deodorant 1	Full	7.6	22	41
	Nearly empty	6.3	18	32
Deodorant 2	Full	4.5	14	38
	Nearly empty	5.7	17	41
Deodorant 3	Full	3.7	13	27
	Nearly empty	6.0	18	36

Surface spraying

At present, there are no particle size distribution data available for sprays used in DIY tasks. DIY products in the form of sprays are always surface sprays, and so for this reason, comparable surface sprays were also listed in Table 7. For most spray cans, the d_p (V, 0.50) is close to 40 µm, which is in agreement with the lower limit of the droplet diameter for precipitation on surfaces (Table 6). The particle size distribution of surface sprays seems to display a lognormal distribution, which was also observed for surface spray cans from pest control products [13]. Because DIY products in sprays will only be used as surface spray, 40 µm was selected as the median of a lognormal distribution. A default lognormal distribution for surface spray particles in DIY products was determined with the help of ConsExpo 4. A value of 40 µm is used as the default median of a lognormal distribution, with a coefficient of variation of 0.4 (Figure 1).

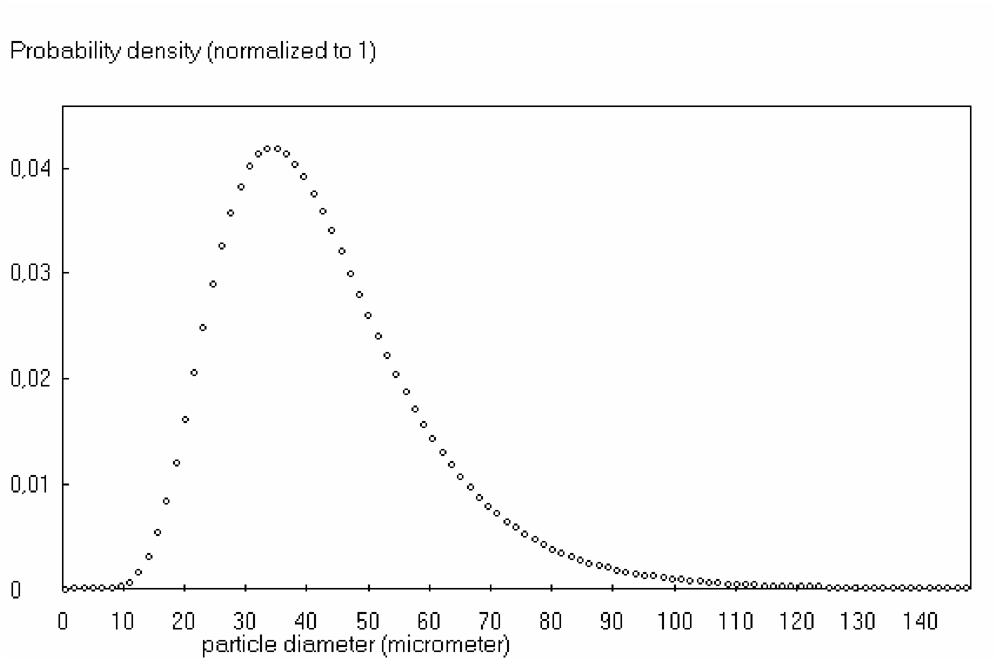

Figure 1: Reproduction of the default initial particle distribution for surface spray cans using ConsExpo 4. Results show a lognormal distribution with a median of 40 µm (C.V. 0.4).

- *Inhalation cut-off diameter*

The inhalation cut-off diameter is the 'threshold' for the diameter of inhaled spray droplets which, if smaller than this diameter, can reach the deeper areas of the lungs (alveoli, bronchioles, bronchia). Particles larger than this diameter deposit in the higher parts of the respiratory tract and will be cleared via the gastro-intestinal tract, leading to oral exposure. The inhalation cut-off diameter is only an approximation of the complicated process of deposition of particles in the lung. In general its value will be around 10–15 µm. The default value is set at 15 µm.

- *Airborne fraction*

The airborne fraction is the fraction of non-volatile material that becomes airborne in the form of droplets. The airborne fraction combines the non-volatile material fraction that ends up in the smaller droplets and the fraction of droplets that becomes airborne. The latter is closely connected to the type of spray and the manner it is used, for example, spraying on a surface (paint, wood preservative) or spraying in the air (spraying against flies), and on the droplet size distribution that has been specified. Airborne fractions have been determined experimentally for different sprays. The airborne fraction is derived from the TNO-PML survey on the exposure from spray cans and trigger sprays [7,12]. The airborne fractions for the investigated spray cans and trigger sprays are presented in Table 8. The default values (Table 9) for the airborne fraction were established based on these values.

Table 8: Airborne fractions of investigated spray can and trigger sprays.

Application	**Percentiles of the initial particle distribution [µm]**			**Main solvents**	**Airborne fraction [%]**
	D_p (0.10)	**D_p (0.50)**	**D_p (0.90)**		
Spray cans					
Air space, against flies and mosquitoes	25	125	414	water	60
Air space, against flies	7	23	109	Isoparafine/ isopropanol	60
Deodorant	7.6	22	41	ethanol	100
Hair spray	17	39	69	Dimethyl ether / ethanol	100
Flea spray	9.4	30	142	Benzine/ acetone	50
Plant spray affecting insects	55	97	232	Water	10
Trigger sprays					
Plant spray fine [a], affecting insects	33	88	191	Water	20
Plant spray coarse [a], affecting insects	39	127	512	Water	20
Spray against crawling insects	29	63	200	Water	10
All purpose cleaner	46	133	391	Water	10

a) *The nozzle can be adjusted so that the plant sprayer generates a fine spray with droplets as small as possible or a spray with coarse droplets.*

Table 9: Default values for the airborne fraction.

	Airborne fraction	**Q**
Air space sprays	1	2
Surface sprays: median of the initial particle distribution < 50 µm	1	2
Surface sprays: median of the initial particle distribution ≥ 50 µm	0.2	2

- *Mass generation rate*

TNO-PML has investigated the mass generation rate of 17 aerosols spray can products [12]. These included: hairsprays, cockpit spray, deodorants, paints, plant spray, fly spray, wood preservative, furniture spray, and textile freshener spray. The mass generation rate of full and nearly empty cans was measured during the experiment. Weight loss was measured during 10 seconds of continuous spraying. The mass generation rate of the nearly empty spray can was in some cases 80–90 % of the full can, while in other cases it was only 30 % of the full can. The median of all full spray cans was 1.0 g/sec, with a 75 percentile of 1.5 g/sec, based on the weight losses observed in full containers.

For aerosol hair spray cans data from Weegels [14] were used to determine the mass generation rate in Cosmetics Fact Sheet [15]. A mass generation rate of 0.47 g/sec was determined, which was in agreement with the hair sprays tested by TNO-PML [12].

It is acknowledged that the above data on mass generation rates are based on either pest control products or cosmetics, and not on DIY products. At present, there are no other data available to derive the mass generation rate for DIY products in spray form. The compositions and volume distributions may be significantly different for DIY products; nevertheless the data from TNO-PML will be used in absence of other relevant data. Hence, the mass generation rate is set at a default of 1.5 g/sec.

2.4 Mixing and loading DIY products

As mentioned above, several DIY products require pre-treatment handling before they can be used. The additional operations may lead to additional exposure from the product besides application. In this fact sheet, three mixing and loading processes are described. The first describes the mixing of two components where inhalation can occur due to evaporation and dermal exposure due to spills. The second mixing and loading process describes the dilution of powders in water. Dust particles from the powder may enter the breathing zone and hence lead to inhalatory exposure. A third mixing and loading process, the mixing of two liquids together, is described in section 8.3.

2.4.1 Mixing and loading: two-component

The mixing of two components for preparing an adhesive agent or filler may lead to inhalatory and dermal exposure. The mixed components vary from liquids to solids, but the mixing and loading process is regarded as being similar. The two components are put together in a shallow mixing cup according to the ratio provided by the manufacturer. The siccative and resin are then mixed with a spatula or other kind of tool until a homogeneous mass is obtained.

When mixed the two components react chemically and hardening can occur. Inhalation exposure can take place if volatile compounds evaporate during the mixing process. It is highly unlikely that volatile substances will be formed during the chemical reaction between resin and siccative because large polymers are formed to hold the bond. The ‘exposure to vapour: evaporation’ model may apply here, where release from a constant area is considered. This model is selected as the default to describe the inhalatory exposure from mixing and loading of two-component DIY products.

- *Room volume, room height and ventilation rate*

‘Room volume’ is interpreted here as personal space: a small area of 1 m^3 around the user. A small area around the user is relevant for the inhalation exposure of the user for the short use duration in which the mixing takes place.
A ventilation rate of 0.6 h^{-1} [3] for an unspecified room is used, because no background information is available on the ventilation rate near the user.

Dermal exposure occurs when the two components are mixed together with some kind of tool. It is assumed that two fingertips will be exposed when holding the tool. The fingertips have a surface area of 2 cm^2. Some products have to be mixed in much larger quantities. In those cases the dermal contact area is much larger and it is assumed that surface area of the fingers will be exposed, which equals a quarter of both hands: 215 cm^2. It is estimated that the mixing and loading process will take two minutes maximum. The user will subsequently conduct his/her DIY task immediately to avoid the mixture hardening before use.

- *Product amount*

The product amount during mixing and loading depends on the type of product used. Therefore the product amount will be described in the relevant product categories, where defaults are provided.

Default values for mixing and loading: two-components.

	Default value	Q	Reference, comments
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration			See product defaults
Application duration			See product defaults
Product amount			See product defaults
Room volume	1 m^3	1	Assumption
Ventilation rate	0.6 h^{-1}	1	See above
Release area			See product defaults
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See Section 2.7
Mol. Weight Matrix	3000 g/mol	3	See Section 3.1
Dermal			
Instant application			
Surface area	2 cm^2	2	Small quantities, see above
Surface area	215 cm^2	2	Large quantities, see above
Product amount			See product defaults

2.4.2 Mixing and loading: powders

Inhalation exposure

During the mixing and loading process, powders can disperse into the air and can subsequently be inhaled. The inhalatory exposure to powders during mixing and loading can be described with the spray model. Instead of aerosols, solid particles are considered to describe the exposure to a dispersed powder. Parameters such as the particle size distribution, airborne fraction and mass generation rate are needed to calculate the inhalation exposure to powders. However, when these parameters are not known, other models must be used (see below).

Default values for spray model

- *Spray duration and exposure duration*

No data are available for the duration of mixing and loading of a powder. It is assumed that the 'spray' duration and exposure duration have the same value as for mixing and loading liquid in a plant sprayer as described in Pest Control Products Fact Sheet, that is, 1.33 min [13].

- *Room volume, room height and ventilation rate*

'Room volume' is interpreted here as personal space: a small area of 1 m^3 around the user. A small area around the user is relevant for the inhalation exposure of the user for the short use duration in which the treatment takes place. The ventilation rate of an unspecified room is used, that is, 0.6 h^{-1} [3].

- *Weight fraction*

The weight fraction for non-volatile substances is set at one.

- *Density*

If data concerning density are not available, the default for density for non-volatile is set at 1.8 g/cm^3 (see section 2.3.2).

- *Particle size distribution*

An important parameter is the particle size distribution (PSD) because the particle size determines the fate of a particle in the respiratory tract. The smaller a particle, the deeper it may reach into the lungs and cause toxic effects. Particle sizes may differ significantly with the type of powder used. Data on particle size distributions of DIY products were not available. For this reason we conducted a small observational study in which powders from tile glue, wall paper glue, and general filler were observed. Dispersing and observing the powders indicated whether or not a powder contains finer particles than another powder for which information on the particle size distribution is available (Appendix A.1). The results are listed in Table 10.

Table 10: Particle size distribution estimates of powders.

Powder	PSD[a] (median (C.V.)	Remark	Q-factor
Portland cement	14 µm (0.5)[16]	Very fine particles, very wide dispersion.	2
Lime	75 µm (0.6)[13]	Very fine particles with some larger particles. Dispersion wide.	2
General filler	14 µm (0.5)	Very fine particles, less fine than Portland cement, finer than Lime. PSD adopted from Portland cement.	1
Tile glue	75 µm (0.6)	Very fine particles, but less fine than Lime. PSD adopted from Lime.	1
Washing powder	-	No PSD known. 0.27 µg dust formed from 200 g product [17] (Q = 1). Particles fine, but no clear dispersion.	-
Wall paper glue	-	Particles are finer than particles from washing powder, but no clear dispersion. No PSD was determined.	-

[a] *PSD: Particle size distribution; C.V.: coefficient of variation.*
- PSD was not determined and no Q-factor was assigned.

Inhalation exposure: other models

The inventory performed by Van Hemmen [18] for the inhalation exposure of pesticides for professional use results in an indicative value for mixing and loading of solid pesticides (wettable powders). The indicative 90th percentile value of the inhalation exposure is 15 mg formulation per hour, which is considered applicable for about 25 kg active substance applied per day.

The indicative value for professional application of pesticides is extrapolated to the consumer application of pesticides in the Pest Control Products Fact Sheet [13]. Although powders may differ significantly between consumer products, it is assumed that the indicative value found for a pesticide is also appropriate for DIY products. Therefore, it is assumed that for consumers the quantity of active substance applied per day is 1000 times lower than for professionals; thus, the amount applied per day is circa 25 g of active substance.

The inhalation exposure for consumers is estimated at 15 µg/h or 0.25 µg/min. This is reasonable for relatively low product amounts. For larger tasks the inhalation exposure is expected to be higher. A factor of 10 is suggested when the product amount exceeds 2.5 kg, resulting in the inhalation exposure of 2.5 µg/min.
With an exposure duration of 1.33 min (see above), the inhalation exposure is 0.3 µg for small tasks and 3.0 µg for larger tasks.

The above-mentioned indicative value for professional application of pesticides is extrapolated to the consumer application of DIY products. A quality factor (Q) of 1 is assigned.

Information on dust formation of washing powder is given in the Cleaning Products Fact Sheet [17,19] a cup containing 200 g washing powder can generate 0.27 µg dust. The term dust was not defined and the method used for determining the amount of dust was not described. Nevertheless, this value is of the same order of magnitude as the extrapolated value for consumers.

Dermal exposure
Dermal exposure to powders can be taken into consideration for mixing the powder with water. The model best suited is the constant rate model. It is assumed that half of both hands (0.5*860 cm^2) will be dermally exposed. The time needed to prepare the mixture is dependent on the amount used.

- *Contact rate*

The contact rate for powders was determined in the Pest Control Products Fact Sheet [13]. For dermal exposure of professionals, the inventory performed by Van Hemmen [18] gives an indicative value during mixing and loading of solid pesticides. The indicative 90^{th} percentile value for dermal exposure is 2000 mg formulation per hour, which is considered applicable for about 25 kg active substance applied per day. It is assumed that for consumers, the quantity of active substance applied per day is 1000 times lower than for professionals; thus, the amount applied per day is circa 25 g of active substance. The dermal exposure for consumers is estimated at 2 mg/h, i.e. 0.033 mg/min. The dermal exposure for larger tasks with consequently larger product amounts will result in higher exposures. A factor of 10 is suggested for tasks with product amounts exceeding 2.5 kg resulting in a dermal exposure of 0.33 mg/min. The release duration of dust falling on skin is considered the same as the ‘spray duration’ of 1.33 min (see section 2.4.2 Mixing and loading: powders, Inhalation exposure). Because information about dermal exposure during mixing and loading of powders is lacking for DIY products, the contact rate observed above for pesticides will be used in this fact sheet. The above-mentioned indicative value for professional application of pesticides is extrapolated to the consumer application of DIY products. A quality factor (Q) of 1 is assigned.

Default values for mixing and loading: powders.

	Default value	Q	Reference, comments
Dermal			
Constant rate			
Surface area	430 cm^2	2	See above
Contact rate	0.033 mg/min	1	Small task, see above
Contact rate	0.33 mg/min	1	Large task, see above
Release duration	1.33 min	2	See above

2.5 Evaporation pattern of adhesives

The evaporation pattern of adhesives is different from most other DIY products. In contrast to paints, for instance, the surface from which chemicals from adhesives can evaporate is not constantly ‘open’. Adhesives are implicitly used to connect parts. This means that the adhesive is covered with the part to be connected. The time during which there is actually a surface–air situation is described as the ‘open time’ of glue. This open time may vary from a few seconds to several minutes. The duration of this open time depends on the hardening process and thus on the type of glue. Solvent based adhesives have relatively short open times, in contrast to water based adhesives, due to a relatively higher evaporation rate. Polyurethane based glues are covered after application to prevent reactions with moisture, which is not desirable for a good end result.

The evaporation pattern of adhesives starts with a relatively high temporal evaporation rate (during open time), which is then followed by a relatively slow constant evaporation rate (when the surface is covered). Experimental data from solvent based glue products show that the starting emission rate is of the magnitude 0.4 g/m^2 per sec. After covering the applied product the vapour concentration will rapidly sink below the odour (smell) detection limit (on the order of 10–20 ppm for solvents) (personal communication with VNL).

Currently, there is no evaporation model in ConsExpo which can describe this two-phased evaporation pattern of adhesives. For this reason, the ‘exposure to vapour: evaporation from increasing surface area’ model is used for relatively small tasks (and amounts). The time during which evaporation takes place is set equal to the exposure duration, which in fact is a worst case approach.

However, this approach is not considered appropriate when larger gluing tasks are considered. A large task must be divided into segments when the total time required to apply the glue and connect the parts exceeds the open time of glue. This will lead to repeated ‘peak’ exposures within the task. Examples of such large tasks are gluing parquet, tiles and carpets.

Because exposure released from the total surface area is not realistic, an alternative description of exposure is required to integrate the repeated exposures during these large tasks. The release area is set equal to the surface area one can treat per segment. It is assumed that an individual treats 1 m^2 per segment. After that, the surface is covered and the exposure is considered negligible compared with the newly treated surface. These steps are repeated until the task is completed. It is assumed that the inhalation exposure is described by evaporation of the total amount, and not the adjusted amount, from a constant surface area, i.e. 1 m^2. The model ‘exposure to vapour: evaporation from constant release area’ is used. This simplification of the model is necessary, to overcome the problem of depletion of the source. It reflects the exposure from 1 m^2 with the adjusted product amount during a treated segment. The application duration and exposure duration are set equal during these tasks.

2.6 Dermal exposure

Describing the dermal exposure to certain DIY products can be troublesome. Because glue spills or other DIY products on hands can prohibit the user from conducting the task properly, the user will clean his/her hands or wipe them off. The result of this behaviour is that the exposure increases from the moment the user starts, decreases when the hands are cleaned, and increases again when the task is continued. When the product contains components that are not absorbed easily through the skin, no internal exposure is expected; but when a component is absorbed rather easily, exposure is evident. However, for many components the dermal absorption rate is unknown.

Currently, there is no dermal exposure model available which describes this fluctuation in exposure. ConsExpo provides two models, the instant application model and the constant rate model, both of which can be used to describe this kind of exposure. To illustrate the difference between the two models, consider a total dermal load (e.g. X) which a subject is exposed to at the end of the task. The instant application model assumes that the subject is exposed instantly to X amount of the product which remains on the skin during the task. This results in an overestimation of the exposure. For large tasks the dermal load may rise up to grams. Being exposed instantly to such an amount is not realistic. The constant rate model describes a more gradually increase in the dermal load over time, up to amount X. The contact rate is determined by dividing the total amount by time. Information on the release duration is required. This model seems to describe a somewhat more realistic scenario, however, it is not known to what extend a subject is exposed during the task. In other words, the pattern of exposure is better described in the constant rate model than in the instant application model, although we do not know the pattern exactly.

In this fact sheet it was decided to apply the instant application model when dermal exposure was expected to be low or the task relatively small. In those cases, a subject will not clean his hands during the task. On the other hand, for relatively large tasks where large spills can be expected, the constant rate model was applied because this provided a more realistic scenario for the behaviour of the subject in view of dermal exposure.

2.6.1 Instant application model

- *Dermal exposure: product amount*

Dermal exposure while using DIY products are often caused by spills. The product amount which actually contacts the skin directly depends on the behaviour of the consumer, DIY task and on the product itself and the total amount used. To obtain more insight in the amount spilled during a task, a short experiment was conducted (Appendix A.2). During the experiment it was established that a drop of glue weighs approximately 50 mg. Spreading a small amount of glue with two fingers led to exposures ranging from 20 mg to 90 mg. When a hand palm is fully covered with glue it was estimated that the dermal load is 1 g glue. When such an amount is spilled, the subject will not be able to proceed.

In an update of the Paint Products Fact Sheet (2007) the relationship between the way of painting (overhead, downward, or painting to the side) and the spilled amount is described. The spilled amount of paint also depends heavily on the type of paint, surface area and accessibility. For several paints it was described that the amount spilled equalled on average to 0.2% of the total amount required. This figure ranged from 0.09% to 0.56%. The product amounts ranged from 250 g to 1,800 g.

In contrast to paint, there is a wider range of the product amounts in DIY products – in some cases the amount can add up to several kilograms. Furthermore, dermal exposure to paint is different from dermal exposure to certain DIY products, like glue or sealant, which might prohibit the user from completing the task. The user will then have to clean his/her hands during the task. In those situations, a relationship between product amount and amount spilled is different compared to paint. Nevertheless, the described relationship can provide useful estimates of spilled amounts. A general default value could not be derived for DIY products. See the product categories for the default values for dermal product amounts.

2.6.2 Constant rate model

- *Contact rate*

The dermal contact rate is required when the constant rate model is advised. A dermal contact rate has not been determined for DIY products so far. For several paints contact rates were determined under several circumstances, summarized in the TNsG [1]. Four exposure models are described for consumer painting. Values (75th percentiles) were found to be ranging from 17 to 186 mg/min, with most values around 50 mg/min. In the update of Paint Products Fact Sheet (2007) the way of painting was related to dermal exposure. Thus, the dermal contact rate is also affected by the way of painting. Three default values for the contact rate were established; overhead painting with low viscosity products, overhead painting with ‘normal’ viscosity products, and downward or to the side painting. These defaults were 120 mg/min, 60 mg/min, and 30 mg/min, respectively. It is assumed that the use of DIY products can best be compared with either overhead painting with products of ‘normal’ viscosity or with downward or to the side painting tasks.

It is acknowledged that no data are available on DIY products. Thus, the comparison with paints is made qualitatively rather than quantitatively. A contact rate of 50 mg/min seems low (equal to one drop of glue spilled per minute; see Appendix A.1), but it may mount up to several grams when a task is conducted for several hours. In that case, spills from DIY products may hamper a subject from performing a task, causing subjects to clean their hands more often. Therefore, for large tasks a default value of 30 mg/min is set, with a quality factor of 1.

2.6.3 Parameters for the constant rate model during spraying

The constant rate model from ConsExpo was used to calculate the dermal exposure for a user during spray applications. The TNsG [1] provides data for consumer spraying for biocidal products, for air space spraying and for surface spraying with pre-pressurized aerosol spray cans and hand-held trigger sprays. Only surface spraying with aerosol spray will be discussed below, as this is the only type of spray used in DIY products. The measured data for dermal exposure vary widely. For consumer spraying these data are used as default values for the contact rate.

Surface spraying

- *Contact rate aerosol spray cans*

In the TNsG [1] under 'Consumer product spraying and dusting', a surface spraying model is stated in which the consumer uses a pre-pressurized aerosol spray can for spraying surfaces, i.e. a skirting board, dining chairs, a sofa and carpet. The dermal exposure on hands and forearms ranges from 1.7 to 156 mg/min with a 75th percentile of 64.7 mg/min. The dermal contact rate for legs, feet and face ranges from 17 to 45.2 mg/min with a 75th percentile of 35.7 mg/min. Although the spraying model does not include DIY products, it is assumed that the data are applicable for dermal exposure assessment from DIY products as well. Using these data, the default value for contact rate is set to 100 mg/min.

2.7 General values

- *Non-specified room*

The study conducted by Magré [6] showed that the location where individuals perform their DIY task can be anywhere, depending mainly on the task. Unless it is obvious or specified where the task will be performed, a 'non-specified room' will be considered. The non-specified room has a volume of 20 m^3 with a ventilation rate of 0.6 h^{-1} [3]. The temperature is usually that of the room, which is set at 20°C.

- *The user*

Users of DIY products are both men and women, (although men use these items more often)[4]. The average size of body parts for adults is used here from General Fact Sheet [3]. The body weight of the adult user is set at 65 kg as a default. It is most likely that individuals will be dermally exposed to their hands while working with DIY products, where both intentionally or accidental contact may occur. The surface area for both hands is set at 860 cm^2 by default [3], whereas sometimes only one hand or one palm will be taken as exposure area. These surface areas relate to the total surface area by factor 0,5 or 0,25, respectively. Fingertips are quite often used to smooth joints made from sealants. Their surface area is set at 1 cm^2 per fingertip [20].

- *Mass transfer rate*

The mass transfer rate is determined by the rate at which the compound is transported away from the evaporation surface. In general this transport rate will depend on the rate of diffusion of the compound through air and the rate of air movement above the product surface.

Langmuir’s method effectively assumes that diffusion of the compound is infinitely fast. As a result the Langmuir method will overestimate the evaporation rate and will provide high peak exposures in contrast to the Thibodeaux method [2]. Thibodeaux’s method is a simple approximation of the more elaborate Liss–Slater two-layer model describing the evaporation of a substance from water.

Because the use of DIY products is expected to lead to high peak exposures, the Langmuir method was selected as default. However, it should be remembered that this method is only an approximation of a specific system (evaporation of a solute from water) and has limited validity outside the domain for which it was derived.

3. Glues

General use
Glues or adhesives are products that are used to connect parts together without making use of machinery or other techniques (welding, soldering and bolts). There are many sorts of glues available for very diverse tasks. Some are used for simple tasks such as tinkering while other glues are used for construction purposes, e.g. wood glue and construction glue. In addition, there are glues made for special purposes in which specific material combinations (e.g. plastic to metal) can be glued together. Different glues have different characteristics and require different handling methods. Clean procedures before gluing are required to obtain a clean, dry, and a dust and grease free surface to which glue can adhere to. These cleaning handlings will not be discussed in this fact sheet, instead the reader is referred to the Cleaning Products Fact Sheet [21].

In principle glues are composed of the following components: an adhesive agent, additives (e.g. filling agent, resins, preservatives, moisturizers) and solvents. There are natural adhesive agents i.e. natural rubbers, starch, and casein, but synthetic adhesive agents are more commonly used. Additives are used to improve the adhesive strength and duration of storage life. As binding agents are solids they are dissolved in solvents in order to become manageable. Most used solvents are acetone, boiling point spirit (60–95 ^{o}C), ethyl acetate, methyl acetate, methyl ethyl ketone (MEK) and white spirit. Furthermore, there are also glues which are ‘solvent-free’. In most cases water is then used to dissolve the binding agent and additives.
The constituents differ per type of glue and for what purpose the glue is used for.

Hardening processes of glues
The difference in use of different glues can be influenced by the hardening process of the glues. For instance, water-based glues function by dehydration (water evaporates slowly or diffuses into the material). Solvent based glues harden by evaporation of the solvent. Two-component glues function by chemical reaction, which is somewhat identical to some kinds of one-component glues where UV-light is a catalyst in the chemical reaction. In addition, there are pressure bindings (contact glue) and hot melts.

The hardening process plays a major role on how a subject may be exposed to the chemicals present in that glue. It is obvious that the kind of hardening process will influence the exposure and is therefore considered in the following paragraphs.

Categorization of glues
In Table 11, glues are categorized according to their main purpose (note that this is a far from complete list of glues). Exposure to glues and its constituents can also be categorized according to the way the glues are used, and hence to user exposure (e.g. grouping tube glues in one category). In most cases, however, there are several alternatives for a specific task. At the same time, multiple-purpose glues can also be used for various tasks. Describing a single default for such a glue would not cover all uses. It is therefore necessary to think carefully about the task, type of glue, and its container before a default scenario is selected to determine the exposure to that glue.

For this fact sheet, glues have been categorized based on their container type. By grouping glues this way, glues are also grouped in terms of exposure and use. This is an alternative categorization than shown in Table 11. For example, universal glues are contained in tubes, bottles, spray cans, and glue guns. The use (and hence the exposure scenario) differs for glues contained in different containers because the glues are handled differently, even though its constituents may differ from each other. Note that some glues are kept in similar containers, but their use is dissimilar, for example tile glue and carpet glue. In those cases, separate product categories were described. It is important to describe all glues with just a few default scenarios in order to keep the fact sheet conveniently arranged.

The following scenarios for glues have been chosen: tube glue, bottled glue, super glue, two-component glue, wood parquet glue, carpet glue, tile glue, wall paper glue, hot melt adhesives, and spray glue as described in Table 2.

Table 11: Glues sorted by purpose.[a]

Group	Purpose	Utility form	Surface size	Container
1. Universal glue	All kinds, paper, tinkering, not strong	Liquid, paste, gels, contact (two-sided)	Small	Tubes, bottles, spray cans, glue guns (heated)
2. Wood glue, PVAc in water	Wood-wood, water resistant, strong	Liquid (white), paste, powders	Variable	Bottles, cartridge gun-tubes, cans
3.Construction glue (PU-based)	Construction, strong	Liquid, paste	Variable	Cartridge gun-tubes
4. Super glue	Fast and strong to super strong	Liquid, gel	Small	Small tubes, dose-pen
5. Two-component glues	Metal, wood, plastic combinations, very strong	Liquids, paste	Small	2 small tubes (stuck) together
6. PVC glues	Gluing, filling of PVC (drain pipes)	Liquid	Variable	Cans with brush
7. Special glue	Glass, plastic, textiles, very strong	Liquid, gel	Small	Small tubes
8. Tile glues	Bathrooms, halls, living rooms	Paste, powder	Large	Cans, buckets, bags
9. Wall paper glue	All rooms	Powder	Large	Box containing powder
10. Carpet glue	All rooms	Liquid, paste	Large	Cans, buckets
11. Parquet glue	All rooms	Liquid	Large	Large tubes, bottles, cans

[a] *Note: this table is far from complete and was not used to categorize glues in the fact sheet.*

3.1 Glues from tubes

Composition
Describing a general composition for tube glues is rather complicated, because numerous glues are contained in tubes. Instead, in Table 12 two types of glues with their composition and application are listed.

Table 12: The type of tube glue and its composition (Sources: Product information).

Type tube glue	Adhesive	Solvents (*may consist of*)	% solid	Product density (g/cm^3)	Application
Universal glue	Polyvinyl acetate (PVAc)	Acetone, Ethanol, Methyl acetate, Ethyl acetate Together (<80%)	32	0.9	Various
Contact glue	Polychloroprene-rubber *or* neoprene rubber	Acetone, Alkanes, Ethanol, MEK, Ethyl acetate Toluene	20-24	0.8-0.9	Various, plastics (soft PVC), polystyrene, Glue-glue

Use
A lot of glues are contained in (small) tubes. These glues are taken as one category since the way they are used is very similar. Hence, it is expected that the exposure is also similar. These glues are: universal glues (including hobby and household glues) and contact glue (Table 12). Keep in mind that these glues may also be contained in other kinds of containers and do not reflect the entire segment of universal glues, for example. In Table 12 an overview of the glues is shown with their components and trademarks.

The tubes vary in size and range from 5 ml to 125 ml glue per tube. The glues are liquids or gels with moderate viscosities. The glues are used for many purposes, but generally for small tasks, e.g. tinkering or gluing of photos. The glue is simply put on the surface to be attached. The glue is then spread (with tool, finger, or tip of the tube; not always necessary for smaller surfaces) to cover the surface and dried for a few minutes. According to the directions on the container, one should check whether the glue will attach properly using one's finger. Then the other object is pushed onto the surface and the objects are tamped tightly to each other. For somewhat smaller surfaces or where strength is not so important, simply holding the surfaces together should be sufficient.

Contact glues often require two-sided application of the glue so that the adhesion is glue-glue. This increases the chance that an individual will be dermally exposed (assumed by twofold).

3.1.1 Scenario tube glue

Two small objects are glued together with 10 ml universal glue. According to an observational study about consumer use of DIY products (Magré 2005) [6] the average duration for a glue job for small surfaces takes approximately 6.5 minutes. Although this figure also includes glues for other kinds of use, it is also considered indicative for the use of tube glues. Time spent on gluing is heavily dependent on the surface area to be treated and not on what kind of glue is used (except for super glue due to its very short working time). A default application duration of 10 minutes is taken into consideration. The time volatile compounds could evaporate may be longer because the glue needs to harden. Assuming that a person stays in the room after use, an exposure duration of 240 minutes will be used as default. In the model ‘evaporation from increasing area’, it is assumed that evaporation can occur during this time, which is a worst case assumption.

The amount of glue also depends on the surface to be treated. In the report by Magré, conclusions considering the product amount used per square metre were not drawn. According to the directions for use of the products per 100 ml, a surface of 0.2 m^2 can be treated. The amount of glue, set as default at 10 ml per 0.02 m^2, will, for this situation, be less, a product amount of 9 g is calculated and a product density is 0.9 g/cm^3.

A room volume of 20 m^3 and a ventilation rate of 0.6 h^{-1} are used when the room where an individual is working is not specified (General Fact Sheet [3]). Otherwise, the specifications of the room, if specified, can be used.
It is estimated that individuals use tube glue on a once a week basis. Dermal exposure can occur when glues are spread out with the fingers or when excess glue is removed manually. The exposure duration will not take much longer than the application duration, because individuals will wash off glue immediately after use. In general, only the fingertips of one hand are used to spread out tube glue. One fingertip is approximately 1 cm^2 [20]; considering two fingertips provides a dermal exposure area of 2 cm^2. A small experiment with glue provided an average product amount of 0.06 g (maximum was 0.09 g) when glue was spread out with one finger (see Appendix A.2). The dermal load is therefore set at 0.08 g for tube glue.

- *Molecular Weight Matrix*

DIY products are in most cases mixtures of compounds; in the case of a mixture the evaporation is not only determined by the compound of interest, but also by the other constituents. The molecular weight matrix parameter is used to correct for the evaporation rate since it describes the average molecular weight of the rest of the total product (the product minus the compound of interest). This parameter can be left blank when the product purity is 100%. The exact composition is not known in most cases, as in the case of tube glue. When the composition is unknown the molecular weight matrix will be set at 3000 g/mol as a worst case value. Roughly, inserting this value in the evaporation model will result in an estimation of a product in its pure form. The calculation of the molecular weight matrix is described in de Paint Products Fact Sheet [22].

Default values for tube glue

	Default value	Q	Reference, comments
General			
Frequency	1 $week^{-1}$	2	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	10 min	2	Estimate
Product amount	9 g	2	Estimate
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	200 cm^2	2	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See above
Dermal			
Instant application			
Surface area	2 cm^2	2	See above
Product amount	0.08 g	1	See above

A more specific but nevertheless a common use for tube glues is gluing of photos. Generally, this task is performed twice per year after holidays or on special occasions. This task is discussed separately, because it may lead to relatively higher concentrations in combination with lesser frequent use. The parameters discussed below can be used to replace the parameter values in the default scenario.
It is assumed that 1 gram of glue is used per photo. Taking 90 pictures (15x10 cm) per occasion provides a product amount of 90 g with a release area per photo of 150 cm^2. This release area is considered the effective release area (150 cm^2). Assuming one minute per photo the application duration is set at 90 minutes.

3.2 Bottled glue – moderate size surfaces

This product category includes all glues that are available in small bottles. It includes, amongst others, universal (hobby) glue, wood glue and construction glue. The compositions of these glues are listed in Table 13.

Use
The bottles or jars contain glue in the range of 25 to 750 grams. In general the glues are used for larger surfaces than the tube glues. The most common known bottled glue is wood glue, which is used for various glue jobs from small to large. The glue is easily squeezed from the bottle onto the objects and spread out with one's finger, tool or with the nozzle. To keep the glues free from fungi and bacteria, preservatives are added. In addition, additives may be present to make the glue water resistant. Hobby or universal glues also display a wide range of use and are used similarly to wood glues (see Table 13).

Table 13: Composition of bottled glues from different kinds of glue (source: product information).

Type bottled glue	**Adhesive**	**Additive**	**Solvents (*may consist of*)**	**% Solid**	**Product density (g/cm^3)**	**Application**
Universal glue	Polyvinyl acetate (PVAc)		Acetone, ethanol, acetates	32	0.9	Various, hobby glue
Wood glue	PVAc	Filling agent, preservative	Water	50	1.1-1.2	Wood-wood/various
Construction glue	Polyurethane (PU)	Filling agent (diphenylmethane diisocyanate, MDI)	Solvent free	100	1.2-1.4	Construction
PVC glue	PVC polymers		THF, cyclohexa-none	22	0.92	Gluing of hard PVC and ABS Two-sided

The exposure duration is not expected to be much longer than estimated for tube glues. One does not have to work precisely in this case and that saves time. Although bottled glues are taken up as one category their use and hence exposure may differ considerably. Therefore, two scenarios will be described with specific defaults for universal/wood glue and construction glue, respectively.

For PVC glue (for hard plastics) no separate scenario is described. To calculate inhalation exposure the default parameters for universal/wood glue can be used. PVC glue is applied with a brush, which is attached to the lid. Glue is applied to both ends of PVC pipes and then stuck together. Dermal exposure will be lower than is expected for other bottled glues and therefore considered negligible.

3.2.1 Scenario universal/wood glue

According to the report by Magré (2005) [6] average application duration for small surfaces is 6.5 minutes. As a default scenario for gluing small surface areas during hobby use (e.g. for making a glider model) the application duration is set at 20 min (estimation) for wood glue and universal/hobby glue alike. It is expected that the individual will stay in that room for four hours in total. The applied amount varies per job and the surface to be treated. For the hobby task it was estimated that approximately 10 gram is needed (personal estimation). This relates to a surface area of 0.04 m^2 according to product information. It is assumed that this task is carried out in a small room (20 m^3 room volume with a ventilation rate of 0.6 h^{-1}). The inhalatory exposure to bottled glues occurs from the (open) bottle itself and during and after application. When the glue is spread with one's finger dermal exposure also occurs. Assuming that one uses only two fingertips of one hand, a dermal exposure area of 2 cm^2 will result. Because spills can occur on the skin or the glue is spread out, a dermal load of 0.06 g is taken into account (see Appendix A.2), thereby assuming that spills may mount up to 0.09 g. As default, the dermal load is set to 0.08 g. It is assumed that the glue will be immediately removed after the task is completed. The dermal exposure duration is therefore equal to the application duration.

Default for bottled glue: universal/wood glue.

	Default value	Q	Reference, comments
General			
Frequency	1/week	2	Hobby use
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	20 min	2	Estimate
Product amount	10 g	1	Estimate
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	400 cm^2	2	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	2 cm^2	2	See above
Product amount	0.08 g	1	See above

3.2.2 Scenario construction glue

Construction glue is more often used for larger tasks than wood glue, here the construction of a closet is described. Construction glues are often water resistant and have filling properties which make them suitable for certain tasks. The way of application is different from the application of wood glue. It needs more precision, because removal of construction glue from surfaces is more difficult. This means that exposure is expected to be different from universal or wood glue. The frequency, however, of these kinds of tasks is much lower in comparison to hobby use, where a frequency of twice a year is assumed.

A surface area of 1 m^2 is assumed is to be treated as a starting point. To treat such a surface requires approximately 250 g glue according to product information. Assembling a closet takes four hours (=exposure duration) of which 30 minutes actual gluing. The task is conducted in a non-specified room, so the default (small) room size of 20 m^3 and a ventilation rate of 0.6 h^{-1} are assumed. Parts which have to be attached must be pressed with clamps or nailed together for at least four minutes.

Inhalatory exposure may occur during application and hardening of the glue, which occurs under atmospheric humidity (reaction with water in air). Diphenylmethane diisocyanate (MDI) in combination with polyol reacts directly with water in the air and forms Poly-MDI or PolyUrethane (PU). MDI itself is a non-volatile (vapour pressure < 0.005 Pa) at room temperature. Due to the low vapour pressure and the reaction with water in the air it seems unlikely that MDI vapour is released. On the other hand, other constituents or by-products may evaporate from the product. When no evaporation can indeed be expected, based on the constituents, inhalatory exposure will be negligible.
Dermal exposure occurs during application of the glue when spreading with one’s fingers or spills during clamping of materials. Holding the glued materials with one hand while tightening the clamp with the other hand can result in a potential exposure

surface of one hand palm which equals to 215 cm^2. Appendix A.2 describes that when a hand palm is completely covered with glue, the amount of the glue is approximately 1 g. Because the glue is hard to remove and accompanied by product information that advises wearing gloves, it can be assumed that subjects will be precautious. A dermal load of 1 g would be too high, therefore 250 mg is assumed.

Default for bottled glue: construction glue.

	Default value	Q	Reference, comments
General			
Frequency	2 $year^{-1}$	2	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	30 min	1	Estimate
Product amount	250 g	2	See above
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	1 m^2	2	Estimate
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	215 cm^2	3	See above
Product amount	0.25 g	2	See above

3.3 Super glue

Composition

The main constituent of super glue is Cyanoacrylate (75-100%). Cyanoacrylate is the active compound in super glue. In addition, filling agents, plasticizers and small amounts of solvent (normally acetone) may be present in very small amounts.

Use

Super glues are used for very small surfaces that have to be glued very strong and fast. Super glues are contained in small tubes or dosage pens of 2-3 grams per product. Super glues are often contained in small syringes which make it easy to dose small amounts of glue. An example of the use of super glue is the repair of a mug which has lost its handle (ear). One droplet per end of the handle should be sufficient to reattach the handle to the mug. Simply put mug and handle together and hold them for a few seconds to two minutes maximum. After 24 hours the glue has reached full strength. Product information warns about the fast and strong adhesive properties (super glue adheres very strongly to skin), but it is not advised to wear gloves.

3.3.1 Scenario super glue

At maximum it will take five minutes to glue a handle to its mug. The report by Magré[6] shows an application duration of almost 18 minutes, but mentioned that the subject had problems gluing the object. The application duration found by Magré is therefore not representative for the use of super glues. The total exposure duration is set at 240 minutes as default when a subject stays in the room after use. Per event it is expected that an individual will not use more than a few droplets. According to a letter from APA (Aromatic Product Association, 1998; as cited in [23]) the amount used for this type of glue will be 0.5 g per event [23]. As default parameters 0.5 gram glue per event will be taken; this will be sufficient to glue at least 2 cm^2 according to the product information. Inhalatory exposure will be low because the amount used is very low. Still, product information warns for inhalatory exposure because cyanoacrylate (if present; vapour pressure is 70 Pa) may cause irritation to the airways.

The model evaporation from constant area for assessing the exposure from super glues was chosen, because the release area is very small. Dermal exposure may occur, because objects can be very small and therefore make it easier to spill. The amount that is spilt from surplus glue will be very low, because the total amount used is already low. Half a droplet size is considered (25 mg) as default, along with a surface area of two fingers (2 cm^2). However, individuals will try to avoid any dermal contact since the glue is hard to remove and stuck fingers are hard to separate.

Default for super glue.

	Default value	Q	Reference, comments
General			
Frequency	1 $month^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation from constant area			
Exposure duration	240 min	2	See above
Application duration	5 min	2	Estimate
Product amount	0.5 g	2	[6, 23]
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	2 cm^2	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	2 cm^2	2	See above
Product amount	25 mg	1	See above

3.4 Two-component glue

Composition
Two-component glues are composed from two separated formulations which have to be mixed together prior to use. Their composition (Table 14) is different from all the other glues in that the glue consists of two components: i.e. a resin and a siccative (hardener). The chemical reaction between the two components provides the strength of the glue. Two-component glues are used for many specific purposes which require fast and strong binding. In general, two-component glues are resistant against water, cold, heat and chemicals.

Table 14: Composition of polyurethane based two-component glue and composition of epoxy based two-component glue (Source: product information).

	PU based	**Epoxy based**
Resin	Polyol	Epoxy resin (Bisphenol A and epichlorohydrine [24])
Siccative (hardener)	Isocyanate (MDI)	Polyamino amide (N(3-dimethylaminopropyl)-1,3-propyleendiamine)
Product density mixture	1.40 g/cm^3	1.05 g/cm^3
Resin : siccative	4 : 1	1 : 1
Product consumption	1.5-3.5 m^2/kg	-

Use
There are two kinds of two-component glues available: glue based on polyurethane (PU) and the other based on epoxy resins. PU based glues are well suited for binding wood, concrete, stone, ceramics and different kind of plastics. Epoxy based glues are more suitable for metals, pottery, porcelain, glass, ivory and plastics [25]. However, the purposes of the two-component glues may overlap, because there is no rule on which two-component glue to use for a specific task.

Two-component glues are most often contained in duo-syringes or in tubes, but sometimes also in buckets or cans (for larger tasks). There are very small duo-syringes that make sure of the correct ratio between resin and siccative, which is used for optimal adhesion and is therefore easy to use. The duo-syringe contains approximately 60 grams of glue (both resin and siccative together). Besides syringes also separate tubes (of 100 ml each) are used, where the products are designed in such a manner that an identical length of the lines of glue will provide the optimum volume ratio for optimal adhesive power. The resin and siccative is then to be mixed together (a mixing cup and a spatula is provided) until a homogeneous colour or mass is obtained.

The mixture is manageable for approximately 15 minutes (polyurethane based) to 90 minutes (epoxy resin based) before the mixture will harden. It is therefore important that the resin and siccative are separated until usage. Before hardening, solvents such as acetone and MEK (methyl ethyl ketone) can be used to remove spilled glue. After hardening, the mixture can only be removed by mechanical force. Dermal contact is to be avoided and wearing of gloves is advised according to product information. However, accidental dermal contact to the mixture may still occur.

In general, two-component glues are used for moderate sized surfaces. Epoxy resin based two-component glues are longer manageable and may be more suitable for larger surfaces. On the other hand, some PU based two-component glues are used to glue parquet and thus a large surface size (see section 3.5).
The mixing and loading process and application (hence the exposure) are similar for both kinds of two-component glues. Furthermore, no clear distinction can be made in the product amount or treated surface size between the uses of both two-component glues. For these reasons one default scenario will be described for the use of two-component glue.

3.4.1 Scenario two-component glue

The use of two-component glues is not assumed to be very frequent. They are used for many tasks, but these tasks are mostly specific tasks that are not very frequent. Therefore a default of three times a year is assumed.

The scenario of gluing a large broken vase with two-component glue is described here. Assuming the vase has broken in half leads to a surface area of 500 cm^2 which is to be treated. For such a surface area approximately 20 g of glue is needed according to product information. In contrast, the amount of glue used for the gluing events observed by Magré [6] was very low (< 0.5 g and 4 g). The surfaces that were treated were consequently small; the task consisted of gluing the ear of a mug and a broken dinner plate. No room was specified and thus the specifications of a non-specified room are considered. The parameters for a non-specified room are 20 m^3 for room volume and 0.6 h^{-1} for ventilation rate.

Mixing and loading: two-component glue

When one of the products (resin or siccative) contains volatile agents, the *evaporation* model should be used to estimate the inhalation exposure. Forming of volatile substances during the chemical reaction between resin and siccative is unlikely (see section 2.4.1). The product amount mixed is 20 g in total and considered here as default. The weight fraction is considered to be 1. The exposure duration from the mixing and loading process is estimated to be five minutes. Evaporation takes place from a constant surface area, i.e. the mixing cup. The surface area is estimated at 20 cm^2. The dermal load is not assumed to be low: 50 mg (one drop: Appendix A.2).

Default mixing and loading: two-component glue

	Default value	Q	Reference, comments
General			
Frequency	3 $year^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	5 min	2	See above
Application duration	5 min	2	See above
Product amount	20 g	2	See above
Room volume	1 m^3	1	See section 2.4.1
Ventilation rate	0.6 h^{-1}	1	See section 2.4.1
Release area	20 cm^2	2	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	2 cm^2	3	See section 2.4.1
Product amount	50 mg	2	See above

Application

The resin and siccative are put in a mixing cup in the proper ratio. With a matchstick or small spatula the components are mixed before being applied to the surface with the same matchstick or spatula. The application duration is set at 30 minutes by estimation. This is not comparable with the application duration observed by Magré [6], in which application duration of 2 and 12 minutes per event were observed. The tasks Magré observed were smaller, which explains the difference. In the EU RAR on bisphenol A, an exposure duration of 210 minutes was estimated for two-component glue. Here, the exposure duration is set at 240 minutes as default, which is the time a subject stays in the room. Mixing and loading are included in the exposure duration, because evaporation of a compound starts during this process.

Because the composition of two-component glue is not completely known, the inhalatory exposure from two-component glue cannot be ignored. If there are proper reasons that suggest that inhalatory exposure to two-component glues are negligible one can leave out this route of exposure.

Dermal exposure, on the other hand, will occur during application when the parts are pushed together. Surplus glue can be spilled on the hands. In the EU RAR document on bisphenol A [26] (constituent of epoxy resin), a surface area of 54 cm^2 (=5% of the total surface of both hands = 1075 cm^2) was taken into account for the dermal exposure assessment for bisphenol A with respect to consumers. The figure of 5% surface area is not related to the manner of use, but merely based on assumption. In the scenario of holding the materials while applying the glue mixture, spills on the palm of one hand will occur. Assuming that approximately 20% of one palm (quarter of the total surface of the hands = 215 cm^2 [3]) is exposed, provides a surface area of 43 cm^2. This value is chosen over the EU assumption, because it is more related to the manner of use.

The dermal load is not high, because relatively low amounts are used. Assuming that two drops are spilled, a dermal load of 0.1 g can be derived.

Default for two-component glue.

	Default value	Q	Reference, comments
General			
Frequency	3 $year^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	30 min	2	See above
Product amount	20 g	1	See above
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	500 cm^2	2	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	43 cm^2	2	See above
Product amount	0.1 g	1	See above

3.5 Wood parquet glue

Composition
PVAc dispersion or one-component PU glue or
Two-component PU glue
Note: Some wood parquet glues are alcohol based

Use
These glues are used to glue wood parquet where the parquet is meant to lie on the surface (parquet is glued to the floor) or to float above it (individual parts are glued together, but not glued to the floor). Because application between the two parquet glues is different, the product (amount) used may differ significantly. Furthermore, for parquet glued to the floor there are also two-component glues, which need to be mixed and loaded before they can be used. The application of the two-component glue is regarded as being similar to parquet glued to the surface. The application of glue for floating parquet is very different, which results in a different exposure. For this reason two scenarios and defaults will be described.

3.5.1 Scenario parquet glued to surface

Gluing parquet onto the surface in the living room was selected as a default scenario for parquet gluing. According to General Fact Sheet [3] a living room has a volume of 58 m^3 with a surface area of 22 m^2 and a ventilation rate of 0.5 per hour. The endurance of such a floor is estimated to be 30 years, which is the lifetime of massive parquet floors. However, people tend to redecorate. Therefore a frequency of once in 8 years will be assumed. The parquet glue is spread out over a floor surface with a glue spatula, that is, the surface that can be covered within 10 minutes. With the glue still wet parquet is placed and firmly tampered or maybe mechanically attached (nails). These steps are repeated until the entire room is covered. The product information shows a consumption rate of 1 kg per every 1-2 m^2. Assuming a realistic worst case this provides 22 kg of parquet glue needed to perform the task. Note that in most cases, the task is performed by professionals, but this scenario refers to non-professional users.

Mixing and loading: two-component parquet glue
Refer to section 2.4.1 for the mixing and loading of two-component glues. When one of the products (resin or siccative) contains volatile agents the *evaporation from constant release area* model should be used to estimate the inhalation exposure. Formation of volatile substances during the chemical reaction between resin and siccative is considered very unlikely (see subsection 2.4.1). The product amount required for this task is very high (22 kg; derived from consumption rate of 1 kg/m^2 and surface area of 22 m^2). The mixing and loading step will be repeated approximately three times, because the product amount is simply too much to handle in one step. The mixing and loading are done in a bucket (surface area 320 cm^2). Per mixing and loading step the exposure duration is 10 minutes. The dermal load during mixing and loading is considered to be 200 mg.

Default mixing and loading: two component parquet glue.

	Default value	Q	Reference, comments
General			
Frequency	3 day^{-1}	1	3 day^{-1}, once every 8 years
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	10 min	1	See above
Application duration	10 min	1	
Product amount	7 kg	1	See above
Room volume	1 m^3	1	See subsection 2.4.1
Ventilation rate	0.6 h^{-1}	1	See subsection 2.4.1
Release area	320 cm^2	1	Surface bucket
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	215 cm^2	2	See subsection 2.4.1
Product amount	200 mg	1	Estimate

Application
After the parquet has been put in place it has to be kept there by putting heavy objects on it, thereby preventing the parquet from warping. After the task is completed it takes approximately 48 hours for the parquet floor to settle. During this period one should not walk on the floor. By estimation it takes individuals an entire day to lay parquet, as was also seen in the EU RAR draft report on MDI [27]. For this reason an exposure duration of 8 hours is taken into account with an application duration of

8 hours. After the task is completed there will be no after-use activity, because the parquet has to settle. For the reasons above the application duration is the same as the exposure duration.

An alternative description of exposure is required, because exposure to a very high product amount released from large areas is not considered realistic. Further, ConsExpo 4 is not able to integrate exposure intervals. This scenario would indefinitely lead to erroneous estimates. Instead, the release area is set equal to the surface area that can be treated per interval. It is assumed that an individual treats 1 m^2 per interval. After that the surface is covered and the exposure will be negligible compared with the newly treated surface. These steps are repeated until the task is completed, resulting in 22 repetitions. The inhalation exposure is described by evaporation of the total amount and not the adjusted amount from a constant surface area, i.e. 1 m^2. This simplification of the model is necessary, because otherwise depletion of the source can occur.

Exposure to parquet glue may occur via inhalation and by dermal contact. It is assumed that approximately 50% of both hands (430 cm^2) will be exposed. The dermal load is often related to the product amount. However, the large quantity of the product and the long duration of the task lead to frequent cleaning of the hands during the task. Therefore the relation between product amount and dermal load is not applicable here. The constant rate model will be used to describe the dermal exposure. A constant rate of 30 mg/min was assigned (see also section 2.6).

Default for parquet glue: gluing on surface

	Default value	Q	Reference, comments
General			
Frequency	1/8 $year^{-1}$	2	See above
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	480 min	2	See above
Application duration	480 min	2	See above
Product amount	22 kg	2	Product information, see above
Room volume	58 m^3	4	Living room [3]
Ventilation rate	0.5 h^{-1}	3	Living room [3]
Release area	1 m^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Constant rate			
Surface area	430 cm^2	3	See above
Contact rate	30 mg/min	1	See section 2.6
Release duration	480 min	2	See above

3.5.2 Scenario floating parquet

The task of constructing a floating parquet floor is considered easier than constructing a parquet floor on the surface. Assuming the same indoor environment as above (subsection 3.5.1) for constructing floating parquet; it will take less time and far less glue to conduct the task. According to the Dutch Environmental Information Centre (*Milieu Centraal*) the durability of laminate or thin parquet is ten years at maximum and the durability of use for an average floor cover in the Netherlands is eight years [28]. Nowadays, laminate that can be clicked together is more prominent than laminate which requires gluing. Considering a person who prefers parquet the frequency of laying parquet may be higher. A frequency of every four years for constructing floating parquets will be considered as default. The task is estimated to take 4 hours where the construction itself is performed with intervals. Hence the exposure duration and application duration are the same. According to the product information 1 kg is sufficient to cover 30 m^2. For an area of 22 m^2 it is assumed that 750 grams of glue is used. The glue is applied in the groove joints and tongue of the parquet elements. The glue is allowed to be absorbed for 2-3 minutes before the next element is placed and tampered with a rubber hammer. It is assumed that 1 m^2 is treated per interval; the effective release area is then 1 m^2. This interval is repeated 22 times to complete the task (see also subsection 3.5.1. under application). Surplus glue must be removed with a moist cloth. The container is a flask with a nozzle that indicates that the glue can be administered precisely to the groove joints. Spills can occur when pressing the parts together. The exposure area will be approximately 50% of one hand palm (110 cm^2). The dermal load is estimated to be 0.5 g.

Default for parquet glue: floating parquet.

	Default value	Q	Reference, comments
General			
Frequency	1/4 $year^{-1}$	1	See above
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	240 min	2	See above
Application duration	240 min	2	See above
Product amount	750 g	2	Product information, see above
Room volume	58 m^3	4	Living room [3]
Ventilation rate	0.5 h^{-1}	3	Living room [3]
Release area	1 m^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	110 cm^2	3	See above
Product amount	0.5 g	2	See above

3.6 Carpet glue

Composition

Adhesive agent:

Copolymer acrylate dispersions *or* Glue based on synthetic resin [24]

Solvents that can be present: Ethylbenzene [29], Cyclohexane [30], Xylene [24], Toluene [24], Water [24]

3.6.1 Scenario carpet glue

Carpet glue is used to keep floor covers in their place and prevent them from warping. Carpet glue can be used for several kinds of floor covers such as, carpets, carpet tiles, and PVC floor covers. Here, the laying of a carpet floor in the living room is considered. The durability of the carpet is heavily dependent on the sort of carpet and the quality. The average durability according to the Environmental Information Centre [28] is eight years. Here, it is assumed that the frequency of laying a carpet is once every four years.

A room volume of 58 m^3 and a surface area of 22 m^2 is selected as default in conformance with the General Fact Sheet [3]. According to product information an average of 1 kg carpet glue per 2.5 m^2 is used for laying carpets, providing a total product amount of approximately 9 kg carpet glue. The glue is spread over the surface with a glue spatula. A manageable time for this specific glue is 40 minutes. An alternative description of exposure is required, because exposure to a very high product amount released from large release areas is not realistic. Instead, the release area is set equal to the surface area one can treat per interval. It is assumed that 4 m^2 per interval can be treated, which will take 15 minutes per effort. Assuming that the carpet is already cut to size and is only moved to fit; application duration is 75 minutes. The total exposure duration is set equal to the application duration. During this process individuals may be exposed via inhalation or the dermal route. The contact rate of the glue is 30 mg/min (default) (see section 2.6) with a release duration of 75 minutes. The surface area will be approximately 50% of one hand palm, resulting in 110 cm^2 contact area.

Default for carpet glue.

	Default value	Q	Reference, comments
General			
Frequency	1/4 $year^{-1}$	3	See above
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	75 min	2	See above
Application duration	75 min	2	See above
Product amount	9 kg	2	See above
Room volume	58 m^3	4	Living room [3]
Ventilation rate	0.5 h^{-1}	3	Living room [3]
Release area	4 m^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Constant rate			
Surface area	110 cm^2	3	See above
Contact rate	30 mg/min	1	See section 2.6
Release duration	75 min	2	See above

3.7 Tile glue

Composition
Paste: Styrene acrylate dispersion, preservatives
Powders: based on cement/mortar

Use
Tile glues are glues for wall and floor tiles that must be attached to all kinds of surfaces such as cement walls, concrete, wood, chipboards, other tiles etcetera. Tile glues can be used while covering floors in the living room, hall and kitchens or covering walls in, for instance, kitchens and bathrooms. Tile glues are available in paste form, which are ready to use, and as powder. In general, the pastes are used to attach tiles to absorbing surfaces, while the powders are used to attach to non-absorbing surfaces. The powder is diluted with water until the desired ratio for the job is obtained. Tile glue (paste or obtained paste) is applied and spread out with a glue spatula. Wet stains or spills can be removed with water; hardened stains or spills must be removed mechanically (see product information).

3.7.1 Scenario tile glue

The scenario selected for tile glue holds for two walls in a bathroom, with a default room volume of 10 m^3 [3] having a surface area of 10 m^2 (two bathroom walls of 2 m wide and 2.5 m high). In this case, the surface area will be considered to be the area treated with tile glue. Tile glues are available in pastes based on primarily styrene acrylate dispersions or as powders. Ventilation rates are generally high in bathrooms according to the General Fact Sheet, where a default of 2 h^{-1} was derived. The glue is applied to the tile or directly to the surface with a glue spatula. The tiles are then attached by pressing them while shifting the tile in the right position. This must be done within a 15 minute time frame in which the glue is still manageable. The use of glue is on average 1-2 kg/m^2. Assuming an average use of 1.5 kg/m^2, this yields a total amount of 15 kg tile glue to be used on 10 m^2. The task is considered to take 6 hours. Covering walls or floors with tiles is not expected to occur at high frequency (a frequency of once every two years is assumed).

Mixing and loading: tile glue
Mixing the powders, which have a mortar and a cement base, with water will provide a similar paste which is applied similarly. Additional dermal/inhalatory exposure from the mixing and loading process may occur. The total product amount will be 15 kg. This 15 kg is obtained by mixing 12 kg of powder with 3 litres of water according to product information, which prescribes 0.26 litres per 1 kg dry powder. The mixing and loading process is repeated five times; otherwise the quantity is too large to mix. The product amount is 15 kg divided by 5 (= 3 kg) per mixing and loading event.

For the exposure scenario of the mixing and loading process refer to subsection 2.4.2. For inhalatory exposure to powder, information concerning particle size distribution, airborne fraction, and mass generation is insufficient or lacking and thus no exposure model from ConsExpo could be assigned.

Due to the high amount of the product (powder) the inhalatory exposure is 2.5 µg/min during exposure duration of 1.33 min (see subsection 2.4.2) leading to 3.0 µg inhalatory exposure. The dermal exposure results from dust falling on hands or direct contact. Contact rate is 0.33 mg/min with the same exposure duration (1.33 min).

Default mixing and loading: tile glue.

	Default value	Q	Reference, comments
General			
Frequency	5 day^{-1}	1	5 day^{-1}, once every 2 years
Dermal			
Constant rate			
Surface area	430 cm^2	2	See subsection 2.4.2
Contact rate	0.33 mg/min	1	See subsection 2.4.2
Release duration	1.33 min	2	See subsection 2.4.2

Application

Although no solvents are present in tile glue, inhalatory exposure may occur from other materials present. When there are sufficient arguments that inhalatory exposure is negligible, the inhalation route can be ruled out. Otherwise, the inhalation exposure can be described by assuming an effective release area of 1 m^2 during the entire task. This is the surface a subject is assumed to cover per interval. Because the source strength is renewed per interval the product amount is considered as the amount required for the entire task. Therefore, the total product amount is taken to prevent an underestimation of exposure due to source depletion.

Dermal exposure results from spills or surplus glue removal. An exposure area of two hand palms (0.5 * 860 cm^2 from General Fact Sheet [3]) will be considered. The constant rate model is applied here, because subjects will clean their hands during the task. A contact rate of 30 mg/min is used, with a release duration of 360 minutes.

Default for tile glue.

	Default value	Q	Reference, comments
General			
Frequency	0.5 $year^{-1}$	2	Estimate
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	360 min	2	See above
Application time	360 min	2	See above
Product amount	15 kg	2	Product information, See above
Room volume	10 m^3	3	Bathroom [3]
Ventilation rate	2 h^{-1}	3	Bathroom [3]
Release area	1 m^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Constant rate			
Surface area	430 cm^2	2	See above
Contact rate	30 mg/min	1	See section 2.6
Release duration	360 min	2	See above

3.8 Wall paper glue

Composition
Poly Anionic Cellulose (PAC) or methyl cellulose or Polyvinyl Acetate (PVAc)
Preservatives [25]

Use
Wall paper glues are available in powder form, which have to be suspended with water before use. The powder may contain PAC, methyl cellulose or PVAc and does not normally contain any solvents. The adhesive powder is poured into cold water in a proper ratio (according to use directions) and stirred until there is a solution without any lumps. According to product information 125 grams of glue powder can be mixed in 6 to 10 l water (this is for normal wall paper); there are also special and heavy wall papers, for which alternative wall paper glue is used. Although heavy wall paper glue is based on the same constituents, it is likely to have other volume percentages. The obtained suspension can be used for surfaces ranging from 30-50 m^2, depending on the type of wall paper. After the powder is in suspension the mixture can be easily applied to the wall paper with a brush. The wall paper covered with glue is folded to make sure it is properly soaked with glue and left to rest before attaching wall paper to the wall.

3.8.1 Scenario wall paper glue

In the default scenario the walls in a living room will be covered with normal wall paper. According to the General Fact Sheet [3] the volume and surface area are 58 m^3 and 22 m^2, respectively. A total surface area of 40 m^2 for the walls (corrected for doors and windows) is assumed for hanging wall paper. Applying wall papers is not a frequent DIY task but is assumed as a default once every two years.

Mixing and loading: wall paper glue
The mixing and loading process is described in subsection 2.4.2 where default values for parameters are set. During mixing and loading inhalatory exposure to particles from the powder can occur. No exposure model from ConsExpo could be assigned for inhalatory exposure to powder. Information concerning particle size distribution, airborne fraction, and mass generation is insufficient or lacking and thus another description of the exposure was preferred.
Due to a relatively low product of the powder, the inhalatory exposure is 0.25 µg/min during exposure duration of 1.33 min (see section 2.4.2) leading to 0.30 µg inhalatory exposure.

Dermal exposure is described according to the constant rate model. For normal wall paper and a surface area of 40 m^2 a 7.5 l, suspension (125 grams wall paper glue suspended in 7.5 l) must be made according to product information. Because a low amount is considered, the dermal contact rate is 0.033 mg/min.

Default mixing and loading: wall paper glue.

	Default value	Q	Reference, comments
General			
Frequency	0.5 year^{-1}	1	See above
Dermal			
Constant rate			
Surface area	430 cm^2	2	See subsection 2.4.2
Contact rate	0.033 mg/min	1	See subsection 2.4.2
Release duration	1.33 min	2	See subsection 2.4.2

Application

The obtained suspension is applied with a brush after which the wall paper is folded to allow it to soak properly. Afterwards, the wall paper can be attached. Surplus glue should be removed instantly with a moist cloth. It is assumed that covering the walls with paper in a living room takes 6 hours (estimation). The application duration is estimated to be 4 hours which means that two hours after-use activity (cleaning up) is assumed.

Because wall paper glue does not contain volatile components, it is concluded that there will be no evaporation and hence no inhalatory exposure during application. Dermal exposure, on the other hand, will occur during application. The spreading of the glue, folding and hanging of wall paper will cause spills on both hands. The dermal load can be significant, depending on how the subject handles the wall paper. Since wall paper glue is not considered harmful and easy to remove afterwards, subjects tend to be more careless. The dermal exposure duration is set at 4 hours. The constant rate model is applied for dermal exposure. Release duration is set equal to application duration with a contact rate of 30 mg suspension per minute (see section 2.6).

Default for wall paper glue.

	Default value	Q	Reference, comments
General			
Frequency	0.5 year^{-1}	1	Assumption
Dermal			
Constant rate			
Surface area	860 cm^2	2	Both hands, see above
Contact rate	30 mg/min	1	See above
Release duration	240 min	1	See above

3.9 Hot melt adhesives

Composition

EVA (Ethylene vinyl acetate; a thermoplastic) or other thermoplastic

2% Methylenediphenyl diisocyanate (MDI) [27]

Use
Hot melt adhesives are solidified glues that are primarily for hobby use. They have a wide range of applicability and are used mainly for small surfaces such as connections of model parts and flowers for decorative purposes. The adhesive agent is a thermoplastic, such as EVA. A glue gun is required to use a hot melt adhesive. The glue gun is an electric device which heats up the solidified glue bar (65 g [27]). The glue is inserted in the rear and then heated up for approximately five minutes. The temperature at which the glue is manageable is 150 to 180 degrees Celsius. As a result the glue bar will melt inside the glue gun. By triggering the glue gun, the melted glue is squeezed out onto the surface. The connection must then be realized within 15-20 seconds; otherwise the glue has cooled down too much. During the heating process MDI vapours may be released from the MDI containing glue bars. The vapours coming from the heating process can enter the breathing zone of the user [27]. Although the volume percentage of MDI is rather low, it may still elicit irritant effects in the respiratory tract.

3.9.1 Scenario hot melt adhesives
The scenario of gluing the soles of the shoes (surface area approximately 100 cm^2) with a hot melt adhesive is described here. The effective release area is, however, much lower due the gradual release of the hot melt in combination with the cooling down of the glue. The effective release area is estimated to be approximately 5 cm^2. During this task, one glue bar will be consumed (65 g). The task is conducted in a non-specified room. This room is therefore defined to have a volume of 20 m^3 and a ventilation rate of 0.6 h^{-1} [3]. In total, an application duration of 25 minutes will be taken into account which is spread over a longer period of time (gluing occurs with intervals). The default exposure duration is also set at 25 minutes due to a fast cooling down of the glue. The frequency of use is estimated to be once per month.

Exposure to a hot melt adhesive takes place during the heating of the adhesive. Inhalation exposure may be caused by a chemical reaction due to heating, or from evaporation at high temperature. ConsExpo does not include models to evaluate chemical reactions. An estimate of the amount of chemical produced in the reaction has to be made separately. The exposure can then be calculated using the instantaneous release model. Similarly, the evaporation models in ConsExpo do not include an option where the evaporation takes place at a different (much higher, in this case) temperature than the surrounding space (room temperature). As the evaporation in this case is likely to be much higher than evaporation at room temperature, the use of the ConsExpo evaporation model could lead to an underestimation of the exposure. Therefore it is advised to use the instantaneous release model in this case as well. The modelled concentration can be limited to the vapour pressure of the substance at room temperature to prevent the occurrence of unrealistically high concentration levels that may arise from the immediate release of the substance. Ticking the box: ‘limit the air concentration to the vapour pressure of pure substance’ in ConsExpo is required.

Inhalatory exposure takes place when the glue is being heated or melted. Vapours of MDI or EVA can reach the breathing zone of the user. Dermal exposure during use is considered negligible, because one can work very precisely with a glue gun and, moreover, the glue is too hot to spread over the surface. Before use, there is dermal contact when the glue bar is inserted. Assuming that only one hand will be used to insert the glue bar; 20% of a hand palm will be exposed. This equals a contact surface of 43 cm^2. The dermal load will be low, because the glue is still solid at room temperature. The glue is more or less rubbed off the glue bar. The dermal load is estimated to be in the order of 100 mg. In the EU RAR on MDI [27] the dermal load from MDI alone was estimated to be 168 mg, which was a worst case estimation.

Default for hot melt adhesive.

	Default value	Q	Reference, comments
General			
Frequency	1 $month^{-1}$	2	Estimate
Inhalation			
Exposure to vapour: instantaneous release			
Exposure duration	25 min	2	See above
Product amount	65 g	3	One glue bar [27]
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Dermal			
Instant application			
Surface area	43 cm^2	3	See above
Product amount	100 mg	2	See above

3.10 Glue from spray

Composition

In contact spray the active component is SBR (Styrene-butadiene rubber). In the Netherlands a mixture of propane and butane (50%: 50%) is often used as propellant. A spray can contain about 30-35% of this mixture. According to product information the content of solid materials is 16%.

Use

Besides having glues in tubes, bottles, cartridges, syringes and canisters, there is also glue is also available in the form of spray. Generally glue spray is used on materials such as paper, cardboard, photos, textiles, cork and metal foils. Glue spray is also suitable for temporary attachment of materials. The glue is applied on both surfaces which are to be attached, except when porous materials are used, in those cases only one side should be sprayed with glue.

3.10.1 Scenario glue spray

The scenario of gluing a poster to a wall or door, or put in a frame is described here. This task is not performed often and thus a frequency of once per month is assumed. The surface of the poster is assumed to be 1.5 m^2. According to product information 300 ml (255 g; product density is 0.85 g/cm^3) is required to glue the poster. Using the mass generation rate from subsection 2.3.3 (1.5 g/sec) provides a spraying duration of 170 seconds. The exposure duration is the time that a person stays in the room during and after the task. The total exposure duration is set at 240 minutes. The volume percentage of non-volatiles is 16% according to product information.

The room is not specified, therefore default values for room volume, room height and ventilation rate from General Fact Sheet for a non-specified room are considered in this case. These values are 20 m^3, 2.5 m, and 0.6 h^{-1}, respectively. Dermal exposure can be estimated with the constant rate model. The exposed area will be half of both hands (430 cm^2; estimate).

Default for glue spray.

	Default value	Q	Reference, comments
General			
Frequency	1 $month^{-1}$	1	Estimate
Inhalation			
Exposure, spray model			
Spray duration	170 sec	2	See above
Exposure duration	240 min	2	See above
Room volume	20 m^3	3	[3]
Room height	2.5 m	4	Standard room height
Ventilation rate	0.6 h^{-1}	3	[3]
Mass generation rate	1.5 g/sec	3	See subsection 2.3.3
Airborne fraction	1 g/g	2	See subsection 2.3.3
Weight fraction non-volatile	0.16	2	Product information
Density non-volatile	1.3 g/cm^3	3	See subsection 2.3.2
Initial droplet distribution – median (C.V.)	40 µm (0.4)	3	See subsection 2.3.3
Inhalation cut-off diameter	15 µm	3	See subsection 2.3.3
Dermal			
Constant rate			
Surface area	430 cm^2	2	See above
Contact rate	100 mg/min	1	See subsection 2.3.4
Release duration	170 sec	2	See above

4. Sealants

Sealants are products which are used in several DIY tasks, ranging from sealing off gaps in the bathroom to gluing materials together at construction sites. Sealants are contained in cartridges of approximately 300 ml or larger cartridges of approximately 750 ml. The sealants are applied using a cartridge gun or caulk gun in which the cartridge is placed. By triggering the cartridge gun a barrel is pushed slowly through the cartridge, which presses the sealant out.

The use of sealants can be separated into two applications: (1) sealing off gaps to obtain an air- and water-tight joint, and (2) as a glue to connect materials together. The difference in use leads to a difference in exposure and therefore sealants are divided into two product categories. These product categories are defined as joint sealants and assembly sealants which are discussed in sections 4.1 and 4.2, respectively.

4.1 Joint sealants

Composition
The composition of joint sealants can differ significantly amongst the different types of joint sealants. In general, the joint sealants have a main component (silicon, acrylate, butylenes, or polyurethane (PU)) and filling agents. Some joint sealants contain volatile solvents. In Table 15 a list of different types of sealants is provided.

Use
Joint sealants are used in and around the house to seal off joints or small gaps to prevent air and/or water to pass. ‘Use’ of joint sealants is different, because each different sealant has its own characteristics. Silicone based sealants are known for their elastic and water resistant properties, and will be used in moist environments such as bathrooms, toilets and kitchens. Here, it is important that no water can penetrate the sealant to cause moisture problems such as mould or leakages. Sealants used for water resistant purposes are often referred to as caulk. Furthermore, due to their elasticity silicon based sealants are often used to seal off glass. However, the disadvantage of silicone sealants is that they cannot be painted.
Acrylate based sealants have stronger adhesive abilities then silicone based sealants and are more suitable for sealing off gaps around windows, windowsills, and doors. For this utility it is important that the sealant can be attached to several surfaces (brick, wood, plastic, metal, and glass). These sealants have the main advantage that they can be painted without reacting with the paint (product information). However, acrylate sealants lack elasticity and cannot be used on joints which are prone to warp. Next to the two sealants already mentioned above there are sealants based on butylenes as well. Butylene based sealants have a long hardening time and attach easily to glass. The main advantage of these sealants is that they harden by forming a ‘skin’ on the surface but remain plastic, thereby making it easy to detach an object when necessary. Nowadays, these sealants are often replaced by acrylate based sealants (www.DHZ-Shop.nl).

Although their ‘use’ is different, the application is the same. The sealants are applied with a cartridge gun. Joint sealants will not be used for large surfaces, but more for long joints with small diameters. The amount used depends on the job at hand. On average one cartridge of 300 ml can be used to seal off a 20 m joint of 3 x 5 mm (product information).

Therefore only one scenario will be described for joint sealants: in this case, sealing off joints in a bathroom. The task is conducted indoors in a relatively small room, while the task itself is relatively large. The scenario can therefore be regarded as a reasonable worst case scenario.

Table 15: Composition of different kind of sealants is listed below (information from Terwoert et al., 2002) [31]

Type sealant	**Composition**	**Content**	**Main purpose**
Silicon based I	Polydimethyl siloxane Filling agent		Construction, window frame
Silicon based II	Polydimethyl siloxane Filling agent Octylisothiazolinone (fungicide)	~ 0.01%	Sanitary use
Silicon based III	Polydimethyl siloxane Filling agent Butanonoxim	1-5%	Glazing, sealing of 'glass' joints (source VNVI: www.nrk.nl)
Acrylate based I (waterborne)	PVAc Filling agent MCI/MI (biocide)	< 0.01%	Construction Masonry, window frame-stone joints
Acrylate based II (solvent based)	PVAc Xylene Filling agent	20-30%	Masonry, window frame-stone joints
Butylene based	Polybutylene White spirit Filling agent Vegetable oil	1-5%	Wooden window frames
Polysulphide (one-component)	Polysulphide Manganese oxide Toluene Filling agent	10-30% < 1% < 2%	Glazing, sealing of 'glass' joints
PU based (one-component)	Isocyanate polymer (MDI) Xylene Calcium oxide	< 2.5% 2.5-10% < 2.5%	Glazing, sealing of 'glass' joints Flexible joints
Hybride	MS polymer (PU modified polysiloxane) Filling agent Gamma-aminopropyltriethoxy-silane	1-5%	Glazing, sealing of 'glass' joints

Some of the uses of joint sealants overlap with other DIY groups. For instance, sealants can be used to fill gaps in cement joints. However, this is not the main use for these products. Only the main purposes of sealants will be described here.

4.1.1 Scenario joint sealant

The scenario for joint sealants is assumed to be performed in a bathroom (moist environment), where the joints between bathtub, shower cabinet, or washstands and wall will be sealed off. The total joint length when sealing off the joints between a bathtub and wall is estimated to be five metres. Assuming that one cartridge of 300 ml can seal off a 20 m joint, sealing a 5 m long joint can be calculated to require 75 ml. Silicon based sealants are most suitable for this type of DIY task. A product density of 1 g/cm^3 is used here, which provides a product amount of 75 g. The product density of joint sealants in general ranges from 0.98 to 1.55 g/cm^3.

In the report by Magré (2005) [6] five tasks performed with sealants were observed four times. One of these tasks also consisted of filling gaps in walls. However, this is not the main purpose of the product. Excluding that observation resulted in an average product amount of approximately 40 g sealant per task. This is slightly lower than the calculated value above, but the tasks observed by Magré were consequently smaller. The calculation of 75 g is in agreement with observed amounts when corrected for the magnitude of the task. The time needed to perform the task was also observed by Magré. Exact application durations are not clear, but range from 14 to 24 minutes. Here, 30 minute application duration is set as default, with a total exposure duration of 45 min. Finishing off after use consists of cleaning up, which should not consume much time.

The sealants are liquid gel-like and harden quite fast. Safety directions present on the product indicate that inhalatory exposure may occur for silicone based sealants. Mainly the solvents present in the silicone sealants will evaporate from the joints. No such indications were present on the two acrylate based sealants [6]. Inhalatory exposures can be caused from solvents present (see Table 15); however most acrylate based sealants do not contain solvents.

Dermal exposure is also expected to occur. According to product information the sealant must be pressed into the joint with a spatula or with a finger dipped in water containing soap. The latter option is simple; it does not require a tool and is used more often. After smoothening the sealant, the finger is wiped clean, dipped and subsequently used to smoothen the next section of sealant. The dermal exposure area is the tip of one finger (1 cm^2). Due to the amount of surplus sealant the exposure area is set at 2 cm^2 instead of just the fingertip. The dermal load can be significant and is estimated to be 1.5 g in total. Using the constant rate model the constant rate is calculated to be 50 mg/min (1.5 g divided by release duration of 30 min). Even though only small sections can be smoothened, each time the finger tip is completely covered with sealant.

Default for the use of joint sealant.

	Default value	Q	Reference, comments
General			
Frequency	3 $year^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	45 min	2	See above
Application duration	30 min	2	See above
Product amount	75 g	2	See above
Room volume	10 m^3	3	Bathroom [3]
Ventilation rate	2 h^{-1}	3	Bathroom [3]
Release area	250 cm^2	2	5 m * 5 mm
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Constant rate			
Surface area	2 cm^2	3	See above
Contact rate	50 mg/min	2	See above
Release duration	30 min	2	See above

4.2 Assembly sealants

Composition
Polyurethane pre-polymers
Filling agent
Diphenylmethane diisocyanate (MDI)

Use
Assembly sealants (Modified Silicone polymers) have multiple purposes. The main purpose is to attach materials to each other during construction, but these products are also used to seal off gaps at the same time. The product can be used to glue all kinds of materials together, both indoor and outdoor, which is indicative for the broad scale of applications. The product is generally sold as glue; however, its use is similar to the use of joint sealants. For this reason, assembly sealants are discussed in this chapter.

4.2.1 Scenario assembly sealant

The scenario for assembly sealant is the construction of a wooden frame inside the house. Assembly sealant is suitable for this task because the wooden parts are glued fast and firmly. The frame is assumed to be constructed indoors before being placed. The placing of the frame is also conducted with the assembly sealant. Since the room is not specified, the default values for room volume (20 m^3) and ventilation rate (0.6 h^{-1}) from the General Fact Sheet for a non-specified room are considered. The task described is therefore a rather professional one. The frequency of use of assembly sealants is low, because of the product's focus on professionals. Therefore, the use of once a year is assumed.

The task here is fairly large, but gluing the parts together will not consume much time. An application duration of 30 minutes is chosen here. The time a subject stays in the room after the DIY task is 4 hours which will be used in the default scenario. US EPA estimated an exposure duration of 210 minutes for assembly glue without considering tasks (as cited from EU RAR on Toluene section consumer exposure in glues – original reference: US EPA 1987 [23]). Assembly sealant put on with cartridge guns are kept in cartridges of 390 g according to product information. It is assumed that the task will consume the entire cartridge (for approximately 1.5 m^2 treated surface).

There is no information on inhalation exposure; however, safety instructions point out that vapours are not to be inhaled, which indicates that there can be inhalatory exposure. When exposure of the respiratory tract occurs, it will be similar to the exposure described for joint sealant (see subsection 4.1.1). This is the reason that the model 'Exposure to vapour: evaporation from increasing area' was selected. The application of assembly sealant with a cartridge gun is performed very precisely on the objects even for hard-to-reach places. Spreading out the glue is not necessary in most cases. Therefore, the dermal exposure is dissimilar in comparison to joint sealants. However, when using clamping materials, surplus sealant can be spilled on one's hand. The dermal load is expected to be low: 0.5 g. The surface area will be approximately 20% of one hand palm which equals to 43 cm^2.

Default for assembly sealant.

	Default value	Q	Reference, comments
General			
Frequency	1 $year^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	30 min	2	See above
Product amount	390 g	1	See above
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	1.5 m^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	43 cm^2	3	See above
Product amount	0.5 g	2	See above

5. Fillers and putty

Composition
Fillers and putty are DIY products which are used to remove unevenness from surfaces. The fillers are generally used to fill gaps and holes in walls and wood (often decayed wood). Putty is used to smooth relatively small uneven surfaces caused by screw holes, scratches or coarse materials. The DIY tasks can be very specific. For these specific purposes there are several fillers and putties available on the consumer market. There are general powder based fillers, ready-to-use large hole fillers, fillers and putty in tubes, two-component filler, and spray putty. An overview of available fillers and putty is presented in Table 16 with their compositions and application.

A default scenario is described for each of the above mentioned types of filler or putty, because exposure and exposure conditions may differ during mixing and loading, during application, and in the magnitude of the task at hand.

5.1 General filler from powder

Use
The general fillers are used for the filling of holes and cracks with a maximum depth of 5 cm. Furthermore, the filler can be used to set corners when a new wall is constructed. The general fillers are powders, which have to be mixed and loaded with water in ratio of 2:1 (powder: water). As soon as a lump-free paste is obtained the filler can be applied in the hole with a filling-knife. This step is repeated until the hole is completely filled and can be smoothened with the filling-knife. These fillers are suitable for indoor use (some are also suitable for outdoor use) and can be painted with all kinds of paints according to the product information.

5.1.1 Scenario general filler from powder

The filling of small holes in a wall is described here. It is difficult to determine the amount of powder needed to fill those holes, because that is heavily dependent on the depth and size of the holes. Here it is assumed that 250 g of powder is suspended in water to fill the holes in the wall. The task is performed in a non-specified room. Using the parameters for this room for the General Fact Sheet [3] provides a room volume of 20 m^3 and a ventilation rate of 0.6 h^{-1}. Performing this task will not occur that often. Twice a year is assumed for the default scenario.

Mixing and loading: general filler from powder
For the mixing and loading of powders please refer to the scenario described in subsection 2.4.2., No exposure model from ConsExpo could be assigned for inhalatory exposure to powder. Information concerning particle size distribution, airborne fraction, and mass generation is insufficient or lacking and thus another description of the exposure was preferred. The product amount of 250 g is suspended in approximately 125 ml water. The inhalation exposure is 0.3 µg which is calculated by the contact rate of 0.25 µg/min and exposure duration of 1.33 min (see subsection 2.4.2). The dermal exposure can be estimated with the constant rate model, where the surface area, contact rate and release duration are 430 cm^2, 0.033 mg/min, and 1.33 min, respectively.

Table 16: Composition of different types of fillers is listed below (based on information from Terwoert et al. [31], supplemented with product information).

Type filler	Composition	Container	Content	Main purpose
Filler - powder	Polymer resin	Carton		Universal filler Up to 5 cm depth
Large amount fillers	Polymer dispersion Filling agents (cement)	Bucket, jar		Universal filler Up to 10 cm depth
Filler/putty – water based	Calcium carbonate PVAc Magnesium silicate Isothiazolinon (biocide)	Tube	25-50% < 2.5% < 2.5% < 0.01%	For inside and outside use, re-paintable
Lacquer Filler/putty – solvent based	Alkyd resin Aliphatic/Aromatic Carbon hydrates Calcium Carbonate/magnesium silicate White lead Barium sulphate Methanol	Tube	< 10% 10-15% 50% < 0.5% 2.5-10% 0.2%	For inside use, or for both inside and outside
Liquid wood (water based or solvent based)	Wood powder in polymer dispersion	Tube		For wood repair Layer thickness maximum of 1 cm
General wood repair filler (two-component)	Resin: Epoxy resin Bisphenol A Reactive thinners Siccative: Aliphatic amine Benzylalcohol Nonylphenol	Tubes, cans	 10-100% 10-50% 10-25% 2.5-10%	Repair of (decayed) wood, where cracks and gaps are filled.
Two-component Filler	Resin: Polyester resin Styrene Magnesium silicate Barium sulphate Siccative: Dibenzoylperoxide Dibutyl phthalate	Tubes, cans	 ~ 35% 10-30% 10-25% 10-25% 30-60% 30-60%	Filling and repair of wood or steel
Putty – spray	Alkyd resin Alkane mixture (propellant)	Spray can		Superficial, small scratches. For metal

Default mixing and loading: general filler from powder.

	Default value	Q	Reference, comments
General			
Frequency	2 $year^{-1}$	1	Estimate
Dermal			
Constant rate			
Surface area	430 cm^2	2	See subsection 2.4.2
Contact rate	0.033 mg/min	1	See subsection 2.4.2
Release duration	1.33 min	2	See subsection 2.4.2

Application

After the filler is prepared for use, it is applied to the hole with the filling-knife. This takes approximately 15 minutes. Afterwards the filler hardens by water diffusion and evaporation. When the filler is hardened it can be sanded so that a smooth surface is obtained. Inhalatory exposure is expected to be negligible, because the product does not contain constituents which are likely to evaporate except water. For this reason no inhalatory scenario is proposed. Dermal exposure, however, does occur during application (15 minutes). Filler is spilled on hands, while putting the filler in the hole. The spilled amount will be low, because working with fillers is relatively easy. The dermal load is estimated at 0.25 g, which is 0.1% (estimation) of the total product amount. The surface area is the same as during the mixing and loading process described above: 430 cm^2.

Default for the use of general filler from powder.

	Default value	Q	Reference, comments
General			
Frequency	2 $year^{-1}$	1	Estimate
Dermal			
Instant application			
Surface area	430 cm^2	2	See above
Product amount	0.25 g	1	See above
Exposure duration	15 min	1	See above

5.2 Large hole filler

Use

Large hole fillers are used for gaps and holes that have depths from more than 5 cm up to 10 cm. The large hole fillers are stored in buckets or jars (ready to use) or are made from powders. The product can be used indoor and outdoor and can be painted, also with water based paint.

5.2.1 Scenario large hole fillers

The frequency of use is expected to be less than that for the use of fillers for smaller holes (once a year). Here, filling the gaps in a cement/concrete wall is considered as a starting point. The larger gaps of up to 10 cm depth in a wall require a significant amount, which may easily rise up to 1 kg of filler. Performing the task will not take much more time than for a general filler since large gaps can be filled in few repeated steps.

Mixing and loading
The large hole fillers made from powders require the mixing and loading of the powder with water. The mixing and loading process is similar to the mixing and loading of a general filler (see subsection 5.1.1). No exposure model from ConsExpo could be assigned for inhalatory exposure to powder. Information concerning particle size distribution, airborne fraction and mass generation is insufficient or lacking and thus another description of the exposure was preferred.

The inhalation exposure is 0.3 µg dust which is calculated by the contact rate of 0.25 µg/min and exposure duration of 1.33 min (see section 2.4.2). The dermal exposure can be estimated with the *constant rate* model where the surface area, contact rate, and release duration are 430 cm^2, 0.033 mg/min, and 1.33 min, respectively.

Default mixing and loading: Large hole filler from powder.

	Default value	Q	Reference, comments
General			
Frequency	1 $year^{-1}$	1	Estimate
Dermal			
Constant rate			
Surface area	430 cm^2	2	See subsection 2.4.2
Contact rate	0.033 mg/min	1	See subsection 2.4.2
Release duration	1.33 min	2	See subsection 2.4.2

Application
The application duration is estimated to be 30 minutes. Inhalatory exposure is negligible, because the constituents are not expected to evaporate. Dermal exposure during application occurs via spills. The dermal load will be higher, because the total product amount is larger compared to normal filling tasks. The dermal load is estimated at 0.5 g. The surface area is assumed to be the surface of one's fingers which equals to 430 cm^2.

Default for large hole fillers.

	Default value	Q	Reference, comments
General			
Frequency	1 $year^{-1}$	1	Estimate
Dermal			
Instant application			
Surface area	430 cm^2	2	See above
Product amount	0.5 g	1	See above
Exposure duration	30 min	1	See above

5.3 Filler / putty from tubes

Use
The fillers and putties from tubes are generally used for shallow holes and gaps. The products are ready to use or require a mixing and loading process; the two-component fillers. The two-component fillers will be discussed in section 5.4.

The fillers and putties from tubes include the water based fillers/putties, lacquer based fillers/putties and liquid wood. These fillers are mainly used to repair little scratches and fill (screw) holes in wood to prepare the materials for another DIY task such as painting. The application of these products is rather superficial and should not be used for depths over 1 cm. Furthermore, the products can be applied indoors, or both indoors and outdoors. Liquid wood is different from the lacquer and water based fillers/putties, because it is available in different wood colours. In the UK approximately 800 kg of wood filler is sold per year according to information from EU RAR on bisphenol A (2003) [26]. This is not a large number, indicating that the product is not used that often.

5.3.1 Scenario filler / putty from tubes

Here, the treatment with filler of screw-holes of an entire bookcase is considered before it is painted. No room is specified for this task, therefore the parameters for a non-specified room are used here; room volume is 20 m^3 and ventilation rate is 0.6 h^{-1} according to the General Fact Sheet [3]. Magré [6] conducted observations of subjects using fillers or putty for their DIY task. Application durations varying from 1 minute to nearly 20 minutes were observed. One of the longest observation times was for filling the holes in a wooden drawer. The default chosen for application was 20 minutes. Assuming that the subject stays in the room for 4 hours in total, the exposure duration will be 4 hours. The task is expected to occur with a frequency of three times a year. The filler or putty is put from the tube on to the filling-knife. The product is then applied to the small gap or hole and smeared over it. The hole is filled in this way and filler/putty smoothened where application is uneven.

The scenario chosen for inhalation exposure is exposure to vapour: evaporation from an increasing area, because the evaporation is related to the surface area. The surface area is determined by summing each cover of a screw hole. This is estimated at 5 cm^2 per screw hole, assuming 40 screw holes; a total surface area of 200 cm^2 is provided. It is estimated that this DIY task will require 40 grams to fill the holes. Dermal exposure is expected to be small, because of the easy application method. However, spills may occur. As default, 5% of one hand will be exposed during application (equal to 22 cm^2). The amount of filler that comes into contact with the skin is estimated to be 50 mg (personal judgment).

Default for fillers/putty from tube.

	Default value	Q	Reference, comments
General			
Frequency	3 $year^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	20 min	2	See above
Product amount	40 g	1	See above
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	200 cm^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	22 cm^2	3	See above
Product amount	0.05 g	2	See above

5.4 Two-component filler

Use

Two-component fillers are used to repair decayed wood (wood decay fillers), stone, polyester, or steel (extra strong filler). These products are required to be very strong, water resistant and capable of stopping further decay (wood decay filler). The two components are mixed in a ratio of 1:1. The two-component filler consists of a resin and a siccative (2-4% volume percentage); otherwise the filler will not harden properly.

5.4.1 Scenario two-component filler

Repairing all spots in the decayed wood of a window frame is considered here. It is assumed that a total of 200 g filler is used to fill the holes and gaps after the decayed wood has been removed. This task can be conducted in every room. A non-specified room with a volume of 20 m^3 and ventilation rate of 0.6 h^{-1} , with parameters from General Fact Sheet [3] is considered. The use of two-component fillers is not expected to be frequent (twice a year is assumed).

Mixing and loading: two-component filler

For the default scenario of mixing and loading of two-components please refer to subsection 2.4.1. The two components can be put on the filling-knife and mixed according to product instructions. An equal amount of 100 g is taken from the two components. The two components are mixed (surface area 100 cm^2) with help of a tool (another filling-knife or spatula) until a homogenous colour is obtained. During the mixing and loading, inhalatory exposure may occur. The exposure to vapour*:* evaporation model is selected. The mixing and loading process is estimated to take five minutes. Dermal exposure is not expected to be high because of the use of tools and relative low product amount. The dermal load is therefore estimated to be 20 mg.

Default mixing and loading: two-component filler.

	Default value	Q	Reference, comments
General			
Frequency	2 year^{-1}	1	Estimate
Inhalation			
Exposure to vapour: evaporation constant release area			
Exposure duration	5 min	1	See above
Application duration	5 min	1	See above
Product amount	200 g	1	See above
Room volume	1 m^3	1	See subsection 2.4.1
Ventilation rate	0.6 h^{-1}	1	See subsection 2.4.1
Release area	100 cm^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	2 cm^2	3	See subsection 2.4.1
Product amount	20 mg	1	See above

Application

Before mixing the components together the decayed wood has to be removed and the surface cleaned properly. The mixed product is then applied with the filling-knife in to the hole until it is filled completely. The filler can be smoothened with the filling-knife. The application duration is not long. A period of 30 minutes is assumed to be needed to repair the wood. The exposure duration is set at 240 minutes by default. During that time inhalatory exposure may occur from the volatile components present such as benzyl alcohol. The model selected here is exposure to vapour: evaporation from constant area. The surface from which the chemicals can evaporate is estimated to be 50 cm^2 (5 x 10 cm^2). The surface area during application is lower than during mixing and loading, because the product is used to fill up holes. Hence, a part of the product is not spread out over a surface.

Dermal exposure can occur due to spills. The dermal exposure scenario is similar to the dermal exposure scenario for filler/putty from tubes. The dermal load is estimated at 0.2 g which is 0.1% (assumption) of the total product amount. The dermal contact area is assumed to be 22 cm^2.

Default for two-component filler.

	Default value	Q	Reference, comments
General			
Frequency	2 $year^{-1}$	1	Estimate
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	30 min	2	See above
Product amount	200 g	1	See above
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	50 cm^2	1	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	22 cm^2	3	See above
Product amount	0.2 g	2	See above

5.5 Putty from spray

Use

Putty from spray is generally used for very small scratches on wood and metal. The spray produces a superficial layer which fills even the smallest scratches. For this reason, the product can be used to finish a task using fillers from tubes or powders. The product is a common asset in automobile and paint shops. Generally, a thick layer is sprayed onto the surface. Special equipment is required to shave and polish the treated surface into form before a paint job. Therefore, this product is generally used by professionals. This scenario, however, is described for non-professional users.

5.5.1 Scenario putty from spray

The default scenario described for putty from spray is removal of the scratches on a metal surface before the surface is re-painted: in this case, restoring a kettle to its natural state. This kind of task is generally not conducted inside the house, but more often in a garage, so the parameters from the General Fact Sheet [3] for a garage are used. The volume of the room is 34 m^3 and the ventilation rate 1.5 h^{-1}. After completing the task the subject will leave the garage, making the total exposure duration half an hour.

The putty is not applied all at once, but three spraying efforts are assumed to be needed to cover the scratches completely. For this task it is assumed that 200 g is required to cover a surface area of 500 cm^2. A mass generation rate of 1.5 g/sec provides spray duration of 135 seconds (rounded off number; 3x spraying to cover the scratches provides a spraying duration of 45 seconds). The weight fraction of non-volatiles is estimated to be 30%, twice as high as for glue spray, because it is assumed that putty requires a higher percentage of solids. Dermal exposure can be estimated with the constant rate model. The exposed dermal area will be the surface of both hands (860 cm^2 according to the General Fact Sheet).

Default for putty spray.

	Default value	Q	Reference, comments
General			
Frequency	1 $year^{-1}$	1	Estimate
Inhalation			
Exposure, spray model			
Spray duration	135 sec	2	See above
Exposure duration	30 min	2	See above
Room volume	34 m^3	3	Garage [3]
Room height	2.5 m	4	Standard room height
Ventilation rate	1.5 h^{-1}	3	Garage [3]
Mass generation rate	1.5 g/sec	3	See subsection 2.3.3
Airborne fraction	1 g/g	3	See subsection 2.3.3
Weight fraction non-volatile	0.3	1	See above
Density non-volatile	1.3 g/cm^3	3	See subsection 2.3.2
Initial droplet distribution – median (C.V.)	40 µm (0.4)	3	See subsection 2.3.3
Inhalation cut-off diameter	15 µm	3	See subsection 2.3.3
Dermal			
Constant rate			
Surface area	860 cm^2	2	See above
Contact rate	100 mg/min	2	See subsection 2.3.4
Release duration	135 sec (45 sec * 3)	2	See above

6. Plasters and equalizers

Composition
Plaster (lime wash, calcium sulphate)
Filling agent based on polymer dispersion (calcium carbonate)
Cellulose derivates
Synthetic resins

General use
Plasters are used to smooth or apply structure on walls. This task is conducted for decorative purposes rather than repairing purposes. Equalizing a wall, on the other hand, is very difficult and generally will not be performed by consumers. Floor equalizers are mainly used to level large surfaces such as uneven floors. Although these tasks are mainly performed by professionals, there is a tendency that consumers will conduct these rather large tasks themselves.

In this chapter two scenarios will be described: (1) a floor equalizer which is used to fill small holes and smooth the floor, and (2) the use of plaster to structure the walls. Floor equalizers come primarily in the form of powders, which are to be suspended in water. The mixing ratio must be so that the product spreads easily over the surface. Plasters are available as pastes and are ready to use.

6.1 Floor equalizer

6.1.1 Scenario floor equalizer

In this default scenario the floor of a room in the house is equalized. To level the floor (slight unevenness and holes) only a small film of equalizer is needed to obtain a smooth surface. A surface area of 8 m^2 is obtained from the General Fact Sheet for a non-specified room. The specifications of the non-specified room are: 20 m^3 room volume and a ventilation rate of 0.6 h^{-1} [3]. The frequency of this task is low and set at once per two years. The floor equalizer is made from a powder which is suspended in water prior to use. When the powder is suspended in water to a runny liquid the product is poured over the surface and spread out with a squeegee. The time it takes the product to harden is approximately 30 minutes; however, repeated pouring will prohibit the equalizer hardening too soon. It is expected to take half an hour to equalize a floor and another 24 hours before the equalizer is completely hardened. The thickness of the equalizer applied may vary from 1 mm to 50 mm. The consumption rate of the product is 1.5 kg/m^2 per mm thickness. A surface area of 8 m^2 and an average layer thickness of 2 mm provide a product amount of 24 kg in total for the task. This means that one bag of 25 kg equalizer powder is required.

Mixing and loading: floor equalizer
Inhalatory exposure to the powder itself can occur during mixing and loading (refer to subsection 2.3.2 for this scenario). The product amount (25 kg) is not mixed all at once. Therefore the frequency of the mixing and loading process is three per task. Approximately 8 kg of powder is suspended in water per occasion. For inhalatory exposure to powder, no exposure model from ConsExpo could be assigned. Information concerning particle size distribution, airborne fraction and mass

generation is insufficient or lacking and thus another description of the exposure is preferred. Inhalation exposure to such large amounts was calculated by the rate of contact: 2.5 μg/min x exposure duration of 1.33 minutes yields an inhalation exposure of 3.0 μg. Dermal exposure can also occur during the mixing and loading process. Due to the large product amount a contact rate of 0.33 mg/min is used (see subsection 2.4.2).

Default mixing and loading: floor equalizer.

	Default value	Q	Reference, comments
General			
Frequency	3 day^{-1}	1	3 day^{-1} once every 2 years
Dermal			
Constant rate			
Surface area	430 cm^2	2	See subsection 2.4.2
Contact rate	0.33 mg/min	1	See subsection 2.4.2
Release duration	1.33 min	2	See subsection 2.4.2

Application

Due to the relatively large amount and the non-toxicity of the product, subjects will be more careless, which can result in a relatively high dermal load. The exposed area is both hands, according to General Fact Sheet [3] : 860 cm^2. The dermal exposure duration is set at half an hour (equal to the application duration; see above). Since application consists of pouring and spreading the floor equalizer, but does not require further treatment; the 'instant application' model is selected to describe the dermal exposure. The dermal load is estimated to be 2 g.

Default for the use of floor equalizer.

	Default value	Q	Reference, comments
General			
Frequency	0.5 $year^{-1}$	1	Estimate
Dermal			
Instant application			
Surface area	860 cm^2	2	See above
Product amount	2 g	1	See above
Exposure duration	30 min	1	See above

6.2 Wall plaster

6.2.1 Scenario wall plaster

Decorating an entire wall in the living room with plaster is considered here as default scenario. Decorating in this case means: applying structure and maybe colour to the wall. This scenario does not include the professional wall plasters which are to be applied with trowels and/or spack-knives. These products, made from powders, are often based on mortar or cement. The wall plasters considered here are applied with either brushes or rollers and are ready to use. The decorative wall plasters are based on lime wash and/or calcium sulphate.

The wall in the living room is 5 m by 2.5 m (height of room) which equals a surface area of 12.5 m^2. The specifications of the volume of a living room are 58 m^3 and

0.5 h^{-1} ventilation rate. It is assumed that only one wall will be treated per task. The frequency of this task is estimated to be once every five years.

The consumption rate is dependent on the layer thickness. The maximum layer thickness of the product is 5 mm. Here, a layer of 2 mm is assumed. This task requires an amount of 25 kg, assuming 12.5 kg per 1 mm layer thickness. The application duration is estimated at two hours (regarded as release duration for dermal exposure). The exposure duration is set at 120 minutes. There are no intervals, because the wall should be covered in one occasion.

Inhalation exposure was not expected to be based on the composition of the product. Dermal exposure can occur during this DIY task. Two transfer steps of the product, working against a wall and sometimes above one's head will lead more rapidly to dermal exposure, where both hands and forearms may be exposed. The dermal exposure may be even higher when a sponge is used to give structure to the surface. The dermal load is therefore considered to be high. To describe the dermal exposure the constant rate model is used. The contact rate is set at 50 mg/min. The exposed surface area is set at 1900 cm^2 as a default for the surface of both hands and forearms.

Default for the use of wall plaster.

	Default value	Q	Reference, comments
General			
Frequency	0.2 $year^{-1}$	2	Estimate
Dermal			
Constant rate			
Surface area	1900 cm^2	3	Hands and forearms
Contact rate	50 mg/min	1	See section 2.6
Release duration	120 min	1	See above

7. Coatings

General composition
General coating: alkyd urethane or acrylate copolymers
Gutter coating: liquid rubber/metal DD-polyurethane or mastic, xylene, preservatives

General use
Coatings are used to apply a protective layer to large surfaces: for instance, walls, roof tops, gutters, pavements, wood and so on. These products are meant to protect materials against weather influences, filth and in some cases oily liquids and moss. There are specific coatings that protect against fungi (e.g. wood decay stopper). Coatings can be categorized according to their use: covering a large surface such as walls, floors, and roofs (general coatings), repairing rooftops and gutters, and impregnating walls or wood. Impregnating walls or wood is not considered here because its use is rather complicated and done by professionals only.

7.1 General coatings

Use
General coatings are used mainly to protect walls or floors made of wood or stone surfaces against oily liquids, fungi, and moss or weed. Examples of general coatings are primers, wood decay stopper and surface coatings. The coatings are contained in cans or buckets and available in liquids and powders. When applying coatings indoors on walls and floors it is important to ventilate well according to safety directions. Vapours from coatings can be toxic and flammable. For the use of some coatings in closed spaces, it is advised to wear an air mask to protect the operator. Furthermore the product information describes that multiple layers should be applied and that individual layers should be thick in order to function properly. The coatings are generally used outside or in sheds and garages. However, the use of coatings indoors is of interest and will be described in this chapter. The frequency of use is not considered to be high, as default the frequency is set at once per three years.

7.1.1 Scenario general coating on a floor
The coatings are applied with a large brush or roller. In general the application of these coatings is very similar to painting. The chemical characteristics of general coating are somewhat identical to stains which are described in the previous version of Paint Products Fact Sheet [32]. The application of coatings on walls and/or objects is similar to painting objects with stain. However, the application of coatings on floors is different. In this case the coating is poured over the surface and spread out with a brush. The coating is then allowed to soak into the surface. Obviously the coating cannot be applied on non-absorbing surfaces, because it cannot soak into a non-absorbing surface. Therefore only the application of general coatings on horizontal surfaces is described. For the other applications please refer to Paint Products Fact Sheet [32], concerning solvent-rich paint.

The coating of a floor in a garage is considered as a default scenario. Coatings are often applied in garages since individuals often work with oily liquids or vehicles are stationed there. To keep the floor clean from oil and grease coatings are considered suitable. The defaults for a garage are listed in General Fact Sheet [3]: 34 m^3 room volume and a surface area of 15 m^2. The ventilation rate in a garage is relatively high in comparison to rooms inside the house: 1.5 h^{-1}. The consumption rate of the coating is according to product information 0.15 litre per square metre. In total 2.5 litres (3 kg using 1.2 g/cm^3 [32]) of coating is required for one layer. After approximately one hour the coating will be dry. It will take another 48 hours before the surface can be accessed, and yet another 48 hours before a vehicle can be put in the garage. The task itself will not take long. The application duration is assumed to be one hour, with total exposure duration of one hour too, because the user will not stay in the garage afterwards.

The dermal load is not expected to be high and exists solely from spills. A dermal load of 250 mg was estimated. The contact area is approximately 50% of one hand palm. From General Fact Sheet the surface area for the two hands comes to 860 cm^2. One hand palm is one-fourth of the surface area of both hands, resulting in a contact area of 108 cm^2.

Default for the use of general coating on a floor.

	Default value	Q	Reference, comments
General			
Frequency	0.33 $year^{-1}$	2	See above
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	60 min	2	See above
Application duration	60 min	2	See above
Product amount	3 kg	1	See above
Room volume	34 m^3	3	Garage [3]
Ventilation rate	1.5 h^{-1}	3	Garage [3]
Release area	15 m^2	3	Garage [3]
Temperature	15 °C	2	Estimate
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	108 cm^2	2	See above
Product amount	0.25 g	1	See above

7.2 Gutter coating

Use

Coatings used to protect and repair gutters, rooftops and walls are described in a different scenario, because their application is different from the general coatings. Rubber and metal based coatings are used mainly for protecting gutters (and roofs), making them weather and corrosive resistant. For roof top protection mainly acrylate based coating or metal based coating is used. Gutter coatings can contain volatile organic compounds such as xylene.

These products are used only outdoors. ConsExpo does not provide a model which describes inhalation exposure to consumer products used outdoors. Weather conditions, highly variable and affecting ventilation rate and temperature, and an infinitely large 'room' volume prevent any sensible estimate of outdoor exposure using ConsExpo. Therefore, no defaults are proposed for inhalation exposure. Currently available models can be used to assess the inhalation exposure to gutter coating indoors. The single conclusion of this exposure assessment is then that outdoor inhalation exposure will be lower than assessed for indoor use of the product. The evaporation model can be used where room volume and ventilation rate are set at 20 m^3 and 0.6 h^{-1}, respectively (non-specified room) in combination with task specification mentioned below (see subsection 7.2.1).

Since dermal exposure can occur, a scenario has been drawn up for this specific application. The frequency of use is once per 10 or 15 years (EU RAR on MDI 2003) [27]. This estimation is considered representative for liquid roof coatings. As a default a frequency of once per 10 years is assumed.

7.2.1 Scenario gutter coating

This task is performed outdoors. Here the repair of gutters is described. A thick layer of paste is spread out over a crack or hole with a filling-knife (pre-treated with white spirit). A glass cloth is then put over the applied layer before another thick layer is put on the gutter. Subsequently the layers and glass cloth are allowed to harden, a process which normally takes 24 hours. A number of holes and weak spots are repaired on a single occasion. Because application requires multiple layers the product consumption is relatively high per square metre (0.5 l/m^2 per layer). The holes mount up to a surface area of 0.5 m^2 which can be treated with 0.75 l gutter coating (= approximately 1 kg). The task is expected to take half a working day due to the application of the three layers. The exposure duration is assumed to be the same, because afterwards individuals are not expected to linger.

Gloves may be worn during this task because the product is very sticky and considered unpleasant to work with. Product information does not mention the use of gloves and warns solely for vapours from the product. Here, it is assumed that fingers on both hands will be exposed when the glass cloth is put in place. The surface area is set at half the area covered by the two hands (430 cm^2). The dermal load is estimated to be 250 mg due to the fact that the product will stick to one's hand. The dermal load is not related to the amount product used. The dermal exposure duration is assumed to be the same as the application duration, hence the exposure duration is 240 minutes. Furthermore, gutter coating is hard to remove; therefore individuals will take precautionary actions, explaining the relatively low dermal load.

Default for gutter coating.

	Default value	Q	Reference, comments
General			
Frequency	0.1 $year^{-1}$	2	See above
Dermal			
Instant application			
Surface area	430 cm^2	3	See above
Product amount	0.25 g	2	See above
Exposure duration	240 min	1	See above

8. Removers

Composition
Glue remover: Methylene chloride (70–90 %), methanol (max 10%), Propane / butane mixture (10–30%, used in spray form) or N-methyl-2-pyrrolidon, Carbon hydrates or Dibasic esters
(Product information)

Wall paper remover: non-ionogeneous active surfactants (15–30%) (Product information)

Sealant remover: citrus terpenes (unsaturated hydrocarbons) (Product information)

Paint remover: Methylene chloride (DCM) or dibasic esters or other removers which do not contain DCM or other solvents. Product information lacks the ingredients

General use
Removers are used to remove old layers or remnants of paint, glue, carpet glue, wall paper, cement, sealants, and foam. Removing tasks are generally carried out before another DIY task is conducted or directly afterwards when spills have to be removed. There are products specially designed for removing paint, carpet glue, wall paper, cement, sealant or foam. In addition, there are general solvents such as white spirit, acetone and thinners which not only dissolve paint, glue, sealants and foam, they are also used to clean tools and thin paints (for which scenarios are described in the Paint Fact Sheet [32]).

In this chapter, four scenarios with defaults will be provided for removers. These are paint remover, glue remover, wall paper remover and sealant/foam remover. Cement remover is used like glue remover to remove spills or remaining spots. The removal of wall paper is regarded to be specific and is therefore also described. Further, the removal of sealant is identical to the removal of insulation foam and is for this reason described under one default scenario.

Removers are applied directly onto the layer which is to be removed, such as graffiti or pieces of foam. In case of some wall papers it is necessary to perforate the wall paper in order to allow the remover to function properly. The product soaks into the layer for a minimum of 15 min (initiation period), and then the resulting pulp is removed. These products are used simultaneously during other DIY tasks such as painting, carpet gluing, sealing, and insulating with foam, whether it is used to remove old remains or to remove spills. The frequencies used for the mentioned tasks are therefore also used for removal tasks.

8.1 Paint remover

8.1.1 Scenario paint remover
The removal of paint from a door is described here. The surface area is approximately 2 m^2 (one side of the door) for which 1 l is required (= 1 kg). The remover is applied and left to soak for 15 minutes; afterwards the resulted pulp is removed with a

scratching tool. In total the application duration is set at one hour. After-use activity is considered negligible compared to the application duration. Hence, the exposure duration is set at one hour. The specifications of a non-specified room are taken into consideration here: 20 m^3 room volume and 0.6 h^{-1} ventilation rate. This task is assumed to be performed once a year.

During the task inhalatory exposure from vapours of methylene chloride or other solvents (methanol) can occur. Dermal exposure occurs during application and removal of the paint. Pulp is removed from the door with the scratching tool. During this removal contact with the pulp can occur. It is assumed that both hand palms will come into contact (430 cm^2). The dermal load from pulps and remnants are estimated to be 0.5 g. Because the product is allowed to soak for 15 minutes, a lot is already evaporated. The pulp will therefore not contain large amounts of the product.

Default for paint remover.

	Default value	Q	Reference, comments
General			
Frequency	1 $year^{-1}$	1	See above
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	60 min	2	See above
Application duration	60 min	2	See above
Product amount	1 kg	2	See above
Room volume	20 m^3	3	[3]
Ventilation rate	0.6 h^{-1}	3	[3]
Release area	2 m^2	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	430 cm^2	3	See above
Product amount	0.5 g	1	See above

8.2 Glue remover

8.2.1 Scenario glue remover

In general, all glue removers function in the same manner. The remover is allowed to soak in for a minimum of 15 minutes before the glue can be removed with a scratching tool. Glue removers can be used for many removing tasks ranging from very small (removing super glue) to very large tasks (removing carpet glue). The product is therefore available in containers ranging in size from 10 ml bottles to 750 ml cans.

The removal of carpet glue will be considered as a default scenario, because the main difference in use between the small and large containers is the product amount used and the surface treated. When the product amount and surface treated are taken into account the same defaults can be used for different containers of glue remover.

For the default scenario of glue remover, it is assumed that the stairs are stripped of their carpet and carpet glue. The surface of the stairs is approximately 5 m^2. Using the product information (0.35 l/m^2) provides a product amount of about 2 kg. The stairway is in most cases connected to hallways providing a large 'room volume'. Furthermore, the ventilation is assumed relatively high. The 'room volume' is estimated at 30 m^3 and the ventilation rate is assumed to be 1.5 h^{-1}.

The exposure and application durations are each four hours. The application duration is based on the pouring and spreading of the remover, the activation time, and the time needed to scratch off the old glue. The latter will consume a lot of time. The total exposure duration is set at four hours, because after the task the subject will not stay in the same 'room'.

The glue remover is applied with brush on the stairs. Amount of spills will therefore not be that high. During the removal of the glue (scratching off glue) dermal exposure may be significant, requiring application of the constant rate model. The dermal release duration is set at 240 minutes with a quality factor of 1. The contact rate is 30 mg/min by default (see section 2.6). Surface area which comes into contact is assumed to be the fingers of both hands (equal to 230 cm^2).

Default for glue remover.

	Default value	Q	Reference, comments
General			
Frequency	1/4 $year^{-1}$	2	See above
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	240 min	2	See above
Application duration	240 min	2	See above
Product amount	2 kg	2	Product information, see above
Room volume	30 m^3	2	Estimate, see above
Ventilation rate	1.5 h^{-1}	2	Estimate, see above
Release area	5 m^2	2	Estimate
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Constant rate			
Surface area	230 cm^2	3	See above
Contact rate	30 mg/min	1	See section 2.6
Release duration	240 min	1	See above

8.3 Wall paper remover

8.3.1 Scenario wall paper remover

Removing wall paper can be conducted with wall paper remover; simply ripping the wall paper is not possible. The product is used by suspending 250 ml wall paper remover in 5 l lukewarm water. The resulting wall paper remover solution is sufficient for 75 m^2. The dissolved wall paper remover is then applied with brush or sponge on to the wall paper. For water resistant wall papers perforation of the wall paper is required to allow the solution to function. It is assumed that this will not result in additional exposure. The same scenario settings are considered for the removal of wall paper as for wall paper glue (see section 3.8). Hence, a release area of 40 m^2 (the surface area of the walls in a living room) will be taken into account.

Mixing and loading: wall paper remover
This mixing and loading process is different from other DIY products, because it involves the mixing of two liquids. The mixing and loading of two liquids is already described in the Cleaning Products Fact Sheet [21], where both inhalatory and dermal exposure is described. However, mixing and loading wall paper remover does not result in inhalatory exposure, because wall paper remover does not contain volatile organic compounds or other volatiles. Therefore exposure from the mixing and loading process results from contact with the skin only. It is emphasized here that the dermal exposure results from liquid spills around the opening of the bottle and spatters of the product. The 'instant application' model used here describes exposure assuming that all compounds in the product are directly applied to the skin.

As a default for 40 m^2 the total product amount is set at 3 litres of suspension (150 ml wall paper remover in 3 l lukewarm water, equal to approximately 3 kg; dilution factor = 20). The time needed to make the suspension is approximately five minutes. For dermal exposure of pesticides used by amateurs, the UK POEM model [33] describes the pouring of fluid from container into a receiving vessel. The 75th percentiles for dermal exposure during mixing and loading are given for 1 litre and 2 litre containers i.e. 0.01 ml (undiluted product) per operation. A default for mixing and loading of wall paper remover of 0.01 ml per operation (=10 mg/operation) will be used.

Default mixing and loading: wall paper remover.

	Default value	Q	Reference, comments
General			
Frequency	0.5 $year^{-1}$	1	See above
Dermal			
Instant application			
Product amount on skin	10 mg/operation	3	Undiluted product, see above
Surface area	2 cm^2	2	Small product amount, See subsection 2.4.1

Application
Removing wall paper glue is expected to occur at the same frequency of gluing wall paper, because it is often used prior to renewal of wall paper. Wall paper removal in the living room is taken into consideration. The product is applied with a sponge and rubbed on to the surface. After the suspension has soaked in wall paper is removed with a filling-knife or other tool. The application duration is set at 2 hours. The total exposure duration is set at 4 hours due to after-use cleaning-up.
The exposure via inhalation is considered negligible during application, because the product does not contain volatile compounds. Dermal exposure is expected to be high, especially when the suspension of wall paper remover is applied with a sponge.

During application and removal contact to the skin takes place. The aqueous liquid easily runs down the hands and forearms. The dermal exposure area is therefore set at 1900 cm^2, which equals the surface area of both hands and forearms [3]. Furthermore, ripping wall paper off with hands will lead to an even higher dermal load. It is assumed that suspension spilled or run off from the sponge during use forms a layer on the skin of 1 mm. The volume on the skin is then 19 cm^3, which equals a product amount of 19 g (product density is assumed to be 1.0 g/cm^3).

Default for wall paper remover.

	Default value	Q	Reference, comments
General			
frequency	0.5 $year^{-1}$	1	See above
Dermal			
Instant application			
Surface area	1900 cm^2	3	See above
Weight $fraction_{dilution}$	0.2 * W_f	3	Dilution factor = 20
Product $amount_{dilution}$	19 g	1	Skin layer 1 mm, see above

8.4 Sealant / foam remover

8.4.1 Scenario sealant / foam remover

Presented below is the default scenario for removing old sealant, which is comparable in use with the removal of hardened insulation foam. Product information on both products warns for inhalation exposure to vapours. Starting point is the DIY task to replace the old sealant with new sealant as partly described in Chapter 4, where a scenario was set up for the use of sealants in a bathroom (see section 4.1). Before that task can be conducted the old sealant has to be removed with sealant remover, as described here. The frequency of the task is assumed to be five times per year.

Before applying the sealant remover the sealant has to be mechanically removed so that most of the sealant has been removed prior to application of the product. Remnants of the sealant then have to be removed with the chemical remover. Contained in a small bottle or tube of 100 ml, the gel-like substance is applied with a small brush. It takes approximately 15 minutes before the remover has soaked in the remnants, which can then be removed with a filling-knife. The application is considered to take two hours. Altogether, a joint of 5 m x 5 mm is treated (250 cm^2) in 30 minutes. From experience this is not an easy job and may take up to two hours. The exposure duration is set at three hours, because it is expected that there is a cleaning-up phase after which persons are expected to leave the room. No information is available on the rate of use of the product; therefore an estimated use of 100 ml (assuming a product density of 1.0 g/cm^3 provides 100 g) sealant remover performs the task.

After the pulp is removed with a filling-knife, subjects are assumed to remove the pulp from the filling-knife with their hands. Another imaginable scenario for dermal exposure to sealant remover is picking up pieces which have just been removed. In both situations the fingertips of one hand will be exposed (5 cm^2). The exposure is estimated to be 0.1% of the total amount used: 0.1 g.

Default for the use of sealant remover.

	Default value	Q	Reference, comments
General			
Frequency	5 $year^{-1}$	2	Assumption
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	180 min	2	See above
Application duration	120 min	2	See above
Product amount	100 g	1	See above
Room volume	10 m^3	3	Bathroom [3]
Ventilation rate	2 h^{-1}	3	Bathroom [3]
Release area	250 cm^2	3	From 5 m x 5 mm joint
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	5 cm^2	3	See above
Product amount	0.1 g	1	See above

9. Miscellaneous

9.1 Insulation foams

Composition
1-component or 2-component polyurethane (PU) foam
Propellant
Methylenediphenyl diisocyanate (MDI) 10%
Polyol
(source: product information)

Insulation foams for consumers are only available in pressurized spray cans. Information about the composition of PU foam is described in the excerpt below from the draft report EU RAR on MDI [27].

'In general the formulation to produce a rigid PU foam would consist of 1) A polyol of low molecular weight 2) A catalyst to control the reaction rate 3) A silicone oil to control cell structure and stabilization 4) A fire retardant to impart fire resistance to the foam 5) A blowing agent to expand the reacting mass to form a foam 6) MDI to form PU in reaction with the polyol. The ingredients 1 to 5 may be preblended or blended in line before the addition of the MDI. Rigid PU foam has a uniform closed cell structure. The formulation for flexible PU foam would be similar to the above however, it would employ a high molecular weight polyol and a chemical known as a cell opener would be used in place of the silicone oil'.

One-component PU foams react with moisture in order to harden. Two-component PU foams have two components already inside the spray can which are mixed in the spray nozzle in a 1:1 ratio. Detailed information on which two components are mixed is not known as product information does not provide information on the exact composition.

Use
Insulation foams can be used for many purposes, including filling, insulation, attaching, and assembling, although the latter two do not reflect insulation's main functions. These insulation foams attach easily to all kinds of surfaces. The insulation foam is supplied in pressurized cans and is applied through a pre-expansion tube. The product (held upside down) is released from the nozzle as viscous foam, rather than a sprayed aerosol. Because the foam will expand over ten times it original volume, it is recommended that a gap or hole is not filled completely. After application, the spray is held horizontally and sprayed to drive out the remnants of foam. Otherwise the foam will harden inside the spray can. After spraying the foam hardens (speed of hardening differs between insulation foams) which then can be treated (the foam can be sawed, cut, and painted). The containers available for consumers range in size from 300–750 ml.

Because no aerosols are formed, the spray model was not considered relevant for this application. Evaporation of the propellants and solvents takes place from the nozzle of the spray and the foam itself. The active compounds polyurethane and MDI are not likely to evaporate due to their low vapour pressure; inhalation exposure from the active compounds was therefore considered negligible. To describe the inhalatory exposure from propellants and solvents, the ‘exposure to vapour: instantaneous release’ model was selected as being the most suitable model. Dermal exposure can occur during application, as foam spatters may fall on the skin during spraying.

9.1.1 Scenario insulation foam

Insulation foams are often used to fill gaps to overcome the problem of draught. A standard DIY task concerning insulation foam is the insulation of the attic to avoid heat loss and prevent draught. In the General Fact Sheet a surface area for the attic is provided: 23 m^2. Taking 2.5 m for the height of the attic provides 57.5 m^3. The ventilation is relative high and set at 1.5 h^{-1}.

For this task it is expected that an entire spray can is used to insulate the attic. Once the insulation is applied it stays for a long period of time. The frequency of use is therefore low and set at once per five years. The product amount is 750 ml which equals to 825 g when 1.10 g/cm^3 is considered as product density (product information). One spray can provide up to 40 l of foam, which is considered sufficient to insulate the attic. To complete the task it will take approximately 30 minutes. No after-use activity is expected and thus the exposure duration is also 30 minutes.

It was assumed by Lansink ((1998) from EU RAR on MDI) that both hands and part of the forearms can be exposed, corresponding to an exposed area of 1900 cm^2 [3], due to bouncing spatters. The amount which spatters on the skin is thought to be minimal. By estimation the amount will be 250 mg.

Default exposure scenario insulation foam – active agents (PU/MDI) and solvents.

	Default value	Q	Reference, comments
General			
Frequency	0.2 $year^{-1}$	1	See above
Inhalation			
Exposure to vapour: instant release			
Exposure duration	30 min	1	See above
Application duration	30 min	1	See above
Total product amount	825 g	2	Content can; see above
Room volume	57.5 m^3	2	See above
Ventilation rate	1.5 h^{-1}	1	Estimate
Dermal			
Instant application			
Surface area	1900 cm^2	2	Both hands and forearms
Product amount	0.25 g	1	See above

9.2 Joint colour

Composition

Dispersion based paint is thought to be a major component of joint colour. Other constituents may be present, but at the moment none are known to us.

Use

Joint colour is used to colour the joints between ceramic tiles on floors and walls. Joints can take up filth, fungus, and/or moisture that will have an effect on the colour of the joint. Joint colour works as follows: joints should be cleaned properly and dried before the product is applied. Joint colour can be applied with a small brush; afterwards the product is allowed to soak into the joints. After the joints have dried completely, the tiles and joints are moisturized with water and allowed to soak shortly. The walls are then cleaned again with a sponge to finish the task (according to product information).

9.2.1 Scenario joint colour

The task of cleaning and colouring joints can be performed wherever walls or floors are covered with tiles. Most likely the joints used in bathrooms and kitchen are exposed to moist, fungus and/or filth.

The colouring of joints in a bathroom is considered for the present scenario. Defaults for a bathroom: room volume of 10 m^3 with a ventilation rate of 2 h^{-1} [3]. The surface to be treated is 4 m^2 (shower cabinet, walls) in total. Although in principle only the joint will be treated, the joint grid is regarded equal to the treated surface (surface area of tiles is considered instead of the joints). The application with the brush is precise, but time consuming. It is estimated that it will take 45 minutes to treat the grid of joints. Afterwards the subject will leave the bathroom, because the joint colour has to soak in for one hour. Afterwards, when the joint colour is properly absorbed, the surface (tiles included) is cleaned and washed with a sponge, thereby removing surplus joint colour. In total the application is assumed to take two hours. The exposure duration is the same, because a subject will not stay in the bathroom.
Per litre product, 40-60 m^2 can be treated. A reasonable worst case considered for this product amount is 100 ml (= 100 g) for 4 m^2.

Inhalatory exposure can be caused by dispersion based paint. Whether this kind of paint contains volatile components is unknown, for this reason a default scenario for inhalatory exposure was set up. Dermal exposure can occur during application of joint colour and cleaning of the tiles. Because a sponge is used, the dermal exposure can be substantial. The surface area is set at both forearms and hands (= 1900 cm^2), because water can run down one’s arm. The dermal load is estimated to be 0.5% of the product amount and mounts up to 0.5 g.

Default for the use of joint colour.

	Default value	Q	Reference, comments
General			
Frequency	1 $year^{-1}$	2	assumption
Inhalation			
Exposure to vapour: evaporation from increasing area			
Exposure duration	120 min	2	See above
Application duration	120 min	2	See above
Product amount	100 g	1	See above
Room volume	10 m^3	3	Bathroom [3]
Ventilation rate	2 h^{-1}	3	Bathroom [3]
Release area	4 m^2	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir		See section 2.7
Mol. Weight Matrix	3000 g/mol	3	See section 3.1
Dermal			
Instant application			
Surface area	1900 cm^2	3	See above
Product amount	0.5 g	1	See above

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Appendix: pilot experiments

A.1 Powder experiment

Exposure to powders during the mixing and loading process can be described with the spray model. An important parameter in this model is the particle size distribution, because it determines in part the amount that actually can be inhaled by the user. As a cut-off point, particles larger than 15 µm are assumed not to lead to inhalatory exposure.

The particle size distributions of most DIY products are not known. For this reason, a small observational experiment was set up to provide an indication of the distribution. Some information on the particle size distribution is available for both Portland cement [16] and lime [13]. The following products were included in this experiment: tile glue, wall paper glue, filler, washing powder, cement, and lime. In the experiment the powders were observed and compared to each other on a piece of paper and while dispersed into the air. The observations provided insight into the dispersion and size of the powders compared to the reference materials. The results of this experiment are described below and summarized in Table A.1.

Portland cement: This reference material contains the finest particles of the powders. The dispersion of the cement is wide and forms a cloud. The cloud can be seen floating in the air for a relatively long period (over 1 minute). Data derived by Ferraris showed that the particle size distribution of Portland cement has a lognormal distribution rather than a normal distribution.
A median of 14 µm with a coefficient of variation of 0.5 was established.

Lime: The second reference material, lime, also contained very fine particles, but seemed to contain larger particles than Portland cement. However, lime also forms a wide dispersion cloud when dispersed into the air. When the powders were simply dropped from a certain height (eye level), lime dropped faster than Portland cement indicating that larger particles are present.

Data on the particle size distribution of lime originate from dusting powders discussed in Pest Control Products Fact sheet [13]. It is assumed that dusting powders and agricultural lime have a somewhat similar particle size distribution, because both are based on caulk. For lime marl, the legal requirement is that 99 % of the lime particles are smaller than 1000 µm and 90 % are smaller than 150 µm. It is assumed that most of the particles will have a diameter between 50 and 150 µm.
In the TNsG under 'Consumer product spraying and dusting' a model is described in which the consumer uses a hand-held dusting applicator pack for crack and crevice powders against fleas and ants. The products were found to be particles of inert filler such as fine talc or chalk (median, 45% of dust less than 75 µm).

On the basis of these data, the default value for the initial partial distribution was determined to be a lognormal distribution with a median of 75 µm and a coefficient of variation (C.V.) of 0.6.

General filler: The filler consists of very fine material. In comparison to the reference materials it was observed that the filler is finer than lime, but less fine than Portland cement. Again, a wide dispersion cloud was formed after blowing the product from a piece of paper and the cloud remained suspended in the air for a while.

No data are available on the particle size distribution of general filler. As a worst case, the distribution of Portland cement was assumed for general filler: median of 14 μm (C.V. of 0.5).

Tile glue: The powder was clearly coarser than Portland cement, lime, and filler. It appeared that the tile glue contained small sand grains. When the powder was blown from the paper some of the sand grains remained on the paper while a dust cloud was formed by the smaller particles. In that respect there was no difference between the powders except for the washing powder and wall paper glue.

Neither are data available for tile glue. Therefore as a worst case, the particle distribution of lime was assumed: median of 75 μm (C.V. of 0.6).

Washing powder: Washing powder did not contain many fine particles. Cloud formation was almost not visible and disappeared immediately. When dropped from eye level, a conic dispersion and relatively high falling speed were observed. This indicates that washing powder contains larger particles than the previously discussed powders. In the Cleaning Products Fact Sheet, the exposure to washing powder is described as the amount of dust that can be formed and consequently inhaled. Van de Plassche[19] observed that 0.27 μg dust was formed from 200 g washing powder. As a worst case scenario, it is assumed that all formed dust can be inhaled by the user.

Wall paper glue: Wall paper glue powder showed similarities with washing powder when placed on a piece of paper. The particles are coarser then the other powders used in DIY products. In contrast to washing powder, however, the product does disperse into the air when dropped from eye level, which indicates that the particles are finer. However, it was concluded that the spray model should not be used for wall paper glue, as wall paper glue powder is too different from other powders to obtain a realistic particle size distribution. Assigning the particle size distribution of lime would not provide a realistic worst case scenario.

Since wall paper glue is comparable to washing powder, the amount of dust formed from wall paper glue during mixing and loading was assumed to be the same as that of washing powder.

Table A.1: Results of elementary experiments concerning the particle size distributions of powders used in DIY products.

Powder	PSD[a] (median (C.V.)	Remark	Q-factor
Portland cement	14 µm (0.5)	Very fine particles, very wide dispersion. PSD from Ferraris et al. [16]	2
Lime	75 µm (0.6)	Very fine particles with some larger particles. Dispersion wide. PSD from Pest Control Products Fact sheet[13]	2
General filler	14 µm (0.5)	Very fine particles, less fine than Portland cement, finer than lime. PSD from Portland cement adopted	1
Tile glue	75 µm (0.6)	Very fine particles, but less fine than Lime. PSD from Lime adopted.	1
Washing powder	-	No PSD known for washing powder. From 200 g of product, 0.27 µg dust is formed [17] (Q = 1). Particles fine, but no clear dispersion.	-
Wall paper glue	-	Particles are finer than particles of washing powder, but no clear dispersion. No PSD was determined.	-

[a] PSD: Particle size distribution; C.V.: coefficient of variation.
- No PSD was determined or no quality factor was assigned.

A.2 Glue experiment

To obtain an indication of the magnitude of the dermal load from glue spills, a small experiment was performed. In this experiment hobby/universal glue (from a bottle) was simply applied to a piece of paper or directly onto the skin.

We first determined the mass of one drop of glue. The bottle was weighed before and after a drop was placed on a fingertip. This procedure was conducted twice providing two measurements close to 50 mg. Therefore, the weight of one drop of glue was established to be 50 mg.
We then determined the dermal load. A piece of paper was covered with glue spread out with one finger. The glue bottle and paper were weighed separately before the glue was applied. After the glue was applied and spread out, the bottle and paper were weighed again. Simple calculations provided the amount of glue which remained on the fingertips. Again, this procedure was performed twice. The dermal loads calculated were 0.03 g and 0.09 g. Averaging these figures gave a dermal load of 0.06 grams.

These observations provide an idea of the amount of glue when small amounts of glue are spilled. However, during large tasks requiring large amounts it can be expected that the product amount which comes into contact with the skin is also larger. This raised the question: How much glue can fully cover one hand palm? To answer this question glue was applied and spread out over one hand palm. The difference in weight of the bottle before and after application provided the amount of glue applied. Again, this was conducted twice and resulted in 0.96 g and 0.52 g of glue. From these results it can be assumed that the dermal load from glue on one hand palm during a

DIY task is 1 g, maximum. A subject will most definitely clean or wipe his/her hands when covered with this amount of glue before continuing the DIY task.